Stakeholder Requirements

020.10.15.01.00-0001-REQ

Status: **RELEASED**

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Change Record

Version	Date	Author	Notes/Changes
01	2018-06-01	Treacy	Initial version for preliminary Stakeholder Requirements Review (StRR)
02	2018-11-05	Treacy	In-progress draft addressing RIDS from preliminary StRR
03	2018-11-19	Zuckerberg, Selina, Hiriart	Addressed gap analysis, updates from RIDs, and major edits throughout for requirements quality. Reformatted to doc.
04	2018-11-26	Zuckerberg, Selina, Hiriart	Added new categories of requirements for organization. Finished major edits from preliminary StRR and team review.
05	2018-12-05	Selina, Hiriart, Zuckerberg	Updated numbering scheme for consistency with Requirements Management Plan. Updated traceability column entries. Minor updates to requirements flow-down strategy narrative.
06	2019-05-30	Lear	Prepared document for review.
07	2019-05-31	Selina	Minor edits for release.
08	2019-07-08	Selina	Addressing comments from MM review.
A	2019-07-09	Lear	Prepared document for approvals & release.
A.01	2019-08-22	Leyba-Newton, Selina	Fixed template for StRR. Updated throughout with requirements capture from the AIV and CSV Concepts.
A.02	2019-08-27	Lear	Finalized template for document update and release.
A.03	2019-08-27	Selina	Clarifications to the introduction and scope of the document. Updated Abbreviations & Acronyms.
A.04	2019-08-29	Hiriart, Selina	Updates to template code. Typographical corrections in a few requirements.
B	2019-09-04	Selina, Murphy	Incorporated comments from EJM and MM. Release for StRR.

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1 Introduction

1.1 Purpose

This document aims to present a set of stakeholder requirements for the ngVLA that should guide the development of the facility.

Many requirements flow from the system lifecycle concept [AD02] documents, especially the Operations and Maintenance Concept [AD07]. Input from the Assembly, Integration and Verification (AIV) Concept [AD08] and the Commissioning and Science Validation (CSV) Concept [AD09] is also reflected.

In addition, an attempt has been made to capture other stakeholder (programmatic, safety, regulatory compliance, etc.) requirements from representatives of various stakeholder groups. Where possible, traceability for these requirements is provided to a source, but this document should be considered a primary reference for stakeholder-level requirements.

1.2 Scope

The scope of this document is the ngVLA facility over its full lifecycle. This includes not just the scientific instrument, but the supporting infrastructure necessary for full operations.

The emphasis in this document is on requirements that will inform the technical development of the facility. Programmatic, schedule, and regulatory requirements that influence the design and final deliverable are captured, but requirements that only impact the conduct of the project are not considered in scope.

For relevant requirements that inform the conduct of the project, please consult the Project Execution Plan [RD01] and its references including AUI/NRAO policies, and the NSF Large Facility Manual [RD02].

2 Related Documents

2.1 Applicable Documents

The following documents are applicable to this Requirements Specification to the extent specified. In the event of conflict between the documents referenced herein and the content of this Requirements Specification, the content of the lowest level specification (in the requirements flow-down) shall be considered the superseding requirement for design elaboration and verification.

Ref. No.	Document Title	Rev/Doc. No.
AD01	ngVLA Science Requirements	020.10.15.00.00-0001-REQ
AD02	ngVLA Lifecycle Stages & Concepts	020.10.05.00.00-0001-PLA
AD03	ngVLA Requirements Management Plan	020.10.15.00.00-0001-PLA
AD04	ngVLA Reference Observing Program	020.10.15.05.10-0001-REP
AD05	ngVLA Safety Requirements (L0)	020.10.15.10.00-0004-REQ
AD06	ngVLA Land Acquisition and Regulatory Compliance Requirements (L0)	020.70.00.00.00-0001-REQ
AD07	ngVLA Operations Concept	020.10.05.00.00-0002-PLA
AD08	Assembly, Integration & Verification Concept	020.10.05.00.00-0005-PLA
AD09	Commissioning & Science Validation Concept	020.10.05.00.00-0006-PLA

2.2 Reference Documents

The following documents provide additional supporting context or are referenced in the text.

Ref. No.	Document Title	Rev/Doc. No.
RD01	ngVLA Project Execution Plan	020.05.00.00.00-0003-PLA
RD02	NSF Large Facilities Manual, March 2017	NSF 17-066

3 Overview of the Stakeholder Requirements

The L0 Stakeholder Requirements along with any explanatory notes are found in Section 5. The system safety and regulatory compliance requirements are documented separately and incorporated by reference:

[AD05]	*ngVLA Safety Requirements (L0)*	020.10.15.10.00-0004-REQ
[AD06]	*ngVLA Land Acquisition and Regulatory Compliance Requirements (L0)*	020.70.00.00.00-0001-REQ

As noted in Section 4.2, this document includes a number of L0 requirements captured from the lifecycle concept documents including the Assembly, Integration and Verification Concept [AD08], the Commissioning and Science Validation Concept [AD09], and the Operations and Maintenance Concept [AD07].

These concepts are a tool for requirements elicitation. The goal is to capture the *need* expressed in the concept, but not necessarily the *solution*. For example, the maintenance concept may describe tracking the configuration of the system through barcodes on line replaceable units (LRUs). The *needs* expressed in this statement are (1) packing of serviceable hardware systems into interchangeable LRUs, and (2) the need for a system for tracking the location and configuration of these LRUs throughout the array. The barcode system is a solution to satisfying this need. In this L0 requirements capture, we aim to capture the need only, leaving the solution space open for the detailed design phase.

This approach requires a degree of abstraction in the L0 requirements capture, with detail added at subsequent requirements refinement and derivation at the L1 or L2 level. It may be appropriate to revisit the lifecycle concept documents in this L1 and L2 requirements derivation to ensure the full expressed need is satisfied in context (i.e., requirements validation).

Since the stakeholder requirements are written in the stakeholder's language (i.e. non-technical), they are typically not verifiable. The verification and validation strategy for ngVLA aims to capture the broad intent or need with stakeholder requirements, with sufficient specificity in the subsequent derivation of system-level L1 requirements to enable their verification. ngVLA performance to the L0 stakeholder requirements will be validated as part of the commissioning effort and the handover to operations.

4 Requirements Management

4.1 Requirement Definitions

Consistent with the Requirements Management Plan [AD03], the following definitions of requirement "levels" are used in this document.

Requirement Level	Definition
L0	User requirements expressed in terms applicable to their needs or use cases ("Science Requirements" or "Stakeholder Requirements")
L1	Requirements expressed in technical functional or performance terms, but still implementation agnostic ("System Level Requirements")
L2	Requirements that define a specification for an element of the system, presuming an architecture ("Sub System Requirements")

4.2 Requirements Flow-Down

The L0 Requirements are captured in a pair of documents. The functional and performance requirements necessary to support the key science goals of the facility are captured in the L0 Science Requirements [AD01]. Other Stakeholder Requirements also influence or dictate design choices. Examples include programmatic requirements, regulatory compliance requirements, and the lifecycle concepts (e.g., the operations and maintenance concept [AD07]) for the facility, and these requirements are captured here.

