
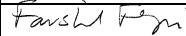


WISCONSIN ICECUBE PARTICLE ASTROPHYSICS CENTER

Project Management Tools Used by the IceCube Upgrade Project

2022-005.2

Approval

Title/Name	Signature	Date
Project Director: V. O'Dell	 <small>Vivian O'Dell (Apr 12, 2022 07:52 CDT)</small>	Apr 12, 2022
Project Manager: F. Feyzi		Apr 12, 2022

Revision History

Version	Date	Author	Summary of changes
V1.0	2021-12-01	M. Rogal, V. O'Dell	Started document
V1.1	2021-12-23	V. O'Dell	Added information from GAO best practices (scheduling); latest NSF Research Infrastructure Guide. Document is still work in progress. Need to make some snippets to embed.
V1.2	2022-03-05	V. O'Dell	Incorporated comments from Jim Lowe.
V2.0	2022-04-11	M. Zernick	Released Version

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1. Purpose of this Document

This document describes the project management tools used by the IceCube Upgrade Project. The requirements of the PM software are listed in Section 2, and Section 3 gives in detail how the IceCube Upgrade PM tools meet these requirements.

2. Key Requirements of the Project Management Tools

The Government Accountability Office (GAO) has published the “Schedule Assessment Guide, Best Practices for Project Schedules” (1). Section 2.1, the GAO guide’s best practices are listed and briefly described, and in Section 2.2 these requirements are further codified into requirements for the IceCube Upgrade Project Management Toolset.

2.1 Overview of GAO Schedule Best Practices

From (1), the ten best practices for project schedules are listed and briefly described below.

- 1. Capturing all activities**

The schedule should contain all activities needed to achieve the project’s WBS.

- 2. Sequencing all activities**

The project management scheduling tool should support the sequencing of all activities; that is support the dependencies between activities so that activities are logically ordered from start to finish. This means all tasks should be logically linked with predecessors and successors. Date constraints, lags, and leads should be minimized and justified.

- 3. Assigning resources to all activities**

The schedule activities must be loaded with all necessary resources to complete the activities: labor, materials, travel, etc.

- 4. Establishing the duration of all activities**

The schedule should be comprised of activities with limited durations; the duration length should be consistent with useful reporting for progress measurement.

- 5. Verifying that the schedule can be traced horizontally and vertically**

Activities in the schedule should be horizontally traceable, meaning tasks are linked from left to right. Vertical traceability means that higher level activities are consistent with lower level activities.

- 6. Confirming that the critical path is valid**

The schedule should identify the critical path, which determines the project’s early finish dates and the activities that determine the longest path to the project’s early finish date. These activities are the critical ones for management to monitor.

- 7. Ensuring a reasonable total float**

The total float should be identifiable in the schedule. A reasonable total float takes into account the duration uncertainty of tasks, especially those tasks along the critical path.

- 8. Conduct a schedule risk analysis**

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Reviewing the probability of the schedule being met given project risks.

9. Updating the schedule using actual progress and logic

Project progress and logic updates are made regularly and compared to the project's baseline.

10. Maintaining a baseline schedule

The project is measured against the project baseline. Cost and schedule variances are reported against the project baseline.

Requirements for a mid-scale project from the NSF Research Infrastructure Guide (2) includes the following:

EVMS Requirements: Define control accounts based on the project's Work Breakdown Structure and Organization Breakdown Structure. The control accounts should be at the "...WBS level that suits the management needs" (section 6.8.5.3 of the NSF RIG). For the IceCube Upgrade Project, the control accounts are typically at L4 of the WBS. The planned work, the actual work, the planned costs, and the actual costs are collected at this level of detail.

Change Control: Major changes to the project plan should be implemented with change control and incorporated into the performance measurement baseline through the established change control process. The Project has a change control process and a change control log. We anticipate updating the change control procedure to include updates to the project management baseline and the project management tools must support these changes to the baseline.

