IceCube Upgrade: Logistics

IceCube Upgrade NSF Rebaseline Review
April 26-28, 2022

Ian McEwen
University of Wisconsin

Speaker Bio

- IceCube Upgrade Implementation Manager (WIPAC), June 2020
- South Pole Station Operations Manager 2014-2020
  - Oversaw flight operations, fuels, equipment operations, vehicle maintenance, survey, and waste functional areas
  - Assisted SP Area Management with procedural development & emergency response planning
  - Provided planning & implementation support for wide range of science projects including SpiceCore, ARA, Bicep Upgrade, & IceCube Upgrade
  - Lead planner/leader of the South Pole Retrograde Initiative (SPRI)

- 11 Austral summer seasons at the South Pole and 2 deployments to Summit Station in Greenland
- Involved in remote operations/construction for 15 years in Northern Maine, Alaska, Greenland, and Antarctica
- Educational background: Circumpolar Studies, Engineering, Resource Management, & Automotive Technology

Outline

- Assumptions
- AIL capacities
- AIL capacity vs plan comparison
- ICU planning tools; Integrated Master Schedule & Cargo Master
- Float table
- Logistics risk analysis
- Load planning
- Responses to Logistics Review recommendations
- Conclusions

Logistics Assumptions

- ICU is on an eight-year path with:
  - No FY23 field deployment
  - Three consecutive field season beginning in FY24 and culminating with an FY26 drill season
    - An additional drill retrograde effort may be planned in an outyear (FY27) as a separate effort coordinated between NSF, the USAP contractor & WIPAC
- Stated AIL/OPP FY23-26 logistics capacities remain unchanged for the duration of ICU
- ICU delivers required cargo on-time from point of origin to USAP cargo system entry location (Port Hueneme, Littleton/Christchurch, New Zealand)
- DNF storage capacity at McMurdo & S. Pole is available
  - McMurdo DNF - Smaller DNF crates are preferred (ASC communication)
    - ICU standard 30" X 32", 40" x 48" & 45" x 48" crates or smaller preferred
  - South Pole DNF – pre-arranged storage in Cryogen Facility for 3-4 463L Air Force Pallet shipments

Logistics Capacities

ICU will ship the majority of cargo by vessel

Fuel movement impacts available ACL (Allowable Cabin Load) for cargo; max planning capacity 3000 gallons per mission

Each sled 40' in length w/ 60,000 lbs capacity
SPOT 1 arrives by 12/1
SPOT 2 arrives by 1/1
SPOT 3 arrives by 2/1

ICU Planning Capacities
OPP-AIL, 1/31/2022

Year	FY23	FY24	FY25	FY26	FY27
Vessel South (TEUs)	18*	as needed	as needed	n/a	n/a
Vessel North (TEUs)	n/a	17	50	17	50
LC-130: Hours/Flights^	12/2	114/19	60/10	42/7	36/6
SPoT-1 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-2 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-3 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
Pole Population (Nov-Jan)	0	11	21	46~	4

*If ICU needs more space to move things ahead, we will find a way to make more TEUs available.

^This does not fully meet the goal to have all fuel required on site prior to the FY26 main drilling season. AIL will continue to look at ways to mitigate that risk as planning moves forward.

~This is a hard maximum and needs to be reviewed again for ways to bring it down if at all possible.

In general:

1. Our supportability is dependent on moving as much cargo to Pole as possible in FY24. This means getting as much cargo on the FY23 vessl or, if needed, getting it to MCM via commercial surface shipment/C17 no later than Nov. 2024.
2. FY27 info is provided in advance of IPT discussion/clarification on retro requirements.
3. Temperature controlled storage (at MCM and Pole) is likely still an issue that needs to be resolved with this capacity.

TEU - **twenty-foot equivalent unit** (abbreviated **TEU** or **teu**) is an inexact unit of cargo capacity, often used for container ships and ports. It is based on the volume of a 20-foot-long (6.1 m) intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains, and trucks

Charge Question L2

OPP/AIL Logistics Capacities vs Project Requirements

Year	FY23 Capacity	FY23 Planned	FY24 Capacity	FY24 Planned	FY25 Capacity	FY25 Planned	FY26 Capacity	FY26 Planned	FY27 Capacity	FY27 Planned
Vessel South (TEU)	18	6.25	as needed	3.25	as needed	5.25	n/a	n/a	n/a	n/a
Vessel North (TEU)	n/a	-	17	.5	50	.5	17	-	50	TBD
LC-130: Flights / Cargo [lbs]	2 missions	0/0	19 missions	0.6/11,445	10 missions	2/43,103	7 missions	3.6/73,939	6 missions	TBD
LC-130: Flights / Fuel [gallons]		2/6,000		18.4/55,200		8/24,000		3.4/10,200		TBD
SPOT-1 (Sleds/lbs)	3/180,000	3/21,601	3/180,000	2/56,900	3/180,000	2.9/56,143	3/180,000	2.5/110,362	3/180,000	TBD
SPOT-2 (Sleds/lbs)	3/180,000	3/109,405	3/180,000	0/0	3/180,000	0.45/16,302	3/180,000	0/0	3/180,000	TBD
SPOT-2 (Sleds/lbs)	3/180,000	1/28,000	3/180,000	0/0	3/180,000	0/0	3/180,000	3/46,791 R	3/180,000	TBD
Pole Population (Nov-Jan)	0	0	11	11	21	21	46	46	4	TBD

Overview of Intracontinental Cargo Movement

Intracontinental leg	volume [cu ft]	weight [lbs]	# SPOT Sleds	# 263 Pallets
At South Pole	733	12,241	0.00	0.00
FY23 LC-130	0	0	0.00	0.00
FY23 SPOT 1	5,654	21,601	3.00	
FY23 SPOT 2	7,989	109,405	3.00	
FY23 SPOT 3	2,720	28,000	1.00	
FY24 LC-130	576	10,380	0.00	2.15
FY24 SPOT 1	4,119	56,900	2.00	
FY24 SPOT 2	0	0	0.00	
FY24 SPOT 3	0	0	0.00	
FY25 LC-130	3,145	39,553	0.00	9.25
FY25 SPOT 1	5,055	56,143	2.90	
FY25 SPOT 2	1,120	16,302	0.45	
FY25 SPOT 3	0	0	0.00	
FY26 LC-130	5,438	67,549	0.00	17.56
FY26 SPOT 1	3,934	110,362	2.50	
FY26 SPOT 2	0	0	0.00	
FY26 SPOT 3	0	0	0.00	
Total	**40,483**	**528,436**	**14.85**	**28.96**

DNF & Seasonal Resupply

Drill heads, drill refit components, & resupply

ICL power & timing electronics, FieldHubs, patch cables, 87 & 88 sensors/calibration/special devices, drill refit components, & resupply

89-93 sensors, calibration & special devices, breakout cables, resupply, & logging winch

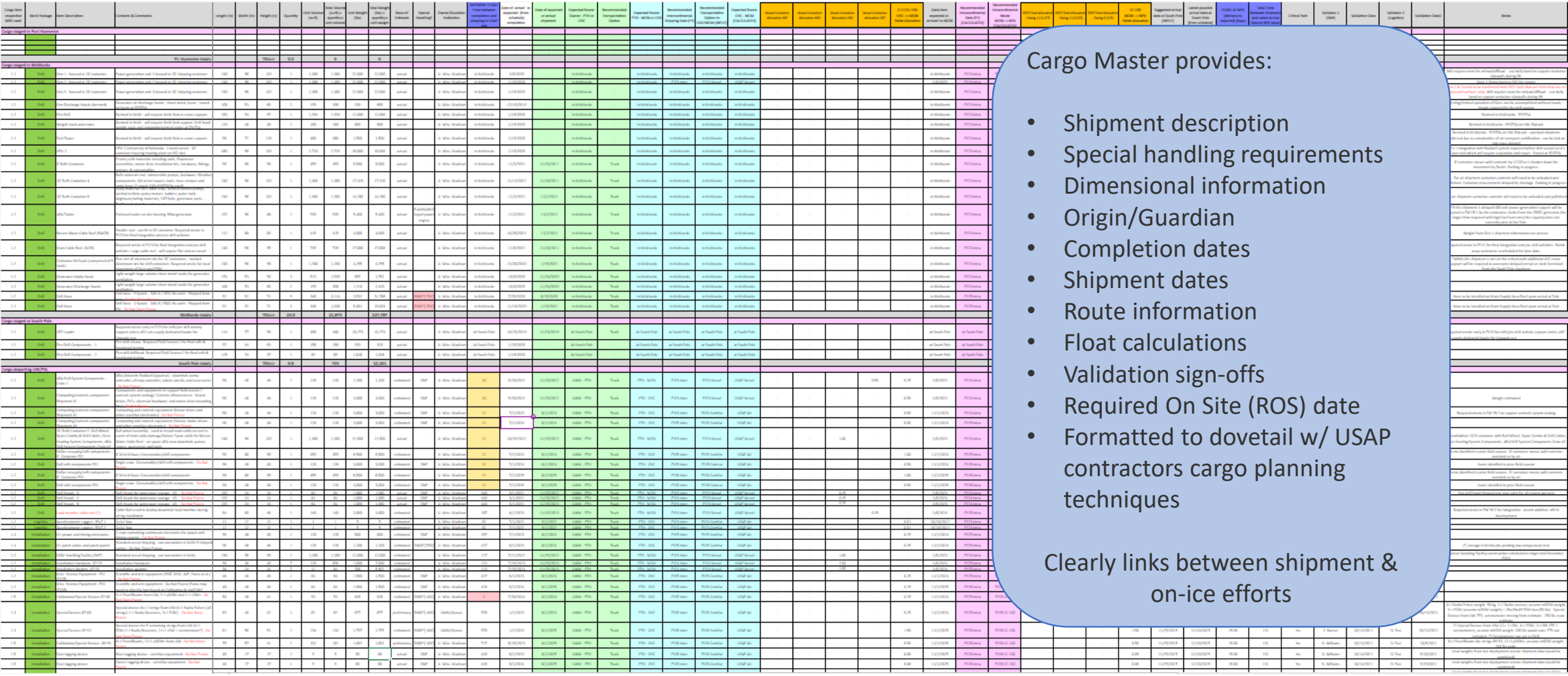
Logistics Planning Tools – Smartsheet Schedule Report/Filters