The Science Requirements and Stakeholder Requirements fully encapsulate all known L0 requirements. The System requirements and subordinates fully encapsulate all known L1 requirements.

Specifications for individual subsystems (L2) generally flow from the L1 System Requirements, and may not always be directly attributable to a single system requirement (e.g., phase drift specifications at the system level may be apportioned to multiple subsystems, or a subsystem spec may be in support of multiple higher-level requirements). In some cases, L2 requirements may directly flow directly from L0 requirements. This is permitted in order to not require duplication of requirements between the L0 and L1 levels, and to enable extraction of detailed requirements from the lifecycle concepts. Completeness of the L2 requirements is assessed at the requirements review of each subsystem.

Maintaining enumerated and traceable science requirements, system requirements, and subsystem specifications ensures this trade-off process is complete and well understood by the project team. The effect of a change in a subsystem specification can be analyzed at the system level, and thereafter the impact on a specific scientific program can be ascertained.

The details of the requirements management strategy can be found in [AD04].

5 Stakeholder Requirements

5.1 Programmatic Requirements

Parameter	Req. #	Value	Traceability
Construction Budget (Total, Maximum)	STK0100	The construction budget shall have a design target of less than $1.7B (2018)	[Director's Office, 2018]
Operations Budget (Annual, Maximum)	STK0101	The annual operations budget shall have a design target of less than $80M/yr. (2018)	[Director's Office, 2018]
Community Engagement	STK0102	The project and system architecture must be structured to permit community development and partner contributions.	[Director's Office, 2016]
Site / Location	STK0103	It is a goal to center the array near the existing VLA, on the plains of San Agustin, NM.	[Director's Office, 2016]
VLA Reuse	STK0104	It is a goal to reuse infrastructure and buildings built as part of the VLA or EVLA effort.	[Director's Office, 2016]
Design & Development Timeline	STK0105	The project shall aim to conclude design and development activities in a seven year period ending in 2024.	[Director's Office, 2016]
Construction Timeline	STK0106	The project shall aim to begin construction by 2025, and conclude within a ten year period in 2034.	[Director's Office, 2016]
Commissioning Scope	STK0107	Commissioning of the observatory shall be within the scope of the construction effort, not operations.	[ngVLA PD]

5.2 Science Operations

Parameter	Req. #	Value	Traceability
Operations Concept	STK0200	The system shall be designed as a PI-driven and pointed general purpose instrument.	[020.10.05.00.00-0002-PLA-C, Sec 1, Para 2]; [020.10.05.00.00-0002-PLA-C, Sec 12.2, Table]

5.3 System Life Cycle

Parameter	Req. #	Value	Traceability
ngVLA Transition Plan	STK0300	A Plan to transition from VLA Operations to ngVLA Operations shall be written. This plan shall define milestones and resources at a level of detail so that costing can be determined for the operations ramp-up of ngVLA activities while coordinating with the shutdown of the VLA and any decommissioning requirements.	[020.10.05.00.00-0001-PLA-A, Sec 3.4.1, Para 2]
ngVLA Development Program	STK0301	A plan to address needs for a budgeted ngVLA Development Program (as part of Operations) shall be written. Using community proposals and other initiatives, the program will fund the studies and projects designed to encourage three areas of development typically outside the scope of operations: (1) Scientific advancement and enhancements of capabilities of the array, (2) Development of new or improved hardware, software, or techniques, and (3) Fostering and advancement of Legacy Science Programs.	[020.10.05.00.00-0002-PLA-C, Sec11, Para1]
Material Selection & Sustainability	STK0302	The project shall consider the environmental sustainability of materials selected in the design of the instrument, and the environmental impact of the disposal phase.	[020.10.05.00.00-0001-PLA-A, Sec 3.4.3, Para 3]; [020.10.05.00.00-0001-PLA-A, Sec 3.6, Para 2]
Design Life	STK0303	The system shall be designed for a design life and initial operations campaign of 20 years.	[Director's Office, 2016]
Projected Environment	STK0304	The system shall be designed to survive the environmental conditions expected over the Design Life of the instrument. Goal to withstand 50-year events (extreme weather, seismic, etc.) without damage.	[020.10.05.00.00-0001-PLA-A, Sec 3.4.2, Para 2]
Part Selection and Obsolescence	STK0310	The project shall place emphasis on the prediction of elements prone to early obsolescence, with plans for replacements to commence perhaps even before the system is fully commissioned.	[020.10.05.00.00-0001-PLA-A, Sec 3.4.3, Para 3]

Parameter	Req. #	Value	Traceability
Community Access	STK0320	The project shall provide community access to the ngVLA as soon as a commissioned observing mode is available with capabilities in excess of the current VLA. Commissioned observing modes must include the delivery of SRDPs.	[020.10.05.00.00-0001-PLA-A, Sec 3.4.1, Para 3], [020.10.05.00.00-0002-PLA-C, Sect 5.0, Para 4, Sect 5.5, Para 3.]
Operations Plan	STK0321	The project shall deliver an Operations Plan that fully describes the operational model to be employed following ngVLA construction.	[020.10.05.00.00-0001-PLA-A, Sec 3.5.1, Para 5]

5.4 AIV

Parameter	Req. #	Value	Traceability
Provision of Assembly Verification Tools	STK0400	The project shall include the necessary test fixtures for component, assembly and subsystem verification within the scope of construction.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.5, Para 1]
Provision of Assembly/Integration Facilities	STK0401	The project shall include necessary assembly and integration facilities in the project scope. Goal to have dual use assembly/integration facilities that fulfill a necessary operations role (e.g., Assembly space in AIV transitions to Operations Warehouse or Repair Facility).	[020.10.05.00.00-0005-PLA-B, Sec 4, # 11]
Provision of System Verification Software Tools	STK0402	The project shall include the software interfaces and tools necessary to test system integration milestones, without the use of the full end-2-end software system. (e.g., tools to generate and execute test scripts for first fringes; tools to see fringes in near real-time.)	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 3]
Spare Parts	STK0403	The project shall include the provision of critical spares for the operating life of the facility within the scope of construction.	[020.10.05.00.00-0002-PLA-C, Sec 7.1, Para 2]
Integration and Verification-WP Product	STK0405	Each work package group shall integrate and verify their respective deliverables before delivering them to their IPT for acceptance.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 2]
Integration and Verification-IPT Product	STK0406	Each IPT shall integrate deliverables into sub-assemblies or subsystems, verify their performance to specification, and deliver them to the system AIV group for acceptance.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 2]

