SKA1 PROJECT EXECUTION PLAN

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DOCUMENT HISTORY

Revision	Date Of Issue	Engineering Change Number	Comments
A	2018-04-05		Initial draft of SKA1 Project Execution Plan

B	2019-04-05		Updates to Organization; addition of science requirements, etc
C	2019-05-04		Updates to Organisation, summary sections

DOCUMENT SOFTWARE

	Package	Version	Filename
Word processor	MSWord for Mac	16.11.1	SKA-TEL-SKO-0001100-01 SKA1 Project Execution Plan
Block diagrams			
Other			

ORGANISATION DETAILS

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AD	Applicable Document
AN	Another
HSE	Health, Safety and Environmental
PM	Project Manager
RD	Reference Document
SKA	Square Kilometre Array
SEAC	Science Engineering Advisory Committee
SKAO	Square Kilometre Array Organisation

Preface

The purpose of this document is to provide an overview of the SKA1 Project Execution Plan, a succinct description of the realization of the Project Management Plan and the processes by which we will deliver the project scope within budget and schedule.

The Project Execution Plan refers to:

- This parent document (SKA-TEL-SKO-0001100) which provides a broad summary of the Plan but mainly refers to other documents for detailed information.
- The confederation of documents that together realise the overall execution plan for the SKA1 construction.

The Project Execution Plan is a resource whose intended audience is the Project staff who will execute the plan; as such, it must provide sufficient detail to inform that execution and to ensure alignment across areas to achieve the SKA1 mission.

The core documentation representation of this is:

- Core Documents [4 Documents]
    - SKA-TEL-SKO-0000007 Science Requirements (Level 0)
    - SKA-TEL-SKO-0000307 SKA1 Operational Concept Document (Level 0)
    - SKA-TEL-SKO-0000008 System Requirements (Level 1)
    - SKA-TEL-SKO-0000038 System Baseline Design
- Project Execution Plan Composition [8 Documents]
    - SKA-TEL-SKO-0001100 SKA1 Project Execution Plan
        - SKA-TEL-SKO-0001101 SKA1 WBS Dictionary
        - SKA-TEL-SKO-0001102 SKA1 Project Management Baseline Cost Book
        - SKA-TEL-SKO-0001103 SKA1 Integrated Project Schedule
    - SKA-TEL-SKO-0001200 SKA1 Project Management Controls System
    - SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan
    - SKA-TEL-SKO-0001400 SKA1 Financial and Business Systems

The Project Execution Plan structure is a framework for the core content of the project scope and processes. We note that it maps to other frameworks as shown in Table 1.

	ISO 21500	PMBOK	PEP
Subject Area	**Process**	**Process**	**Process**
Integration	4.3.2 Develop Project Charter	4.1 Develop Project Charter	1.1 Scientific Objectives. 1.2 Scientific Requirements. 1.3 Facility Infrastructure. 1.4 Scientific & Broader Societal Impacts
	4.3.3 Develop Project Plans	4.2 Develop Project Management Plan 5.1 Plan Scope Management 6.1 Plan Schedule Management 7.1 Plan Cost Management 9.1 Plan Human Resource Management 11.1 Plan Risk Management Plan 12.2 Stakeholder Management	4.4 Scope Management Plan and Scope Contingency 4.9 Baseline Schedule Estimating Plan and Integrated Schedule 4.5 Cost Estimating Plan, Cost Reports, and Baseline Budget. 6.1 Risk Management Plan 2.2 External Organization and Communication
	4.3.4 Direct Project Work	4.3 Direct and Manage Project Work	10.1 Project Management Control Plan
	4.3.5 Control Project Work	4.4 Monitor and Control Project Work	10.1 Project Management Control Plan
	4.3.6 Control changes	4.5 Perform Integrated Change Control	10.1 Project Management Control Plan. 8.1 Configuration Control Plan. 8.3 Document Control Plan
	4.3.7 Close project phase or project	4.6 Close Project or Project Phase	16.1 Project Close out
	4.3.8 Collect lessons learned		Mission Assurance
			10.2 Earned Value Management System
Stakeholders	4.3.9 Identify Stakeholders	13.1 Identify Stakeholders	2.2 External Organization and Communication 2.3 Partnerships 2.5 Community Relations and Outreach
	4.3.10 Manage Stakeholders	13.3 Manage Stakeholder Engagement 13.4 Control Stakeholder Engagement	2.2 External Organization and Communication
Scope	4.3.11 Define scope	5.2 Collect Requirements. 5.3 Define Sscope	4.1 Summary of Total Project Definition
	4.3.12 Create WBS	5.4 Create WBS	4.2 Work Breakdown Structure (WBS)
			4.3 WBS Dictionary
	4.3.13 Define Activities	6.2 Define Activities	
	4.3.14 Control scope	5.5 Validate Scope 5.6 Control scope	8.2 Change Control Plan. 10.1 Project Management Control Plan
			11. Site and Environment. 12. Cyber Infrastructure 13. Environmental, Safety and Health
Resources	4.3.15 Establish project team	9.2 Acquire project team	5.2 Hiring and Staff transition plan
	4.3.16 Estimate resources	6.4 Estimate Activity Resources	5.1 Staffing plan
	4.3.17 Define project organization	9.1 Plan Human Resource Management	2.1 Internal Governance & Organization. 2.4 Roles and Responsibilities
	4.3.18 Develop project team	9.3 Develop project team	5.2 Hiring and Staff transition plan
	4.3.19 Central resources	-	-
	4.3.20 Manage project team	9.4 Manage project team	10.1 Project Management Control Plan
Time	4.3.21 Sequence activities	6.3 Sequence Activities	4.9 Baseline Schedule Estimating Plan and Integrated Schedule
	4.3.22 Estimate activity durations	6.5 Estimate Activity Durations	4.9 Baseline Schedule Estimating Plan and Integrated Schedule
	4.3.23 Develop schedule	6.6 Develop Schedule	4.9 Baseline Schedule Estimating Plan and Integrated Schedule
	4.3.24 Control schedule	6.7 Control Schedule	10.1 Project Management Control Plan
			4.10 Schedule Contingency
Cost	4.3.25 Estimate costs	7.2 Estimate Costs	4.5 Cost Estimating Plan, Cost Reports, and Baseline Budget
	4.3.26 Develop budget	7.3 Determine Budget	4.7 Cost Book, Cost Model Data Set, and Basis of Estimate
	4.3.27 Control costs	7.4 Control Costs	10.1 Project Management Control Plan
			4.6 Budget Contingency 4.8 Funding Profile
Risk	4.3.28 Identify risks	11.2 Identify Risks	6.1 Risk Management Plan
	4.3.29 Assess risks	11.3 Perform Qualitative Risk Analysis. 11.4 Perform Quantitative Risk Analysis	6.1 Risk Management Plan. 6.2 Risk Register
	4.3.30 Treat risks	11.5 Plan Risk Responses	6.2 Risk Register
	4.3.31 Control risks	11.6 Control Risks	6.2 Risk Register 6.3 Contingency Management Plan
Quality	4.3.32 Plan quality	8.1 Plan Quality Management	7.4 QA/QC Plans
	4.3.33 Perform quality assurance	8.2 Peform Quality Assurance	7.4 QA/QC Plans
	4.3.34 Perform quality control	8.3 Control Quality	7.4 QA/QC Plans
			7.1 Systems Engineering Plan
			7.2 Systems Engineering Requirements
			7.3 Interface Management Plan
			7.5 Operational Concepts
			15.1 Integration and Commissioning Plan
			15.2 Acceptance and Operational Readiness Plan
Procurement	4.3.35 Plan procurements	12.1 Plan Procurement	9.1 Acquisitions Plans
	4.3.36 Select suppliers	12.2 Conduct Procurement	9.2 Acquisition Approval Process
	4.3.37 Administer contracts	12.3 Control Procurement	10.3 Financial and Business Controls
Communication	4.3.38 Plan communications	10.1 Plan Communications	14.1 Reviews and Reporting
	4.3.39 Distribute information	10.2 Manage Communications	14.1 Reviews and Reporting
	4.3.40 Manage communications	10.3 Control Communications	14.1 Reviews and Reporting

Table 1: Comparison of the ISO 21500, PMBOK and this document (Project Execution Plan) content.

Overall the content maps between the three different frameworks but with some rearrangement and additional details.

1 Introduction

1.1 Document Purpose

The project execution plan describes how the project will be executed, monitored and controlled. For the SKA1 Construction phase, this content is contained in a confederation of separate documents, which evolve at different rates. This document is therefore a means of navigating/discovering the mapping of the project documentation consistent to the project execution plan framework. Table 1 below references the complete information and its organisation; areas shaded blue are summary chapters pointing to the detailed information in a separate document while un-shaded areas are covered in their entirety within this parent document.

Document Component	Project Document Location
1 Introduction	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan REF: SKA-TEL-SKO-0000007 SKA1 Science Requirements (Level 0) SKA-TEL-SKO-0000307 SKA1 SKA1 Operational Concept Document (Level 0) Description of scientific objectives and impacts motivating the proposal.
2 Organization	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of Internal and External Organisation, Governance and Communications (including key roles and responsibilities)
3 Design and Development	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan REF: SKA-TEL-SKO-0000038 System Baseline Design Brief summary of Pre-Construction Design Development phase; link to Design Baseline Description.
4 Construction Project Definition	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0001101 SKA1 WBS Dictionary SKA-TEL-SKO-0001102 SKA1 Project Management Baseline Cost Book SKA-TEL-SKO-0001103 SKA1 Integrated Project Schedule Description of WBS, Scope Management plans, cost estimating plans, cost reports and baseline budget, funding profile, baseline schedule and all contingencies.
5 Staffing	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of staffing plan and hiring and staff transition plans.
6 Risk and Opportunity Management	SKA-TEL-SKO-0001200 SKA1 Project Management Controls System Description of Risk Management Plan and Contingency Management Plan.

7 Project Engineering	SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan SKA1 System Functional Architecture Block Diagram SKA1 Top-level Interface Description of Systems Engineering plan (roles and responsibilities), requirements, and interface management plans.
8 Configuration Control	SKA-TEL-SKO-0001200 Project Management Controls System Description of configuration management and change control and document control plans.
9 Acquisitions	SKA-TEL-SKO-0001400 Financial and Business Systems Description of Procurement plans, processes and contracting strategy, including time-phased list of procurement actions and assumed contract approval governance process. We note this points directly to the Observatory Procurement Policy & associated Procurement Procedures.
10 Project Management Controls	SKA-TEL-SKO-0001200 SKA1 Project Management Controls System Description of project management organization and processes including EVMS and Financial and Business Controls.
11 Site	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan REF: SKA-TEL-SKO-0001040 South African Site Information: SKA1_MID SKA-TEL-SKO-000xxxx Soutch African Site Rules for Contractors SKA-TEL-SKO-000xxxx Australian Site Information: SKA1_LOW SKA-TEL-SKO-000xxxx Australian Site Rules for Contractors Summary of site environments and all permitting and compliance management aspects.
12 Computing and Software	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan Plan for maintaining security of data, hardware and networks during all stages of the project life cycle; plans for writing, testing and verifying, deploying and documenting software including configuration control during the stages of development.
13 Safety, Health and Environment	SKA-TEL-SKO-0000740 SKAO Health, Safety and Environmental Management Plan Description of Safety, Health and Environmental strategy during all stages of observatory life cycle; includes context of SKAO, leadership, worker participation, planning, support, competence, operational planning and control, performance evaluation, improvement, software and safety, functional safety and will include sections on construction and AIV.
14 Quality/Product Assurance	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan

	Description of the PQA requirements and management activities during construction.
15 Review and Reporting	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Description of the planned reporting from the project to its oversight/stakeholders as well as regular planned reviews.
16 Acceptance, Integration, Verification and Commissioning	SKA-TEL-SKO-0001201 SKA1 Engineering Management Plan SKA-TEL-SKO-xxxxxxxx SKA1 Roll Out plans/AIV plans SKA-TEL-SKO-0001350 SKA1 Commissioning Plan Detailed planning and procedures to perform and verify the system performance against both the Level 1 and the Level 0 requirements (for a subset of identified observing modes).
17 Project Close-out	SKA-TEL-SKO-0001100 SKA1 Project Execution Plan Note the handling of the observatory decommissioning phase and responsibilities as currently understood.

Table 1: Project Execution Plan content and pointers to detailed documents.

1.2 Project Research Objectives

The first phase of the Square Kilometre Array (SKA1) will address a broad range of scientific problems, allowing us to explore the evolution of atomic Hydrogen from the early Universe to the present day. This same telescope will permit a wealth of other discoveries to be made, in areas as diverse as the formation of Earth-like planets, the detection of gravitational distortions of Space-Time, the origin of cosmic magnetic fields, and the formation and growth of Black Holes. The expected SKA1 science programme will build on the strong foundations put in place through the development of the science cases presented in "Advancing Astrophysics with the Square Kilometre Array", provides an update to "Science with the Square Kilometre Array" edited by Carilli and Rawlings (2004), and the original compilation of the same name edited by Taylor and Braun (1999).

The high level science objectives which have motivated the SKA1 design choices are tabulated in Figure 1, while we summarize a few in more detail here:

Planet Formation: Since the discovery of the first planetary body outside of the solar system in 1988 there have been almost 2000 planets discovered around more than 1000 stars. Planets have been found with the most diverse properties, ranging in size from half that of the Earth to about twice that of Jupiter and in density from half that of freshly fallen snow to twice that of lead. A particularly vexing problem facing planetary astronomers is understanding how the small pebbles in the disk surrounding a young star are able to stick together to form the boulders that ultimately coalesce into planets. At both smaller and larger sizes, the growth mechanisms are understood, but this key step in the planet formation process is still shrouded in mystery. SKA1-MID will enable direct observation of this phase of planet assembly

through continuum imaging at those radio (band 5) wavelengths that are matched to the size of coalescing particles, from cm-scales to metres.

Gravitational Waves: When Einstein's General Theory of Relativity was published in 1915, it made some of the most surprising predictions about the nature of space and time; predictions that continue to be confirmed with increasing precision to this day. One of the recently confirmed predictions of the theory is that the rapid relative motion of massive compact objects, will lead to a propagating Space-Time distortion of the Universe; a phenomenon termed Gravitational Waves. The only method yet proposed to measure long period Gravitational Waves makes use of our entire Galaxy as a detector. Rapidly spinning neutron stars with pairs of radio beams emanating from their poles known as millisecond pulsars serve as a system of high precision clocks. By accurately measuring the pulse arrival times from many of these clocks over the course of several years the SKA1 will create a Gravitational Wave Telescope. In practice, this will be achieved through complementary pulsars surveys using SKA1-LOW and SKA1-MID and subsequent high precision timing with SKA1-MID band 2 or 3.

	SKA1	SKA2
The Cradle of Life & Astrobiology Hoare, M. et al. 2015 PoS(AASKA14)115	Proto-planetary disks; imaging snow/ice line (@ < 100pc), Searches for amino acids.	Proto-planetary disks; sub-AU imaging (@ < 150 pc), Studies of amino acids.
	Targeted SETI: airport radar 10^4 nearby stars.	Ultra-sensitive SETI: airport radar 10^5 nearby star, TV ~10 stars.
Strong-field Tests of Gravity with Pulsars and Black Holes Kramer, M. & Stappers, B. 2015 PoS(AASKA14)036	1st detection of nHz-stochastic gravitational wave background.	Gravitational wave astronomy of discrete sources: constraining galaxy evolution, cosmological GWs and cosmic strings.
	Discover and use NS-NS and PSR-BH binaries to provide the best tests of gravity theories and General Relativity.	Find all ~40,000 visible pulsars in the Galaxy, use the most relativistic systems to test cosmic censorship and the no-hair theorem.
The Origin and Evolution of Cosmic Magnetism Johnston-Hollitt, M. et al. 2015 PoS(AASKA14)092	The role of magnetism from sub-galactic to Cosmic Web scales, the RM-grid @ 300/deg^2.	The origin and amplification of cosmic magnetic fields, the RM-grid @ 5000/deg^2.
	Faraday tomography of extended sources, 100pc resolution at 14Mpc, 1 kpc @ $z \approx 0.04$.	Faraday tomography of extended sources, 100pc resolution at 50Mpc, 1 kpc @ $z \approx 0.13$.
Galaxy Evolution probed by Neutral Hydrogen Staveley-Smith, L. & Oosterloo, T. 2015, PoS(AASKA14)167	Gas properties of 10^7 galaxies, $\langle z \rangle \approx 0.3$, evolution to $z \approx 1$, BAO complement to Euclid.	Gas properties of 10^9 galaxies, $\langle z \rangle \approx 1$, evolution to $z \approx 5$, world-class precision cosmology.
	Detailed interstellar medium of nearby galaxies (3 Mpc) at 50pc resolution, diffuse IGM down to $N_H < 10^{17}$ at 1 kpc.	Detailed interstellar medium of nearby galaxies (10 Mpc) at 50pc resolution, diffuse IGM down to $N_H < 10^{17}$ at 1 kpc.
The Transient Radio Sky Fender, R. et al. 2015 PoS(AASKA14)051	Use fast radio bursts to uncover the missing "normal" matter in the universe.	Fast radio bursts as unique probes of fundamental cosmological parameters and intergalactic magnetic fields.
	Study feedback from the most energetic cosmic explosions and the disruption of stars by super-massive black holes.	Exploring the unknown: new exotic astrophysical phenomena in discovery phase space.
Galaxy Evolution probed in the Radio Continuum Prandoni, I. & Seymour, N. 2015 PoS(AASKA14)067	Star formation rates (10 $M_\odot$/yr to $z \sim 4$).	Star formation rates (10 $M_\odot$/yr to $z \sim 10$).
	Resolved star formation astrophysics (sub-kpc active regions at $z \sim 1$).	Resolved star formation astrophysics (sub-kpc active regions at $z \sim 6$).
Cosmology & Dark Energy Maartens, R. et al. 2015 PoS(AASKA14)016	Constraints on DE, modified gravity, the distribution & evolution of matter on super-horizon scales: competitive to Euclid.	Constraints on DE, modified gravity, the distribution & evolution of matter on super-horizon scales: redefines state-of-art.
	Primordial non-Gaussianity and the matter dipole: 2× Euclid.	Primordial non-Gaussianity and the matter dipole: 10× Euclid.
Cosmic Dawn and the Epoch of Reionization Koopmans, L. et al. 2015 PoS(AASKA14)001	Direct imaging of EoR structures ($z = 6 - 12$).	Direct imaging of Cosmic Dawn structures ($z = 12 - 30$).
	Power spectra of Cosmic Dawn down to arcmin scales, possible imaging at 10 arcmin.	First glimpse of the Dark Ages ($z > 30$).

Figure 1: An overview of some of the key science applications of the Square Kilometre Array, both in its early deployment phase, SKA1, and as the fully scoped, SKA2. Scientific

topics are ordered by their increasing distance from the Earth. Definitions of abbreviations are given in the references.

Cosmic Magnetism: Magnetic fields may well play a key role in regulating a whole range of processes in the Universe, from the formation of planets and stars to both the accumulation and the dispersal of material on the scales of galaxies and clusters of galaxies. The challenge facing astrophysicists today is explaining how and when magnetic fields arose to achieve their current prominence. What is particularly puzzling is the strength of those fields on the largest physical scales. Current theories fall short of explaining the observed field strengths by factors of a million or more. The only way to solve this puzzle, is with a much better sampling of our magnetic environment, with so that the sources of magnetic enrichment become apparent as well as the timescales over which they operate. SKA1 has the potential to enable the first three-dimensional magnetic map of the Universe. This will be achieved by measuring the individual magnetic components toward extremely large samples of sources distributed in all directions on the sky and at varying distances. In this way, we will form the first detailed magnetic map of our own Galaxy, as well as the much larger volume around us, reaching back in time to the birth of the first galaxies.

Galaxy Evolution: Although Hydrogen is the most abundant element in the cosmos, it is only visible as a faint radio glow in the sky and that intrinsic faintness is exacerbated by large distances. It was the desire to study 21cm atomic Hydrogen in distant galaxies that originally motivated the concept of a radio telescope comprising one square kilometre of total collecting area. Even in its first phase, the SKA1-MID will already provide samples of 10 million galaxies spanning 8 billion years of evolution, which will greatly advance our understanding of the galaxy life cycle. Such surveys will also provide insight into the structure and kinematics of the ISM in galaxies over areas of 1000s of square degrees.

The Transient Sky: Over the last century, radio-wavelength surveys have unveiled new classes of time variable transient phenomena. One such class of source is the Gamma-Ray Bursts; now believed to originate in the supernovae of particularly massive stars in the distant Universe. A similar phenomena are the Fast Radio Bursts, first discovered in 2007 and only established as a population in 2013. SKA1 will enable us to associate thousands of individual bursts with the objects that host them, allowing us to map out the Universe's plasma content and how it evolves with time in a way that was never previously possible. This is particularly important since we believe that about 70% of all normal matter in the Universe today is in the form of such plasma, but we only have direct measurements of about 10%.

Cosmology and Dark Energy: The discovery that the Universe is accelerating in its expansion has led to the belief in a mysterious form of Energy. This "Dark Energy" is in many respects the antithesis of the previously hypothesized Dark Matter, exerting a repulsive rather than attractive force that seems to grow in proportion to the volume of the Universe. It is anticipated that the SKA1 may fundamentally advance our understanding of Dark Energy by allowing astronomers to constrain many parameters that describe both the nature and time evolution of this mysterious phenomenon. These constraints would be achieved through wide-field surveys of the bulk 21cm HI line emission from galaxies, a technique known as "intensity mapping".

Cosmic Dawn and the Epoch of Re-ionisation: Studies of redshifted atomic Hydrogen with SKA1-LOW will permit us to study the impact of the first galaxies and AGN on their surrounding intergalactic medium in the early Universe. Following the period referred to as the "Dark Ages" when few stars would have had time to form, the Universe entered the Cosmic Dawn, characterised by the first signs of temperature contrast between heated and unheated regions, even though essentially all of the Hydrogen is still relatively cold and neutral. The next major era is termed the Epoch of

Reionisation (EoR) lasting from about 370 to 800 million years of age. SKA1-LOW is expected to uniquely enable a measurement of the power spectrum of 21cm Hydrogen fluctuations on different angular scales from the onset of Cosmic Dawn. It may also be feasible to directly image the expected ionized bubbles of gas during the EoR. Together, these data should address the question of when exactly did the first stars form? Were individual stars, large stellar clusters or even early black holes the most important source of heating and ionisation of the Universe? How exactly did the process unfold and was there a single progression from dark to light or were there multiple fits and starts with different heating populations dominating at different times?

1.3 Science Requirements

The Science Requirements are summarised in SKA-TEL-SKO-0000007 (Science Requirements). The approach taken in the document was to review a spectrum of observational use cases and choose from them the most demanding observational requirements (as currently envisaged) and then from these derive the most stringent technical requirements needed for the observatory systems.

1.4 The SKA Observatory

The SKA Observatory will consist of a Global Headquarters, two SKA Telescopes to cover the huge range of frequency, and the local activities necessary for their operation, data processing and data archiving. While the Global Headquarters is located at the Jodrell Bank Observatory site, near Manchester, U.K., the SKA Telescopes will be located within radio quiet zones provided by the host countries of Australia and South Africa, eventually including all of Southern Africa. In particular, the Murchison Radio-astronomy Observatory in Western Australia will host the “SKA1-Low” Telescope, operating in the 50 MHz - 350 MHz frequency range, while the “SKA1-Mid” Telescope will be centered in the Karoo Central Astronomy Advantage Area and operate between 350 MHz and 15.35 GHz.

