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IceCube Upgrade Winter Power/Monitoring Requirements

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Purpose: This document is to inform ASC of IceCube Upgrade's (A-334) requirements for heating and monitoring equipment during the South Pole winter. These heating needs may begin as early as 2022 winter and continue through each winter until the end of the project.

Background: The drill system includes a substantial amount of DNF equipment, including motor drives and control system hardware. During IceCube (2004-2011), three drill modules were heated over winter to store this equipment: TOS1, TOS2, and the DCC. Selecting these buildings to be heated minimizes the amount of equipment that must be uninstalled and relocated. The Main Drill Hose Reel was heated starting in 2008, after hose failures were largely attributed to brittle transition of the hose during unheated storage. The containers and hose reel were provided power from the Cheese Palace, which no longer exists. Winter heating requirements for IceCube Upgrade are much the same as they were for IceCube, and detailed below. For Upgrade, we are adding a remote monitoring capability.

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1. Executive Summary

IceCube Upgrade requires the following for the duration of the South Pole winter:

- **39.6kW of 480V 3 phase power** (at peak load)
- **10.5kW of 208V 3 phase power** (at peak load)
- **Remote monitoring** via wireless or Ethernet (Ethernet preferred)
- Estimated that total **fuel** will be **3229 gallons per winter**
    - 1694 gallons for container heating (972 for DCC, 361 for each TOS)
    - 1535 gallons for hose heating

2. Container Heating Requirements

Three IceCube containers are used to store DNF hardware over the winter. Each container has 4x electric space heaters that are set to 'low' and kept powered for the duration of the winter. Each heater's low setting requires 3.3 kW of power. The heaters have internal thermostats and will shut off if the temperature in the container reaches above the set point. The three containers to be heated are the DCC, TOS1, and TOS2. Their dimensions, power requirements, and connector specifications are summarized in the below table.

	CONTAINER DIMENSIONS	EST. AVERAGE STEADY-STATE POWER LOAD	PEAK POWER LOAD	ELECTRIC SERVICE	PEAK CURRENT TO CONTAINER	CONNECTOR ON CONTAINER
DCC	8’ x 34’	2.1 kW	4x 3.3kW = 13.2 kW	480V 3 phase	27.5 Amp	Appleton ADR6034RS
TOS1	16’ x 34’	0.8 kW	4x 3.3kW = 13.2 kW	480V 3 phase	27.5 Amp	Appleton ADR1034RS
TOS2	16’ x 34’	0.8 kW	4x 3.3kW = 13.2 kW	480V 3 phase	27.5 Amp	Appleton ADR1034RS
TOTAL		**3.7 kW**	**39.6 kW**		**82.5 Amp**	

The **DCC** is an insulated 34-foot-long ISO container. Electric power (480V 3 phase) is supplied through a **60A Appleton receptacle** (P/N ADR6034RS). There are 4x electric space heaters in the container. At peak load, the heaters may consume **13.2 kW** of power and draw **27.5 Amps** through the cable feeding the container. An image of the DCC is shown below.

Figure 1. The **DCC** is a single ISO container, 34 feet long. The power is fed to the electric heaters through a 60A Appleton connector mounted on the outside of the container (shown on far right of image).

TOS1 is an insulated double-wide ISO container, 34 feet long. **TOS2** is an identical double-wide container. Electric power (480V 3 phase) is supplied through a **100A Appleton receptacle** (P/N ADR1034RS) on each container. There are 4x electric space heaters in TOS1 and 4x in TOS2. At peak load, the heaters in each container may consume 13.2 kW of power, for a total of **26.4 kW** between the containers. The heaters in each container will draw up to **27.5 Amps**. One of the TOS containers is shown below. During winter storage access should be maintained to the doors at the ends of the buildings, at minimum.

Figure 2. TOS1 and TOS2 are identical containers. Both are double-wide ISO containers, 34 feet long. On each, the power is fed to the electric heaters through a 100A Appleton connector mounted on the outside of container (gray enclosure in image). End doors are on the far end of the building, not shown.

3. Hose Reel Heating Requirements

Description: The 9,200 feet of rubber hose used for drilling needs to be kept above -53C at all times. Winter temps can reach as low as -82C, which means the hose must be heated through the winter. This is accomplished by wrapping the hose reel with electric heated blankets and insulation, shown schematically in Fig 3. The temperature of the hose is measured with sensors, which feedback to a controller that adjusts the power supplied to the blankets. The controller can output diagnostics via wireless or Ethernet for remote monitoring.