Risk Assessment: The project is responsible for doing a comprehensive risk assessment and maintaining a risk register. A risk Monte Carlo is not needed for a mid-scale project.

2.2 Overview of the requirements of the Project Management Tools

From the discussion of requirements and best practices above, a table of requirements of the Project Management Software is shown in Figure 1.

Requirements	
Scheduling Tool	
S.1	Support task dependencies (i.e. predecessor / successor dependencies) and task durations
S.2	Support milestones.
S.3	Support critical path analysis
S.4	Support resource loading (personnel / equipment)
S.5	Support named / critical resources. Flag when these resources are overcommitted
S.6	Horizontally and vertically traceable
EVMS Tool	
E.1	Support Task Status Reporting
E.2	Support calculation of schedule & cost variances against a project baseline cost and schedule (e.g. SPI / CPI) at an appropriate WBS level.
E.3	Support spending and resource profiles by funding source.
General	

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G.1	Must have mechanism for CAMS to update task status while maintaining the project baseline
G.2	Should have user-friendly views / outputs in order to monitor how the project is doing in terms of cost and schedule (e.g. SPI/CPI dashboards)
G.3	Must be backed up regularly.
G.4	Must support interfacing with NSF 1030 forms
Risk	
R.1	Must maintain a risk register that contains budget and schedule risk impacts, date or trigger to implement or retire, and responsible person, (Note that Monte Carlo risk analysis is <i>not</i> a requirement for mid-range projects)

Table 1 Requirements for a complete Project Management Toolset for a mid-sized NSF project. Column 1 numbers the requirements for later reference, and column 2 briefly describes the requirement.

3. IceCube Upgrade Project Management Tools

3.1 Overview of tools

The IceCube Upgrade Project uses several different tools to meet the requirements from Section 2. This section reviews the different tools and details how they meet the requirements. Section 3.1.1 shows an overview of how the tools work together, and the following Sections show some details of the tools.

3.1.1 Introduction

Figure 1 shows an overview of the project management toolset needed for Earned Value monitoring. The workhorse of the toolset is the SmartSheet (3) platform. The project schedule, containing tasks, durations, and dependencies is contained in the “Upgrade Project Schedule” smartsheet. The resources and costs are contained in the “Cost Database” SmartSheet. The Actual Cost of Work Performed (ACWP) for each task comes from the UW Accounting system, and from the US Subawards PIs.

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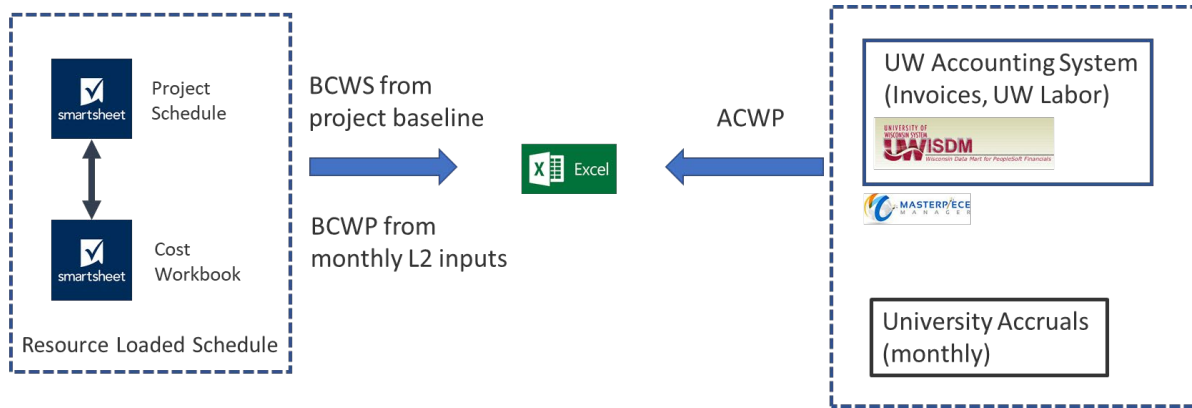


Figure 1 Overview of the Upgrade EVMS system showing the various project management tools being use.