Parameter	Req. #	Value	Traceability
Assembly and Integration	STK0407	The packaging of components, and assembly and test procedures shall support most assembly and integration taking place off-site.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 3]
Integration and Verification-Product Responsibility	STK0408	The provider of a deliverable shall be responsible for the integration and verification testing of that deliverable.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 4]
Acceptance-Product Responsibility	STK0409	The group who receives the deliverable for integration into a higher-level element shall be responsible for deliverable acceptance.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 4]
Validation-Stand-alone Systems	STK0410	Respective product IPTs shall deliver comprehensive test frameworks to enable verification of stand-alone systems as well as partially integrated systems, such as unit tests, hardware simulators, and test racks.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 5]
Verification-Functional Capabilities	STK0411	There shall be a system AIV group whose responsibility is to deliver verified functional system capabilities for commissioning and science validation.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 6]
Sub-array Capabilities	STK0413	The project shall deliver sub-array capabilities as an early commissioning milestone, in order to facilitate concurrent AIV, CSV and Operations.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 7]
Capability Verification Plan	STK0425	Prior to the delivery of capabilities to CSV, a Capability Verification Plan shall be developed by AIV and agreed to by CSV.	[020.10.05.00.00-0005-PLA-B, Sec 5.1, Para 5]
Software Package Releases	STK0426	Software deliverables from the IPTs shall consist of subsystem software package releases, with incremental delivery of functionality.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 2]
Testing-Software and Firmware	STK0427	All software and firmware delivered to the project shall be delivered with suitable automated unit, integration, and regression testing suites.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 1]
Maintenance-Software	STK0428	Maintenance of delivered software shall be the responsibility of the delivering IPT, until the acceptance of the final product from the IPT.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 1]
Testing-Interfacing Systems	STK0430	Compatibility with interfacing systems shall be tested and documented for each release.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 2]

Parameter	Req. #	Value	Traceability
AIV Software Tools	STK0431	Development tools, compilers, source code, and the build system shall be delivered by the responsible IPT.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 3]
ICD-API and Software Definition	STK0432	All Application Program Interfaces (API) or other software interfaces shall be defined in an ICD.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 4]
ICD-Automated Conformance Testing	STK0433	Automated testing for conformance to the ICD shall be delivered with the product, by the delivering IPT.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 4]
Test Stands and Test Software	STK0440	For hardware deliverables, at the same time as first article delivery for AIV activities, the product IPT shall deliver the product test stands, including any necessary test software (e.g., LabVIEW executables and other test routines or scripts).	[020.10.05.00.00-0005-PLA-B, Sec 5.2.5, Para 1]
Documentation-Test Stands	STK0441	Product test stands shall conform to the same documentation and acceptance requirements as other hardware delivered by the IPT.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.5, Para 2]
Maintenance and Calibration-Test Stands	STK0442	Maintenance and calibration of the test stands shall be the responsibility of the delivering IPT during the array construction phase until acceptance of the final product delivery from the IPT.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.5, Para 2]
Deployment for Risk Reduction	STK0448	The sequence of AIV and CSV activities shall strike a balance between: (1) providing a commissioned capability to users as early as practical, and (2) retiring technical risks as early in the AIV and commissioning phase as possible.	[020.10.05.00.00-0006-PLA-B, Sec 2.2.1, Para 1, 2.2.2, Para 1.]
Antenna Characterization Responsibility	STK0449	The system AIV group shall perform characterization of the integrated antennas, including activities such as the recording of pointing and focus model coefficients, and the nominal antenna surface setting.	[020.10.05.00.00-0006-PLA-B, Sec 6.1, Para 2]

5.5 CSV

Parameter	Req. #	Value	Traceability
First Look Science Products	STK0500	The Observatory shall release a set of First Look Science Products, obtained as part of the Science Validation activities, ahead of PI access to the array.	[020.10.05.00.00-0002-PLA-C, Sec 5.5, Para2]; [020.10.05.00.00-0006-PLA-B, Sec 2.4.1, Para 4]
Availability for Early Science	STK0501	Early PI access, or Early Science, shall commence as soon as a commissioned observing mode is available with capabilities in excess of the current VLA. Commissioned observing modes must include the delivery of SRDPs. Additional PI access shall be offered at other significant milestones prior to the end of construction (for example when baselines expand beyond the Plains of San Agustin).	[020.10.05.00.00-0001-PLA-A, Sec 3.4.1, Para 3], [020.10.05.00.00-0002-PLA-C, Sect 5.0, Para 4, Sect 5.5, Para 3]
Provision of Commissioning Tools	STK0502	The project shall include the software interfaces and tools necessary to achieve the commissioning and science validation milestones (e.g., tools to plot real time calibration coefficients).	[020.10.05.00.00-0006-PLA-B, Sec 5.1, Para 1]
Observing Processes	STK0503	There shall be a project CSV group, responsible for delivering observing processes, building on the functional capabilities delivered by AIV.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 6]
Test and Optimization	STK0504	The project's CSV activities shall test and optimize the various elements of the ngVLA observing system to ensure that it meets the scientific requirements.	[020.10.05.00.00-0006-PLA-B, Sec 2.1, Para 1]
Predefined SRDPs	STK0509	The project's CSV activities shall demonstrate that science observing modes can be processed from beginning to end through the same pipeline data path that PI data will follow, ultimately producing a set of predefined Science Ready Data Products (SRDPs).	[020.10.05.00.00-0006-PLA-B, Sec 2.2.6, Para 1]
Transition to Ops-Capabilities and Observing Modes	STK0511	Operational capabilities and observing modes shall be made available in stages during the transition from construction through to the commencement of full operations.	[020.10.05.00.00-0006-PLA-B, Sec 2.4.1, Para 2]
Commissioning-Observing Mode SRDP Pipeline	STK0512	Delivery of a fully-commissioned standard observing mode shall include an operational SRDP pipeline before it is offered for regular use through PI proposals.	[020.10.05.00.00-0006-PLA-B, Sec 2.4.1, Para 3]

Parameter	Req. #	Value	Traceability
API and Scheduling Blocks	STK0516	A science-oriented API (scripting interface) for calling high-level array functions, prior to the widespread use of Scheduling Blocks (SBs), shall be delivered as part of the project's computing & software subsystem.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 5]
Simulators-Development of Observing Scripts	STK0517	Simulators to enable the development of observing scripts without the real system shall be delivered as part of the project's computing & software development activities.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 6]
Interactive Shell Access	STK0518	The system shall include interactive shell access to the calibration and imaging software (assumed to be CASA) running on an observatory-supported Linux OS.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 7]
Contemporaneous Flux Densities-Spectra-Polarization of Calibrators	STK0520	It is a goal to provide interfaces to make use of any contemporaneous flux densities, spectra, and polarization of calibrators in the various ngVLA bands that are already provided by the VLA and/or ALMA.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 9]
Atmospheric Phase Monitor	STK0521	To make efficient use of test observing time, an Atmospheric Phase Monitor (APM) at the Central Cluster shall be available, and interface with the scheduling system.	[020.10.05.00.00-0006-PLA-B, Sec 5.2.1, Para 1]
Data Access-Visibility Data	STK0523	In order to support system commissioning, the system shall provide interfaces to, and tools to process, the visibility data outside of the automatic, non-interactive processing model that is needed for the steady-state operational mode.	[020.10.05.00.00-0006-PLA-B, Sec 5.2.4, Para 2]
Validation-Observing Modes	STK0526	The project shall define a specific list of standard observing modes to be validated by CSV activities.	[020.10.05.00.00-0006-PLA-B, Sec 7, Para 1]
Mode Definition	STK0527	The operational lifecycle of new modes shall be clearly defined, including the product delivered to the PI. Example lifecycle stages may include New Mode Test Observation (NMTO), Shared Risk Observing (SRO), Non-Standard Data Reduction (NSDR), and progress to Standard Mode Data Reduction (SMDR).	[020.10.05.00.00-0006-PLA-B, Sec 8, Para 1]

