IceCube Upgrade: Logistics

IceCube Upgrade NSF Rebaseline Review
April 26-28, 2022

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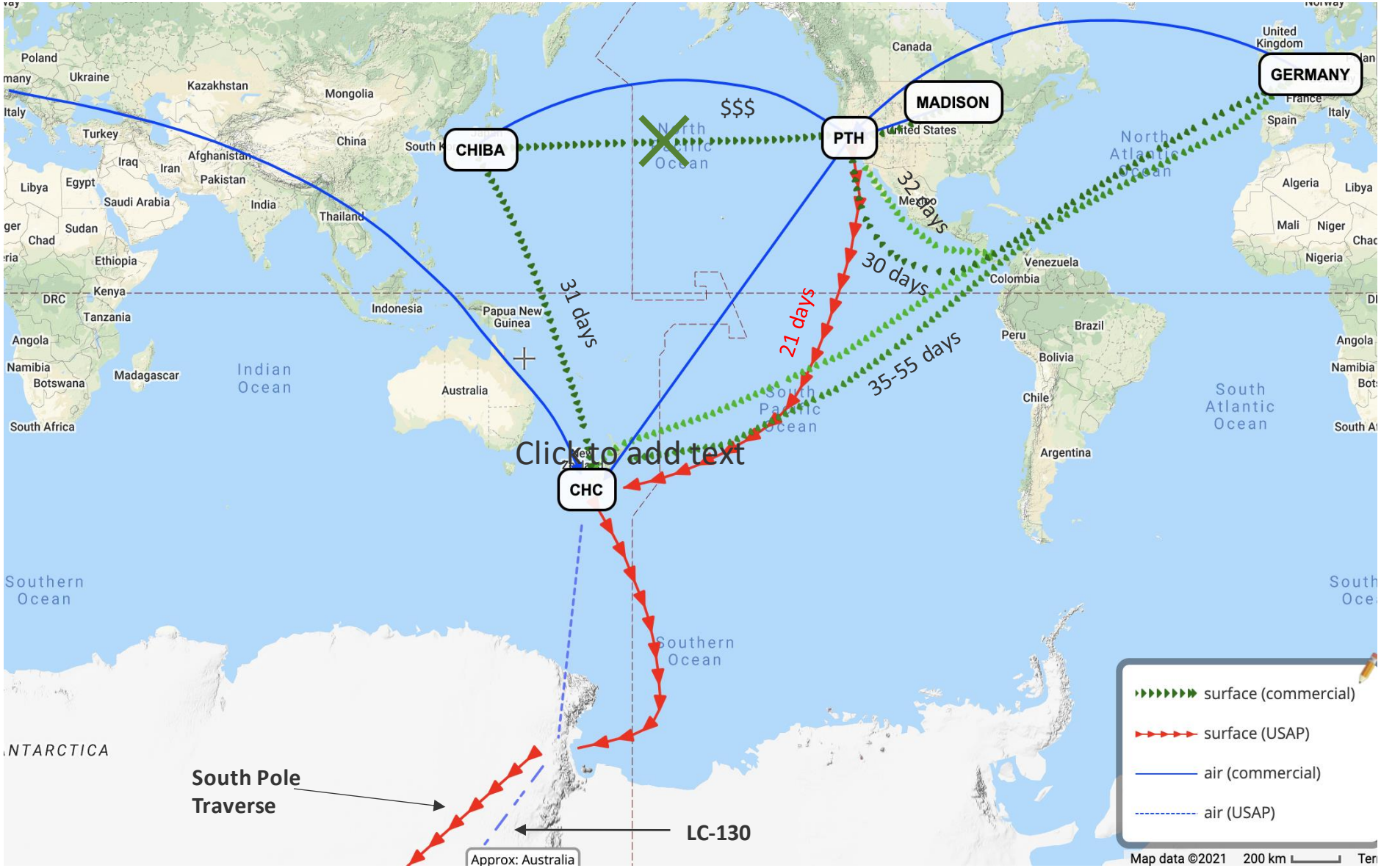
University of Wisconsin

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 summers at the South Pole and 2 deployments to Summit Station
- 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


CHIBA
PTH
MADISON
GERMANY
CHC
$$$
31 days
21 days
30 days
32 days
35-55 days
Click to add text
South Pole
Traverse
LC-130
Approx: Australia
surface (commercial)
surface (USAP)
air (commercial)
air (USAP)
Map data ©2021
200 km
Indian Ocean
Pacific Ocean
Southern Ocean
South Atlantic Ocean
North Atlantic Ocean
Australia
Canada
United States
Mexico
Venezuela
Colombia
Peru
Brazil
Bolivia
Chile
Argentina
China
Mongolia
Kazakhstan
India
Indonesia
Papua New Guinea
Thailand
Pakistan
Afghanistan
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Saudi Arabia
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Chad
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Angola
Namibia
Botswana
Madagascar
South Africa
Turkey
Ukraine
Poland
United Kingdom
France
Spain
Italy
Algeria
Mali
Niger
Nigeria

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 and cargo movement begins in the FY23 USAP field season
- Required cargo is delivered 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

South Pole Traverse
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

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	5.25	as needed	3.25	n/a	n/a	n/a	n/a
Vessel North (TEU)	n/a	-	17	0.5 (EST)	50	0.5 (EST)	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-3 (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

