Rubin Observatory

Vera C. Rubin Observatory
Systems Engineering

Operations Readiness Criteria

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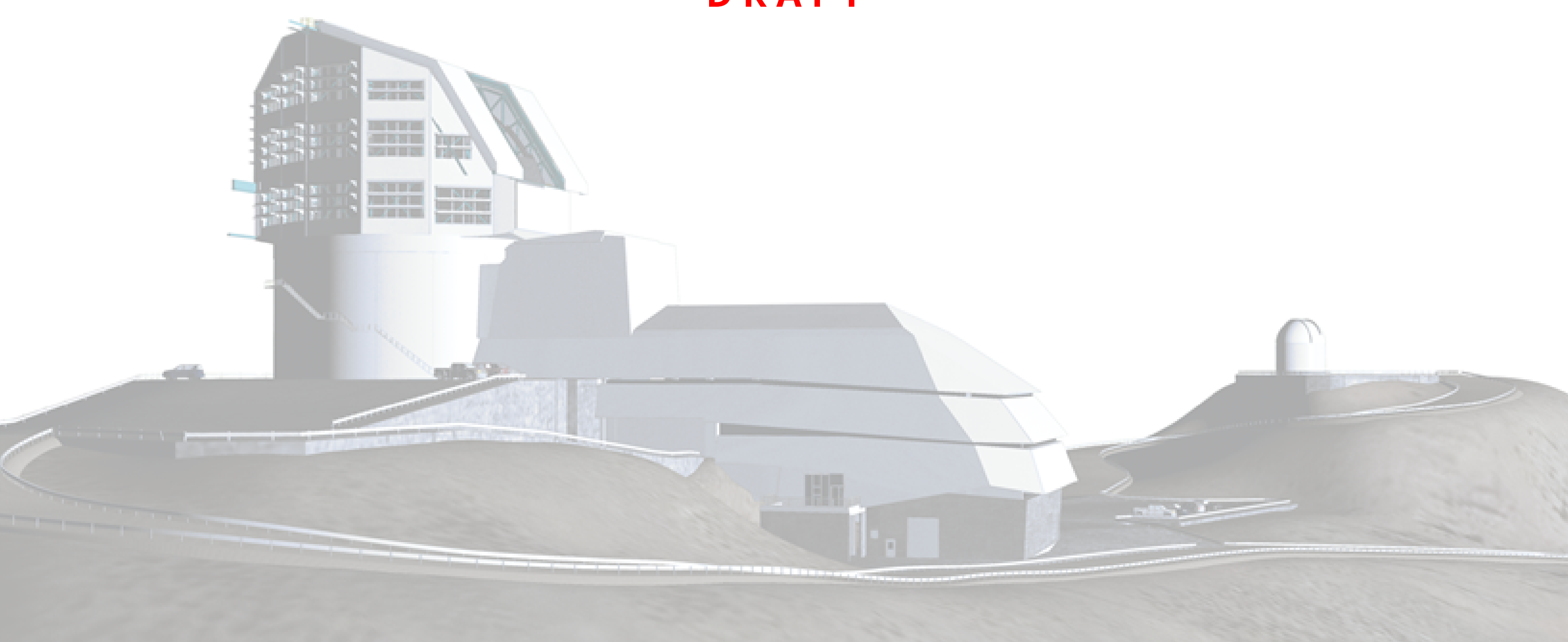

Rubin Observatory

Abstract

This technote collects together the elements that constitute criteria for Operations Readiness of the Rubin Observatory

Rubin Observatory

Change Record

Version	Date	Description	Owner name
1	2020-08-06	First draft	Leanne Guy

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Rubin Observatory

Contents

Operations Readiness Criteria

1 Introduction

One of the primary high-level strategic inputs to developing the System AI&T and Commissioning Plan (LSE-79) are the construction completeness requirements for the Operations Readiness Review (ORR). At the conclusion of the Commissioning Phase of the LSST construction project an ORR will be undertaken by an external panel, jointly appointed by the DOE and NSF, in consultation with the LSST Project Team. The ORR will signifiy the end of the NSF MREFC funded construction project and DOE Commissioning.