1.2	1.2.8.5	**USAP Field Season 1 (FY24)**	279d	02/01/23	02/29/24	02/01/23 8:00 AM	02/29/24 4:59 PM
1.2	1.2.8.5.1.1	McM Mainbody Season Begins (USAP)	0	10/01/23	10/01/23	10/01/23 8:00 AM	10/01/23 8:00 AM
1.2	1.2.8.5.1.2	South Pole Season Begins (USAP)	0	11/01/23	11/01/23		
1.2	1.2.8.5.1.4	Pole Season Ends (USAP)	0	02/15/23	02/15/23		
1.2	1.2.8.5.1.5	MCM Season Ends (USAP)	0	03/01/23	03/01/23		
1.2	1.2.8.5.3	USAP Cargo Movements (FY24)	70d	11/01/23	02/12/24		
1.2	1.2.8.5.3.1	Pole (USAP)	60d	11/15/23	02/12/24		
1.2	1.2.8.5.3.1.1	LC130 - Pole (USAP)	60d	11/15/23	02/12/24		
1.2	1.2.8.5.3.1.2	SPOT1 - Pole (USAP)	0	12/01/23	12/01/23		
1.2	1.2.8.5.3.1.3	SPOT2 - Pole (USAP)	0	01/01/24	01/01/24		
1.2	1.2.8.5.3.1.4	SPOT3 - Pole (USAP)	0	02/01/24	02/01/24		
1.2	1.2.8.5.3.2	**MCM (USAP)**	65d	11/01/23	02/05/24		
1.2	1.2.8.5.3.2.1	SAAM (ComSur) (USAP)	0	11/01/23	11/01/23	11/01/23 8:00 AM	11/01/23 8:00 AM
1.2	1.2.8.5.3.2.2	Vessel - MCM (USAP)	0	02/05/24	02/05/24	02/05/24 8:00 AM	02/05/24 8:00 AM
1.2	1.2.8.5.3.3	Retrograde (USAP)	0	02/05/24	02/05/24	02/05/24 8:00 AM	02/05/24 8:00 AM
1.2	1.2.8.5.3.4	Cargo Storage Support Pole and McMurdo (USAP)	0	11/01/23	11/01/23	11/01/23 8:00 AM	11/01/23 8:00 AM
1.2	1.2.8.5.4.1	Excavate EHWD & Equipment Berms for Access (USAP)	5d	11/07/23	11/13/23	11/07/23 8:00 AM	11/13/23 4:59 PM
1.2	1.2.8.5.4.2	Deliver MECC & Fuel Tank, Shop, SEW to Cryo (USAP)	3d	11/09/23	11/13/23	11/09/23 8:00 AM	11/13/23 4:59 PM
1.2	1.2.8.5.4.3	Set-up Cryo Worksite Power Feed & Fuel (USAP)	5d	11/07/23	11/13/23	11/07/23 8:00 AM	11/13/23 4:59 PM
1.2	1.2.8.5.4.5	Re-establish SES Pad, Groom & Compact Roads (USAP)	8d	11/21/23	12/01/23	11/21/23 8:00 AM	12/01/23 4:59 PM
1.2	1.2.8.5.4.6	Provide Heaters (PolarTherm) (USAP)	62d	11/15/23	02/13/24	11/15/23 8:00 AM	02/13/24 4:59 PM
1.2	1.2.8.5.4.7	Provide 287B Skidsteer & Snomo's (USAP)	1d	11/15/23	11/15/23	11/15/23 8:00 AM	11/15/23 4:59 PM
1.2	1.2.8.5.4.8	Provide Fire Extinguishers (USAP)	1d	11/15/23	11/15/23	11/15/23 8:00 AM	11/15/23 4:59 PM
1.2	1.2.8.5.5.1	Receive & Set Gen 2 on Skis with Crane (USAP)	1d	12/01/23	12/01/23	12/01/23 8:00 AM	12/01/23 4:59 PM
1.2	1.2.8.5.5.2	Generators 1, 2, 3 & PDM Delivered to Cryo (USAP)	0	12/01/23	12/01/23	12/01/23 4:59 PM	12/01/23 4:59 PM
1.2	1.2.8.5.5.3	CRELL Gen Delivered to Cryo (USAP)	0	11/22/23	11/22/23	11/22/23 4:59 PM	11/22/23 4:59 PM
1.2	1.2.8.5.5.4	Prepare CRREL Gen for Firn Drill Testing (USAP)	5d	12/05/23	12/11/23	12/05/23 8:00 AM	12/11/23 4:59 PM
1.2	1.2.8.5.5.8	Install 3rd Disconnect on PDM (USAP)	2d	12/04/23	12/05/23	12/04/23 8:00 AM	12/05/23 4:59 PM

SmartSheet export example:

- USAP task interface
- Integrated Master Schedule sorted for USAP tasks to facilitate on-ice contractor support coordination

Logistics Planning Tools – Cargo Master



Cargo Master provides:

- Shipment description
- Special handling requirements
- Dimensional information
- Origin/Guardian
- Completion dates
- Shipment dates
- Route information
- Float calculations
- Validation sign-offs
- Required On Site (ROS) date
- Formatted to dovetail w/ USAP contractors cargo planning techniques

Clearly links between shipment & on-ice efforts

Float Tables

Item description	Special Handling?	SHIPMENT FLOAT: Time between completion and ship-by-date to USAP	FLOAT AT NPX (delivery to required) [days]	Total Time Between Ship-By-Date and Latest Arrival Date at NPX [days]
ARA Drill System Components - Crate #1	DNF	30	16	412
Computing/controls components Shipment #1	DNF	14	0	396
Computing/controls components Shipment #2	DNF	31	0	106
Computing/controls components Shipment #3	DNF	31	0	106
20' Refit Container C: Bull Wheel, Spare Combo & Drill Cables, Hose Heating System Components, ARA Drill System Components Crate #2	-	31	418	830
Driller resupply/refit components - 8' Container FS2	-	31	0	106
Drill refit components FS2	DNF	31	0	106
Driller resupply/refit components - 8' Container FS3	-	31	0	106
Drill refit components FS3	DNF	31	0	106
Drill Heads - X	DNF	409	648	1127
Drill Heads - Y	DNF	409	648	1127
Drill Heads - R	DNF	409	648	1127
Load member cable reel [placeholder, may not be required]	-	136	151	595
Accelerometer Loggers SPoT 1	-	62	0	91
Accelerometer Loggers SPoT 2	-	62	0	122
ICL power and timing electronics	DNF	462	1	122
ICL patch cables and patch panels	DNDF [TBD]	624	1	122
DOM Handling Facility (DHF)	-	50	368	780
Installation Hardware 87-93	-	97	321	765
Installation Weights 87-93	-	110	321	765
Misc. Science Equipment - FS2 (FY25)	DNF	50	1	122
Misc. Science Equipment - FS3 (FY26)	DNF	25	16	122
Calibration/Special Devices 87-88	DNDF [-40C]	2	13	149
Special Devices 87-88	DNDF [-40C]	2	13	149
Special Devices 89-93	DNDF [-40C]	61	15	131
Calibration/Special Devices 89-93	DNDF [-40C]	61	15	131
Dust logging device	DNF	61	15	131

Item description	Special Handling?	SHIPMENT FLOAT: Time between completion and ship-by-date to USAP	FLOAT AT NPX (delivery to required) [days]	Total Time Between Ship-By-Date and Latest Arrival Date at NPX [days]
Dust logging device	DNF	61	15	131
Dust logging device	DNF	61	15	131
Dust logging device	DNF	61	15	131
Logging winch	0	61	15	131
Logging winch control box	DNF	61	15	131
Surface Junction Boxes	-	2	380	792
Surface Cable Assemblies	DNDF [-55C]	106	14	792
Breakout cables for strings 87-88	DNDF[-40C](*)	477	298	421
Breakout cables for strings 89-93	DNDF[-40C](*)	379	15	421
Main (downhole) load members 87-93 [placeholder, may not be required]	DNDF[-40C](*)	563	1	413
Main (downhole) cables 87-93	DNDF[-40C](*)	31	1	779
String Sensors 89-93 (mDOMs MSU)	DNDF [-40C]	68		
String Sensors 89-93 (mDOMs MSU)	DNDF [-40C]			
DM-Ice	DNDF [-40C]			
String Sensors 87-88 (mDOMs DESY)	DNDF [-40C]			
String Sensors 87-88 (mDOMs DESY)	DNDF [-40C]			
Special Devices 87-88 (Europe)	DNDF [-40C]			
Calibration Devices 87-88 (Europe)	DNDF [-40C]			
FieldHub electronics	DNF			
String Sensors 89-93 (mDOMs DESY)	DNDF [-40C]			
Special Devices 89-93 (Europe)	DNDF [-40C]			
Calibration Devices 89-93 (Europe)	DNDF [-40C]			
String Sensors 87 & 88 (D-Eggs-	DNDF [-40C]			
String Sensors 87 & 88 (D-Eggs-	DNDF [-40C]			
String Sensors 87 & 88 (D-Eggs-12x)	DNDF [-40C]			
String Sensors 87 & 88 (D-Eggs-12x)	DNDF [-40C]			
String Sensors 89-93 (D-Eggs-8x)	DNDF [-40C]			
String Sensors 89-93 (D-Eggs-12x)	DNDF [-40C]			

Float Table:

- Generated from Cargo Master
- Provides:
  - Shipment float
  - South Pole float
  - Total time between shipment and latest South Pole arrival

Logistics Planning Tools – ICU Guidance Doc

ICU Logistics Document includes:

- Background on USAP Logistics Chain
- Logistics Overview
- Logistics Methodology
- Terminology
- QC Processes
- List of additional resources

WISCONSIN ICECUBE PARTICLE ASTROPHYSICS CENTER

IceCube Upgrade Logistics – Cargo Estimation and Shipment Planning

Document #2021-003.2

Approval

Title:	Name:	Date
Quality & Safety Manager	Mike Zernick	Oct 19, 2021
Project Manager	Farshid Feyzi	Oct 19, 2021
Implementation Manager	Ian McEwen	Oct 19, 2021

Change Log

Rev	Description : Author	Date
-	Original document: Mike Zernick/Dar Gibson	October 2020
	Ian McEwen, Delia Tosi, Dar Gibson	September 2021

222 West Washington Avenue
Telephone:+1.608.890.0548
Madison,WI53703
FAX:+1.608.262.2309
contact-us@icecube.wisc.edu

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Cargo Estimation and Shipment Planning

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ICECUBE UPGRADE

NSF

Logistics Planning Tools – Population Sheet

ICECUBE UPGRADE NPX 2025/2026 Field Season 3 - Population vs. Category Plan

Start date 11/10/2025 End date 2/4/2026

Revision: 02/27/2022

Columns in Green are Sunday - No Flights

PROJECT NUMBER	WBS	L2 Category	L3 Category	Member #	Team Members	Institution	Labor Code	Total days On Ice	Total working days	Total paid hours (November) 11/1/2025 11/30/2025	Total paid hours (December) 12/1/2025 12/31/2025	Total paid hours (January) 1/1/2026 1/31/2026	Total paid hours (February) 2/1/2026 2/28/2026	"On Ice"	"Off Ice"	Role
A-334-S	1.1	Management	Mgmt&Safety	1b	Kael Hanson	UW-Madison	MA	24	22	0	0	198	0	1/5/2026	1/29/2026	PI
A-334-S	1.1	Management	Mgmt&Safety	1a	Albrecht Karle	UW-Madison	KE	35	29	0	234	27	0	12/1/2025	1/5/2026	Assoc. Director, Icecube Science and Instrumer
A-334-S	1.1	Management	Mgmt&Safety	2	Mike Zernick	UW-Madison	MA	66	54	108	234	144	0	11/15/2025	1/20/2026	Quality & Safety Mgr
A-334-S	1.2.1	Management	Mgmt&Safety	3a	Ian McEwen	UW-Madison	SE	51	41	108	234	27	0	11/15/2025	1/5/2026	Impl. Mgr
A-334-S	1.1	Management	Mgmt&Safety	3b	Farshid Feyzi	UW-Madison	MA	24	22	0	0	198	0	1/5/2026	1/29/2026	Project Mgr
A-334-S	1.1	Management	Project Engineer	4	Perry Sandstrom	UW-Madison	SS	54	44	18						er
A-334-S	1.2.9	Implementation	Installation	1	Delia Tosi	UW-Madison	SS	75	62	108						- D1, Overall install lead
A-334-S	1.2.9	Implementation	Installation	2	TBD	TBD	IK	51	43	0						+ SME Senior (DOM INSTAL
A-334-S	1.2.9	Implementation	Installation	3	TBD	Chiba	IK	48	40	0						+ SME (DOM INSTALLER #2
A-334-S	1.2.9	Implementation	Installation	4	TBD	DESY	IK	48	40	0						+ SME (LOGBOOK)
A-334-S	1.2.9	Implementation	Installation	5	TBD	Munich	IK	48	40	0						+ SME (DOM SUPPLIER #1)
A-334-S	1.2.9	Implementation	Installation	6	Gary Hill	Adelade	IK	75	62	108						ead
A-334-S	1.2.9	Implementation	Installation	7	TBD	Chiba	IK	47	39	0						+ SME (DOM INSTALLER #1
A-334-S	1.2.9	Implementation	Installation	8	TBD	MSU	IK	47	39	0						+ SME (DOM INSTALLER #2
A-334-S	1.2.9	Implementation	Installation	9	TBD	Wuppertal/Mainz	IK	47	39	0						(LOGBOOK)
A-334-S	1.2.9	Implementation	Installation	10	TBD	TBD	IK	47	39	0						(DOM SUPPLIER #1)
A-334-S	1.4	CPT	CPT (electronics)	1a	John Kelley	UW-Madison	SC	52	42	108						
A-334-S	1.4	CPT	CPT (electronics)	1b	TBD EE	MSU	EN-EE	12	11	0						
A-334-S	1.4	CPT	CPT (cables)	2a	Chris Ng	MSU	EN-ME	47	38	72						
A-334-S	1.4	CPT	CPT (cables)	2b	Allan Hallgren	Uppsala	KE	14	13	0						
A-334-S	1.6	DAQ	ICECUBE Integration	1	Erik Blaufuss	Maryland	SS	47	40	0						Team)
A-334-S	1.6	DAQ	SPAT SME	2	Jeff Weber	UW-Madison	SE	51	41	108						nce Testing (SPAT SME)
A-334-S	1.2	Implementation	Drill	1	Dar Gibson	UW-Madison	EN-ME	84	70	144						