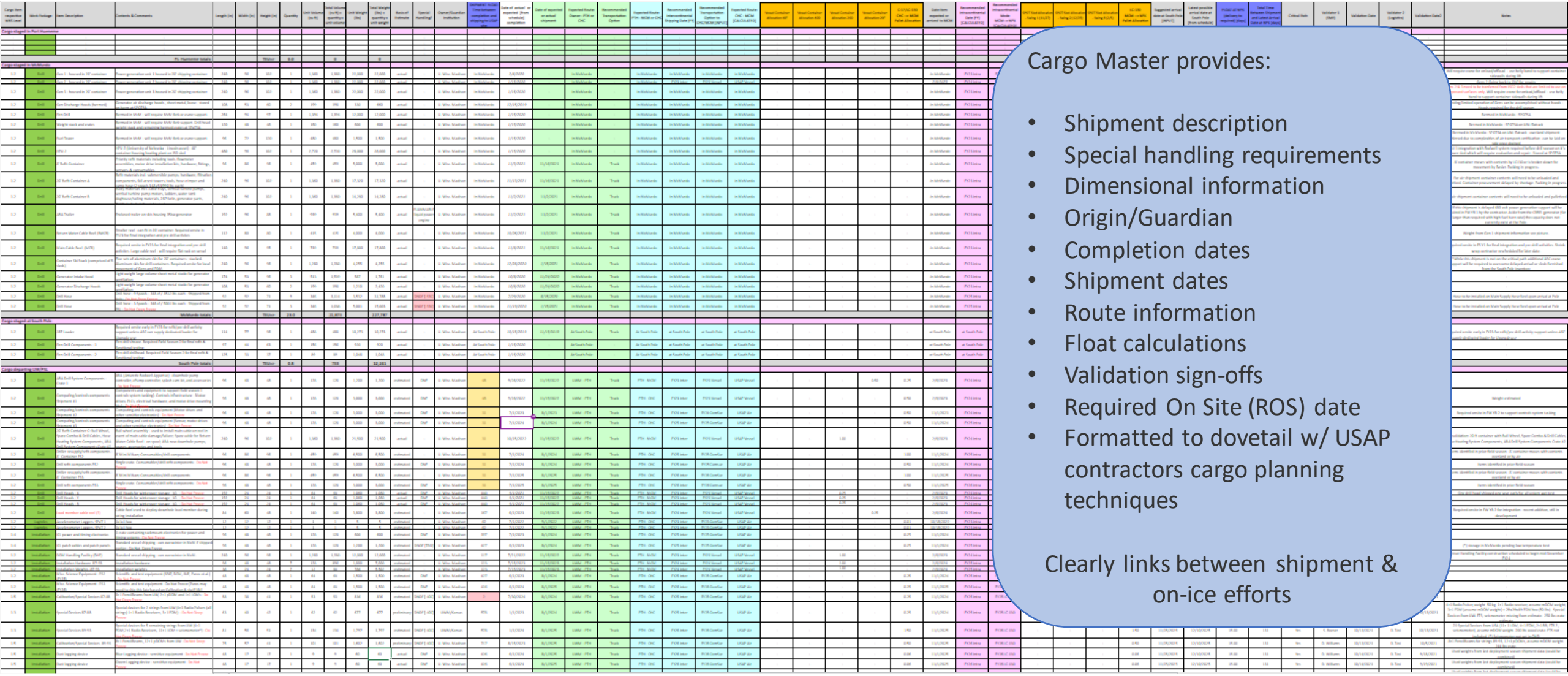
Logistics Planning Tools – Smartsheet

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 site	FLOAT AT NPX (delivery to required) [days]	Total Time Between Ship-By-Date and Latest Arrival Date at NPX [days]
Gen 1 - housed in 20' container	-	In McMurdo	334	-
Gen 2 - housed in 20' container	-	In McMurdo	0	-
Gen 3 - housed in 20' container	-	In McMurdo	334	-
Gen Discharge Hoods (bermed)	-	In McMurdo	376	-
Firn Drill	-	In McMurdo	348	-
Weight stack and crates	-	In McMurdo	1096	-
Fuel Tower	-	In McMurdo	369	-
HPU 2	-	In McMurdo	350	-
8' Refit Container	-	In McMurdo	348	728
20' Refit Container A	-	In McMurdo	317	728
20' Refit Container B	-	In McMurdo	348	773
ARA Trailer	FLAMMABLE liquid power engine	In McMurdo	371	765
Return Water Cable Reel (RWCR)	-	In McMurdo	367	792
Main Cable Reel (MCR)	-	In McMurdo	367	778
Container Ski Stack (comprised of 5 sleds)	-	In McMurdo	31	716
Generator Intake Hood	-	In McMurdo	376	1113
Generator Discharge Hoods	-	In McMurdo	376	1113
Drill Hose	DNDF [-53C]	In McMurdo	14	1583
Drill Hose	DNDF [-53C]	In McMurdo	14	1430
287 Loader	-	At South Pole	at South Pole	1477
Firn Drill Components - 1	-	At South Pole	at South Pole	-
Firn Drill Components - 2	-	At South Pole	at South Pole	-
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

Float Table:

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

IceCube Upgrade

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

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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

PROJECT NUMBER	WBS	L2 Category	L3 Category	Member #	Team Members	Institution	Labor Code	Total days On Ice	Total working days	Total paid hours (November)	Total paid hours (December)	Total paid hours (January)	Total paid hours (February)	"On Ice"	"Off Ice"
A-334-S	1.1	Management	Mgmt&Safety	1b	Vivian ODell	UW-Madison	MA	24	22	0	0	198	0	1/5/2026	1/29/2026
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
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
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
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
A-334-S	1.1	Management	Project Engineer	4	Perry Sandstrom	UW-Madison	SE	56	46	36	234	144	0	11/25/2025	1/20/2026
A-334-S	1.2.10	Implementation	Installation	1	Delia Tosi	UW-Madison	SC	75	62	108	234	216	0	11/15/2025	1/29/2026
A-334-S	1.2.10	Implementation	Installation	2	TBD	Munich	IK	44	37	0	180	153	0	12/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	3	TBD	Chiba	IK	44	37	0	180	153	0	12/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	4	TBD	DESY	IK	44	37	0	180	153	0	12/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	5	Gary Hill	Adelade	IK	59	50	0	234	216	0	12/1/2025	1/29/2026
A-334-S	1.2.10	Implementation	Installation	6	TBD	Chiba	IK	44	37	0	180	153	0	12/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	7	TBD	MSU	IK	44	37	0	180	153	0	12/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	8	TBD	Wuppertal/Mainz	IK							/8/2025	1/21/2026
A-334-S	1.2.10	Implementation	Installation	9	TBD	TBD	IK							/2025	1/21/2026
A-334-S	1.4	CPT	CPT (electronics)	1a	John Kelley	UW-Madison	SS							025	1/6/2026
A-334-S	1.4	CPT	CPT (electronics)	1b	CPT SME	MSU	SS							26	1/20/2026
A-334-S	1.4	CPT	CPT (cables) / Installation	2a	Chris Ng	MSU	EN-ME							025	1/3/2026
A-334-S	1.4	CPT	CPT (cables) / Installation	2b	CPT SME	MSU	EN-ME							26	1/20/2026
A-334-S	1.6	DAQ	ICECUBE Integration	1	Erik Blaufuss	Maryland	SS							025	1/31/2026
A-334-S	1.6	DAQ	SPAT SME	2	Jeff Weber	UW-Madison	SE							025	1/18/2026
A-334-S	1.6	DAQ	SPAT Helper	3	Install (Rotation)	TBD	IK							025	1/18/2026
A-334-S	1.2	Implementation	Drill	1	Dar Gibson	UW-Madison	EN-ME							025	2/3/2026
A-334-S	1.2	Implementation	Drill	2	Jonas Kalin	UW-Madison	TE							025	2/3/2026
A-334-S	1.2	Implementation	Drill	3	TBD	TBD	TE							025	1/26/2026
A-334-S	1.2	Implementation	Drill	4	TBD	TBD	TE							025	1/26/2026
A-334-S	1.2	Implementation	Drill	5	TBD	TBD	TE							025	1/20/2026
A-334-S	1.2	Implementation	Drill	6	TBD	TBD	EN							025	1/20/2026

