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 IAN MCEWEN (Oct 19, 2021 14:09 CDT)	Oct 19, 2021

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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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1 Introduction

1.1 Purpose

This document provides a description of the United States Antarctic Program (USAP) logistics framework and addresses how, within this framework, to estimate, pack, label, document and ship materials for entry into United States Antarctic Program (USAP) Cargo Tracking System. In conjunction with USAP Packing and Shipping Manual TL-MAN-0002 (1), this document guides IceCube Upgrade institutions planning, preparing, and forwarding of South Pole bound shipments. The goal is a comprehensive description of the process to get cargo to the South Pole using the USAP logistics pipeline.

This document is organized as follows. Section 2 starts with background material including identifying the cargo management sites, the means of transportation available (Conveyances) and a description of their typical use, and then describes the USAP role, responsibility, and key personnel for cargo logistics. Section 3 summarizes the cargo logistics for IceCube-Gen1 for context on how the logistics situation has changed for the Upgrade project. Section 4 goes over the logistics methodology for IceCube Upgrade cargo. A comprehensive example of the logistic methodology is provided in the Appendix describing the shipment of optical sensors from Germany to the South Pole. A Glossar is provided at the end of the document.

1.2 Requesting Logistical Support

Each field season, the IceCube Upgrade project states its logistical needs (passengers/cargo) using the Support Information Package (SIP) submitted in the Participant On-Line Antarctic Resource Information Coordination Environment (Polar Ice). Based on the SIP, the USAP contractor develops a Research Support Plan (RSP) in collaboration with the National Science Foundation (NSF).

2 Background: the USAP Logistics Chain

The logistic streams to Antarctica are some of the longest and most difficult cargo delivery routes in the world. All the cargo directed to the South Pole flows through one or more the following cargo management sites:

- Port Hueneme, California **(PTH** or **NBVC)**
- Lyttelton, New Zealand **(NZ LYT)**
- USAP Air Cargo Yard Christchurch, New Zealand **(CHC)**
- McMurdo Station **(MCM)**
- South Pole Station (**NPX**)

2.1 Conveyances

To plan USAP related logistics flows, it is imperative to understand the paths of cargo transport to and on the Antarctic continent. The USAP contractor ultimately determines the mode of transport (USAP Vessel, COMSUR, & COMAIR) based on the date received and date required on site. The

shipping modes and transport times both need to be taken into account to meet the Port Hueneme cargo arrival cut-off dates. The USAP contractor annually publishes a Continental Area Acquisition Schedule (2), TL-FRM-0049, which should be used to determine the key dates.

2.1.1 USAP Resupply Vessel

The USAP charters one container ship annually to move cargo between Port Hueneme, California and McMurdo Station. Lyttelton, New Zealand is a regular stopover port during the voyage to McMurdo Sound. The vessel departs Port Hueneme in late December and arrives in McMurdo in late January/early February. Cargo slated for vessel should be delivered to Port Hueneme at least two to four weeks before the mid-December cut-off to allow for processing/loading. This is the point where cargo enters the USAP cargo system.

The annual resupply vessel is the most cost effective and the most reliable method for Antarctic shipping. Use of the resupply vessel minimizes touchpoints associated with cargo transfers from surface modes to air modes and eliminates the potential delays and bottlenecks that frequently accompany airlift operations. Heavy airlift space, referred to as pallet positions, are a valuable commodity. It is not uncommon for reprioritization of cargo to occur due to emergent requirements.

In mid-March, the USAP resupply vessel returns from Antarctica with retrograde cargo to Port Hueneme, CA for offload. The handling and onward shipment of scientific materials/samples shipped on the northbound vessel are given priority over general cargo. The resupply vessel should be considered the primary option for shipments north, as well, for cost and efficiency.

2.1.2 Commercial Shipping

Commercial surface shipping (COMSUR) moves cargo via ocean going surface vessel throughout the year from the port of origin to Lyttelton, New Zealand. Upon arrival in Lyttelton, cargo can either be held at the port's cargo yard and loaded onto the USAP vessel when it stops there on its passage South, or it can go through customs and be delivered to the USAP Air Cargo Yard for delivery by air to McMurdo. Cargo that arrives in Port Hueneme with a McMurdo/South Pole required on site (ROS) date that precedes vessel arrival will be containerized and shipped COMSUR to New Zealand. COMSUR shipments that require utilization of airlift to McMurdo should be avoided to the greatest extent possible. The USAP airlift capacity is heavily burdened and costly. Cargo that uses this transport method has far greater chance to experience delays than cargo moved by vessel.

Commercial Air Cargo (COMAIR) moves cargo through a commercial airline. It is used for extremely sensitive shipments and those that cannot arrive at their Antarctic destination by using available surface transport options. COMAIR should not be considered a primary shipping option because it is quite costly and requires prior approval from the NSF.

2.1.3 **USAP Airlift**

The primary heavy airlift link between Christchurch and McMurdo is the Special Assignment Airlift Mission (SAAM) flights supplied by United States Air Force's (USAF) C-17 cargo planes chartered by the USAP. SAAM flights typically start at the beginning of the austral summer and continue into mid-November. In early February they resume to support passenger redeployment and final station supply. Special coordination is required for all SAAM flights, and they are expensive. As much as possible avoid use of SAAM for cargo movements; there is no guarantee a SAAM flight will be available.

The New York Air National Guard (NYANG) supplies LC-130 heavy airlift, carrying passengers, cargo, and fuel to Amundsen-Scott South Pole Station. With roughly 80 missions per season the cargo capacity is limited. As much as possible, shipments should be packaged and timed to allow cargo movement overland. Shipments that require special handling such as temperature sensitive equipment are not suitable for overland transport.

The dimensions of all cargo packages that could potentially ship by heavy airlift should be given special consideration to maximize the use of available aircraft space. Details for air cargo are covered later in this document.

2.1.4 **South Pole overland (or operational) Traverse (SPoT)**

The South Pole overland Traverse (SPoT) was developed over the last decade to haul fuel over the 995-mile-long route connecting McMurdo Station to South Pole Station. Efficiencies learned over the past fifteen years have allowed for expansion of capacity to include cargo movements to and from the South Pole. Oversize cargo and cargo loaded into 20' shipping containers are ideal for overland transport.

Two sets of tractors are operated over the season making a total of three South Pole traverses. The first traverse, SPoT1, heads south in early November breaking and proving trail while pulling a load of fuel. In general, SPoT1 has very little capacity for cargo. Near Thanksgiving SPoT1 arrives at the Pole to offload fuel and make repairs, in short order, before returning to McMurdo. Roughly three weeks after the departure of SPoT1 from the Pole, roughly December 1, the second set of tractors, SPoT2, arrives with a heavy load of fuel and cargo. SPoT1 becomes SPoT3 when it is turned around in McMurdo with a fresh load of fuel. The well-packed trail makes for an easier traverse. In addition to the fuel resupply, some limit cargo movement may be possible but SPoT3's travel window is limited since it must get off the ice-shelf before the temperature makes travel prohibitive.