Risk management is performed outside of the project schedule and cost workbook. The risk register is implemented in excel and described in the Project’s Risk Management Plan (4). Information from the Risk Register is used in a Monte Carlo to assess the overall cost exposure created by the collection of risks.

3.1.2 SmartSheets

An overview of SmartSheet capabilities, with respect to the requirements in the previous section is shown in Table 2. In the next sections, we detail how SmartSheets supports each of these requirements.

	Critical Requirements	
S.1	support task dependencies (i.e. predecessor / successor dependencies) and task durations.	Yes
S.2	support milestones (i.e. zero duration tasks)	Yes
S.3	support critical path analysis.	Yes*
S.4	support resource loading (personnel / equipment)	Yes
S.5	support named / critical resources. Flag when these resources are overcommitted.	Yes*
E.1	allow task statusing	Yes
E.2	support calculation of schedule & cost variances against a project baseline cost and schedule	Yes
E.3	support spending and resource profiles by funding source	Yes
G.1	mechanism for CAMS to update task status and actual costs while maintaining the project baseline.	Yes
G.2	user-friendly views / outputs in order to monitor how the project is doing in terms of cost and schedule.	Yes
G.3	backed up regularly.	Yes (cloud based)

Table 2 List requirements and smartsheets capabilities. Items marked with * require some manual intervention.

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3.1.2.1 Task dependencies, milestones, and critical path analysis (S1, S2, S3)

Figure 2 shows a simplification of part of the Upgrade schedule showing the task dependencies and milestones for the Digital Optical Modules (mDOMs). This snippet represents a technically driven schedule, with the yellow float bars highlighting the amount of float between modules ready to ship, and the module ship date from the Required On Site (ROS) dates. Arrows run from the successors to the predecessors. Durations are shown in the length of activity bars.