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

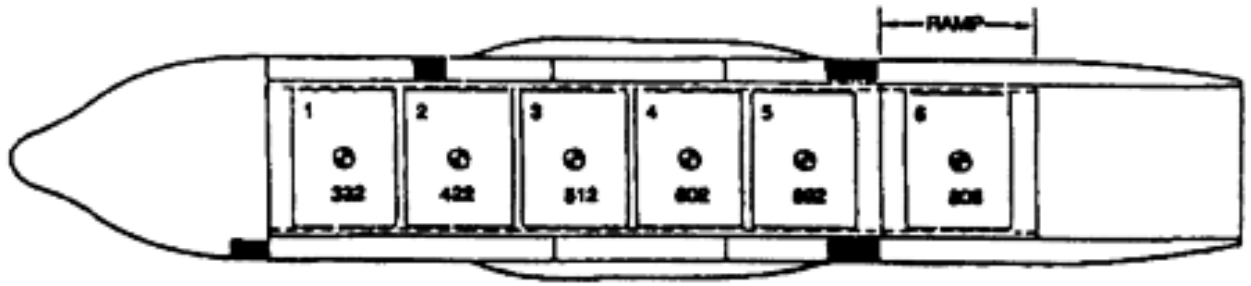
Cargo Item #	WBS L2	Item Description	Contents	Date Item expected or *arrived* to MCM	Date/Month for Items needed at South Pole	Logistical Mode	48hrs		168hrs (1 wk)		336 hrs (2 wks)		672 hrs (4 wks)		1 week delay impact notes	2 week delay impact notes	4 week impact notes
							Probability	Estimated Cost 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					full 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 ate 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 - urs 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)

- 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



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.

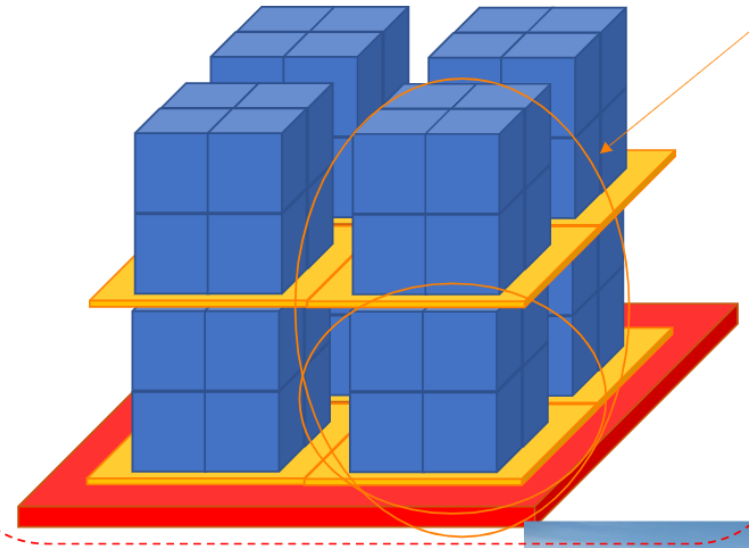
Sensor Load Planning

mDOMs on USAP airlift

CHC→ NPX

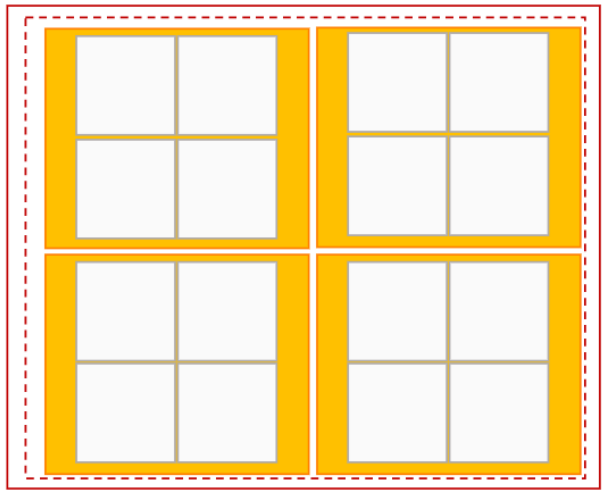
This assembly is done in CHC for C-17/C-130 transport