2.2 USAP Role/Responsibility

The USAP (NSF & the Antarctic Contractor) provides cargo services, including cargo planning, logistics support from point of USAP cargo system entry to destination, and direct support on station. The USAP contractor covers shipping related costs between the Continental United States (CONUS) or New Zealand and the South Pole. The cargo weight and volume allowances approved for a specific science project are described in the Operational Notice. Any excess above approved allowances requires NSF authorization.

2.3 Key USAP Logistics Personnel

All communications with NSF/ASC on logistical matters should go through the Upgrade Project Office or the Upgrade Implementation Manager for consistency and to maintain a complete record of communications.

NSF Logistics Manager
The NSF Logistics Manager is the leader of the logistics meta-planning group. Cargo, fuel, and season population information are supplied to the Logistics Manager for review and dissemination.

Science Project Manager - contractor
The Science Project Manager is the primary liaison between Upgrade and Antarctic Contractor personnel. Questions and clarifications about specific shipments or packing and shipping details should be channeled through the Science Project Manager.

South Pole Area Manager – contractor
Among a host of other responsibilities, the South Pole Area Manager is responsible for population planning and management and also has a role in outyear fuel projections and resupply planning. Questions and clarifications on population or fuel related matters should be initiated through the Upgrade Implementation Manager

USAP Transportation and Logistics Manager - contractor
The USAP Transportation and Logistics (T&L) Manager may delegate specific actions but is ultimately responsible for cargo operations and science cargo planning to support cargo movements through McMurdo Station.

Port Hueneme Operations Manager - contractor
The Port Hueneme Operations Manager oversees activities at Port Hueneme Naval Base Ventura County (NBVC), the entry point into the USAP cargo system.

South Pole Logistics Supervisor - contractor
The South Pole Logistics Supervisor coordinates all science cargo destined for the South Pole and is the primary contact at the South Pole for logistics related questions and on-site support.

3 IceCube Logistics Overview

IceCube-Gen1

The IceCube Neutrino Observatory (referred to as "Gen1" in this document) was built over the course of seven Antarctic seasons from 2004-2005 to 2010-2011. The logistics effort required moving a total of 4.4 million pounds of cargo, averaging 628,000 pounds per season with a peak of 1.1 million pounds in 2004-05. All IceCube cargo was shipped from each point-of-origin (including international shipments departing Germany and Sweden) to Port Hueneme, CA. The majority of the cargo was shipped from Port Hueneme to Christchurch, NZ by commercial surface/air.

The USAP airlift moved IceCube cargo from Christchurch to McMurdo via Air Force C-141 (decommissioned in 2006) and C-17 aircraft. From McMurdo IceCube cargo was flown to South Pole on ski-equipped LC-130 aircraft operated by the New York Air National Guard (NYANG). During this period, each season there were generally around 250 flights between McMurdo Station and South Pole, though there were seasons with over 300 missions. The South Pole overland traverse was still under development, so the NYANG was the only option for movement of cargo to the station. Full shipping containers were accepted for air transport at that time, including generator containers and complete Mobile Drilling Structures that make up much of the Enhanced Hot Water Drill.

IceCube Upgrade

The USAP logistics system has undergone significant changes since Gen1. During the Austral summer season from mid-November to end of January there is now a heavy airlift (SAAM) gap period, a time in which no C-17 missions are flown. During this period, NYANG LC130s are the primary link to New Zealand. The LC130's smaller size and longer travel times, compared to the C-17, limit both the frequency and the quantity of passenger/cargo movement. Generally, the South Pole will also see fewer missions during the heavy airlift gap as the LC-130s service the north/south intercontinental leg. The USAP cargo vessel is the preferred mode of transport as it moves cargo directly to McMurdo minimizing air transportation needs.

The number of LC-130 missions from McMurdo to the South Pole during the summer season now range between 80 and 90. The Air National Guard no longer accepts full containers for air transport on LC-130s although C-17s can still transport properly restrained full containers. The South Pole overland Traverse (SPoT) recently began moving cargo in addition to fuel, opening a pathway to a far more cost effective mode of transport from McMurdo to the South Pole in the future. This pathway would also allow cargo containers to travel from their point of origin to the South Pole without being unloaded and repacked for transport on the LC-130s.

4 ICU logistics methodology

The success of logistics planning for IceCube Upgrade is vital to the overall project success. The way materials are provided, controlled and utilized affects cost, schedule, quality and safety. Logistics management for Upgrade at the South Pole is much more complex than in in a developed environment, where suppliers are close by, transport is regular and frequent, warehousing/storage

is ample, and support predictable. A significant time investment is needed upfront for logistics planning/implementation that incorporates an ability to adapt and adjust as conditions change.

4.1 Philosophy

The cargo logistics plan is developed to minimize risk while maintaining scope, cost and schedule by

- Reducing waste
- Minimizing surplus materials while maintaining adequate maintenance and repair supplies
- Designing systems/components with shipping in mind
- Maximizing the use of USAP vessel and overland transport to the South Pole
- Minimizing storage time, where possible
- Minimizing touch points, particularly in McMurdo
- Packing institution-owned intermodal shipping containers at point of origin when feasible
- Continuously looking to improve logistics efficiencies with ongoing process improvement

4.2 Assumptions

- The resupply vessel that departs from Pt. Hueneme annually in mid-December and arrives in McMurdo early in February is the preferred method of transport.
- Commercial surface shipping can provide cargo movements from international locations and the continental US outside the resupply vessel timeline. Cargo will be delivered to Lyttelton, NZ for loading onto the USAP resupply vessel or delivery to the Christchurch Air Cargo Yard for SAAM shipment.
- Commercial Air (COMAIR) is to be used only for sensitive cargo or urgent resupply - permission for use of COMAIR is granted through ASC by NSF.
- Very little ‘Do Not Freeze storage’ is available at either McMurdo or the South Pole.
- On the McMurdo to South Pole leg, overland transport is the preferred shipment method rather than by air.
- As much as possible, cargo should be loaded in 20’ shipping containers for overland transport. Cargo inside containers should also be packaged in crates that work well with 463L palletization if possible. This allows cargo to be placed on planes should pallet positions be available or delays incurred that require expediting shipments.
- The only constant in Antarctica is change so contingencies must be considered and planned for.

4.3 Planning

The NSF/Antarctic contractor is the primary logistics provider. The IceCube Upgrade (ICU) will comply with the processes and procedures described in the USAP Packing and Shipping Manual, TL-MAN-0002 (1), collaborating with NSF/Contractor project managers and NSF/Contractor logistics planners to detail shipment information & requirements.

Shipment departure and arrival dates and contractor support requirements must be detailed in the Upgrade Schedule to facilitate communications/tracking. For ICU shipments to USAP cargo

system entry sites (Christchurch & Port Hueneme) adding float, two to four weeks or more, is appropriate. This buffer provides for commercial shipment delays and allows the USAP site ample time to receive, inspect, and prepare the shipment.

