

# WMKO Instrument Development Guide

## Vol. II

Version	Staff	Description
V2	Kassis with help from Larry Lingvy, Rob Bertz, Steve Gibson, Kodi Rider	Version II of the Instrument Development Guide

### 1 Summary

This Instrument Development Guide for WMKO is a second version that provides the process and guidance for W. M. Keck Observatory’s instrument life cycle process that sets major milestones and gating reviews. There are two main umbrella phases to the lifecycle process that are Design Formulation and Construction with detailed phases for conceptual design, preliminary design, proposal development, construction and commissioning. The previous version pulled from military processes and this version pulls from processes described by NSF’s Research Infrastructure Guide (formerly the Major Facilities Guide) and NASA’s Space Flight Program and Project Management Handbook. WMKO’s instrument development process parallels those with the NSF and NASA because WMKO works with these two agencies to fund instrumentation projects; however, the phases described below are tailored appropriately for WMKO instrument sized projects that are smaller than those NSF facilities and NASA space-based missions. WMKO’s lifecycle guidance is designed to be tailored and scaled to projects with tracking tools for and reporting to WMKO and institutional leadership that is appropriate for the size of the instrument project. A guiding philosophy is that the project leadership works with WMKO to establish a specific project’s lifecycle process pulling from this guide and that the technical scope is locked in at the preliminary design review. WMKO projects like KCRM and KPF followed these guidelines and were pioneers for successful project gating and milestones as defined herein.

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### 3 Introduction:

Through use of advanced instrumentation, WMKO's scientific community explores the frontiers of astronomy in ways that lead the astronomical community in the US and globally. The instrument suite provides WMKO's observers with the tools to perform astronomical research and respond strategically to initiatives outlined in the US Decadal Surveys and those defined in WMKO strategic plan. Instrument developers engineer new technologies in response to the identified needs defined in the WMKO strategic plan and the US Decadal Survey as well as those identified by the WMKO community of astronomers.

Historically, instrument development at WMKO was based on military processes with strict review milestones that served as gates for key decision points. These reviews followed a development cycle from concept to commissioning, and the process successfully shepherded a few instruments to first light. Although not explicitly stated, the process had flexibility based on the size of the project but was focused on medium and large facility class instrumentation activities.

The instrument development guide version two is a revision of previous guidance for W. M. Keck Observatory's instrument life cycle process that set major milestones and gating reviews. In 2020, WMKO recognized a need to revise the instrument development process in order to formalize flexibility and to better align the process to US funding agencies. Instrument development teams frequently submit to the National Science Foundation (NSF) and have historically submitted proposals to TSIP, ATI, MRI, MSIP, and MsRI grant programs. WMKO has also submitted project funding requests to NASA which has increasingly more opportunities available. Aligning the instrument life cycle process with both NSF and NASA will better position the WMKO community of PIs to both propose to the available grant programs and ease reporting to the NSF and NASA program officers. To this end, this revision has folded in processes, philosophies, deliverables, and common language from the NSF Major Facilities Guide (NSF 19-68 Sept. 2019) that is used as guidelines for MSIP and MsRI programs. In addition, NASA's Space Flight Program and Project Management Handbook was reviewed to fold in life cycle best practices and for evaluating project size and scaling.

With larger telescopes being planned, and instrument projects at WMKO partner institutions in design phases for those facilities, instrument teams and PIs are exposed to processes and rigor that may not be appropriate for WMKO projects. The complexity of the larger facility partnerships necessitates the overheads in both reporting and documentation, but those same needs don't apply for Keck work and this revised guide is also being updated so that the same teams designing for the larger facilities understand that WMKO's process is scaled appropriately for WMKO. NSF's major facility guide is designed for larger projects and thus scaling the guidance in that document for smaller Keck projects is appropriate.

WMKO leadership, the SSC, and the Board also recognize a need to better understand the project costs before proposing to NSF and NASA grant opportunities. Guidance from both the NSF and our community of observers on the level of investment needed to appropriately assess full construction costs are included in this document, and the early design phases that are precursors to submitting a proposal to a private or public funding agency are designed such that our instrument teams and WMKO makes that investment. To this end, WMKO will be better at predicting the project costs over the full life cycle and demonstrate to NSF and NASA that we have the tools and programmatic structure to complete the project with the identified funds once the project starts.

#### 3.1 Roles and responsibilities

Throughout the instrument life cycle, the project will report and make requests at gating milestones to observatory leadership that includes the Science Steering Committee (SSC), WMKO Director, WMKO

Chief Scientist, and members of the WMKO Board. The responsibilities for the leadership positions help define the gating strategy for approval to subsequent stages as well as ensuring that the project performance is meeting the expectations of stakeholders. The roles and responsibilities for these leadership positions are as follows:

**WMKO Board:** Evaluates recommendations on instrumentation provided by the SSC, WMKO Director, and WMKO Chief Scientist. The Board has ultimate authority whether a project may start a design phase and proceed with a proposal. The Board reviews high level instrumentation budget and gives directives on budget and schedule. The Board communicates any directives for instrumentation projects to the WMKO Director and Director of the instrument development teams originating institution.

**SSC:** The SSC reviews all requests for starting the early design phases of the instrument. PIs make requests to start a design phase with the SSC typically in June or July. The SSC establishes the scientific priorities for the instrument in context with existing instrumentation and projects under development or consideration. The SSC reviews proposed instrument science drivers, sets strategic goals, assesses the high-level budgets and schedules, assesses the instrument team capabilities, and weighs PI requests against others under consideration. The SSC sets priorities keeping in mind national recommendations and the WMKO strategic plan. The SSC makes instrumentation recommendations to the WMKO Director and Board. The SSC includes representative membership from all observatory user groups.

**WMKO Director:** The Director receives recommendations for instrumentation from the SSC and Chief Scientist. The Director monitors and oversees the construction of the approved instruments and communicates status on budget, schedule, and capability to the Board. The Director takes direction from the Board on both budget and programmatic processes for instrument development and communicates these directives to the IPM.

**WMKO Chief Scientist:** The Chief Scientist provides an independent assessment of the instrument capabilities and helps the SSC establish the scientific priorities for the instrument in context with existing instrumentation and projects under development or consideration. The Chief Scientist leads the Scientific Strategic Planning process working with the SSC to identify the future instrumentation initiatives. The Chief Scientist provides recommendations to the Director and Board when requested and takes direction from the Director and Board. The Chief Scientist communicates directives to the IPM. The Chief Scientist communicates with and takes guidance from the NASA InfraRed Telescope Facility and Keck Users Group (NIKUG) ensuring that the national observing community's opinions are considered.

**Director of originating institution:** The Director provides project oversight and final budget authority at the primary institution. They receive status reports from the PI and PM. The Director receives the SSC recommendations communicated to the Board. In many circumstances, the director may be a member of the SSC and Board. The Director communicates Board and observatory recommendations and mandates to the instrument project leads. With input from the PI and PM, both technical and programmatic decisions may be made by the Director when they are not resolved at the project level.

**PI:** The instrument Principal Investigator is responsible for communicating project status to the SSC and Observatory leadership. The PI requests approval from the SSC to move forward into the Design phases, and when funded, has the responsibility of delivering the instrument to the observatory. The PI keeps the Director of the home institution informed of project status by providing regular reports. The PI collaborates with the IPM on reports and leads the project through the established instrument life cycle process. Based on the scale and complexity of the project, the PI collaborates with the IPM to establish an agreed upon phased path of instrument milestones and reviews described later in this document.

**IPM:** WMKO Instrument Program Manager provides oversight external to the lead institution. The IPM collaborates with the PI and PM on reports to the Directors and the SSC and will provide independent updates to the SSC when requested with an emphasis on actual expenditures, schedule, and budgets. In consultation with the PI, the IPM organizes the independent review committees for major reviews. The

timing of developmental project reviews and their organization will be overseen by the IPM in consultation with the PI and PM with oversight from the SSC and Directors. The IPM provides all review reports to leadership.

**PM:** The project manager is responsible for the programmatic processes of the instrument managing technical scope, budgets, and scheduled in close partnership with the PI. The PM works with the PI and IPM in developing reports to leadership. The PM works with the IPM and PI on meeting review milestone goals and ensuring requirements are met.

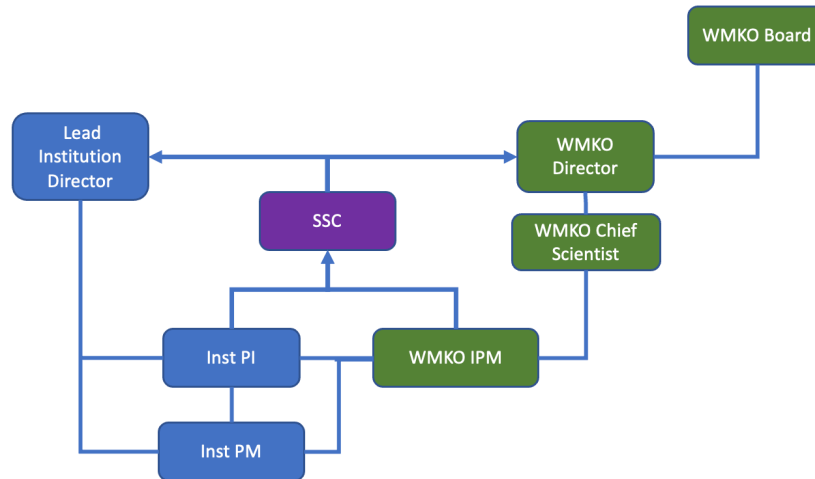


Figure 1: Leadership organizational structure for instrument development

## 4 Instrumentation Development Life Cycle

The instrumentation life cycle is broadly categorized by the Design Formulation and Construction stages with the progressive steps under these categories that have reviews and key decision points before moving to the next stage of the project. Figure 2 identifies the phases in the instrumentation life cycle. Projects advance to the next phase if recommended by the SSC and endorsed by the Board (advance is not guaranteed). Key decision points often follow a review that is designed to provide periodic assessments of technical and programmatic health. Reviews serve to assure stakeholders that the project is progressing and completing the work required. Written reports submitted by the PI to the SSC and major project review reports provided by independent review teams are inputs into decision points for recommending a project moves forward.

Design Formulation starts with the initial concept and brings it to a full Preliminary Design. Under the Design Formulation, there are four phases that include:

- **Concept** phase to determine feasibility and an initial science case;
- **Phase A system** design phase during which designs for the instrument are matured on the most important aspects of the instrument as well as maturing the budget and schedule;
- **Proposal Development** phase for soliciting funding from private and public granting agencies;
- **Preliminary design** when all technical subsystems are designed and matured while programmatic processes are introduced and refined relative to the proposal phase.

During these phases, no major purchases are made. At the end of each one of these phases, the SSC recommends to the Board whether the project should continue. Preliminary Design usually does not formally begin until major project funding is secured. The start of the Preliminary Design phase is considered the formal project start date.

Funding internal to WMKO is available for the early phases of development through Proposal Development. Instrument development teams may seek other sources of funding for these early phases. PIs are encouraged to present to and gain endorsement from the SSC even if external funds are used.