Population Sheet:

- Personnel by season, role, WBS
- On-ice/off-ice dates
- Work day & total on-ice duration calculations
- Bed occupancy vs. time (billet)
- Population charts
- Monthly hours crosschecked with Smartsheet hours reports

Risks - Sensitivity analysis cargo & people

Charge Question R1, R2, R5

Cargo Item #	WBS L2	Item Description	Contents	Date Item expected or *arrived* to MCM	Date/Month for Items needed at South Pole	Logistical Mode	48hrs		168hrs (1 wk)		336 hrs (2 wks)		672 hrs (4 wks)		1 week delay impact notes	2 week delay impact notes	4 week impact notes
							Probability	Estimated Cost Impact	Probability	Estimated Cost Impact	Probability	Estimated Cost Impact	Probability	Estimated Cost Impact			
1	1.2	Gen 1 - housed in 20' container	Power generation unit 1 housed in 20' shipping container	*In McMurdo*	12/1/2023	SPoT	Moderate	0	Low	12420	Low	72460					ull position add in following year overcome (505 hours)
2	1.2	Gen 2 - housed in 20' container	Power generation unit 2 housed in 20' shipping container	*2/6/2023*	12/1/2023	SPoT	Moderate	0	Low	12420	Low	72460					on add in following year come (505 hours)
3	1.2	Gen 3 - housed in 20' container	Power generation unit 3 housed in 20' shipping container	*In McMurdo*	12/1/2023	SPoT	Moderate	0	Low	40000	Low	80000					tor returns following year
4	1.2	Gen hoods Discharge Hoods	Generator air discharge hoods , sheet metal, loose - stored on berm at SPOTSA	*In McMurdo*	12/12/2023	SPoT	Moderate	0	Low	0	Low	0					
5	1.2	Firn Drill	Bermed in McM - will require McM fork or crane support.	*In McMurdo*	12/15/2023	SPoT	Moderate	0	Low	6210	Low	12420					ed labor - 216 hours
6	1.2	Weight stack and crates	Bermed in McM - will require McM fork support. Drill head weight stack and remaining bermed crates at SPoTSA	*In McMurdo*	12/1/2025	SPoT	Moderate	0	Low	0	Low	0					
7	1.2	Fuel Tower	Bermed in McM - will require McM fork or crane support.	*In McMurdo*	12/5/2023	SPoT	Moderate	0	Low	6210	Low	12410					ional driller hours
8	1.2	HPU 2	HPU 1 (University of Nebraska - Lincoln asset) - 40' container housing heating plant on ISO sled	*In McMurdo*	1/17/2024	SPoT	Moderate	0	Low	6210	Low	12420					t be used is delivered late assume 20% in drilling effiency
9	1.2	Container Ski Stack (comprised of 5 sleds)	Five sets of aluminum skis for 20' containers - stacked. Aluminum skis for drill containers. Required onsite for local movement of Gens and PDM.	*In McMurdo*	1/1/2023	SPoT	Moderate	0	Low	0	Low	9200					s with work around - ours to recover
10	1.2	Generator Intake Hood	Light weight large volume sheet metal stacks for generator ventilation	*In McMurdo*	12/12/2023	SPoT	Moderate	0	Low	0	Low	0					
11	1.2	Generator Discharge Hoods	Light weight large volume sheet metal stacks for generator ventilation	*In McMurdo*	12/12/2023	SPoT	Moderate	0	Low	0	Low	0					
12	1.2	Drill Hose	Drill hose - 9 Spools - 348 cf / 3532 lbs each - Shipped from Italy	*In McMurdo*	12/15/2024	SPoT	Moderate	0	Low	3450	Low	25875					no longer possible.
13	1.2	Drill Hose	Drill hose - 3 Spools - 348 cf / 5001 lbs each - Shipped from PSL	*In McMurdo*	12/15/2024	SPoT	Moderate	0	Low	3450	Low	25875					no longer possible.
14	1.2	8' Refit Container	Priority rent materials including tools, flowmeter assemblies, motor drive installation kits, hardware, fittings, sensors, & consumables	*In McMurdo*	11/14/2023	SPoT	Moderate	0	Low	49680	Low	99360					work contingent on 8' tents 1296 hours lost tainer A arrived 12/1
15	1.2	20' Refit Container A	Refit materials incl. submersible pumps, hardware, filtration components, fall arrest														ge 8 people 12 days or

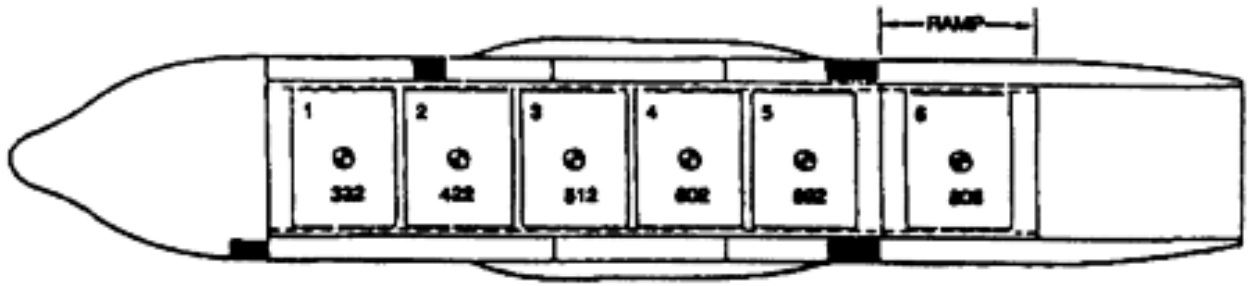
Logistics Sensitivity Analysis:

- Impact of 48 hr, 1 week, 2 week, & 4 week, delays on schedule/cost for each cargo shipment considered
- Impact of 48 hr, 1 week, 2 week, & 4 week, delays on schedule/cost personnel delays considered

LC-130 Load capability (NPX)

Charge Question L2

- Max Aircraft Cabin Load (ACL) – 22,600 lbs cargo, fuel, & pax (passengers)
- 463L Pallet positions – 6
  - 1-4 with max weight of 10,335 lbs
  - 5 - 8,500 lbs
  - 6 – 4,664 lbs (ramp pallet)
- 463L usable area:
  - 102” x 82” (Pallet size is 108”x88”)
  - The max height 102” but 96” is preferred for ease of loading



GROUND ESCAPE EXITS (4)

DUAL RAIL SYSTEM

NOTE: Diagram is not to scale.

PALLET POSITION (PP)	MAXIMUM DIMENSIONS[1] WEIGHT[2] (in pounds) including weight of the pallets and nets	HEIGHT[2] (in inches)
1-4	10,355	96[2]
5	8,500	96[2]
6	4,664	76

[1]Pallet position maximum dimensions may be further restricted by temporarily installed aircraft equipment. Contact your affiliated AMC ALCS for specific guidance.

[2]Maximum single pallet weight for cargo secured with nets and stacked above 96 inches (not to exceed 100 inches) shall not exceed 8,000 pounds.

Figure 2-2. C-130 Pallet Positions.

Sensor Load Planning

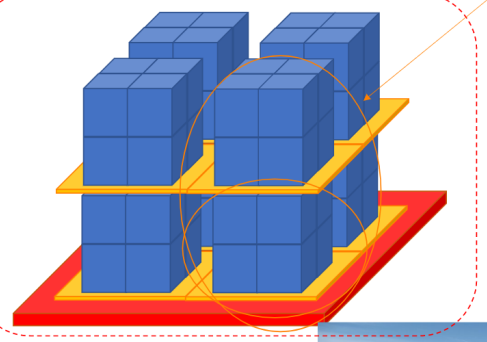
Charge Question L2

mDOMs on USAP airlift

CHC→ NPX

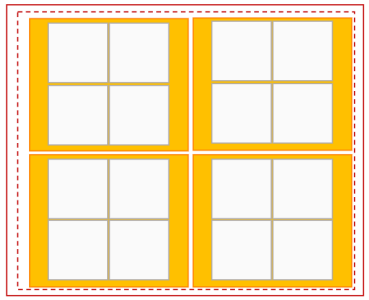
This assembly is done in CHC for C-17/C-130 transport

The single pallet is prepared at shipping location



Assumptions:
Box size is 456x456x480 mm → ~18"x18"x19"
Max air cargo is 102"x 84" x 102" (H)
number of mDOMs/string is 57-60
mDOM weight: 25 kg

64 mDOMs/one pallet (spares included)
Penetrator hole side vs pallet side: TBD



All standard pallets 40"x48"
or EUR2 (1000mmx1200mm),
4-way
ISPM-15: heat treated for export

Looking scaring?
Just like in Gen1

Sensor packaging designed to maximize 463L

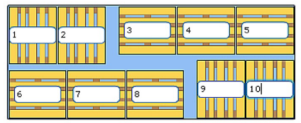
mDOM packaging proposed solution

Use a 20' **High Cube** Single Door container for commercial travel on vessel to CHC

20ft Container Load Planning for Standard Pallets

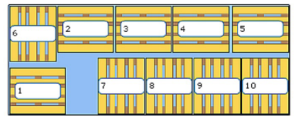
20ft Container width and length:
2350mmx5900mm
Standard pallet width and length :
1000mmx1200mm

Layout 1 : 10 pcs of standard pallets fit in a 20ft container



Each pallet has H =162mm
→ total height occupied is:
2*(480*2+162)= 2.24 m
→ 34.5cm clearance to door **OK**

Layout 2: 10 pcs of standard pallets fit in a 20ft container



3 containers will carry 480 mDOMs

	20' DRY CONTAINER			HI-CUBE 20' DRY CONTAINER			
	Internal length	Internal width	Door opening width	Internal height	Door opening height	Internal height	Door opening height	units
	5.898	2.352	2.34	2.39	2.28	2.698	2.585	m
	19.4	7.7	7.7	7.9	7.5	8.9	8.5	ft
	232.8	92.4	92.4	94.8	90	106.8	102	in

	20' DRY CONTAINER			HI-CUBE 20' DRY CONTAINER		
	Tare weight	Payload capacity	Cubic capacity	Tare weight	Payload capacity	Cubic capacity
	2250 kg	28230 kg	33.08 m^3	2300 kg	28,180 kg	37.23 m^3
	4960.40 lbs	62236.49 lbs	1168.26 cu ft	5,071.5 lbs	67196.9 lbs	1,314.9 cu ft

2 layers x8 mDOMs/pallet x10 pallets mDOMs = 160mDOMs x 28 kg/mDOM → 4480 kg
20 pallets (only pallet weight) → 20x35 kg = 700 kg
Total weight: 5180 kg **OK**

