*Description of Work*

Work in the post-2011 period (Preparatory Phase and Pre-Construction Phase) will be carried out on the Baseline Design and the Advanced Instrumentation Program (AIP) with the aim of preparing the international project for start of the construction of SKA1in 2016. Key to this effort is the system engineering approach and formal project management adopted during the system design in the Preparatory Phase. Ten main areas will be addressed: 1) overall system, 2) maintenance and support, 3) dish sub-system, 4) aperture array sub-systems, 5) signal transport and networks, 6) signal processing, 7) software and computing, 8) power, 9) site and infrastructure, and 10) management and management support such as quality assurance, configuration management, procurement etc. This Plan provides a top-level Description of Work and a Work Breakdown Structure for these Work Packages, lists of milestones and deliverables, and the project structure, dependencies, and schedule including the planned formal reviews. The Risk Strategy and Risk Management principles are also outlined.

* + - 1. *Power*

Power is a critical consideration for the SKA, with current demand estimates being in the region 50-100 MW, assuming significant innovation in electronic system design and environmental conditioning arrangements. Apart from the direct operating cost implications and the implied opportunity costs to areas such as telescope upgrades, experience with large radio telescopes has shown that high quality design, construction and maintenance of power systems is crucial to minimizing overall lifetime costs and maximizing science returns. While many of the tasks associated with the provision of SKA power are most efficiently undertaken by experienced industry consultants, it is important that the project-specific requirements are built into the power solutions from inception. In practice, this means dedicating full-time SPO resources to working alongside industry partners, and drawing on experience with SKA precursors and other telescopes in framing the solutions.

*WP10.1 Management*

WP10.1 handles the overall management of the workpackage as well as interfaces with other WPs.

*WP10.2 SKA Intra-System Power Design*

This activity will review the PrepSKA system design for SKA1 (and the top-level design for SKA2) from the perspective of power minimization and optimization of intra-system power distribution. It will be led by the SPO, and will involve participants from industry and other relevant sectors.

*WP10.3 SKA Power System Design*

This is the major power design activity for the SKA; it will produce a complete, costed power solution for SKA1, and a detailed plan for the extension of the solution to SKA2. It will be led by one or more prime contractors from the power industry and will set out power generation and transmission designs, taking account of SKA-specific requirements.

*WP10.4 SKA Power Systems Operation*

This activity will develop and prosecute a plan for operating and maintaining the SKA power system, having regard to power quality, demand evolution, and related issues. It will be led by power engineering consultants, in association with power providers and the SPO.

*WP10.5 SKA Strategic Power Planning*

This activity will assess the applicability of emerging power solutions to the SKA. It will be led by a specialist power engineering consultancy, working closely with proponents of various generation and environmental conditioning technologies.

1. **Work Package 10 (WP10) – Power**

Power is a critical consideration for the SKA, with current demand estimates being in the region 50-100 MW, assuming significant innovation in electronic system design and environmental conditioning arrangements. Apart from the direct operating cost implications and the implied opportunity costs to areas such as telescope upgrades, experience with large radio telescopes has shown that high quality design, construction and maintenance of power systems is crucial to minimizing overall lifetime costs and maximizing science returns. While many of the tasks associated with the provision of SKA power are most efficiently undertaken by experienced industry consultants, it is important that the project-specific requirements are built into the power solutions from inception. In practice, this means dedicating full-time SPO resources to working alongside industry partners, and drawing on experience with SKA precursors and other telescopes in framing the solutions.

*Preparatory phase*

The last stage of Preparatory Phase will focus on delivery an energy-efficient system design for SKA1, on briefing a pool of power industry consultants and suppliers on the needs of the SKA, and on conducting (in association with power industry representatives), a Preliminary Design Review of the top-level power specifications for the telescope. The latter will focus on (i) ensuring that critical SKA technical and operational demands (including EMC) have been encapsulated in the specifications and (ii) that the specifications are in a form suitable as the basis of the pre-construction work package WP10.4, an activity designed to produce, in conjunction with selected industry engineering consultants, detailed specifications for the SKA power systems.

*Pre-construction phase*

The following assumptions are made in setting out a pre-construction phase plan for power systems.