The ORR will consist of two parts: 1) The evaluation of the Rubin Construction Project completeness and 2) the readiness of Rubin Operations to receive the construction deliverables and begin routine operations for conducting the Legacy Survey of Space and Time – the 10-year science survey for which the Rubin Observatory was designed.

In this document, we collect together the elements that constitute criteria for Operations Readiness. Each topic has, or will reference defined requirements – in many cases along with goals and stretch goals – each will have the relevant supporting documentation for performance against the requirement. For those requirements that specify performance after some period of operations, the basis of estimate of projected performance will be provided. Unless otherwise specified, functional requirements will be verified by direct test, and performance requirements will be verified by direct test, analysis, or a some combination thereof. For each requirement, there will either be a clean pass, or there will be a waiver process that documents why it is acceptable to proceed to operations (or the reason we must postpone the transition to operations).

Some of the topics are already covered by existing verification plans. Some functional requirements (and any accompanying goals and stretch goals) are still in review (at the time of this document version) – in those cases, the requirements and associated verifications are being developed together to ensure clarity and crisp requirement for verifiability. Some topics, such as the Science Validation survaeys, have requirements that are a combination of performance and functionality that do not necessarily flow directly from the high-level requirements; in those cases, we identify the minimum requirements that must be met to proceed to operations, along with a range of goals and stretch goals and the accompanying rationale.

2 Verification of Observatory System Specifications (LSE-30)

2.1 Construction Completeness Criteria

The project team shall demonstrate that the integrated LSST systems (Camera, Telescope & Site and Data Management subsystems) as well as the Education and Public Outreach (EPO) system have met the technical specifications enumerated in the LSST Observatory System Specifications (LSE-30).

2.2 Objectives

The main objective with this Operations Readiness Requirement is to verify the system specifications in the OSS (LSE-30) are proven and well documented.. The OSS is essentially the highest level document describing the basic LSST system architecture. It contains sections derived from the OSS on the following broad topics:

- System Composition and Constraints
- Common System Functions and Performance, including:
  - System Control
  - System Monitoring and Diagnostics
  - System Maintenance
  - System Availability
  - System Time References
- Detailed Specifications:
  - Science and Bulk Data
  - Optical System
  - System Throughput
  - Camera System
  - Photometric Calibration
  - System Timing and Dynamics
- Education and Public Outreach

2.3 Criteria or Completeness

Compliance with this objective will follow the process as defined in the Verification and ValidationProcess document (LSE-160) and associated documentation. All technical specifications in the OSS (LSE-30) and LSR (LSE-29) are expected be met at the end of construction.

2.4 Pre–Operations Interaction

None. Unless there are non-compliance issues against the ORR requirements and specifications.

2.5 Artifacts for Completion

- Verification matrix containing entries for all OSS requirements and specifications. Methods, inspections, demonstration, analysis or test, shall be identified for every OSS requirement. Final compliance status will be included.
- Analysis reports where the verification method has been identified as ”test” or ”analysis”.
- Non-compliance reports.

3 LSST System Requirements & SRD Verification/Validation

3.1 Construction Completeness Criteria

The project team shall characterize and document the performance of the integrated LSST system with respect to the survey performance requirements and specifications enumerated in the LSST System Requirements, Observatory System Specifications and Science Requirements Document (LSE-29, **?** & LPM-17 Section 3 respectively).

3.2 Objectives

The primary objective for this Operations Readiness Requirement is verify and validate that the data produced from the science validation surveys (and any additional observing campaigns) meets the science verfication requirements as described in the LSST Verification and Validation (LVV) elements and test cases. This will include:

- Verification of the generation of all required data products and services;
- Verification that the relevant metadata are being collected and archived;
- Verification of astrometric performance (relative and absolute);
- Verification of photometric performance (relative and absolute);
- Verification of data throughput and processing requirements for prompt data products;
- Completeness and purity of sources detected in AP and DRP;
- Image template generation;
- Completeness and purity of moving object orbit calculations;
- The impact of stray light and optical ghosts;
- Image quality (defined for each subsystem: telescope, camera, data management);
- Crosstalk, filter response, and calibration.