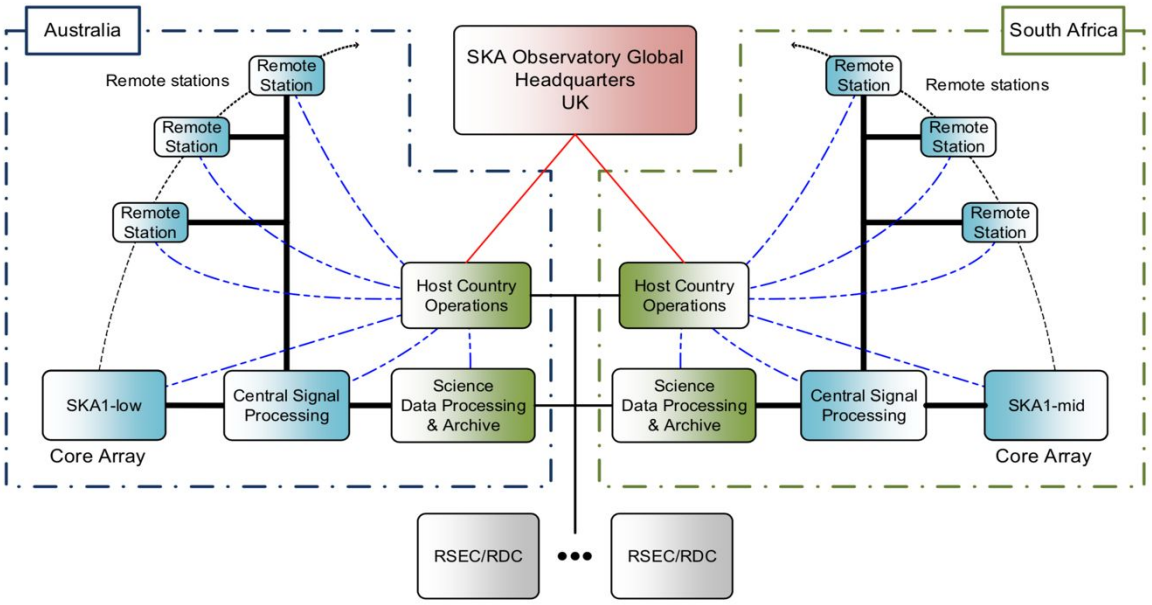


Figure 1 Schematic diagram of the SKA Observatory.

In order to reach the sensitivity necessary for SKA, the SKA Telescopes use the array concept where multiple connected "receptors" work together as a single antenna. As shown in Figure 4, for both SKA1-Low and SKA1-Mid configurations, the receptors (red dots) are arranged in a core with a diameter of ~1 km, and three spiral arms. The maximum baseline is 65 km and 160 km respectively for SKA1-Low and SKA1-Mid. While for SKA1-Low, the core is very compact, and the arms are quasi- spiral in the inner area, for SKA1-Mid the core is moderately compact and there is a 3-km area (surrounding the core) where the "receptors" are randomly placed.

Due to the different frequency ranges, the SKA1-Mid "receptors" will be 15-m projected-diameter offset Gregorian dishes, while in SKA1-Low "receptors" will be "aperture arrays" composed of 256 dual-polarised log-periodic antennas randomly distributed in a 38-m circular area (this refer to the maximum distance from the centers of the antennas).

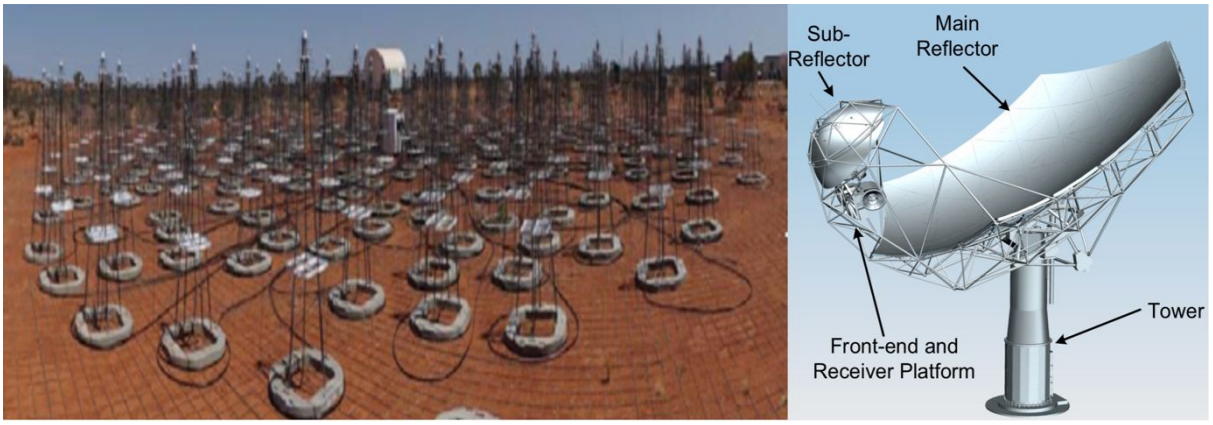


Figure 2 SKA-Low aperture array prototype (AAVS1) (left) and SKA1-Mid (right) dish design.

Data captured by each dish will be digitized and processed, as well as data from each aperture array (station) will be processed, after digitization, to form up to 8 independently steerable "station beams". These data will be sent to the Central Processing Facility located near the core of each Telescope in order to be correlated as well as beamformed to generate multiple tied-array beams which will be further processed by the Pulsar Timing and Pulsar Search Engines. Visibility data, pulsar search candidates and heuristics, and pulsar timing results will be sent to the Signal Data Processor (SDP), located in High-performance Computing Centres in Perth and Cape Town for SKA1-Low and SKA1-Mid respectively. SDP software will further process the visibility and pulsar/single-pulse data and archive science-ready data.

In addition to conventional imaging and pulsar observations, the telescopes will also include substantial support for transient and time-domain science. Each telescope will provide Transient Buffers storing up to 510 seconds (SKA1-Low) or 22 seconds (SKA1-Mid) of channelized voltage data for each "receptor", triggerable from internal or external sources. The SKA1-Low system will also provide raw voltage-capture for a subset of the antennas in each station. Both of the SKA Telescopes will also provide VLBI capabilities and participate as stations in the global network.

The SKA Observatory will be deployed in two phases; an early deployment phase termed SKA1 of 10 – 20% of the complete system, followed by the fully scoped SKA2. The detailed design is discussed in Section 4.

The scope of the SKA1 initial deployment has been adjusted to match the budget established by the SKA Board of Directors (€691M 2017€). This requires an adjustment to the scope of SKA1 (See Section 3).

2 Organization

2.1 Governance

The international SKA Observatory is the legal entity that will design, build and operate the SKA. It will carry out this task on behalf of the SKA Participating Countries, who are the members and associate members of the organisation. The SKA Organisation, with its headquarters in Cheshire, UK, was established in December 2011 as a not-for-profit company in order to formalise relationships between these international partners and centralise the leadership of the Project; the company will formally transfer its assets to an International Governmental Organization (IGO), the SKA Observatory, in 2020, governed by a Council composed of Member representatives. Each of the Members has a single vote on the Council but can have up to two representatives. The IGO Council is responsible for the overall governance of the SKA Observatory and will approve all policies, rules, and regulations of the SKAO as well as approval of budget and supervision of expenditures and financial activity. The Director-General is given the responsibility and authority to set up the observatory and establish the project management, engineering and operations.

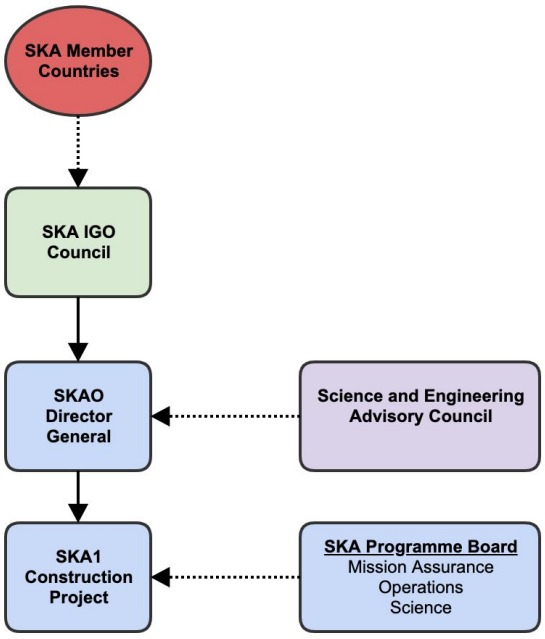


Figure 3 High Level Observatory Structure above the SKA1 Construction Project

2.2 Steady-State Organisation

2.3 Project Organisation

2.3.1 Project Line Management

2.3.2 Project Roles and Responsibilities

2.4 External Organisation & Partnerships

2.5 Stakeholder Management

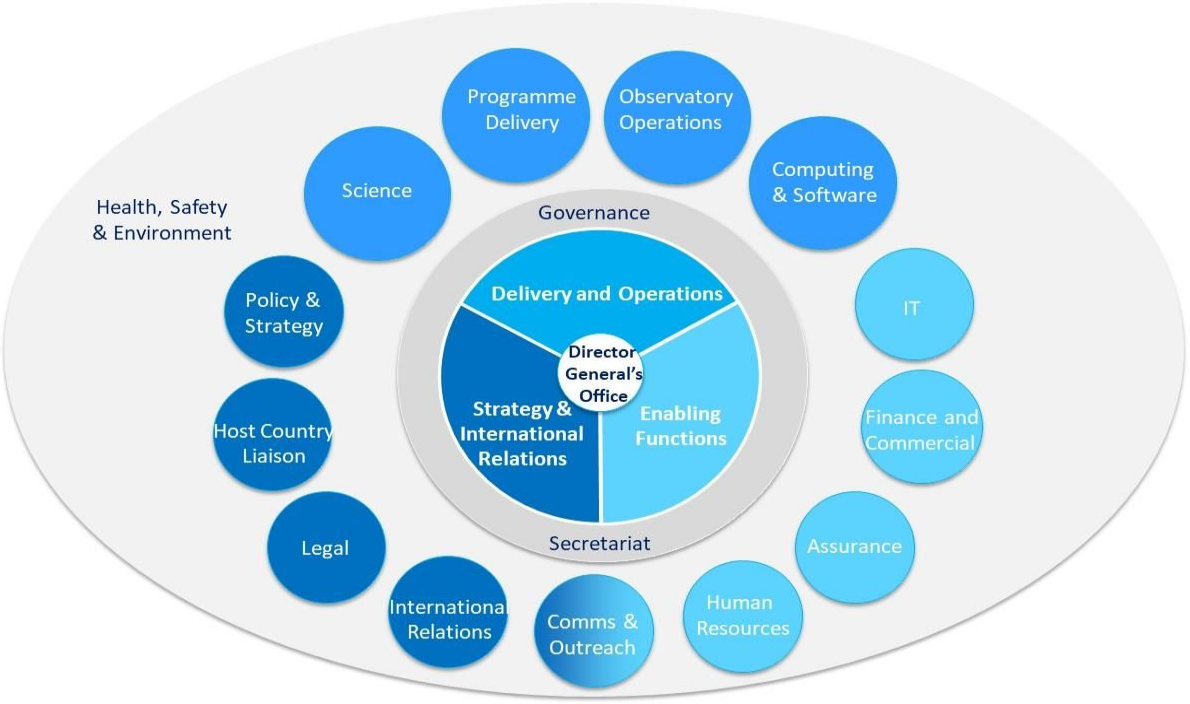


Figure 4 Organisational Accountabilities

The high level structure of the observatory functions is illustrated in Figure 5 along with the divisional responsibilities. This represents the 'steady state' observatory structure that exists both at the start of the construction phase as well as that for operations with the staffing profiles and priorities varying over time.

Figur

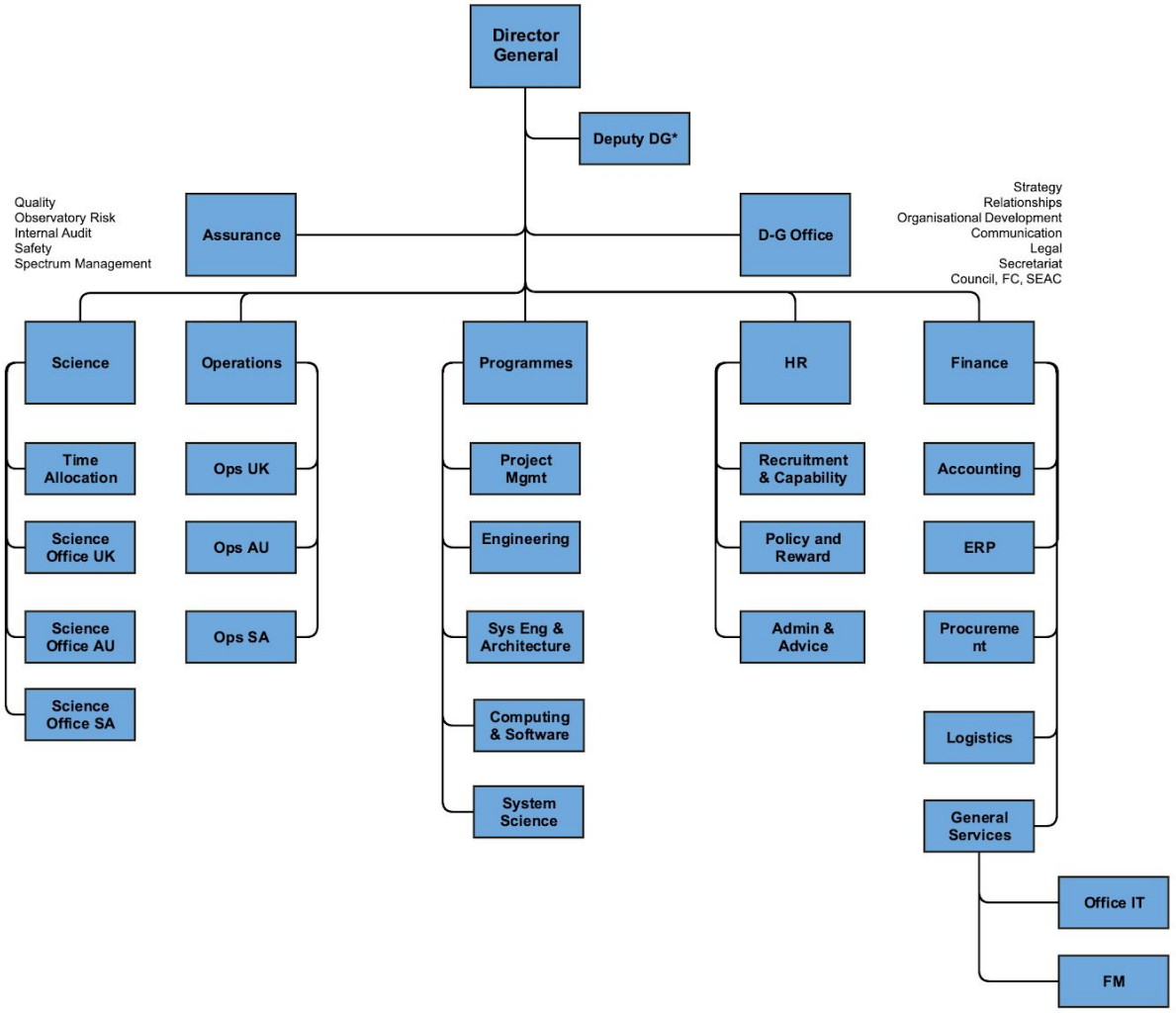


Figure 5: High Level Observatory Structure anticipated for steady state operations. Divisions include: Science, Operations, Programmes, HR and Finance with Assurance and DG Office supporting across those divisions. The Deputy DG* position is a part time position and will be filled by a Divisional Lead; during construction, the Programme Director holds this position.

	Directorate/Function	Description
	Science	The Science Directorate will lead the scientific direction of the Observatory, being the guardians of the delivery of science in line with the Observatory's mission. This will include developing SKA's science strategy and working with stakeholders and the science community in defining science priorities, in order to lead the way in science discovery.

	Operations	The Operations Directorate is ultimately responsible for coordinating and managing Observatory operations across host sites in such a way to meet stakeholder needs whilst delivering the Observatory's mission. This directorate will ensure the effective preparation and planning of observing programmes, the operation and maintenance of state-of-the art high-tech observing instruments and will ensure the management of data through the SRCs. Ahead of full Operations the Directorate will be responsible for the development of the Operations Plan for the future Observatory and will work closely with the Programmes Directorate in the effective commissioning of the telescopes and delivery of early science.
	Programmes	The Programmes Directorate is responsible for leading the delivery of construction through the key phases of the project and for ensuring the establishment of the necessary computing and software capability. This includes finalising the construction proposal following the conclusion of all design activities, the management of the Bridging Phase and preparation and delivery of the Construction phase before managing handover to the Operations Directorate. This Directorate will work closely with both Science and Operations Directorates as well as the broader science and engineering communities to ensure the design and build of the telescopes meets both the science needs and the practical requirements of effective Operations. Beyond Construction and into Operations the Programme Directorate will continue to be responsible for the ongoing construction associated with planned operational development to continue to meet the needs of science.

	Director-General's Office	The Director-General's (D-G's) Office is focused on all activities that support the strategy and development of SKA. In particular the D-G's office supports the D-G in all his external activities as well as being responsible for governance activities that ensure the organisation is meeting its legal and strategic commitments. In delivering this, it brings together those activities where especially close contact with the Director-General is important to achieve this aim and therefore includes: · Strategy and Business Development · External Relations · Legal · Communications and Outreach · Secretariat, Governance and Executive Administration
	Assurance	The Assurance function is focused internally, providing assurance to the D-G that all processes and procedures are carried in line with Quality and HSE (Health, Safety and Environment) standards. The Assurance function is also responsible for the management of Business Risk and Spectrum Management.
	HR	The HR function is responsible for defining and delivering a people strategy that meets the current and future business needs where people are integral to the success of the organisation. This covers all aspects from resource & capability planning, diversity and inclusion, recruitment & relocation, individual & leadership development, performance & succession management, reward, staff engagement, employee relations and HR policy development. Core to the function of HR is also supporting the management of staff time away from work, dealing with staff issues and managing all associated administration and system management.

	Finance	The Finance function is responsible for leading all financial and commercial related matters at both strategic level and operational level. This includes the management of all financial policies & procedures, financial planning, budget, cash flow and accounts management as well as banking and treasury. The finance function will work with internal and external audit to ensure compliance with taxation and accounting standards, as applicable. With responsibility for the organisation's commercial matters, over time Finance will take on responsibility for Procurement. In addition, the Finance function will have responsibility for General Services of the Headquarters, including Logistics and Facilities Management.

2.6 SKAO High Level Roles & Responsibilities

Director-General

The Director General is responsible to the SKA Observatory Council for effective leadership of the SKA Observatory. He is delegated authority to assume the responsibility of all areas of management and, in particular, has responsibility for all personnel, safety and financial matters. He is delegated the authority to administrate the Observatory. In addition, the DG is responsible to the Council for the management of relationships within the SKA Observatory Membership and will engage with all Member Countries and their representatives. He/she will also be dynamic in the engagement and recruitment of new members. The DG will be the main ambassador for the SKA Observatory to the outside world and has the responsibility to engage with other scientific establishments and authorities. He has the delegated authority to further delegate financial and personnel responsibilities.

Director of Strategy and Head of the D-G's Office (Title to be confirmed)

The Head of the DG Office is responsible for the efficient operation of the governance structure of the organisation, the development of the IGO and the development and maintenance of relationships and communication across the environment. As a member of SKAO's senior leadership team, the Head of DG Office will work closely with the Director-General and other Directors in the development of overall policy and strategic planning across the organisation to ensure the success of the Observatory's mission.

During construction, Head of DG Office will be responsible to the DG for completing the transition from SKAO to Observatory. This will include the work required to bring all potential members into some form of membership. The Head of DG Office will also be responsible for relationships across the membership of the IGO, especially with the Host Countries. In addition, will have responsibility for all legal and development issues. As a member of SKAO's senior leadership team, the Head of DG Office will work closely with the Director-General and other Directors in the development of overall

policy and strategic planning across the organisation to ensure the success of the Observatory's mission.

The Head of DG Office will be highly visible in the function of the Observatory, interacting continuously with the SKA Member States and with the governing SKA Board/Council and their external advisory bodies.

- Complete transition to IGO
- Manage expectations of actual and potential Members
- Seek new Members from community
- Lead continued development of Funding Schedule
- Lead on development within IGO
- Lead on any legal issues
- Ensure internal communications is effective
- Develop and implement business continuity
- Develop any change process required within Observatory
- Support to Council
- Support to Finance Committee
- Lead Audit, both Internal and External
- Provide communication to both internal and external stakeholders
- Provide outreach and education support to enable ambitions of Observatory
- Will support the DG through effective management of plans and supporting papers

Science Director

The Science Director will lead the scientific direction of the Observatory. The Science Director will report directly to the Director-General and will be responsible for all SKA Science prioritisation and development. To enable this the Science Director shall coordinate the Time Allocation Process.

The Science Director will have responsibility of Science across the Observatory and, as such, shall act as Head of Specialism for all astronomers employed by the Observatory.

As a member of SKAO's senior leadership team, the Science Director will work closely with the Director-General and other Directors in the development of overall policy and strategic planning across the organisation to ensure the success of the Observatory's mission. The Science Director will be highly visible in the function of the Observatory, interacting continuously with the SKA science and engineering communities and with the governing SKA Board/Council and their external advisory bodies.

- Develop science policy and priorities for Observatory
- Coordinate SKA Science Community
- Coordinate Science Conferences and workshops
- Act as Head of discipline to all scientists within observatory
- Manage science groups in all three locations, including development of all post-docs
- Provide sufficient mentoring to astronomers working within Operations on the two sites.
- Manage Time Allocation System and support TAC
- Hand over allocations to Operations

Director of Operations

The Director of Operations will lead the operations of complex, high-tech, state-of-the art scientific instruments in two remote locations. The Director of Operations will report directly to the Director-General and will be responsible for all SKA operations and accountable for their execution. As a member of SKAO's senior leadership team, the Director of Operations will work closely with the Director-General and other Directors in the development of overall policy and strategic planning across the organisation to ensure the success of the Observatory's mission. The Director of Operations will be highly visible in the function of the Observatory, interacting continuously with the SKA science and engineering communities and with the governing SKA Board/Council and their external advisory bodies.

· Provide leadership to the Operations' Division;
· Finalise and implement the SKA Operations Plan, building on the extensive planning done to date;
· Work closely with SKA's international partners, especially those in the telescope host countries of Australia and South Africa, to ensure the operations plan is efficiently implemented;
· Oversee the recruitment of the operations team across the SKA's three host countries;
· Oversee the delivery of host country assets that meet SKA requirements;
· Work closely with the SKA Programme Director in the commissioning and early science phase of the telescopes;
· Oversee all aspects of the operations of the two SKA telescopes, including close interaction with the SKA Regional Centres distributed across the globe;
· Assume responsibility for the setting of operational priorities and resource planning;
· Work together with the Director-General and other Directors to develop and implement the SKA's policies and strategies; and
· Provide regular information and status reports to the Director General as required

Director of Programme

The Programme Director will be a person who will ensure that the SKA Project is delivered to time, budget and performance. This will include both the coordination of the Construction Proposal to SKA Council for approval and then the delivery of the full construction phase. As a member of SKAO's senior leadership team, the Director of Programmes will work closely with the Director-General and other Directors in the development of overall policy and strategic planning across the organisation to ensure the success of the Observatory's mission. The Director of Programmes will be highly visible in the function of the Observatory, interacting continuously with the SKA science and engineering communities and with the governing SKA Board/Council and their external advisory bodies.

Under the direction of the SKA Director-General the postholder will:
· Lead the overall project activity;
· Define the process by which the SKA Office and contractors will undertake the SKA construction;
· Coordinate the integrated efforts of the project management and engineering , SKA System Engineering and Architecture within the SKA Office;
· Ensure that the SKA Office engineering team recruits the best and brightest;
· Coordinate the resources available according to agreed priorities;
· Oversee the negotiation of the work-package contracts;
· Oversee the management of the construction contracts;
· Ensure that all appropriate management and monitoring processes are in place;
· Ensure that the SKA Office is appropriately represented on all key design reviews.

· Travel, as required, to any of the SKA countries.

During the Construction Phase the post will take on responsibilities for the Observatory Development Programme (SODP):

· Identify development requirements through feedback from observatory operations and SEAC development plan.
· Manage SKA Development Plan through work with SEAC
· Define the process by which the SKA Office and contractors will undertake the SKA construction;
· Coordinate the integrated efforts of the project management and engineering , SKA System Engineering and Architecture within the SKA Observatory;
· Ensure that the SKA Observatory engineering team recruits the best and brightest;
· Coordinate the resources available according to agreed priorities;
· Oversee the negotiation of the work-package contracts;
· Oversee the management of the development contracts/agreements;
· Ensure that all appropriate management and monitoring processes are in place;
· Ensure that the SKA Observatory is appropriately represented on all key design reviews.
· Travel, as required, to any of the SKA countries.