Container loading options analyzed

SPOT Load Planning

Charge Question L2

SPOT1

- Sled 1
- Sled 2
- Sled 3

60,000 lb/40' ISO Flatrack
Arrives between 25Nov - 5Dec

SPOT2

- Sled 1
- Sled 2
- Sled 3

60,000 lb/40' ISO Flatrack
Arrives between 25Dec – 1Jan

SPOT3

- Sled 1
- Sled 2
- Sled 3

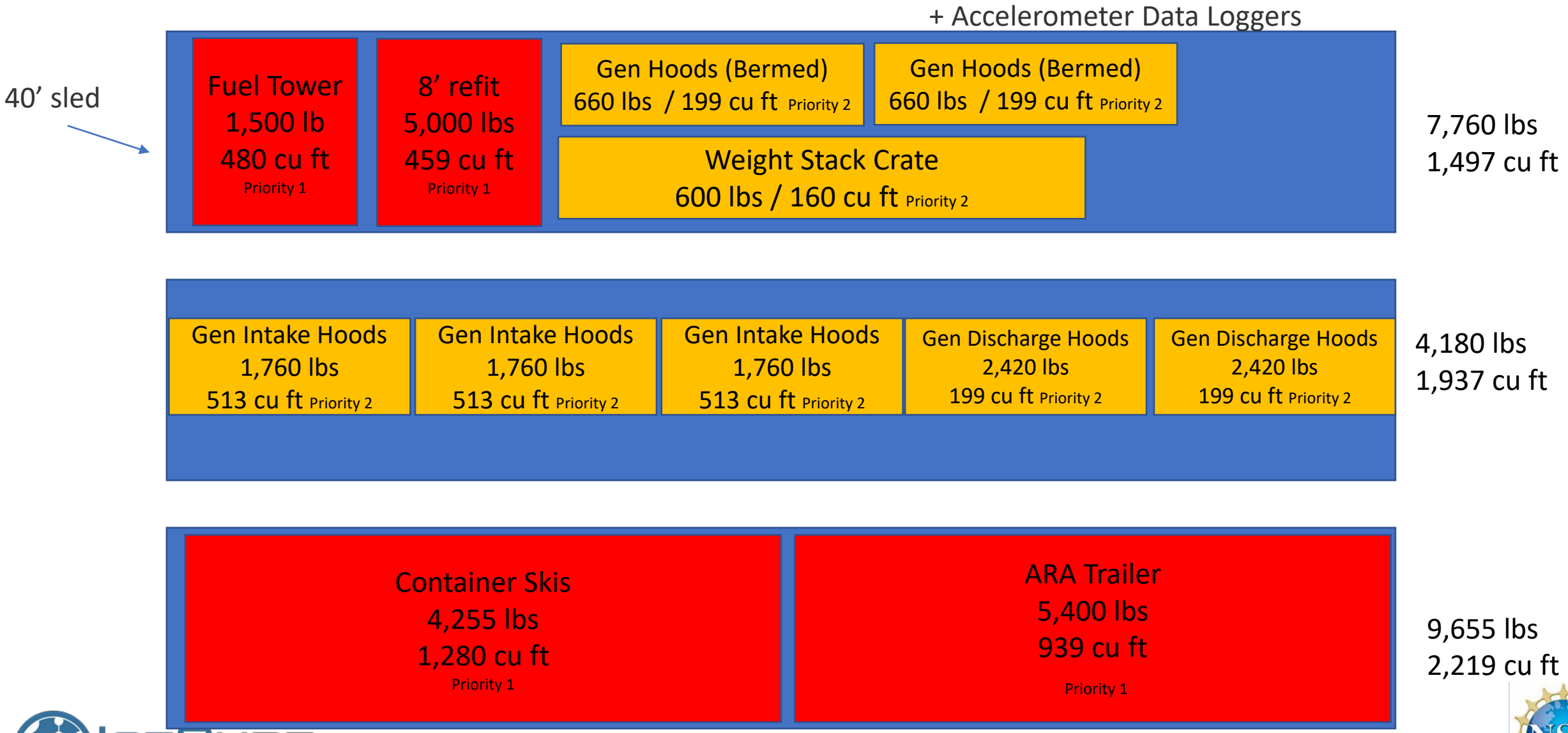
60,000 lb/40' ISO Flatrack
Arrives between 28Jan – 7Feb

12/1* 1/1* 2/1*

*actual arrival may be 5-8 earlier or later than planned

SPOT Load Planning - FY23 SPOT 1 - Southbound

Charge Question L2



Total FY23 SPOT 1 weight: 21,595 lbs / volume: 5,653 cu ft

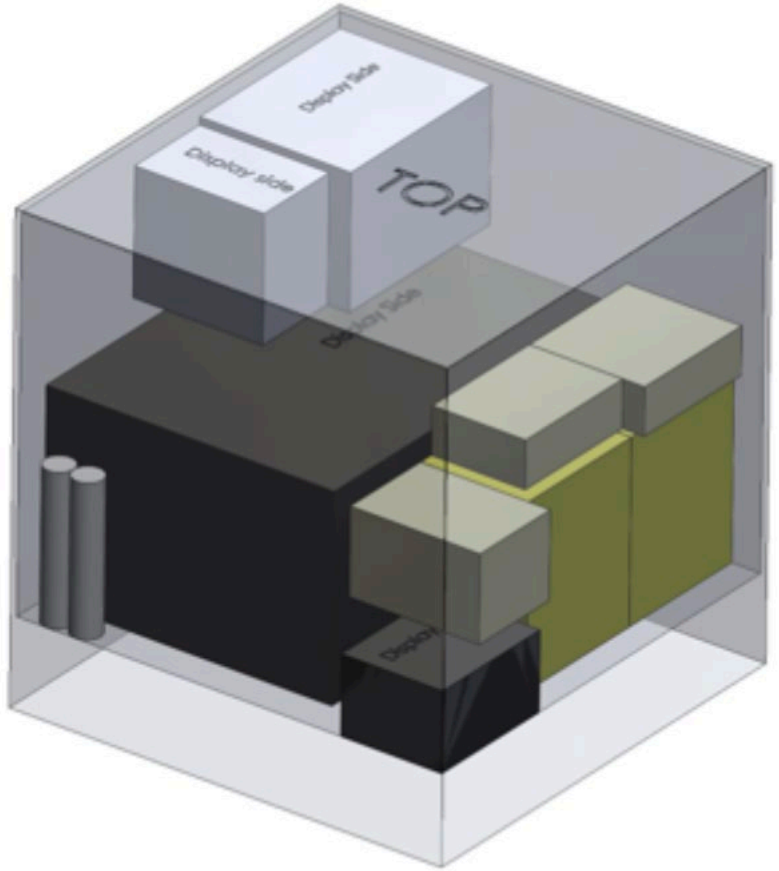
DNF Load Planning

Charge Question L2

- DNF space limited – smaller crate are preferred
- Modeling of pieces in each shipment allows to optimize use of space
- Use of standard size crates allows for modularity

Collapsible bulk container

IFD DNF 30" x 32" x 30"



Independent Firn Drill - DNF Shipping Supplies

Item/Description	Dimensions	Weight (lbs	Crate Designat	Qty.
Thermostats + Differential Pressure Guage	5.5 x 6.5 x 9"	5	IFD	1
Firn drill recepticals for load cell	3 x 6.5 x 9"	5	IFD	1
Honeywell load cell	3 x 8 x 9"	3	IFD	1
DNF readout meter	6 x 8 x9"	4	IFD	1
Grease tubes	2 x 2 x 9.5"	2	IFD	2
Appleton Disconnect	7.5 x 9.5 x 11.5"	10	IFD	2
Simpson black box interface (w/cable)	5 x 7 x 9"	8	IFD	1
Temperature readout black box	8.5 x 10.5 x 13"	25	IFD	1
Firn drill controller black box	13 x 20 x 27"	80	IFD	1

TOTAL CRATE WEIGHT: 195 lbs

Response to Previous Reviews

Charge Question L-1

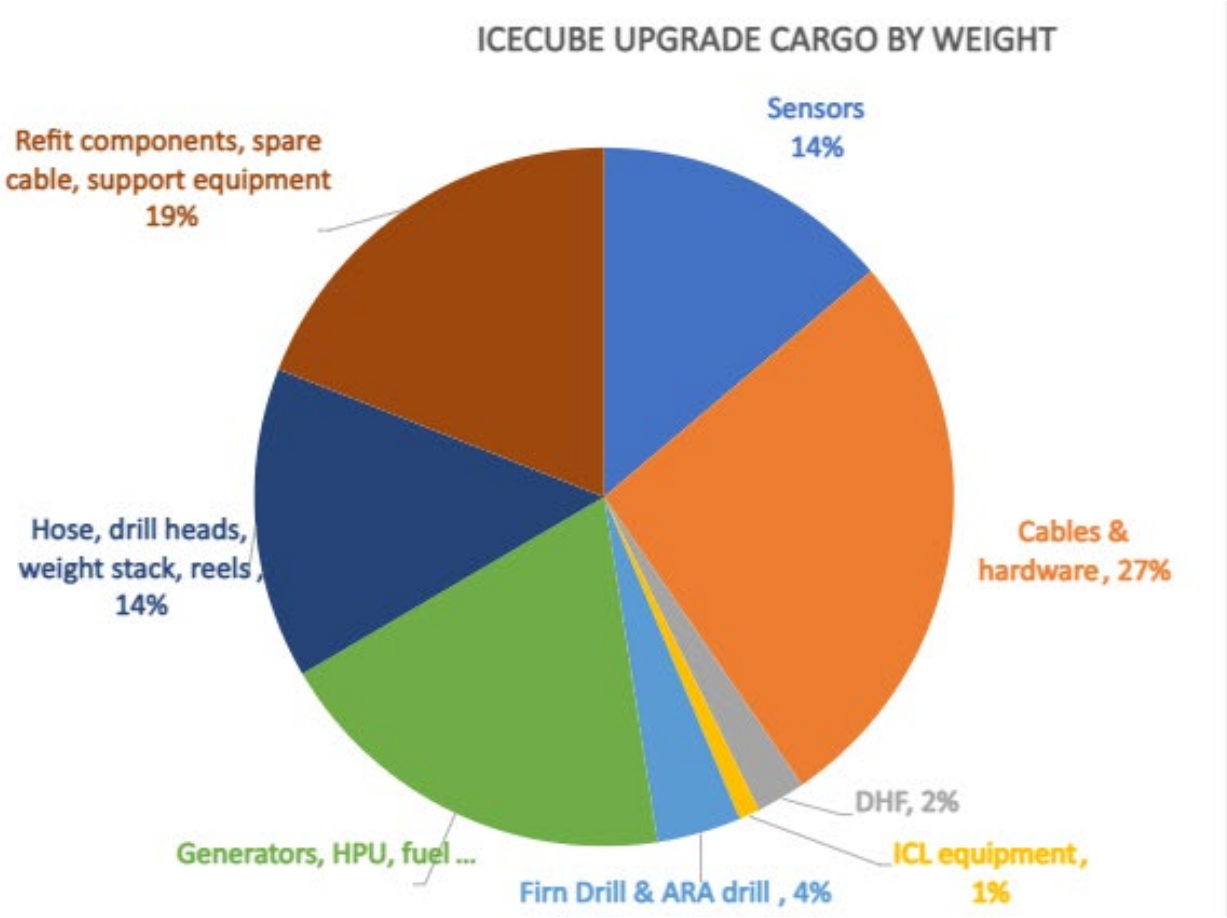
ID	Recommendation	Responsible	Status	Estimated Date for	
LR7	Planning should identity the schedule float that exists between the earliest and latest dates when deliverables must be ready to enter the USAP logistics system. Add a float column with conditional formatting (red, yellow, green; based on number of days) in the cargo spreadsheet.	Vivian O'Dell / Marek Rogel/Ian McEwen/Delia Tosi	In progress	04/01/22	Float calculations are now included in the Cargo Master as Shipment Float & South Pole Float. Total time between Shipment and need by date at South Pole is calculated additionally.
LR8	Include recording accelerometer in sample packaging for first available South Pole Traverse to get a sense of the potential for shock and vibration damage during shipment using the traverse.	Terry Benson	In progress	10/01/22	Deveiled plans to include data loggers on 2 traverses (SPOT1 & SPOT2). Package shipments are in the FY23 cargo plan. Research into commercially available accelerometer loggers is underway.
LR12	The Excel spreadsheet that was provided as an output from Smartsheet showed that generic resources are applied for tasks occurring in the same time period. EN and TE are the two most common resource types. With multiple activities occurring during the same time frame that use EN and TE resources it is not possible to determine if the planned staffing is over or under allocated. This can be solved by creating unique resource names (SHFT1_ENG, SHFT1_DRL, SHFT1_HOS, SHFT2_ENG, SHFT2_DRL, etc.). This may provide for a better analysis of the resource loading and population planning.	Ian McEwen, Jim Lowe, Terry Benson, Dar Gibson	In progress	04/01/22	Resource tags have been expanded to allow for better visibility and analysis. Electrical Engineer (EN-EE), Mechancial Engineer (EN-ME), and Safety Engineer (EN-S) are now sorted in Smartsheet hours reports.
NSFLR4	Provide better visualization such as float associated with tasks and cargo	Jim Lowe, Ian McEwen, Delia Tosi	In progress	03/10/22	Float calculations are now included in the Cargo Master as Shipment Float & South Pole Float. Total time between Shipment and need by date at South Pole is calculated additionally.
NSFLR6	Refine quality control / assurance processes for packing/shipping	Ian McEwen, Delia Tosi, Mike Zernick	In progress	04/01/20	Quality assurance process for packing and shipping are being updated and incorporated in the logistics plans.