In addition to the normative data quality requirements above, there are several science validation and characterization objectives that represent important benchmarks of scientific capability. The optimization of associated algorithms is in many cases an active research topic, and performance is expected to improve throughout Operations. Potential science validation studies include:

- Object detection completeness;
- Object de–blending;
- Object classification – *e.g.*, star-galaxy separation;
- Galaxy photometry – *e.g.*, for photometric redshifts);
- Difference image analysis photometry – *e.g.*, for statistical variability metrics);
- Low surface brightness features;

- Weak-lensing null tests and shear calibration;
- Treatment of crowded fields.

The verification will make use of Quality Assessment (QA) and Quality Control (QC) tools developed during DM construction.

- Quality Assessment: versatile pipelines to calculate performance metrics and other diagnostics
- Quality Control: ensure that metrics are routinely calculated and track their distributions as the pipelines evolve and encounter new data

In particular, Key Performance Metrics produced by DM and the Commissioning team together with additional test cases will be compared against the tabular requirements in the LSST SRD.

Discussion

For the purpose of evaluating readiness we define the steps associated with verification, validation, and characterization of the LSST data and processing.

Verification: Demonstrate that the system as built is consistent with the design. Ensure that the requirements for the system are met using LSST and precursor data. Express the requirements in terms of metrics that can be evaluated using LSST and precursor data. Document the system performance for each of the verification metrics and requirements.

Validation: Demonstrate that the system is capable of meeting the scientific objectives of the survey. Ensure that the data products, data access, and science requirements can meet the objectives for LSST's four major science themes. Document the system performance for each of the validation metrics and requirements and verify that there exist mechanisms to monitor the system performance during operations. Validate that the derived data products and access tools meet the science requirements of the community.

Characterization: Determine how the performance of the system degrades as a function of environment and technical performance of the components of the system. Measure how the metrics used in verification change as a function of operational conditions (including weather, site, operations, telescope, instrument, and software).

The scope of science verification and validation activities includes:

- Determining whether the specifications defined in the OSS, LSR, and SRD are being met;
- Characterizing other system performance metrics in the context of the four primary science drivers;
- Studying environmental dependencies and technical optimization that inform early operations;
- Documenting system performance and verifying mechanisms to monitor system performance during operations; and
- Validating data delivery, derived data products, and data access tools that will be used by the science community.

The goal is to quantify the range of demonstrated performance by using a combination of on-sky data, informed simulations of the LSST system, and external datasets. Observations taken during this period will enable higher-level data quality assessments that are not explicitly identified as requirements in the LSR or SRD, but nonetheless represent important benchmarks of scientific performance (e.g., source detection completeness, accuracy of star-galaxy separation, precision of photometric redshifts, and weak-lensing null tests).

All test cases as described under the LSST Verification and Validation project will be implemented as either part of the DM Key Performance Metric validation system, as separate test procedures (e.g., Jupyter notebooks), or via visual inspection (e.g., to demonstrate that a service or data produce has been delivered). The LSST Science Platform will be the primary tool for data access and exploration. All metrics will be applied to data from the two main Science Validation surveys (the Wide-area Science Validation Survey and the 10-year Depth Science Validation Survey) and evaluated against the numerical values described in the LSST System Requirements, Observatory System Specifications and Science Requirements Document.

If the schedule for on-sky observations is compressed, there might be a tight timeline for data processing and subsequent analysis of the Science Validation surveys. The statistical power of tests may be more limited if there are fewer observations. In that case, the validation and characterization may be more limited. For example, if the baseline for the wide-area science verification survey is shortened we will have to verify variability measures (e.g., periods) to specific classes of object. We may want to specify which classes of variability we will prioritize. Similarly, for the data release products, priority might be assigned to the verification of science performance for a brighter sample of objects (e.g., magnitudes $i < 25$).

3.3 Criteria for Completeness

The Project team shall complete sufficient science verification, validation, and characterization studies to be confident that 10-year LSST survey can satisfy OSS, LSR, and SRD. Some aspects of science performance are fixed by the telescope, camera, and observing startegy, while others can be continually improved through refinements of the Science Pipelines. In this context, key objectives of science verification are to distinguish between anomalies that can be addressed in the science pipelines and those that are more fundamental to the raw data, and to establish confidence that more subtle anomalies do not fundamentally limit science reach during Early Operations.

To achieve this level of confidence, we identify several essential categories of science performance (in order of increasing algorithmic dependence):

- image quality (PSF FWHM, ellipticity), system throughput, ghosts/scattered light, sky brightness and readout noise, detector anomalies;
- instrument signature removal;
- PSF modeling, photometric calibration, astrometric calibration.