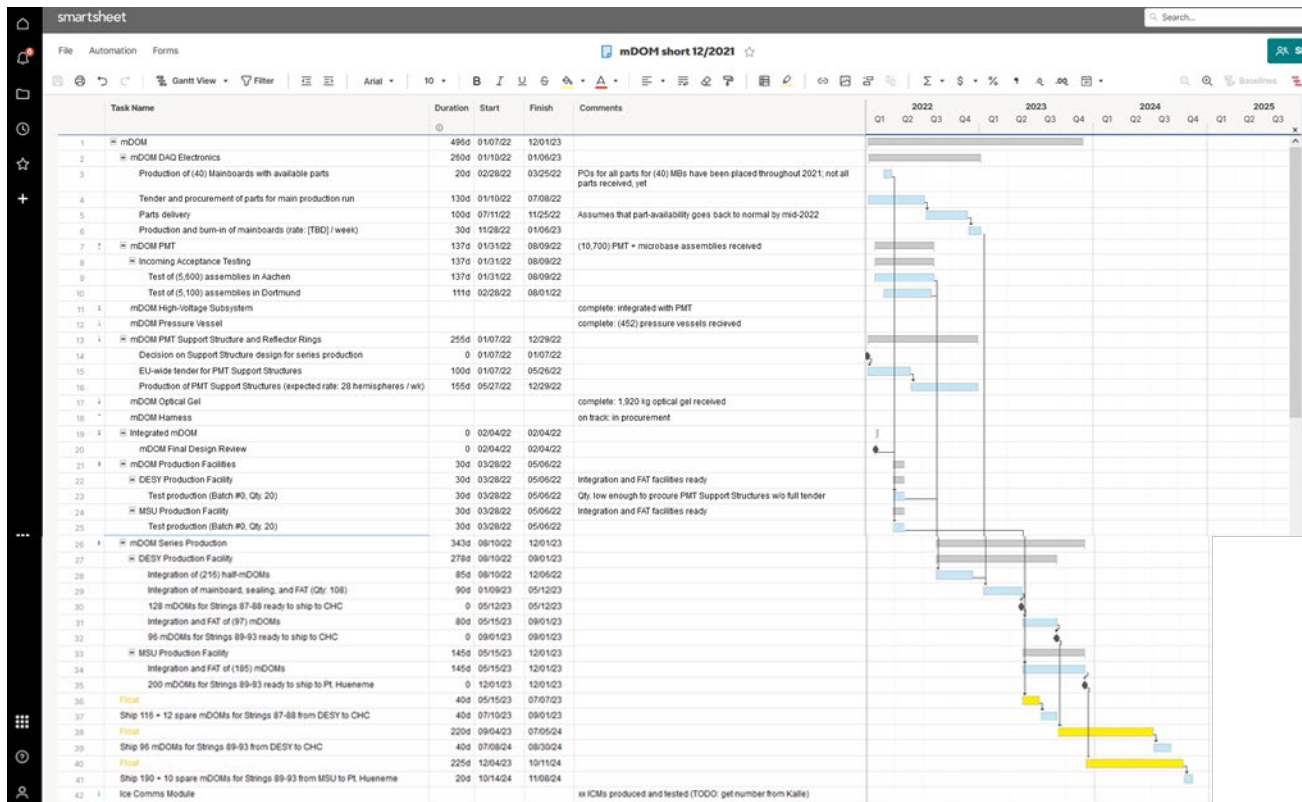


Figure 2 Snippet of the Integrated Master Schedule showing an overview of the mDOM tasks. The yellow boxes represent the float to shipping dates.

Figure 3 shows the same snippet with the critical path function turned on. Activities on the critical path are highlighted in red. In this case, the critical path runs through the mainboard electronics production.

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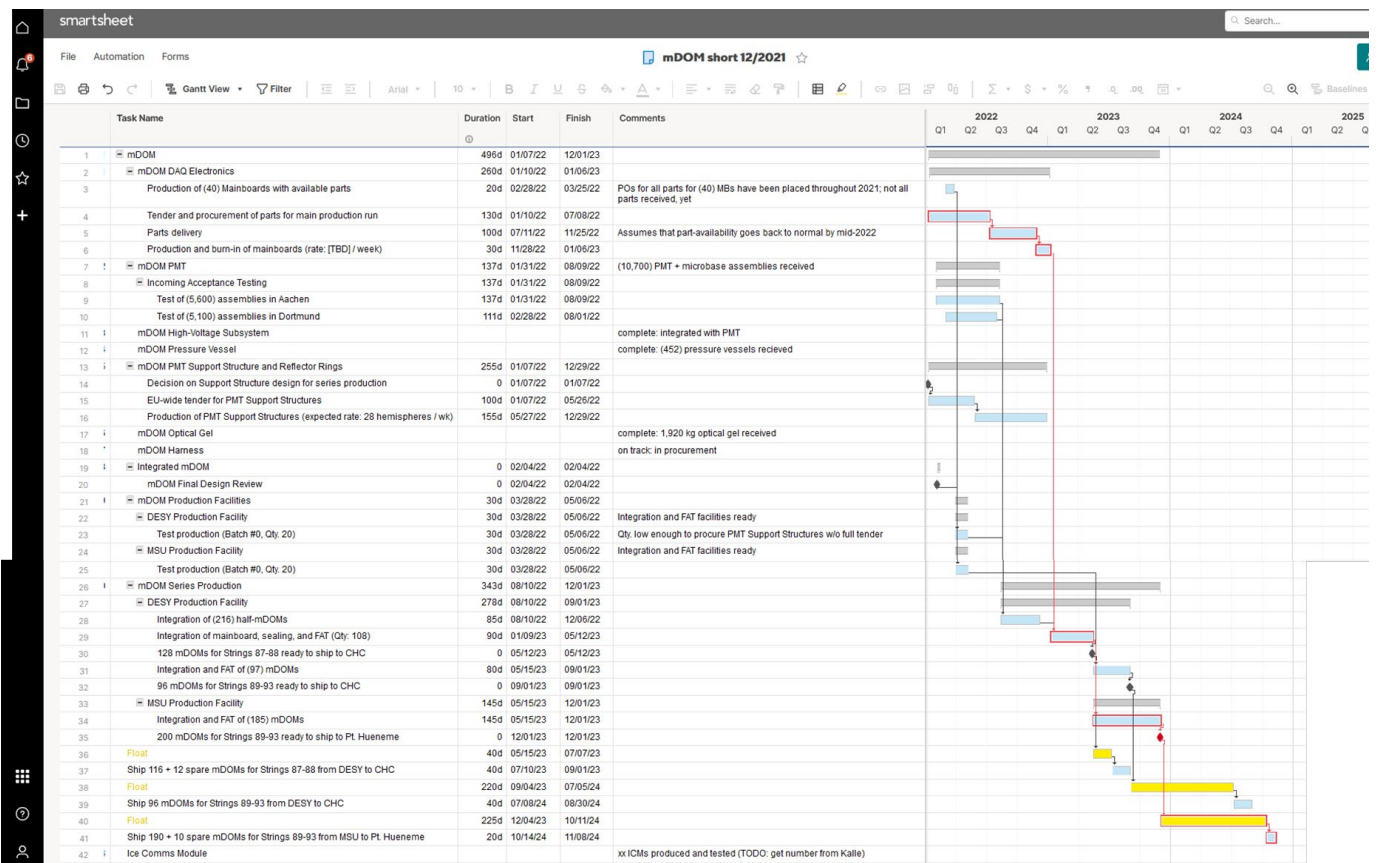