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

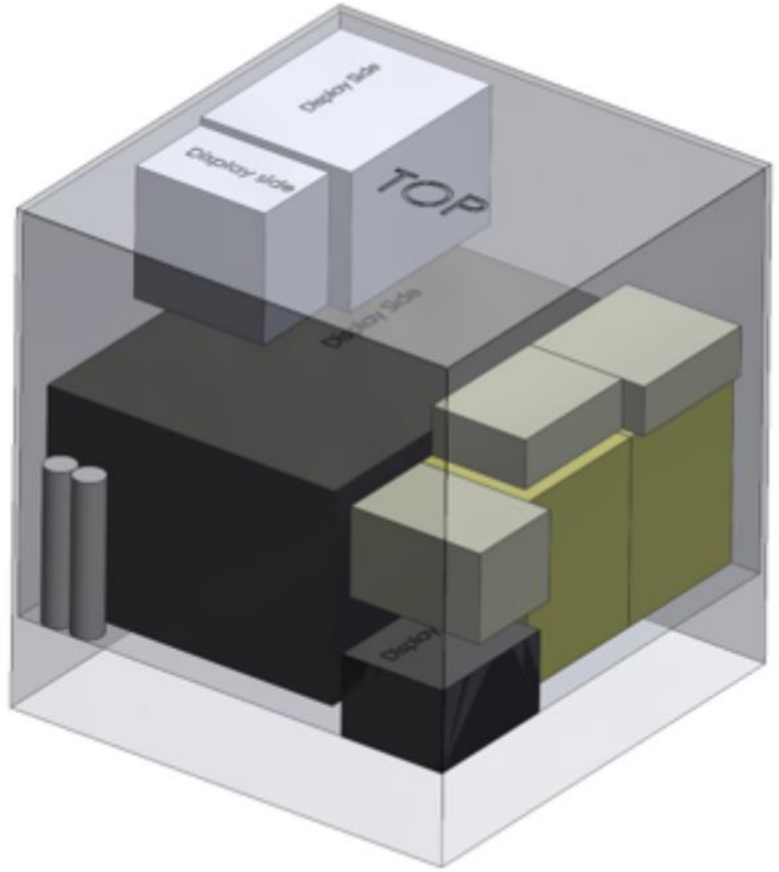
DNF Load Planning

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

SPOT Load Planning

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

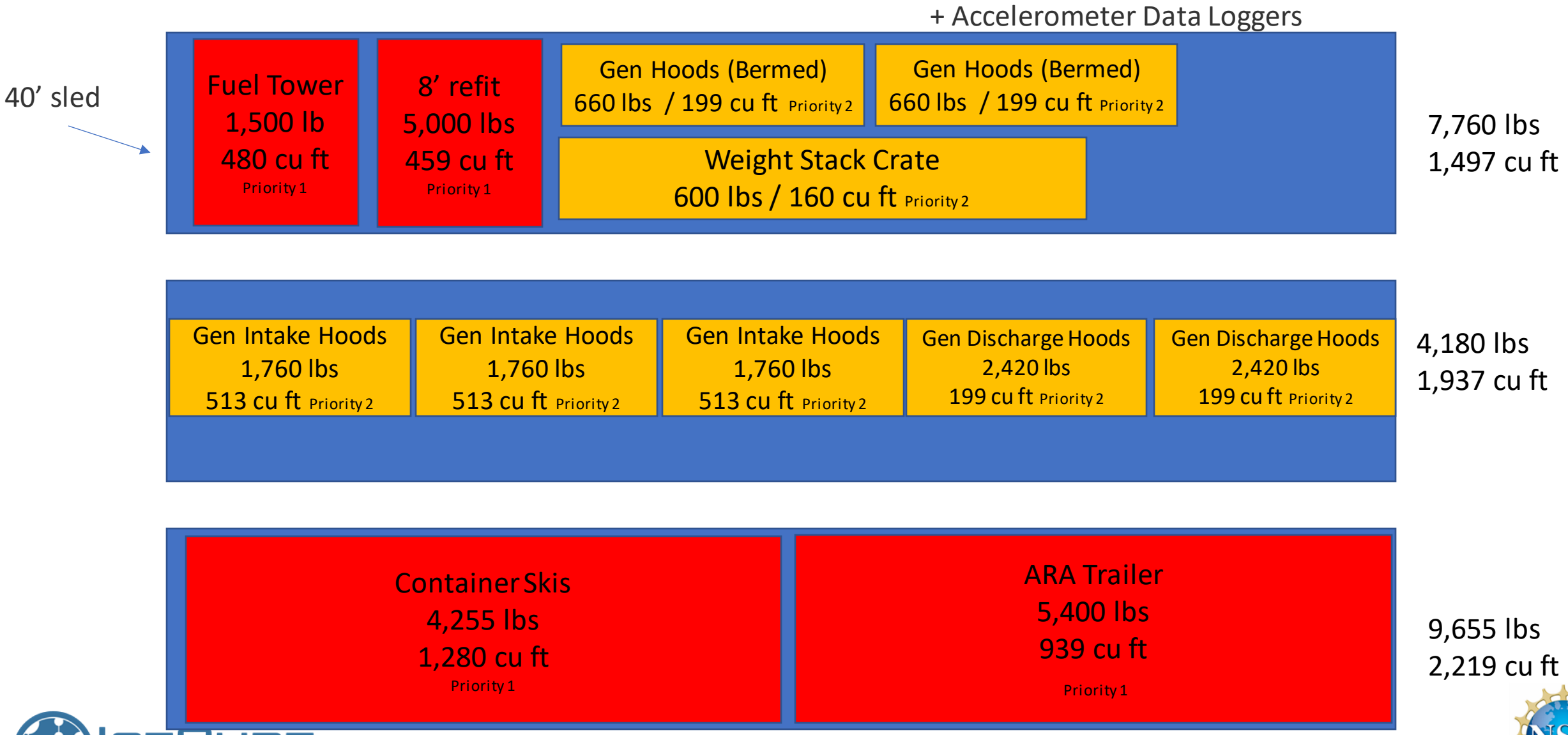
60,000 lb/40' ISO Flatrack
Arrives between 28Jan – 7Feb

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

Response to Previous Reviews

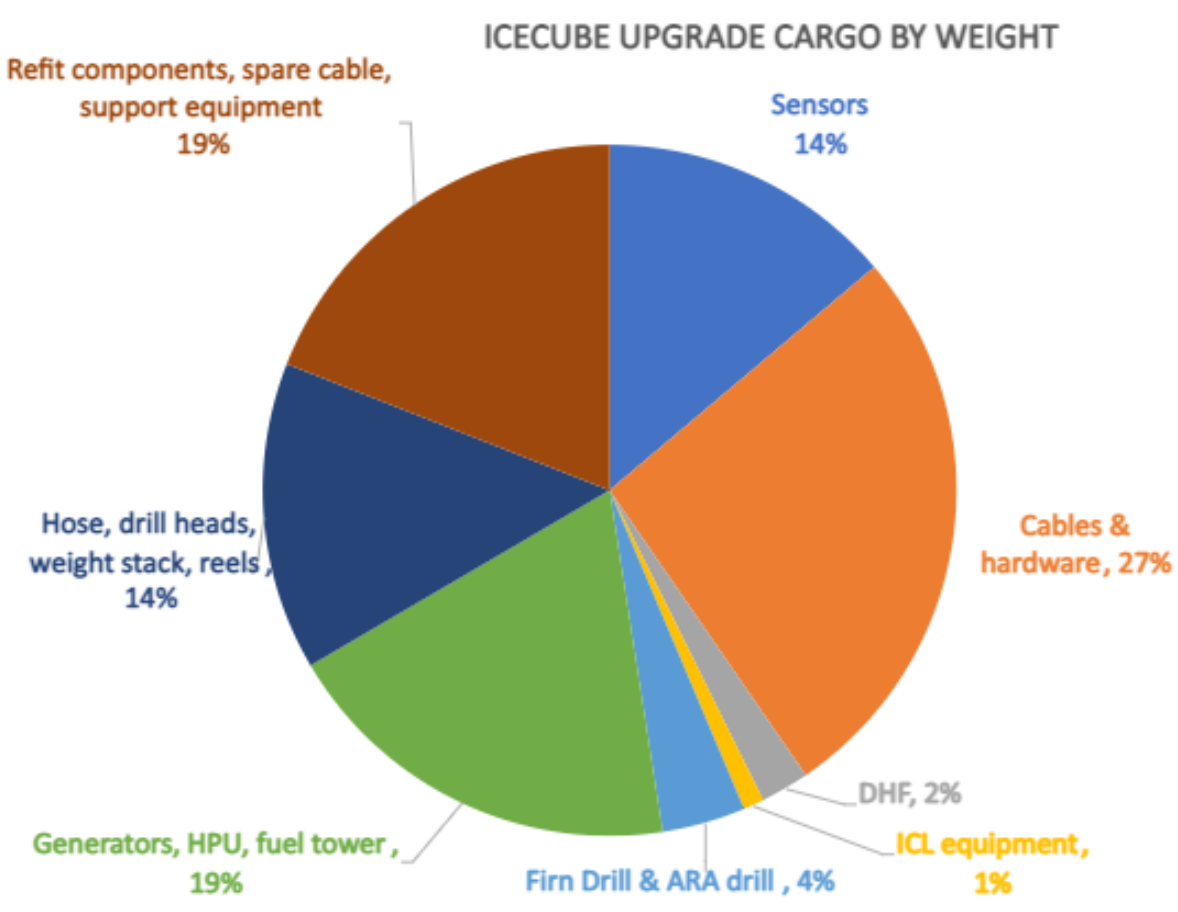
LR5	Give serious consideration to splitting shipments of the two Conex vans of D-eggs into two carriers to reduce potential impacts of an accident with one.	Aya Ishihara, Ian McEwen	open		Will look into shipping separately	Will look into shipping separately
LR7	Planning should identity the schedule float 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 /Ian McEwen/Delia Tosi	closed	04/01/22	Will be done in the IMS as well during IMS cleanup.	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.
NSFLR3	Develop the software toolset to meet the requirements of an integrated master schedule including linkages and dependencies	Jim Lowe	closed	03/10/22	Have made a new bottom up estimate of cost and schedule, including dependencies and linkages.	Have made a new bottom up estimate of cost and schedule, including dependencies and linkages.
NSFLR4	Provide better visualization such as float associated with tasks and cargo	Jim Lowe, Ian McEwen, Delia Tosi	In progress	03/10/22	Working on a good way to show this.	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	closed	04/01/22		Quality assurance process for packing and shipping are being updated and incorporated in the logistics plans.