Do not pad Required On-Site (ROS) dates, when the cargo must be at the South Pole, with float. USAP logistics planners need to see unbuffered required by dates to make good logistical decisions. The USAP logistics system is heavily burdened. Adding a buffer of two weeks could preclude a USAP shipment option (overland vs air) that would otherwise be considered. Assign reasonable arrival dates based on the schedule and communicate to ASC that the (ROS) date is when the item is needed. They will weigh the options based on all Antarctic cargo needs and build in the buffer. Grantees adding float to a shipment breaks the USAP cargo system. While the current USAP Continental Acquisition Calendar TL-FRM-0049 (2) should be used for planning purposes, it is good practice to confirm ROS calendar dates with NSF/contractor every year.

As much as possible, the USAP resupply vessel should be used to move cargo to McMurdo. While a small portion of resupply vessel shipments can arrive at the South Pole before station close, via late season LC-130s, the majority will overwinter in McMurdo and ship to the South Pole by air or surface in the following summer season. In general, allowing a minimum of 9-10 months between McMurdo arrival and delivery to the South Pole is realistic for most shipments.

Shipments that have special storage requirements, such as Do Not Freeze (DNF) or Do Not Deep Freeze (DNDF, a lower storage temperature limit of -40°C), cannot overwinter at McMurdo due to limited DNF storage resources. These shipments should move directly to Pole before station close. South Pole also has limited DNF storage space. Allocation of this space for overwinter storage must be coordinated with and approved by the "owner" of the space; IceCube M&O for IceCube Lab (ICL) storage and the USAP contractor for anywhere else at South Pole (Cryo, Logistics DNF, B2 Lab).

All shipments from the continental US (CONUS) should enter the USAP cargo system in Port Hueneme. The majority of international shipments should be routed through New Zealand. Moving cargo from Japan or Germany to Port Hueneme adds cost, complexity, touch points, and risk. In these cases, it is far more efficient to ship directly to Christchurch where the cargo can either be placed on the USAP resupply vessel when it stops in Lyttelton, New Zealand (preferred) or on a SAAM to McMurdo. See Figure 1 for an illustration of the various paths to the South Pole for cargo departing from points of origins relevant to the IceCube Upgrade project.

There will be cases where emergent items and field season resupplies will need to move South at an expedited pace. For example, during the refit and pre-drill seasons there will likely be discoveries made in the course of drill repair and set-up that require additional material early in the following season. Reasonable allowances must be made in the logistics plan to account for these resupplies. These expedited resupplies will consume SAAM airlift pallet positions and should be kept to a minimum by planning thoroughly, accomplishing off-ice work on time, and through rigorous quality control. Expedited shipments, as much as possible, should be sized to fit within the usable area of single 463L Air Force pallet (see Figure 2).

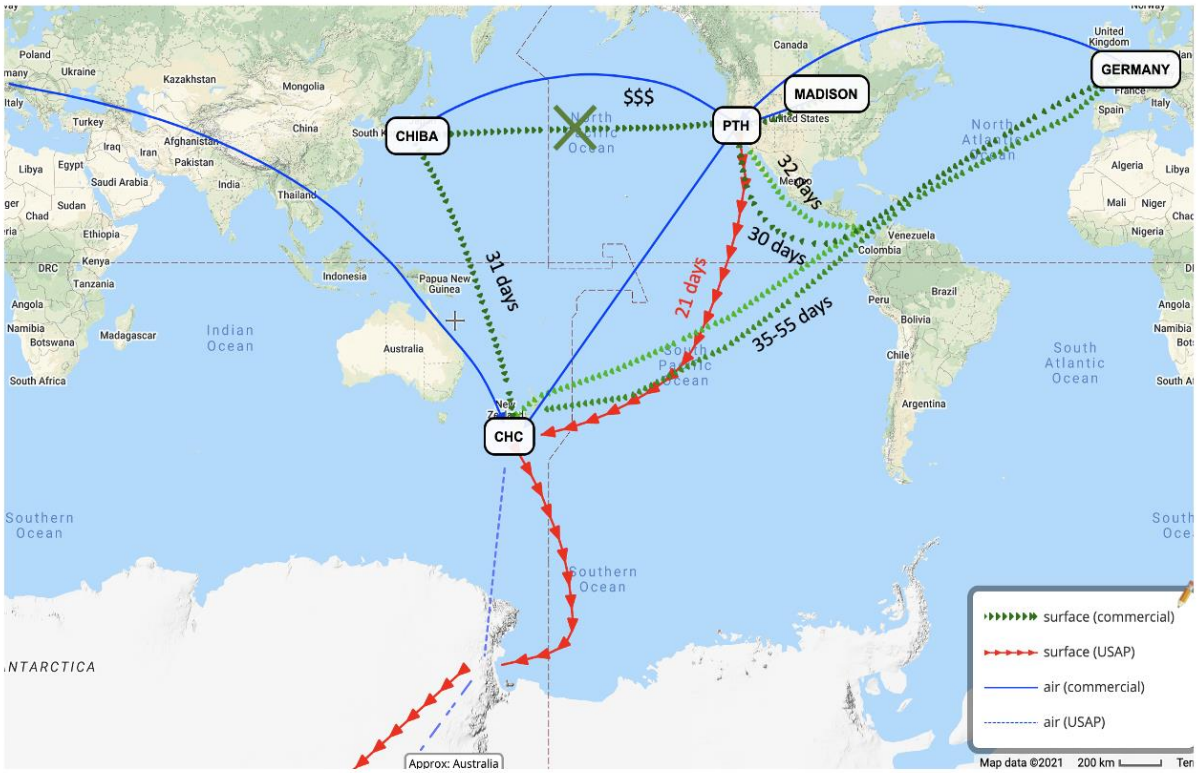


Figure 1: Modes of transport for cargo from point of origin to the South Pole

463L Air Force Pallet

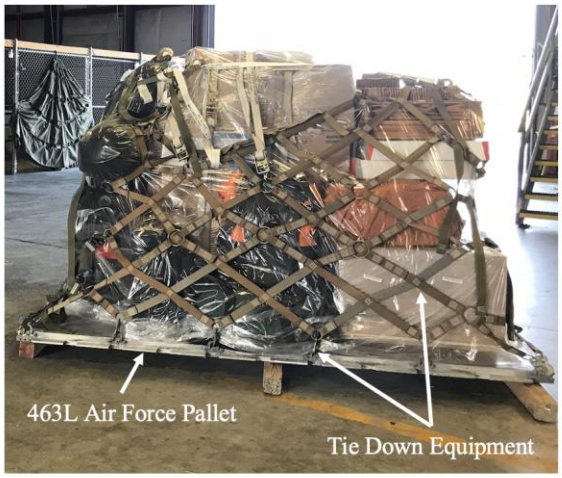
- External dimensions are: 108"W X 88"L X 2.25"H
- Pallet weight: 300 lbs
- Max load capacity 9700 lbs (including Tie Down Equipment "TDE")

463L pallets can be linked together into pallet trains up to 5 pallets long (LC-130) - requires special handling so it should be avoided if possible