Construction begins when the project passes a Preliminary Design Review and the SSC and Board endorses the project to continue through a full build. Construction has two primary phases

- **Implementation phase** is when the instrument detailed designs are finished and the build of the instrument is completed for all subsystems. Before delivery to the summit a review is held;
- **Commissioning** includes integration of the instrument at the observatory and night time engineering activities to commission the instrument for routine operations. The project completes with a hand over to operations at the end of this phase.

At the start of the Implementation Phase, major purchases may be made while fabrication designs are being finalized. WMKO recognizes that small instrument teams spread over multiple campuses and sometimes managing independent sub systems cannot afford marching army costs for staff while waiting for the critical path subsystems to complete design ahead of a review gate that triggers purchases and fabrication. Instead, the Implementation phase allows subsystems to transition into full scale development and continue momentum with build activities before other subsystems complete designs. A project major programmatic review is held at an appropriate time during the Implementation phase to assess project programmatic status only as by this time all major technical decisions have been made. Please see the **Error! Reference source not found.** section for details.

Instead of an Implementation phase, both NSF and NASA guidelines divide this work into two distinct phases, a Detailed Design phase gated by a review before transitioning into a Full-Scale Development Phase. This is the language and process used in past instrument development projects with WMKO. However, the scale and budgets of both NSF major facilities and NASA projects is significantly larger (refs) than the majority of WMKO instrument projects, and therefore, WMKO is adopting a streamlined **Error! Reference source not found.** phase. For significantly large projects, WMKO may require a detailed design review before major purchases may be made if observatory and project leadership deems this necessary. In this way, WMKO will maintain flexibility, and at the start of the Preliminary Design, the PI and instrument team will agree to the review, gating, and development process tailored to their instrument.

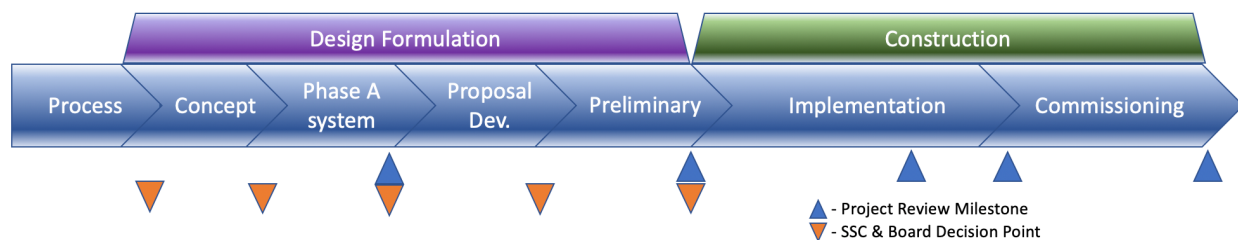


Figure 2: Development Life Cycle for WMKO projects

#### 4.1 Project sizes

Projects are broadly categorized as large, medium, and small based primarily on project cost.

- Large \$6-\$30M
- Medium \$1.5-\$6M
- Small < \$1.5 M

The scale of the project sets the level of rigor and formality for the project life cycle of development and is agreed to at the start of the project defined when significant funding is provided to kick off the preliminary design phase. Minor upgrades are likely small. Major instrument overhauls and instruments with a specific science niches may be considered medium depending on technical complexity. Facility class instruments are often larger in scope and cost. These roughly coincide with NSF funding boundaries for programs like the ATI, MRI, MSIP, and MsRI that PIs will likely submit proposal to. Examples of projects in the Small, Medium, and Large categories are the LRIS red detector upgrade 2020 that replaced the detector and controller electronics, the HISPEC instrument or the NIRSPEC upgrade which replaced the two detectors, electronics, and all the IR guider opto-mechanicals, and the Keck Planet Finder instrument. There is flexibility in the review system, as for example the KCRM \$8M upgrade although large in costs obtained full funding before preliminary design.

## 4.2 Life Cycle Reviews General information

Project reviews provide the development team an opportunity to demonstrate that it has completed the work of the previous phase and provides institutional leadership with an independent assessment on the projects technical and programmatic health. In general, the reviews serve to evaluate whether the

- Science goals, science impact, and alignment with the WMKO strategic plan,
- Technical assessment and approach: flow down of science requirements, instrument architecture and design, operational concepts and modes, and data handling.
- Project management approach, partnerships, organization, staffing resources and institutional resources.
- Cost, Schedule, and Budget with what are the possible control plans like descopes or upsscopes, as well as contingency. Includes funding plan and profile.
- Risk management plan, approaches, assessments, and actions and resources to mitigate.

At different times in the project lifecycle, emphasis on these five major themes will vary. Influencing the emphasis will be variables such as current in-hand funding, what phase the project is in, risks involved, and project size.

- Emphasize with the teams what is most important, PIs and project managers should know this is what the SSC and Board are thinking.
  - In the early phases of project development Scientific and technical scope is most important as the project aligns with strategic needs.
  - As the project moves forward with a proposal Budget and Scope are balanced.
  - Once full project funds are secured, Budget and project schedule costs have a greater emphasis than Science Scope and schedule deliver milestones.

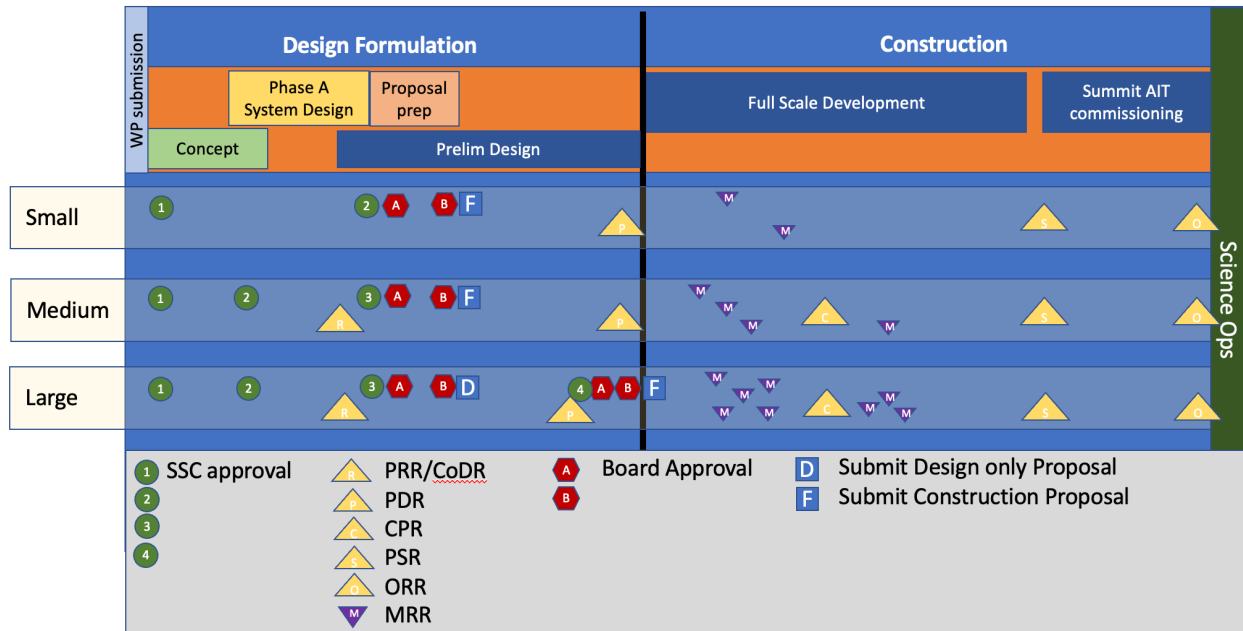


Figure 3 Phases and reviews showing flexibility for the scale of the projects.

#### Life cycle reviews

- PRR or CoDR: Proposal Readiness Review is equivalent to a Conceptual Design Review with the additional component that at the review the project is being assessed to determine the projects maturity in advance of submitting a proposal for major project funding. If no funding request is part of the review, then the review is called a CoDR.
- PDR: Preliminary Design Review assess the projects status and gates moving into the construction phase with a focus on technical designs, project costs, and schedule with contingencies for the remaining project work.
- MRR Manufacturing Readiness Reviews assess technical aspects of project subsystems and interfaces to maintain technical momentum. These should be technical deep dives, locking in interfaces before fabrication. Review summaries for reviews held before CPR and are included as supporting documentation at CPR.
- CPR: Construction Programmatic Review assess the projects budget and schedule for the current and remainder of the work and is not focused on technical analysis.
- PSR: Pre-ship Review assesses project readiness to integrate and commission at WMKO
- ORR: Operational Readiness review follows commissioning and assesses project deployment and documentation status for long term support of the instrument at the observatory.

PRR, PDR, PSR, and ORR are a one-step review that assess technical and programmatic status during a one or two day review.

MRRs and CPR form a two-step review process with the MRRs designed to assess technical progress with deeper dives into each subsystem while simultaneously being gating reviews for fabrication and purchases. The CPR focuses on the programmatic positions, budget, and schedule for the remainder of the construction phase. This enables the teams to maintain technical progress and provide project management with guidance for maintaining scope, schedule, and budget.

#### Special reviews:

- Delta reviews: Any of the reviews may be subject to a delta review to address aspects flagged as critical before moving to the next phase of the project. These are reviews triggered by observatory and institutional directors or by the PM and IPM following feedback in the committee reports.
- Detailed Design Review: may be defined as needed at the outset of the project planning to refine preliminary designs before long-lead items may be purchased. The PI, PM, and IPM agree to hold this review and put it into the project execution plan with a budget and schedule to support it. This review may also be suggested at PDR by the PDR review committee as a means of mitigating project risk.
- Cost Reviews may be triggered by IPM in consultation with project leadership to control project costs.
- Termination reviews may be triggered by the IPM in consultation with the project leadership, SSC, and Board when minimum project requirements may not be met.

Review committee panels range between 3 and 6 panel members. The project leadership encourages the Chair of the committee to have touchstones on the project throughout the development to provide the Chair with more in-depth insight. The review Chair is encouraged to remain Chair for the life cycle of the project. Continuity of panel members across the reviews is also encouraged.

Following all reviews, the WMKO director provides a decision memorandum that provides direction to the instrument development team. The direction is provided following review of the review committee report and is communicated to the PI as well as SSC co-chairs and the Board if deemed appropriate. This memorandum becomes part of the instrumentation documentation.

## 5 Design Formulation Phases

The early Design Formulation phases of the instrument development life cycle are to incubate instrument concepts to a mature enough level to seek funding. These early design phases are the Concept, Phase A/system, and Proposal Development phases. At the end of the proposal development phase, the PI and PM have developed a mature project plan, schedule, and budget that has been vetted by a review team and endorsed by the SSC and Board. The instrument project then works to secure funding. Once funding is secured, the project officially starts the Preliminary Design phase kicking off the start of the project.

