National Science Foundation

DATE: June 22, 2022

TO: Kael Hanson, Vivian O'Dell, Farshid Feyzi

FROM: William Wester, Vladimir Papitashvili

SUBJECT: IceCube Neutrino Observatory Upgrade (ICNO-U) Re-baseline Review

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Dear ICNO-U Project Team:

The IceCube Upgrade project has experienced significant delays and cost increases due in part to the COVID pandemic and a total of 3 consecutive field seasons being unavailable for work on-ice at the South Pole. NSF charged a re-baseline review of the ICNO-U project, which was held April 26-28, 2022, to have an independent assessment of the degree of confidence that the project scope can be completed within the revised budget, schedule extension, and risk assessments. This memorandum transmits a summary of the NSF view of the panel review report. It includes a list of specific items that NSF requires from the project to determine whether there is reliable path forward that addresses all the panel's concerns and provides confidence that the project is in a position to complete the upgrade as proposed.

Summary Statement:

NSF acknowledges several positive findings spelled out by the review committee:

- The project provided high quality presentations and timely answers to questions.
- The project has relied heavily on original IceCube project experiences.
- In several areas (schedule, risk analysis), significant improvements were noted by panelists with "a historical perspective on the project".
- The summary opinion of the review panel is that they have high confidence that the ICNO-U team can accomplish the remaining project scope **provided that manageable concerns are addressed in a timely fashion**.

Recommendations and Concerns:

The review report spells out 9 specific recommendations (included as Appendix A) that remain to be addressed. In order to move forward, NSF requires a detailed plan that includes the actions being taken to address the specific concerns and a timeline indicating when the actions are expected to be completed. In order to meet the timeline for making a recommendation on the proposal, and the constraints on scheduling for on-ice activities at the South Pole, it is imperative that NSF and the project have an agreed-upon understanding of appropriate responses by July 1, 2022.

One over-riding concern that flows through the panel report is that the project has project management tools that are lacking in cost estimating, scheduling, risk analysis and EVMS. This creates a key question as to whether the project team will be able to demonstrate an adequate ability to respond promptly in planning as potential risks may be realized given the unusual circumstances of conducting field work at the South Pole. A central component for strengthening the project is a detailed schedule risk analysis and an assessment of needed schedule contingency for the on-ice efforts. We would expect this to flow from a robust schedule that should have predecessor and successor relationships, float defined for each activity, and the critical path determined. This would allow for what-if scenarios and forecasting. NSF expectations, in terms of the response, are dominated by these general observations.

Arising from the specific recommendations and this general observation are a number of points of emphasis that have already been communicated to the project and that the project has begun to address.

- A set of “what-if” strategies associated with the project’s needed fuel delivery to South Pole, considering the risk table associated with AIL’s intended capacities, should be included. Evaluate the strategies in terms of just-in-time drilling and deployment activities and suggest risk mitigation alternatives and/or impact on cost.
- Enhance the project office to ensure that there is sufficient staff to manage and monitor the state of the project. We anticipate that this will require going beyond just adding a project controls officer and part-time support and should include the use of external consultants until the project office is fully staffed.
- The project should strongly consider the engagement of externally contracted surge support to realize a timely and effective response to prepare for the independent cost review that is the next step in allowing the NSF to make a decision on an award. We encourage seeking assistance of experts who are familiar with supporting NSF projects to speed up the preparation process.
- Continue to evolve the tools being used for project management but avoid over-implementation. These tools should be selected and tailored based on the technical nature and scale of the project, including the challenges of conducting a project at the South Pole.

- The project should have a detailed action plan that identifies key elements of the project along with target dates for completion. This will enable the project to track progress and will assist NSF in exercise of oversight.

Included as Appendix B to this memorandum is a spreadsheet that outlines two sets of items. At the top is a reminder of the NSF policy and guidance on planning and management of major facilities and mid-scale projects through their full life cycle. The purpose of the Guide is to provide guidance to NSF staff on conducting oversight of major facilities and mid-scale projects and to recipients in carrying out effective project planning and management and clearly states the required policies and procedures as well as pertinent guidance and practices at each stage of a facility's life cycle. Below this is a list of those specific items that will be examined as part of the independent cost estimate review. These fall into the general categories included in the first column. The middle column highlights those specifics that the cost review will examine. These relate to the items identified by the review panel and are included in the details of the panel report. These also touch upon the additional points raised in the previous paragraph.

NSF would like to express appreciation of the ICNO-U project team in its preparation of review materials and participation in the review. We stand ready to address any points of clarification about what is needed in the responses and eagerly await your reply.

Submitted,

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Appendix A: Panel Recommendations

The Panel strongly supports the goals of the Project, which has a very strong case for re-baselining, once the following manageable recommendations have been addressed.

Recommendation 1: Review the comments in this Panel report and take action as deemed necessary.