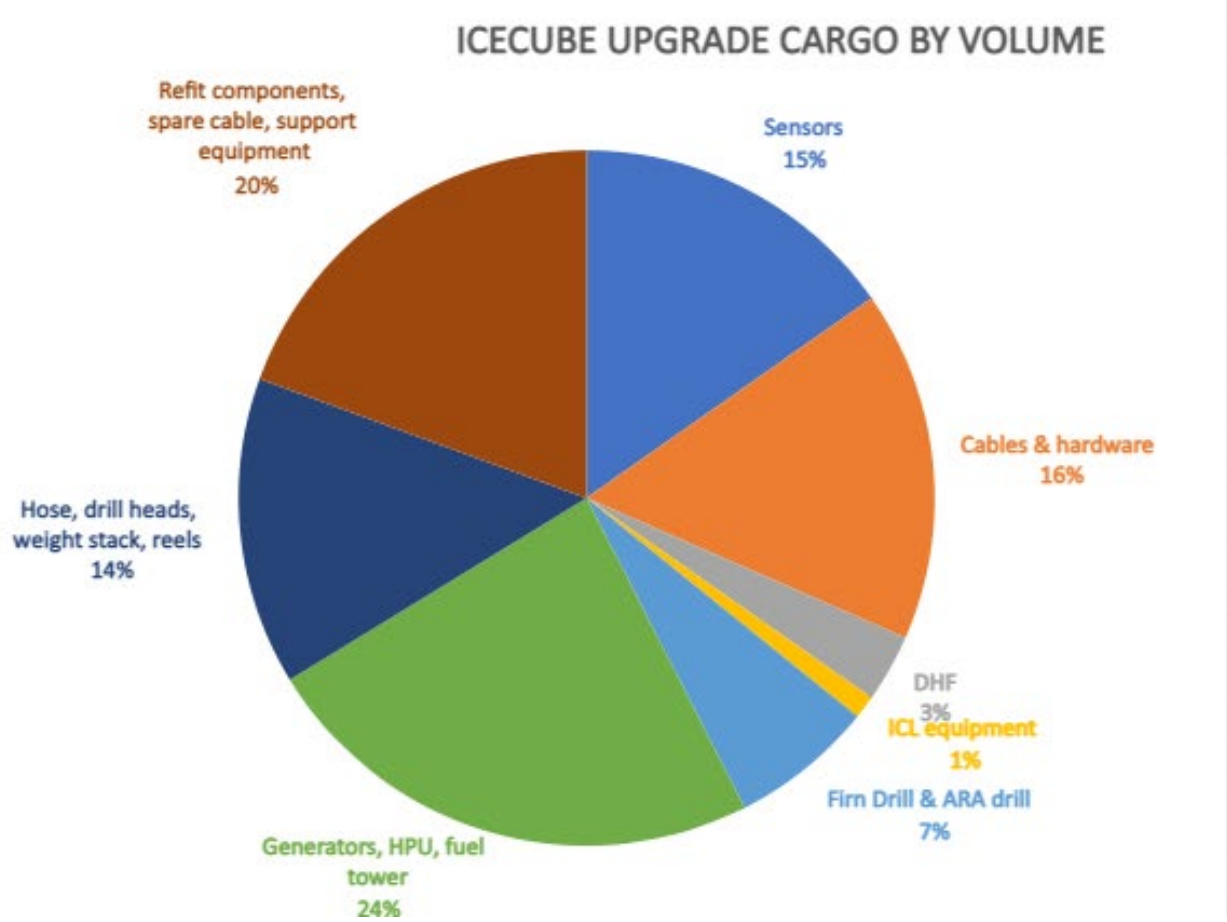
Conclusions

- AIL logistics capacities are adequate to support ICU's three season plan
- Comprehensive outyear logistics "look ahead" has provided the opportunity to shift from logistics driven to task/risk mitigation driven schedule
  - Almost all shipments required for FS1 (FY24) tasking arrive the season prior in the current plan
  - JIT shipments are comprised almost exclusively of environmentally sensitive components that cannot be overwintered at the South Pole.
- In collaboration with NSF/ASC ICU recently developed logistics management tools and IMS greatly improve visibility, traceability and stakeholder communication/coordination