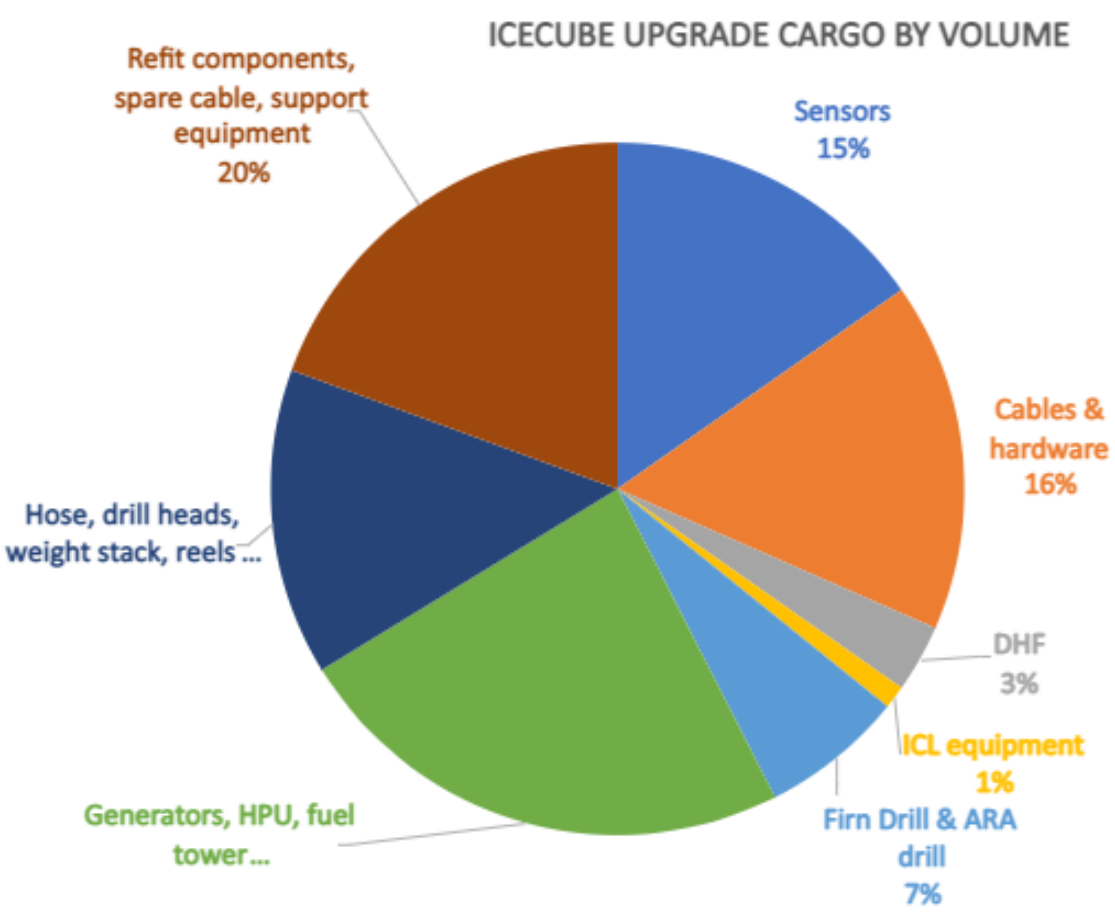
Conclusions

- 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 has developed logistics management tools and IMS greatly improve visibility, traceability and stakeholder engagement