Construction completeness is achieved when LSR and SRD metrics in the categories above pass the design requirements as stated in the SRD. Non-compliance exceptions to the above requirements will be considered following internal and external reviews of the assessed performance and operational impacts.

In addition, substantial progress should be made on towards initial verification of difference imaging, de–blending, galaxy photometry including shape measurement, moving object linkage, and proper motions.

3.4 Pre–Operations Interaction

Brief the Operations Team on current status of science verification, validation, and characterization; and

Handoff of QA and QC tools. Ensure that operations team can run these tools, interpret the results, and add new metrics as needed.

3.5 Artifacts for Completion

- Minimum:
  - Summary report of system–level science performance metrics, with comparison to specifications in the OSS, LSR, and SRD;
  - Impact study in the case of non-compliance;
  - Documentation of Quality Assessment and Quality Control tools;
  - Draft of Construction Paper for Commissioning Science Verification and Validation (not released until time of public release of commissioning data products).
- Baseline:
  - For each science performance requirement in the LSR and SRD, summary statistic(s) or diagnostic plot(s) demonstrating the distribution of performance and correlations with environmental conditions, astrophysical foregrounds, etc.;
  - Brief reports for a small collection of end-to-end studies demonstrating realistic workflows used for science validation (see examples above). It is envisioned that these studies may mature into full scientific publications during the first year of operations and may involve collaboration with the larger scientific community.

4 Science Validation Survey

4.1 Operations Readiness Requirement:

The project team shall conduct at least one Science Validation Survey with the science camera (LSSTCam) over a limited area of the sky that will be autonomously driven by the scheduler and will last at least 30 days;

4.2 Objectives:

The main objective with this Operations Readiness Requirement is to effectively conduct a "full dress rehearsal" of science operations. The 30-day time span is intended to include operations affected by a full lunar cycle including:

- Filter swapping the u-band during dark time;
- Management of survey scheduling during the period around full moon;
- Scheduler response to a range of environment conditions encountered at the observatory over a 30-day period, including periods of cloud cover and variable atmospheric seeing, variable winds, and changes in daytime / nighttime temperature;
- Response of the LSST Data Facility to sustained data rates including simultaneous execution of the Alert Production and Data Release Production pipelines.

In addition, the following concepts of operations and their procedures will be rehearsed and demonstrated:

- Full rehearsal of safety procedures for science operations;
- Routine daytime maintenance of the observatory;
- Collection and processing of routine calibration data and data products consistent with the time allotted in the 24-hour operations cycle;
- Routine nighttime survey observing operations driven by the scheduler with minimal human interaction, including response to realtime telemetry, AuxTel;
- Demonstration of near real time data quality assessment;
- Prompt processing of alerts within the required latency time (i.e., 60 seconds);
- Recovery from interruptions to observing (e.g. failure of the network)
- Distribution of prompt products;
- Prompt processing and the "24-hour" data products (e.g., asteroid orbit calculations);

- Data Release Production (at least once) and publication to the LSST Science Platform.

Data acquired during the SV survey(s) should be science quality to allow a summative assessment of the delivered scientific performance of the as-built system.

4.3 Criteria for Completeness Description:

The baseline schedule of on-sky observations during commissioning concludes with a 8-week period to undertake two science validation surveys. The two surveys are designed to test the Prompt Products and Data Release Products, respectively.

Wide-area Science Validation Survey: In a first phase, observe a region of roughly 1000 deg^2 to an integrated exposure equivalent to 1 year of the Wide-Fast-Deep survey in multiple filters (2 weeks). Create image templates with the Data Release Production pipeline to be used as input for difference imaging. In a second phase starting roughly 4 weeks after the completion of the first phase, observe the same region to an integrated exposure equivalent to 1 year of the Wide-Fast-Deep survey, running the Alert Production pipeline at full scale (2 weeks). The 4-week separation between phases is used for template generation and to allow evolution of variable and transient astrophysical sources between template and test images. 10-year Depth Science Validation Survey: Observe a region larger than 100 deg^2 to an integrated exposure equivalent to the 10-year Wide-Fast-Deep survey in multiple filters (4 weeks). Process the data with the Data Release Production pipeline.