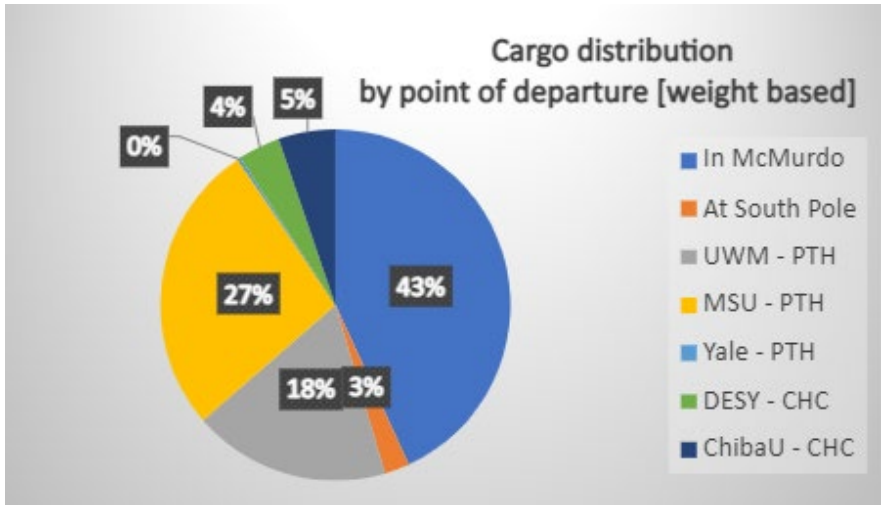
Backup Slides

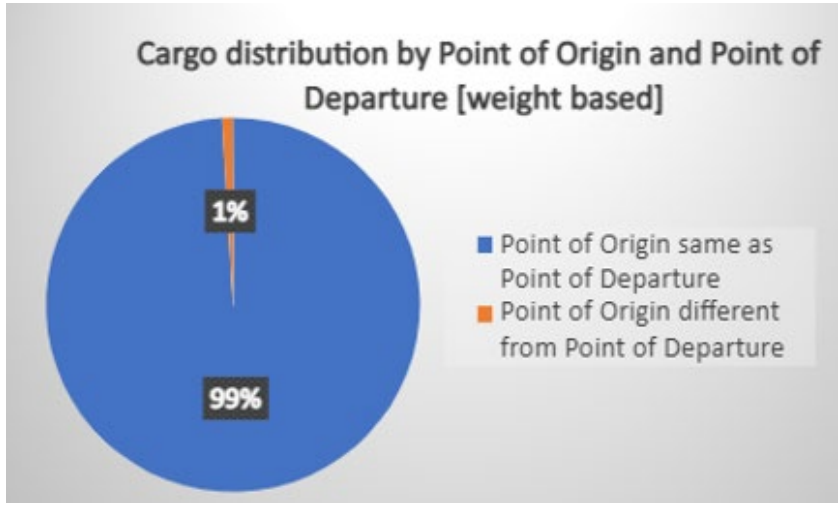
Cargo by Weight/Volume

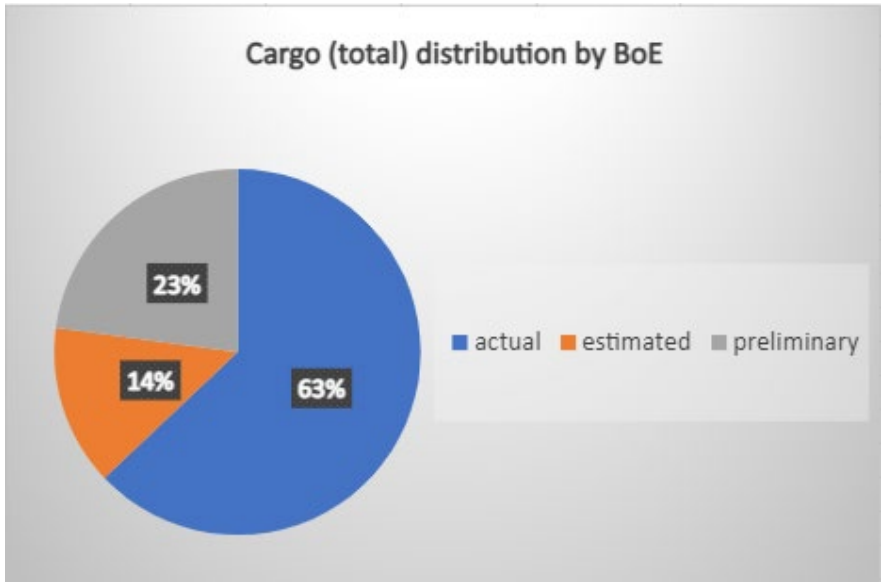


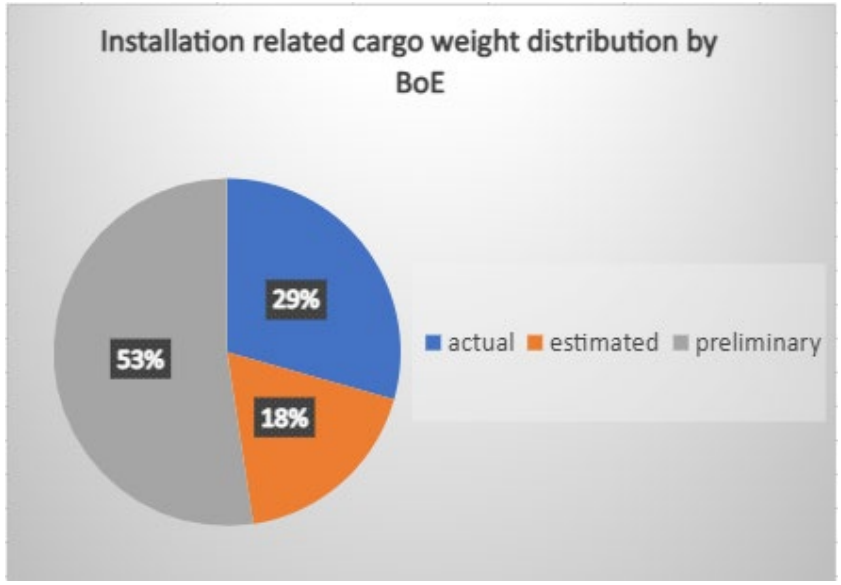


Cargo Point of Origin & Estimation Method









Float Tables

Item description	Special Handling?	SHIPMENT FLOAT: Time between completion and ship-by-date to USAP	FLOAT AT NPX (delivery to required) [days]	Total Time Between Ship-By-Date and Latest Arrival Date at NPX [days]
ARA Drill System Components - Crate #1	DNF	30	16	412
Computing/controls components Shipment #1	DNF	14	0	396
Computing/controls components Shipment #2	DNF	31	0	106
Computing/controls components Shipment #3	DNF	31	0	106
20' Refit Container C: Bull Wheel, Spare Combo & Drill Cables, Hose Heating System Components, ARA Drill System Components Crate #2	-	31	418	830
Driller resupply/refit components - 8' Container FS2	-	31	0	106
Drill refit components FS2	DNF	31	0	106
Driller resupply/refit components - 8' Container FS3	-	31	0	106
Drill refit components FS3	DNF	31	0	106
Drill Heads - X	DNF	409	648	1127
Drill Heads - Y	DNF	409	648	1127
Drill Heads - R	DNF	409	648	1127
Load member cable reel [placeholder, may not be required]	-	136	151	595
Accelerometer Loggers SPoT 1	-	62	0	91
Accelerometer Loggers SPoT 2	-	62	0	122
ICL power and timing electronics	DNF	462	1	122
ICL patch cables and patch panels	DNDF [TBD]	624	1	122
DOM Handling Facility (DHF)	-	50	368	780
Installation Hardware 87-93	-	97	321	765
Installation Weights 87-93	-	110	321	765
Misc. Science Equipment - FS2 (FY25)	DNF	50	1	122
Misc. Science Equipment - FS3 (FY26)	DNF	25	16	122
Calibration/Special Devices 87-88	DNDF [-40C]	2	13	149
Special Devices 87-88	DNDF [-40C]	2	13	149
Special Devices 89-93	DNDF [-40C]	61	15	131
Calibration/Special Devices 89-93	DNDF [-40C]	61	15	131
Dust logging device	DNF	61	15	131

Float Tables

Item description	Special Handling?	SHIPMENT FLOAT: Time between completion and ship-by-date to USAP	FLOAT AT NPX (delivery to required) [days]	Total Time Between Ship-By-Date and Latest Arrival Date at NPX [days]
Dust logging device	DNF	61	15	131
Dust logging device	DNF	61	15	131
Dust logging device	DNF	61	15	131
Logging winch	0	61	15	131
Logging winch control box	DNF	61	15	131
Surface Junction Boxes	-	2	380	792
Surface Cable Assemblies	DNDF [-55C]	106	14	792
Breakout cables for strings 87-88	DNDF[-40C](*)	477	298	421
Breakout cables for strings 89-93	DNDF[-40C](*)	379	15	421
Main (downhole) load members 87-93 [placeholder, may not be required]	DNDF[-40C](*)	563	1	413
Main (downhole) cables 87-93	DNDF[-40C](*)	31	1	779
String Sensors 89-93 (mDOMs MSU)	DNDF [-40C]	686	15	131
String Sensors 89-93 (mDOMs MSU)	DNDF [-40C]	686	15	131
DM-Ice	DNDF [-40C]	426	20	126
String Sensors 87-88 (mDOMs DESY)	DNDF [-40C]	440	13	149
String Sensors 87-88 (mDOMs DESY)	DNDF [-40C]	440	13	149
Special Devices 87-88 (Europe)	DNDF [-40C]	578	13	149
Calibration Devices 87-88 (Europe)	DNDF [-40C]	792	13	149
FieldHub electronics	DNF	304	1	108
String Sensors 89-93 (mDOMs DESY)	DNDF [-40C]	721	15	131
Special Devices 89-93 (Europe)	DNDF [-40C]	578	15	131
Calibration Devices 89-93 (Europe)	DNDF [-40C]	1157	15	131
String Sensors 87 & 88 (D-Eggs-	DNDF [-40C]	736	13	149
String Sensors 87 & 88 (D-Eggs-	DNDF [-40C]	736	13	149
String Sensors 87 & 88 (D-Eggs-12x)	DNDF [-40C]	736	13	149
String Sensors 87 & 88 (D-Eggs-12x)	DNDF [-40C]	736	13	149
String Sensors 89-93 (D-Eggs-8x)	DNDF [-40C]	812	15	131
String Sensors 89-93 (D-Eggs-12x)	DNDF [-40C]	812	15	131

Overview of Intercontinental Cargo Movement

Container Allocation estimated by ICU – needs review by ASC SMEs

Intercontinental leg	volume [cu ft]	weight [lbs]	Vessel Container Allocation 40F	Vessel Container Allocation 40D	Vessel Container Allocation 20D	Vessel Container Allocation 20F	TEU Count	C-17 Pallet Allocation
In McMurdo	20,513	205,787	0.00	0.00	0.00	0.00	0.00	0.00
At South Pole	733	12,241	0.00	0.00	0.00	0.00	0.00	0.00
FY23 Vessel	5,470	73,632	0.00	0.00	5.75	0.50	6.25	0.75
FY23 ComSur	2	10	0.00	0.00	0.00	0.00	0.00	0.02
FY24 Vessel	4,704	121,302	0.00	0.00	5.00	0.25	5.25	0.00
FY24 ComSur	128	3,000	0.00	0.00	0.00	0.00	0.00	0.50
FY25 Vessel	1,022	12,362	0.00	0.25	3.00	0.00	3.25	0.00
FY25 ComSur	2,953	37,553	0.00	0.00	0.00	0.00	0.00	8.75
FY26 Vessel	0	0	0.00	0.00	0.00	0.00	0.00	0.00
FY26 ComSur	4,958	62,549	0.00	0.00	0.00	0.00	0.00	16.56
Total	**40,483**	**528,436**	**0.00**	**0.25**	**13.75**	**0.75**	**14.75**	**26.58**

Overview of Intracontinental Cargo Movement

463L pallets & sleds allocation estimated by ICU – needs ASC review

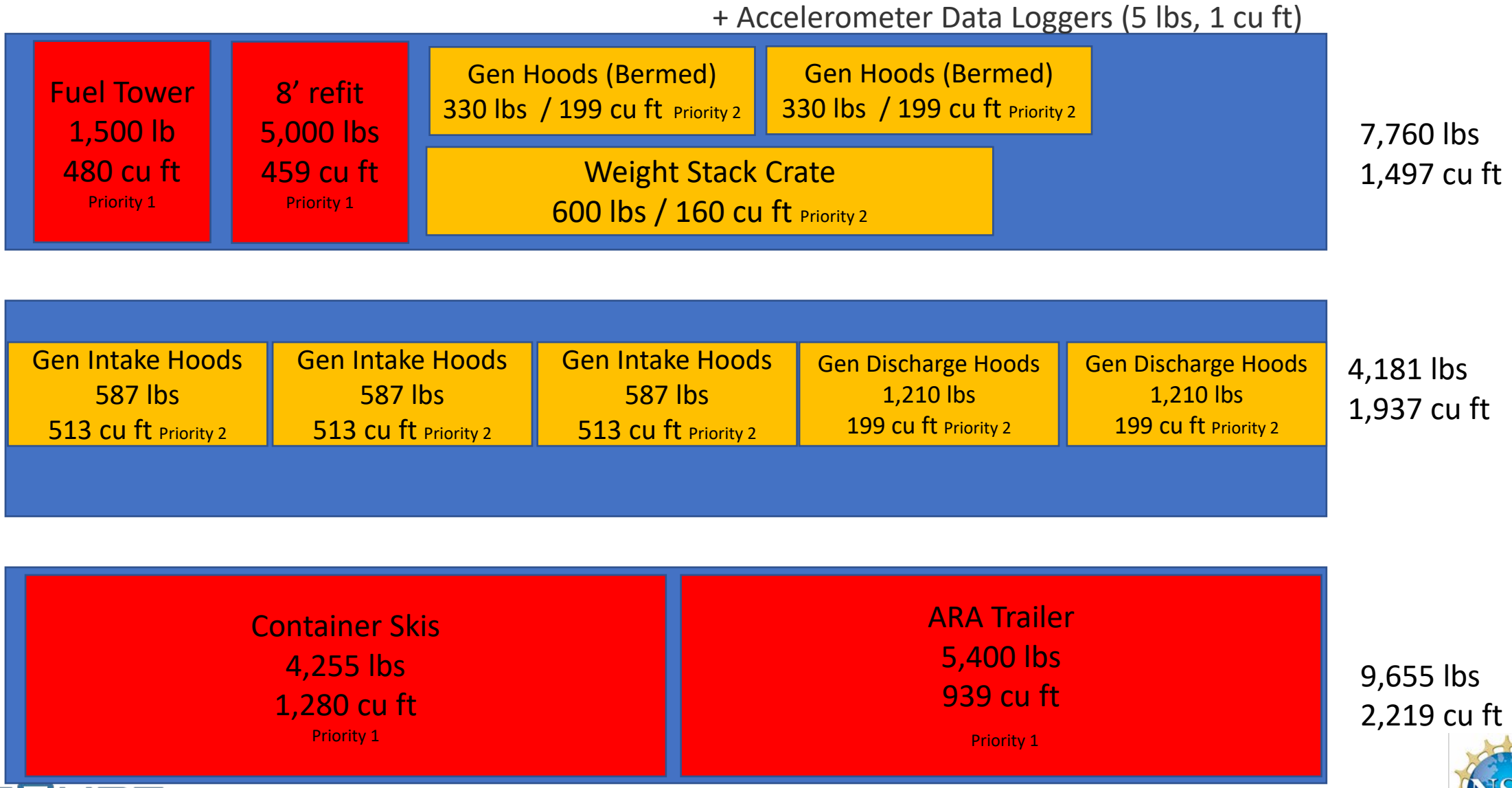
Intracontinental leg	volume [cu ft]	weight [lbs]	# SPOT Sleds	# 263 Pallets
At South Pole	733	12,241	0.00	0.00
FY23 LC-130	0	0	0.00	0.00
FY23 SPOT 1	5,654	21,601	3.00	
FY23 SPOT 2	7,989	109,405	3.00	
FY23 SPOT 3	2,720	28,000	1.00	
FY24 LC-130	576	10,380	0.00	2.15
FY24 SPOT 1	4,119	56,900	2.00	
FY24 SPOT 2	0	0	0.00	
FY24 SPOT 3	0	0	0.00	
FY25 LC-130	3,145	39,553	0.00	9.25
FY25 SPOT 1	5,055	56,143	2.90	
FY25 SPOT 2	1,120	16,302	0.45	
FY25 SPOT 3	0	0	0.00	
FY26 LC-130	5,438	67,549	0.00	17.56
FY26 SPOT 1	3,934	110,362	2.50	
FY26 SPOT 2	0	0	0.00	
FY26 SPOT 3	0	0	0.00	
Total	**40,483**	**528,436**	**14.85**	**28.96**

ICU Overland Ground Rules/Assumptions

- Rough arrival dates:
  - SPOT 1: 12/1
  - SPOT 2: 1/1
  - SPOT 3: 2/1

  (actual arrival may be 7-10 days beyond planned date of arrival)
- 3 40' sleds each traverse w/ 180k lbs available capacity for IceCube Upgrade cargo
- Preference for load distribution:
  - Lighter loads on both SPoT1/ SPoT3
  - SPOT 2 heavy hauler
- Offloads requiring a crane should be consolidated and ship on SPOT 2
  - Crane support needs to be called out in the ICU schedule and coordinated with the USAP contractor
- Sensitive cargo and hazardous materials are not suitable for overland transport