(a) The Preparatory Phase has delivered an SKA1 design, including an electronics system design framed in the context of power demand minimization requirements;

(b) Exemplar physical layouts and representative electrical loads are available for SKA2;

(c) Top-level EMC and RFI standards for the SKA system and subsystems have been put in place;

(d) An operational model for SKA1, and at least a representative operational model for SKA2, are available; and

(e) A pool of qualified and briefed consultant engineers and suppliers is available from which to select prime contractors, sub-contractors and suppliers.

It is important to stress that detailed power system design, construction and operation will be done by industry. The role of the SPO is to frame the SKA-specific requirements in terms understood by one or more prime contractors, to provide a specialized consultancy service during design and construction, and to be actively engaged in the commissioning and acceptance testing processes. With this in mind, all of the pre-construction work packages listed below have SPO and industry participation, and most draw on the experience of SKA precursor and other telescopes.

* 1. **Description of Work**
* **WP10.1 – Engineering and Management**

Within the SPO both management and engineering resources are allocated to this task. The SPO team consists out of a Technical Project Manager, System Engineer and Engineers. This team’s responsibilities are described in more detail in section . The task handles the overall management of the work package as well as interfaces with other WPs.

* **WP10.2 – Intra-System Power Design**

This activity will review the PrepSKA system design for SKA1 (and the top-level design for SKA2) from the perspective of power minimization and optimization of intra-system power distribution. It will be led by the SPO, will involve participants from the space and other relevant sectors, and will feature active participation from the prime contractor(s) selected to design the SKA power solution. It will produce a detailed design report, with particular attention to the light-current ("electronics") to heavy-current ("power") interfaces.

* **WP10.3 – Power System Design**

This is the major power design activity for the SKA; it will produce a complete, costed power solution for SKA1, and a detailed plan for the extension of the solution to SKA2. It will be led by one or more prime contractors from the power industry and will set out power generation and transmission designs, taking account of SKA-specific requirements. The SPO and in-kind collaborators will supply specialist engineers to work alongside the contractor(s), providing continuous design and review functions in critical areas such as EMC/RFI, monitoring and control, and protection and test. The SPO will also supply critical information related to the evolving power requirements of the SKA. Prior to the finalization of the design, the contractor(s) and SPO will conduct a Detailed design Review and a Critical Design Review, the review panels to include independent power engineering specialists, industry sector representatives, and engineers familiar with SKA precursor and other large facilities in remote sites.

* **WP10.4 – Power Systems Operation**

This activity will develop and prosecute a plan for operating and maintaining the SKA power system, having regard to power quality, demand evolution, and related issues. It will be led by power engineering consultants, in association with power providers and the SPO.

* **WP10.5 – Strategic Power Planning**

This activity will assess the applicability of emerging power solutions to the SKA. It will be led by a specialist power engineering consultancy, working closely with proponents of various generation and environmental conditioning technologies. The SPO and POs will provide specialist telescope operational and other engineering expertise.

* 1. **Milestones**

|  |  |  |
| --- | --- | --- |
| **Milestone #** | **Description** | **Milestone date** |
| M10.1 | PDR for SKA1 (SKA Intra-system power design) | 2012Q4 |
| M10.2 | CDR for SKA1 (Power system design) | 2013Q4 |
|  | On Site AR for SKA1 | 2015Q4 |

* 1. **Deliverables**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Milestone #** | **Deliverable #** | **Deliverable title** | **Nature of deliverable** | **Dissemination level** | **Due date** |
| M10.1 | D10.1 | SKA1 Intra-system power design PDR report | R | PU | 2013Q1 |
| M10.2 | D10.2 | SKA1 power system design CDR report | R | PU | 2014Q1 |

* 1. **Resources**
* **WP11.6 – Power System Construction and Commissioning**

This activity will deliver the SKA1 power supply system on the SKA site, the system being extensible to meet the needs of SKA2. It will be led by prime contractor(s) from the power engineering industry, with the SPO and POs supplying engineers to monitor the roll-out, develop SKA-specific test and acceptance protocols, and take a leading role in the commissioning of central and remote facilities. The prime contractor(s) will manage procurement and related activities, with the SPO providing technical oversight of major specification documentation. The SPO will work closely with the contractor(s) to ensure that all required design and "as built" documentation is supplied. A Post-Commissioning Review, of a scope to be agreed between the SPO and contractor(s) will be conducted.