Observation Timeline (baseline): 2 weeks Wide-area Science Validation Survey: Template Generation Phase 4 weeks 10-year Depth Science Validation Survey 2 weeks Wide-area Science Validation Survey: Realtime Alert Production Phase

The wide-area SV survey is designed to approximate the difference imaging templates and data rates that would be expected during early science operations, thus also providing a full-scale test of the LSST Data Facility. The scheduler will drive nighttime observatory operation during the SV surveys.

In event of a shortened period for on-sky observations, we have a draft minimum observing strategy:

- Single-visit KPMs: 6 Star flats in $ugrizy$ ×4 epochs = 4 nights
- Nominal observing for scheduler testing = 3 nights (Note: some scheduler testing will be done during ComCam and LSSTCam integration periods)
- Challenging regions = 1 night
- Full-Depth Survey: 20 year depth in $ugrizy$ overlapping at least 1 external reference field, allowing WFD dithers (factor 3) -> ∼5K visits = 8 nights
- Wide-Area Survey: 1600 deg^2 in gi filters to 1-year equivalent depth, repeated in two phases -> 12K visits = 20 nights

Program above is ~ 36 nights total. The essential elements of any observing strategy for the Science Validation surveys are (1) the need to reach 10-year WFD equivalent depth in at least 3 filters in at least one field, (2) to reach 1-year WFD equivalent depth in at least 2 filters over an area exceeding 100 deg^2, (3) to exercise the nominal scheduler continuously for at least 1 night, and (4) to have coverage to at least 1-year WFD equivalent depth in all 6 filters in at least three fields spanning a range of stellar density. The observatory should operate continuously in scheduler-driven mode for at least 5 days of the 30 days allocated to the Science Validation surveys.

4.4 Pre-Operations Interactions:

At the conclusion of the SV Survey(s), roughly two years will have elapsed since the start of Early System Integration and Testing, which places the LSST Observatory on schedule for its 2-year major maintenance and servicing.

M1M3 Mirror Recoating: Remove, strip, clean, and re-coat the M1M3 mirror surfaces. Reinstall M1M3 mirror backinto telescope. Associated activities include:

- Remove Top-End Integrating Structure with Camera and transfer to Summit Facility camera lab.
- Install camera dummy mass to allow the telescope to point to zenith for removal of the M1M3 mirror cell. Remove M1M3 mirror assembly and transfer to Summit Facility recoating plant.

- Strip old coating, clean and re-coat mirror surfaces.
- Re-install M1M3 in telescope and prepare to receive the top-end integrating structure with the camera.

Camera Maintenance and Servicing: Clean, service, perform maintenance, and replace shutter. Associated activities include:

- Replace camera shutter with ?fresh? operational unit;
- Inspect, service, or repair filter mechanisms;
- Clean internal camera optics;
- Inspect, service, and repair utility trunk electronics

4.5 Artifacts for ORR:

- Safety report from continuous observatory operations during the survey(s)
- Summary of daytime and nighttime activity for each 24 hour period of the survey(s)
- Metrics for the effective survey speed, including number of visits per night, telescope slew angles and slew times, filter changes, etc., which can be used to inform survey strategy during early operations
- Characterization of the distribution of data quality delivered by the as-built system, for example, distributions of single-visit image quality and image depth.
- Realtime alert stream
- Associated data release production products accessed via the LSST Science Platform (LSP)
- Pre-ORR observatory maintenance report summarizing the pre-operations engineering activities and current status of the observatory
- Documentation for observatory operations, including recommendations for optimization of data quality and survey efficiency
- Documentation for LSST Data Facility (LDF) operations

5 Verification and Validation of Data Management

5.1 Verification Procedure for Data Management System Requirements (LSE-61)

5.2 Prompt Processing

5.3 Data Release Processing

Operations readiness for Data Release Processing is difficult to fully disentangle from the verification and validation of the full DM system; a Data Release Production involves not just the image processing pipeline that is the component most visible to scientists, but integration with and usage of many other DM deliverables as well, including:

- data access middleware that archives and organizes both raw data from the observatory and processing outputs;
- process control middleware that provides a harness for running the pipelines at scale;
- systems for transferring processing outputs to components of the science platform for user access, including database ingest;
- hardware, operators, and other production services.