Head of Assurance

The Head of Assurance will provide the Director General with the necessary assurance that all processes and procedures are provided in sufficient form and are being adhered to. As a member of SKAO's senior leadership team, the Head of Assurance will work closely with the Director-General and other Directors in the development of overall policy and strategic planning across the organisation to ensure the success of the Observatory's mission. The specific responsibilities include management and planning of:

· Quality Assurance and Management
· Business Risk Management
· Internal Audit
· Safety
· Spectrum Management

Head of Human Resources

The Head of HR will have the responsibility to manage HR within the Observatory through employment, engagement and retention. The Head of HR will provide relevant HR policies and strategies to support and implement resource planning, attraction and recruitment, skills and capability development, reward and staff engagement. He/she will ensure that employee relations are managed through a structure and that issues of culture, diversity and inclusion are managed in a totally inclusive manner.

In particular, Head of HR will be responsible for:

- HR Policies and Plans. Procedures and Staff Handbook
- Attraction collateral (eg recruitment site, EVP)
- HR Systems
- Reward and development frameworks
- Leadership standards
- Employee relations frameworks
- Equality, Diversity and Inclusion and the development of an effective culture that support the delivery of organisational objectives
- The management of time away from work and staff issues in line with legal standards
- All associated HR administraton

Head of Finance

The Head of Finance will report directly to the DG and ensure that finance is both brought into Observatory effective, but also managed when spending. The Head of Finance will control overall budget and spend whilst maintaining accounts and working with both external and internal audit. In addition, the Head of Finance will ensure that the procurement is carried out in an effective and efficient manner. The Head of Finance will also have responsibilities to ensure that the General Services of the Headquarters are manage in the cases of IT and Facilities Management.

In particular Head of Finance will be responsible for:

- Finance processes and procedures,
- Maintenance of balance sheets and accounts
- Response to audit
- Procurement Policies and procedures.
- Procurement Contracts.
- Procurement Strategies.
- Audit process and support
- Management of the ERP system

Head of Council Support

The Head of Council Support will work within the DG Office, but have direct access to the DG on matters pertaining to Council and Finance Committee. The Head of Council will be responsible for the effective and efficient operation of both the Council and the Finance Committee and provide bot with sufficient support and guidance.

The Head of Council Support will:

- Coordinate Council and FC meetings
- Circulate Agendas, minutes and agreements
- Liaise with legal services to provide interpretation of agreements when required
- Develop procedures required for new Members

Head of Communications, Education and Outreach

The Head of CEO will work within the DG's Office and have direct access to the DG for matters pertain to communications. The Head of CEO will have responsibility across the Observatory for all aspects of Communications, both internal and external as well as providing the resource to ensure that outreach and education is effective across the Member States. The Head of CEO will assist the

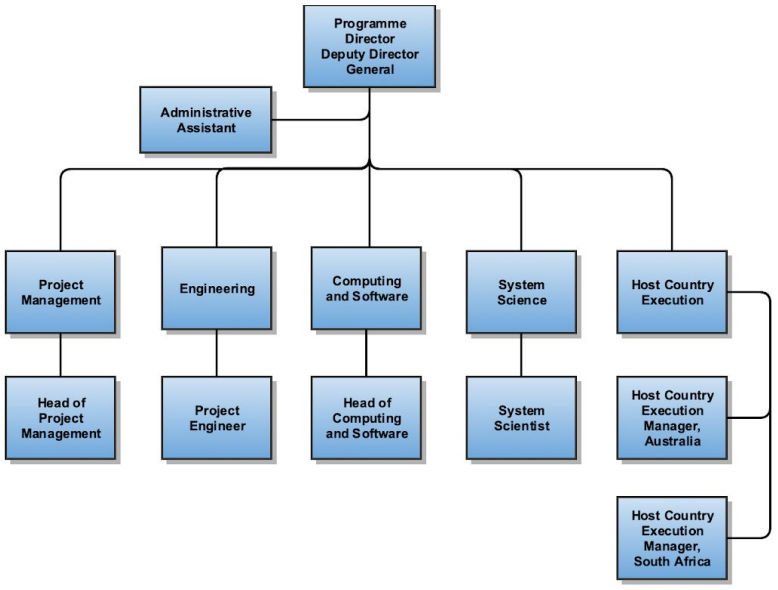
Director-General in ensuring the growth of the financial, political and public support for the international SKA project by communicating its value to stakeholders and the general public. To this end, coordination with Member organisations to ensure SKA Brand is maintained and known.

In particular the Head of CEO will:

· Coordinate CEO across the SKA Observatory
· Provide resources to support communication
· Support conference booths etc
· Coordinate and provide talks and opportunities for engagement
· Ensure the SKA Observatory brand is known
· Provide feedback on CEO and brand

2.7 Programme Organisation

As noted above, the Programme is responsible for the delivery of the SKA1 construction. The Programme Directorate is composed of the senior staff in each branch of the Division along with the host country execution managers.

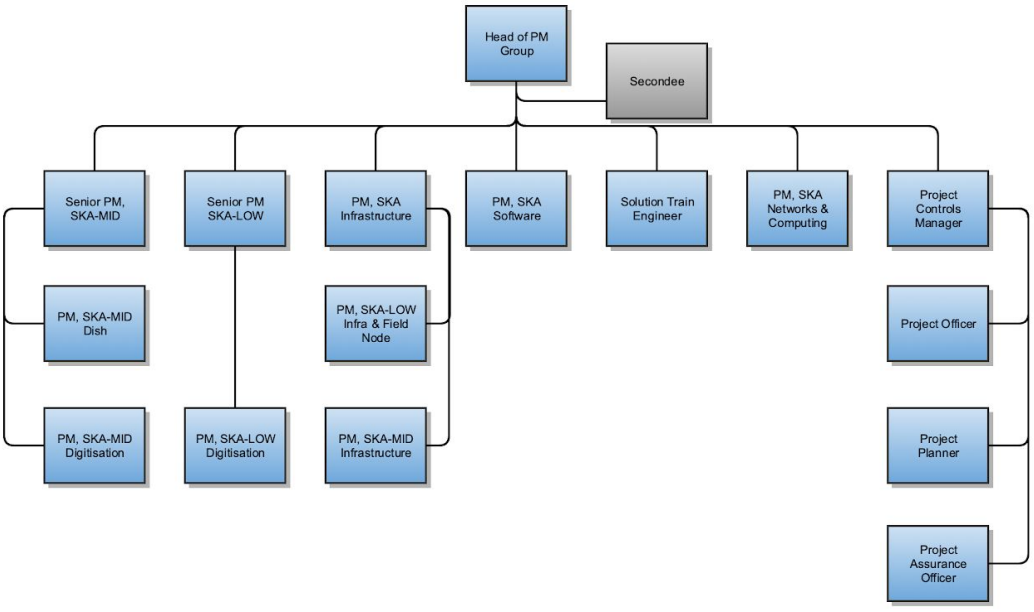


- System Scientist, Head of Project Management, Project Engineer and Head of Computing and Software are outlined in their respective sections.
- Host Country Execution Manager: Responsible for the coordination & integration of existing telescopes and site related matters with SKA1 construction activities in the respective host country. Supports Senior Project Manager planning, providing real time information for the strategic construction execution. Provides integration/coordination with existing facilities on site (MeerKAT, ASKAP, guest instruments, etc; other things at site); power outages, handover (in particular for MeerKAT). Acts as a conduit for host country stakeholder engagement and relations and local communications (e.g. local authorities, local communities, relevant Govt Depts etc.). Monitor and control all host country agreement

obligations; provide reports and updates on these areas. Monitor and control all site permitting and compliance issues; provide reports and updates on these areas.

- Administrative Assistant: Support the Programme Director's Office staff and the construction engineering, computing, project management and mission assurance divisions and staff; providing support for procurements, meeting/area coordination, travel, and document development.

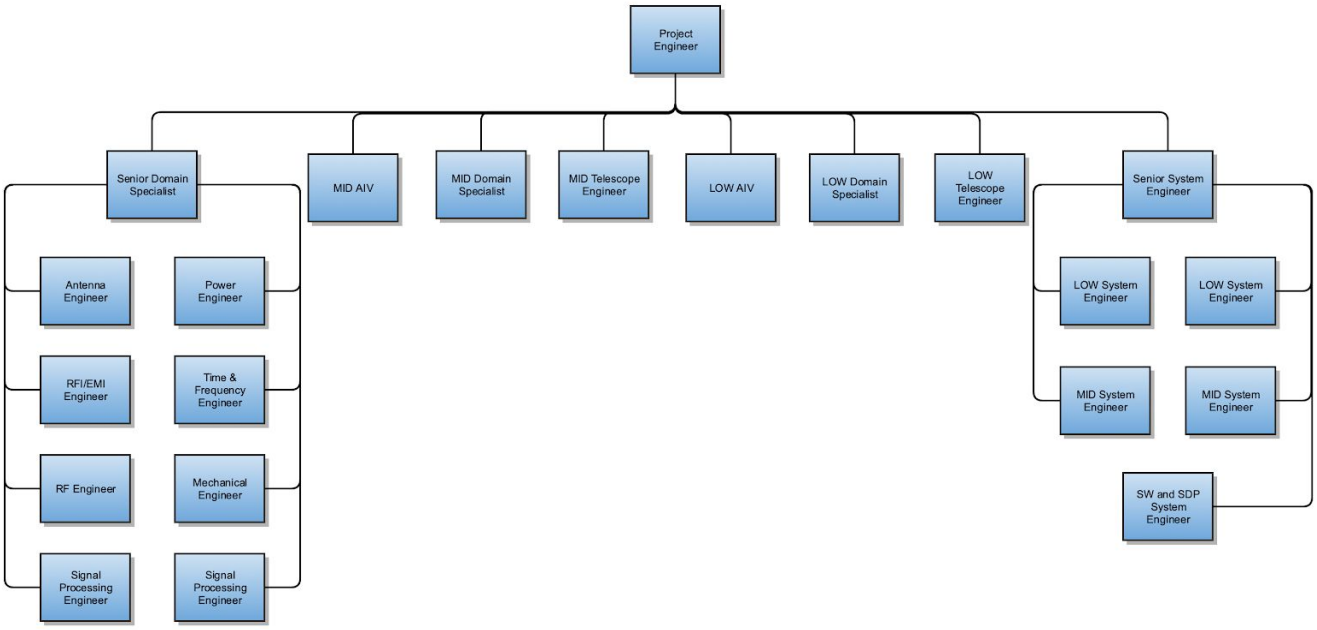
2.7.1 Project Management



- Head of PM: Head of Profession: Responsible for EPM training, support and development. Guides the use of PM processes and resources to provide guidance to achieve the project mission and to provide necessary stakeholder communications and reportings.
- Senior PM: Responsible for the delivery of a telescope facility (Low, Mid) in construction. This includes leading the Low TDT and may also include project managing external contract deliveries through to acceptance. Includes status reporting, planning and control (cost, schedule, scope and quality), risk, issue, stakeholder and change management.
- Engineering PM: Responsible for the delivery of specified WPs and their corresponding products in construction. This includes project managing external contract deliveries through to acceptance and/or managing teams of staff to deliver parts of the WBS. Includes status reporting, planning and control (cost, schedule, scope and quality), risk, issue, stakeholder and change management.
- Project Controls Manager: Responsible for maintenance of the project management control systems including scheduling, earned value management, budgeting, risk and change control. Ensures storage and retrieval of schedules, cost and related planning data.
- Project Officer: Meeting coordination and support; status reporting and performance KPIs; document management and risk management support; TIMS facilitator.
- Project Planner: Owner of the Integrated Project Schedule (Primavera); responsible for providing results of EPM updates in schedule, identification of the critical path and near critical path. Support schedule scenarios as needed.

- Project Assurance Officer: PMCS support (Dash 360, Cobra, CEMAR, Primavera, ERP, risk tool)

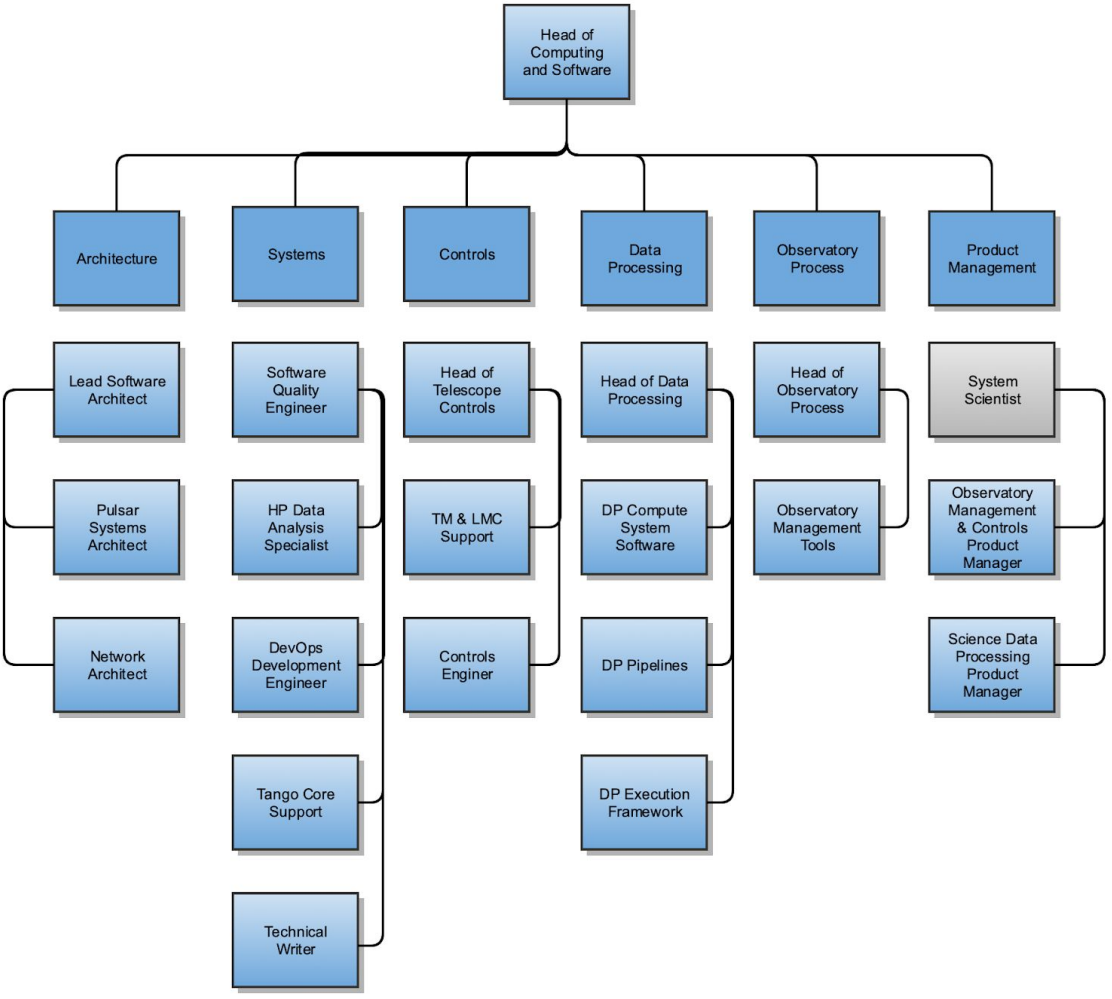
2.7.2 Engineering, Systems Engineering and Architecture



- Project Engineer: Head of Profession and Project Engineer: Responsible for engineering training, support and development. Guides the use of engineering processes and resources to provide guidance to achieve the project mission. Final authority on engineering design and verification.
- Senior Systems Engineer: Responsible of the technical excellence of the observatory. Accountable for L1 requirements and external interfaces. Ensure technical adequacy of verification.Acting as sole point of reference for System engineering best practice in the SKAO.
- Telescope Engineer: Responsible for the performance of a telescope in collaboration with the System Scientist. Report to SPM on technical risks and performance compliance. Identify and manage technical issues. Ensure technical adequacy of verification. Final signature on designs and required signature on Change Requests and requirements impacting the telescope.
- Telescope Domain Specialist: Responsible for the performance of a telescope in collaboration with the System Scientist. Report to SPM on technical risks and performance compliance. Identify and manage technical issues. Ensure technical adequacy of verification. Telescope design authority; required signature on Change Requests and requirements impacting the telescope.
- AIV Lead Engineer: Lead development of host-country ITF establishment, preparation for AIV process. To ensure the technical adequacy of verification at system level in coordination with Mission Assurance. Being the technical reference for the AIV plan, managing the AIV activities on site, Supervise, in collaboration with the Product Delivery Teams, domain authority Verification at lower level in collaboration with Mission Assurance.

- Domain Engineer: Develop and manage technical budgets. Identify and resolve domain-specific technical issues. Monitor and control compliance for a specific domain. Required signature on Change Requests and requirements impacting their domain. Responsible for the cross-product and/or cross-telescope integration of a particular technical domain. Support Systems Engineering and the Design Authority in establishing a link across products and/or telescopes.

2.7.3 Computing and Software

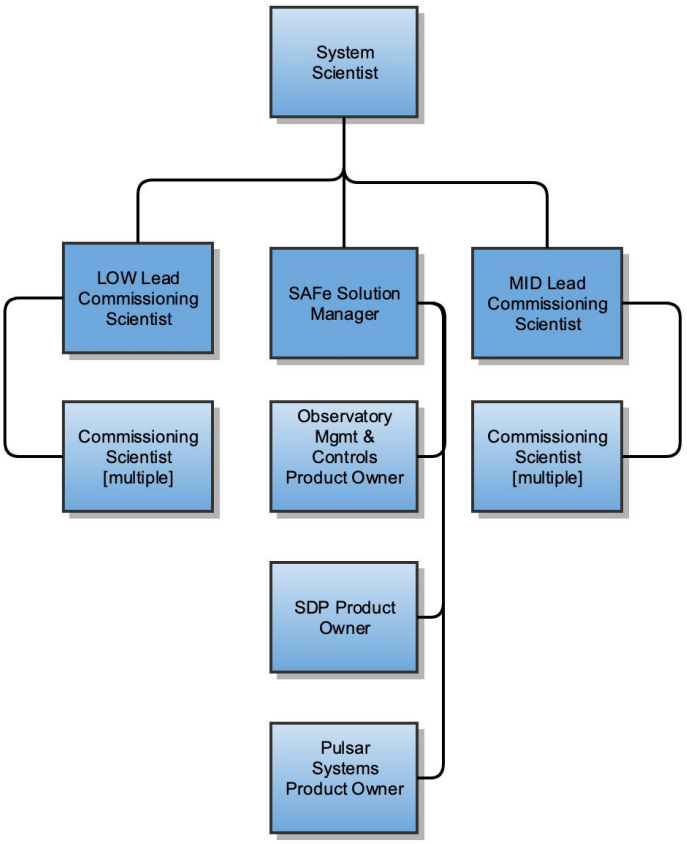


- Lead Software Architect: Responsible for the overall SKA1 software high level design choices, technical standards, coding standards, tools, and platforms. Within SAFe, provides the roadmap for construction supported by the identification of Customer needs, formalised in the requirements; prioritizes features and guides the work through to verification.
- Software Quality Engineer: The Software Quality Engineer acts as the technical lead in the SAFe System Team: Maintain and update the SKA Software Engineering Process documentation. Configure and manage the software support tools (Source code repository, workflow manager, issue tracker, CI system, documentation system etc.). Provide training and on-going support of the toolchain. Maintain an inventory of all software product and version dependencies. Work with the construction consortia to ensure best practices are

maintained during construction. Support element level integration and verification. Support system-wide integration and verification.

- Head of Telescope Controls
- Head of Data Processing

2.7.4 System Science



- System Scientist: System Scientist: Provides scientific advice and guidance for all elements of the SKA1 construction project implementation; assures that the system design and development are consistent with the science requirements and objectives. Supports development of science requirements, goals and objectives. Leads identification of science-engineering trades required to achieve project objectives within the schedule and resources available.
  Responsible for scientific aspects of commissioning and system verification, working closely with hardware and software engineering and AIV teams to ensure that the SKA meets its Level 1 requirements. Leads definition of the science verification process, in collaboration with Science Operations Team. This process will demonstrate whether the system meets science (Level 0) requirements.
- Lead Commissioning Scientist
- Commissioning Scientist

- SAFe Solution Manager
- Product Owner: Typically a scientist responsible for defining the priorities for the individual system's release development while maintaining the overall system integrity; responsible for accepting work as done.

2.8 SKA1 Construction Roles and Responsibilities

2.8.1 Agile Engineering and SAFe

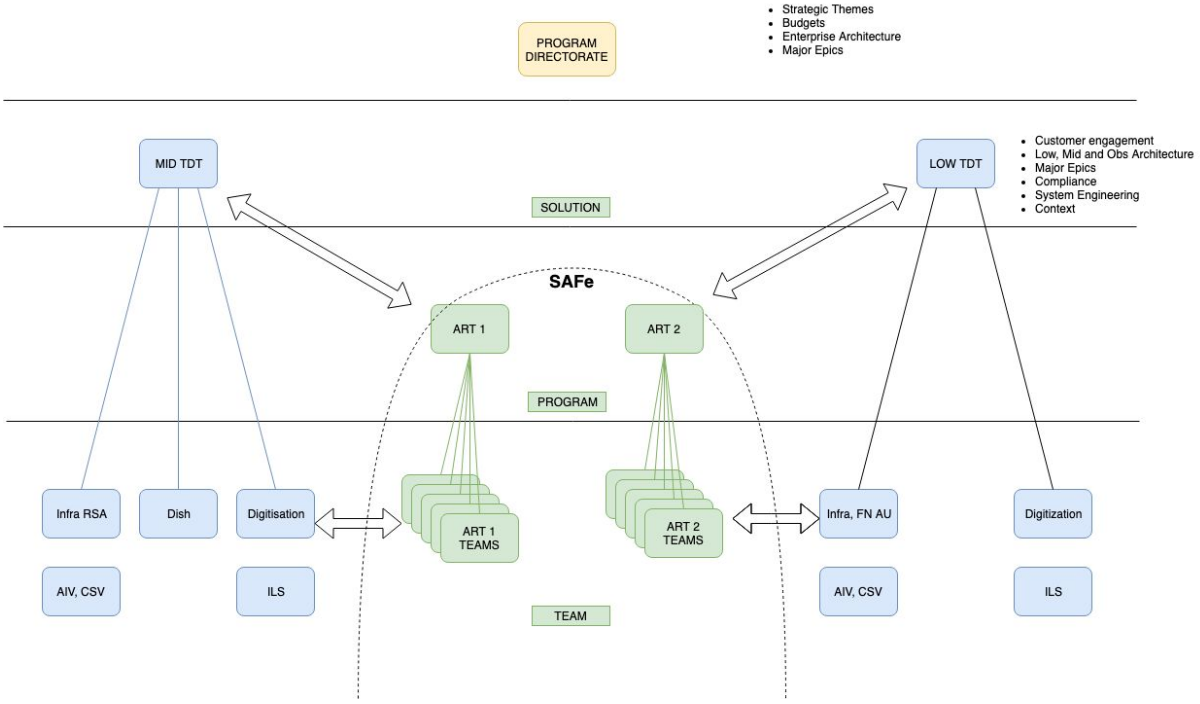
The SKA1 Project execution seeks to follow engineering best practice, in particular, the following approaches:

- lean engineering (system focus, eliminate waste, relentlessly cut areas with little or no value)
- agile engineering (develop working system, collaboration with customer, proactively respond to change)

will be built into the Project processes and schedule. Further, the software engineering development will follow the Scaled Agile Framework (SAFe) best practice (https://www.scaledagileframework.com/; see Section 11 for details).

These approaches will be tuned to the needs of the SKA1 Project execution and their details reconciled to represent a coherent set of roles, responsibilities and processes.

- SKA1 construction adopts a Project-level synchronisation cadence of 3 months, following from the SAFe practice. This synchronisation enforces an alignment in priorities between all development areas.
- SKA1 construction adopts a Project-level reporting cadence of 1 month for review and communication of status and KPIs (earned value, risk exposure, estimate-to-complete, etc).
- SAFe Agile Teams will deliver to Product Delivery Teams.
- SAFe Agile Release Trains will deliver to Telescope Delivery Teams.
- Observatory Level Integration will occur through the Programme Directorate employing the Program Board support.