During Design Formulation phases the project explores a full range of implementation and scope options and develops project costs while defining what an affordable project concept will be that will meet scientific goals. This is an iterative process that matures the project plan with each successive phase.

The instrument development community, SSC, Board, and WMKO instrumentation leadership recognize the need to mature instrument designs to a level of confidence that a project could be completed with the proposed needed funding identified by the PI. NSF guidance provided in the Major Facilities Guide suggests that the Design Formulation phases could range in cost from 5-25% of the expected total cost of the instrument, and average 10%. For the NSF, this investment includes the Preliminary design phase. Instrumentation projects are significantly less than major facilities, yet the sentiment from the WMKO community is that we should invest 5-10% of the expected total instrument costs in order to vet the critical technical design aspects as well as the budget and schedule.

This investment would pay for some level of involvement of an instrument scientist, system engineer, optical engineer, mechanical engineer, electrical engineer, and a detector expert. The level of involvement from the engineering staff depends critically on the technical risks that are present in the project and not all of the listed engineers need to be involved for all projects. The most essential and difficult to fund part of pre-proposal work is the support of these engineers to flesh out the optical/mechanical design with enough specificity to have a believable budget and performance numbers. Software is usually not directly addressed in the proposal development stage unless there is some unique application.

Below is guidance based on community input and the WMKO internal budgeting that is available for the Concept, Phase A, and Proposal development phases. This estimate encompasses all costs leading up to the start of the Preliminary Design Phase. The estimates assume 5-10% of the total instrument budget is spent before seeking funding for the full instrument.

- Minor improvements at <\$1M: <\$100k available annually via WMKO internal funds
- Instrument upgrades at \$1-3M: \$50-\$300k available annually via WMKO internal funds
- Brand new instrument \$3-30M
  - \$3-6M => \$150-600k: WMKO internal funds over 2.5 years
  - \$6-\$15M => 300-1.5M: WMKO internal funds over 2.5-3.5 years
  - \$15-30M => 750K-3M: WMKO internal funds over 2.5-3.5 years requiring external supplemental funding

The primary goal is to mature the proposed plan to a point where leadership has confidence that a project may be completed using the proposed funding. Following agreement on project costs through the review process fueled by early funding, funding caps are imposed by institutional leadership.

PIs are encouraged to participate in the early formulation phases via an Instrument Development Call to the community soliciting:

- Instrument **concept studies** and **Phase A design** studies for both new instruments and upgrades to existing instruments
- **Mini grants** for efforts and equipment costs for either new tools and techniques to improve the observatory scientific productivity or minor hardware capability enhancements
- **Proposal development** efforts to draft and submit proposals to funding agencies

Mini grants for instrument work are considered too small and handled outside of the instrument lifecycle development processes described in this document. The Concept studies, Phase A design, and Proposal Development are funded through this call to the community. The call is made annually with notionally each phase lasting one year.

Figure 3 shows the notional trajectory for the early design formulation phases laid out on a calendar year. The notional trajectory is driven by both WMKO fiscal year constraints and planning that starts 1 Oct annually as well as anticipated NSF grant submission deadlines that are in the winter months. The latest SSC meeting that lines up with the FY and NSF funding time frames is the summer SSC meeting, and it is at that meeting when instrument development initiatives are evaluated. WMKO's instrument development trajectory begins with a call to the community that is released in either April or May following an SSC meeting during which the call is approved for distribution. The community composes and submits white papers for concepts, phase A/system design, proposal development activities, and mini grants. All white papers are evaluated by the SSC in June or July during the summer SSC meeting. Projects are recommended to move forward at the summer SSC meeting, and PIs are provided feedback and funding instructions if funds are awarded. There is a second SSC evaluation period in November if further review is requested by the SSC. The November period is intended for proposal development extended review.

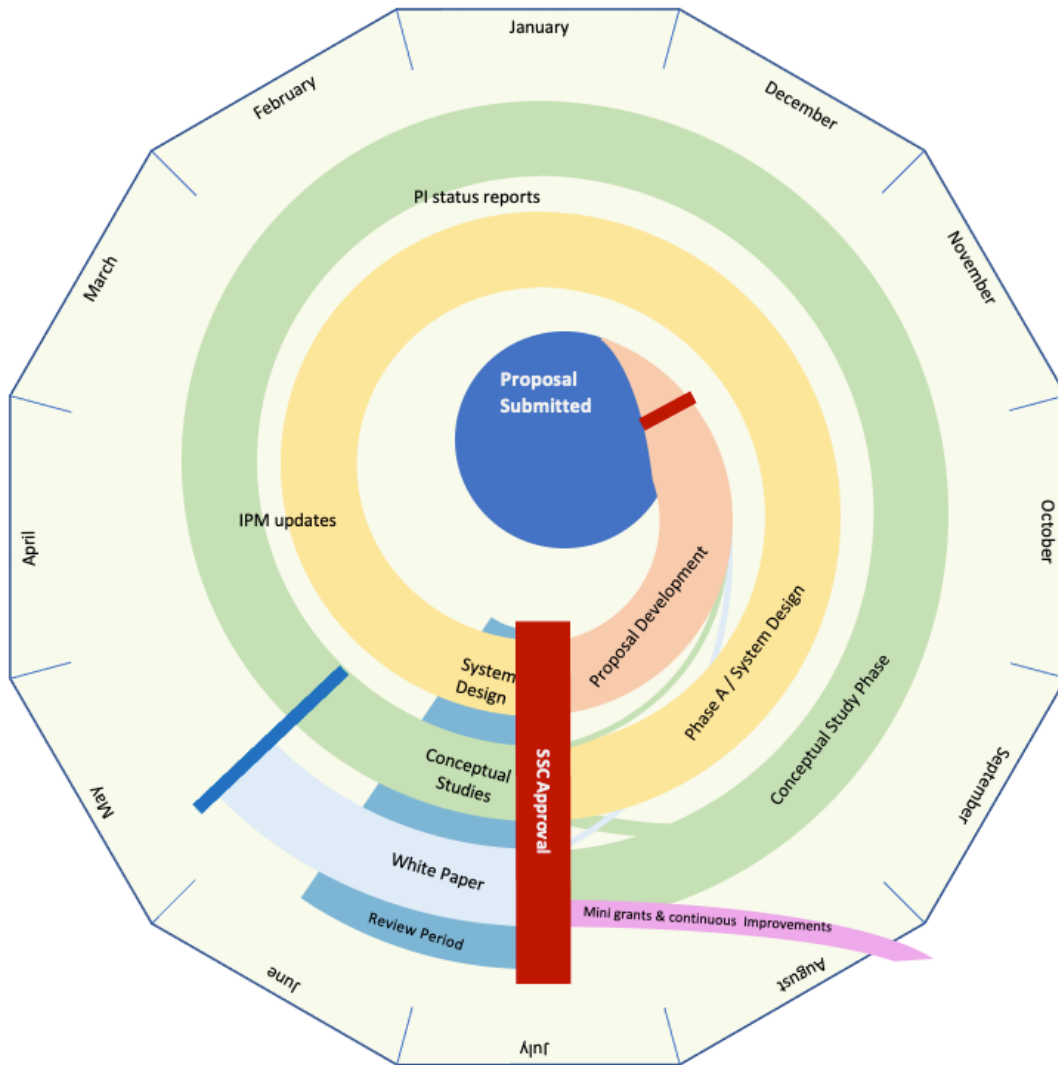


Figure 3: Early Design Formulation Phases

The spiral progression assumes a one-year duration for each phase, but the schedule and process are flexible. As an example, instruments that have completed a conceptual design prior to approaching the SSC for approval, may present their conceptual design seeking funding and approval to move into the Phase A/system design phase. Smaller upgrade projects may request moving to a proposal development phase and skip the Phase A/system design phase because the scope of the project does not merit that level of planning. Larger projects or teams with limited time could request two years of Phase A/System design work to properly mature the designs.

PIs may propose what funding track to pursue, but the SSC will approve and recommend the track for the project and may suggest a different track than what the PI proposed. At any step, the SSC may recommend that a project not proceed to the next phase. It is important to understand that previous SSC approvals at any phase are not a green light to seek project funding for the build of the instrument, and it is anticipated that funding and proposal requests be approved by the SSC in the proposal phase of development.

In any year, the funding requested may be more than what is available, and the SSC will recommend not funding projects in order to fund higher priority projects. Even though funding may not be awarded, the

SSC may recommend continued pursuit of a concept, and thus, encourage PIs to find other resources to develop concepts further. Some projects may have to temporarily halt work if funding is not provided.

Although this is unfortunate, PIs are encouraged to address SSC concerns as best they can and re-propose the following year.

The following subsections explain the project activities for each phase of a project. In practice, this document recognizes that the activities and deliverables may not always be carried out exclusively in that phase due to schedule requirements, staffing, complexity, and budget limitations. This may result in deltas in the review process or agreements on paths forward towards completing those deliverables in the next phase. It is more fluid in the earliest phases of the project. However, PDR and CPR are major project gateways, and as such, all deliverables are expected.

## 5.1 Concept studies

In response to the white paper Instrument Development Call, proponents of an instrument concept will provide the SSC with a concept proposal that describes in general terms the essential characteristics that define the instrument and that also presents an initial case necessitating development of an instrument or upgrade. The purpose of the Conceptual Design phase is for the team to identify a promising instrument concept and design that is feasible for the observatory. At the end of the phase, the conceptual designs should clearly articulate how it meets research initiatives that are defined in developed science cases. A feasible concept is one that is probably achievable technically and must demonstrate that it will meet the needs of the scientific community.

For concept studies, the SSC is the reviewing body that recommends whether a project moves to the next phase, and the SSC will review both the technical feasibility as well as the scientific merit of the project. This is an exploratory exercise and may result in an instrument concept that is not feasible to move forward at that time.

### 5.1.1 Purpose and process

PIs should provide SSC with a concept proposal white paper in response to the Instrument Development call. The concept proposal should briefly describe the instrument and present both scientific and technical justification that would necessitate its development. It is assumed that the project is in its infancy.

The PI will propose to the SSC a Concept study with a small budget sufficient to refine the science and technical case for the instrument as well as assess feasibility at the observatory. The PI will provide a written report and present to the SCC at the summer SSC meeting. The report, presentation, and next phase request will be part of the evaluation package for the SSC.

These initial proposals identify what is known at that point in project development, as well as what tasks remain to be accomplished in order for NSF to consider a project for eventual funding. In the near term, they also define what work should be done to develop the project to the Conceptual Design level of maturity.

The list below describes the activities that a project needs to accomplish to demonstrate a sound concept that provides the SSC the necessary information to evaluate the proposed instrument concept.

#### Science and Technical

- Develop a science case backed by community support
- Build a science team
- Develop a feasible instrument concept(s);

- Identify scope and future upgrade options
- Identify preliminary key technologies
- Develop preliminary high-level driving requirements
- Assess observatory interfaces
- Identify future key trade studies
- Assess heritage components and reuse of equipment

#### Programmatic

- Estimate cost schedule of full instrument build
- Estimate costs and schedule for scope and upgrade options
- Develop a budget, schedule, and scope of Phase A activities
- Identify preliminary risks and possible future mitigation effort
- Provide a preliminary organization chart with key staff and partnerships
- Determine staffing for Phase A and assess availability
- Provide a written report for the SSC for review; this may take the form of a Phase A proposal
- Provide a presentation to the SSC

#### 5.1.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that Phase A funding is paying for effort for a small team of individuals.