The Project will produce several Data Previews, each resembling an operations-era Data Release with steadily increasing scale, algorithmic sophistication, and integration across DM (and the rest of the Project). Successful completion of these represents our highest-level criteria for operations readiness for data release processing, and the vehicle for much of our validation work – performing validation using our own science platform on our own data products is the most direct way to demonstrate that scientists will be able to perform similar investigations with these tools on these data products.

5.4 Rubin Science Platform

6 Community Services and EPO

7 Science Data Quality Assessment

8 Recording and Archiving of System State Metadata

8.1 Operations Readiness Requirement

The Rubin Project Team shall demonstrate that relevant metadata are being collected and archived.

8.2 Objectives:

The objective with this requirement is to ensure that the technical state of the environment and hardware/software systems during the time of survey data collection is recorded with sufficient fidelity to be used in support of subsequent processing to produce the LSST science products. This is of particular importance for the determination and correction of systematics in the data as the survey progresses and statistics improve. Additionally, the metadata record in required to assure efficient operation and maintenance of the observing facility. The primary repository of this metadata is the Engineering Facility Database (EFD) - having two components: 1) a searchable SQL Cluster based capture of "house keeping" telemetry and 2) the Large File Annex for non-telemetry records (e.g. configuration files, images, other binary files outside the science pixel data etc...).

Technical Metadata at the time of each visit includes but not limited to:

- Meteorological state on the Summit;
- Environmental conditions in the dome interior;
- Atmospheric seeing as measured by the tower mounted DIMM;
- Sky transparency map from the All-Sky Camera;
- Technical "house keeping" telemetry from each subsystem component as published to the EFD;
- Software version configuration status of all operating systems; and
- Configuration parameters of all active subsystems.

8.3 Criteria for Completeness

Satisfying this criteria includes at a minimum:

- Demonstrate the technical data (see above) are being recorded by the EFD at >99% (TBC) reliability level - e.g. no significant dropouts in the live database at the Summit Facility;
- Demonstrate the recorded data are being archived for long term access - copy at Base Facility in Chile and Copy at NCSA (possibly Interim Data Facility);
- Access to the technical data is achievable through standard monitoring dashboards;
- Access to the technical data is chewable through use customizable GUI interface(s); and
- Technical data are queryable through Rubin Science Platform tools - e.g. Jupyter Lab notebooks and WEB interface.

8.4 Pre–Operations Interactions

Transfer and archiving the EFD at the Interim Data Center would be required for external queries.

8.5 Artifacts for ORR

- Report documenting minimum criteria as defined in the discussion section above
- SDK and example code for custom dashboards and dashboard templates available through software repository(s) - e.g. GitHub
- Example code for Rubin Science Platform queries through software repository - e.g. GitHub

9 Operational Procedures and Technical Documentation

9.1 Operations Readiness Requirement

The project team shall deliver a complete set of documented operational procedures and supporting technical documents needed to operate the LSST as a scientific facility for the purpose of conducting a 10-year survey.

9.2 Objectives:

The objective with this Operational Requirement is to ensure that the procedures necessary for operations and maintenance of the LSST Observatory System are documented and provided in a form that allows the operations team conduct the 10-year planned survey. The documentation is to include but is not limited to:

- Technical as-built design records - including functional descriptions; 3-D CAD files; drawing files used for fabrication; and software code and it's associated documentation and any as-built metrology;
- Process procedures describing user level standard operations;
- Maintenance needs and procedures for all systems in use;
- System software documentation - including their functionality, interacts with other systems and the observatory scheduler algorithm; and
- A configuration management plan for observatory wide software systems.

9.3 Criteria for Completeness

- A clearly defined and documented architecture and implementation for the Project's varied documentation. This includes:
  - As-built drawings, diagrams and metrology
  - Operating software versions and their documentations
  - CAD models and fabrication drawings
  - Documented operations procedures
  - Documented maintenance needs and procedures

  - Definition of delivered data properties

- A WEB based (and associated document) roadmap / directory for the Project's document repositories (see above).

9.4 Pre–Operations Interactions

The final delivered documentation will be negotiated between the Rubin Construction Project and Rubin Operations.

9.5 Artifacts for ORR

See Criteria above.