Recommendation 2: Hire Project Controls effort to support key Project Office functions. These include more rigorous cost estimating, scheduling, EVMS reporting, and risk analysis. Consider engaging outside experts to provide ongoing guidance on such topics.

Recommendation 3: Improve Project Office processes to better integrate schedule, cost, and resource information. This will result in a more credible schedule and time-phased costs (e.g., float management, EVMS). The Project should implement rigorous processes that ensure Smartsheet (or a replacement) will demonstrably use activity durations and schedule logic to build a technically-driven schedule with credible early/late start/finish dates, critical path, and correct free float and total float values per activity. These improved processes should follow GAO/NSF best practices and allow quick "what-if" analysis capabilities. Consider engaging outside expertise to guide the team, review schedule changes, and help establish schedule quality metrics (reports) that drive improvements to the schedule.

Recommendation 4: Use EVMS reports and practices with the project team to help manage the Project. These include planned value, earned value, and actual costs per month (S-curves), as well as cost and schedule variances, variance analysis reports, and corrective action tracking.

Recommendation 5: Establish appropriate logic links for all activities in the schedule. This will enable the schedule to be used to: assess actual and needed float (e.g., prior to "ready to ship" milestones); perform critical path analysis; explore what-if scenarios; and analyze risks stochastically to determine risk drivers, and compute cost and schedule contingency needs at a high level of confidence.

Recommendation 6: Update the Risk Management Plan to describe more specifically how the project manages risk. For example, summarize or cross-reference management of partner in-kind risks, cargo sequence float management, on-ice risk management, and schedule risk analysis methodology. Clearly delineate the boundary between Project risks and risks owned by the NSF, and ensure this is reflected in the Risk Register.

Recommendation 7: Review and improve the Risk Register fields and associated data following best practices, taking the comments in this report into account, and focusing on quantitative (rather than binned) probabilities and impacts. Ensure the following are adequately described: risk mitigations, risk response plans, and the basis of estimates for risk probabilities and minimum, likely, and maximum cost and schedule impacts.

Recommendation 8: Establish a recognized methodology for performing schedule risk analysis and use it to assess risk-adjusted float and schedule contingency needs. This could consist of schedule risk what-if scenarios, toy Monte Carlo models to aggregate delays to key milestones from associated risks, or a Monte Carlo analysis of all the risks in the full schedule. Include the burn rate costs of risk delays (such as marching army and escalation costs) in the cost risk analysis.

Recommendation 9: Write up Standard Operating Procedures (SOPs), Training Plans (TP), and Field Work Plans (WP) and ensure that Project personnel are familiar with them prior to field deployment.

Appendix B: ICE Review Checklist

	REQUIREMENTS for ICER	
	Alignment with requirements in Section 5.0 of Research Infrastructure Guide.	
	Schedules should be developed following the applicable best practices associated with creating and maintaining high-quality and reliable schedul. These are outlined in the GAO Schedule Assessment Guide (See Section 4.3 of the RIG) and available https://www.gao.gov/assets/gao-16-89g.pdf	
	Budget should be supported by well-documented Basis of Estimates (BoE) developed in accordance with the best practices and twelve steps outlined in the GAO Cost Estimating and Assessment Guide to meet the four characteristics of a high-quality estimate: well documented; comprehensive; accurate; and credible. The GAO Cost Estimating and Assessment Guide is available at https://www.gao.gov/products/gao-20-195g	
	Closure of recommendations in Re-baseline External Panel, Final Draft, dated 5/23/2022	Closure determined by adequate response to the points raised in the NSF directions to the project along with the final report.
Topic of Interest	**Specific Items that Project should address**	
Robustness of the Project Master Schedule	Existing and/or newly identified gaps in Master Project Schedule need to be closed. These include, i.e., partial logically sequenced activities, missing logic of predecessor/successor links for all activities, critical path based on incomplete schedule logic and float, lack of documented rules for max/min duration for non-placeholder/non-LOE activities, weakness with the manual approach that requires separately updating of forecast resource usage and cost information when schedule information is updated, and lack of subaward documentation.	The team will review the Master Project Schedule to assess the following questions, as applicable: 1. Does it capture all activities? 2. Are all activities sequenced? 3. Are resources to do the work assigned to all activities? 4. Have realistic durations been established for all activities? 5. Can the schedule be traced horizontally and so that it links products and outcomes associated with other sequenced