5.6 Disposal

Parameter	Req. #	Value	Traceability
Disposal Costs	STK0600	Disposal costs shall be accounted for in any life cycle optimization for the project.	[020.10.05.00.00-0001-PLA-A, Sec 3.6, Para 2]

5.7 Observing Modes

Parameter	Req. #	Value	Traceability
Standard Modes: Time-Phased Availability	STK0700	By full operations the Observatory shall provide a set of standard supported observing modes, which are a construction project deliverable, necessary to achieve the key ngVLA science goals.	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 4]
Standard Modes: Generation of Scheduling Blocks	STK0701	For standard observing modes, observing instructions (e.g., scheduling blocks) shall be generated based on the scientific requirements specified by the PI in their submitted proposal.	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 4]
Non-Standard Observing Modes	STK0702	In operations, in addition to the standard observing modes, the Observatory shall support innovative programs of sufficient scientific merit that require other instrument configurations and/or non-standard and non-automated data processing.	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 5]
Observing Awards: Array Time on Source	STK0703	Successful PIs shall be awarded array time on source rather than guaranteed satisfaction of a scientific objective such as sensitivity.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 4]
Standard Modes: Observing Strategy	STK0704	The Observatory shall generally provide a defined observing strategy (including array characterization and quantitatively known calibration overheads within an acceptable margin of error) for all standard modes and capabilities.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 4]
Standard Modes: Flexibility	STK0705	Flexibility for PIs to make changes to the standard strategy, within limits and only when required to meet the scientific objectives, shall be available.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 4]

5.8 Proposal Submission

Parameter	Req. #	Value	Traceability
Proposal Submission Criteria	STK0800	Proposals will include the information necessary for scheduling the telescope, configuring the instrument, collecting the data appropriate to address the scientific goals, and in most cases, for automatically generating the appropriate Science Ready Data Products (SRDPs).	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 3]
Proposal Submission Tool	STK0801	Users shall specify the scientific and technical requirements for their projects via an Observatory-supplied proposal tool. Projects include both telescope time and/or compute resources (i.e., archive reprocessing).	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 1]
Proposal Assessment	STK0802	The proposals shall be evaluated for scientific merit by science review panels made up of experts from the broad astronomy research community, and a Time Allocation Committee will advise the Observatory of the scientific rankings of proposals.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 1]
Mitigating Bias in Proposal Peer Review	STK0803	The ngVLA proposal review process shall adopt the best practices aimed at minimizing bias related to gender, culture, race and other potential sources of bias.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 1]
Proposal Attributes and Staged Capability	STK0804	The Observatory shall support proposal attributes such as regular, triggered, monitoring, large and legacy (see 020.10.05.00.00-0004-PLA), joint (with other observatories) once the Observatory reaches full operations, as will the goal include support for a diverse set of capabilities and observing modes.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 3]
Proposal Submission Concept	STK0805	The proposal process shall aim to minimize the need for PIs to have expert knowledge of the hardware, calibration and data processing issues specific to the ngVLA.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 1]

5.9 Scheduling

Parameter	Req. #	Value	Traceability
Priority in Scheduling Observations	STK0900	Observations shall be scheduled based on the scientific rankings of proposals, taking into consideration issues such as technical feasibility, data processing requirements, array status and observing conditions.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 4]

Parameter	Req. #	Value	Traceability
Priority for Triggered Observations	STK0901	A capability to interrupt the execution of the observing program in order to respond to a triggered observation with a higher scientific rank shall be provided.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 3]
Concurrent Maintenance and Observation	STK0902	In order to meet the goal of observing at all times, the ngVLA must use a concurrent maintenance and observation model.	[020.10.05.00.00-0002-PLA-C, Sec 6.1, Para1]

5.10 Data Processing

Parameter	Req. #	Value	Traceability
Pipeline Use for Standard Observing Modes	STK1000	The goal will be that, in operations, 80–90% of the scientific program will use a diverse but well-defined set of standard observing modes for which the calibration and data processing will be undertaken through an automated pipeline developed and run by the Observatory.	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 3]
Computing Resources for Standard Modes: Reprocessing	STK1001	The Observatory shall provide sufficient computing resources for reasonable reprocessing of data requested by PIs.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 2]
Computing Resources for Standard Modes	STK1002	The Observatory shall provide sufficient computing resources for the data processing associated with normal operations using standard modes and capabilities (including delivery of Science Ready Data Products to PIs).	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 2]
Delivery of Operational SRDP Pipeline for Early Science	STK1003	Delivery of a fully-commissioned standard observing mode or capability shall include an operational SRDP pipeline before it is offered for regular use through PI proposals.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 3]
Support for Legacy Programs	STK1004	Large and Legacy scale projects will identify data processing requirements and resources, and may require additional computing resources to be made available from non-Observatory sources in order to be scheduled.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 5]
Data Delivery: Process in Place	STK1005	Where possible, interfaces to ngVLA data should favor processing the data in place rather than transferring the data across the internet to users.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 5]

5.11 Data Archive

Parameter	Req. #	Value	Traceability
Data Product Types to Archive	STK1100	Raw visibilities, calibration tables, and SRDPs will all be stored and made available to PIs and archival researchers through the Data Archive.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 4]
ngVLA Data Archive Functionality: Image selection and download	STK1101	Archive functionality shall allow users to inspect and select image data for download.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 1]
Reprocessing and Automated QA via Archive	STK1102	The Data Archive shall provide an interface to allow scientists to initiate reprocessing of ngVLA archived data using Observatory-provided techniques and tools, and shall include automated quality assurance processes.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 1]
Proprietary Period for PI Data	STK1103	PI access to data will be protected by a proprietary period (nominally a year, but determined by Observatory policy), after which the data and data products are fully and publicly accessible.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 2]
User Produced Data Products	STK1104	The Data Archive shall have provisions for accepting user-produced data products where those products can be quality assured by the Observatory (such as products from Large projects or Legacy projects). In such circumstances the Observatory shall approve the user QA process, not the individual products.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 3]
Proprietary Period for Legacy Program Data	STK1105	Large and Legacy projects and some other special cases may have a different proprietary period, subject to Observatory-level proprietary policy changes.	[020.10.05.00.00-0002-PLA-C, Sec 5.4, Para 4]
Data Delivery via Observatory Archive	STK1106	Data shall be delivered to the Principal Investigators through an Observatory Science Data Archive.	[020.10.05.00.00-0002-PLA-C, Sec 5, Para 3]
Interfaces to Similar Archival Systems	STK1107	The Data Archive shall be designed to interface easily with WFIRST, LSST and VLASS and other similar archival systems to maximize the data discovery space.	[020.10.05.00.00-0002-PLA-A, Sec 5.4, Para 5]