PROGRAM DIRECTORATE
Strategic Themes
Budgets
Enterprise Architecture
Major Epics
MID TDT
LOW TDT
Customer engagement
Low, Mid and Obs Architecture
Major Epics
Compliance
System Engineering
Context
SOLUTION
SAFe
ART 1
ART 2
PROGRAM
Infra RSA
Dish
Digitisation
ART 1 TEAMS
ART 2 TEAMS
Infra, FN AU
Digitization
AIV, CSV
ILS
AIV, CSV
ILS
TEAM

	OLT	TDT - Mid	TDT - Low	DST	PDT1 INFRA	PDT2 Dish Structure	PDT3 Field Nodes	PDT4 Mid Rx	PDT5 Low Rx & CSP	PDT6 Networks	PDT7 CPF & SPC	PDT8 Clocks	PDT9 Central SW	PDT10 MeerKAT	PDT11 Support Equip.
000 - Observatory	x														
100 - LOW Telescope			x	x											
101 - LFAA							x		x						
102 - CSP - LOW									x						
103 - TM LOW													x		
104 - SDP LOW													x		
105 - SaDT LOW										x					
141 - SAT LOW												x			
514 - Low Telescope INFRA					x						x				
300 - MID Telescope		x		x											
301 - Dish						x		x							
302 - CSP MID									x						
303 - TM MID													x		
304 - SDP MID													x		
305 - SaDT MID										x					
307 - MeerKAT Integrated Segment														x	
308 - MeerKAT Interfacing Items														x	
341 - SAT MID												x			
410 - Mid Telescope INFRA					x										
400 - INSA MID					x										
401 - Site monitoring					x										
402 - Power System					x										
403 - Access					x										
405 - Buildings											x				
407 - Site comms					x										
409 - Security					x										
411 - Land					x										
412 - Construciton facilities					x										
500 - INAU LOW					x										
503 - Power					x										
505 - Site Monitoring					x										
506 - Site Comms					x										
508 - Buildings											x				
509 - Vehicles					x										
510 - Camps					x										
511 - Water & Sanitation					x										
513 - Access					x										
600 - Common		x	x												
601 - TM Observatory													x		
602 - EMS															x
603 - Helpdesk											x				
604 - SDP Obs tools													x		
F0000 - MeerKAT Infra											x			x	

Table: Representation of Telescope and underlying Product Delivery Teams along with key scope areas.

2.8.2 Site Construction Management

3 Design and Development

During the Pre-construction design and development, the SKA design was a global effort by 12 international engineering consortia representing 500 engineers and scientists in 20 countries all feeding in to making the SKA a truly exceptional instrument. The consortia were responsible for working out the look and functionality of the different elements of the SKA and ensuring that they will all perform together. The 12 consortia were made up of research institutions and industry partners which were spread across the globe, with each one having a designated lead institution that coordinates the work. They operated in conjunction with a specialist project manager based at SKA Headquarters in the UK (see Figure 8 for a high level representation of the organisation during this phase).

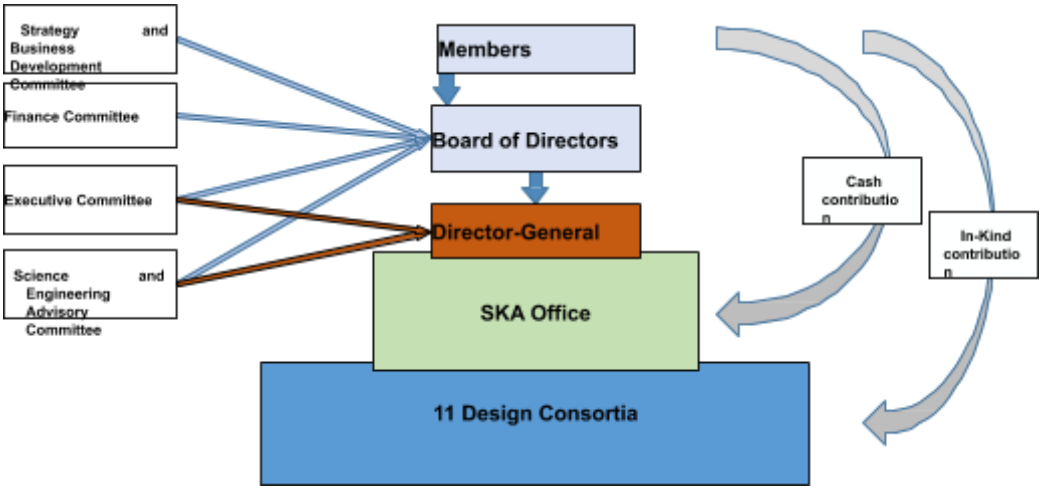


Figure 8 Pre-construction organisation.

Each consortium was tasked with designing a particular element of the SKA – from the very visible parts like the dishes or the infrastructure at each site, to the essential software and networking that allow the SKA's arrays to act as one enormous telescope.

The development budget from the combined membership is estimated at approximately €200M (through 2019) with a schedule outlined in Table x.

Nine of the consortia focused on a component of the telescope, each critical to the overall success of the project, while three others have focused on developing advanced instrumentation for the telescope.

- Assembly, Integration and Verification (AIV)
- Central Signal Processor (CSP)
- Dish (DSH)
- Infrastructure South Africa (INSA)
- Infrastructure Australia (INAU)
- Low-Frequency Aperture Array (LFAA)

- Signal and Data Transport (SaDT)
- Science Data Processor (SDP)
- Telescope Manager (TM)

Advanced Instrumentation Programme (AIP)

- Wideband Single Pixel Feeds (WBSPF)
- Mid-Frequency Aperture Array (MFAA)
- Phased Array Feed (PAF)

Element	RRN Submission	CDR Submission	CDR Meeting	CDR Close
AIV	29 Oct 2018	30 Nov 2018	04-07 Mar 2019	31 Mar 2019 Jun 2019 (Baselined)
CSP	18 May 2018	30 Jun 2018	25-28 Sep 2018 [PSS: 29-30 Jan 2018] [PST: 31-01 Feb 2018] [Mid.CBF 05-07 Mar 2018] [Low.CBF 08-09 Mar 2018]	31 Oct 2018 Feb 2019 (Baselined)
DSH	07 Sep 2018	28 Sep 2018	Jun 2020 26-27 Nov 2018 (Pre-CDR) [Dish Str: 23 Mar 2020] [LMC: 20 Sep 2018] [Rx B1,2: 13 Jun 2019] [SPF B1: 19 Sep 2018] [SPF B2: 11 Dec 2017] [SPF B5: 16 Dec 2019]	TBD Pre: Jul 2019 (Baselined)
INAU	19 Mar 2018	30 Apr 2018	27-29 Jun 2018	31 Jul 2018 Dec 2018 (Baselined)
INSA	19 Mar 2018	30 Apr 2018	02-04 Jul 2018	31 Jul 2018 Feb 2019 (Baselined)
LFAA	15 Oct 2018	29 Oct 2018	11-13 Dec 2018	31 Mar 2019 Jul 2019 (Baselined)
MeerKAT Integration	23 Jul 2018	NA	22-24 Oct 2018	28 Feb 2019 Apr 2019 (Baselined)
SaDT	17 Jan 2018	15 Mar 2018	15-16 May 2018 SAT 17-18 May 2018 Networks & Architecture	13 Jun 2018 Jan 2019 (Baselined)

SDP	17 Sep 2018	31 Oct 2018	15-18 Jan 2019	28 Feb 2019 Apr 2019 (Baselined)
TM	29 Jan 2018	28 Feb 2018	17-20 Apr 2018	30 Jun 2019 Jul 2018 (Baselined)

An essential part of each consortium's role was to ensure that their design ultimately enables the SKA to achieve its science goals. This means scientists and engineers have worked closely together to ensure that the final design meets the science community's requirements. To that end, the SKA formed the Science Working Groups (SWGs) to feed in to the process.

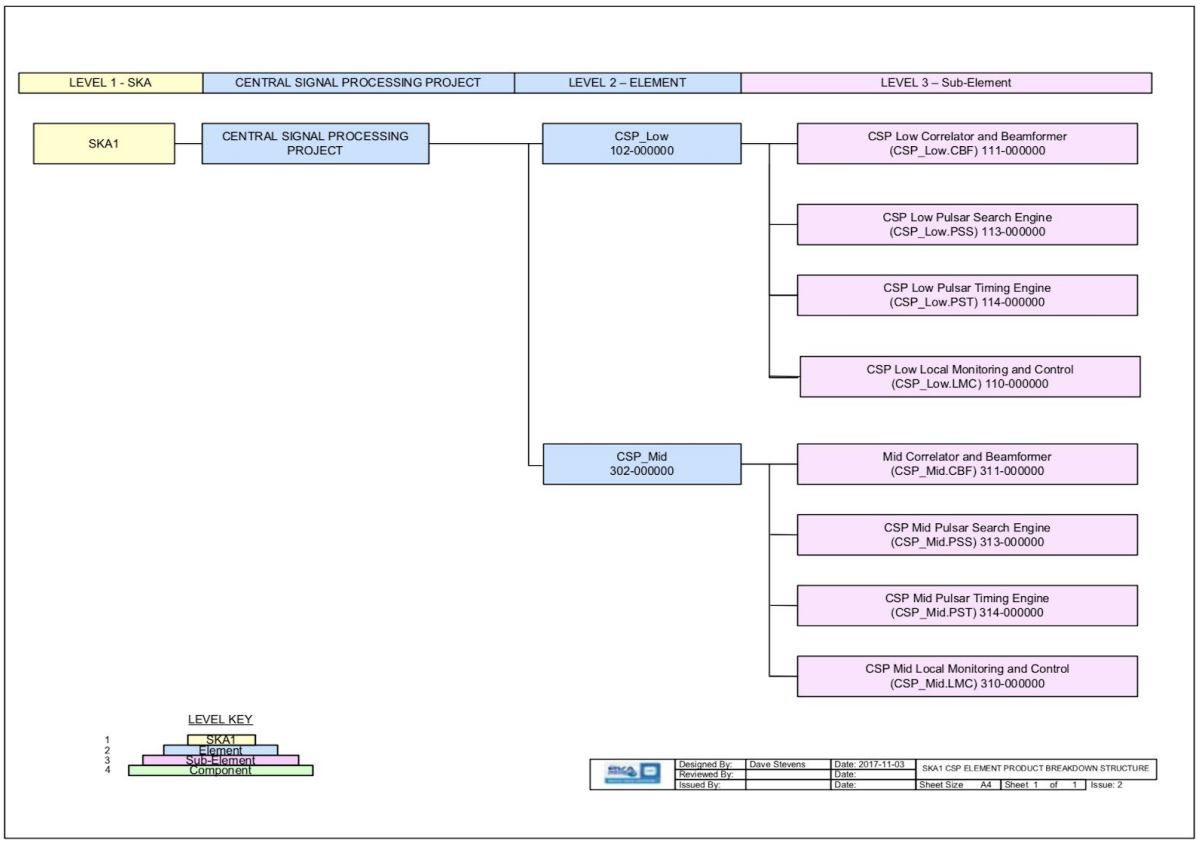
Since the consortia were first formed in 2013, the design of the SKA has evolved in response to available funding and to take account of scientific advances. In December 2014, the process reached its first milestone, with the start of the Elements' Preliminary Design Reviews (PDRs). Each consortium presented its detailed proposals for assessment by an expert panel from the SKA and external organisations, and the results were fed back into the ongoing design work.

There followed several years of effort by the international consortia to arrive at the Element Critical Design Reviews (CDR), which began in 2018 and continued until the overall System CDR in late 2019.

3.1 Pre-Construction SKA1 Design Consortia

3.1.1 Assembly, Integration and Verification (AIV)

3.1.2 Central Signal Processor (CSP)



3.1.3 Dish (DSH)

3.1.4 Infrastructure South Africa (INFRA SA)

3.1.5 Infrastructure Australia (INFRA AU)

3.1.6 Low-Frequency Aperture Array (LFAA)

3.1.7 Signal and Data Transport (SaDT)

3.1.8 Science Data Processor (SDP)

3.1.9 Telescope Manager (TM)

3.2 Critical Design Process

The critical design review definition is governed by document SKA-TEL-SKO-0000652. This document describes the two-part design process during the pre-construction.

3.3 System Critical Design Review

3.4 Design Baseline

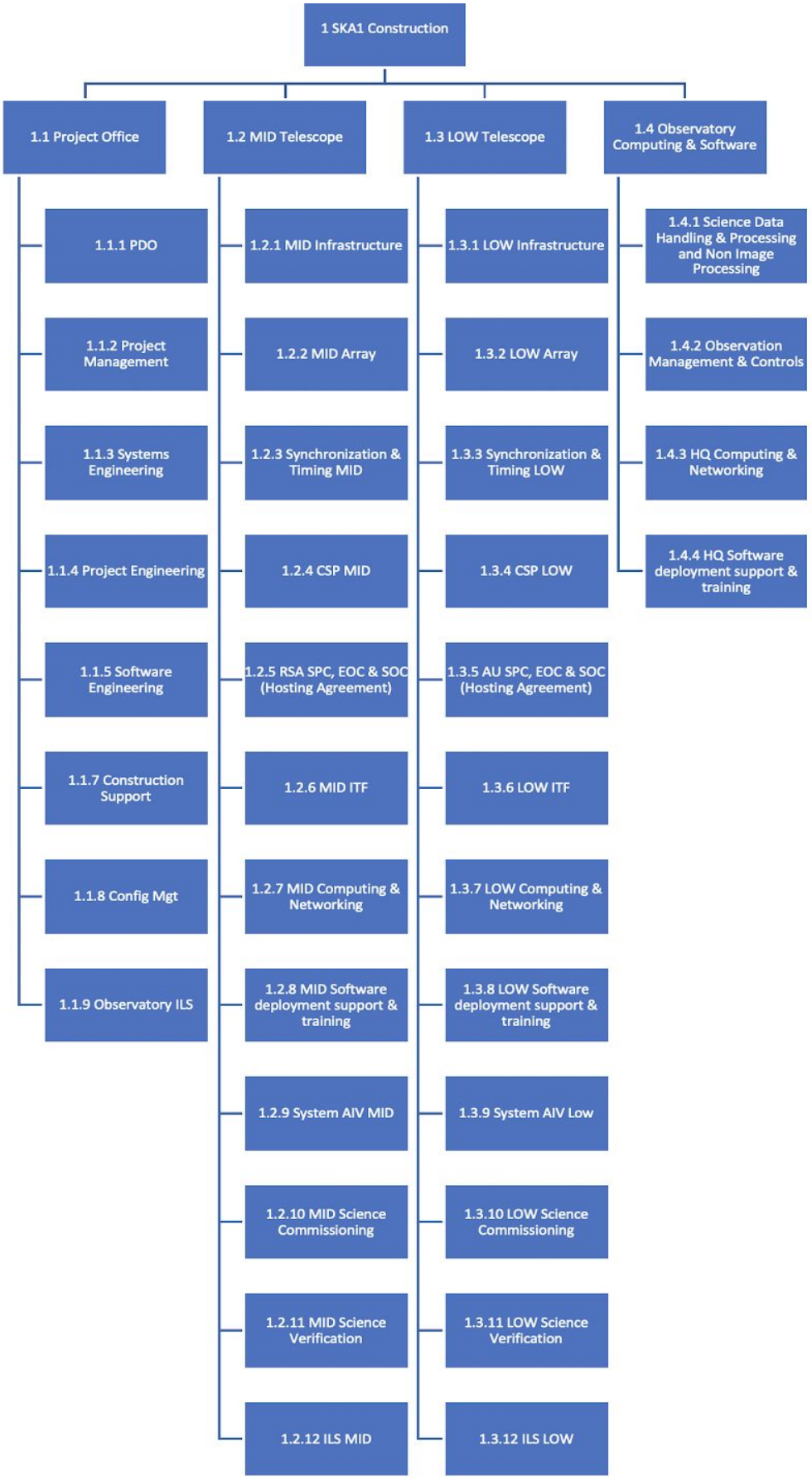
3.4.1

Figure 10 Pre-construction Consortia with their respective logos.

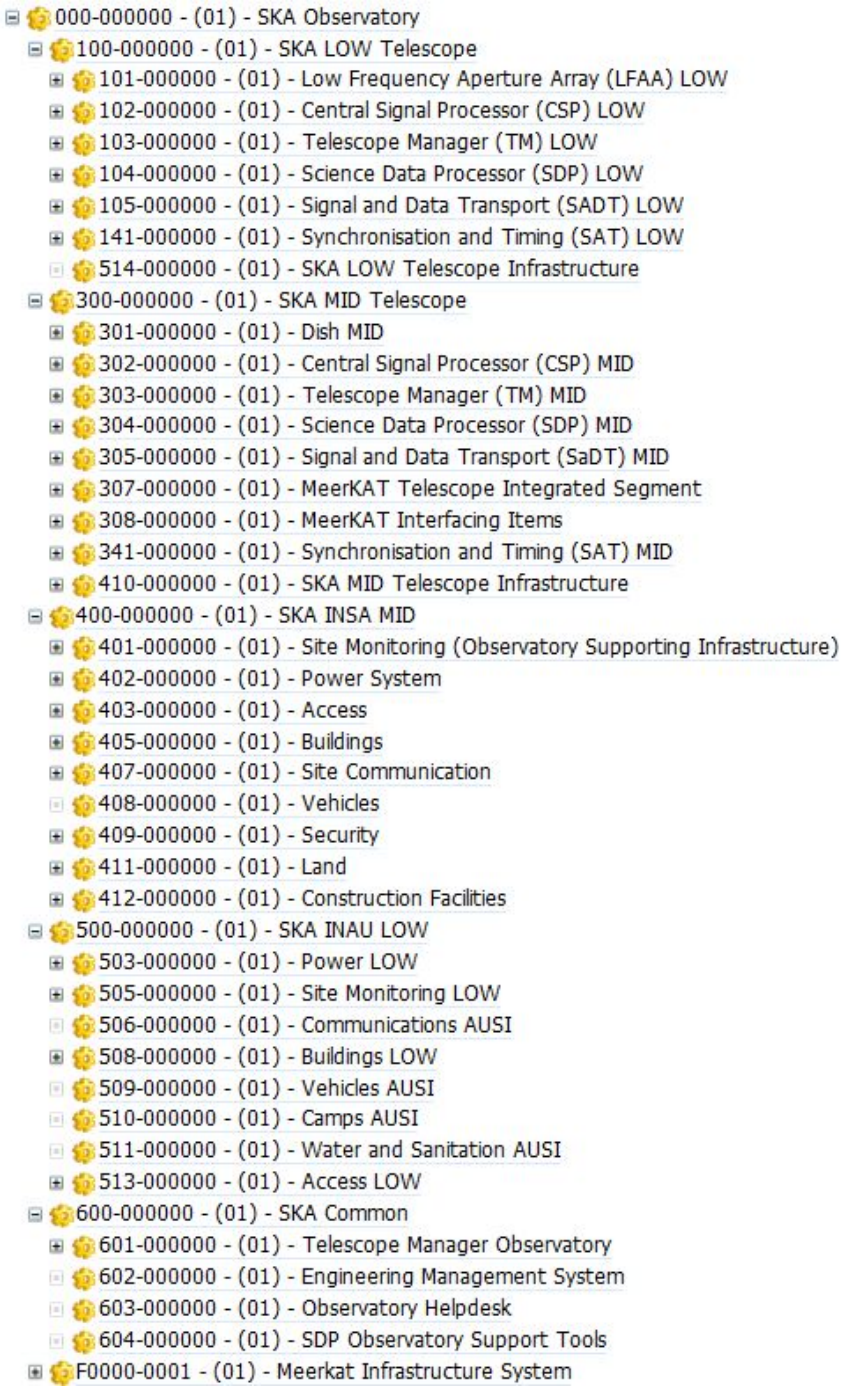
4 Construction Project Definition

4.1 Summary of Total Project Definition

4.1.1 Work Breakdown Structure


1 SKA1 Construction
1.1 Project Office
1.2 MID Telescope
1.3 LOW Telescope
1.4 Observatory Computing & Software
1.1.1 PDO
1.1.2 Project Management
1.1.3 Systems Engineering
1.1.4 Project Engineering
1.1.5 Software Engineering
1.1.7 Construction Support
1.1.8 Config Mgt
1.1.9 Observatory ILS
1.2.1 MID Infrastructure
1.2.2 MID Array
1.2.3 Synchronization & Timing MID
1.2.4 CSP MID
1.2.5 RSA SPC, EOC & SOC (Hosting Agreement)
1.2.6 MID ITF
1.2.7 MID Computing & Networking
1.2.8 MID Software deployment support & training
1.2.9 System AIV MID
1.2.10 MID Science Commissioning
1.2.11 MID Science Verification
1.2.12 ILS MID
1.3.1 LOW Infrastructure
1.3.2 LOW Array
1.3.3 Synchronization & Timing LOW
1.3.4 CSP LOW
1.3.5 AU SPC, EOC & SOC (Hosting Agreement)
1.3.6 LOW ITF
1.3.7 LOW Computing & Networking
1.3.8 LOW Software deployment support & training
1.3.9 System AIV Low
1.3.10 LOW Science Commissioning
1.3.11 LOW Science Verification
1.3.12 ILS LOW
1.4.1 Science Data Handling & Processing and Non Image Processing
1.4.2 Observation Management & Controls
1.4.3 HQ Computing & Networking
1.4.4 HQ Software deployment support & training

4.1.2 Product Breakdown Structure



4.1.3 WBS Dictionary

The Project WBS Dictionary is contained in SKA-TEL-SKO-0001101.

4.1.4 WBS Status

Tabular view of WBS status (high level indication of the maturity, readiness for procurement).

4.2 Baseline Budget

Tabular view of funding profile by year.
Tabular view of budget break down by WBS elements (total).
Graphic of S-curve for planned value.

Table of annual construction cost estimate in 2017 Euros (M) split by internal and contract

	2021	2022	2023	2024	2025	2026	2027	2028
Contract								
Internal								
Total								

Table of annual cost estimate in 2017 Euros (M) by WBS

	2021	2022	2023	2024	2025	2026	2027	2028
01.01 Project Office								
01.02 Mid Telescope								
01.03 Low Telescope								
01.04 Observatory Computing & Software								
Total								

4.2.1 Cost Book and Basis of Estimate

The SKA Cost book (SKA-TEL-SKO-0001102) provides the detailed budgeting information down to the work package level. SKA-TEL-SKO-0001200 provides the details on the project processes, measurements and metrics for monitoring and controlling the project during its execution.

4.3 Baseline Schedule

The baseline schedule completion date for the construction phase is March 31, 2028.

4.3.1 Level 1 Milestones and Critical Path

Table/Schedule of Level 1 Milestones out to 2028; propose:

- Permits in place
- C0 (first contract agreed/granted)
- Infrastructure completion
- AA0.5
- AA1.0
- AA2.0
- Observing Modes Verified
- AA3.0
- Observing Modes Verified
- AA4.0
- Observing Modes Verified
- Operations Acceptance Review

Table view of Level 1 milestones with baseline finish, previous month finish, current month finish, delta from baseline and delta from previous month.

Primavera output of SKA1 Integrated Project Schedule Critical Path

4.3.2 Integrated Project Schedule

The Integrated Project Schedule is maintained in Primavera (see SKA-TEL-SKO-0001200 SKA1 Project Management Controls System).

4.4 Contingency

Contingency is described in detail in SKA-TEL-SKO-0001200 SKA1 Project Management Controls System.

4.4.1 Scope Contingency

Any issues that arise that are beyond our ability to handle through risk management must be handled through de-scopes. The project maintains a de-scope list (including considerations for feasibility, Health, Safety & Environmental impact, Cost-Schedule impact, Technical impact, Science impact, Operations impact, Upgradeability, Timeline of Opportunity) and is actively maintained. There are approximately €xx.xM in de-scopes possible with moderate impact.

4.4.2 Budget Contingency

The initial budget contingency was developed using a standardized risk analysis algorithm applied to each individual work package/activity. The cost estimators evaluate technical, cost, and schedule risk for each element. The initial framework is based on established values used by similar projects (LIGO, SSC, ICECube, LSST, ALMA, etc) and derives from Large Project Cost Estimating Guidelines. The risk factoring details employed are described in SKA-TEL-SKO-0001200 SKA1 Project Management Controls System. The risk factoring provides the initial contingency pool to allow the project to manage the represented uncertainties and still deliver the project scope within budget and schedule.