Figure 3 Same schedule snippet as previous figure showing the critical path. In smartsheets, the critical path is highlighted by clicking on the "critical path" tool in the tool bar.

3.1.2.2 Resource loading, support of named or critical resources

Resource loading of the smartsheet schedule is done with a "Cost Workbook" smartsheet. The schedule and the cost workbook are linked together such that moving the activities in the schedule highlights the resources that must be moved to match the schedule. These resources are then moved by hand in the cost workbook.

3.1.2.3 Task statusing, interface with CAMS

The L2's interface directly into the schedule every month and update the % complete column. This allows the calculation of earned value.

3.1.2.4 Calculation of variances against project baseline

Actual values from the UW accounting system are put into a spreadsheet and compared with the planned values from the schedule updates in the previous section in order to calculate variances.

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Estimated values (accruals) are gotten from each of the partner institutions, and are replaced by invoiced amounts once the invoices are logged into the UW accounting system.

The monthly EVM cycle has the Level 2's updating the % complete by the 4th of the month, the collection of actuals by project controls by the 8th of month, and the calculation of variances by the 10th of month, when the report is also finalized.

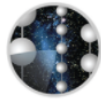
3.1.2.5 Backups

Smartsheets supports a cloud-based backup for all files. Additionally, project controls saves both the schedule and the cost workbook monthly, after updates for the monthly report.

3.1.2.6 User friendly Views and Outputs

Dashboards allow for user friendly views into the cost and schedule smartsheets. The L2's each have a dashboard to help them enter % complete each month by highlighting upcoming tasks, tasks already started, and tasks behind schedule.

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ICECUBE
SOUTH POLE NEUTRINO OBSERVATORY

Upgrade Proj...
PC Updates



All Project Elements included

WBS	Task	Target	% Complete	Status
1.1	Project Office	53%	57%	Green
1.2	Implementation (EHWD Drill Refurbishment, Dr	96%	63%	Yellow
1.3	Sensors	95%	79%	Yellow
1.4	CPT	83%	55%	Red
1.5	Characterization and Calibration System	28%	57%	Green
1.6	IceCube Data Systems Integration	96%	41%	Yellow