- Max usable footprint (T1 pallet)*: 102" W x 88" L
- Max usable footprint (T2 pallet)*: 102" W x 176" L

*includes 6-inch walkway on W dimension (108"→ 102")

- Max height of 102" H (96" is preferred for loading ease)
- The dimensions above INCLUDE user provided wood/plastic pallet



HTTPS://WWW.AARCORP.COM/463L-HCU-6/E-PALLET/

Figure 2: Air Force Pallet dimensions and capacity

4.4 Estimating cargo weight and size

An ICU Cargo Master Spreadsheet is maintained to coordinate project cargo requirements with the NSF/USAP contractor and monitor it internally. All project cargo bound for Antarctica must be listed along with actual (or estimated) dimensions and weight along with shipment departure

and arrival dates that align with the project schedule. Details such as a description of the shipment, owning institution, point of origin, and special handling requirements are also included. When actuals are not available, the dimension and weight estimates should be made to the greatest possible accuracy and include packaging but not tie down equipment (TDE). To estimate the size and weight of each cargo shipment, a bottom-up approach should be used, with a local subject matter expert at each IceCube Upgrade institution listing contents size and weight and defining appropriate packaging. If the intent is to ship cargo in an institution-owned container to McMurdo, the tare weight of the shipping container needs to be included as well. In this case, a "container tare weight included" note should be added in the comments column of the spreadsheet if it is not obvious in the description.
For a summary of deliverables by WBS and corresponding Subject Matter Experts (SME) and Logistics Experts, see Table 1. A case study example for shipping light sensors from Michigan State University and DESY in Germany to South Pole can be found in the Appendix.

Table 1: SME and Logistics contacts based on WBS structure

WBS	**Physical items deliverable to South Pole**	**Subject Matter Expert (SME)**	**Logistics Expert**
1.1 Project Office	-		
1.2 Implementation	Drill Equipment Installation materials	T. Benson / D. Gibson D. Tosi	I. McEwen I. McEwen
1.3 Deep Sensors	mDOMs DEggs pDOMs Special Devices	T. Karg A. Ishihara P. Sandstrom S. Boeser / Various	D. Tosi
1.4 CPT	Surface Cables/Junction Boxes Downhole cables (Main + BCA) FieldHubs ICL Patch Cables/Panels Timing Electronics Power System	T. DeYoung / J. Kelley T. DeYoung K. H. Sulanke J. Kelley J. Kelley J. Kelley	D. Tosi
1.5 Calibration	POCAM Acoustic Module Pencil Beam Dust Logger + Winch	D. Williams / E. Resconi D. Williams / C. Wiebush D. Williams / C. Wendt D. Williams / D. Tosi	D. Tosi
1.6 Integration	-		

4.5 Estimating cargo shipping date

To define the Required Delivery Date (RDD) of a shipment to the port where it enters the USAP cargo system, it is easiest to begin with the date it is required at the South Pole and work backwards. The following visual aids illustrate the process for defining logistics pathways and key dates.

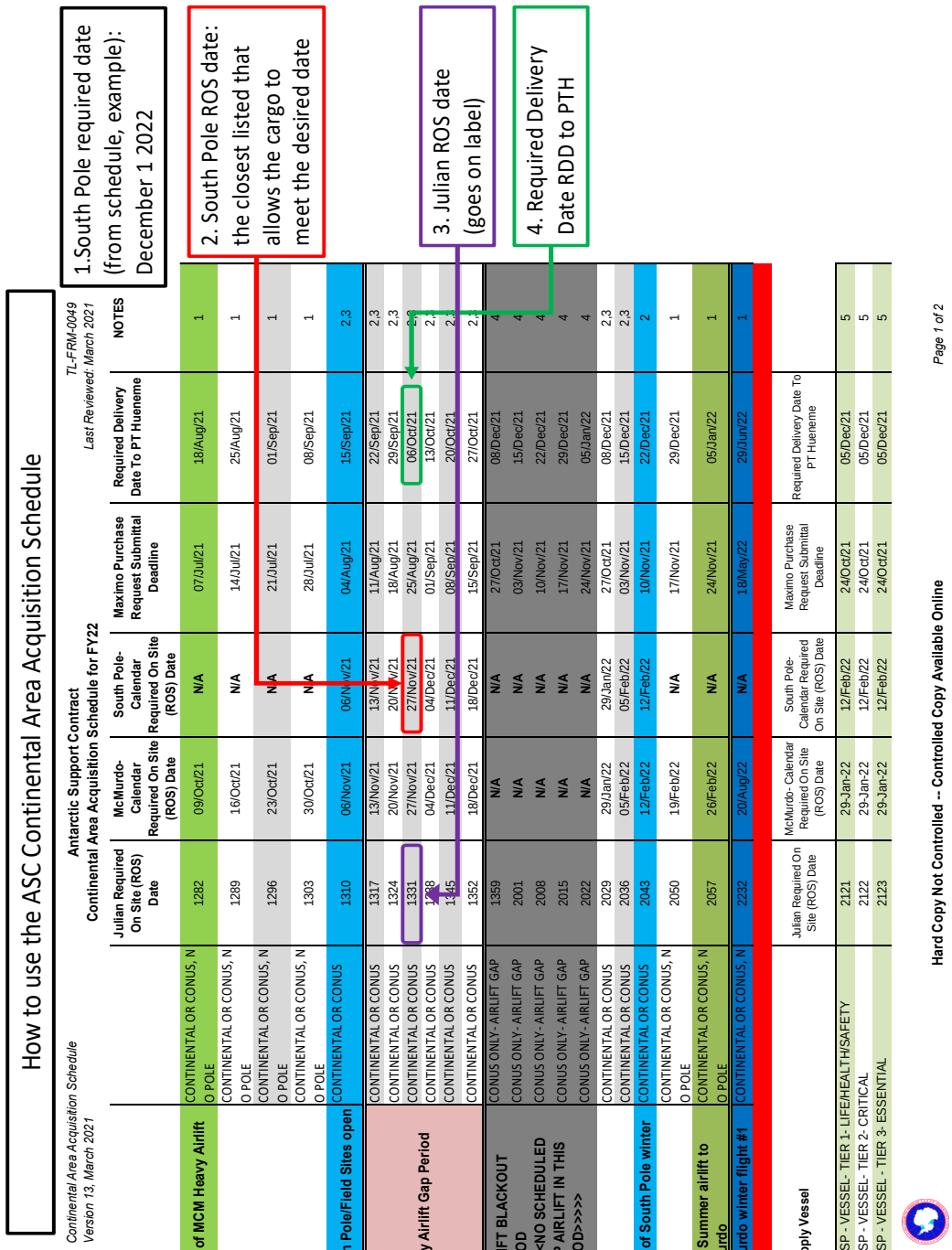


Figure 3: USAP Continental Area Acquisition Schedule

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- For each cargo piece, the most efficient shipping path is determined using the diagram in Figure 4 for items departing the continental United States, and in Figure 5 for items with a point of departure located outside the continental United States.
- Refer to the project schedule to determine the South Pole arrival requirement.
- Next, determine Required On Site (ROS) and Required Delivery Dates (RDD) using the USAP Continental Acquisition Calendar, TL-FRM-0049, as shown in Figure 3. Use the same RDD for direct shipment to Port Hueneme from CONUS locations and for international shipments bound for New Zealand.