- Principle Investigator
- Instrument Scientist as the main instrument architect
- Mechanical Engineer(s) who will mature mechanical designs
- Optical Engineer who will further develop the opto-mechanical model
- System Engineer who will mature risk, requirements, and programmatic documentation

For observatory activities, the following people will be involved with helping assist with observatory planning and defining interfaces. Requests for engineering assistance will be coordinated via the IPM and do not need to be specified in a proposal. The IPM will request engineering assistance from WMKO staff for a limited number of hours.

- IPM who assists the project as requested managing limited resources and is the main point of contact in the conceptual phase

#### 5.1.3 SSC reporting process:

At the end of the conceptual phase, the PI will submit a written report to the SSC for review. This report may take the form of a summary report or may be folded into the Phase A proposal which is a continuing request with the SSC to pursue the instrument design. A presentation at the summer SSC meeting combined with the written report serve as the deliverables for the project.

#### 5.1.4 Concept Phase Exit

Formal exit from the Concept Phase follows an endorsement from the SSC to move forward to the Phase A design efforts. The PI will make a brief presentation to the SSC providing the team with an opportunity to summarize the project and provide a response to the SSC questions and concerns. The SSC will consider the project and re-review the science cases in context with WMKO's ongoing initiatives. The SSC will vet the maturity of the project and provide recommendations to the Board and WMKO whether the project is achievable and should continue. The SSC may recommend terminating an

instrument study or request that PIs continue their conceptual study for an additional year instead of moving to the Phase A design efforts.

For projects that have received previous development and design funding from other sources, a project may skip the concept stage and propose a Phase A study to the SSC. This request should be coordinated with the IPM. Project looking to the next phase will be required to present at the SSC.

## 5.2 Phase A Design

During Phase A design, the team further develops a conceptual instrument design and architecture that is credible and responsive to the science drivers defined by the science team, SSC, and WMKO strategic plan. The project plan will demonstrate that it is striving to meet science requirements and requirements due to demands of staffing, schedule, and potential funding resources. The project team is formed and expanded to develop the instrument concept and begin or assume responsibility for technical development as the WBS is defined. The project explores a range of implementation options and defines an affordable project concept that can address the science requirements. A key outcome of this phase is a robust vetted estimate of the project costs and schedule for the preliminary design phase through commissioning.

For Phase A Studies, the SSC will continue to vet the science case of the instrument, and a review will be held at the end of the phase. The review is a milestone in project development and is a gate before projects may seek construction funding.

### 5.2.1 Purpose and process

The project team will propose to the SSC Phase A work with a budget and staffing request sufficient to mature the project so that the project is ready to propose for major construction funding. The WMKO IPM will hold a Proposal Readiness Review of the project in advance of the summer SSC meeting. The review findings will be part of the evaluation package presented to the SSC as an independent assessment of the project. It is expected that during this phase the project will make both technical and programmatic progress as described below:

Science and technical work:

- Bolster the science case and establish science requirements
- Flow science requirements to primary technical requirements
- Develop initial designs for critical components and overall instrument packaging, layouts, location, and key interfaces
- Risks detailed
- Identify technical risk mitigation plans.
- Identify long lead items and major milestones
- Start high level trade studies
- Identify key technologies and requirements of those technologies
- Assess early prototyping and models needs
- Provide technical scoping options

Project management, planning, and control tasks

- Refine the full project budget, schedule, and scope for the instrument.
- Develop an initial project plan
- Develop an instrument funding plan and approach
- Create a technical, cost, and schedule risk matrix
- Identify initial programmatic risk mitigation plans
- Define WBS elements with partnership and vendor responsibilities
- Baseline a project execution plan at the appropriate level for the size of the project

- Provide an. organization chart with key staff and partnerships
- Provide report to the SSC and written request to seek a proposal if desired

The project at this time should be collecting and developing documentation. Depending on the scale of the project, tools the team may employ to help manage the project include:

- Documentation repository (Google Docs, Atlassian, SharePoint, ...) accessible by all staff at participating partner institutions
- Team communication tools like email distribution lists and communication team software (e.g. Slack, Microsoft Teams, Zoom, Bluejeans,...)
- Project plan with a level of sophistication appropriate for the size of the project to assess the budget and schedule.
- Requirements document
- Risk matrix for managing risks
- Initial CAD mechanical and optical models

For a summary of the documentation see the deliverable documents associated spreadsheet.

### 5.2.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that Phase A funding is paying for effort from all or some subset of these individuals.

- Principle investigator to relieve them from other institutional responsibilities if needed. The PI may perform any of the activities below listed for other staff members
- Instrument scientist who is the main architect of the instrument and will mature designs in all areas
- Project Scientist who is leading the science team and developing the science cases
- Mechanical Engineer(s) who will mature mechanical designs
- Optical engineer who will further develop the opto-mechanical model
- Software Engineer(s) to define software high level software plans

For observatory activities, the following people will be involved with helping assist with observatory planning and defining interfaces. Requests for engineering assistance with a specified number of hours should be part of the Phase A proposal to the SSC. The IPM and PM do not need to have hours requested.

- IPM who assists the project as requested managing limited resources
- PM who will help the IPM develop a project plan for observatory activities
- Mechanical Engineer provides technical planning for observatory interfaces and WBS
- Staff Astronomer who will provide both technical and scientific guidance and information.
- Other engineers as the need is identified

### 5.2.3 Proposal Readiness Review Process:

A Proposal Readiness Review will be held at the end of the Phase A design phase at an appropriate time the project determines that it is mature enough to request major project funding. A PRR is a mandatory review milestone and is often timed to be one month ahead of the SSC meeting in June. This review may be held up to 6 months in advance. Review dates after the summer SSC meeting are difficult to accommodate gaining approval by all governing bodies identified in Section 3.1. An example charter for the review is provided in the appendix.

At this point, it is expected that the Phase A baseline plan will have cost and schedule uncertainties. The full detailed scope may not yet be defined but major systems have been evaluated, staffing resources considered, technical risk identified and initial plans for mitigation discussed. Unknowns and uncertainties may remain to be addressed in more advanced stages of planning and development and are

identified as key tasks when kicking off the Preliminary Design phase. The Phase A design, top level requirements, supporting budget estimates, risk analysis, and institutional partnerships should be detailed enough for reviewers and the SSC to decide whether the project status mature enough to start preparing a proposal for major funding.

#### 5.2.4 Phase A Exit

Formal exit from the Phase A Design Phase follows a successful PRR reviewed by a committee of at least three members and attended by interested SSC members and board representatives. The review committee will vet the maturity of the project and provide a recommendation to the SSC, Board, and WMKO whether the project is achievable at the proposed costs. The PI or IPM will make a brief presentation to the SSC providing the team with an opportunity to summarize the project and provide a response to the review recommendations. The SSC will consider the recommendations and re-review the science cases in context with WMKO's ongoing initiatives as well as national directions before making a funding recommendation to the Board. The SSC may recommend terminating an instrument study or request that PIs continue their Phase A study for an additional year instead of moving forward with a proposal.

The Board will review the SSC recommendation and input from WMKO and give permission to seek future funding. WMKO IPM will then work with the PI and team to develop a proposal in the next phase of development, if approved to move forward to the next phase.

During the PRR, the review committee will be reviewing materials defined in the charter. An example charter is provided in Appendix B (Check internal reference)

For medium and large-scale projects that have received previous development and design funding from other sources, a project may skip the Phase A work stages and immediately request a PRR to vet current designs for moving forward with a proposal. This request should be coordinated with the IPM. PIs may not bypass the PRR as this is a mandatory gate.

### 5.3 Proposal Development

During proposal development, the instrument design team is focused on developing the content necessary for submitting a proposal. This is primarily a documentation development phase, although, engineering assistance may also be needed to address critical recommendations from the Phase A review team or SSC.

Instrument teams that have completed phase A activities either internal or external to the WMKO instrument development call may request permission and support of minor cost efforts to develop a proposal for a public grant program or a philanthropic opportunity. When the size and funding opportunity warrants it, WMKO awards are contingent upon a successful review by a Phase A committee prior to submitting a funding request and is contingent upon a favorable SSC recommendation.

#### 5.3.1 Purpose and process

Following the SSC favorably recommending a project seek construction funding, the development team begins preparing the necessary documentation needed for the identified funding opportunities. Funds provided by WMKO are specifically intended to develop and deliver a proposal for submission. If following an NSF grant cycle this requires a proposal being completed in Nov – Jan before deadlines like the ATI, MRI, MsIP, and MsRI. The previous phases of development, deliverables, and documentation identified in this phase are part of the needed documentation for a successful NSF proposal.

It is recommended that the PI requests a red team to review the proposal before submission. This activity, however, is not mandated nor funded by WMKO. Depending on the institution or the size of the proposal, the PI's home institution may organize a red team review.

Budgets and institutional agreements are finalized during this phase and must be approved by the board in advance of final submission. The IPM will coordinate communication of the budget, schedule, and agreed upon responsibilities to the SSC, Board, and WMKO Directorate.

The request in response to the white paper Instrument Development Call should include for this phase of work:

1. Request to submit a funding proposal with the program(s) identified
2. Budget for proposal development
3. Draft budget and funding profile for the intended proposal and institutional responsibilities
4. It should highlight and address findings presented in the report summary from the PRR

PIs may not solicit major funding from private or public funding agencies without having an endorsement from the SSC and approval from the Board.

During this phase of development, the project team will:

- Finalize the full project budget, schedule, and scope for the instrument.
- Baseline a project plan
- Finalize a technical, cost, and schedule risk matrix with mitigation plans
- Complete definitions of WBS elements with partnership and vendor responsibilities
- Complete a project execution plan at the appropriate level for the size of the project
- Finalize an organization chart with key staff and partnerships
- Work with sponsored program officers to coordinate a proposal submission
- Coordinate proposal supporting documentation for institutions and co-investigators
- Obtain institution agreements (SOW, IAL)

### 5.3.2 Staffing

Project funding for this phase may fund activities for the following individuals as needed. It is expected that proposal development funding is paying for these individuals. It is assumed that the financial team and SPO department will be supporting the instrument team in the development of the proposal and that the PIs will be notifying the SPO team.

- Principle investigator to relieve them from other institutional responsibilities if needed to lead the proposal development effort. PI will coordinate with institutional officials to ensure timely processing of the proposal. In some cases, the PI will work with institutional leadership to secure the proposal slot.
- Instrument scientist who will develop technical material for the proposal
- Project Scientist who will draft the science cases for the proposal
- Mechanical Engineer(s) who will contribute instrument design material for the proposal
- Optical engineer who will contribute optical design material for the proposal
- Other team members who will make significant contributions.