NSF Upgrade Funding Project Elements Only

WBS #	Earned Value (EV)	Percent Complete
1	\$12,182,617	56%
1.1	\$3,398,438	56%
1.2	\$8,053,410	56%
1.3	\$923,788	73%
1.4	\$1,109,513	60%
1.5	\$76,464	21%
1.6	\$923,005	52%

Update Instructions

10/31/21
Reporting Date

L2	Red	Yellow
1.1	2	4
1.2	167	32
1.3	139	16
1.4	113	12
1.5	24	8
1.6	32	13

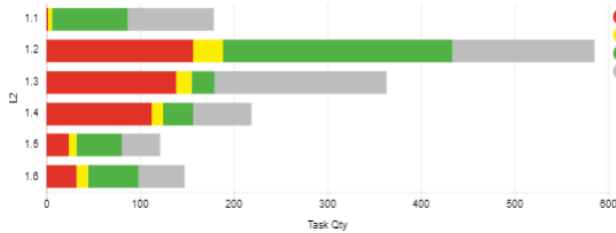
- 1.1 Dashboard
- 1.2 Dashboard
- 1.3 Dashboard
- 1.4 Dashboard
- 1.5 Dashboard
- 1.6 Dashboard

Total Tasks

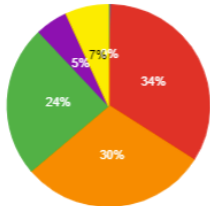
- 1
- 1
- 6
- 2
- 34
- 3
- 162
- 4
- 591
- 5
- 631
- 6
- 215
- 7
- ∞

Status Codes:

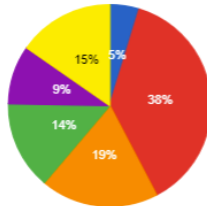
- Green: Up to 5% Variance
- Yellow: 5-20%
- Red: Greater than 20%



Red Items



Yellow Items



L2	Red	Yellow
1.1	2	4
1.2	167	32
1.3	139	16
1.4	113	12
1.5	24	8
1.6	32	13

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🕒 1.4 Dashboard ☆

WBS	Task	Target	% Complete	Status
1.1	Project Office	53%	57%	🟢
1.2	Implementation (EHWD Drill Refurbishment, Dr	69%	83%	🟡
1.3	Sensors	95%	79%	🟡
1.4	CPT	83%	55%	🔴
1.5	Characterization and Calibration System	26%	57%	🟢
1.6	IceCube Data Systems Integration	59%	41%	🟡

10/31/21

Reporting Date

📅
PC Updates

L2	Red	Yellow
1.1	2	4
1.2	157	32
1.3	139	18
1.4	113	12
1.5	24	8
1.6	32	13

📅 Upgrade Project Schedule Year 3

1.4 Overdue Tasks

L2	WBS	Task	Start Date	End Date	Target	% Complete	Status	Status No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	
1.4	1.4	CPT	11/14/18	09/29/23	83%	55%	🔴																
1.4	1.4.1	Downhole Cable Assemblies	11/14/18	11/30/21	98%	62%	🔴																
1.4	1.4.1.1	Main Cable Assembly	11/14/18	09/30/21	98%	51%	🔴																
1.4	1.4.1.1.2	Final Design Phase	02/24/20	10/30/20	100%	77%	🔴																
1.4	1.4.1.1.2.2	Main cable breakout design	02/24/20	04/03/20	100%	50%	🔴																
1.4	1.4.1.1.2.3	Final Design Review and procurement specification	04/08/20	05/29/20	100%	85%	🟡																
1.4	1.4.1.1.2.4	Main Cable Design Complete	10/30/20	10/30/20	100%	0%	🔴																
1.4	1.4.1.1.3	Main Cable Production	06/01/20	09/16/21	95%	7%	🔴																
1.4	1.4.1.1.3.1	Procurement	06/01/20	07/10/20	100%	80%	🟡																
1.4	1.4.1.1.3.2	Production of first-run cable	07/13/20	04/02/21	93%	0%	🔴																
1.4	1.4.1.1.3.2.1	Fabrication	07/13/20	10/30/20	95%	0%	🔴	Triplets pro															
1.4	1.4.1.1.3.2.2	First-run Main Cable Delivered for Evaluation	02/01/21	02/01/21	100%	0%	🔴																
1.4	1.4.1.1.3.2.3	Electrical verification	11/02/20	11/13/20	92%	0%	🔴																
1.4	1.4.1.1.3.2.4	Comms and RapCal pulse verification testing	11/16/20	12/11/20	93%	0%	🔴																
1.4	1.4.1.1.3.2.5	Iteration on design and fabrication methods	11/13/20	04/02/21	92%	0%	🔴																
1.4	1.4.1.1.3.2.6	Production Readiness Review	04/02/21	04/02/21	92%	0%	🔴																
1.4	1.4.1.1.3.3	Manufacturing	04/02/21	09/16/21	93%	0%	🔴																