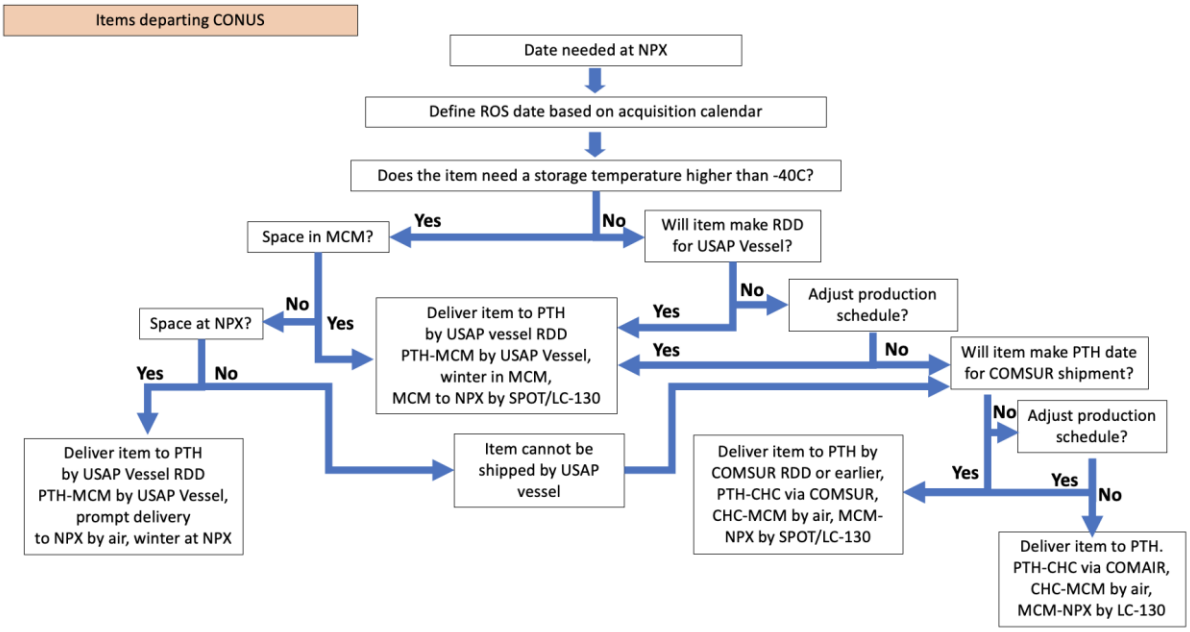

Figure 4: Shipping flowchart for point of departure within CONUS

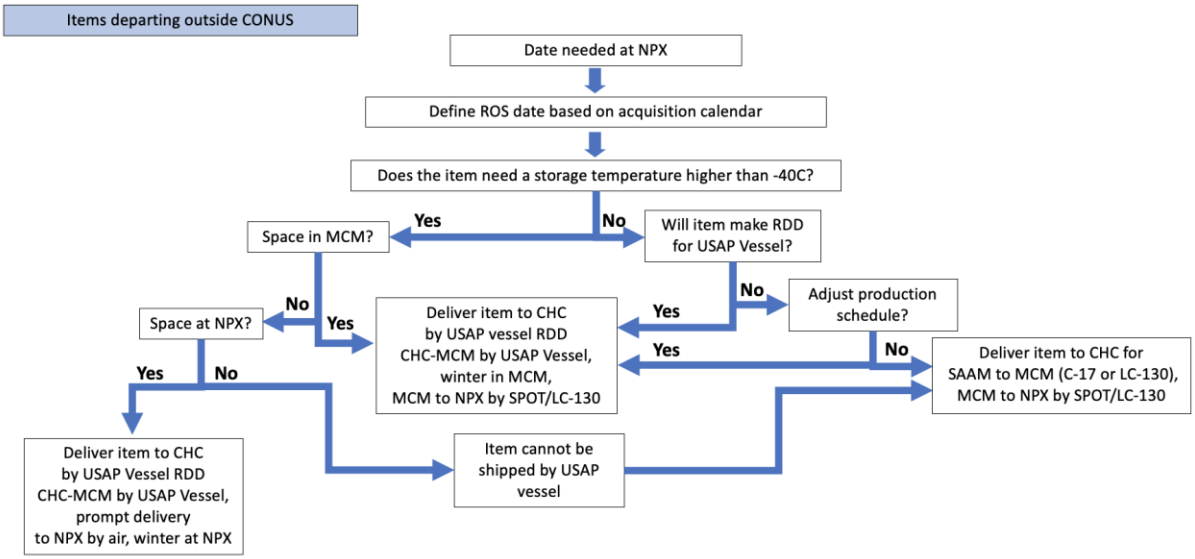

Figure 5: Shipping flowchart for point of departure outside CONUS

The ICU logistics managers oversee the movement of all the cargo items. They collect the information on the ICU Cargo Master Spreadsheet and provide instructions for consolidation based on volumes, similar shipping schedule, port of origin and special handling considerations. A designated point of contact at each departure point with a deep knowledge of the shipping process ensures that packaging is appropriate and shipping dates are observed. The Point of Departures (POD) and corresponding Point of Contacts (POC) designated for the IceCube Upgrade are shown in Table 2.

Table 2: IceCube Upgrade designated Points Of Departure and Points of Contact

Point of Departure	**Logistics Points of Contact**
Physical Sciences Laboratory (PSL)	Ian McEwen/Delia Tosi
Michigan State University (MSU)	Tyce DeYoung
DESY (Germany)(*)	Timo Karg
Chiba (Japan)	Aya Ishihara / Shigeru Yoshida
(*) The intent is to have all shipments departing from Europe (several locations in Germany and Sweden) to depart from DESY, but there may be complications related to payment for customs. Local personnel are investigating this possibility.	

The list of items is validated once by a subject matter expert and a second time by the logistics managers. The list will be used as a checklist throughout the duration of the project by the point of contact at the point of departure. This guarantees the completeness of the cargo leaving each institution.
An example of the shipping procedure with the level of detail required for this planning is provided in the Appendix.

4.6 Packing/Shipping

Shipments must be packaged to withstand contact with the sharp corners of other containers, crushing weights, and shocks sustained while in transit, in the warehouse, aboard ship, and on the ice. Extra padding around the contents of the containers to cushion them against impact is critical for the shipping environment. Packing must be done securely, filling any voids or extra space. If the crate or box is not inherently waterproof and the contents are sensitive to moisture, it is prudent to add moisture protection internally. It might not rain in McMurdo but it does in Christchurch and California.