For observatory activities, the following people will be involved with helping assist with proposal documentation.

- IPM who will be the main point of contact for all proposal documentation and coordination for WMKO required materials. The IPM will also ensure all stakeholders have reviewed the proposal and provided feedback.
- Institutional CO-I if the IPM will not be the CO-I: Director, Chief Scientist, Lead of Technical Development

- Fiscal Controller who will prepare and validate the WMKO budgeted activities
- Administrative assistant to the Chief Scientist who will coordinate required document collection for CO's and Senior Personnel

### 5.3.3 Proposal Development Process:

The process described below is the WMKO internal process and milestones for submission. This is independent and in addition to any process that is required at the primary institution.

### 5.3.4 Proposal Development Exit

Congratulations, you have been funded! The proposal development stage may take multiple years and take on new flavors as different funding opportunities become available. The team is in a proposal development cycle until full funding is awarded. Coordinating with the IPM on funding activities is critical until funds are awarded so that WMKO can help with the funding process and maintain the development team while awaiting notification. If the approach to funding the project changes, such as seeking funding for partial build or folding in scope increases identified in future years, the PI shall present changes for approval to the SSC.

## 5.4 Preliminary Design

The preliminary design phase is the most important phase in the instrument lifecycle process at WMKO. The reason why this is the most important phase is that following this phase, project costs, contingency, and schedule are locked in for the remainder of the project. The end of this phase becomes the benchmark plan to which all comparisons are made. During this phase the PI and PM finalize the project baseline definition and project execution plan that includes the final planned budget, schedule, with a fully loaded project plan to enable FY year resource planning. Scoping options (descopes and upscoptes) are clearly defined with milestones for making those scoping decisions identified in the plan. The plan must now identify the minimum successful mission with the science requirements supporting that minimum mission. At the end of the phase, the project design is sufficiently mature enough to begin purchasing long lead items that would commit the project to a specific technical design.

Instrument teams that have completed phase A activities either internal or external to the WMKO may enter a preliminary design phase with the expectation that this phase is collaborative with WMKO. Project may not complete this phase without directly working with WMKO as observatory requirements must partially drive the preliminary design of the instrument.

The successful conclusion of this phase results in the SSC/Board and project institutions committing to proceed to the implementation phase and accomplishing the project's design for the proposed cost and schedule with the understanding that the project costs will grow with inflation and the schedule will slip if full funding is not available for the duration of the development project. This understanding is achieved because the project plan and budget estimates have sufficient detail that to convince and have confidence that the project will be successfully completed with the acceptable budgetary risk.

### 5.4.1 Purpose and process

Following the SSC and Board favorably recommending a project enter into the preliminary design phase which is usually accompanied by this phase being fully funded at least through this phase, the development team works towards a preliminary design package that fully describes the instrument scope.

The activities in this phase are iterative and collaborative with the engineer team working to baseline the instrument design scope with sufficient detail. At the end of the iterative design work, the PM works with the engineers to rebaseline the project plan, schedule, and costs. System engineering works to ensure that the design is detailed enough to demonstrate that there are no outstanding technical risks that would result in a non-feasible design within project costs and schedule. Interfaces are identified and detailed enough to ensure that the subsystem leads and project leadership clearly understands the handshakes and have agreed to them.

Project leadership continues to monitor and control the project requirements, technical design, schedule, and cost of the project to ensure that the high-level requirements levied on the project are met. The science and engineering team will work to further refine and track modifications to the level one requirements and correlate requirements with different scoping options and science trades. Requirements will be flowed down to a sub-system level, as it is applicable to optics and detector trades.

PM provides a re-baselined schedule and demonstrates that all external agreements with partners and vendors are in place. With this re-baseline, the PM and PI will have a complete understanding of the scoping options and shall present the costs associated with the scoping options to establish the baseline instrument design and to demonstrate that there are project control options to save budget and schedule. Project leadership assesses the funds needed to complete with adequate contingency endorsed by WMKO Board and supported by the partner institutions. Project leadership completes trades and designs that reduces project risk, and there is a clear demonstration and tracking of how key risks are retired with paths identified to mitigate others. The project identifies risk mitigation plans and associated resources for managing and mitigating risks.

Three ground rules are adhered to in this phase:

- Delivery of the minimum baseline instrument will benefit the WMKO community and achieve aspects identified in the WMKO strategic plan.
- Staff is a critical asset and the core engineering team must be maintained.
- WMKO must stay off the critical path, and thus, observatory ICDs are critical to complete with staffing resources appropriately assigned.

With the refinement/re-baselining of the project plan, the project team updates the requirements and plans for staffing and infrastructure at PDR. The PM will be able to justify the cost and schedule relative to the previous baseline and assert the need for the planned staffing. The new baseline will now include an initial draft of an AIT plan that includes both the lab integration and summit. This plan defines the integration and verification strategies and is structured to show how components come together to assemble each subsystem and how all of the subsystems are assembled into the full instrument. This draft plan helps shape the costing and schedule. The PM should also provide an estimate for a marching army cost that is the minimum needed to keep the core team alive should the project not be fully funded. Project will agree to reporting cadence and content for project manager reports and provide examples for the project reporting.

Science and technical work:

- Technical designs for the full instrument with details for all components at the subsystem level
- Refined science cases and requirements
- Flow down of science requirements to a subsystem level
- ICDs for the observatory and instrument subsystem interfaces.
- Identification of long lead items with quotes and plans for purchasing

- Demonstration of high-level trade studies being completed
- Detailed technical scoping options
- Develop draft test and verification draft plans for implementation and construction
- Develop draft data management plans

Project management, planning, and control tasks:

- An updated baseline of the full project budget, schedule, and scope for the instrument
- Integrated master schedule (IMS: often an MS Project file) that is risk-informed, cost-loaded, and resource-loaded.
- Understand the top critical paths in the IMS and control plans
- Major Milestones are finalized with the plan to completion.
- Instrument funding and management plan including management of contingency for cost and schedule.
- Create a technical, cost, and schedule risk matrix
- A mature risk list demonstrating risk retirement of top-level risks and mitigation steps for remaining risks.
- Update the project execution plan in anticipation of seeking public funds
- Provide an organization chart with key staff and partnerships with WBS elements that have partnership and vendor agreements in place.
- Present a possible spares list and policy.

During this phase, the project should be collecting and developing documentation with an eye towards providing WMKO with a document suite at the end of the project. The preliminary design documentation will be accessible and a deliverable to WMKO as a design reference for the project.

For a summary of the documentation see Appendix ...

#### 5.4.2 Staffing

Project funding for this phase should fund all activities needed to complete preliminary design activities. Staffing descriptions are largely unchanged relative to the Phase A phase, but at the PD phase, there is an expectation that the project will be fully staffed with all disciplines defined below assigned to someone on the instrument development team. The individuals who complete these rolls would be identified on the org chart and will have bought into the scope of the project.

- Principle investigator to relieve them from other institutional responsibilities if needed. The PI may perform any of the activities below listed for other staff members
- Instrument scientist who is the main architect of the instrument and will mature designs in all areas with a primary documentation responsibility of creating a technical design document that is a main deliverable for the instrument at the end of this phase
- Project Scientist who is leading the science team
- Project Manager who will update and manage the instrument development plan and provide updates on the plan
- System Engineer who will establish the ICDs and requirement flowdowns
- Mechanical Engineer(s) who will create preliminary designs for all WBS elements
- Optical engineer who will finalize the opto-mechanical design
- Software Engineer(s) to design low- and high-level software to a preliminary design level

For observatory activities, the following people will be involved with assist with observatory planning and defining interfaces. These people should be budgeted in the plan, and requests for engineering assistance with a specified number of hours should be part of the MS Project plan with the WMKO PM & IMP working to ensure those hours are reserved in the FY planning that begins annually in October.

- IPM who assists the project as requested managing limited resources
- PM who will update the project (often the IPM)
- Mechanical Engineer(s) provide designs consistent with the assigned WBS elements; help set the ICD between the observatory and the instrument
- Staff Astronomer who will provide both technical and scientific guidance and information and will work with the development team to help address the observatory interfaces; will work with the software engineer to define the software changes required to support the instrument and will participate in team meetings.
- Electrical Engineer(s) provide designs consistent with the assigned WBS elements; often pertaining to the observatory interface infrastructure
- Software engineer(s) provide designs consistent with the assigned WBS elements; often pertaining to AO modifications and guiding the team on the development of instrument software and standard observatory practices.

#### 5.4.1 Preliminary Design Exit

Formal exit from the Preliminary Design Phase follows a successful PDR reviewed by a committee of approximately 5-6 external members with appropriate backgrounds and attended by interested SSC members and board representatives. The WMKO has the responsibility for organizing the review and committee and acts as the interface between the design team, review committee, and the WMKO partner leadership. The purpose of the review is to provide an independent evaluation of the completeness and consistency of the planning, technical design, technical scope, budget, and schedule baselines. The review committee will vet the preliminary designs of the project and provide a recommendation to the SSC, Board, and WMKO whether the project is again achievable at the proposed costs. The PI or IPM will make a presentation to the SSC providing the team with an opportunity to summarize the project and provide a response to the review recommendations. The SSC will consider the recommendations in context with WMKO's ongoing initiatives as well as national directions before making a recommendation to the Board.

The review committee will assess the compliance of the preliminary design with applicable requirements and recommend whether the project is sufficiently mature to enter the implementation phase. The committee scrutinizes the effectiveness of project management through this phase of development, as well as plans for completion of final design and eventual construction and operation. The management structure and credentials of key staff are probed by the committee to assure the SSC and Board that an appropriately skilled management organization and technical team is ready to complete final design and construction activities. During the PDR, the review committee will be reviewing materials defined in the charter. An example charter is provided in Appendix C (Check internal reference).

The SSC may recommend off ramping an instrument project or request major scope changes to stay competitive due to any of the reasons below following review of the PDR committee recommendations:

- A change in observatory and science strategic priorities; e.g. being eclipsed by competitors.
- A change in institutional partnerships within the project
- Significant increases in the estimated or actual costs
- Significant changes in schedule
- Technical challenges that are deemed excessively risky, challenging, or costly
- Decrease interest in the observing community's support of the instrument

The Board will review the SSC recommendation and input from WMKO and give permission to move to the implementation phase. WMKO IPM will then work with the PI and team to create the necessary subcontracts to provide the needed funding for the next phase of development. Until WMKO provides a response to the PDR recommendations, the project may proceed as planned or may start addressing committee recommendations anticipated to be confirmed by WMKO leadership.

WMKO approval is given if WMKO leadership determines that:

- The project has a sound financial plan for supporting the remaining construction activities and that the project has the needed funds for executing the plan.
- WMKO believes that the panel of experts have done due diligence in assessing the project
- WMKO supports the organizational structure and governance of the project
- WMKO and the Board understands the level of risk inherent in the project and is convinced that the primary institution understands and accepts the level of risk.