	If full integration of schedule is not feasible, document processes steps with for use of Smartsheet to illustrate how the integrated cost and schedule implementation data are synchronized and consistent at all times.	activities, and is it vertically traceable so that lower-level schedules are clearly consistent with upper-level schedule 6. Does the schedule identify the program's critical path—the path of longest duration through the sequence of activities? 7. Has the schedule identified reasonable total float (or slack)—the amount of time a predecessor activity can slip before the delay affects the program's estimated finish date—so that the schedule's flexibility can be determined. 8. Has a schedule risk analysis been conducted to into a statistical simulation to predict the level of confidence in meeting the program's completion date; to determine the contingency, or reserve of time, needed for a level of confidence; and to identify high-priority risks? 9. Does the schedule incorporate progress updates and logic to provide a realistic forecast of start and completion dates for program activities? Have the people responsible for the updating should be trained in critical path method scheduling? 10. Have the processes been established and documented for maintaining a baseline schedule? A baseline schedule is the basis for managing the program scope, the time period for

		accomplishing it, and the required resources. A corresponding basis document explains the overall approach to the program, defines custom fields in the schedule file, details ground rules and assumptions used in developing the schedule, and justifies constraints, lags, long activity durations, and any other unique features of the schedule.
Robustness of On-Ice Activities Schedule	Where applicable, update project documentation (cost, schedule, risks) after more formal or rigorous documentation of field season work plans and equipment, materials, spares and consumables requirements is completed.	
Robustness of the Cargo Master Schedule	Integrate (link) source data (cost estimates and resources) where feasible to project master schedules cargo schedule. This will allow automatic cost updates with schedule changes.	
Reliability of the schedule risk and schedule contingency estimates	Conduct schedule risk analysis and update schedule contingency. At a minimum assess schedule risk using what-if scenarios or using a toy MC to aggregate delays to key milestones from associated risks.	
Reliability of the schedule risk and schedule contingency estimates	Verify that various what-if scenarios (after the missing schedule logic has been fixed) have assessed the potential consequences of the main schedule risks.	
Status of EVM and metrics	Assess feasibility of using an alternate tool to automatically calculate EVM metrics or outline actions in current process that reduce risk of incorrect cost and schedule variance	Question: What steps are incorporated in the current manual process to reduce the risk of generating incorrect cost

	information that could arise from a manual approach.	and schedule variance information?
Reliability of the overall risk register	Update risk register to close existing gaps and any newly identified risks such as ones related to in-kind contributions, oversight of subawards, and logistics, and remove of outdated data (e.g. to a backup copy), obsolete risks, pre-mitigated (and possibly out-of-date) risk assessments, inclusion of uncertainty for labor as well as materials and supplies in the inflation risks. Also replace unwieldy risk binning with simple hard numbers, such as percentage probabilities and min/likely/max dollar impacts. Risks should be clearly linked to a handful of key milestones in the schedule, to enable what-if scenarios or simply risk MC models to be explored. Add quantitative values for probabilities (percent) and minimum, likely, and maximum cost impacts (dollars) and schedule impacts (months of delay to successor tasks).	
Reliability of the overall risk register	Flesh out risk register documentation (pre-emptive risk mitigation in the baseline and reactive risk response plans) in more detail. The basis of estimate justification for the post-mitigation risk probabilities and cost and schedule impacts should be summarized in the risk register and reviewed by suitable experts (other than the risk owner) to ensure overall coherence.	
	Update contingency (budget, schedule and scope) estimates. (1) Verify that the construction schedule contingency has been developed in the same manner as the budget contingency estimate, following the WBS structure at the lowest available level of detail, and technical estimates should be made for each task's duration and its dependence on other tasks. (2) reassess use of scope	

	contingency and update plan to make effective use of scope contingency during construction.	
	If future change in scheduling tool (P6) is anticipated during construction, incorporate updates to project cost, BOE and schedule estimates. The project documentation should also outline the detailed scope and implementation included in the change of tools.	
	Review and update as applicable the Key Assumptions document.	
Reliability of the overall risk register	Update the Risk Management Plan with descriptions of the IC/U Project-specific risk-related activities. The RMP should be updated to describe more specifically how the project actually manages risk, e.g., summarize or cross-reference: management of partner in-kind risks, cargo sequence float management, on-ice risk management, and schedule risk analysis (e.g., push tests and what-if scenarios). The RMP should delineate the boundary between risks owned by the project, and risks owned by NSF.	
	Review work plans and procedures for current IC/U on-ice labor effort for any potential to reduce peak population requirements. Assure alignment with the population capacities provided by NSF. Update risk handling for the final field season if reduction below the maximum available population capacity cannot be achieved.	
	Action Description	
	Close gap on missing project controls support, either through hire of individual or contracting external services. If not complete, present plan with target date to complete and key activity milestones.	The list of items below are the items that are not needed directly for completion of ICER but critical to Project success and the reduction of risk. Updates are needed by this time to allow NSF time to adjust award terms/conditions if needed.

	Resolve full-time effort of project manager (now split with managing WBS 1.2). If not complete, present plan with target date to complete and key activity milestones.	
	Strengthen logistics process documentation to include thresholds on float, "issues" tracking issues, which are currently captured in the footnotes of the *Overview of IC/U Planning Capacities* table, for resolution.	
	Demonstrate with NSF the integration of schedule in routine project monitoring (cost and schedule variances, generation of EVM such as a detailed monthly forecast of planned value for the remainder of the Project).	