Overland Capacity Analysis - FY23 SPOT 1 South



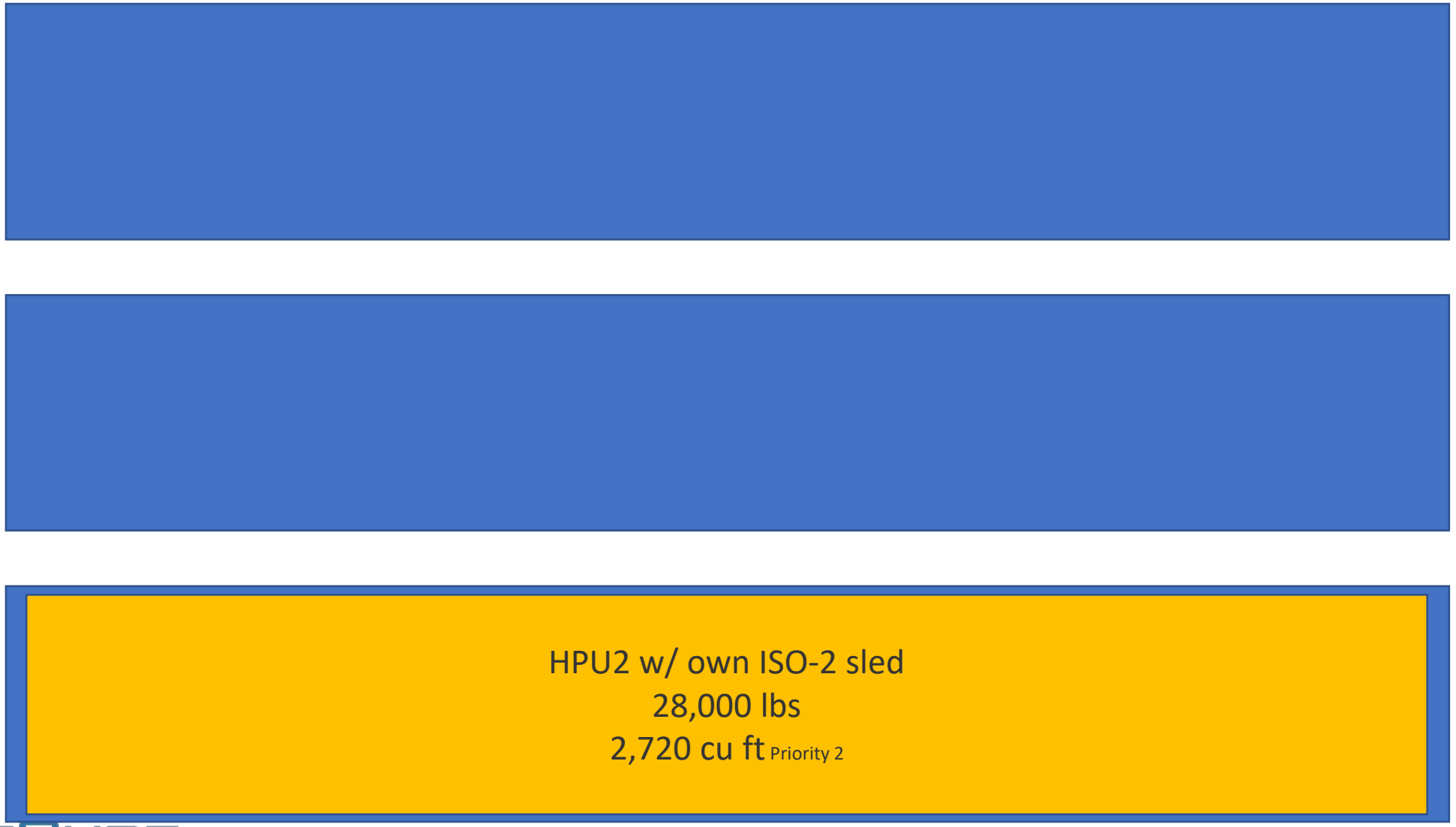
Total FY23 SPOT 1 weight: 21,601 lbs / volume: 5,654 cu ft

Overland Capacity Analysis - FY23 SPOT 2 South

+ Accelerometer Data Loggers (~5 lbs, 1 cu ft)

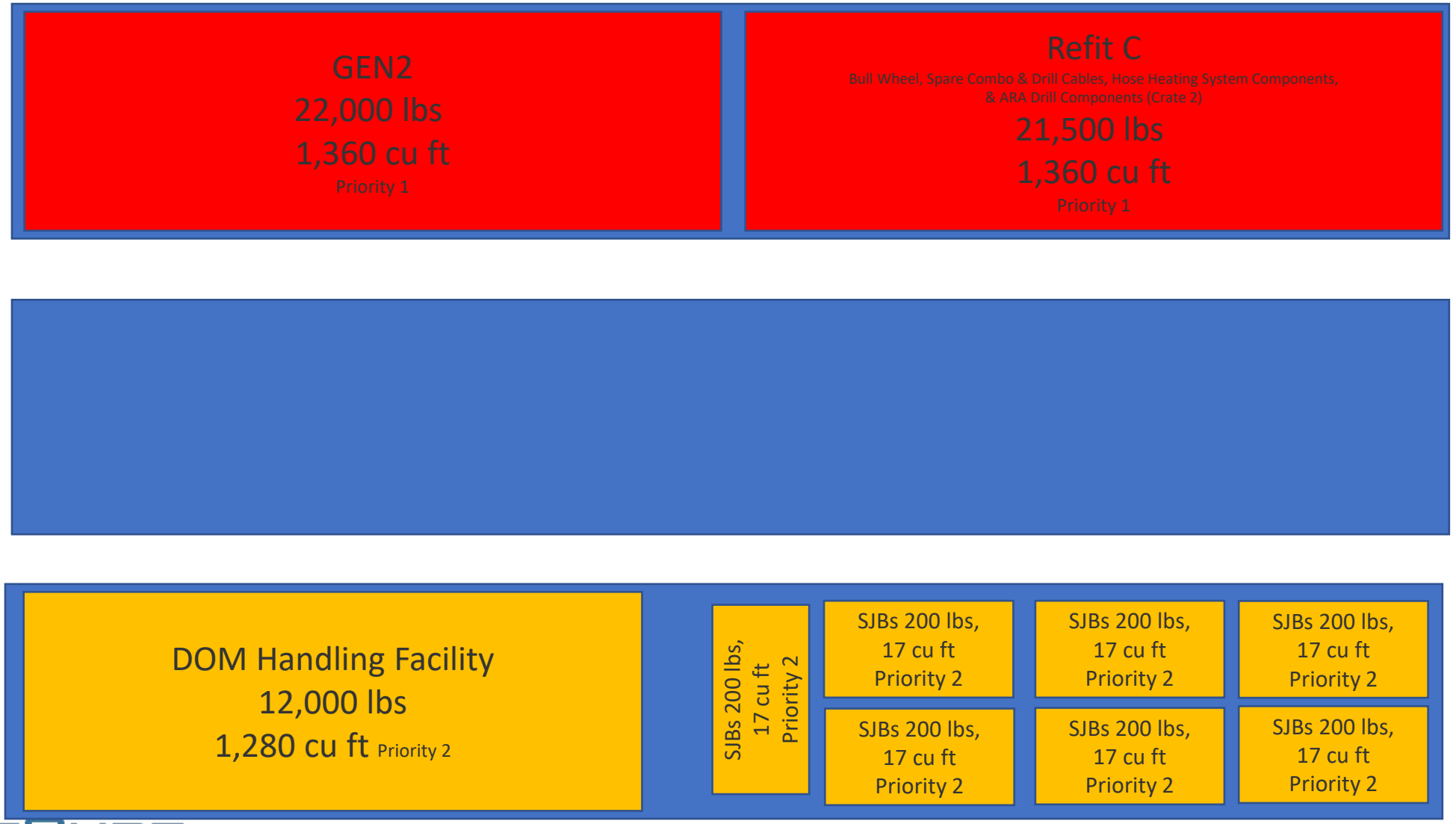
Total FY23 SPOT 2 weight: 109,405 lbs / volume: 7,989 cu ft