5.12 Support Datastores

Parameter	Req. #	Value	Traceability
Calibration Databases	STK1150	A system calibration database shall be designed to store additional antenna-based calibration parameters such as gain curves and polarization D-terms, while the astronomical calibrator database will store calibrator flux density histories and image models.	[020.10.05.00.00-0006-PLA-B, Sec 2.4.3, Para 1]
Calibration Database - Delivery	STK1151	The Calibration Database and Astronomical Calibrator Database shall be delivered prior to the start of CSV activities.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 3]
Monitor Data Archive - Delivery	STK1152	The monitor data archive shall be delivered as early as practical in the AIV activities, and prior to the start of CSV activities.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 2], [020.10.05.00.00-0005-PLA-B, Sec 10.1, Para 2]

5.13 User Support

Parameter	Req. #	Value	Traceability
Operational User Support	STK1200	The Observatory shall provide user support for any aspect of ngVLA use related to proposing, observing, data quality, processing and analysis through to the publication of scientific results.	[020.10.05.00.00-0002-PLA-C, Sec 5.6, Para1]
Software Packages Available to User Community: Data Analysis	STK1201	The Observatory shall provide software tools to the user community for data analysis. The package shall be executable on Observatory compute resources and on external computers.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 6]
Software Packages Available to User Community: Data Processing	STK1202	The Observatory shall provide software tools to the user community for processing ngVLA visibilities. The package shall be executable on Observatory compute resources and on external computers.	[020.10.05.00.00-0002-PLA-C, Sec 5.3, Para 6]

5.14 Calibration

Parameter	Req. #	Value	Traceability
Storage and Retrieval of Calibration Coefficients	STK1300	System parameters determined by calibration, such as delays or bandpass gains, shall be stored and automatically retrieved as needed.	[020.10.05.00.00-0002-PLA-C, Sec 5.8, Para1]

Parameter	Req. #	Value	Traceability
Automated Re-Measurement of Calibration Coefficients	STK1301	Re-measurement of calibration and related scientific performance characteristics of the array shall be automated and performed as an Observatory function using small subarrays of antennas, contemporaneously with science observing on larger subarrays.	[020.10.05.00.00-0002-PLA-C, Sec 5.8, Para1]
Inclusion of Calibration Pipelines and Supporting Systems	STK1302	The design of online and offline calibration strategies for standard observing modes, including any supporting hardware and software, shall be a construction deliverable.	[020.10.05.00.00-0006-PLA-B, Sec 2.4.3, Para1]

5.15 Observational Efficiency

Parameter	Req. #	Value	Traceability
Subarrays for Maintenance	STK1400	Maintenance, testing, characterization and capability development (including software) will primarily be done on a subset of the array, using subarrays where appropriate.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 1]
Subarrays for Scheduling	STK1401	A limited number of predefined science subarrays will be used by the Observatory to simplify scheduling of the scientific program.	[020.10.05.00.00-0002-PLA-C, Sec 5.2, Para 1]
Observational Efficiency	STK1402	The system shall be designed to maximize the array's resources and time spent on science observations (vs maintenance, testing, and development efforts.) Target of 95% of time available for science observations.	[020.10.05.00.00-0002-PLA-C, Sec 6.1, Para 2]
Calibration Efficiency	STK1403	Within the portion of time spent on science observations, the system shall be optimized for time spent on the science target, with consideration given to minimizing operational and calibration overheads.	[020.10.05.00.00-0002-PLA-C, Sec 5.1, Para 4]

5.16 Array Operations

Parameter	Req. #	Value	Traceability
Array Operations: Location	STK1500	Array operations shall be conducted from the Array Operations Center. It is a goal to reuse the Domenici Science Operations Center in Socorro, NM.	[020.10.05.00.00-0002-PLA-C, Sec 6, Para 1]

Parameter	Req. #	Value	Traceability
Array Operations: Subarray Use	STK1501	The scheduling of array time for observations, testing, commissioning, and maintenance shall accommodate the use of small concurrent subarrays, allowing a more continuous concurrent implementation of science observations, maintenance, and testing.	[020.10.05.00.00-0002-PLA-C, Sec 6.1, Para 2]
Duties of the Operator	STK1502	A human operator shall oversee the array. The operator will supervise the scheduling tools and executor, ensuring that the intent of each observation is met and that the array is kept in a safe operating condition.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para1]
Performance Metrics Definition	STK1503	The operations plan shall detail the specific performance metrics to be used such as array uptime, resource utilization, and operations costs per antenna.	[020.10.05.00.00-0002-PLA-C, Sec 6.3, Para 1]
Performance Metrics Reporting	STK1504	Array Operations shall be responsible for reporting its operations performance metrics.	[020.10.05.00.00-0002-PLA-C, Sec 6.3, Para 1]
Array Operations Interface to Array Maintenance and Engineering	STK1505	Array Operations and Science Operations shall coordinate priorities (initiation, triage, tracking, and closure of operationally-based tickets) to optimize the balance of science time and time required for maintenance.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para2]
Array Operations: Remote and Automated Functions	STK1506	Functions leveraging remote operations and automation of antenna functions shall be used when possible to reduce operations costs.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para3]

5.17 Configuration Management

Parameter	Req. #	Value	Traceability
Remote Access of System Configuration	STK1600	The system configuration shall be remotely ascertainable from each major element of the system, even those that do not typically have integrated diagnostic monitoring (e.g., cryogenic refrigerators), so that the facility configuration can be tracked dynamically with minimal effort.	[020.10.05.00.00-0002-PLA-C, Sec 7.2, Para 3]

Parameter	Req. #	Value	Traceability
Configuration Management	STK1601	A configuration management system is required to indicate which serial numbers of LRUs and other hardware items are in the array, under repair, or available from spare inventory, as well as each configuration item's location, repair, and upgrade history.	[020.10.05.00.00-0002-PLA-A, Sec 9.4-Para1]
Identification by Serial Numbers	STK1602	Individual LRUs, and all other configurable items, shall be uniquely identifiable to facilitate status and location tracking across the Observatory.	[020.10.05.00.00-0006-PLA-B, Sec 5, # 4]
Packaging as LRUs	STK1603	Electronics shall be packaged as Line Replaceable Units (LRU), where LRU modules are interchanged at the antenna.	[020.10.05.00.00-0002-PLA-C, Sec 7, Para 5]
Configuration Management Tools	STK1604	Prior to any assembly and integration activity, the project shall provide configuration management tools for tracking design versions and construction deliverables.	[020.10.05.00.00-0005-PLA-B, Sec 3, Bullet 7]
Version Control-Software and Firmware	STK1606	All software and firmware delivered to the project shall be version controlled via the configuration management process.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.2, Para 1]