The contingency funds developed by this risk assessment process are held by the Programme Director and lose their identification with the WBS component that was used in the estimating process. Contingency is held by the Programme Director to provide flexibility to manage within the established Performance Measurement Baseline. The project tracks the amount of contingency available versus the percent of the project completed and the exposure from identified risks. SKA-TEL-SKO-0001200 describes the development of the risk register for management of the budget contingency during the project execution.

EVM Status Report	**€M**	**Description**
EVM Reporting Date	Jun 2020	Date of the report
Total Project Cost (TPC)	€691	Performance Baseline+Contingency
Member Funding To-Date	€0	Amount of funding received to date
Budget at Completion (BAC)	€	Approved Budget
Planned Value ($M)	€	
Earned Value ($M)	€	
Actual Costs ($M)	€	
% Complete (Planned)	0%	PV/BAC*100%
% Complete (Actual)	0%	EV/BAC*100%
% Complete (Spent)	0%	AC/BAC*100%
Cost Variance (CV)	€0.0	EV-AC
Schedule Variance (SV)	€0.0	EV-PV
Forecast		

Estimate at Completion (EAC - €M) EAC_1: AC+(BAC-EV) EAC_2: AC+(BAC-EV)/(CPI*SPI)	 €691 €691	Latest updated budget estimate
Date of last EAC update	Jun 2020	Date of last update of the EAC
Unencumbered Funds	€x.x	TPC-BAC
Liens		Known costs, variances not in BAC
Budget Contingency	€x.x	Unencumbered Funds - Liens
Estimate to Complete (ETC)	€691.0	EAC_1-AC
	€691.0	EAC_2-AC
% Budget Contingency of ETC	xx.x%	$(BC/ETC_1)*100\%$
	xx.x%	$(BC/ETC_2)*100\%$
Risk Exposure		
Risk Confidence Level	80%	Confidence level of Risk Exposure
Critical Milestone Planned Date	Mar 2028	Planned Project end date
Critical Milestone Forecast Date	Mar 2027	Forecast Project end date
Schedule Contingency	12 mon	Amount of float/contingency

4.4.3 Schedule Contingency

Schedule contingency, as with budget contingency, represents the known unknowns in task duration for the various WBS components that will contribute to the overall duration of the project but that are not deterministic at the outset of the project.

Each work package has an assessed best-case and worst-case schedule scenario for completion. A Monte Carlo simulation of the project with these ranges indicated a 12 month schedule contingency (guess! – to be calculated) was required for the 80% likelihood of success.:

- Mar 31, 2028: Fiducial MC 80% project end date; we have sufficient risk exposure identified to extend the project completion to this date.
- Mar 31, 2027: The current approved baseline completion date; there are 12 months of schedule contingency remaining from this date to the Mar 31, 2028 date.
- Mar 31, 2027: The current IPS end date; this schedule will be reviewed monthly.

5 Staffing

5.1 Staffing FTE Plan

Section 2 covers the representation of the observatory organisation.

The time-phased representation of the projected construction phase roles is illustrated below (Note: This is in the BP but doesn't match the profile we submitted and is missing a year of construction).

	END-2019	CONSTRUCTION						EARLY OPS		ROUTINE OPS	
Position	**FTE**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
D-G Office	2	2	3	3	3	3	3	3	3	3	3
Administration	22.5	29.5	35.5	37.5	37.5	37.5	37.5	39	39	29	27
Communications	5	6	6	6	6	6	6	6	6	6	6
Comp.Softw & IT	15	21	43	57	65	89	98	98	98	95	95
Corporate Strategy	8.6	6.6	10	10	10	10	10	10	10	10	10
Eng. & Develop	42	59	64.5	73.5	78.5	84.5	84.5	78.5	75.5	49	49
Operations GHQ	7	9	11.5	11.5	10	11	15	18	20	19	18
Operations AUS	0	0	11	26.2	36.6	50.1	55.5	60.4	64.6	75	73
Operations RSA	0	0	11	25.7	38.1	54.6	62.7	67.6	71.8	104.1	102.1
Science	6	7	7	8	9	10	12	12	13	13	13
TOTAL	**108.1**	**140.1**	**199.5**	**255.4**	**290.7**	**355.7**	**384.2**	**392.5**	**400.9**	**403.1**	**396.1**
GHQ Total	***37***	***112.1***	***124.5***	***131.5***	***138***	***155***	***164***	***166.5***	***167.5***	***138***	***131.5***
GHQ	37	112.1	124.5	131.5	138	155	164	166.5	167.5	134.5	131.5
AUS	2	14	38	60.2	74.6	97.1	105.5	110.4	114.6	121.5	119.5
RSA	3	14	37	63.7	78.1	103.6	114.7	115.6	118.8	147.1	145.1
TOTAL	**108.1**	**140.1**	**199.5**	**255.4**	**290.7**	**355.7**	**384.2**	**392.5**	**400.9**	**403.1**	**396.1**

5.2 Recruitment, Termination and Transitions (to be completed by HR)

6 Risk and Opportunity Management

Risk factoring, identification, and monitor/control processes are discussed in SKA-TEL-SKO-1200 SKA1 Project Management Controls System. These topics are tightly coupled with the change management process which is also discussed in that document.
The Table of Contents for these sections are:

7 Project Engineering

SKA-TEL-SKO-0001300 SKA1 Engineering Management Plan provides an overview of SKA1 Engineering Management encompassing all project, software and systems engineering.
[Luca/Nick: TOC/Summary of doc]

8 Configuration Control

The change management process during the construction phase is elaborated in SKA-TEL-SKO-0001200 SKA1 Project Management Controls System.

9 Procurement [Ian]

- [Recommend move this to a separate document (SKA-TEL-SKO-0001400 SKA1 Financial and Business Systems) and provide just a pointer]

9.1 Policy

9.1.1 Definitions:

ERP System – means the SKA Observatory (SKAO)'s Enterprise Resource Planning system
Fair Work Return – is identified to have been achieved when the cumulative value of the goods, works and services provided by a Member through the procurement process, broadly reflects the financial contribution committed by that Member
Invitation to Tender - means the set of documents drawn up by SKAO for the purpose of inviting Suppliers to submit a bid for goods, works or services with an estimated value greater than EUR 200K
Legal Officer –a member of the SKAO legal team
Market Survey – means the set of documents drawn up by SKAO for the purpose of inviting Suppliers to express their interest in a forthcoming Invitation to Tender and providing them with the opportunity to pre-qualify for an Invitation to Tender
Member(s) -means both full Member State(s), and Associate Member States(s) on the terms determined by the Council

Procurement Officer –a member of the SKAO Procurement Services team

Procurement Procedures – agreed step-by-step sequence of activities that shall be followed in the same order to correctly procure goods, works and services
Procurement Services – the SKAO business function established and empowered conduct procurement on behalf of SKAO
Purchase Requisitions (Requisition) – a Requisitioner's request to order goods, service or works
Requirement - means a precise description of SKAO's needs.

Requisitioner – the SKAO representative of the end user of goods, works or services to be procured, in most cases the Requisitioner is also the budget holder
Staff Members - an individual bound by a contract of employment with the SKAO, a contractor engaged under a commercial contract to undertake specific tasks or render a specific service, or a secondee to the SKAO bound by a secondment agreement.
Supplier(s) – includes commercial companies and delivery partners participating in invitations to tender, price enquiries expressions of interest, calls for offers or having entered into a contract or other binding agreement with SKAO to perform contracts, including contracts for in-kind contributions.

9.1.2 Core Principles

The primary objective of procurement shall be to successfully acquire the goods, works and services required to deliver the SKA Project through financial contributions, whether cash or in-kind or a combination of both, while effectively managing risk.

Procurement shall be implemented based on principles of Fair Work Return, equity, transparency and competitiveness.

9.1.3 Policy Purpose Application and Responsibilities

This Procurement Policy applies to all Staff Members, including Procurement Officers, involved in the procurement process, whether as Requisitioners, purchasers, approvers including those members of staff accepting/rejecting goods, services or works and authorising payments to Suppliers.

This Policy commits the SKAO and all Staff Members involved in the procurement process to use their best endeavours and professional judgement to ensure that all procurement activities are compliant with this Policy.

Staff Members shall ensure that any third-party organisation or non-SKAO personnel engaged in procurement activities for, and on behalf of, the SKAO or designated for SKAO end use or onward supply, shall abide by and promote the principles contained within this Policy.

This Policy applies to all tendering and supplier selection activities carried out by the SKAO, all procurement related commitments to which the SKAO is, or intends to be, a party to, and to all agreements which amend, modify or terminate contractual rights, duties or obligations such as change orders, settlement of contract claims, letters of intent that authorise or commit work to be performed, notices of termination, notices of work suspension and the end-of- life disposal of SKAO assets.

9.1.4 Policy Limitations

The provisions of this Procurement Policy do not apply to those excluded agreements and services highlighted at Appendix 1 to this Policy.

9.1.5 Role of Procurement Services

The role of Procurement Services is to sustainably procure all supplies and services for SKAO, meeting the specified and contractual technical, delivery and performance requirements of our Requisitioners at the lowest possible overall cost, while considering Member state's work-return aspirations and otherwise respecting this Procurement Policy.

Procurement Services:

- Advises and supports SKAO Requisitioners and assists them in identifying procurement strategies, refining requirements and defining the best solutions within budgetary and time constraints;
- Follows up all commercial and contractual issues during the lifetime of all contracts and orders;
- Monitors and reports procurement activities and statistics, including Member Work Return statistics, to the SKAO management and Member states; and
- Proactively identifies, and where necessary qualifies, potential suppliers and contractors in all SKAO Member states.

To accomplish its mission and optimal use of SKAO's resources, Procurement Services defines and implements the necessary procurement policy, strategy, process, risk management and business controls as well as its own internal organisation.

9.1.6 Code of Conduct, Legality and Confidentiality

This Policy is based on public sector procurement ethics. The basic test is:

"Could SKAO defend its procurement actions in public?"

Procurement Services is, quite rightly, under constant scrutiny. Its activities are subject to internal and external audit to ensure probity and propriety. All key procurement documentation is retained securely in accordance with SKAO document retention policies.

There are four key principles underpinning SKAO's high standard of ethical behaviour:

- Staff Members do not allow (or foster any suspicion of) any conflict between SKAO and private interests;
- Staff Members are not influenced by any gift/consideration or show favour or disfavour to any person or organisation;
- Dealings with Suppliers are always honest, fair and even-handed; and
- These standards are promoted and supported by SKAO systems and procedures.

Procurement Officers shall maintain the highest standards of integrity in all business relationships, by:

- Rejecting any business practice which might be deemed improper;
- Never using their authority or position for their own financial or personal gain;
- Declaring to their line manager any personal interest, as soon as it arises, that might affect, or be seen by others to affect, their impartiality in decision-making;
- Ensuring that the information they give in the course of their work is accurate and not misleading;
- Never breaching the confidentiality of information they receive in a professional capacity;
- Constantly striving for genuine, fair and transparent competition;
- Being truthful about their skills, experience and qualification;
- Dealing with Suppliers promptly, courteously and professionally; and
- Avoiding responses to casual enquiries from Suppliers that could be misconstrued.

Suppliers participating in SKAO procurement activity shall adhere to the SKAO Supplier Code of Conduct. SKAO does not use Suppliers who we believe:

- Exploit people in a negative sense;
- Disregard health and safety legislation;
- Damage the environment; or
- Pirate intellectual property or breach intellectual property laws.

All procurement activities, and subsequent dealings with Suppliers, shall be carried out in an equitable, impartial and professional manner.

Safeguards and controls to ensure compliance with this Policy shall be established and maintained by SKAO.

9.1.7 Intellectual and Commercial Information

Procurement Officers shall protect intellectual property rights and commercial information from unauthorised access by third parties, or misuse by the parties bound by a contract. Procurement Services may suggest having a separate confidentiality agreement if the information that the Supplier will have access to is deemed to be highly sensitive. Any unauthorised disclosure of Supplier's commercial terms by Staff Members, especially prices or price differences, shall be regarded as a serious misconduct.

The results of the processes for opening commercial offers, their evaluation and award of contracts, and their details, are strictly confidential.

Particular attention shall be given to the circumstances under which the SKA Observatory has the right to disclose confidential information within Price Enquiries Market Surveys and Invitations to Tender.

9.1.8 Health and Safety

All applicable SKAO health and safety rules shall be specifically mentioned with all procurement specifications. All conditions affecting health and safety, either with respect to the design and testing of equipment, or for work on SKAO sites, shall always be explicitly presented in SKAO technical requirements.

9.1.9 Sustainability and the Environment

Sustainable procurement is about avoiding depleting natural resources. Procurement should take account of environmental, social and economic factors when making purchasing decisions. It is about looking at what products are made of, where they have come from, and who has made them. It is even about looking at whether the purchase needs to be made at all.

SKAO shall identify the environmental impacts within our supply chain and we shall work with Suppliers to embed and manage sustainable practices within their organisation and drive such practices within their own supply chains.

SKAO shall work with Suppliers to reduce their environmental footprint through:

- Conservation of resources, including the use of energy, water and materials;
- Waste minimisation, both within their operations and through reduction of non-reusable packaging;
- Reducing the impact of transportation and maximising local sourcing; and
- Applying the principle of 'whole life costing' to promote sustainable procurement. This looks at all life-cycle costs (including disposal costs) of goods or services and makes sure they are minimized.

9.1.10 Language

All procurement documentation and written exchanges between SKAO and Suppliers shall be in the English language.

9.1.11 Commitments

No financial liability shall be incurred without the prior approval of the corresponding budget holder.

All Supplier commitments must always be in writing and in effect prior to the commencement date of any work.

All Purchase Requisitions must be approved in the ERP System before any procurement activity is initiated. The resulting purchase order or contract must be approved in the ERP System before it is sent to the Supplier.

Letters of intent or authorisations to proceed shall only be used in exceptional circumstances and must be pre-approved by the Director-General regardless of value.

9.1.12 Segregation of Duties and Documentation of Activity

Wherever possible the requisition, procurement, acceptance and payment for goods and services shall each be actioned by a different Staff Member. In all cases the specific Staff Member actioning any of these procurement related activities shall be documented and clearly identifiable in SKAO records.

All steps within the procurement process shall be appropriately documented within the SKAO ERP System. As a minimum, the following shall be recorded:

- Justification of the initiation of a procurement action, including the purchase or contract requisition;
- The process for making key procurement decisions, including the entire supplier selection process and any subsequent contractual agreement;
- Acceptance or rejection of all goods, works and services;
- The destination of all goods or services received;
- The nature, justification for and amount of all Supplier payments made in relation to procurement; and
- End of life disposal of SKAO assets and any payments made or received in relation to disposal.

9.1.13 Equal Treatment of All Member Suppliers

Procurement from Suppliers within Member states is preferred. The Procurement Procedures shall treat all Member Suppliers equally and fairly.

9.1.14 Basis for Procurement

Similar requirements arising at the same time or expected to arise in a limited time-span shall be covered by a single contract.

Requirements shall not be fragmented into several smaller procurements or be broken down into several quantities of similar items.

9.1.15 Competitive Process Principles

Competitive bidding is the SKAO's preferred method for Supplier selection.
As a rule, SKAO's tendering procedures shall be selective and shall not take the form of open invitations to tender or open price enquiries.

If an Invitation to Tender has been sent to a sufficiently large number of Suppliers, the procurement is considered competitive even if the number of subsequent offers is less than three.

Whenever competitive bidding is not used to select SKAO's preferred Supplier, the reasons for applying an alternative award criterion must be fully documented and justified within a Single Source Justification. The Single Source Justification shall be included as an annex to the award recommendation document.

Clarifications related to tender submissions are permissible, however negotiation of submitted bids will not be carried out with Suppliers if, in the opinion of the Head of Procurement Services, it will violate the principles of fair and transparent competition between Suppliers.

9.1.16 Tender Evaluation Criteria

SKAO shall evaluate Supplier tender returns using two principal methodologies:

- Lowest-priced technically compliant: the contract is awarded to the lowest-priced tender that complies with the technical requirements. This methodology is appropriate for goods, especially relatively straightforward commodity goods (commonly available on the market) or basic services.

- Most Economically Advantageous Tender (MEAT): the contract is awarded to the tender with the best price-quality ratio, considering the selected weighted criteria justified by the scope and nature of the contract. This evaluation methodology is appropriate where quality is a key consideration and complex goods that are not commonly available on the market, particularly those with a significant design element, services and works.

Both evaluation method and award criteria where MEAT is applied must always be indicated within the Price Enquiry or Invitation to Tender package.

9.1.17 Waivers

In order to deviate from the principles established in this Policy, the Procurement Services must seek a Policy Waiver from the Council.

A Policy Waiver request should be presented by the Director General.

The request should clearly identify:

- The alternative process to be followed;
- The Procurement Officer responsible for the business case and carrying out the process;
- The justification for why the alternative procurement process would provide better outcomes for SKAO;
- A clear demonstration of how the alternative process remains aligned to the delivery of Fair Work Return, equity, transparency, and competition and; and
- a clear outline of how the alternative process will remain adherent to the requirements of Paragraph 11, 'Segregation of Duties and Documentation of Activity'.

Council will then make a majority decision whether to authorise the deviation based on the business case.

9.1.18 Deviations without Waiver

In a case where there is a deviation from this Policy, undertaken without a waiver, any outcomes of the procurement process which has deviated may be disregarded. A unanimous decision of the SKAO Council may choose either to:

- Restart the procurement process from whichever stage the deviation first occurred; or
- Continue with the deviated process, including awarding the contract to a Supplier under the deviated process.

In making this decision SKAO Council will consider the extent to which the deviated process meets the requirements of: Equity, Transparency, Competition (Value for Money) and Fair Work Return.

If a unanimous decision cannot be reached the choice shall be made by a majority decision of the Council.

In any case the Procurement Officer responsible for the deviation may be held to account in line with the SKAO Code of Conduct or prosecuted under criminal or civil law.

9.1.19 Entry into Force and Amendments

This Procurement Policy shall be approved by the SKAO Council by unanimous vote.

Amendments to this policy can only be made by a unanimous vote of the SKAO Council.

Amendments to the associated procurement procedures and process can be made by a majority decision of the Finance Committee. Any amendments to procurement procedures must be consistent with all elements of this Policy.

9.1.20 Fair Work Return

Fair Work Return shall be managed through the application of a work return weighting mechanism. The pre-defined weighting scheme will be applied in order to advantage Suppliers from Member States who are furthest from achieving Fair Work Return.

9.1.21 Continual Improvement and Staff Development

SKA Procurement Officers shall have in place an individual plan, agreed with their line manager for the development of skills and knowledge relevant to their procurement work at SKAO.

This plan will include remaining informed on prevailing trends in public and private sector procurement and considering how to implement emerging best practice into SKAO procurement activity.

Annex 1 – Policy Exclusions

- Collaboration Agreements
- Routine employment contracts
- Export Control Agreements
- Material transfer of ownership or title agreements
- Data sharing agreements
- Services acquired from International Government Organizations, governments or government regulatory bodies or agencies
- Lease and rental agreements for real estate
- Non-procurement related MOUs, letters of intent and heads of agreement which do not commit SKA funds or commit SKA to perform work
- Non-Procurement related confidentiality agreements and non-disclosure agreements
- Royalty payments
- Ex-gratia payments and honoraria

9.2 Procurement Procedures

9.2.1 Definitions

Contract – is a legally binding or valid agreement between two parties including purchase orders.
ERP System – means the SKAO's enterprise resource planning system.
Industrial Liaison Officer (ILO) – means a representative of a SKAO Member state. responsible for ensuring the proper contacts and flow of information between SKAO and Suppliers in the Member State concerned.
In-Kind Contribution – means means a non-cash contribution of goods, services or works to the SKA Observatory by a Member State in consideration for an agreed Cost Book Value.
Internal Audit - the SKAO business function established and empowered by the Director General to verify compliance with these procedures
Invitation to Tender (ITT) – means the process described in paragraph X to these procedures.
Local Warehouse - a location for storing goods before they are requested for use by the Requisitioner.
Market Survey – means the process embedded within the ITT process described in paragraph X to these procedures.
Member(s) -means both full Member states and Associate Member states of the SKAO, except where expressly stipulated otherwise.

Member Work Return - is the combined value assigned to a Member of all procurements and the agreed value of in-kind contributions of the Member to the SKA Observatory, as a percentage of the Member's total contribution to the SKA Observatory.
Open Competitive Tender – the Contract opportunity is advertised on the SKAO procurement web portal and the Supplier does not need to be pre-qualified to bid.
Purchase Order – is a form of Contract that is normally used for the supply of tangible goods or simple, low value services or works.

Procurement Officer – general term for a member of SKAO's Procurement Services team
Purchase Requisition (Requisition) – a Requestor's request to procure a Contract.
Punch-out Catalogue -means the ERP System functionality which gives Requestors direct access via SKAO's on-line procurement system to the catalogues of Suppliers offering negotiated prices for agreed items.
Request for Quote (RFQ) - is the SKAO process described within paragraph X to these procedures whose purpose is to invite Suppliers into a bidding process to Tender for Contracts with an estimated value greater than EUR 10k and less than EUR 200k.
Requestor – the SKAO representative of the end user of goods, works or services to be procured, in most cases the requestor is the budget holder.
Requirement - means a precise description of SKAO's needs.

Restricted Competitive Tender – the Contract opportunity is advertised on the SKAO procurement web portal and the Supplier needs to be pre-qualified to bid.
Single Source – means a procurement situation where two or more Suppliers can supply, but only one Supplier invited to tender.
Sole Source - only one Supplier can supply.

Supplier(s) – includes commercial and non-commercial entities participating in pre-qualification, Requests for Quotation and Invitations to Tender or having entered into a contract or other binding agreement with SKAO.

Tender – is any valid commercial offer for goods, works or services capable of acceptance.

Tenderer - mean a Supplier who has submitted a tender.

Tender Evaluation Committee (TEC) – A Tender Evaluation Committee is a committee that is constituted for the purpose of evaluating procurement action specific pre-qualification returns and tenders with a value greater than EUR 200k.

9.2.2 Core Principles

Procurement is the overall process of acquiring contracts for goods, services and works.

The primary objective of procurement is to successfully acquire the goods, works and services required to deliver the SKA Project through financial contributions, whether cash or In-Kind Contributions or a combination of both, while effectively managing risk.

Procurement is implemented based on principles of Fair Work Return, equity, transparency and competitiveness.

9.2.3 Purpose

The purpose of this section is to set out the various procedures to be followed by all Staff Members involved in the procurement of Contracts for SKAO.

9.2.4 Expected results

Compliance with these procedures is expected to result in SKAO procurement activities that:

- Meet SKAO operational requirements at the right time and the right price;
- Promote competition, reflect fairness and ensure value for money;
- Stand the test of external scrutiny;
- Give Suppliers confidence that they will have equal opportunities; and
- Avoid nugatory work and unnecessary administrative burden for Staff Members and Suppliers.

9.2.5 Scope

These procedures cover the various cash procurement business processes including:

- Planning of procurement activities;
- Development of technical requirements;
- Supplier selection;
- Tendering;
- Tender evaluation;
- Contract award; and
- Contract management and close-out.

9.2.6 The Role of Procurement Services

Procurement Services has delegated authority from the Council to procure Contracts in accordance with the Procurement Policy and these Procedures in order to achieve the following strategic objectives:

- Provide strategic, tactical and transactional procurement expertise to SKAO Staff Members;
- Protect SKAO's interest when procuring Contracts;
- Develop and maintain these procurement procedures and associated business processes;
- Provide the professional capability and competence to enable SKAO to procure Contracts;
- Document all significant steps of the procurement process;
- manage the end-to end Supplier selection process; and
- Close-out Contracts, ensuring that contractual obligations are met and potential issues, if any, are resolved.

Requestors are responsible and accountable for creating technical and Schedule requirements and evaluating all Tenders against these requirements.

Post Contract award, Requestors are responsible and accountable for the general technical, schedule and managerial performance of the Supplier. However, Procurement Services will provide commercial and contractual advice to the Requestor as and when requested or under the circumstances outlined at paragraphs X and Y of these procedures.

