

Basis of Estimate

1. **WBS ID** 1.4.5 \$0 total cost for this WBS

2. **WBS Name** Northern Test System

3. **Estimated by** Tyce DeYoung (Michigan State University)

4. WBS Dictionary Description

This element includes design, construction and maintenance of a string-scale test facility in the Northern Hemisphere suitable for testing of DAQ software and firmware. The test facility will be remotely accessible to IceCube developers.

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” (IceCube Upgrade Project) and the “Cost Estimating Plan” (IceCube Upgrade Project, n.d.).

- 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 (IceCube Upgrade Project). 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 (IceCube Upgrade Project).

6. Scope

The scope of this BOE covers the following L3 areas:

1.4.5.1	IceCube Emulator	The labor, materials, and capital equipment required to set up compute servers, GPS receivers, etc. capable of emulating the IceCube DAQ, master clock, control systems, and CPT central infrastructure. The actual software emulating the IceCube DAQ and control systems, and the compute servers hosting this software, are the responsibility of WBS 1.6.
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1.4.5.2	Cable/Quad	The labor, materials, and capital equipment required to procure and install a downhole cable or substitute in the Northern test facility.
1.4.5.3	Dark Facility	The labor, materials, and capital equipment required to design and install a dark facility to house the sensors and calibration instruments included the Northern Test System.
1.4.5.4	NTS Operations	The labor and materials required to maintain and operate the Northern Test System after construction.

The Northern Test System (NTS) is a system integration testing intended to replicate the IceCube Upgrade systems at the South Pole. It is designed to permit testing of different Upgrade components (DOMs, FieldHubs, calibration devices, compute servers, power and timing systems, software and firmware) and their interactions in a controlled, accessible location prior to deployment at the Pole. NTS will house multiple mDOMs and DEggs, and one of each type of calibration device, in a reconfigurable system which permits testing of arbitrary combinations of devices either sharing a quad or connected to two separate FieldHubs. The facility is at room temperature. It is remotely accessible and connected via private network to the South Pole Test Facility (SPTS) at Wisconsin, replicating the network-level connections between IceCube and Upgrade systems at the Pole. NTS facilitates system testing only; acceptance testing of individual devices is conducted elsewhere, e.g. in the DOM FAT facilities.

Space, power, etc. for the NTS facility is an in-kind contribution from MSU. The FieldHubs and most DOMs and calibration devices are in-kind contributions from the institutions producing them, including DESY and Chiba. NSF project support for NTS encompasses design and construction of the facility, the computing and timing systems replicating the ICL compute environment, and procurement of the replica full-length twisted quads used to connect the surface electronics to the DOMs and other devices.

7. Materials, Supplies, Equipment, Travel

7.1. Procurement of Materials, Supplies, Equipment

There are no further materials or equipment purchases planned from PY5 onward.

7.2. Summary of Materials, Supplies, and Equipment Resources

There are no on-project materials, supplies, or equipment for this WBS element from PY5 onward. All support falls under M&O.

7.3. Travel

There is no on-project travel associated with this WBS element.

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8. Labor

8.1. Labor Estimate

There is no further on-project labor associated with this WBS element from PY5 onward.

8.2. Summary of Labor Resources

There is no on-project labor for this WBS element from PY5 onward. All labor falls under IceCube M&O.

9. References

[Ref-1] IceCube Upgrade Project. (n.d.). *Cost Estimating Plan*. Retrieved from 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

[Ref-2] IceCube Upgrade Project. (n.d.). *Key Assumptions for the IceCube Upgrade Project*. Retrieved from 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

Revision History

Date	Revised by	Summary of changes
2022-02-28	Tyce DeYoung	First version created
2022-03-09	Tyce DeYoung	Updated to reflect no on-project costs from PY5 onward
2022-04-10	Tyce DeYoung	Removed references to PY4 cost elements