Backup Slides

Cargo by Weight/Volume





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**

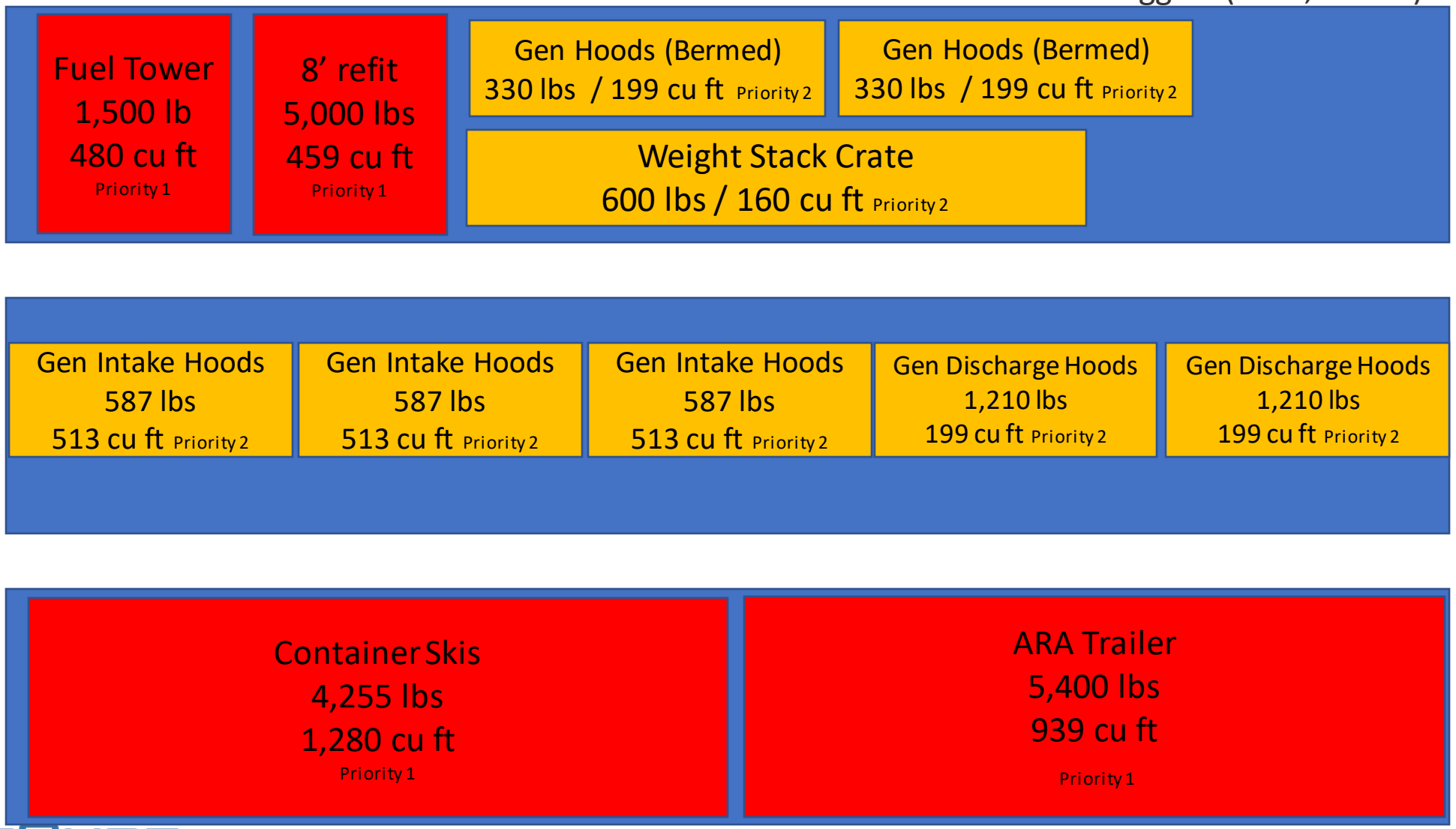
ICU Overland Ground Rules/Assumptions

- 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

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



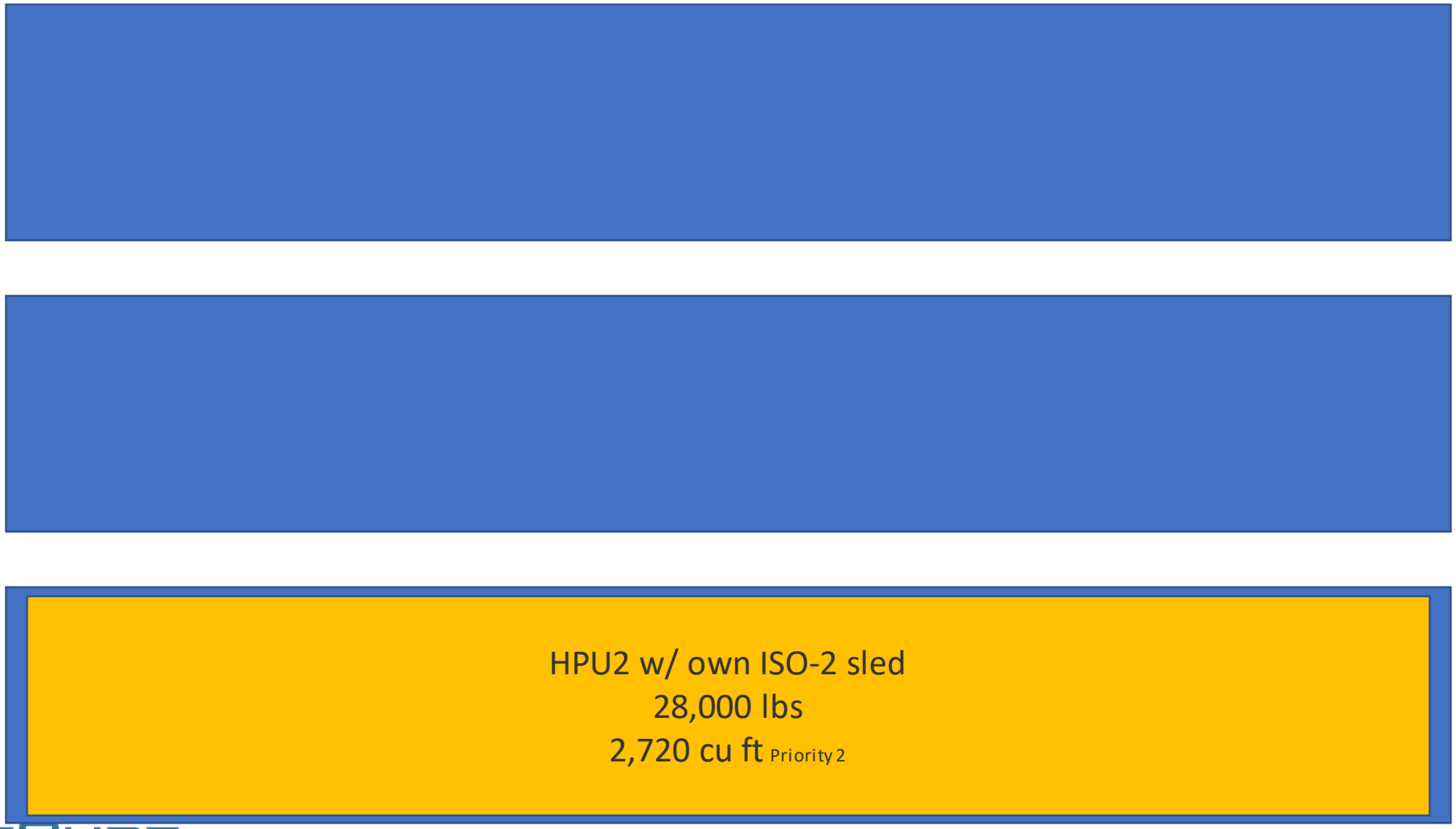
Total FY23 SPOT 1 weight: 21,601 lbs / volume: 5,654 cu ft