Key packing points

- Cargo should be reduced in size and consolidated as much as possible prior to packaging
- Packaging should be designed to fit within and to maximize the useable area and allowable height of a 463L Air Force pallet when possible
- Packing materials should be reusable/recyclable
    - Do not use polystyrene, polyurethane foam, or silicone sponge
    - Suitable alternatives are bubble wrap, shredded paper, corrugated cardboard, burlap, and packing tissue
    - Polystyrene “peanuts” are prohibited
    - All materials entering the USAP waste stream should be easy to break down for

retrograde containerization

- Wood packaging products (crates/pallets) must meet International Standards for Phytosanitary Measure #15 (ISPM-15) regulations and comply with NZ regulations
    - Treated crates/pallets with the ISPM-15 stamp on them may be constructed/procured
    - Alternative shipments may be fumigated and certified prior to shipping (3)
- Any Special Handling requirements (Do Not Freeze, Fragile, Do Not X-ray, Keep Dry, Keep Upright, Do Not Expose to Magnetic Field, Do Not Drop, etc) need to be marked clearly on the package and also included in the shipping paperwork
- Hazardous materials (HAZ) need to be identified and transported with an SDS – it is best to ship HAZ separately from other shipments
    - Contact the USAP contractor's Hazardous Materials Coordinator for assistance
- Ensure no materials that will trigger biosecurity protocols are in shipments. Make certain that all equipment is cleaned inside and out
    - Make sure to meticulously inspect items that have been sitting outside or have operated in other environments
    - Be thorough to avoid violations of NZ Biosecurity (4) and the Antarctic Treaty (5) regulations
- Between September 1 and April 30 all cargo destined for New Zealand must be fumigated with one of the agents listed below to avoid possible infestation by the Brown Marmorated Stink Bug
    - Methyl Bromide, which leaves no residue

Sulfuryl Fluoride, which is often requested if the shipment contains delicate electronic equipment See the USAP Packing and Shipping Manual, TL-MAN-0002 (1) for detailed information on all of the above points.

4.6.1 **Intermodal Shipping Containers**

Intermodal freight transport refers to the shipping of containerized cargo by multiple means (rail, ship, aircraft and truck) without any handling of the freight itself between modes. For instance, container shipments can move from an ocean vessel to the USAP Airlift (SAAM or C-17) without being unloaded and repacked. Intermodal shipping reduces cargo handling, improves security, reduces damage or loss, and allows freight to be transported faster. The International Organization for Standardization (ISO) maintains container requirements, which were first based upon original Department of Defense (DOD) standards.

With the exception of large items, such as the Main Cable Reel, all ICU cargo will be shipped to/from Port Hueneme /McMurdo in ISO standard intermodal shipping containers. All containers must be ISO certified. For loose cargo sent to Port Hueneme, the contractor will provide USAP owned shipping containers for the voyage south. The Port Hueneme personnel will visually verify the contents of each container for seaworthiness including the proper blocking and bracing of cargo for transport. This inspection is documented and reported to the shipper and the USAP contractor's management.

Hazardous materials should be shipped separately when possible, and must include a safety data sheet (SDS) with the packing list. DNF cargo must be shipped separately. DNF cargo could be

shipped via COMAIR or COMSUR, as determined by the Port Hueneme operations manager. The current MILSPEC guidelines for certifying an intermodal container for seaward transportation to Antarctica can be found in the DOD document; MIL-STD-2073-1D *Standard Practice for Military Packaging* (6).

Intermodal containers (Shipping containers or Milvans) should have labels on the outside, typically by the door. Additional labels with the container number may be placed at the corners. Depending on their contents, containers may require additional labels. Intermodal containers with temperature sensitive shipments (DNF - Do Not Freeze) must be as labeled prominently on front and back. Use yellow tape with black lettering to make sure that they are easily identified from 100 meters away (about 300 feet). When the container enters the USAP cargo system each container is sealed with serialized, color-coded labels, and the numbers are entered into the USAP cargo tracking system, Maximo.

4.6.2 **Required Paperwork**

Each individual container, crate or box requires its own paperwork. When shipping commercially to a USAP location, obtain the Bill of Lading or the Air Waybill and make sure it includes:

- Delivering carrier
- Shipment number
- Piece count
- Date departed
- Scheduled delivery date

Include one USAP Proforma/Invoice TL-FRM-0005 for each one piece shipped (detailed list of contents, special handling instructions, size and weight, value) – see Figure 6. The paperwork needs to travel with the shipment and also needs to be e-mailed to the appropriate contact at the USAP destination site.

USAP Proforma Invoice
Version 15, June 2020

Leidos Proprietary

TL-FRM-0005
Blank Form Last Reviewed: June 2020

SHIPPER INSTRUCTIONS

Complete all orange shaded areas. The first line item will be the Maximo Description.
The blue shaded area **SHOULD** be completed unless the information is unknown.
Item "Descriptions" should detail OEM nomenclature or function. Use only industry-related acronyms.
Keep font size & style consistent.
Include relevant "Country of Origin" article manufacturer (not suppliers/distributors)
Create a new form/tab for shipments with different temperature and/or special handling requirements.
Create a new form/tab for shipments with different addresses and/or environmental requirements.
You **MUST** choose a Special Handling Requirement or No Special Handling Required.
Email the completed form to the appropriate station logistics staff

ROUTING:	
Ship To Destination:	
End User:	

Shipper: (Select from drop down menu)

LEIDOS CORPORATION obo US NATIONAL SCIENCE FOUNDATION
NAVAL BASE VENTURA COUNTY, BLDG 471-NORTH END
PORT HUENEME, CA 93043
(805-985-6851)

Port Hueneme address

Consignee: (Select from drop down menu)

Mark Special Handling requirements

Attention:

PROJECT NUMBER:	A334
LOCATION:	NPX
POC:	Barb Birrittella
POC NUMBER	
POC EMAIL:	bbirrittella@wisc.edu
ROS:	

Priority Number

3

Shipment Data (indicate as applicable)

Invoice #:
DMCQ #:
BOOKING #:
CONTAINER #:
SLI#:

Special Handling Requirements:

Do Not Freeze(DNF) __
Do Not Drop (DNP) __
Do Not X-Ray (DNX) __
Fragile __
Keep Chilled (KC) __
Keep Dry (KD) __
Keep Frozen (KF) __
Keep Upright (KU) __
Do Not Expose To
Magnetic Field (MAG) __
No Special Handling Required_x_

Additional Handling Instructions:

Project Number, destination and POC contact information

DESTINATION CONTROL STATEMENTS: Select appropriate from the drop down menu or leave blank for EXPORT determination.

Qty	Shipping No.	Detailed Description	Part Number	Manufacturer	Country of Origin	Total Wt. (kgs.)	Export Classification/ Control	Schedule B/ HTS	Unit Value	Total Cost
3		Generator Intake Hood - 14.5' long aluminum duct with hinged doors	N/A	Cardinal Heating & Air Conditioning	US	800.00			3433 1/3	$10,299.99
2		Generator Discharge Hood - 9' long aluminum duct with hinged doors	N/A	Cardinal Heating & Air Conditioning	US	300.00			2895	$5,790.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00
										$0.00

Quantities and description of each item in the shipment

TOTAL **$16,089.99**

Barb Birrittella
Print Name (Your printed name constitutes a signature)

(Select from drop down menu)

Signature

FOR NORTHBOUND CARGO ONLY: **Was all cargo previously exported from the US?** (select yes or no)

This is not a sale. The prices shown reflect the value of the item in the open market and do not reflect administrative, processing, or certification costs that may be included in the exported value of the item.