5.18 Monitor and Control

Parameter	Req. #	Value	Traceability
Performance Analysis and Automated Maintenance Scheduling	STK1700	Array software systems shall provide a continual and largely automated analysis of array status and health, providing the key source of automatically generated maintenance tickets and automated maintenance scheduling.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para 2]
Hot Swaps of LRUs	STK1701	Hardware and software shall be designed to accommodate and recover from hot swaps with minimal interaction required by the maintenance and operations personnel.	[020.10.05.00.00-0002-PLA-C, Sec 7, Para 6]
Intelligent LRUs and Subsystems	STK1702	LRUs and other subsystems shall be smart devices with on-board diagnostics that can be accessed remotely for troubleshooting.	[020.10.05.00.00-0002-PLA-C, Sec 7.2, Para 1]
Interface between Operator and Operations Software	STK1703	The Operational software shall provide the operator with status and alert screens to indicate array health, and the Operational software shall inform the operator regarding maintenance work order tickets.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para 1]

Parameter	Req. #	Value	Traceability
Antenna Automation	STK1704	Individual antennas and subsystems within the array shall perform basic system configuration and monitoring functions without the need for human intervention.	[020.10.05.00.00-0002-PLA-C, Sec 6.2, Para 3]

5.19 Maintenance Operations

Parameter	Req. #	Value	Traceability
Preventive Maintenance Schedules	STK1800	Preventive maintenance (PM) schedule estimates must be consistent with the antenna systems operating for a year or more between PM visits.	[020.10.05.00.00-0002-PLA-C, Sec 7, Para 3]
Maintenance Tiers	STK1801	Maintenance tasks shall be classified in tiers to assign the level of skill or maintenance visit required. It is a goal that site-based maintenance be limited to lower levels, with high-skill work generally performed at the Repair Center by specialized staff and equipment under a higher degree of environmental and process control.	[020.10.05.00.00-0002-PLA-C, Sec 7, Para 6]
Optimization for Maintenance	STK1802	Organization of the maintenance and repair teams must be optimized to maximize efficiency of time spent on antenna visits and repair of equipment.	[020.10.05.00.00-0002-PLA-C, Sec 7, Para 7]
Criteria for Scheduling Maintenance	STK1803	Maintenance will be automatically scheduled based on a combination of the severity of existing issues, required preventive maintenance, and predictions of pending problems.	[020.10.05.00.00-0002-PLA-C, Sec 7.1, Para 1]
Use of Failure Analysis in Spares Planning	STK1804	Failure analysis shall be used in the planning of spares inventory. Factors considered shall include the projected availability for spares, the time required to repair the failure, and viability of critical vendors, with the threat of obsolescence taken into account for planning upgrades.	[020.10.05.00.00-0002-PLA-C, Sec 7.1, Para 2]
Reporting of Failures and Anomalies	STK1805	Failures and anomalies will be reported by operators, data analysts, post-processing pipelines, and users. These reports, along with those generated by automated means, shall be tracked in an issue tracking system with a corresponding database.	[020.10.05.00.00-0002-PLA-C, Sec 7.3, Para 1]

Parameter	Req. #	Value	Traceability
Maintenance Personnel Duty Stations: Antenna based	STK1806	Technicians who need regular access to the antennas, central electronics, and infrastructure systems shall be based close to their work responsibilities.	[020.10.05.00.00-0002-PLA-C, Sec 9.1, Para 2]
Maintenance Personnel Transportation: Array Site	STK1807	A fleet of maintenance and service vehicles will be used by staff to reach areas of the array requiring maintenance.	[[020.10.05.00.00-0002-PLA-C, Sec 9.1, Para 3]
Maintenance Personnel Transportation: Maintenance Center	STK1808	Daily transportation shall be provided to the Maintenance Center from the Array Operations and Repair Centers.	[020.10.05.00.00-0002-PLA-C, Sec 9.1, Para 3]
Maintenance Metrics Definition	STK1809	The operations plan shall detail the specific maintenance metrics to be used such as mean time to repair, resource utilization, and maintenances costs per antenna.	[020.10.05.00.00-0002-PLA-C, Sec 7.4, Para 1]
Maintenance Metrics Reporting	STK1810	Array Maintenance groups will be responsible for reporting their performance metrics.	[020.10.05.00.00-0002-PLA-C, Sec 7.4, Para 1]
Operations and Maintenance - Transfer of Deliverables	STK1811	All procedures, test equipment, and test software shall be delivered to the Operations and Maintenance staff prior to full operations.	[020.10.05.00.00-0005-PLA-B, Sec 6.4, Para 1]

5.20 Quality Assurance and Quality Control

Parameter	Req. #	Value	Traceability
Quality Control Database	STK1900	The associated repair log and test data shall be entered into a database prior to acceptance review, and should be globally visible to all groups from any location, even out in the field at remote antennas. The equipment shall only be considered repaired upon acceptance of this test data.	[020.10.05.00.00-0002-PLA-C, Sec 9.3, Para 3]
Quality Assurance of Repaired Items	STK1901	During the repair process, testing and quality control procedures must be sufficient to mitigate process errors and address pending failures before components and systems are redeployed.	[020.10.05.00.00-0002-PLA-C, Sec 9.3, Para 3]

Parameter	Req. #	Value	Traceability
Quality Control of Repaired Items	STK1902	Acceptance testing of software and hardware deliverables must occur before delivery to, or installation on, the array. Repair groups will produce the acceptance test data for review and acceptance by the groups responsible for either inventorying or using the repaired items.	[020.10.05.00.00-0002-PLA-C, Sec 9.3, Para 3]

5.21 Facilities

Parameter	Req. #	Value	Traceability
Inclusion of a Visitor Center	STK2000	An ngVLA Visitor Center will be provided for public outreach and will be located near the array, but at some distance from the center of the core to mitigate RFI. It is a goal to renovate and reuse the VLA Cafeteria for this purpose.	[020.10.05.00.00-0002-PLA-C, Sec 8.4, Para 1], [Director's Office, 2018]
Inclusion of a Maintenance Operations Center	STK2001	A Maintenance Operations center shall provide the duty station for safety, security, and maintenance personnel. This center shall serve as the node for maintenance activities and the storage of LRUs, field tools and equipment.	[020.10.05.00.00-0002-PLA-C, Sec 8.5, Para 1]
Inclusion of a Warehouse	STK2002	A central warehouse shall provide controlled inventory of all components used for preventive and corrective maintenance.	[020.10.05.00.00-0002-PLA-C, Sec 8.5, Para 3]
Inclusion of a Repair Center	STK2003	The Repair Center will host staff and equipment necessary for the transfer, diagnosis, repair, and test of electronic LRUs and other equipment.	[020.10.05.00.00-0002-PLA-C, Sec 8.6, Para 1-2]
Inclusion of an Array Operations Center	STK2004	An Array Operations Center (AOC) shall provide sufficient space to host offsite array operations and a comparable complement of office space, laboratory space, storage and transfer capabilities, and computing infrastructure as in the existing DSOC.	[020.10.05.00.00-0002-PLA-C, Sec 8.6, Para 1-2]
Inclusion of a Science Operations Center	STK2005	A Science Operations Center (SOC) is required to house the scientific operations staff constituted of scientists, data analysts, computing, software, and IT positions, and some administrative and management staff. The facility will primarily consist of office space and computing infrastructure.	[020.10.05.00.00-0002-PLA-C, Sec 8.7, Para 1-2]