10 As-Built Record, Modifications, non-Compliance and Recommendations

11 Rubin Operations Team Readiness

11.1 Operations Readiness Requirement

- The Operations Team shall have a detailed operations plan approved by NSF and DOE.
- The Operations Team shall have a staffing plan with all roles in the operations plan filled with identified personnel.
- The Operations Team must understand the state of the system that is being handed over to them and be able to execute the detailed plan to efficiently in order to capture store and process science quality images.

11.2 Objectives

The primary objective of this element of the ORR is that the Operations Team needs to demonstrate that it is ready to smoothly continue running the full Rubin System as it exists at the end of the commissioning period. A successful initial phase of operations may include beginning the full Legacy Survey of Space and Time at the approved nightly schedule and cadence. It may also include other activities as necessary depending on the final outcome of commissioning. These could include special observing modes to enable Early Science and further development of detailed procedures for operations that not done in commissioning but which do not prevent completion criteria from being satisfied.

11.3 Criteria for Readiness

- Demonstrate planning and staff for safety in operations are in place.
- The team should demonstrate that all needed roles are filled, or will be, with trained staff at the time of hand over to full operations.
- All Human Resources processes for on-boarding operations staff should be complete or ready by the date of handover as appropriate. Expatriate staff for Chile based deployments should have all necessary documents and requirements for work in Chile in place. Chilean staff should have any needed changes to their contracts made before operations begin.
- An operations budget profile fully covering the needs of the observatory should be agreed to with the agencies in advance of full operations beginning.
- All supplies and non-labor capital items should be in place.
- Contracts needed in year 1 for operations services or supplies should be in place.
- Any in-kind contributions necessary for operations should be demonstrated to be in place and functioning at the level needed for year 1. Any systems handed over to operations from construction in advance of this review should be demonstrated to be functioning at the required level of performance.
- Demonstrate all needed advisory committees/structures are ready and in place.
- Demonstrate that all construction related documentation is captured in an operations documentation management system.
- Demonstrate that a significant fraction of the community has been granted user accounts in the US DF, that the Rubin Science Platform supports their access and authorization and that they have been given suitable training or information to do science with the Rubin data products as they are delivered.

- Demonstrate a working alert stream and that the interface to the community brokers is working.

11.4 Artifacts for ORR

As prelude: the Construction team will be responsible for creating sets/lists of topics/documents that fully describe the characteristics and performance of the Rubin systems, how to maintain them, how to operate them, and anything else critical for the Operations Team (initial survey of documents suggested date November 2020. The Operations Team will review these lists and identify anything that needs to be added (or removed) from those lists. A collaborative negotiation will be carried out with the Construction Team.

Final approved detailed Observatory Operations Plan, including:

- Work breakdown structure;
- Activity based plans for each department;
- Milestones for each department though several year of operations;
- Performance metrics;
- Performance requirements;
- Maintenance Management plans;
- Fully populated staffing plan;
- Budget profile; and
- Work Breakdown Structure.

A References

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B Acronyms

Acronym	Description
AP	Alert Production
ComCam	The commissioning camera is a single-raft, 9-CCD camera that will be installed in LSST during commissioning, before the final camera is ready.
DF	Data Facility
DIMM	Differential Image Motion Monitor
DM	Data Management
DOE	Department of Energy
DRP	Data Release Production
EFD	Engineering and Facility Database
EPO	Education and Public Outreach
FWHM	Full Width at Half-Maximum
GUI	Graphical User Interface
LDF	LSST Data Facility
LPM	LSST Project Management (Document Handle)
LSE	LSST Systems Engineering (Document Handle)
LSP	LSST Science Platform (now Rubin Science Platform)
LSR	LSST System Requirements; LSE-29
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
M1M3	Primary Mirror Tertiary Mirror
MREFC	Major Research Equipment and Facility Construction
NCSA	National Center for Supercomputing Applications
NSF	National Science Foundation

ORR	Operations Readiness Review
OSS	Observatory System Specifications; LSE-30
PSF	Point Spread Function
QA	Quality Assurance
QC	Quality Control
SE	System Engineering
SQL	Structured Query Language
SRD	LSST Science Requirements; LPM-17
SV	Science Validation
TBC	To Be Confirmed
US	United States
WFD	Wide Fast Deep
deg	degree; unit of angle