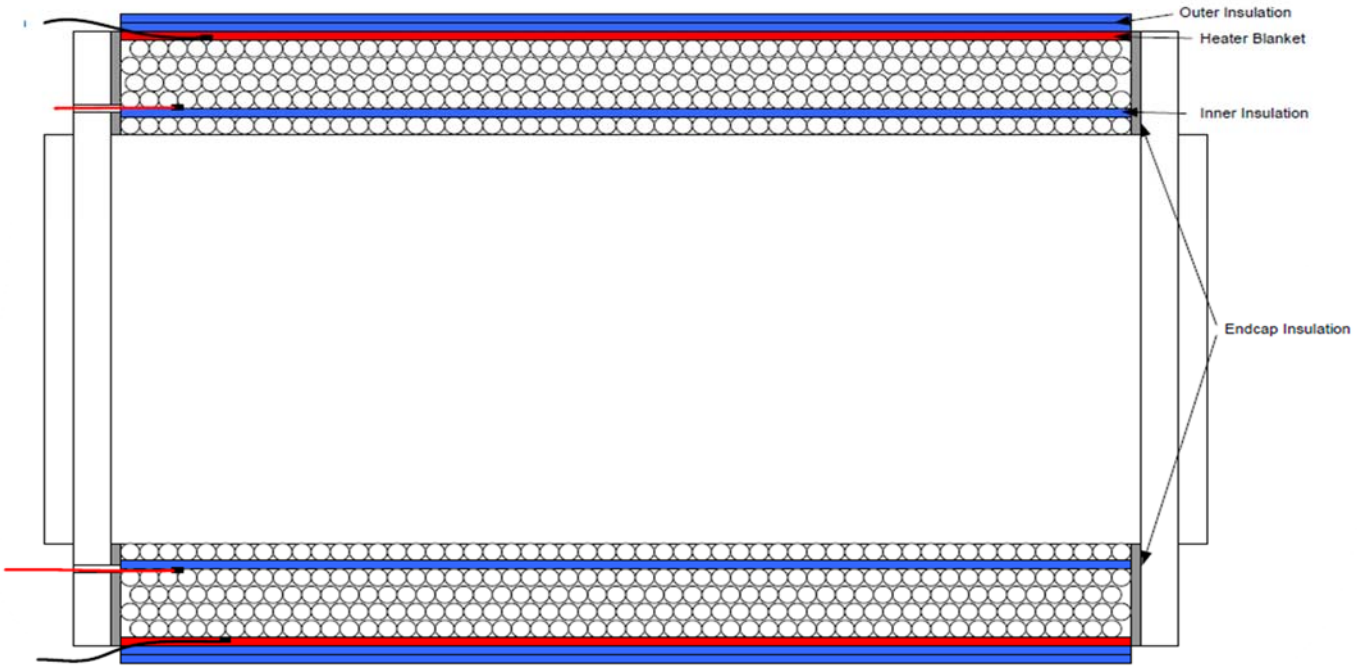

Figure 3. Schematic of electric heated blankets wrapped around the hose on the hose reel. The layer of blankets is shown in red, insulation in blue.

Figure 4. a) 'Non-drive' end. Blanket control box mounts onto green unistrut frame in lower right. Photo taken 19/20 season. b) 'Drive' end. Reel shown with layer of heated blankets. Photo taken 07/08 season.

Location and Electrical Considerations:

- The footprint of the hose reel is **35 feet long x 19 feet wide**.
- A power cable will need to reach from the power source to the control box, which will be located near the 'non-drive' end of the hose reel. Power cable is IceCube Upgrade scope
- A 208V 3-phase receptacle and outdoor-mounted fused disconnect is requested as ASC-scope.
    - 208V 3-phase delta with ground
    - 4-pin 60-amp receptacle mounted to fused disconnect switch: Hubble HBL460R9W
    - Installed fused rating: 40 amps
- An alarm light is mounted on the control box, which is mounted on the 'non-drive' end of the hose reel. The reel must be positioned such that this light is visible from station or from a frequently traveled road (e.g. the road to the ICL).

Power Requirements:

- The **peak** power required by the hose heating system is **10.5kW of 208V 3 phase power** (50.5 Amps).
- The estimated average **steady-state** power required is **3.3 kW**.

4. Remote Monitoring Requirements

Description: The temperatures of the 3 containers and the hose reel will be monitored by their respective controllers and reported to the Northern Hemisphere. IceCube winterovers will be alerted if any of the heaters need on-site attention. Signal transmission can occur via Ethernet or wireless, however Ethernet is preferred. Details below:

- The monitoring/control function requires TCP/IP transport via standard Ethernet termination.
- Two separate IP addresses are required to perform the remote monitoring function.
    - One address to be used by a UW furnished/maintained monitoring station (Win10 PC)
    - One address to be used by the Blanket Heater controller w/ an embedded Ethernet port.
- 10/100 Mbps wired-connectivity to the Controller is sufficient. (100 Mbps, preferred)
- Northern Hemisphere remote access to either IP address (Monitoring PC or Controller) is required.

5. Fuel Requirements

Fuel estimates are based on estimated average steady-state power loads, using a conversion of 14 kW-hr/gal of fuel. Duration is assumed to be February 1 – November 1, for a total of 9 months ~ 6480 hr.

	EST. AVERAGE STEADY-STATE POWER LOAD	TOTAL WINTER KW-HR	TOTAL WINTER FUEL CONSUMPTION
DCC	2.1 kW	13,608 kW-hr	972 gal
TOS1	0.8 kW	5054 kW-hr	361 gal
TOS2	0.8 kW	5054 kW-hr	361 gal
HOSE	3.3 kW	21,490 kW-hr	1535 gal
TOTAL PER WINTER	**7 kW**	**45,206 kW-hr**	**3229 gal**

Rev History:
04.23.20 – Original – BMB
04.27.20 – Added container heating information, total heating requirements – BMB
05.04.20 – Added remote monitoring requirement, specified voltage of hose reel heating – BMB
07.25.20 – Added comms (Remote Monitoring Requirements) detail – PAW
07.27.20 – Made Monitoring Requirements its own section, changed start date to 2022 winter, changed voltage of hose heating to 208V – BMB
12.15.20 – Added fuel estimates, changed power of heater low setting to 3.33kW, changed hose peak power to 10.5 kW – BMB
12.16.20 – Added to Background, added average SS load, added elec. hookup details for hose heating, added Section 5: Fuel Requirements - TLB