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

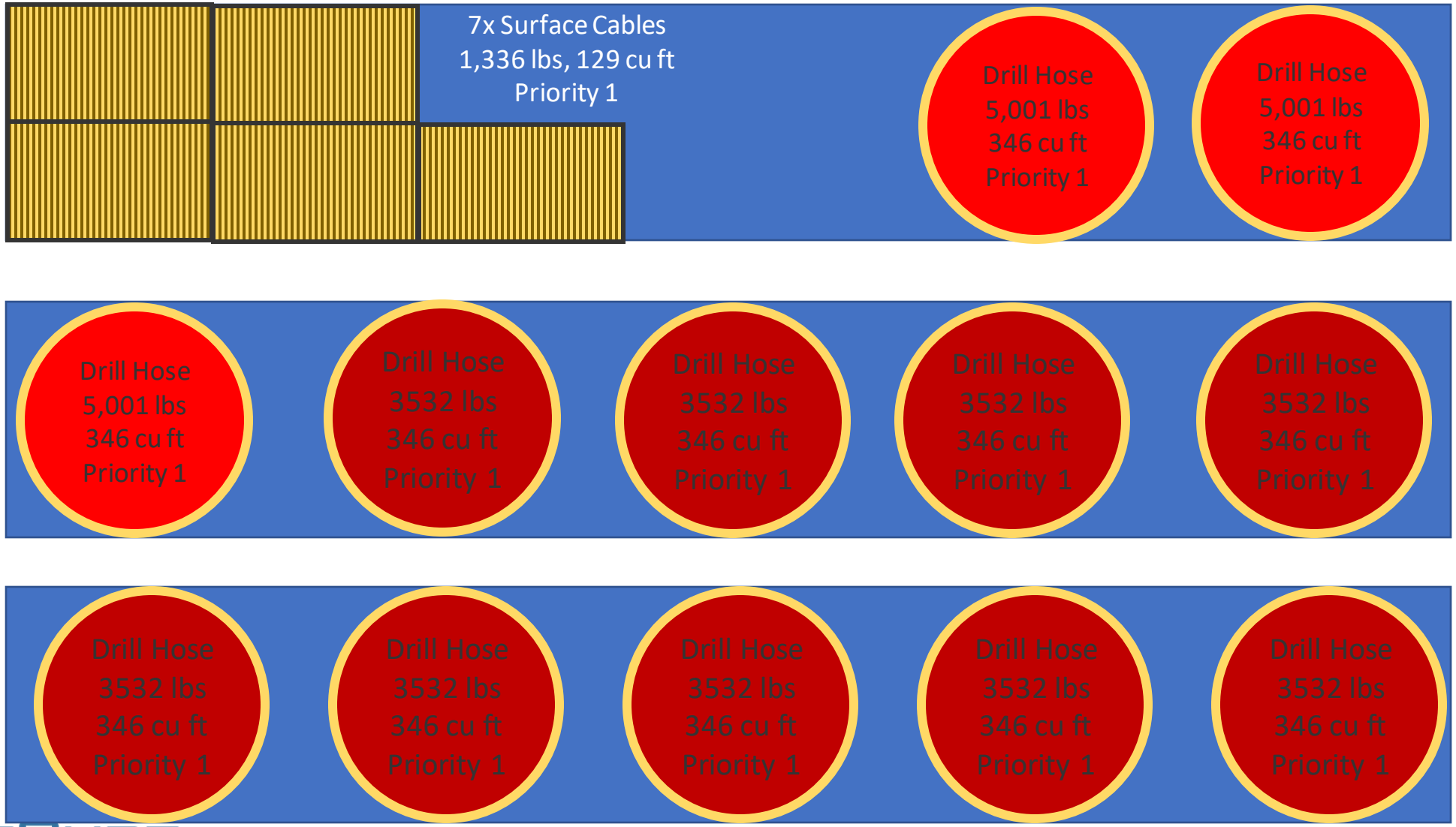
0 lbs
0 cu ft

0 lbs
0 cu ft

0 lbs
0 cu ft

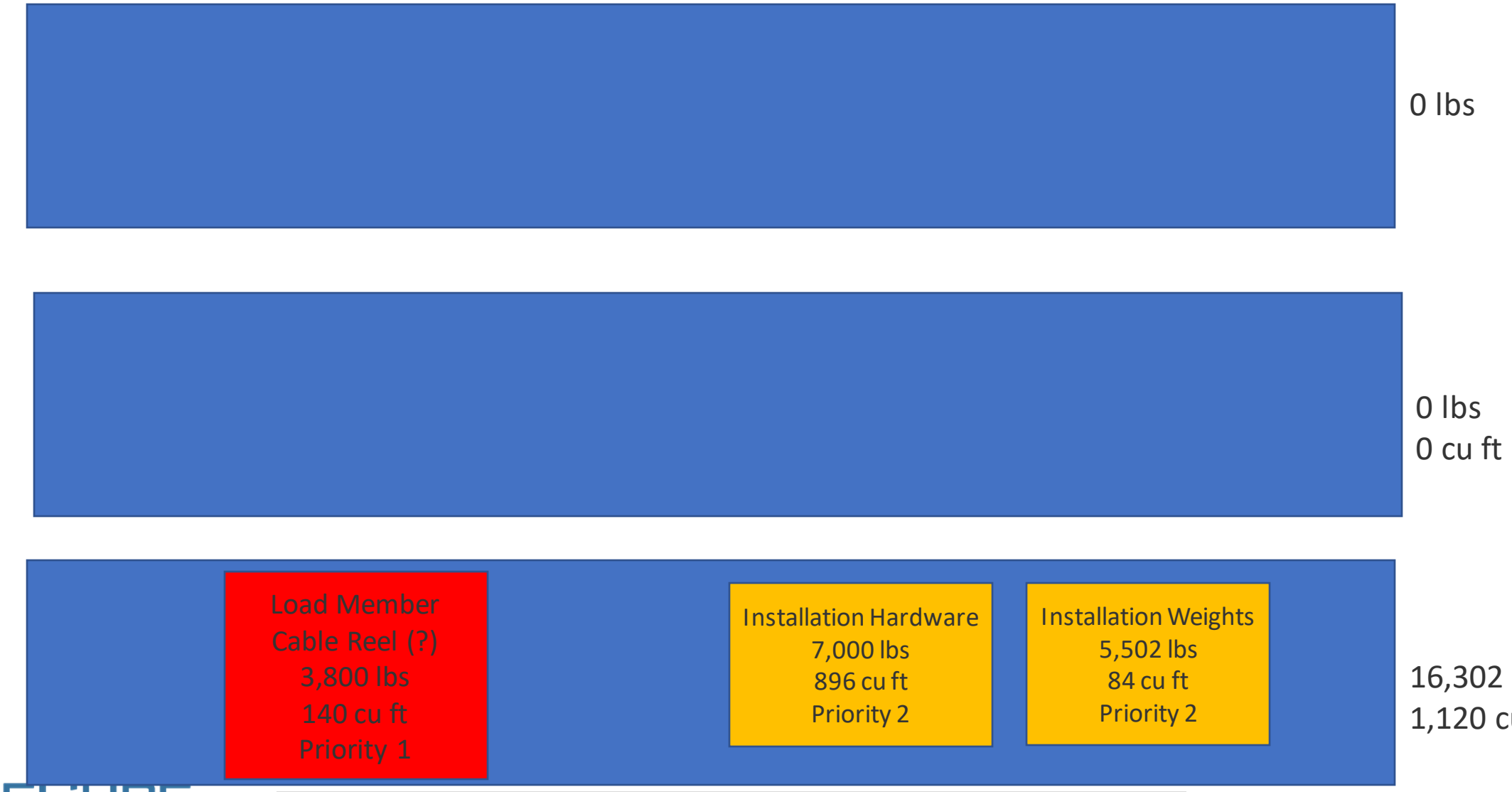
Total FY24 SPoT 3: 0 lbs

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

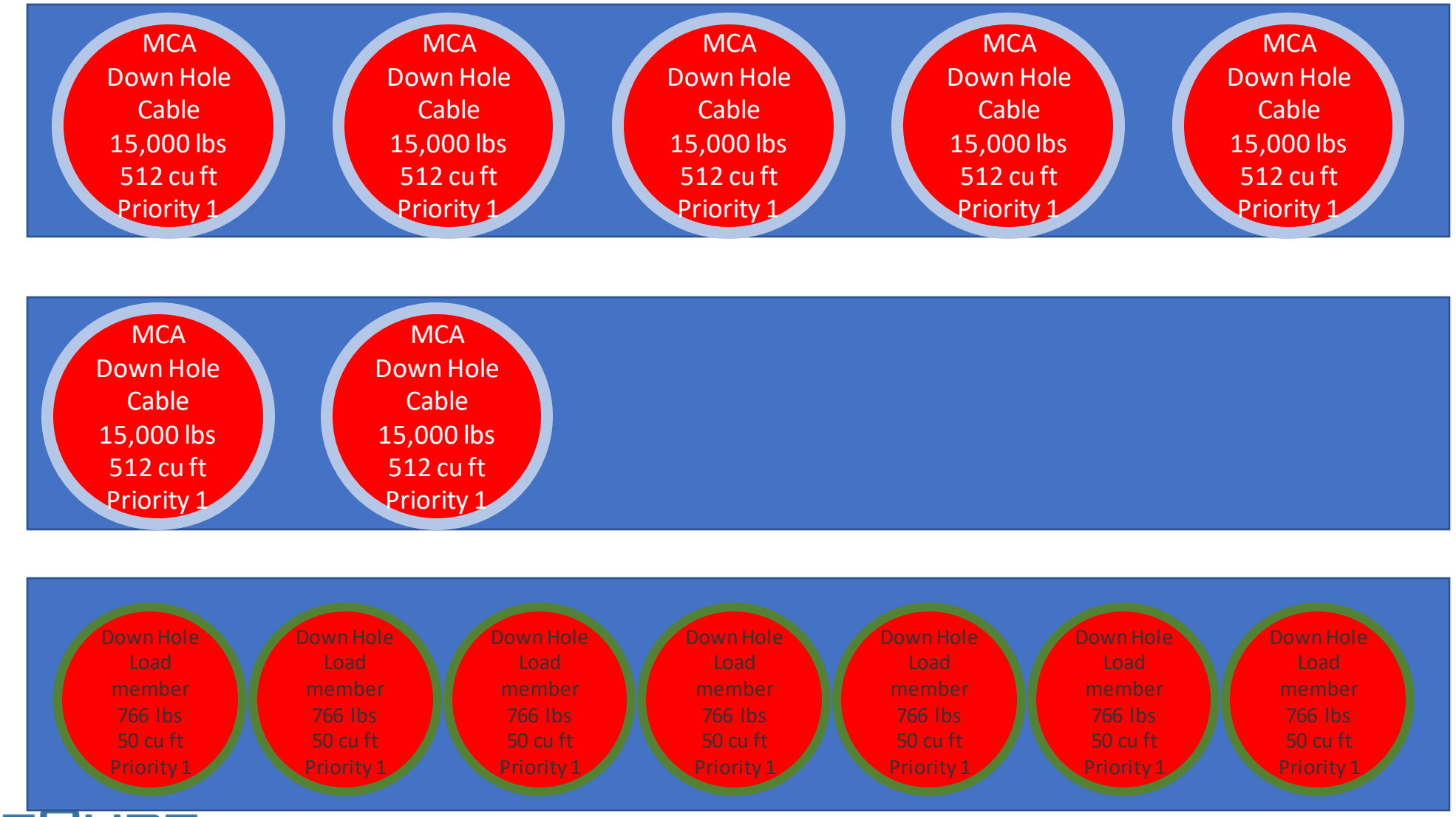