Overland Capacity Analysis - FY23 SPOT 3 South



Total FY23 SPOT 3 weight: 28,000 / volume: 2,720 cu ft

Overland Capacity Analysis - FY24 SPOT 1 South



Total FY24 SPOT 1: 56,900 lbs / volume: 4,119 cu ft

Overland Capacity Analysis - FY24 SPOT 2 South

0 lbs
0 cu ft

0 lbs
0 cu ft

0 lbs
0 cu ft

Total FY24 SPOT 2: 0 lbs

Overland Capacity Analysis - FY24 SPOT 3 South

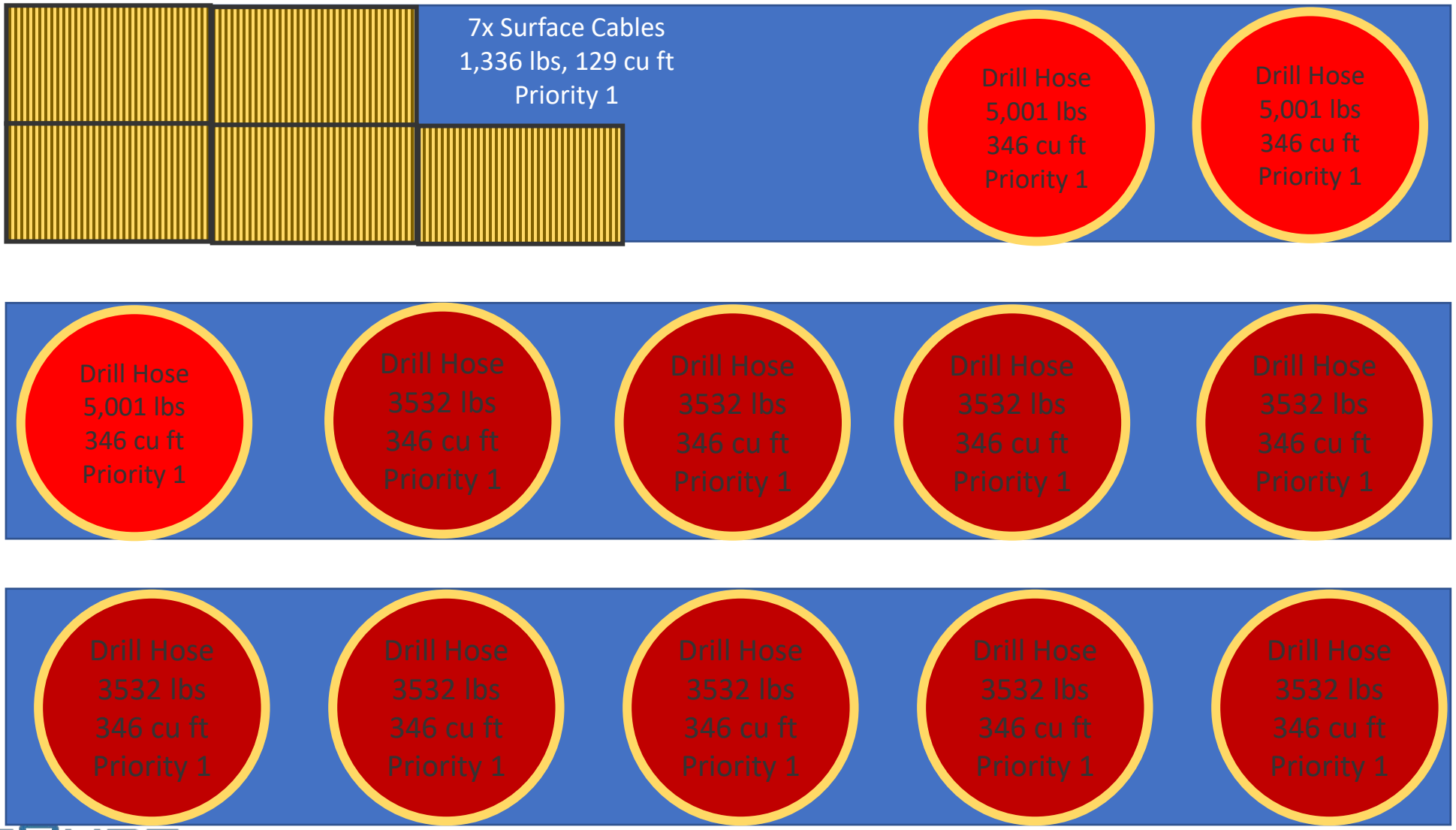
0 lbs
0 cu ft

0 lbs
0 cu ft

0 lbs
0 cu ft

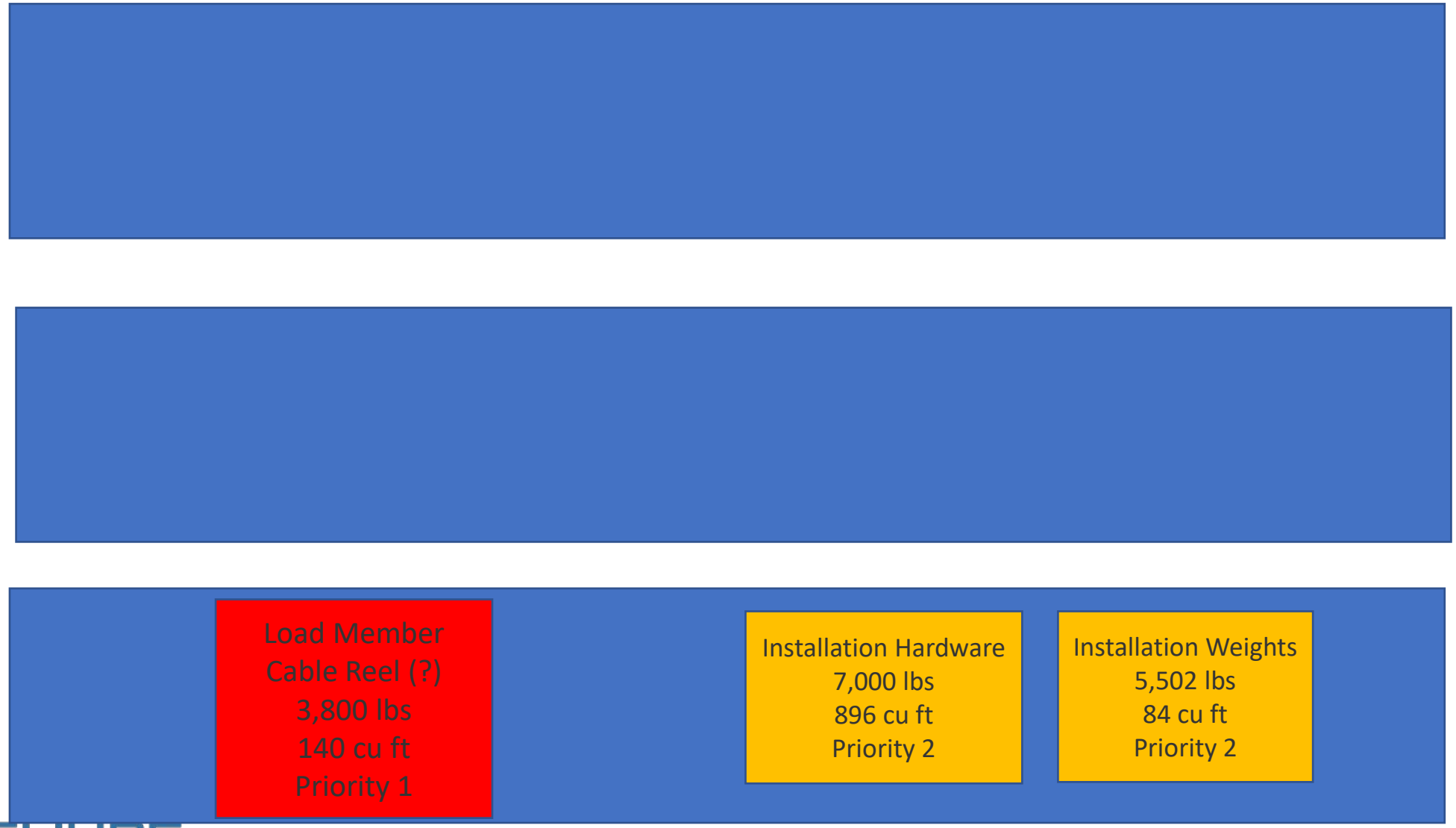
Total FY24 SPoT 3: 0 lbs

Overland Capacity Analysis - FY25 SPOT 1 South



Total FY25 SPOT 1: 56,143 lbs / volume: 5,055 cu ft

Overland Capacity Analysis - FY25 SPOT 2 South



Total FY25 SPOT 2: 16,302 lbs / volume: 1,120 cu ft

Overland Capacity Analysis - FY25 SPOT 3 South

Total FY25 SPOT 3: 0 lbs

Overland Capacity Analysis - FY26 SPOT 1 South

Total FY26 SPOT 1: 110,362 lbs / volume: 3,934 cu ft

Overland Capacity Analysis - FY26 SPOT 2 South

0 lbs
0 cu ft

0 lbs
0 cu ft

0 lbs
0 cu ft

Total FY26 SPOT 2: 0 lbs

Overland Capacity Analysis - FY26 SPOT 3 South

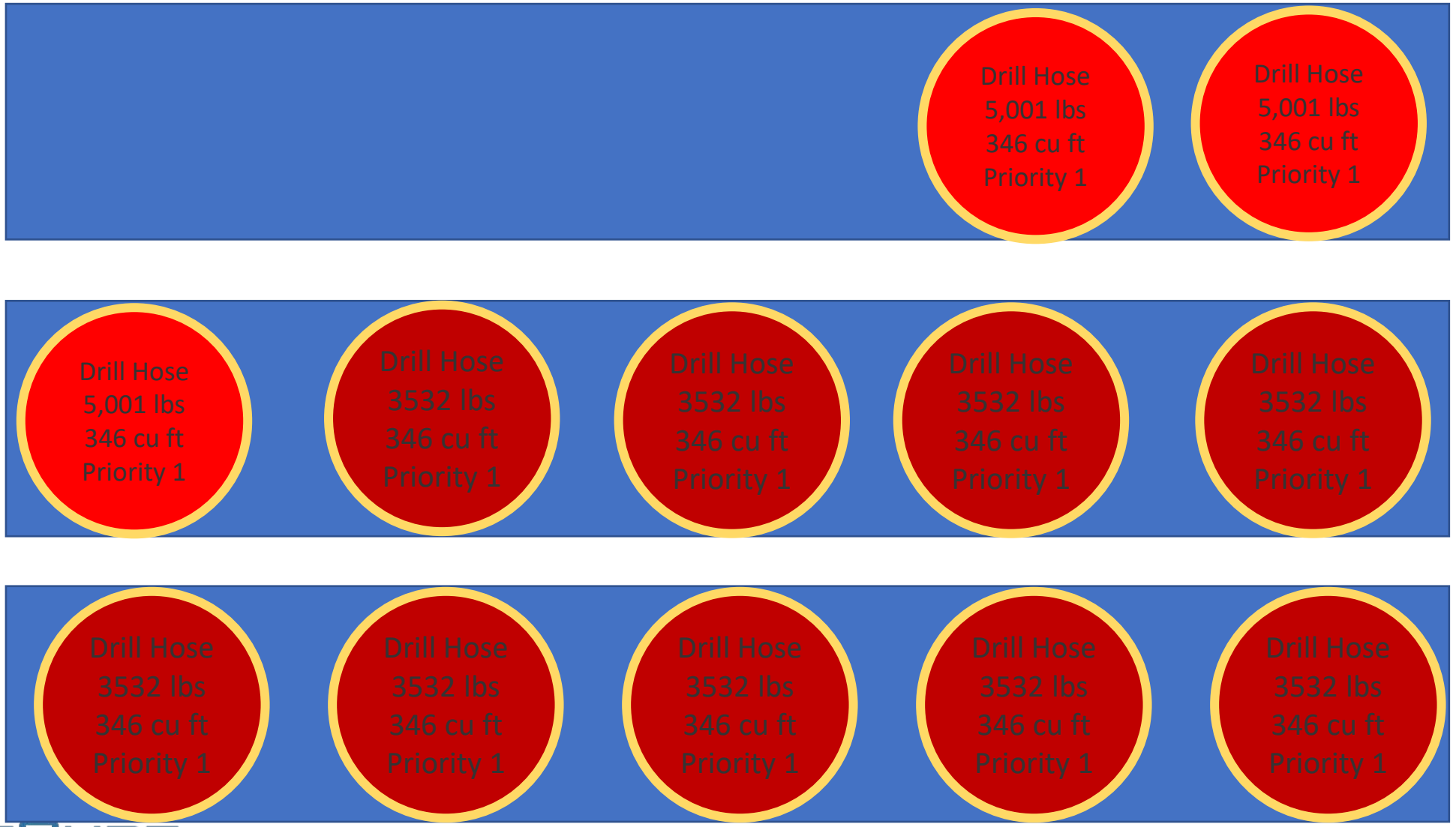
0 lbs
0 cu ft

0 lbs
0 cu ft

0 lbs
0 cu ft

Total FY26 SPOT 3: 0 lbs

Overland Capacity Analysis - FY26 SPOT 3 North - Retrograde



Total FY26 SPOT 3 North: 46,791 lbs / volume: 5,055 cu ft

Fuel Transport Assumptions

- No overland fuel hauling capacity for ICU
- LC-130 McMurdo→NPX Available Cargo Load : 22600 lbs, max of 5+1 463L pallets
- LC-130 Tanker average capacity: 3000 gallons

Fuel Transport Proposed Schedule

All fuel requested can be flown into NPX in time

Fiscal Year	Intracontinental leg	Needed Fuel [Gallons]	#263 Pallets (ROUND UP)	Cargo Weight including Pallets and TDE [lbs]	Available LC Flights	LC Cargo	LC Tanker (use conservative 3000 gallon/flight)	Fuel delivered by LC -130 for ICU [Gallons]
FY23	FY23 LC-Tanker	0	0	0	2	0.0	2.0	6,000
FY24	FY24 LC-Tanker	3,643	3	11,445	19	0.6	18.4	55,200
FY25	FY25 LC-Tanker	20,551	10	43,103	10	2.0	8.0	24,000
FY26	FY26 LC-Tanker	71,167	18	73,939	7	3.6	3.4	10,161
Total	**Total**	**95,361**	**31**	**128,487**	**38**	**6**	**32**	**95,361**

Fuel Contingency

IceCube Upgrade Fuel Contingency

Units = Gallons
(A) = Actual

- Contingency is added into each major component of the fuel budget
  - Deep drilling: 20%
  - Firn drilling: 20% on fuel per hole, + 4 extra firn holes = 73% contingency
  - Base: Has many subcomponents estimated from engineering judgement. For purposes here, we will assume 0% contingency.
  - Winter heating: 20%
- We can back out an overall contingency:

	No Contingency	Contingency	With Contingency
Deep Drilling	44653	8930 (20%)	53583
Firn Drilling	2250	1650 (73%)	3900
Base	34823	0 (0%)	34823
Winter Heating	3588	717 (20%)	4305
Total	**85314**	**11298 (13%)**	**96612**

Total contingency

- And then distribute across each field season, for fuel left to go:

	Field Season 1	Field Season 2	Field Season 3
No Contingency	3191	18178	62694
Contingency	452	2373	8473
Total	**3643**	**20551**	**71167**

95361 gal to go

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