9.2.7 Supplier Relations

All Staff Members must maintain and practice the highest possible standards of business ethics, professional courtesy and competence when dealing with Suppliers.

Staff Members shall not use their authority or influence with Suppliers for personal gain.

9.2.8 Strategic Procurement Planning

Strategic procurement planning ensures that Procurement Services is sufficiently informed to plan the necessary procurement resources required to predictably and professionally transact SKAO procurement business in accordance with these procedures.

Strategic procurement planning is essential for the effective and timely solicitation of quotations, tenders, award of Contracts in order to meet Requestor's operational needs.

Properly planned procurements provide Procurement Services and Requestors with the best opportunity to meet operational requirements and obtain value for money.

At least annually, the Head of Procurement Services will formally consult with all SKAO Heads of Department in order to ascertain the timing and magnitude of all Contracts with a value greater than EUR 200k required during the following twelve months.

This consultation takes the form of a written structured request for information and follow up meetings to reconcile operational requirements and spikes in workload for Procurement Services.

The output of this process is a report, endorsed by both Heads of Department and Procurement Services containing the following information:

- Title of procurement and a brief technical description;
- Unusual risks or novel constraints;
- Estimated Contract value;
- Date of planned availability of scope of work and technical requirements;
- Required delivery dates; and
- Anticipated contract signature date.

A summary of this report is presented to Finance Committee in order to plan Contract award approvals.

For planning purposes, it can be assumed that all significant procurements with a value greater than EUR 1m will normally require 9 months to develop from the point Procurement Services receives an approved Purchase Requisition to the point of making a Contract award.

Heads of Department and Requestors should inform Procurement Services as soon as possible of any material changes to need dates that could affect procurement planning.

9.2.9 Planning Individual procurement actions with an Estimated Value Greater than EUR 200k

Before work is initiated to procure an individual Contract with an estimated value greater than EUR 200k the Procurement Officer and the Requestor develop and publish a detailed procurement plan.

This procurement plan describes the procurement process to be followed and recommends either the Negotiated Award Procedure or the Invitation to Tender (ITT) Procedure.

The default position is the ITT Procedure unless there is an overwhelming and justified business need to follow the Negotiated Award Procedure.

Procurement plans for Contracts with an estimated value less than EUR 200k are approved by the Procurement Office and the Requestor.

Procurement plans for Contracts with an estimated value greater than EUR 200k are approved by the Head of Procurement Services and the Requestor.

The Head of Procurement Services and the Director-General review and approve all procurement plans recommending the Negotiated Award Procedure.

The Requestor should attach the approved procurement plan to the Purchase Requisition.

After conclusion of the Market Survey and pre-qualification the validity of the use of the ITT Procedure might need to be reassessed by the Procurement Officer based on the final number of pre-qualified Suppliers interested into tendering.

If there are fewer than two pre-qualified Suppliers the Procurement Officer amends the procurement plan to recommend that the Negotiated Award Procedure is followed, and the revised plan is reviewed and approved by both the Head of Procurement Services and the Director-General.

All material amendments to procurement plans result in a requirement to re-approve.

9.2.10 Purchasing Thresholds

The following table indicates the correct procedure to be followed for procuring Contracts based on an estimated value threshold:

Estimated Procurement Value	Procurement Procedure
Less than EUR 1k	Ad-hoc Procedure ● Self-service via Punch-out Catalogue on ERP System, or ● Corporate credit card ● ● No
between EUR 1k and 10k	Low value Purchase Order Procedure ● Self-service via punch-out Catalogue on ERP System, or ● Supplier(s) selected by Requestor ● Tender(s) obtained by Requestor ● Requestor generates a Purchase Requisition using ERP system and attaches Tender(s) ● Multiple Tenders preferred however, at least 1 Tender is required ● Contract prepared and sent by Procurement Services

Greater than EUR 10k and less than 200k	Request for Quote (RFQ) Procedure • Requestor generates a Purchase Requisition using ERP System • Open Competitive Tender procurement action led by Procurement Services • At least 3 Tenders required • Evaluation of Tenders by Procurement Services • Award approval in accordance with Paragraph X of these procedures • Contract prepared and sent by Procurement Services
Greater than EUR 200k	Invitation to Tender Procedure • Requestor generates a Purchase Requisition using the ERP System • Procurement plan required • Invitation to Tender Procedure, or • Negotiated Award Procedure • Evaluation of Tenders by Tender Evaluation Committee • Award approval in accordance with paragraph X of these procedures • Contract prepared and sent by Procurement Services

9.2.11 Award Authority

Any Contract for approval by the Finance Committee, the Director-General or the Head of Procurement Services must be presented with the following documentation:

- Summary of Contract (or Purchase Order);
- Evidence of approved Purchase Requisition;
- Consolidated final scoring sheet is signed by all members of the Tender Evaluation Committee;
- Signed Award Recommendation Document; and
- Summary of procurement process, including any approved waivers.

PROCEDURE	PRICE LEVEL	AWARD DECISION BY:	CONTRACT TYPE
Competitive Procurement (ad-hoc, low value, RFQ, ITT)	above EUR 500K	Finance Committee upon recommendation from the Director-General	Contract
	EUR 200K to 500K	Director-General upon recommendation by the Tender Evaluation Committee	Contract
	Above EUR 50K to non-Member State	Director-General upon recommendation by Head of Procurement Services	Purchase Order or Contract
	EUR 10K to 200K	Head of Procurement Services	Purchase Order or Contract
	EUR 1K to 10K	Procurement Officer	
Single Source Procurement	above EUR 250K	Finance Committee, upon recommendation from the Director-General	Purchase order or contract
	EUR 150K to 250K	Director-General	
	EUR 10K to 150K	Head of Procurement Services	
	Above EUR 50K to non-Member State	Director-General upon recommendation by Head of Procurement Services	Purchase Order or Contract
	below EUR 10K	Procurement Officer	Purchase Order

9.2.12 Definition of Technical Requirements

The creation and approval of technical requirements is the responsibility of the Requestor. Requestors should inform Procurement Services of their requirements as early as possible in order

to permit plan a schedule of events that will allow for the appropriate procurement procedure to be followed correctly.

For procurements with a value likely to exceed EUR 200k the Requisitioner should always account for the following steps in their planning:

- Market Survey and pre-qualification of Suppliers; and
- Coordination with, and inputs from, ILOs.

Specifications are drafted as functional and/or performance specifications. In order to leave flexibility to Suppliers in the elaboration of their Tenders, only technical specifications which are regarded as essential should be precisely specified. Care should be taken to avoid technical requirements which are:

- Unnecessarily rigorous;
- Inappropriately vague; or
- Favouring a specific Supplier

9.2.13 Purchase Requisitions

A Purchase Requisition is the means by which Requestor identifies and submits a request to Procurement Services in order to initiate the procurement of a Contract.

Sourcing from a Punch-out Catalogue automatically creates a Purchase Requisition in the ERP System.

The Requestor must generate all other Purchase Requisitions using the ERP System. All Purchase Requisitions must include:

- A clear, concise statement of the purpose of the procurement;
- Cost centre number;
- Estimated value supported by a cost estimate, quotation or pro-forma invoice;
- Complete description of goods, services or works required;
- Technical specifications including background information;
- Supplier contact details (where known);
- Single Source justification if applicable; and
- Sole Source justification if applicable.

The Purchase Requisition should be created at the earliest practical stage to gain the optimum benefit from the expertise of Procurement Services.

Repetitive requirements (including service contracts over several years) which can be foreseen may not be broken down into several Purchase Requisitions with the objective circumventing approved

procurement thresholds. Every effort should be made to by the Requestor to identify such repetitive requirements in order to maximise single order sizes and benefit from cost breaks.

Procurement Services will initiate planning before receiving an approved Purchase Requisition. However, transactional procurement activity will only be initiated by when Purchase Requisition has been funds-checked through the ERP System and approved in accordance with paragraph X of these procedures.

If a Contract is created for a value less than the value of the Purchase Requisition any excess commitment in the ERP system will be returned to the budget holder.

9.2.14 Approval of Purchase Requisitions

After a Purchase Requisition has been raised in the ERP System it is automatically funds checked by the ERP System to ensure the necessary budget is available.

After funds checking the Purchase Requisition is automatically routed to the budget holder for approval who is responsible for checking the Purchase Requisition and all supporting documentation.

After approval by the budget holder the Purchase Requisition is automatically routed through the ERP System for further approvals.

After the Purchase Requisition is fully approved, it is automatically received by Procurement Services for processing.

Purchase Requisitions for goods sourced from Punch-Out Catalogues are automatically converted into a Purchase Order and sent to the Supplier after final approval.

Procurement Services will not process a Purchase Requisition until it is fully approved in the ERP System.

Purchase Requisitions are based on an estimated value, this value can be lower than the final Purchase Order or Contract value.

The ERP System contains a tolerance that allows a Purchase Requisitions to be converted to a Contract even if the final value is greater than the Purchase Requisition value. The tolerance value, which may be a fixed percentage or a series of fixed values according to the threshold in force, are set, amended and approved by the Finance Committee.

If the price variance between the Purchase Requisition and the Contract is within the tolerance limit, the Contract can be created without any re-approval of the Purchase Requisition.

However, if the tolerance value is exceeded the Requisitioner will need to amend the Purchase Requisition to match the final Purchase Order or Contract value and it will need to be resubmitted through the ERP System with the actual Contract value for re-approval.

9.2.15 Requests for Information (RfI)

A Request for Information (RFI) is primarily used by both the Requestor and Procurement Services to gather information for the market to assist with procurement planning.

The Requestor is empowered to lead a RfI exercise without oversight by Procurement Services.

The speculative nature of a RfI is always made clear to Suppliers and any included RfI should only request indicative, budgetary or rough order of magnitude pricing information.

Terms and conditions, payment terms or need dates should never be included in a request for information although indicative lead times can be requested.

RfIs are not covered by these procedures however, care should be taken to ensure that Suppliers do not obtain privileged information than might give them a competitive advantage when responding to any subsequent Market Survey, RFQ or ITT.

9.2.16 Tender Evaluation Methodologies

SKAO evaluates Tenders using two principal methodologies:

A. Lowest Priced Technically Qualified Tender

This methodology is to be used for evaluation of Tenders for relatively straightforward commodity goods (commonly available on the market) or basic services resulting from the Request for Quote process described in Procedure X.

The lowest priced technically qualified offer is always accepted under this methodology

This evaluation methodology should not be used for the evaluation of tenders for complex services or works where quality is a critical factor.

The application of the lowest priced technically qualified evaluation methodology is described in Procedure X.

B. Most Economically Advantageous Tender

The most economically advantageous tender ('MEAT') evaluation methodology allows for greater emphasis on qualitative, technical and sustainability aspects of a Tender to be considered when making a Contract award decision.

Tenderers are required to present their offers against clearly defined award criteria. Each award criterion is assigned a minimum "pass-mark" and a weighting; and an overall technical/price weighting is agreed.

Applying this evaluation methodology enables technical quality to be assigned a higher weighting than price.

Standard weighting is a maximum of 60% for technical and a minimum of 40% for price, however this is variable. Weighting are proposed by the Requestor and approved by the Procurement Officer for RFQs; for ITTs, the overall technical/price weighting is proposed by the Requestor and the Procurement Officer and approved by the Head of Procurement Services.

The price quoted by the Tenderer is an objective element and should not be weighted or scored.

When applying this methodology, a specific scoring for price is applied. The price element score is calculated by awarding the compliant offer with the lowest price the maximum score and by awarding the other compliant offers a score that is reduced in proportion to the fractional increase in the price of the offer relative to the lowest compliant price. For example, if Tenderer X offers EUR 100 and Tenderer Y offers EUR 120, then Bidder X gets 50 from the available 50 points and Bidder 2 gets 40 from the available points (20% less because of a 20% higher price).

This evaluation methodology is appropriate for more complex, high value Contracts, particularly those with a significant design element, services and works.

9.2.17 Tender Evaluation Committee

A Tender Evaluation Committee ("TEC)" is an ad hoc committee set established by Procurement Services to provide technical assistance when procuring Contracts with an estimated value greater than EUR 200k. The objectives of the TEC are to:

- Review Supplier selection (pre-qualification) criteria
- Review Contract award criteria and any weightings to be applied;
- Evaluate Supplier pre-qualification returns and subsequent Tenders;
- Confirm that evaluations and final evaluation reports are logical and consistent; and
- Verify that procurement is correctly documented.

TECs are established on a case by case basis and the composition and competencies of a TEC varies according to technical requirements.

A TEC is not required for the evaluation of pre-qualification returns and tenders with a value less than EUR 200k under this value Tender evaluation can be carried out by the Requisitioner and the Procurement Officer.

The TEC is comprised of a chairperson, a secretary, the Requestor and another technically competent person, preferably not drawn from the Requestors technical division. The chairperson and secretary are normally provided by Procurement Services. The Head of Procurement Services can elect to combine both chairperson and secretary roles.

The chairperson and secretary are not normally empowered to evaluate and score technical submissions.

A TEC is established by Procurement Services at the outset of each individual Contract procurement no later than starting the Market Survey.

A TEC is comprised of members holding relevant and adequate technical and professional expertise. For a complex procurement action, the Head of Procurement Services may consider the

appointment of external members with expertise to support a TEC. A member of the SKAO Finance Department and or in-house legal team may also be appointed to a TEC to assist with complex commercial evaluations. However, they are not empowered to evaluate technical submissions.

Nomination and approval of composition of a TEC shall be managed as follows:

- For Tenders with an estimated value greater than EUR 200k but below EUR 2.5m the Head of Procurement Services nominates and approves the composition of a TEC.
- For tenders with an estimated value greater than EUR 2.5m the Head of Procurement Services nominates a TEC and the Director-General approves the membership.
- The Head of Procurement Services chairs all TECs where the procurement action has an estimated value greater than EUR 5m.

A member of a TEC may not delegate their participation to another person.

All members of a TEC, including the chairperson must complete and sign a Declaration of Impartiality which is returned to the Head of Procurement before any sensitive information related to the Invitation to Tender is distributed. If the Head of Procurement Services is acting as the chairperson their Declaration of Impartiality is returned to the Director-General.

The Declaration of Impartiality form covers:

- Any potential conflict of interest situation with any of the Suppliers; and
- previous employment with any of the Suppliers.

The Head of Procurement Services and/or Director-General will review all Declarations of Impartiality and replace any members as required.

A TEC is primarily, but not exclusively, concerned with evaluating and scoring technical submissions.

Evaluating commercial submissions, including the validation of pricing, is the primary role of Procurement Services.

The segregation of duties within a TEC is designed to ensure that technical evaluations are carried out without reference to pricing information.

When calculating a Tenderer’s overall weighted score, the TEC will meet to agree a normalised overall score for each of the individual award criteria, a mathematical average award criteria scores is not be applied.

9.2.18 Instructions to Proceed

Staff Members are not permitted to create new financial liabilities, including amendments to Contracts that increase existing liabilities, with Suppliers without prior approval through the ERP System.

Instructions to proceed, authorisations to proceed or letters of intent are not permitted unless their use is approved by the Director-General.

9.2.19 Internal Audit

Internal Audit evaluates and monitors compliance with these procedures and may carry out checks against all stages of the procurement process.

9.2.20 Supplier Selection Procedure

Wherever practical the SKAO is committed to competitively sourcing from Suppliers in Members states.

Contracts are considered to have been competitively sourced if the Request for Quotation or Invitation to Tender has gone out to a sufficiently large number of Suppliers (three or more), even if the number of Tenders received is less than three.

Contracts with an estimated value of less than EUR 200k are procured by Open Competitive Tender unless a Restricted Competitive Tender is justifiable and approved by the Head of Procurement Services.

Contracts with an estimated value greater than EUR 200k are procured by Restrictive Competitive Tender unless the requirement is for simple commodity goods and the Head of Procurement considers that pre-qualification of Suppliers is not required and approves procurement by Open Competitive Tender.

The selection of Suppliers for RFQs and ITTs is the responsibility of Procurement Services. The list of Suppliers contacted will be created to create a balance, whenever possible, between the Member states.

Unless there are valid business reasons endorsed by the Head of Procurement, no more than five Suppliers from each Member state will be included for any RFQ or ITT.

The selection of Suppliers from non-Member states is permissible when there is a clear technological advantage for doing so, when there is a proven significant financial or time savings, or when there are no competent Suppliers within any of the Member states.

All procurements with a value greater than EUR 50k from non-Member States must be put forward by the Head of Procurement Services and approved by the Director-General.

ILOs are actively involved in the identification of Suppliers within their respective countries for all procurements with an expected value greater than EUR 200k.

ILOs are provided with 3 weeks advance notice of all Market Surveys including a summary of the requirements to be posted and the qualification criteria for Suppliers. This advance notice allows ILOs an opportunity to contact prospective Suppliers and encourage them to respond positively to the Market Survey on the web portal.

Procurement Services consolidates the list of Suppliers from:

- Inputs received from Requestors;
- Inputs received from the web portal; and
- pre-qualified registered Suppliers known to Procurement Services.

After consolidation the Procurement Officer develops a final list of Suppliers with the Requestor and, if the expected Contract value is greater than EUR 200k the Supplier Qualification procedure is initiated.

9.2.21 Supplier Qualification Procedure

The purpose of pre-qualification is to determine if a Supplier is qualified to participate in an Invitation to Tender.

Pre-qualification ensures Suppliers have the minimum required competency, resources, experience and process standards to perform Contracts, validating the Supplier's capability to reliably perform in a manner compliant with SKAO expectations with an acceptable level of risk.

Suppliers seeking to Tender for Contracts with an estimated value greater than EUR 200k must first be pre-qualified before being shortlisted to receive an ITT.

The Head of Procurement Services can consider and approve a higher or lower pre-qualification threshold based on the complexity and risk of the Contract to be tendered.

The qualification of Suppliers is led by the Procurement Officer under the oversight of the Tender Evaluation Committee.

Pre-qualification is carried out according to the following standard process:

Procurement Services and the Requisitioner jointly prepare a Pre-Qualification pack which is forwarded the Tender Evaluation Committee for review and approval before being sent out to all Suppliers expressing an interest in taking part in the ITT.

All Suppliers have a minimum of 21 calendar days to return a compliant pre-qualification pack response and any associated information.

A Pre-Qualification pack comprises:

- Cover letter, including instructions;
- Selection criteria;
- Technical summary;
- Pre-Qualification Questionnaire (PQQ);
- Outline procurement schedule;
- Quality assurance questionnaire;
- Supplier Code of Conduct declaration; and
- Safety questionnaire.

The PQQ, signed Supplier Code of Conduct Declaration and any supplementary materials requested within the cover letter must be returned by the Supplier in the correct electronic format.

PQQ questions should be developed in order to accurately determine if a Supplier has the necessary financial, economic, quality, technical and professional capacity and competencies to perform the Contract scope of work in a manner compliant with SKAO expectations.

PQQ questions should be clear, transparent, non-discriminatory and proportionate to the subsequent Contract. PQQ questions should allow for measurable and verifiable responses by Suppliers and be devised to allow clear pass or fail assessments to be made against each of the questions.

Supplier information requested in the PQQ should be restricted to the nature of the subsequent ITT (if the ITT relates to electrical engineering the PQQ should be based on Supplier competency in electrical engineering). Care is required when developing PQQ questions to ensure that the field of potential Suppliers is not unduly narrowed down to the point where competition is adversely affected or impossible.

The PQQ should include questions that are specific to the technical requirements of the ITT and 'business generic'. Business generic PQQ question should cover the following:

- Financial stability;
- Experience in the sector/location;
- Relevant certification and compliance to standards;
- Health, safety and environmental considerations; and
- Supplier code of conduct considerations.

In addition, Suppliers need to demonstrate a level of commercial activity such that, if a Contract is awarded, the aggregate value of all SKAO Contracts with that Supplier would not represent more than 30% of the Supplier's annual turnover.

The Pre-Qualification pack should be sufficiently clear to preclude the need for Suppliers to request additional clarification during the pre-qualification procedure. However, if clarifications are requested the Procurement Officer either directly contacts the Supplier or seeks assistance from ILOs as appropriate.

Clarification questions from Suppliers can only be accepted in writing and only insofar as they are received seven calendar days prior to the closure of the pre-qualification exercise.

Issuing of responses to all clarification questions is the responsibility of the Procurement Officer. Clarification questions and answers are sent to all Suppliers and these become part of the pre-qualification record. The identity of the Supplier requesting clarification is withheld.

PQQ submissions are evaluated and scored by the Tender Evaluation Committee in accordance with Procedure X and a Final Qualification Report is developed by the Procurement Officer and jointly approved by both the Chair of the Tender Evaluation Committee and the Head of Procurement Services.

The Final Qualification Report either qualifies or rejects the Suppliers based solely on their formal responses to the PQQ and any associated materials submitted.

The Procurement Officer notifies both qualified and rejected Suppliers within five working days of publication of the Final Qualification Report and a copy of the notification is copied to the respective ILOs.

If there are no pre-qualified Suppliers, the entire process is cancelled, the pre-qualification pack will be re-worked, and the exercise is repeated.

9.2.22 Supplier Registration Procedure

Procurement Services is responsible for approving and registering Suppliers on the ERP System. General Supplier details, including the category of Contracts that the Supplier is pre-qualified to perform, are entered by Procurement Services.

Up to date copies of insurance certificates provided by registered Supplier, such as public liability and employer's liability insurance should be filed on the ERP System for all Suppliers registered to perform services and works.

Supplier Bank account details are entered on the ERP System by the SKAO Finance Team.

The SKAO approved Suppliers list is checked and reviewed annually by Procurement Services. All inactive Suppliers, or Suppliers performing services or works failing to supply up to date insurance certificates, will be deleted from the Approved Supplier List unless there is a valid commercial reason to retain their listing.

9.2.23 Ad-hoc purchasing Procedure

This procedure is for simple commodity goods with a value less than EUR 1k.

Requestors should source their requirements from the SKAO Local Warehouse or from one of the Supplier Punch-out catalogues on the ERP System. After sourcing the required goods from the Supplier Punch-out catalogues Requestors should 'check-out' electronically.

After check-out the Requestor's Purchase Requisition is automatically generated and routed to the budget holder for approval. After approval by the budget holder the Purchase Order is automatically raised and sent to the Supplier by email without intervention by Procurement Services.

If the Requestor's requirements cannot be satisfied from a Punch-out Catalogue the Requestor should follow the Low Value Purchase Order Procedure or use their corporate credit card to make the purchase in accordance with the SKAO Corporate Credit Card Policy.

Ad-hoc purchases can be made in local currency.

Services and/or works (including software as a service or software support) should not be procured using the ad-hoc purchasing procedure.

9.2.24 Low Value Purchase Order Procedure

This procedure is for simple commodity goods or low risk, clearly defined services with an estimated Contract value between EUR 1k and EUR 10k.

Whenever possible Requestors should source their requirements either from the SKAO Local Warehouse or one of the Supplier Punch-out Catalogues on the ERP System.

If the required goods are not available from a Punch-out Catalogue, or the requirement is a service or works, the Requestor is empowered to solicit written email offer(s) or pro-forma invoice(s) from Suppliers without requesting assistance from Procurement Services.

Multiple offers are preferred; however, one only one written Supplier offer is required.

The Requestor generates a Purchase Requisition in accordance with Procedure X and attaches electronic copies of Supplier offer(s) and/or pro-forma invoice(s).

If only one Supplier offer is attached to the Purchase Requisition the Requestor should attach a note explaining why multiple offers have not been obtained.

If there are multiple offers, the Requestor raises the Purchase Requisition based on the offer and/or pro-forma invoice provided by the lowest priced technically compliant Supplier.

If the Purchase Requisition is not based on the lowest priced technically compliant offer, the Requestor must clearly justify the reasons why they have used a higher prices compliant offer within the Purchase Requisition.

After approval by the budget holder the Purchase Requisition routes automatically through the ERP System to Procurement Services for checking and processing.

Procurement Services reviews the Purchase Requisition, the Supplier offer(s) or pro-forma(s) and any supporting justification provided by the Requestor. If the Purchase Requisition is complete and acceptable, Procurement Services will register the Supplier in accordance with Procedure X (if they are not already registered) and issue a Purchase Order to the Supplier.

Purchase Orders can be priced in local currencies.

