

Basis of Estimate

1. **WBS ID** 1.6 \$1,031,425 total for this WBS

2. **WBS Name** IceCube M&O Data Systems Integration

3. **Estimated by** Erik Blaufuss (University of Maryland)

4. WBS Dictionary Description

This element is responsible for the seamless integration of all new systems from the IceCube upgrade project into the existing IceCube detector maintenance and operations structures. This includes integration with online software systems, databases, offline software components, simulation software packages, and computing infrastructure needed to support this effort.

5. Assumptions and Related Documents

The estimates described in this document rely on the following assumptions, which are consistent with the Project’s “Key Assumptions” document” (1) and the “Cost Estimating Plan” (2).

- The cost estimate technique classifications (A-L) follow the US Government Accountability Office (GAO) best practices. These are summarized in the Project’s Key Assumptions document (1). The techniques are: A=Analogy; C=Engineering build-up; D=Expert opinion; E=Extrapolation from actuals; F=Parametric; L=Learning Curves.
- Contingency codes are assigned to each item: C1—C8. These reflect the estimated uncertainty in the estimate. The meanings of the contingency codes and the percentage of contingency in each case are described in the Key Assumptions document (1).

6. Scope

The scope of this BOE covers the following L3/4 areas:

1.6.0	Task Management	L2/L3 management support for WBS element
1.6.1.4	OM Software	Provide OM resident software for testing, calibration, and data collection for all types of OMs.
1.6.1.6	OM Firmware	Provide OM resident firmware for testing, calibration, and normal (in-ice) data collection for all types of OMs
1.6.4.2	SPS computing needs	Provide computing and networking hardware and OS/admin support for the integration of new optical sensors and calibration devices in the ICL at South Pole.

Basis of Estimate

7. Materials, Supplies, Equipment, Travel

7.1. Procurement of Materials, Supplies, Equipment

M&S supplies, plus some small amount of capital equipment in the form of some rack-mounted servers for DAQ needs at Pole at for the northern test systems are included here.

PQ travel and outfitting costs for 3 South Pole deployments are included.

Misc Supplies for support of computing installations at NTS and at South Pole are included (\$500/yr)

Capital purchases are limited to a handful of rack-mounted servers to host data acquisition processes at NTS and at South Pole. These estimates are based on actual purchases made in support of IceCube M&O efforts. A supporting quote from a recent South Pole computing purchase of similar models is attached below. Higher than expected inflation rates seen recently (2022) have increased the contingency risk code for these items.

7.2. Summary of Materials, Supplies, and Equipment Resources

WBS	M&S/Equipment Activity	SubType	FY23	FY24	FY25	FY26	Institution	GAO Estimation Technique	Base Year of Estimate	Contingency Code
1.6.0	PQ process - all L3 areas	M & S	\$0	\$950	\$950	\$0	UW	E - Extrapolation from Actuals	FY22	C1
1.6.0	PQ process - all L3 areas	M & S	\$0	\$0	\$950	\$0	UMD	E - Extrapolation from Actuals	FY22	C1
1.6.1.4.3.11	Prepare and ship SPAT toolset to Pole	M & S	\$0	\$7,500	\$0	\$0	UW	D - Expert Opinion	FY22	C2
1.6.4.0	Miscellaneous supplies	M & S	\$500	\$500	\$0	\$0	UW	E - Extrapolation from Actuals	FY22	C1
1.6.4.0	NTS computing system purchase	CapEx	\$0	\$0	\$2,500	\$0	UW	E - Extrapolation from Actuals	FY22	C3
1.6.4.0	Miscellaneous supplies	M & S	\$0	\$0	\$500	\$0	UW	E - Extrapolation from Actuals	FY22	C1
1.6.4.0	SPS computing system additions	CapEx	\$0	\$0	\$12,000	\$0	UW	E - Extrapolation from Actuals	FY22	C3

Basis of Estimate

7.3. Travel

This table comes from cost workbook and are based on domestic and polar deployment travel costs from the Key Assumptions documents. Travel for in-person reviews for L2/L3 personnel, and to NTS for concentrated work on integration of new devices into testing system are expected.

WBS	Travel Activity	FY23	FY24	FY25	FY26	Institution	GAO Estimation Technique	Contingency Code
1.6.0	Travel to annual project reviews	\$3,600	\$3,600	\$1,800	\$0	UMD	E - Extrapolation from Actuals	C1
1.6.0	Travel to project planning workshops and meetings	\$1,800	\$0	\$0	\$0	UMD	E - Extrapolation from Actuals	C1
1.6.0	Deployment to Pole - all L3 areas	\$0	\$1,800	\$1,800	\$0	UW	E - Extrapolation from Actuals	C1
1.6.0	Deployment to Pole - all L3 areas	\$0	\$0	\$1,800	\$0	UMD	E - Extrapolation from Actuals	C1
1.6.1.0	Travel to project planning workshops and meetings	\$1,800	\$1,800	\$1,800	\$0	UW	E - Extrapolation from Actuals	C1
1.6.1.0	Travel to NTS for new OM integration work	\$1,800	\$0	\$0	\$0	UW	E - Extrapolation from Actuals	C1
1.6.1.0	Travel to NTS for new calibration device integration work	\$0	\$1,800	\$1,800	\$0	UW	E - Extrapolation from Actuals	C1
1.6.1.0	Travel to NTS for OM integration work	\$0	\$1,800	\$1,800	\$0	UW	E - Extrapolation from Actuals	C1
1.6.4.0	Trip to MSU to install NTS equipment	\$0	\$0	\$1,800	\$0	UW	E - Extrapolation from Actuals	C1

8. Labor

8.1. Labor Estimate

The estimates to complete each tasks are estimated by IceCube M&O experts based on experience with the current IceCube DOM and DAQ systems developed over more than a decade of operational experience. Contingency codes for each item reflect the maturity and level of detail known to be in work plan item.