Terms of delivery: DAP

Figure 6: Example of USAP Proforma/Invoice TL-FRM-0005

4.6.3 Shipments from Continental United States

Use the following address and information for cargo shipments to Port Hueneme. Label each box with the following information. Ensure this information is clear and legible.

National Science Foundation c/o Antarctic Support Contract
5020 Stethem Road
Building 471, North End, NBVC Port Hueneme, CA 93043
ATTN: USAP South Pole
NPX (or ZSP)
<Principal Investigator>
<Event number> or <Project code>
<ROS>

Email all the paperwork related to each shipment (Bill of Lading or Air WayBill and Proformas) to PH-CargoOps@usap.gov.

4.6.4 International shipments

Aside from packages from Canada, direct shipment from international points of origin to Christchurch, NZ is the most efficient and lowest cost transportation method. There are fewer touch points in the logistics chain and the total shipping time is greatly reduced. At the time of this document update (fall 2021), widespread cargo vessel offload delays in all California ports are being experienced. This trend is anticipated to continue for some time. While no duty or GST will be incurred during importation at the Los Angeles cargo port, Merchandise Processing Fees, a Harbor Maintenance Fees, Bond Fees, and domestic transportation add to shipping costs.
There is no duty or GST payable on shipments sent to PAE New Zealand Ltd going to Antarctica. The shipment is transferred to PAE New Zealand Ltd on their customs release note going to their customs-controlled area.

To ship directly to New Zealand:

- Consult the USAP Packing and Shipping Manual
- Allow at least 5 weeks between the carriers (or forwarder) projected NZ arrival date and the Pole date
- Ensure your cargo is properly prepared for shipment
- E-mail CHC-CourierNotifications@usap.gov to coordinate and for advice and assistance; e-mail copies of shipping documents (e.g. AWB, Courier Tracking slip)
- **Note:** Some companies, such as Federal Express (New Zealand), do not operate 24 hours a day and are closed on weekends
- All direct shipments must be sent Duty Delivery Paid (DDP)
- Use this address for shipping directly to New Zealand:

National Science Foundation
c/o PAE (New Zealand) Limited
Gate 1, 45 Orchard Road North
Christchurch International Airport
Christchurch, New Zealand
A-334-S
Tel: +64-3-358-8139 / FAX: +64-3-358-1479

5 Appendix

Shipment Planning Case Study:

The IceCube Upgrade will feature a total of 402 mDOMs that will be shipped from the Deutsches Elektronen-Synchrotron (DESY), Germany and from Michigan State University (MSU), USA.

The project is planning on sending sensors for the first two strings a year ahead of drilling for indoor storage at the South Pole. Having sensors on site for two strings ready to go reduces risk related to cargo delays that may impact the start of drilling operations. Space has been verified by ASC to be available in the Cryogen building.

The shipment of mDOMs is therefore divided between the sensors that are to be installed on the first two strings (116 units plus 12 spares, all departing from DESY), and those that will be installed on the other five strings (96 units from DESY and 190 units plus 10 spares from MSU).

Schedule

The origin for the first sensor shipment is DESY so they will be shipped directly from Germany to Christchurch (CHC). Since they have a minimum storage temperature of -40°C, they need to be flown via USAP airlift from CHC to McMurdo and from McMurdo to NPX. Unlike cargo that can tolerate low storage temperatures, the sensors cannot be shipped one year ahead of their ROS date to be loaded onto the USAP Vessel in CHC, moved via sea to McMurdo and stored in McMurdo until the following austral summer.

Sensors for the two strings need to reach NPX in time to be tested before station close.

- On the IceCube Upgrade schedule the arrival of these sensors has a date of 01.15(.2024). This is the date needed at Pole.
- Since the FY24 continental area acquisition calendar is not available, we use as reference the latest released one, which is the FY22 one (2). According to the table in this document, due to the airlift blackout, the earliest South Pole ROS date that would guarantee the sensors to be on site at the needed time is December 18. According to the same document, the equivalent Julian date is 1352. This ROS date is what should be written on the label, together with the destination code (NPX).
- The Required Delivery Date (RDD) to Port Hueneme for this ROS date is Oct 27. This date is within the heavy airlift gap, during which SAAM flights (C-17) are not occurring between McMurdo and CHC. In order to maximize the potential for this shipment to transport on a SAAM flight we want to be able to deliver our cargo to the Christchurch Air Cargo Yard at the beginning of the Heavy Airlift period. Therefore, an RDD of August 18 should be used, while still keeping the December 18 ROS date for the shipment (label and proforma will read: “ROS NPX 3152”).
- Since travel time from our major hubs (the Physical Sciences Lab or Michigan State University) can be 5-7 business days, we add a buffer to allow for issues related to trucks availability (based on our previous experiences).
- We then set our target date for shipping to be Aug 1 (2023) which is shown in our master shipping spreadsheet.

- For consistency and simplicity, we adopt the same shipping date even for shipments that leave other countries, based on the observation that travel times of commercial vessel from Germany to Christchurch are similar to those from Port Hueneme to Christchurch within our chosen buffers.
- Notes that these dates are revised every year. Floats on our side are kept large on purpose to reduce risk that in 3-4 years the dates may change so significantly to impact our sensor delivery schedule.
- As time gets closer (usually within the same calendar year) dates are confirmed with ASC to ensure our cargo does not burden the program by arriving to PTH or CHC too early.

For the sensors for the five strings, we follow the same logic with our shipping date being exactly one year later (date on site: 11/25/2024. ROS date: 20 Nov. Target PTH date: Aug 18. Target shipping date: Aug 1)