The Procurement Officer is empowered to approve, sign and release the Purchase Order.

9.2.25 Requests for Quotation (RFQ) Procedure

This procedure is for goods or services with an estimated value between EUR 10k and EUR 200k.

The Requestor generates a Purchase Requisition in accordance with Procedure X.

After approval, the Purchase Requisition routes through the ERP System to Procurement Services and is assigned to a Procurement Officer for sourcing and Contract development.

It is the responsibility of Procurement Services to finalise and release the RFQ based on the Purchase Requisition received from the Requestor.

The Procurement Officer selects Suppliers using Open Competitive Tender.

Procurement Services publishes the Tender opportunity on the SKAO web portal and Suppliers have 14 calendar days to register interest.

The published RFQ opportunity includes:

- Title of planned procurement;
- Brief technical description;
- Delivery need dates;
- Evaluation criteria; and
- Outline of procurement planning including closing date likely award date.

A maximum of five Suppliers from each Member State (shortlisted by Procurement Services) that have correctly registering interest in the opportunity, plus other Suppliers selected by the Procurement Officer from the approved Suppliers list are sent the RFQ.

Suppliers have a maximum of 14 calendar days to respond to the RFQ.

Due to the simplified nature of the RFQ procedure the 'Lowest Priced Technically Qualified Tender' evaluation methodology described in Procedure X is normally applied although the 'most economically advantageous tender' methodology can also be applied if deemed more appropriate by the Procurement Officer.

Suppliers should follow the RFQ instructions and send their offer to the electronic bid-box in two separate electronic envelopes, one envelope containing the technical proposal and the other, the commercial proposal (pricing).

Only offers received in the SKAO electronic bid box by the specified closing date, in the specified format are opened and evaluated by the Procurement Officer. All late offers or offers not received in the correctly specified format are returned to the Tenderer un-opened.

If fewer than three offers are received, the Procurement Officer prepares a summary note for file justifying the fact that fewer than three offers have been received.

Evaluation of offers is jointly carried out by the Requisitioner and the Procurement Officer who jointly draft a document recommending that the Contract is awarded to the lowest price, technically compliant Tenderer.

The award recommendation document is endorsed by the Procurement Officer and the Requestor and approved by the Head of Procurement Services.

Any RFQ resulting in a lowest commercial offer greater than EUR 250k is be cancelled and the procurement re-run as an Invitation to Tender.

The Procurement Officer is empowered to approve, sign and release any Contract resulting from the RFQ procedure if the Contract value remains under EUR 200k.

A TEC is not required under the RFQ procedure. Evaluation of Tenders and drafting of the award recommendation document is the responsibility of the Procurement Officer supported by the Requestor.

If the final Purchase Order or Contract value exceeds EUR 200k but is less than EUR 250k the award must be presented to the Director General for approval.

Clarification of pricing and scope of work is accepted up to Contract award. However, Procurement Services does not significantly negotiate prices of proposed scope resulting from a competitive procurement process with the intention of obtaining a more advantageous overall commercial position as this potentially impairs the principles of
fair competition

If only one quote is received the procurement is considered as competitive however Procurement Services is permitted to negotiate with the one remaining Tenderer with the intention of obtaining a more advantageous overall commercial position.

9.2.26 Invitation to Tender Procedure

This procedure is for goods or services or works with an estimated value greater than EUR 200k.

Before commencing any transactional procurement, activity or raising a Purchase Requisition the Procurement Officer and the Requisitioner develop and publish a procurement plan in accordance with paragraph X of these procedures and this needs to be attached to the Purchase Requisition.

The Requisitioner creates a Purchase Requisition in accordance with Procedure X.

After approval the Purchase Requisition routes through the ERP System to Procurement Services and is assigned to a Procurement Officer for sourcing and Contract development

The Invitation to Tender procedure, including all direct communication with Suppliers, falls under the direct responsibility of Procurement Services.

Before starting a Market Survey, Procurement Services constitutes a TEC in accordance with paragraph X of these procedures.

A Market Survey is a mandatory step in the Invitation to Tender Procedure that enables Suppliers to express an interest in being included in any subsequent tendering exercise.

All Market Surveys are published by Procurement Services on the SKAO web portal.

Procurement Services provide ILOs three weeks prior notification of all Market Surveys to be published on the web portal. This notification includes enough information to enable the ILOs to start prospecting and generating interest in the Market Survey within their own Member Country markets.

All Market Surveys published on the SKAO web portal should include the following minimum information:

- Title of planned procurement;
- Adequate technical description;
- Evaluation criteria to be applied;
- Basis of contract terms (e.g. NEC4 PSC contract with core options XYZ)
- Required delivery dates; and
- Outline of procurement planning including likely award date.

Suppliers have 10 working days to register their interest in submitting a Tender after which the Market survey is closed on the web portal.

No later than 10 working days after closure of the Market Survey, Procurement Services sends pre-qualification packs to all Suppliers who have registered interest in tendering and pre-qualification process described in Procedure X is started.

If less than 10 Suppliers express an interest in tendering the Head of Procurement Services can decide to combine the pre-qualification procedure and the ITT procedure into one seamless exercise.

Following pre-qualification, the ITT is issued electronically to pre-qualified Suppliers.

The ITT package is comprised of the following elements:

- Covering letter;
- Instructions to Tenderers including:
    - Terms and conditions of Contract;
    - Contract award criteria;
    - Tender acknowledgement form;
    - Tender Form covering pricing, currency, price type, revision formula;
    - Scope of work;
    - Approved technical requirements (including drawings);
    - Further information as required; and
    - Checklist.

If total cost of ownership or through life cost is a Contract award criterion stated in the ITT the Tender Form should be constructed to require the Tenderer to offer pricing for consumable items, spares packages, maintenance, support etc.

The ITT evaluation methodology and award criteria should always be extremely clear within the ITT documentation.

The Procurement Officer reviews the final ITT document with the Requestor before it is issued to pre-qualified Suppliers.

All offers submitted to SKAO as a result of an ITT must conform to a two-envelope presentation format, i.e. technical and financial offers must be separate and emailed to the electronic bid-box as two separate files.

If Pre-Qualification and ITT are combined into a single process, the ITT documentation must clearly indicate:

- Supplier Selection process;
- Contract award criteria; and
- Evaluation methodology.

The Procurement Officer issues the ITT to all pre-qualified Tenderers. The minimum deadline for submitting Tenders is eight weeks from the sending date of the ITT unless otherwise approved by the Head of Procurement Service.

All Suppliers intending to submit a Tender should return the tender acknowledgement form in accordance with instructions to tenderers.

Clarification questions related to the ITT must be received in writing no later than 15 calendar days before the Tender closing date.

Responding to requests for Tender clarification is the responsibility of Procurement Services.

Clarification questions and answers will be distributed to all Tenderers and these become part of the ITT documentation.

The name of the Tenderer requesting clarification will be withheld.

There might be specific circumstances when a clarification, and the corresponding response, will not be distributed to all Tenderers in order to protect a Tenderers proprietary information or intellectual property.

Requests to extend the ITT closing date will be considered by the Procurement Officer and approved by the Head of Procurement Services. No extension to the ITT closing date will ever be considered after the Tender closing date.

When necessary Procurement Services organises a tender conference and/or a site visit to ensure the understanding of the scope of work and technical requirements, and to familiarise Tenderers with a site.

For reasons of economy conducting tender conferences and site visits with individual Tenderers is not the preferred option and all Tenderers will be invited to a single conference and/or site visit.

If Procurement Services informs Tenderers that a tender conference or site visit is mandatory failure to attend is likely to result in disqualification.

If Tenderers have followed the instructions within the ITT, the commercial offer will be retained for evaluation by Procurement Services and the technical offer will be forwarded to the Tender Evaluation Committee for review and scoring.

Clarification of pricing and scope of work is accepted up to Contract award. However, Procurement Services does not significantly negotiate prices of proposed scope resulting from a competitive procurement process with the intention of obtaining a more advantageous overall commercial position as this potentially impairs the principles of
fair competition.

If there is a requirement to revise the requirements of ITT it is handled as follows:

- If the amendment is required before the ITT has been opened all Tenderers are given the opportunity to submit their Tender against the revised requirements and the Procurement Officer can consider, after consultation with the Requestor, granting an extension to the Tender submission deadline.
- If the amendment is required after opening of the Tenders all Tenders are given the opportunity to re-submit their Tenders against the revised requirements and the Procurement Officer and Requestor will extend the Tender submission deadline.
- If the amendment is required after completion of all Tender evaluations the effect of the modification(s) shall be negotiated by Procurement Services with the lowest priced compliant Tenderer if the financial impact can reasonably be expected to be smaller than the difference in price with the second lowest priced compliant Tender. However, If the amendment is required after completion of all Tender evaluations and the financial impact can reasonably be expected to be greater than the difference in price with the second lowest priced compliant tender the ITT is declared null and void and the ITT is repeated

When only one Tender is received the procurement is considered as competitive however Procurement Services is permitted to negotiate with the one remaining Tenderer with the intention of obtaining a more advantageous overall commercial position.

9.2.27 Contract Pricing Requirements

Fixed pricing is preferred, if Contract performance over several years is anticipated, fixed pricing, subject to a suitable price revision formula, is recommended.

The pricing section of both RFQs and ITTs should be constructed in such a way that there is no ambiguity. Pricing is requested using a Tender Form, signed by the Tenderer. The Tender Form includes a clear pricing matrix and an overall Tender price.

In order to treat all Members equally, irrespective of their geographical distance from the delivery point, ITTs must solicit pricing on FCA Incoterms (Free Carrier - Incoterms 2010).

A clear, well-constructed pricing matrix or table should encourage Tenderer's to offer an overall Tender price presented on a Tender Form. However, if calculation is required in order to derive the Tenderer's overall Tender price the Procurement Officer will calculate a price 'rack-up'. Complex price rack-ups should be avoided, if a complex rack-up is required the Procurement Officer's calculations should be double checked by a representative from the SKAO Finance Department and this should be noted within the final commercial evaluation scoring sheet.

All RFQs and IITs and subsequent Contracts with a value less than EUR 200k are be priced either in Euros or local currency. All RFQs and ITTs and subsequent Contracts with a value greater than EUR must be priced in Euros (EUR).

9.2.28 Tender Opening Procedure

Matters related to the opening and evaluation of Tenders are strictly confidential.

All Tenders should be opened simultaneously within just a few days of the ITT closing date.

In the case of a late Tender, a formal letter is promptly issued by the Procurement Officer to the concerned Tenderer giving the date and time of late receipt and informing them that their offer is being returned unopened.

Opening of the electronic bid box shall be carried out shortly after the Tender closing date by the nominated Procurement Officer in possession of the electronic access codes and witnessed by another Staff Member a witness. The electronic bid-box automatically keeps an audit trail of contents and records the date and time of opening.

The Procurement Officer carefully checks that Tenderers have strictly followed instructions that all administrative requirements indicated in the Invitation to Tender are met.

The Tenderers technical submission is always opened and evaluated first. Commercial submissions are only opened after approval of the final consolidated technical evaluation scoring sheet by the TEC.

A short note covering Tender opening and any immediate administrative checks is prepared by the Procurement Officer and signed off by the witness. This note is added to the procurement file.

9.2.29 Tender Evaluation Procedures

9.2.29.1 Lowest Priced Technically Qualified Tender

Requests for Quotation are normally evaluated using the Lowest Priced Technically Qualified Tender methodology described in paragraph X applied as follows:

- Technical and commercial offers are received in two separate envelopes;
- Only technical offers are opened and reviewed and all Tenderers achieving the agreed minimum 'pass-mark' against all technical criterion go through to commercial evaluation phase;
- Tenderers failing to achieve the required technical score are disqualified and their commercial offers are returned unopened;
- Commercial offers are evaluated against price only; and
- The Tenderer with the lowest price is always awarded the Contract.

9.2.29.2 Most Economically Advantageous Tender

Invitations to Tender are always evaluated using the most economically advantageous tender methodology described in paragraph X applied using the follows:

A. Check for compliance with Invitation to Tender instructions;
B. TEC kick-off meeting;
C. Technical compliance and qualitative evaluation;
D. Commercial evaluation, including pricing; and
E. Final award recommendation.

A. Checking Compliance with Invitation to Tender Instructions

The Procurement Officer should first check all offers for compliance against the Invitation to Tender instructions shortly after opening the electronic bid-box.

B. Tender Evaluation Committee Kick-off Meeting

At the TEC kick-off meeting the Procurement Officer first briefs the TEC and outlines the Tender evaluation process, the role of Procurement Services and the role of the TEC.

During the kick-off meeting, the detailed tender evaluation scoring sheets are presented by the Procurement Officer and agreed upon by all members of the TEC, noting that these scoring sheets must align with the ITT award criteria. The kick-off meeting is also an opportunity to discuss and

recommend the disqualification of non-compliant tender submission and agree the timeline for tender evaluations and finalisation of award recommendation.

Disqualification of Tenderers because they are non-compliant with the Invitation to Tender instructions is an extremely serious decision, therefore all disqualifications for this reason must be irremediable without affecting the integrity of the process and approved by the TEC, and the Director-General.

C. Technical Compliance and Qualitative Evaluation

Only tenders compliant with the Invitation to Tender instructions are evaluated by the TEC.

The Procurement Officer distributes the technical submissions to the TEC for evaluation and scoring. The Procurement Officer and Head of Procurement Services do not evaluate and score any technical submissions.

The TEC reviews and scores the technical proposals in accordance with the scoring sheets agreed at the TEC kick-off meeting.

Members of the TEC should take extra care when evaluating Tenderer's technical compliance against the agreed technical "pass marks" as non-compliance results in the disqualification of the Tenderer.

After each Member has evaluated and scored the Tenders, the Procurement Officer convenes a meeting of the TEC to discuss and agree a normalised technical scoring sheet for each proposal.

Tenders are normalised when all members of the TEC 'meet in the middle' and agree on a common score. The chairperson facilitates the normalisation process.

The Procurement Officer is responsible for preparing a final consolidated technical evaluation scoring sheet, the sheet should highlight Tenderers deemed technically non-compliant with a clear explanation and justification why.

The Procurement Officer should note all discussions pertaining to the normalisation of significant misalignments of individual scores in the award recommendation document.

The final technical evaluation scoring sheet is approved by the Chair of the TEC and the Procurement Officer.

D. Commercial Evaluation, Including Pricing

Only tenders compliant with both the Invitation to Tender instructions and the technical requirements are commercially evaluated.

Commercial submissions are only opened after completion of all technical evaluations, normalisation of scores and agreement by the TEC of the final technical evaluation scoring sheet.

Commercial submissions from Tenderers who have been evaluated as technically non-compliant are returned to Tenderers unopened.

The commercial terms quoted by the tenderer(s) are carefully analysed, in particular:

- Prices including checking for arithmetical errors;
- Price revision provisions (if applicable);
- Payment conditions;
- Non-compliances with SKAO proposed terms and conditions of Contract

The commercial elements of the Tenders are evaluated against the criteria established in the ITT.

The Procurement Officer documents the commercial evaluation and the final commercial evaluation scoring sheet is approved by both the Chair of the TEC and the Procurement Officer.

E. final Award Recommendation

The Procurement Officer takes the final technical and commercial scoring sheets, calculates the final overall score for each Tenderer, and prepares a consolidated final scoring sheet and award recommendation document.

The Tenderer with the highest overall score has made the most economically advantageous offer and is awarded the Contract.

Should two or more tenders have an equal overall score, the award is made to the Tenderer with the lowest price.

The consolidated final scoring sheet is signed by all members of the TEC. The Award Recommendation Document is signed by the Requestor, the Procurement Officer and the Chair of the TEC.

Procedures Common to both Evaluation Methodologies

SKAO shall not take undue advantage of any arithmetical errors within a Tenderers' offer.

If the Procurement Officer considers that a Tenderer's price is 'abnormally low', i.e. approximately 30% below the mean price, clarification will be sought from the Tenderer to ensure it is a realistic and sustainable bid.

The award criteria to be applied during evaluation must always be indicated in the RFQ or ITT. The evaluation criteria shall not be modified following release of the RFQ or ITT.

Tenderer's offers are evaluated solely based solely on information submitted in their tenders. If a tender contains information that is contradictory or unclear, the Procurement Officer seeks clarification from the Tenderer with the aim of better understanding the Tender. All requests for clarifications and subsequent Tenderer's responses must be in writing and logged by the Procurement Officer.

No material amendment of a Tender submission that affects the overall award recommendation, price or technical, is accepted as a result of a clarification question. Minor amendments, for example to correct arithmetical errors are permissible and are recorded in the final consolidated scoring sheet.

During or after clarification no material changes to either the technical or commercial offer are permitted by the Tenderer.

SKAO has no obligation to award a Contract, the Head of Procurement Services can declare to the Requestor that the RFQ or ITT has not been successful.

9.2.30 Negotiated Contract Award Procedure

This procedure is for goods, services or works with an estimated value between greater than EUR 10k where the Request for Quotation or Invitation to Tender process has identified that there is only one qualified Supplier and/or there are justifiable business reasons for either a Single Source, or Sole Source procurement action.

As soon as it is recognised that following a competitive procurement process is either not possible or unlikely to be successful the Requestor drafts a justification for either Single Source or Sole Source procurement in accordance with Procedure X and attached it to the Purchase Requisition.

If it is recognised that competitive procurement is either impractical or likely to be successful at the start of the procurement process, the justification for Single or Sole Source procurement is attached by the Requestor to the Purchase Requisition. If it is recognised that competitive procurement is neither practical or likely to be successful after an RFQ, Market Survey or pre-qualification process the justification for Single Source or Sole Source procurement is attached to the existing Purchase Requisition however re-approval via the ERP System is not required. If there is a tactical Procurement Plan, it is amended and requires re-approval.

In the event of a Sole Source or Single Source procurement action a modified RFQ or Invitation to Tender procedure will be followed that allows for the Tender to be negotiated (technical and commercial) to be negotiated in accordance with this procedure.

After receipt of the Tender in the electronic bid box negotiation meetings will be held with the Tenderer to interrogate the qualitative and financial aspects of their submission with the objective of concluding a mutually acceptable offer.

When this position has been achieved the Tenderer shall prepare a final offer which will be attached to the award recommendation. This document will include:

- Summary of market engagement activity including Market Survey and pre-qualification;
- Justification for either sole source or Single Source procurement;
- A description of the negotiation process, identification of the negotiation team;
- Any agreed deviations or waivers from standard procedure;
- Dhe summary of agreed changes and narrative describing to what extent these have been made in the final proposal; and
- A formal recommendation to award the contract.

The award recommendation document shall be submitted to the delegated governance authority for approval.

This information will be assessed by the SKA project team to ensure that costs are realistic and proportional. They will also assess the supplier's proposal against the relevant minimum standards.

This process shall be carried out so that commercial information is treated as strictly confidential.

9.2.31 Contract Award Recommendations and Award

After the appropriate evaluation methodology has been applied, and a preferred Tenderer has been identified, an award recommendation document shall be prepared that includes:

- A summary of pre-market activity, including the pre-qualification process, the Supplier selection process;
- A description of the entire tendering process;
- Any approved deviations or waivers from this Policy or procedures;
- A description of the evaluation methodology, identification of the evaluation team and a description covering its application; and
- A formal recommendation to award the contract.

The award recommendation document shall be submitted to the awarding body identified in Paragraph X of this procedure for approval.

Only Staff Members nominated by the Director-General are authorized to sign a Contract, or any amendment thereto covered by these procedures, on behalf of the SKAO after it has been approved in accordance with Paragraph X of this procedure.

For all RFQ's over EUR 10k and all ITTs the Procurement Officer shall inform all unsuccessful tenderers in writing once the Contract is signed.

9.2.32 Cooling Off Period

9.2.33 Conditions of Contract

9.2.34 Single and Sole Source Procurements

SKAO Procurement Policy requires that, wherever possible Contracts are procured competitively. However, it is recognised that there are circumstances when competition is not possible or viable and there are justifiable business reasons for a Single Source, or Sole Source procurement action.

If the planned Sole Source procurement has an estimated value less than EUR 200k the Requestor includes a Sole Source Justification with the Purchase Requisition and, if this is acceptable to the Procurement Officer, the Contract will be awarded to the Sole Source Supplier. If the justification is not valid the Procurement Officer works with the Requestor to identify alternative Suppliers.

If the planned single source procurement has an estimated value less than EUR 50k the Procurement Officer evaluates the Single Source Justification and if acceptable, the Contract will be awarded to the Single Source Supplier. If the justification is not valid the Procurement Officer works with the Requestor to identify alternative Suppliers.

If the planned single source procurement has an estimated value greater than EUR 200k the Director-General evaluates the Single Source Justification and if acceptable the Contract will be awarded to the Single Source Supplier. If the justification is not valid the Procurement Officer works with the Requestor to identify alternative Suppliers.

If the planned procurement has an estimated greater than EUR 200k and less than EUR 500k the SSJ is approved by Procurement Officer and the Head of Procurement Services.

It should be noted that there are very few justifications for Single Source procurement, a declared emergency can be considered as a valid justification however, ‘urgency’ is not normally considered a valid justification.

The following examples constitute valid justifications for Sole Source Procurements:

- Market Survey and pre-qualification have been carried out and there is only one qualified Supplier;
- Special equipment/services for which there is only one Supplier;
- spare parts and accessories for equipment already in service;
- Equipment to be integrated into an existing installation, in so far as such integration does not fundamentally alter the nature of the installation; and
- Standardised equipment.

Care should be taken by the Requestor and the Procurement Officer to identify Contracts that could potentially ‘lock-in’ technology creating subsequent Sole Source situations. An example of this could be a relatively low value evaluation Contract that recommends a proprietary Supplier technology

that gets 'locked-in' creating a situation where the Requestor is committed to procuring a subsequent higher value Contract from the same Supplier.

If the Requestor or the Procurement Officer consider that this type of Supplier 'lock-in' is possible the procurement procedure to be followed is based on the total likely value of all contracts with the same Supplier, e.g. in the above example the likely value of both the low value evaluation Contract and the subsequent the likely follow-on Contract should be combined in order to establish the procurement procedure to be followed.

9.2.35 Contract Amendments

Procurement Services ensures that all agreed technical and commercial changes are correctly included within the Contract. Requestors do not have the authority to commit the SKAO to Contract amendments.

A Contract amendment that increases the overall Contract value by less than 10% of the original Contract value can be approved by a person or authority with delegated authority to approve the incremental change in the Contract amendment.

A Contract amendment that increases the overall Contract value by more than 10% of the original Contract Value can be approved by a person or authority with delegated authority to approve the revised total value of the amended Contract.

9.2.36 Contract Close-out

A Contract close-out occurs when the SKAO and the Supplier have met all the terms of a Contract and all administrative actions have been completed, all disputes settled, and final payment to the Supplier has been made.

The Procurement Officer is responsible for verifying or completing the following key steps required to close a Contract:

- Confirmation that all goods and/or services have been provided;
- No open issues are pending on the Contract;
- Determining that any SKAO owned property has been returned to the SKAO; and
- Verifying that the final invoice has been submitted to and paid by FBD.

The Procurement Officer issues the close-out letter to the Supplier and archives the Contract file.

9.2.37 Penalty Provisions

When SKAO is responsible, in part or in full, for the failure of a Supplier to comply with their obligations a Contract amendment is required.

Penalties shall be applied in accordance with the Contract conditions.

Penalties are deducted from payments due to Suppliers.

The recommendation to waive all or part of the penalties owed by the contractor, or to accept compensation in kind requires the approval of:

- Finance Committee, upon recommendation from the Director General, for any penalty greater than EUR 1m;
- The Director General upon recommendation from the Head of Procurement Services for penalty values greater than EUR 100k and less than EUR 1m; and
- The Head of Procurement Services for penalties less than 100k EUR.

If the decision is taken to accept compensation in kind, this shall be documented as a Contract amendment.

9.2.38 Emergency Procurement Procedure

An 'emergency' is a sudden unforeseen event leading to injury, loss of life or critical damage to property or infrastructure.

This procedure outlines the procurement flexibilities that are available in such an emergency.

The SKAO planned response to an emergency is detailed in the Business Continuity Plan reference SKA-GOV-0000066.

Urgent situations that are created by a lack of planning or risk mitigation do not constitute an emergency.

Declaration of emergency
An emergency can be declared by the Emergency Response Team Leader, the Director-General or the nominated officer in charge.