## 6 Construction Phases

The construction phases begin following a successful PDR and with the infusion of significant funding to run the project at full speed. Minimal funds to keep the core team together/alive does not trigger the start of the construction phase and is recognized as a lifeline that will result in increased costs and schedule. With significant funds to run the project at full speed, the project team will work to develop the instrument as scoped at the end of the PDR phase. It is expected that the project will last during construction, the project has the obligation to report performance relative to the PDR presented baseline plan that serves as the benchmark for marking progress. Contingency needs are identified relative to the PDR plans unless the Board recognizes a scope change that results in a re-baseline. Upscopes larger than 5% of the current budget require a mini review to assess the technical design and impact on the full project budget and schedule. Smaller upscopes must go through the project CCB process and estimated project delta communicated to institutional leadership. The project status is reviewed periodically as agreed to at PDR to assess whether the project is capable of finishing within budget and schedule.

### 6.1 Implementation

Implementation applies a two-stage review approach that is comparable to NASA/NSF methods. During this phase, the engineering team will work to progress the technical progress of the instrument by fabricating components, working with vendors to obtain specific hardware, and then assembling the instrument. For critical WBS elements, Manufacturing Readiness Reviews, will be used to launch fabrication of a subsystem. The MRRs may take place anywhere that is convenient to maintain schedule. Part way through the implementation, a Construction Programmatic Review will be held to assess the overall health of the project. This review does not focus on technical details. The CPR focuses on the technical progress against the plan and determines whether the current scope is achievable within the remaining budget. The timing of the CPR is set such that critical scoping options may be evaluated and triggered to maintain project health. This may include both upscopes and descopes, with descoped components or options put on hold while the project works to find additional support to complete that effort as originally planned. If the minimum viable instrument is not achievable within the current budget, then the PI and PM must report this to all leadership stakeholders (SSC, Board, Directors) and a more

comprehensive CDR will be held to assess both technical and programmatic details and re-evaluate the instrument's intended capabilities.

### 6.1.1 Purpose and process

The project continues to perform the technical activities required to assemble and test the instrument in the lab. The development team completes the fabrication designs and develops vendor specifications, fabricates, purchases, and codes designs after the appropriate MRRs are complete. These activities are implemented in accordance with the PDR endorsed plan. As components arrive, the development team completes validation testing; finalize functional and operational preparations; troubleshoots and updates documentation with fixes and completes lab performance verification. It is understood that without the telescope, the instrument may not be able to confirm with certainty baseline functional performance, but there should be some assurance through test and verification that the instrument will meet the intended performance when delivered to the observatory. In addition, the technical team should be able to provide support with minimal lifetime testing that the instrument will operate for the next 15 years at the summit without major technical downtime due to failed mechanisms. Following verification of the functional performance, the technical team will lead a preship review meeting to demonstrate to committee that includes WMKO operations staff that the instrument is ready to be delivered to the observatory.

During the implementation phase, the PM is closely monitoring the progress as compared to the plan providing traceable evidence that milestones are being met. The PM is reporting regularly on the project's accomplishments relative to the plan and schedule and works to resolve issues as they arrive. It is expected that the PM is using tools to provide an earned value analysis (EVA) with the comparison made to the PDR approved plans. Projects will not be re-baselined for costs without SSC and Board approval. The PM is protecting the project against scope creep and working to keep the project under budget and on schedule with projections through the end of commissioning. If deviations occur, the PM will develop cost recovery plans in partnership with the instrument scientist and PI.

Science and technical work:

- List needed spares and obtain what is reasonable with remaining funding
- Complete and document the final designs used for fabrication
- Assemble, Integrate, and Test all subsystems delivered to the lab
- Complete functional testing of all subsystems and the instrument as a whole; baseline tests needed to prove functionality post delivery to the observatory
- Develop detailed summit integration and commissioning plans
- Prepare preship review documentation

Project management, planning, and control tasks

- Manage technical and programmatic contingency and resources to ensure successful completion of this phase through commissioning within budget, schedule, and risk constraints.
- Assesses the adequacy of anticipated budget availability against plan and commitments, incorporating the impact of performance to date; this is used to track schedule and costs so that the PM may provide management reports on a regular basis
- Prepare documentation for a mid-construction programmatic review and for the preship review
- An updated baseline of the full project budget, schedule, and scope for the instrument
- Manage and update the top critical paths in the IMS and top level risks
- Track and justify contingency use if needed as they relate to risks
- Trigger scope changes that are consistent with budget and schedule. Approach SSC and Board with any major scope changes.

### 6.1.2 Manufacturing Readiness Review description

An MRR is a focused, in-depth technical review of a subsystem, lower-level assembly, or component. The goal of the MRR is to add value and reduce risk through engineering peer or material expert assessment for the WBS designs and assembly approach. A key distinction of an MRR is that the review panel is selected by the project team and not by the IPM/WMKO. It is composed largely of team members with expertise from inside the project team who pull in experts when additional expertise is desirable. The PM and technical lead under review will agree on the committee members. As an example, KPF pulled in WMKO Zerodur experts to review the design and milling plan before machining the KPF Zerodur optics bench.

During the MRR for a specific subsystem, the subsystem lead presents the plans for fabricating and assembling the subsystem. Risks are discussed and the interfaces for the sub system are detailed with evidence that the key stakeholders for the interface all agree. A successful MRR locks in the design and the interfaces for the WBS element and any changes to the ICD will require all stakeholders and the change control board to review.

Exit from the MRR means

- The subsystem is approved for fabrication and may start purchasing and submit fabrication dwgs to the shops
- All stakeholders agree to the interface and the ICD is locked. Any changes must now be approved by the change control board.
- The PI and PM understand the risks to schedule and budget and document any changes to milestones for completion if needed.

### 6.1.3 Programmatic CPR: Construction Programmatic Review

At a milestone set at PDR, a Construction Programmatic Review is held to assess the health of the budget and schedule. The review will be half a day and involve key stakeholders at the lead institutions who have the expertise to make recommendations that will help the project maintain the schedule and budget. The development team will present the project's technical progress without going into technical details. Technical risks that impact budget and schedule will be discussed and analyzed. The PM will provide project tracking material consistent with the routine supports. Scoping options will be re-evaluated with the understanding that the review committee may recommend scoping options that may be either upscope or descope that are consistent with the project deliverables within the defined budget and schedule.

The project will project costs and schedule for the final phases of the project which may include final MRR milestones as the CPR is designed to be held in the middle of the construction phase to ensure there are enough funds to complete the project as currently scoped. The reviewer will assess the readiness of the project and associated supporting infrastructure at the lab and on the summit and evaluate whether the remaining project development can be completed with the available staffing and whether the project is on track to meet the shipping milestones. The evaluation of the shipping milestone is critical to understanding when the instrument may be available to the observing community which is advertised on a semester basis in March and September annually.

Exit from the CPR means

- The plans to complete within the existing funding and schedule are sufficient to meet the scientific goals

- Alternatively, the project must complete specific recommendations related to scoping options to maintain costs and schedule for the desired scope. Recommended major scoping options will be reviewed by the SSC and Board before enacting.

#### 6.1.4 Implementation Exit with a Pre Ship Review

Formal exit from the Implementation Phase follows a successful Pre Ship Review (PSR) with committee members composed of both external engineers and WMKO staff who have a background in operations. The committee will have 5-6 members and interested SSC members and board representatives may also be in attendance. WMKO has the responsibility for organizing the review and committee and acts as the interface between the design team, review committee, and the WMKO partner leadership. The purpose of the review is to provide a project team independent evaluation of the instrument's functional completeness and performance and will assess the remaining plans and budget needed to install and commission the instrument at the observatory. The review committee will vet the installation and commissioning plans and intended deliverable documentation. Recommendations will be provided to institutional leadership as the development team. The PI or IPM will make a presentation to the SSC providing the team with an opportunity to summarize the project preparedness and provide a response to the review recommendations.

Following a successful review, the development team may work to complete shipping preparations working closely with WMKO staff to ship and receive the instrument at the summit facility.

## 7 Commissioning

The commissioning phase includes all activities associated with integrating the instrument at the WMKO facility and the night time engineering tasks that are designed to demonstrate functionality and performance during night time operations. These activities follow a successful PSR and required actions identified at the review that must be completed before shipping the instrument.

#### 7.1.1 Purpose and process

The project team will follow an integration plan that was presented at PSR. The goal during this phase is to integrate the instrument with the WMKO facility at the defined and prepared interfaces that the instrument will be deployed. The instrument will be functionally checked at stow and in-beam positions. The software will be integrated and made accessible via the standard user interfaces for SAs, observers, and engineers. Procedures and troubleshooting documentation will be updated to support operations. Development documentation (drawings, schematics, etc.) that were part of the lab AIT will be delivered to the observatory.

Science and technical work:

- Confirm the delivered performance for the instrument relative to the proposed science driven requirements.
- Provide the development documentation (drawings, schematics, initial procedures, etc.) to observatory staff; transfer development documentation repositories to WMKO
- Deliver the instrument to the observatory

- Integrate the instrument at the WMKO facility at the defined interfaces
- Complete functional testing at all interfaces to complete summit AIT
- Complete nighttime engineering activities
- Update any remaining risks
- List needed spares and obtain what is reasonable with remaining funding

Project management, planning, and control tasks

- Track remaining schedule and costs and continue to provide management reports
- Identify remaining programmatic risks and any mitigation strategies
- Provide report to the SSC and written request to seek a proposal if desired
- Prepare documentation for an OHR

### 7.1.2 Staffing

Project funding for this phase should fund all activities related to summit integration and commissioning. Although the staff composition may remain the same as it was during implementation, the staff hours will ramp down except for key individuals who will participate in the summit integration and commissioning. The expectation is that for the key individuals working at WMKO, they will be fully funded through the remainder of the project schedule.

- Principle investigator to relieve them from other institutional responsibilities if needed. The PI may perform any of the activities below listed for other staff members
- Instrument scientist will transition from lead architect to lead integrator and is the main point of contact for instrument on site assembly and testing.
- Project Scientist will define along with the PI and IS the commissioning plan and initial science targets
- Project Manager who will update and manage the instrument development plan and provide updates on the plan through the project close out.
- Software Engineer(s) will work to integrate the software within the observatory architecture and provide assistance during functional testing.

For observatory activities, the following people will be involved in observatory planning and defining interfaces. These people should be budgeted in the plan, and requests for engineering assistance with a specified number of hours should be part of the MS Project plan with the WMKO PM & IMP working to ensure those hours are reserved in the FY planning that begins annually in October.

- IPM who assists the project as requested managing limited resources
- PM who will update the project (often the IPM)
- Staff Astronomer who will provide summit leadership and coordination during the summit integration. The SA will also be a key contributor to the commissioning plan and will lead some engineering tasks. The SA will also work to ensure that the observer interfaces and on-line documentation is prepared for observer use.
- Instrument Scientist will coordinate summit activities and assist with integration at the summit
- Instrument engineers assist with the integration and testing at the summit and will assess operational preparedness as it pertains to daily support efforts.
- Software engineer will help integrate the control software at the observatory
- Mechanical technicians who will assist with utilities and instrument installation

### 7.1.3 Commissioning Exit

Formal exit from the Commissioning Phase, and by extension the completion of the project, follows a successful Operations Handover Review (OHR) with committee members composed of 4-6 WMKO staff with science, engineering, and operational backgrounds. WMKO has the responsibility for organizing the review and committee and acts as the interface between the design team, review committee, and the WMKO partner leadership.