Parameter	Req. #	Value	Traceability
Inclusion of Remote Operations Stations	STK2006	Remote Operations Stations (ROS) shall be located in southern New Mexico, west Texas, Mexico, and as needed to support LBA operations. Each ROS shall have a footprint to support workbenches, organized tools, supplies, and inventory including spare LRUs required for routine maintenance of a group of antennas.	[020.10.05.00.00-0002-PLA-C, Sec 8.8, Para 1-3]
Location of the Maintenance Operations Center	STK2007	The Maintenance Operations Center should be located near the array site in order to facilitate logistics, but sufficiently far away to mitigate RFI at the Array Core.	[020.10.05.00.00-0002-PLA-C, Sec 8.5]
Location of the Array Operations Center	STK2008	The Array Operations Center should be located within a few hours of the array site in order to facilitate logistics while providing an attractive location to recruit array operations personnel.	[020.10.05.00.00-0002-PLA-C, Sec 8.6]
Location of the Science Operations Center	STK2009	The Science Operations Center should be located at a site that facilitates personnel recruitment, such as an attractive metropolitan area. It may be collocated with the archive and data center (if the project selects local vs cloud services).	[020.10.05.00.00-0002-PLA-C, Sec 8.7]
Location of the Repair Center	STK2010	The Repair Center should be located within a few hours of the array site in order to facilitate logistics while providing an attractive location to recruit array operations personnel. It may be collocated with the Array Operations Center.	[020.10.05.00.00-0002-PLA-C, Sec 8.6]
Location of the Warehouse	STK2011	The Warehouse should be located near the array site in order to facilitate logistics, but sufficiently far away to mitigate RFI at the Array Core. It may be collocated with the Maintenance Operations Center.	[020.10.05.00.00-0002-PLA-C, Sec 8.5]
Inclusion of a Guard Booth	STK2012	To maintain site security at the additional buildings near the core of the array, a guard booth will allow security staff to provide a constant security presence.	[020.10.05.00.00-0002-PLA-C, Sec 8.2 Para 1]

Parameter	Req. #	Value	Traceability
Inclusion of Central Support Buildings	STK2013	Additional buildings near the array core shall provide for the storage and maintenance of heavy equipment that cannot be easily delivered or driven from the nearby Maintenance Center and will support the maintenance and repair staff temporarily on-site.	[020.10.05.00.00-0002-PLA-C, Sec 8.2, Para 1]
Facility Space - AIV	STK2014	The project will provide adequate space needed for pre-deployment activities, equipment maintenance and storage, and AIV staff office space.	[020.10.05.00.00-0005-PLA-B, Sec 4, # 11]
Warehouse Space - AIV	STK2015	The project shall deliver warehouse capabilities needed to store electronics and other assemblies delivered by the IPTs that require safe keeping prior to antenna integration.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.1, Para 2]
Data and Voice Services - AIV	STK2016	It is a goal to deliver data and voice service at each antenna site at the start of civil construction.	[020.10.05.00.00-0005-PLA-B, Sec 8.7 Para 1]
Workspace - CSV	STK2017	Dedicated workspace shall be provided in the local control room at the array site for CSV activities.	[020.10.05.00.00-0006-PLA-B, Sec 5.2.3, Para 1]
Workspace - CSV-Operators	STK2018	The remote control room needed for CSV activities shall contain a sufficient number of IT-supported workstations, in addition to the main multi-monitor control console needed by an operator.	[020.10.05.00.00-0006-PLA-B, Sec 5.2.4, Para 1]

5.22 Logistics

Parameter	Req. #	Value	Traceability
Inventory Tracking System	STK2100	Inventory shall be electronically tracked to determine usage rate and location of spares throughout the locations in the array.	[020.10.05.00.00-0002-PLA-C, Sec 9.2, Para 1]
Inventory of Consumables	STK2101	An inventory of commonly used supplies shall be centrally maintained at the ngVLA Warehouse.	[020.10.05.00.00-0002-PLA-C, Sec 9.2, Para 1]
Shipping and Receiving Logistics	STK2102	Each facility shall have central shipping and receiving and be integrated with a shipping system between sites.	[020.10.05.00.00-0002-PLA-C, Sec 9.2, Para 2]
Repair and Tracking of LRUs	STK2103	LRUs shall be centrally managed, tested, and repaired from the Repair Center, but will be stored near the point of service at the ngVLA Maintenance Center and ROS locations.	[020.10.05.00.00-0002-PLA-C, Sec 9.3, Para 1]

Parameter	Req. #	Value	Traceability
Inventory of Component Spares	STK2104	Component-level spares will primarily be stored at the ngVLA Warehouse and provided on an as-needed basis to the Repair Center.	[020.10.05.00.00-0002-PLA-C, Sec 9.3, Para 2]
Observatory-Controlled Logistics	STK2105	Observatory-controlled shipping resources shall be used to ensure prioritization, possession, and safe-handling of items during transit (i.e. rather than commercial carriers).	[020.10.05.00.00-0002-PLA-C, Sec 9.2, Para 2]
Packaging Used for Shipping	STK2106	The shipping cases and packing practices will provide ESD protection in addition to mechanical shock absorption.	[020.10.05.00.00-0002-PLA-C, Sec 9.2, Para 2]
Logistics Tools and Resources	STK2107	Logistics tools and resources (physical and human) shall be in place to support efficient product flow from suppliers to antenna sites prior to the start of AIV activities.	[020.10.05.00.00-0005-PLA-B, Sec 4, # 10]
Issue Tracking Tool	STK2108	Prior to the start of system-level AIV and site deployments, the project shall have in place an issue tracking tool that tracks open action items/punch list for site activities.	[020.10.05.00.00-0005-PLA-B, Sec 4, # 13]
Packaging - AIV	STK2110	Packaging for delivered hardware shall ensure the safe storage of equipment in nominal warehouse conditions.	[020.10.05.00.00-0005-PLA-B, Sec 5.2.1, Para 1]

5.23 Security

Parameter	Req. #	Value	Traceability
Physical Security Systems	STK2200	Site physical security systems will be recorded and also monitored either by an array operator or a security guard. In the event of an intrusion, local law enforcement will be contacted and relied upon for a response.	[020.10.05.00.00-0002-PLA-C, Sec 9.5, Para 3]
Physical Security Plans	STK2201	Physical security and monitoring for the ngVLA site and the remote sites shall be provided.	[020.10.05.00.00-0002-PLA-C, Sec 9.5, Para 1-2]
Cybersecurity	STK2202	ngVLA IT systems shall be hardened against intrusion consistent with existing NRAO CIS policies.	[020.10.05.00.00-0002-PLA-C, Sec 9.6, Para 1]