8.2. Summary of Labor Resources

This table comes from cost workbook. On project labor efforts focus on development of Upgrade specific software for the OM devices and calibration devices being constructed for the IceCube Upgrade. A large

Basis of Estimate

majority of the IceCube online software effort, and offline software efforts are supported by in-kind contributions from IceCube M&O and the IceCube collaboration.

WBS	Labor Activity	FY23	FY24	FY25	FY26	Institution	GAO Estimation Technique	Contingency Code
1.6.0	L2 Task management - Erik Blaufuss	264	264	264	132	UMD	E - Extrapolation from Actuals	C1
1.6.1.0	L3 Task Management - Jim Braun	96	96	96	48	UW	E - Extrapolation from Actuals	C1
1.6.1.4.3.10	Prototype and test SPAT testing software at NTS	0	240	0	0	UW	D - Expert Opinion	C3
1.6.1.4.3.11	Prepare and ship SPAT toolset to Pole	0	135	0	0	UW	D - Expert Opinion	C2
1.6.1.4.3.13	SPAT testing preparation and execution at Pole FS2	0	0	450	0	UW	D - Expert Opinion	C2
1.6.1.4.3.15	SPAT testing preparation and execution at Pole FS3	0	0	0	450	UW	D - Expert Opinion	C2
1.6.1.4.3.8	Support OM testing app thru FAT testing cycles	540	0	0	0	UW	D - Expert Opinion	C1
1.6.1.4.3.9.1	Extend OM testing app to include support for MMB based special devices	440	0	0	0	UW	D - Expert Opinion	C4
1.6.1.4.3.9.2	Support OM testing app thru calibration device DVT and FAT testing	280	450	0	0	UW	D - Expert Opinion	C2
1.6.1.4.5.4.3	Extend xDOMapp to include support for calibration devices in operations	90	335	0	0	UW	D - Expert Opinion	C4
1.6.1.4.5.6	Support full DAQ testing with xDOMapp at NTS/SPTS with Calibration devices	0	0	110	65	UW	D - Expert Opinion	C2
1.6.1.4.5.8	Support xDOMapp through SPAT testing and deployment	0	0	300	60	UW	D - Expert Opinion	C2
1.6.1.4.6.5	Support MMB-xDOMapp software for calibration devices	180	540	90	0	UW	D - Expert Opinion	C2
1.6.1.6.6	Firmware device maintenance and support for all OM devices during DAQ Development	180	96	96	48	PSU	D - Expert Opinion	C3
1.6.4.0	L3 Task management - Ralf Auer	0	0	72	48	UW	E - Extrapolation from Actuals	C1
1.6.5.0	L3 Task Management	0	0	72	48	UMD	E - Extrapolation from Actuals	C1

9. References

- [Ref-1] 1. **IceCube Upgrade Project.** Key Assumptions for the IceCube Upgrade Project. [Online] https://uwprod.sharepoint.com/:b:/r/sites/icecubeupgrade/PY4%20Rebaseline%20Documents/Project%20Execution%20Docs/CEP_and_KA/IceCubeGen2_KeyAssumptionsv-Upgrade_v1_10.pdf?csf=1&web=1&e=hq0of2.
- [Ref-2] 2. —. Cost Estimating Plan. [Online] https://uwprod.sharepoint.com/:b:/r/sites/icecubeupgrade/PY4%20Rebaseline%20Documents/Project%20Execution%20Docs/CEP_and_KA/IceCube%20Upgrade%20CEPv4_7.pdf?csf=1&web=1&e=Jg6PiU.

Basis of Estimate

Revision History

Date	Revised by	Summary of changes
2021-12-28	Farshid Feyzi	First version created
2021-12-30	Marek Rogal	Added Tables
2022-01-07	V. O'Dell	Did some cleanup
2022-03-02	E. Blaufuss	Updated 1.6 values based on current PY5-8 workplans.
2022-03-29	E. Blaufuss	Updated 1.6 values based on current PY5-8 workplans changes.
2022-04-6	E. Blaufuss	Added computing quote as supporting info.

Dell quote from recent South Pole Computing purchase of DAQ servers.

Subtotal:	\$12,350.40
Shipping:	\$0.00
Environmental Fees:	\$0.00
Estimated Tax:	\$0.00
Total:	\$12,350.40

Group 2 - Group 1

Shipping Contact: ACCOUNTS PAYABLE	Shipping phone: (608) 497-4400	Shipping via: DELL Standard Delivery	Shipping Address: B2B-1061 THOUSAND OAKS TRAIL ELECTRONIC INVOICING ONLY VERONA WI 53593 US
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SKU	Description	Qty	Unit Price	Subtotal
	PowerEdge R740 - [amer_r740_12248]	27	\$5,998.68	\$161,964.36
	Estimated delivery date: May 18, 2018 Contract No: 90058			