Total FY25 SPOT 2: 16,302 lbs / volume: 1,120 cu ft

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

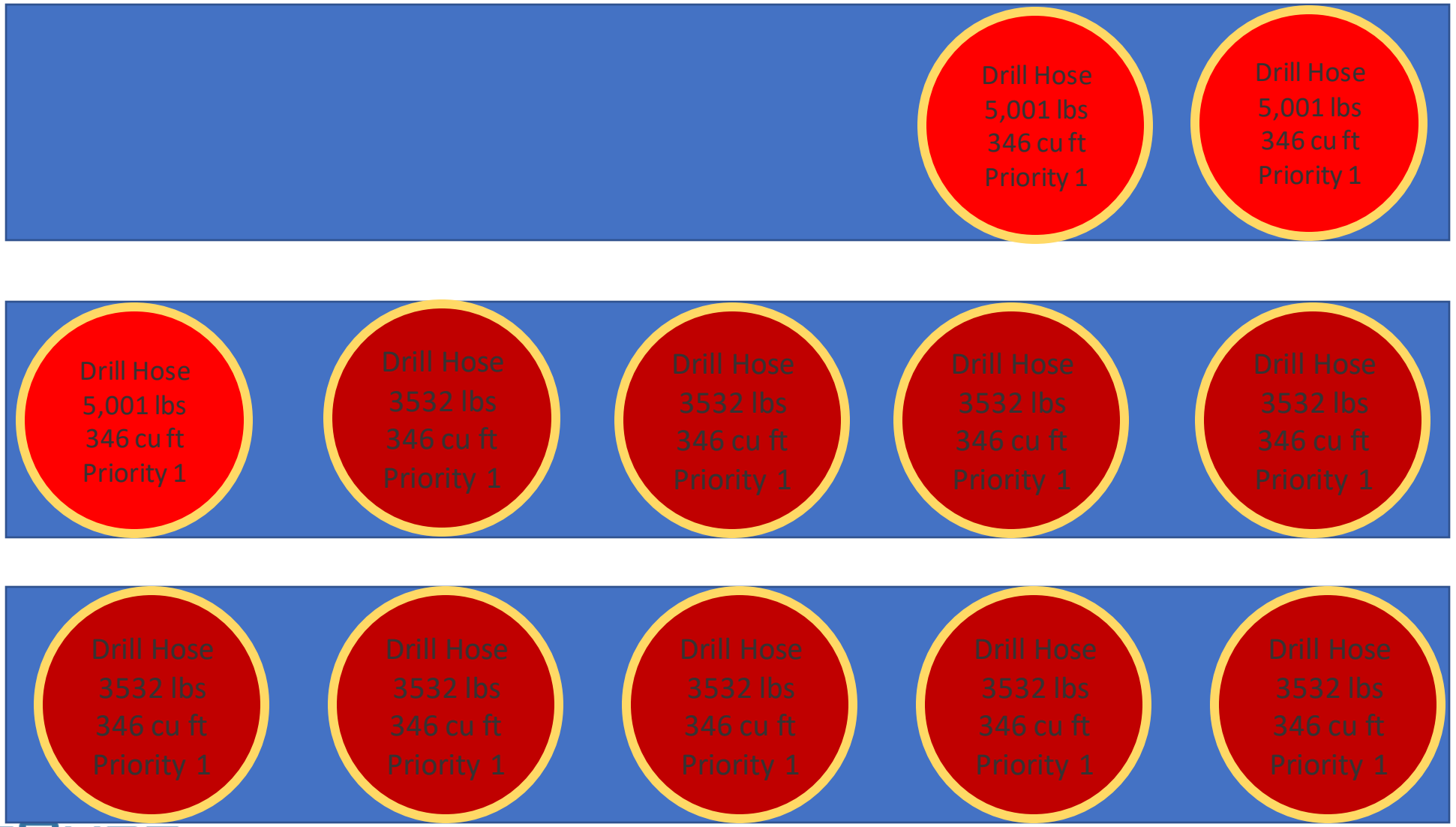
0 lbs
0 cu ft

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

10/14/2021 IceCube Upgrade Fuel - T. Benson 7