In the event of an emergency Staff Members are permitted to forgo routine procurement procedures. In adopting a more flexible procurement Staff Members should consider what is reasonable and justifiable given all the facts and

9.3 Procurement Plan

[Andrea sketch of contracting timeline for construction]

T1 contract group (ranked by highest to lowest value and excluding Mgt/AIV/Logistics)	Proposed C0 start date (earliest is T0 + 6 months, currently 1st July 2021)
LOW Infrastructure	
Dish Structure	
MID Infrastructure	
LFAA Digital System	
MID CPF Computer room fit-out	
Observation Management & Control Teams	
MID CSP	
Field Node Procurement	
Science Data Handling & Processing Teams	
MID SPC Computer Room Fit-out	
LOW SPC Computer Room Fit-out	
LOW CSP	
Non-Image Processing Teams	
MID Digitization	
MID Network Fitout	
SPF Services Inc Vac & Controllers	
LOW CPF Computer Room Fit-out	
Band 2	
Cryogenics	
Band 5	
SAFe Program Level Science Data Handling and Processing	

SAFe Program Level - Observation Mgmt & Control (inc MCCS S/W)	
Band 1	
4.1 LOW Network Fitout	
MID Timing System (Part BTP and Part COTS)	
LOW Observatory Clock & Inst (COTS)	
MID Observatory Clock & Inst. (COTS)	
LOW Timing System	

Need to update table based on PM 1:1s ongoing in May 2019...new ones so far are:
MID software support
LOW software support
SKAO-SARAO Partnership Agreement
SKAO-CSIRO Partnership Agreement

10 Project Management Controls

The SKA1 Project Management Controls System (SKA-TEL-SKO-0001200) provides an overview of the SKA Construction Project Management Controls Systems (PMCS) and the details associated with the methodology for assembling the data, roles of contributors, tools infrastructure, reports, and how the systems have been implemented and are used on SKA to inform decisions.

The design, implementation and maintenance of the SKA1 PMCS are guided by the desire to satisfy its stakeholders and their respective requirements. The high level stakeholders include the:

- SKA IGO Council
- Member Country Funding agencies
- SKA Observatory
- Community of Radio Astronomers who will perform research with SKA

The Project PMCS provides information on:

- Cost Estimation and Budgeting
- Schedule Management
- Budget and Earned Value Management
- Reporting
- Risk Management
- Change Control Management

Roles and Responsibilities

Roles and responsibilities within the PMCS are as follows:

- Head of Project Management - Responsible for EPM training, support and development. Guides the use of PM processes and resources to provide guidance to achieve the project mission and to provide necessary stakeholder communications and reportings.
- Senior Project Manager - With respect to the PMCS, the Senior Project Manager is responsible for the overall facility level delivery of all Level 1 Milestones on schedule and within budget and as such is responsible for the project schedule, budget, earned value, and monthly reporting. Additionally, the Senior Project Manager supports the contingency and risk management for the overall construction.
- Engineering Project Manager (with paired Domain Specialist) - Point of ownership for planning, coordination and achievement for WBS elements and work packages for which they are designated as the EPM. Key responsibilities include management, execution and reporting of:
    - Schedule development including detail inputs for activities, logic and durations
    - Monthly schedule updates
    - Delivery of milestones
    - Budget estimating, management
    - Actual costs
    - Earned value & variance analysis/reporting
    - Risk management
    - Change management
    - Monthly report inputs
- Project Controls Manager - Responsible for maintenance of the project management control systems including scheduling, earned value management, budgeting, risk and change control. Ensures storage and retrieval of schedules, cost and related planning data.
- Change Control Board (CCB) - Responsible for reviewing, approving or rejecting all change requests that impact technical, cost and schedule performance.
- SKAO Finance - Responsible for all accounting related functions and providing the necessary data exports for import into the SKA1 earned value system (Cobra). Responsible for coordinating the establishment of new work packages (as needed) and the processing of invoices.
- Delivery Team - Provide subject matter expertise and key inputs to management team.

SKA1 PMCS RACI Matrix

The RACI model is a straightforward tool used for identifying roles and responsibilities and avoiding confusion over those roles and responsibilities during a project. The acronym RACI stands for:
Responsible: The person who does the work to achieve the task. They have responsibility for getting the work done or decision made. As a rule, this is one person; examples might be a business analyst, application developer or technical architect.

Accountable: The person who is accountable for the correct and thorough completion of the task. This must be one person and is often the project executive or project sponsor. This is the role that responsible is accountable to and approves their work.
Consulted: The people who provide information for the project and with whom there is two-way communication. This is usually several people, often subject matter experts.
Informed: The people kept informed of progress and with whom there is one-way communication. These are people that are affected by the outcome of the tasks, so need to be kept up-to-date.

Activity	PD	HPM	SPM	PCM	EPM	CCB	Fin	DT
Programme Budget Schedule Scope EV	A	C	R	C	C	I	NA	C
SKA1 Contingency	A	C	R	C	C	NA	NA	I
SKA1 Risk Management	A	C	R	C	C	NA	NA	C
Area: Schedule Development	A	C	C	C	R	NA	NA	C
Area: Monthly Updates	C	C	A	C	R	NA	C	C
Area: Budget estimation	C	C	A	C	R	NA	C	C
Area: Budget management	C	C	A	C	R	NA	NA	C
Area: Actual cost reporting	C	C	A	C	R	NA	NA	C
Area: EV and variance analysis	C	C	A	C	R	NA	NA	C
Area: Risk management	C	C	A	C	R	NA	NA	C
Area: Change management	C	C	A	C	R	C	NA	C
Area: Monthly Reports	C	C	A	C	R	NA	NA	C
EPM training and support	I	R	C	(R)	I	NA	C	I
Development & maintenance of IPS	C	A	C	R	C	NA	NA	I
Implementation & maintenance of EVMS	C	A	C	R	C	NA	NA	I
Change Control Process	A	C	C	C	C	R	NA	I
Management of Contingency Log	C	A	C	R	I	NA	NA	NA
Monthly Report Cost and Schedule Inputs	C	A	C	R	I	NA	NA	NA
Development and Support of dash360	I	A	C	R	I	NA	NA	NA
Accounting functions	I	C	C	C	C	NA	R	NA

Provide subject matter expertise, key inputs	I	I	C	C	C	NA	NA	R

11 Site and Environment [Ant/Tracy to point to Site documents]

11.1 Site Selection Criteria

11.2 Permitting

11.2.1 Australia

11.2.2 South Africa

12 Quality and Product Assurance [TIM]

13 Computing [Nick please recast depending on whether you are doing this within the PEP or within the SEMP]

13.1 Cyber-Security

SKAO maintains and enforces a broader cyber-security plan for the summit facility during both construction and operations. Primarily, the plan and associated procedures protect personnel and equipment from harm by outside entities. In addition, the plan includes establishment of access and use policies, control of workflow, interactions with external systems, and requirements from funding agencies and partners.
The general behavior of the SKAO security model provides active, hardened interdiction for remote access, and a more modest detection and intervention policy for internal access. The essential security components are restriction of remote access physical access to the SKAO site network. SKAO limits remote access to the site by allowing connections only from SKAO facilities and requiring additional DMZ login. SKAO also ensures additional physical restrictions to computer systems (e.g., locks on the computer room, observing room, and all control system racks on the telescope and instruments).

13.1.1 Use Cases

There are several general usage patterns for interactions between the SKA1 facilities and off-site users or resources. The connection between SKAO and JBO may be considered as an offsite transaction if that connection is not secured through an acceptable security policy (e.g., VPN connections).

13.1.1.1 Accessing off-site resources

In the normal course of construction and operations, SKAO staff may require access to resources outside of the control of SKAO IT systems. These transactions occur on standard Internet protocols (HTTP, FTP, RSH, SIP, etc.) and are initiated locally by SKAO personnel. Typical operational transactions include retrieving current or archived solar images from other observatories, accessing Internet sites for news, weather, or other information, logging into remote facilities to access mail and file systems, and uploading software programs and patches. Additionally, SIP telephone communications may also occur from the summit through the IT system. Each of these transactions exposes the facility to potential security violations, and are addressed through the SKAO security plan. This plan cannot prohibit or make unduly difficult the process of accessing offsite resources. However, it does institute a specific procedure for each type of access that is fully enforced.

13.1.1.2 Transmitting data

SKA1 construction and operations include the transmission of data to SRCs for archive and distribution. The data stream from the facilities to the repositories is allowed to go offsite with little or no hindrance or bandwidth reduction.

13.1.1.3 Remote observing

SKAO operations allow for observers to partially interact with the facility through an Internet connection. The remote observer is not allowed to directly control the telescope, instrumentation, or any other SKA1 system. The observer is allowed to communicate with the local operator and observer, monitor a best-effort bandwidth version of the quick look display, and download samples of the data from the ongoing observations. The security policies for the facility accommodate these activities.

13.1.1.4 Engineering access

Troubleshooting during construction and operations often requires remote access to specific SKAO computers and software resources that are not exposed directly to outside networks. The SKAO security policy for remote access allows access of this nature while continuing to protect the facility from malicious attack. Engineering access is reserved only for troubleshooting or other non-routine maintenance activities; it is not a part of routine operations or general remote access.

13.1.2 Policy

The SKAO security plan is comprised of a series of policies, each discussing one aspect of the security plan. These policies cover all aspects of IT security, both offsite and internal access.

13.1.2.1 DMZ and firewalls

The SKAO security plan utilizes a demilitarized zone (DMZ) to separate the local area networks crucial to operations from the outside networks. The DMZ acts as a buffer to the internal networks, allowing authentication and providing limited access to any unauthorized access. The DMZ provides servers for the public web site, login, email, network address translation (NAT), telephone, and other proxy services needed to implement the security plan.
The SKAO security plan also includes firewalls as part of the DMZ. All firewalls are proactively monitored and upgraded on a planned and regular basis as provided by the security policy.

13.1.2.2 Off-site access

Off-site access, both incoming requests and outgoing traffic, is supported only through a NSO VPN connection. Procedures are in place to restrict incoming access to DMZ machines for authorized users on the secured channels. Best efforts are implemented to prevent loss of service or external security attacks (e.g., denial of service, password testing, man-in-the-middle, etc.) from unauthorized users. Authorization is the responsibility of the SKAO administration and implemented by the IT personnel.

13.1.2.3 On-site access control

Access control within the site is a less stringent need than external access. The general policy of internal IT security is control of physical access through the use of locks, key cards, and other physical means.
On-site user security during construction and operations may be noticeably lax due to the need by observatory personnel to perform a variety of roles. Operators may be called up to act on behalf of the Operations Engineer(s), Operations Scientist, or other SKAO actor. However, security procedures do prevent other personnel from accessing these accounts or restricted programs. Engineers and IT personnel may need global or super-user access during operations; these actions are be logged as part of operations.

13.1.2.4 On-site data access control

Authorized visitors to the facility— Investigators—are given a different, more stringent access permission for use only with the SKAO data storage and processing facility. The SKAO data storage may contain data from multiple users; it is not required that SKAO prohibit investigators from accessing other investigators' data. If in the future SKAO implements a data embargo or restriction requirement, the security policy is able to provide protection of observer's data from non-SKAO member personnel.

13.1.2.5 Malicious and errant components

Components of the telescope and instrument control systems may become security or safety risks, either errantly or intentionally. SKAO personnel are able to detect components that are non-responsive, incorrectly operating, becoming an equipment or safety risk, accessing other components outside of its normal communications, or spoofing other components. It is not a

SKAO requirement to proactively prevent such behavior, only to quickly detect them and disable the suspect component.

13.1.2.6 Malicious and errant users

Users of the telescope and instrument control systems also may become security or safety risks, either errantly or intentionally. The SKAO security policy prevents non-SKAO users from remotely accessing areas of SKAO software that involve operations and moving mechanisms. Internal users are actively restricted through standard operating systems login and password mechanisms. SKAO IT security provides continuous training and enforcement on strong passwords, social engineering attacks, and other typical illicit access strategies.

13.2 Code Development

SAFe

13.2.1 Development Processes

13.2.2 Version and Configuration Control

13.2.3 Quality Control

Talk about SAFe but also map to Unit Testing, Integration Testing, User Acceptance (verification) Testing

13.2.4 Release and Distribution

13.2.5 Problem Tracking

13.3 Data Management

13.3.1 Infrastructure

13.3.2 Archiving and Transport

14 Health, Safety and Environmental

SKAO HSE philosophy is to integrate good health, and environmental performance as a core element in every planning, design and construction operation to achieve our aim of being safe and secure.

HSE Policy

The SKAO HSSE Policy (ref: SKA-GOV-000063) sets out our general approach to health and safety and environmental issues. It explains how we, as an employer, will manage health and safety in our business.

This policy applies to all aspects of the SKAO Programme.

Implementation within the SKAO being through this SKAO Project Execution Plan while implementation by suppliers and industry partners is achieved through contracts and agreements developed by the SKAO in accordance with the Construction and Operations Plans.

The SKAO senior leadership team will ensure the availability of resources needed to implement this policy and ensure that it remains effective and relevant through regular reviews and updates.

This policy will be reviewed annually and communicated to all employees, users and stakeholders.

HSE Planning

We shall engage with all our staff, partners and suppliers so that everyone is enthusiastically involved in managing risk, securing success and acting as an ambassador for our realistic and practical vision.

Our planning mainly draws on requirements from Occupational Health and Safety Management Standard ISO 45001:2017, Environmental Management Standard 14001:2015 and is also inspired by similar plans from other major telescope projects.

Key national legislation includes (but is not limited to):
South Africa - Occupational Health and Safety Act 1993,
South Africa - Construction Regulations 2014,
Australia - Work Health and Safety Act 2011,
Australia - Work Health and Safety Regulation 2011,
United Kingdom – Health & Safety at Work Act 1974,
United Kingdom - Management of Health and Safety at Work Regulations 1999
South Africa - National Environmental Management Act (NEMA) 1998 and amendments,
Australia - Environmental Protection and Biodiversity Conservation Act (EPBA Act) 1999,
Australia - Environmental Protection Act 1986 (WA) (EP Act),
United Kingdom - Environment Act 1995.

The existing work of the SKA precursor and pathfinder telescope sites (ASKAP and MeerKAT) in the area of operational safety management are acknowledged and referenced with a view to incorporating best practice, lessons learned and coordination

HSSE roles and responsibilities

Head of Health, Safety, Security and Environmental (HSSE) will be responsible for SKAO safety and environmental management at the SKA sites in Australia and South Africa as well as occupational health and safety at the SKA headquarters. He / She will also have overall responsibility for developing security policies and procedures for the SKA headquarters and SKA sites.

The Head of HSSE will demonstrate a visible HSSE leadership on the project and develop a pro-active HSSE culture that delivers positive commitment to, and engages all employees in, continuous performance improvement and promotes best practice.

He / She will be the person who ensures that the SKAO operates in a safe, healthy, effective and efficient manner, allowing the Director General to concentrate on external issues and dependencies.

Head of HSSE will:

- Develop, implement and review the SKA Organisation's policies and procedures for HSSE, including appropriate training and audit programmes;
- Manage incident investigations procedures, expectations and present findings as required;
- Prepare and manage annual budgets for HSSE and, through effective and flexible management, ensure that HSSE expenditure remains within budget;
- Provide HSSE support in the preparation of tenders and in the pre-contract stages of new contracts;
- Review and evaluate contractor safety processes and their implementation;
- Provide HSSE advice to the Senior Leadership Team and to site teams;
- Ensure provision of safety training to the site teams as required;
- Inspect and audit early construction at the host sites;
- Recommend courses of action relating to safety performance of contractors;
- Identify statutory HSSE obligations and communicate these to the relevant stakeholders;
- Ensure effective operation of an incident reporting system and report HSE incident trends and statistics as appropriate;
- Develop HSSE performance indicators and monitor across the project;
- Organise HSSE audits and ensure implementation of recommendations;
- Ensure that safety is considered in the Element designs and in early construction activities at the SKA host sites in Australia and South Africa;
- Ensure that safety related hazards and risks are effectively managed by those responsible;
- Lead the development and/or review of safety related policies, procedures, plans and other safety related documentation;
- Maintain project hazard/risk/action tracking registers on an on-going basis;
- Prepare safety status reports as required;
- Ensure SKA Organisation's compliance with relevant health & safety legislation, both in the UK and in the host site countries;
- Ensure SKA Organisation's Safety Plan is kept up to date;
- Establish a system for reporting hazards across the project;
- Establish a health & safety risk assessment procedure, and co-ordinate all such risk assessments throughout SKA Organisation;
- Conduct investigations into any workplace accidents and report to the appropriate outside agency; and
- Manage the process of Business Continuity Planning within SKA Organisation.

It is envisaged other safety-related roles and responsibilities within the project team will include, but not be limited to:

- Director General,
- Deputy Director General,
- COO,
- Head of Mission Assurance
- SKAO Site Managers,
- SKAO Construction Managers,

- SKAO NEC Project Managers,
- SKAO NEC Supervisors,
- SKAO Safety Managers,
- Host Country “land owners”
- Principal Contractor HSE Managers,
- SKAO EMC Managers.

Safety in Design

The Design Safety Compliance Report (SKA-TEL-SKO-0001059) reviews design safety for Phase 1 of the SKA Observatory, encompassing both SKA-LOW and SKA-MID. It does not consider construction or operation of SKA Phase 2, the scope of which is not yet defined, although it is anticipated that the concepts defined there should be easily extensible to expanded versions of LOW and MID.

This Design Safety review has focused on unusual aspects of the design which may involve unusual hazards that may require unusual risk controls to eliminate or minimise the risk (e.g. a working at height hazard involved in maintenance of light fittings in a building atrium). It is assumed that hazards that can be adequately addressed by applying solutions/guidelines in existing standards, e.g. building code requirements, Standards, specific Industry Guidelines have been addressed via adoption of the relevant solutions/guidelines (e.g. slips/trips/fall hazard associated with a stairway are addressed by compliance to the relevant building code and referenced standards).

The Design Safety compliance review included a process of consolidating consortia health and safety analyses data (from element CDR). Where appropriate, additional safe design options have been incorporated in the design to eliminate or mitigate identified hazards. The results are included in a Hazard Safety Register.

Derived risk levels are an estimation, utilising relevant information available at the time of the Design Safety review. Any assumptions made at the time of the review may need to be confirmed at a later stage. It is strongly advised to confirm, so far as is reasonably practicable, that risks associated with the construction of the design, and use and maintenance of the design as a workplace, have been identified, that any estimated risk levels are appropriate, and that additional control measures (e.g. safe work instructions) instituted where required.

The Design Safety review has sought, so far as reasonably practicable, to involve the participation of relevant project participants, including Operations, to identify unusual hazards and controls associated with any unusual design aspects.
For any ensuing design stages it is strongly recommended that this Design Safety review be reviewed and revised as required to reflect any changes to the defined or assumed design.
This document will be considered as part of the development of any Operations & Maintenance manual for the completed building or structure.

Site Information
Inputs available from Ant and Tracy?

Site Conditions
Inputs available from Ant and Tracy?

Safety Code of Practice
An online Safety COP or, if deemed appropriate Guidance Notes (covering the construction phase on the sites) will be developed prior to start of construction.
Said guidance will include (but not be limited to):

- Approvals, permits, licences and assurance;
- Key performance indicators;
- Recognition and reward;
- Communications – internal;
- Communications – on-site;
- Communications – public;
- Regulatory liaison;
- Information on residual hazards – construction phase;
- Information on residual hazards – use, maintenance, modification;
- Risk assessments and method statements;
- Specific health and safety hazards;
- Specific environmental hazards and risks;
- Procurement and supply chain management;
- Worker involvement;
- Monitoring and reporting;
- Audit and assurance;
- Emergency preparedness and response;
- Construction site management of HS&E (incl)
    - Access to site,
    - Zone induction,
    - Visitors,
    - Drivers,
    - Supervision,
    - Inspections,
    - General Behaviour,
    - Alcohol and Drugs,
    - Smoking,
    - Personal telephones, radios and audio equipment,
    - Control of hours worked,
    - Monitoring, auditing, investigations.
- Construction Transport Management Plan(s).

14.1 Security

The SKA1 construction project is maintained across several sites each with distinct physical security. The physical security measures are intended to address vulnerabilities to project staff, resources and information, in particular handling the threats of:

- Theft
- Physical damage
- Interruption of services/utilities
- Unauthorized disclosure of information

This is distinct from the safety arena which addresses the protection of life and assets against accidents, natural disasters, fire, etc. Physical security encompasses principally vandalism, theft and attacks by individuals while cyber security addresses aspects of electronic interference and theft (covered in Section 13).

For the project sites:

(For each describe the sites, physical security, operating hours, utility access, fire prevention)

- MID Office
- MID Site
- LOW Office
- LOW Site
- HQ Office

15 Review and Reporting

The Key Performance Indicators measured to monitor and control the project execution as well as the reporting to various stakeholders is captured in SKA-TEL-SKO-0001200.

We need a Stakeholder Management section to identify stakeholder roles and groups, analyse their power and impact, assess their needs and state how we will engage/communicate with them.

16 Integration Verification and Commissioning

Distinct groups, responsible for acceptance, integration, commissioning and routine operations, respectively, will be assembled for construction and the transition to steady-state operations. Acceptance, Integration, Verification and Commissioning will be the responsibility of the SKA Construction Project. Science Verification of the telescope system is the responsibility of Operations scientists working within the Construction project and supported by the Commmissioning and AIV teams. Routine Operations will be the responsibility of SKA Operations within the host countries.

Acceptance

Acceptance procedures will be followed for all deliverables: performance verification and quality evaluation according to terms of contract will be the responsibility of the Construction Project. Accepted deliverables will be handed over to the AIV and Commissioning teams.

Integration

Deliverables will be subjected to further evaluation by the Integration Group, optionally in specific test facilities, as required to reduce technical risk that could not be ascribed to the original supplier. The goal is to further reduce risk and to ensure that integration of deliverables into the system occurs smoothly. The Integration Group will be responsible for set-to-work and system integration of evaluated deliverables and will hand them over to the Commissioning Group.

Commissioning

The primary responsibility of the Commissioning Group is to ensure that the entire system is on track to meet performance criteria, including science verification. The Commissioning Group will plan and carry out continuous performance evaluation of the entire system as it grows. The Commissioning Group will also carry out deep in-system performance evaluation of components and software

handed over from the Integration Group, whenever possible in conjunction with science operations. Changes to the design of components, retrofits and/or future production changes may result from the evaluation by the Commissioning Group. Any changes would be proposed to the change control board for the Construction Project. The Commissioning Group for SKA1 will be retained until the telescopes reach a steady state and/or when the transition to SKA2 occurs.

Routine Operations

The Operations Group will be responsible for regular science operations, maintenance, data processing and related activities. During the early stages of system growth, this group will be responsible for the planning of Early Science in conjunction with the Commissioning Group. The dual goals of Early Science are to carry out scientifically useful observations and to use these observations as tools for evaluating system performance. Some staff trained in the Integration and Commissioning Groups will be retained in the Routine Operations Group.

The planning for systems integration, verification and commissioning, including acceptance procedures is covered under:

- SKA-TEL-SKO-0001201 SKA1 Project Engineering Management Plan
- SKA-TEL-SKO-0001350 SKA1 Commissioning and Science Verification Plan

17 Project Close Out

The project close-out will occur in three areas:

- Administrative
    - Historical information and lessons learned are transferred to the SKA Observatory for later use.
    - Project files from construction activities are turned over to the observatory.
    - The project completion is documented through the compliance with the hierarchical requirements (see SKA-TEL-SKO-0001300 SKA1 Systems Engineering). All requirements must be met or have approved waivers. Documented receipt of all deliverables is generated. If the project is terminated prior to completion, documentation on the cause of termination is needed, along with documentation on the transfer of finished and unfinished deliverables.
- Contractual
    - The project contract officer identifies any open contracts and contacts remaining contractors for any relevant actions necessary to close the contract, as designated in the associated contract clauses and per SKA Observatory's procedures and policies.

- Acceptance
    - Acceptance is complete with the receipt of a formal statement that the terms of the project have been met (Outlined in the SKA1 Commissioning and Science Verification Plan).

[Ant/Tracy]Need clarity on Host Country requirements on the decommissioning and deconstruction of the SKA facilities after their use (and how this is funded).]