5.24 Local Stakeholders

Parameter	Req. #	Value	Traceability
Grassland & Water	STK2400	The project shall aim to minimize impact on grasslands and water within the plains of San Agustin. Special care should be given to the array core given the degree of disturbance.	[J&S Bruton, 09/25/2018 visit by PD]
Roads	STK2401	Road widths and lengths should be minimized to reduce the destruction of top soil. The road design should aim to avoid the collection of water into new ditches or arroyos that will exacerbate soil erosion.	[J&S Bruton, 09/25/2018 visit by PD]
Existing Roads	STK2402	Existing ranch roads should be assessed for suitability in both construction and operations. Goal to reuse existing roads where possible.	[J&S Bruton, 09/25/2018 visit by PD]
Fences	STK2403	Any fences should not impede the flow of cattle and wildlife within and between neighboring ranches, or significantly increase the travel distance to water sources.	[J&S Bruton, 09/25/2018 visit by PD]
Ranching Impact	STK2404	The project shall aim to reduce the environmental impact to cattle ranching as well as hunting/outfitting, which are both mainstays of local ranches.	[J&S Bruton, 09/25/2018 visit by PD]
Core Site	STK2405	The specific location of the array core should account for the differences in the quality of lands on the plains.	[J&S Bruton, 09/25/2018 visit by PD]

5.25 NRAO and Other Facility Integration

Parameter	Req. #	Value	Traceability
SRDP Integration	STK2500	The ngVLA project shall use the SRDP project as pathfinder, with the expectation of adopting the SRDP Observatory-User interfacing architecture for ngVLA.	[SRDP AD, 2018. Director's Office, 2018]
Facility Integration	STK2501	It is desirable for ngVLA to support joint (e.g., VLB) observations with other NRAO facilities, as well as other global flagship facilities.	[ngVLA PD]
DMS Integration	STK2502	The ngVLA project shall adopt existing NRAO Data Management & Software (DMS) policies, with facility integration into Observatory infrastructure and standards, in order to promote reuse and maintainability.	[DMS AD, 2016]

5.26 Radio Frequency Interference

Parameter	Req. #	Value	Traceability
Self-Interference	STK2600	The system shall be designed to prevent self-interference that will be detrimental to science operations.	[ngVLA PD]
RFI Survival	STK2601	The system shall be designed to withstand, without damage or long-term degradation, the projected RFI environment over the life of the instrument.	[ngVLA PD]
RFI Mitigation	STK2602	The system shall be designed to operate in the projected RFI environment while still achieving the Key Science Goals and the desired operational efficiencies.	[ngVLA PD]
VLA Interference	STK2603	It is a goal to minimize interference with VLA operations during the construction/transition phase.	[ngVLA PD]

5.27 Non-Functional Requirements

Parameter	Req. #	Value	Traceability
Design Consideration of the "-ilities"	STK2700	The project design shall consider manufacturability, reliability, maintainability, operability, extensibility, fault tolerance, interoperability, resilience, robustness, testability, and stability, as non-functional requirements relevant to the ngVLA system design.	[PMD AD, 2018]

5.28 Non-Traditional Use Cases

Parameter	Req. #	Value	Traceability
SSA Support	STK2800	It is desirable for the ngVLA to support non-traditional use cases related to space situational awareness, such as imaging of geostationary objects.	[Director's Office, 2016]
DSN Support	STK2801	It is desirable for the ngVLA to support non-traditional use cases related to spacecraft operation, such as Deep Space Network (DSN) downlink support for critical NASA missions.	[Director's Office, 2016]

5.29 Future Commensal Systems

Parameter	Req. #	Value	Traceability
Commensal Front-Ends	STK2900	It is desirable that commensal front-ends (e.g., ngLOBO) be considered in the design, and provisions/interfaces for future commensal front-ends be incorporated into the design. (i.e. not "designed out")	[NRL, LWA, 2016]
Commensal Back-Ends	STK2901	It is desirable that commensal back-ends (e.g., RealFast) be considered in the design, and provisions/interfaces for future commensal back-ends be incorporated into the design. (i.e. not "designed out").	[ngVLA PD]

6 Appendix

6.1 Abbreviations and Acronyms

Acronym	Description
AD	Applicable Document
AIV	Assembly, Integration and Verification
ALMA	Atacama Large Millimeter/submillimeter Array
AOC	Array Operations Center
API	Application Programming Interface
APM	Atmospheric Phase Monitor
AST	Division of Astronomical Sciences (NSF)
AUI	Associated Universities Inc.
CASA	Common Astronomy Software Applications
CDL	Central Development Laboratory
CSV	Commissioning & Science Validation
DMS	Data Management & Software
DSN	Deep Space Network
EMC	Electro-Magnetic Compatibility
ESD	Electro-Static Discharge
EVLA	Expanded Very Large Array Project
FOV	Field of View
FWHM	Full Width Half Max
HPC	High Performance Computing
ICD	Interface Control Document/Definition
IF	Intermediate Frequency
IPT	Integrated Product Team
IT	Information Technology
KPP	Key Performance Parameters
KSG	Key Science Goals
LFM	Large Facilities Manual
LO	Local Oscillator
LRU	Line Replaceable Unit
LSST	Large Synoptic Survey Telescope
MOC	Maintenance Operations Center
MoE	Measure of Effectiveness
MoP	Measure of Performance
MREFC	Major Research Equipment and Facilities Construction (NSF)
MTBF	Mean Time Between Failure
MTTF	Mean Time To Failure
NES	Near Earth Sensing
ngLOBO	Next Generation LOw-Band Observatory

ngVLA	Next Generation VLA
NMTO	New Mode Test Observation
NRAO	National Radio Astronomy Observatory
NSDR	Non-Standard Data Reduction
NSF	National Science Foundation
OS	Operating System
PI	Principal Investigator
PM	Preventive Maintenance
PWV	Precipitable Water Vapor
RID	Review Item Discrepancy
RD	Reference Document
RFI	Radio Frequency Interference
rms	Root Mean Square
ROS	Remote Operations Station
RSS	Root of Sum of Squares
SAC	Science Advisory Council
SB	Scheduling Block
SKA	Square Kilometer Array
SMDR	Standard Mode Data Reduction
SNR	Signal to Noise Ratio
SOC	Science Operations Center
SRDP	Science Ready Data Products
SRO	Shared Risk Observing
STRR	Stakeholder Requirements Review
SWG	Science Working Group
TBC	To Be Confirmed
TBD	To Be Determined
VLA	Jansky Very Large Array
VLASS	Very Large Array Sky Survey
VLB	Very Long Baseline (Interferometry)
VLBI	Very Long Baseline Interferometry
WFIRST	Wide Field InfraRed Survey Telescope
WP	Work Package
WVR	Water Vapor Radiometer