1.4 Full List

L2	WBS	Task	Start Date	End Date	Target	% Complete	Status	NSF Upgrade Funding	Critical	Milestone	Comments
1.4	1.4	CPT	11/14/18	09/29/23	83%	55%	🔴	📌			
1.4	1.4.1	Downhole Cable Assemblies	11/14/18	11/30/21	98%	62%	🔴	📌			
1.4	1.4.1.1	Main Cable Assembly	11/14/18	09/30/21	98%	51%	🔴	📌			
1.4	1.4.1.1.1	Preliminary Design Phase	11/14/18	12/31/19	100%	100%	🟡	📌			
1.4	1.4.1.1.1.1	Main Cable RFI	11/14/18	11/15/18	100%	100%	🟡	📌			
1.4	1.4.1.1.1.2	Site visits to potential vendors	11/26/18	04/01/19	100%	100%	🟡	📌			
1.4	1.4.1.1.1.3	Procurement of sample quads	07/01/19	12/31/19	100%	100%	🟡	📌			
1.4	1.4.1.1.1.4	Evaluation of sample quads	03/01/19	07/01/19	100%	100%	🟡	📌			
1.4	1.4.1.1.2	Final Design Phase	02/24/20	10/30/20	100%	77%	🔴	📌			
1.4	1.4.1.1.2.1	Review main cable requirements	03/02/20	04/03/20	100%	100%	🟡	📌			
1.4	1.4.1.1.2.2	Main cable breakout design	02/24/20	04/03/20	100%	50%	🔴	📌			
1.4	1.4.1.1.2.3	Final Design Review and procurement specification	04/08/20	05/29/20	100%	85%	🟡	📌			

3.1.2.7 Backups

The smart sheets used for each monthly report are archived and saved, as well as before and after any implemented change request.

3.1.3 Risk Register and Risk analysis

The risk register is in excel and is reviewed at least quarterly (see Upgrade Risk Management Plan). In order to analyze the risks, the @risk Monte Carlo program is used as described in the Risk Management Plan.

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4. Summary / Conclusion

4.1 Summary

The IceCube Upgrade project uses a suite of software for managing the project, including SmartSheets, Excel, and @risk. This set of software allows the project to address all requirements for a mid-size project.

It should be noted that the full project scope is fairly simple and occupies approximately 3400 lines in the smart sheet schedule and 2000 lines in the smartsheet cost workbook.

References

1. **Office, U.S. Government Accountability.** *Schedule Assessment Guide: Best Practices for Project Schedule.* 2015. GAO-16-89G.
2. **National Science Foundation.** *Research Infrastructure Guide.* 2021.
3. **Smartsheet®.** <https://www.smartsheet.com/>. [Online]
4. **IceCube Upgrade Project.** *The IceCube Upgrade Project Risk Management Plan.*









IceCubeUpgrade_PMTToolsV2.0

Final Audit Report

2022-04-12

Created:	2022-04-11
By:	Mike Zernick (zernick@wisc.edu)
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