The purpose of the review is to provide an independent evaluation of the operation of the instrument with an emphasis placed on long term support, documentation, and preparedness to support the observing community during routine nightly science operation. At this phase of development, the expectation is that the instrument is fully tested at the summit facility and has completed the bulk of the on-sky engineering activities. The project is near the end of the project schedule and limited funding is available for closing out remaining activities. The WMKO facility should have the necessary knowledge, documentation, training, and spares to maintain the instrument for the next 15 years. The instrument should have demonstrated a performance baseline to ensure that science requirements have been met on sky and that performance information is disseminated to the science community through WMKO on-line documentation. The project has defined the remaining activities with a schedule and budget defined and there is a milestone date to close down the development side of the project that can be communicated with all stakeholders.

The review committee will vet the delivered instrument, user interfaces, and procedures and provide recommendations to the WMKO leadership and the development team. WMKO leadership will consider the recommendations in context with WMKO's FY initiatives and provide a response to the lead WMKO staff astronomer and the instrument PI as to how best to move forward with recommendations with observatory support. Completion of project close out activities will signal the end of the project and all tracking of the project will cease. WMKO then assumes responsibility for all operational activities with the instrument.

## 8 Document Summary for Review Milestones

Table showing review documentation what state it is expected to be in and what we will review.  
Excel spreadsheet has this.

## 9 Appendix

### 9.1 Example: Proposal Readiness Review Charter

**Proposal Readiness Review Process and Charter**  
**Instrument Name**  
**Date**

## Introduction

The University of California at San Diego (UCSD) and Los Angeles (UCLA) is collaborating with the W. M. Keck Observatory (WMKO) in the development of the Liger: A wide-field AO-fed integral field spectrograph and imager for WMKO that will be a second generation instrument that will supersede the OH-Suppressing Infra-Red Imaging Spectrograph (OSIRIS) on the Keck I telescope. Liger was originally proposed to the WMKO Science Steering Committee as a merger of the InfraRed Imaging Spectrograph (IRIS) designs and the hardware for the OSIRIS imager. The SSC wants to preserve OSIRIS, and instead, encouraged the Liger team to design a complete new instrument for WMKO. Liger significantly leverages IRIS designs that have already passed design reviews, but there are modifications to the IRIS concept that are necessary for Liger at WMKO.

The Liger project is currently preparing concepts in advance of seeking funding opportunities and this document describes a Proposal Readiness Review (PRR) process, the success criteria and the charter for the review committee.

## Proposal Readiness review

### Process

In the instrument's advanced conceptual phase, science goals are identified and an initial set of requirements are available for review within a broader context of the current scientific landscape. The science goals address needs identified in the WMKO strategic plan, and thus, the desires of the observatory's community. The science requirements drive the advanced conceptual design and operational concepts that results in sufficient detail and risk identification for all instrument sub-system components for both hardware and software. All designs are proposed with sufficient detail to establish that they are feasible, that costs and the uncertainties in those costs are known or understood, and that the instrument is likely to meet its performance requirements. The project plans demonstrate that the budget and schedule are realistic through commissioning, having adequate contingency costs in both budget and schedule. Through this demonstration, the instrument development team establishes that they are prepared to submit funding requests.

### Success Criteria

Success for this review means that the review committee considers conceptual designs and associated specifications presented to be mature and realistic because the

- Science cases are robust and are supported by the observing community
- Conceptual designs meet the science requirements for the instrument
- Schedule and management plan demonstrate that the work to complete the project can be accomplished by the development team
- Budget captures all development costs with acceptable contingency for identified risks, and there is a funding plan to support the instrument through commissioning

## Deliverables and Documentation:

The format of the review documentation will be defined by the review team. The team is encouraged to provide a conceptual design document that would be the base for future design documents that would be deliverables for later development phases. Alternatively, the team may provide a collection of primary technical notes and project files for review. A slide deck may also serve as the review documents, but if it is the primary source of reviewer material, the slides must be provided by the documentation deadline for reviewer feedback. The content for the above documentation is provided below and assumes a primary single document is used. The primary documentation will be clearly identified for the review committee at the time of release. It is not expected that these documents are complete at a level of preliminary design but they should demonstrate an acceptable level of detail for this early phase that would allow the team to request an appropriate amount of funding.

### Documentation:

1. Concept design document
  - Exec summary
  - Science Case
  - Instrument design
  - Management Plan
    - Team makeup and availability
    - Work break down structure
    - Outlined management plan
  - Observatroy interfaces
  - Risk assesement
  - Cost breakdown
  - Schedule
2. Science traceability matrix for major system components
3. Models: These could be links in the primary documentation
  - Optical Model
  - 3D mechanical concept CAD model
4. MS Project file or similar documentation
5. Funding profile/ funding plan(s) (usually slides only)
  - Identify the source(s) for funding
  - Identify cost sharing when applicable
  - Contingency

The committee will use the review documenation as the basis for its evaluation, which will take place in a one-day meeting at UCSD. The committee will consist of three reviewers external to the project, one of whom is the chair of the review committee. The reviewers will have backgrounds in instrumentation, project management, mechanical engineering, or other specific discipline required to assess the project. In addition, WMKO staff members not directly involved in the project and SSC members will be present and may ask questions of the development team.

## Purpose and Objectives

The purpose of the PRR is to provide an external peer review of the current conceptual designs, schedule, costs, risks, and science cases and to provide recommendations to WMKO, the SSC, and the instrument project team on those plans in advance of seeking funding opportunities.

The review committee's charge is to determine if the project meets the success criteria and to recommend one of three courses of action:

1. Proceed as planned with proposal preparations and funding requests
2. Proceed with proposal and funding requests but address specific issues identified by the review committee as critical to the success of the project.
3. Do not proceed with funding requests at this time and instead further develop the conceptual design for the next opportunity that will address and strengthen specific issues raised by the committee.

## Guidelines

In order to make the review as effective as possible we have established three guidelines for the process:

1. The review documentation should include all materials that the development team believes are appropriate to address the questions in the charter for the review committee. No additional materials should be presented at the review except for those needed to answer questions raised by the review committee prior to the review meeting.
2. The review agenda will include time for presentations that summarizes the documentation, but it will be assumed that all of the attendees have reviewed the documentation in some detail prior to the meeting.

## Schedule

The following timetable is proposed for this review process:

<b>Date</b>	<b>Description</b>
May 27, 2019	Documentation released to the review committee
June 3, 2019	Review committee members submit questions
June 4, 2019	Instrument team prepares responses to questions
June 7, 2019	Review meeting
June 13, 2019	Review summary recommendations released
June 26, 2019	Final report released

## Committee Charter

The review committee charter is as follows:

1. Each member of the review committee should read the review materials prior to the review meeting.
2. Each member of the review committee should submit questions to the project team prior to the review meeting to obtain clarification or further information. The WMKO instrument program

manager and the Principle Investigator will serve as the points of contact for the submission of questions.

3. Each member of the review committee should consider the answers to any questions asked in item 2.
4. The committee will hold a one-day meeting with the project team instrument design and the specific areas covered by the questions listed in the purpose and objectives sub-section of the Review Process section of this document.
5. The committee will hold one or more “executive sessions” during the meeting to develop the committee’s report and recommendations.
6. The committee will use three tiers of recommendations for its findings.
  - Tier 1 recommendations must be resolved successfully before the review can be considered successfully completed.
  - Tier 2 recommendations must be resolved before seeking funding.
  - Tier 3 recommendations are offered by the committee for consideration by the development team but are not considered binding.
7. At the conclusion of the review, the committee will provide a brief summary of the review outcomes to the WMKO instrument program manager and the instrument project team.
8. The chairperson of the review committee will lead the drafting of a written report. A preliminary or summary report will be issued within 2 days of the meeting and the final report will be issued within 14 days of the review meeting. This report should summarize the important issues discussed at the review meeting and present the committee’s findings.
9. The preliminary and final reports of the committee will be delivered to the SSC co-chairs and the Observatory Director.

In carrying out the review, you may consider the following questions to help guide you in your evaluation of the project.

1. Conceptual Designs
  - a. Does the instrument concept address a compelling science case and will the instrument design meet the needs of the community?
  - b. Are the technical requirements for the instrument clear, complete and well defined?
  - c. Are the concepts sufficient to establish the
    - i. feasibility of the proposed design?
    - ii. budget of the development process?
    - iii. risks involved with the development of the instrument?
  - d. What is the probability that this instrument will be finished as it is currently proposed?
  - e. Based on the reviewer’s knowledge and experience are the proposed designs based on sound scientific principles and best engineering practices?
  - f. Are the interfaces between the facility and the instrument well identified?
  - g. Are the key interfaces between internal instrument subsystems well identified?
  - h. Have risks been defined and appropriately assessed?
  - i. Are there additional risks that should be considered?
  - j. Are the risk mitigation efforts and future plans likely to result in retirement of all critical risks?
  - k. Does the composition of the development team have the expertise to build the instrument or are there areas that need additional assistance?
  - l. Does the development team have the bandwidth to complete the project?

## 2. Documents and Reports

- a. Are the plans for completion of the project, including schedule and budget, sufficiently detailed and complete?
- b. Is the proposed schedule and budget to completion realistic and honest?
- c. Are cost differences with comparable existing or planned similar instrumentation at Keck or other facilities adequately explained and realistic?
- d. Is there an appropriate funding model through commissioning of the instrument?
- e. Is there adequate contingency and descope options available to stay within the cost cap budget?
- f. Are the conceptual designs clear and sufficiently detailed?
- g. Is there a clear flow down established from the science requirements to the technical requirements?

### 9.2 Preliminary Design Review Charter

TBD

### 9.3 MRR Technical Review Charter

TBD

### 9.4 Construction Programmatic Review Charter

TBD

### 9.5 Preship Review Charter

## **Keck Cosmic Reionization Mapper Pre-Ship Review Process and Charter**

October 2022

## Introduction

The California Institute of Technology (CIT) and the University of California at Santa Cruz (UCSC) are collaborating with the W. M. Keck Observatory (WMKO) in the development of the Keck Cosmic Reionization Mapper (KCRM), a facility class instrument upgrade for the Keck II telescope at WMKO. KCRM is the red arm of KCWI that is a workhorse instrument in high demand on the KII telescope.

The KCRM project is currently in the implementation phase, completing assembly, integration, and testing at Caltech before integrating the hardware with the existing KCRM instrument at the WMKO summit facility. This document describes the Pre-Ship Review (PSR) process, the PSR success criteria, and the charter for the PSR committee.