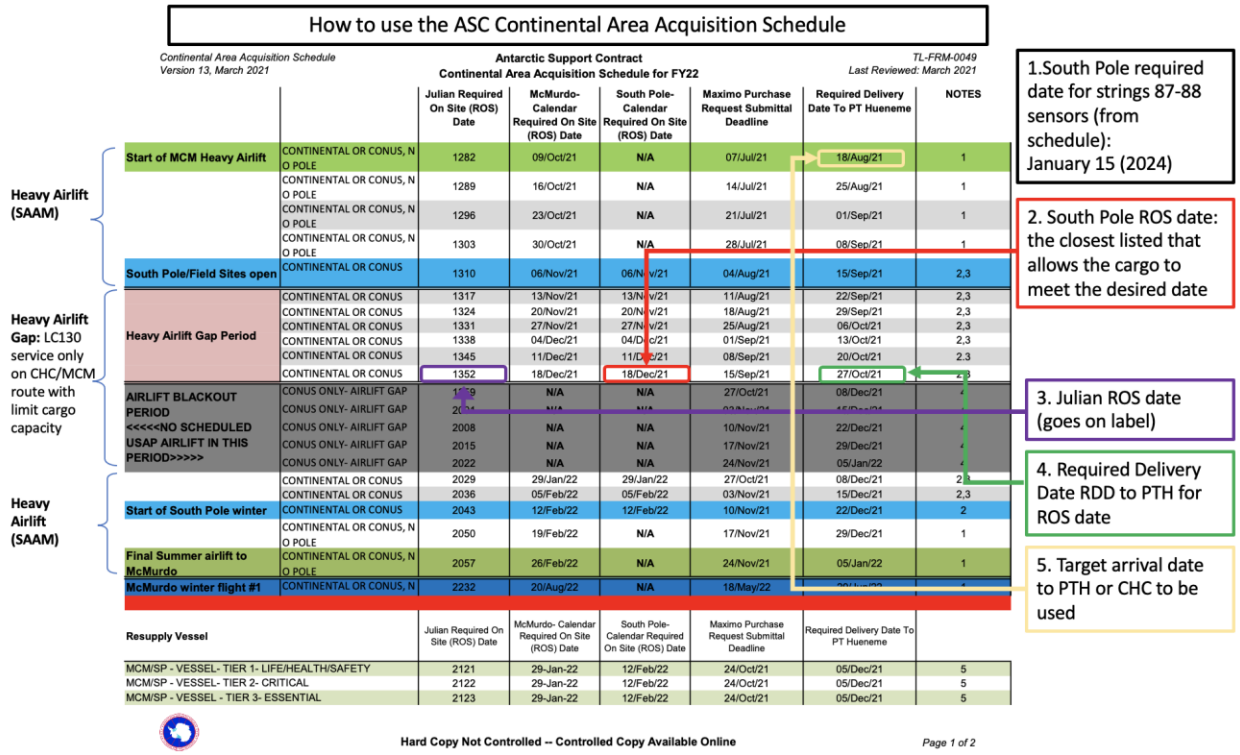

Figure 7: Continental Area Acquisition Calendar with dates marked as in case study

Packing

Once it is determined that the specified items will travel by USAP airlift, this also constrains the packaging dimensions which must not exceed the allowed space on an air force pallet 463L.

- The problem is approached at this point starting from the dimensions of each unit shipped. The SME for the mDOM communicates the box size (470 mm by 470 mm by 510 mm) and weight (28 kg including the box) to the logistics expert.
- It is calculated that 8 mDOMs can fit on a standard pallet 40”x48”x5.5” (EUR-2 in Europe: 1000mm x 1200mm x 160 mm). The total weight of the pallet with 8 mDOMs will be (8

mDOMs x 28 kg/mDOMs + 35 kg/pallet) 259 kg.

- Eight pallets (for a total of 64 mDOMs), rotated appropriately in a 2x2x2 configuration, fit on a 463L. This fits well the project needs as one air force pallet will provide all (and only) the mDOMs required for one string (60 or less). At this point the logistics expert enters and confirms the information in the ICU Cargo Master Spreadsheet (units, size and weights) and checks for the correct shipping and arrival dates. The SME validates the data.
- The logistics expert also works with the SME to define the best way to transport the sensors from their Point of Departure to CHC, and the transportation experts at the Point of Departure verify the proposed solution with local companies for timeliness and cost efficiency. In this specific way, using a 20ft HC container allows to ship all the mDOMs pallets from DESY in one single unit.

6 References Cited

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4. **Ministry for Primary Industries.** Import Health Standard: Vehicles, Machinery and Parts. [Online] 08 11, 2021. www.biosecurity.govt.nz/dmsdocument/30224/direct.

5. **Secretariat of the Antarctic Treaty.** Key Documents of the Antarctic Treaty. [Online] https://www.ats.aq/e/key-documents.html.

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7 Glossary

Cargo Resupply Vessel	A chartered vessel hired to move cargo between Port Hueneme and McMurdo Station. It generally includes a port call at Port Lyttelton, New Zealand. Often referred to as "the Vessel," it is the most cost efficient transport for moving material to McMurdo Station. That cargo is often moved on to inland camps and the South Pole Station.
CHC	Christchurch, New Zealand
COMAIR	Commercial Air Material or supplies transported via commercial aircraft, rather than USAP subcontractor (ANG, Kenn Bork Air Ltd., etc.).
COMSUR	Commercial Surface Cargo transported by a commercial shipping line, usually an ocean-going vessel.
CONUS	Continental United States
DDP	Duty Delivery Paid
DNF	Do Not Freeze
DNDF [min Temp]	Do Not Deep Freeze [minimum storage temperature]
DOD	Department of Defense
ISPM	International Standards for Phytosanitary Measures
Maximo	Maximo manages USAP inventory and asset information, to include: purchase requisitioning and purchase order tracking; receipt of inventory at USAP operating locations; support of in- transit visibility of cargo; and work order data to include preventive maintenance, emergency work order, and service requests.
MPI	Ministry for Primary Industries
NBVC	Naval Base Ventura County Located at Port Hueneme, California.
NPX	National Weather Service airfield designator for South Pole Station.
NSF	National Science Foundation
PI	Principal Investigator
POC	Point Of Contact The individual or office used to centralize input and exercise control over a project. For most events, this will be the Science Planning Manager.
POLAR ICE	Participant On-Line Antarctic Resource Information Coordination Environment. A web-based data collection and dissemination system designed to capture and administer all relevant support requirements for scientific research in Antarctica.
RDD	Required Delivery Date The deadline for cargo intended to arrive at Port Hueneme for further shipped via USAP resources. Please refer to the Required Delivery Date section in this document to determine the cargo deadline to Port Hueneme.
ROS	Required On Site

	Date when an item is required at the location, where it will be used, whether on station, vessel, or field camp. Computing this date migrates to cargo scheduling, bar codes, flight manifests and on to the destination. Cargo tracking uses the first Saturday following the requested date. Cargo is manifested to reach its site by that Saturday. That date is then converted into a four- digit number representing the year and Julian date. For Peninsula operations, this is generally understood to be the date 12 days prior to departure of the vessel arrives at Punta Arenas or in some cases when the material must be carried via alternate means.
SAAM	Special Assignment Airlift Mission
SDS	Safety Data Sheet
Shipping Number	A field in Maximo that indicates a shipping code (an automated bar code) for shipping and receiving cargo and supplies through Port Hueneme and cargo staging areas, CONUS and on station.
SIP	Support Information Package
T&L	Transportation and Logistics Division of ASC
TIE	Tie Down Equipment
USAF	United States Air Force
USAP	United States Antarctic Program
USAP Airlift	This term refers to the scheduled movement of cargo and passengers (PAX) from Christchurch, NZ, to McMurdo Station via aircraft certified to operate in Antarctica.
WPM	Wooden Packaging Material
ZCM	National Weather Service airfield designator for McMurdo Station
ZSP	National Weather Service airfield designator for South Pole Station

2021-003.2_IceCube Upgrade Logistics - Cargo Estimation and Planning

Final Audit Report 2021-10-19

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