## KCRM Pre-Ship review

## The Implementation Process

The implementation phase is divided between the institutional labs and the summit. By the end of the lab implementation phase, the instrument is assembled, aligned, and functionally tested. The instrument has demonstrated a performance baseline to ensure that science requirements will be met during full verification testing on the summit. The WMKO facility is prepared and is ready to receive the instrument, and the instrument will interface with the observatory and existing instrument as designed and fabricated. Project deliverable documentation is either completed, or the team developed and provided a plan for completion prior to operations hand-off at the Operational Readiness Review. The project plan to completion, including the schedule and budget, is updated to reflect implementation of the summit AI&T and commissioning activities.

## Success Criteria

Success for this review means that the committee agrees the instrument has completed sufficient testing in the lab, and that the team is ready to proceed with dis-assembling the instrument and shipping to WMKO. Specifically:

- The instrument has sufficiently demonstrated functionality and a performance baseline to warrant shipment and begin the second phase of instrument AI&T on the summit.
- The summit I&T plans and procedures are sufficiently detailed/defined to support installation activities.
- The observatory is ready to accept the (dis-assembled) instrument and support installation/commissioning activities.
- The project can be successfully completed within the remaining budget and schedule allocations.

## Review Process

### Documentation

The primary document for review is the technical design manual that is an update from the detailed design review. As part of the design document or as additional material, the following information will be included and evaluated:

- Science Requirement Document showing verification
- Provide overviews and performance of all subsystems with an emphasis on operations
- Provide overviews of the control electronics and layouts
- Identify any major scope changes relative to detailed design
- Operational software:
  - Operations overview
  - DRP (Support, Distribution, Performance, Data products)
  - Observing practices and procedures
- Major interface Design and Control documentation
- Integration and commissioning plans

- Operation and maintenance procedures; WMKO long term support commitments; critical sparring
- Verification and test plans and how performance will be disseminated to the observing community
- Programmatic; Management plan for the remainder of the project
  - Project Plan (often MS project file)
  - WBS dictionary
  - Updated project schedule
  - Roles and responsibilities during the final phase
  - Budget and staffing plan for remaining work
  - Status and commitments for project documentation (DWGs, schematics, procedures, design documents)
  - Risks, Management, retirement, and remaining

### Instrument Tour:

In addition to the documentation, the review committee will have an opportunity to tour the instrument in its fully operational laboratory state. This includes:

- Lab tour of the instrument assembly area in the Caltech hi-bay
- Electronics
- Demonstrations of motion control
- Operational software and data acquisition

### Committee

The PSR committee will use the PS documentation as the basis for its evaluation, which will take place in a two-day meeting at Caltech. The PSR committee will consist of six invited reviewers external to the project, one of whom is the chair of the review committee. In addition, two WMKO staff members not directly involved in the KCRM project may serve as an informational resource for the review committee.

### Purpose and Objectives

The purpose of the PSR is to provide an external peer review of the work done in the lab implementation phase, assess whether the project is sufficiently prepared to begin the implementation at the summit, assess whether WMKO is ready to receive and support the instrument for general community use, and to provide recommendations to WMKO and the KCRM project team on achieved performance and plans for completion.

The review committee's charge is to determine if the project meets the success criteria and to recommend one of three courses of action:

4. Proceed as planned with the KCRM summit installation and commissioning that starts with shipping the instrument to WMKO.

5. Proceed as planned with the KCRM summit installation and commissioning after specific issues identified by the review committee have been addressed to the satisfaction of observatory management.
6. Do not proceed with the KCRM summit installation and commissioning until a second “delta” PSR can be held to evaluate the resolution of specific issues raised by the committee.

## Guidelines

To make the KCRM PSR as effective as possible we have established two guidelines for the PSR process:

3. The review recommendations are informed by the submitted PS documentation and any updates and discussion provided at the review meeting. The documentation should include all of the materials that the KCRM team believe are appropriate to address the questions in the charter for the review committee.
4. It is assumed that all reviewers have reviewed the PS documentation in detail prior to the meeting.

## Schedule

The following timetable is proposed for this review process:

<b>Date</b>	<b>Description</b>
October 10	PS documentation released to PSR committee
October 18	Review committee submits questions
October 24 & 25	PSR meeting
November 9	Committee PSR report released

## Committee Charter

The WMKO instrument program manager, in collaboration with the KCRM project team, has written this charter for the PSR committee. The review committee charter is as follows:

10. Each member of the review committee should review the PS documentation prior to the review meeting.
11. Each member of the review committee should submit questions as required to the KCRM project team prior to the review meeting to obtain clarification or further information about the PS documentation and the KCRM project. The WMKO instrument program manager, the principal investigator, and the project manager will serve as the points of contact for the submission of questions.

12. Each member of the review committee should consider the answers to any questions asked in item 2.
13. The committee will hold a two-day PSR meeting with the KCRM project team to discuss the PS documentation.
14. The committee will hold one or more “executive sessions” during the PSR meeting to develop the committee’s report and recommendations.
15. The committee will use three tiers of recommendations for its findings:
  - Tier 1 recommendations must be resolved successfully before the PSR can be considered successfully completed.
  - Tier 2 recommendations must be resolved at/for the Operational Readiness Review (ORR).
  - Tier 3 recommendations are offered by the committee for consideration by the KCRM team but are not considered binding.
16. At the conclusion of the PSR, the committee will provide a brief presentation summary of the review outcomes to the WMKO IPM, the KCRM project principal investigator and the KCRM project team. These initial findings will be shared with KCRM stakeholders by the IPM.
17. The chairperson of the review committee will lead the drafting of a written report. The final report will be issued within 14 days after the review meeting. This report should summarize the important issues discussed at the review meeting and present the committee’s detailed findings.
18. The preliminary and final reports of the PSR committee will be delivered to the Observatory Director.

## 9.6 Example Operations Handover Review Charter

**Instrument Name**  
**Operations Handover Review Process and Charter**  
6 July 2023

### Introduction

The UC Berkeley Space Sciences Laboratory (SSL), the California Institute of Technology (CIT), and the University of California at Santa Cruz (UCSC) have collaborated with the W. M. Keck Observatory (WMKO) in the development of the Keck Planet Finder (KPF), a facility class instrument for the Keck I telescope at WMKO.

The KPF project began scheduled operation of science programs in the second half of the 2023A semester having completed integration and testing at the WMKO summit facility. The project has executed nighttime engineering tasks to commission the instrument on sky in advance of operation activities and continues engineering activities as the KPF project enters operations. This document describes the Operations Handover Review process, charter, and success criteria.

The OHR is an inward facing review where the development team and observatory staff evaluate the readiness to turn over full operational activities to the observatory instrument support staff. As such, there are no reviewers external to the project or the observatory.

## The Operations Handover review

At this phase of development, the instrument is fully tested at the summit facility and has completed the bulk of the on-sky engineering activities. The project is near the end of the project schedule and limited funding is available for closing out remaining activities. The WMKO facility now has the necessary knowledge, documentation, training, and spares to maintain the instrument for the next 15 years. Project has delivered the documentation and procedures, prior to operations hand-off at the Operational Handover Review. The instrument has demonstrated a performance baseline to ensure that science requirements have been met on sky and that performance information is disseminated to the science community through WMKO on-line documentation. The project has defined the remaining activities with a schedule and budget defined and there is a milestone date to close down the development side of the project that can be communicated with all stakeholders.

## Success Criteria

Success for this review means that the observatory staff agrees the instrument has completed sufficient on-sky testing, the instrument is in a robust enough state to support, and the necessary procedures, troubleshooting information, and documentation is sufficient.

- The instrument has sufficiently demonstrated functionality and a performance baseline to warrant routine operational support.
- Design documentation is handed over to the observatory. The instrument is considered maintainable by WMKO staff with a reasonable level of support required for a facility class instrument.
- The observing community has all the necessary tools and documentation to propose for time and use the instrument.

## Review Process

### *Documentation*

The design will be shared in a dedicated OHR presentation slide deck and supported by technical documentation as needed or requested. As part of the slide deck or as additional material, the following information will be included and evaluated:

- Performance Requirement verification matrix that verifies on-sky performance results
- Overviews of on-sky performance
- Documentation of the control electronics and layouts

- Checklist of documentation transferred to WMKO with owners and digital (or physical) location identified
- Spares list with quantities in-hand, and what remains to be purchased.
- Maintenance plan and schedule including use of spare parts
- Engineering troubleshooting guide
- Ops Support:
  - Operations and software overview and user interfaces (SAs, OAs, engineering, and Observers)
  - Observing practices and procedures and/or manual
  - WMKO instrument web documentation
  - Operations troubleshooting guide
  - Data reduction documentation and Git Hub release
- Liens on deliverables or engineering activities
- Milestones and plans to complete remaining activities with project end date defined

#### *Committee composition*

The OHR committee will use the OHR documentation as the basis for its evaluation, which will take place during a 1-day meeting. The OHR committee will consist of four to five invited observatory staff one of whom is the chair of the review committee and will work with the IPM on a written report.

#### *Purpose and Objectives*

The purpose of the OHR is to provide an observatory-facing review of the project and assess whether the instrument is ready to enter the operational phase and whether the observatory is sufficiently prepared to support the instrument for the foreseeable future. This encompasses not only tools and documentation needed to support the instrument at WMKO but also the tools and documentation needed for the science community that will use the instrument.

The review committee's charge is to determine if the project meets the success criteria and to recommend one of three courses of action:

7. Proceed as planned with WMKO taking control of the instrument and ending the instrument development project at the agreed upon milestone date.
8. Proceed as planned with activities leading to WMKO taking control but complete key activities that drive a new milestone date for ending the instrument development process.
9. Do not consider ending the development project until a second "delta" OHR can be held to evaluate the resolution of specific issues raised by the committee that are identified as required but that are not well planned enough for the committee to ascertain whether the activities can be completed by the proposed milestone.

#### Schedule

The following timetable is proposed for this review process:

<b>Date</b>	<b>Description</b>
23 June 2023	Documentation released to OHR committee
30 June 2023	Review committee submits questions in advance
6 July 2023	Operations handover meeting
14 July 2023	Committee OHR report released

#### Committee Charter

The WMKO instrument program manager, in collaboration with the project team, has written this charter for the OHR committee. The review committee charter is as follows:

19. Each member of the review committee should review the documentation prior to the review meeting.
20. The committee will hold one “executive session” after the OHR meeting to develop the committee’s report and recommendations.
21. The committee will use three tiers of recommendations for its findings:
  - Tier 1 recommendations must be resolved successfully before the OHR can be considered successfully completed.
  - Tier 2 recommendations must be resolved before releasing for operational use.
  - Tier 3 recommendations are offered by the committee for consideration by the team but are not considered binding.
22. At the conclusion of the OHR, the committee will provide a brief summary of the review outcomes to the WMKO IPM, the project principal investigator, and the project team. These initial findings will be shared with stakeholders by the IPM.
23. The chairperson of the review committee will lead the drafting of a written report. The final report will be issued within 14 days after the review meeting. This report should summarize the important issues discussed at the review meeting and present the committee’s detailed findings.
24. The final report of the OHR committee will be delivered to the Observatory Director.