



Physical Sciences Laboratory at University of Wisconsin-Madison

Upgrading the IceCube Enhanced Hot Water Drill

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The IceCube Neutrino Observatory is the first detector of its kind, designed to observe the cosmos from deep within the South Pole ice. Encompassing a cubic kilometer of ice, IceCube searches for nearly massless subatomic particles called neutrinos.

On June 25, 2019, the National Science Foundation (NSF) approved \$23M to upgrade the IceCube detector, extending its scientific capabilities to lower energies and thus enabling IceCube to reach neutrino energies that overlap with the energy ranges of smaller existing neutrino detectors worldwide. The IceCube Upgrade project will introduce seven strings of optical modules at the bottom center of the 86 existing strings, adding more than 700 new and enhanced optical modules to the 5,160 sensors already embedded in the ice beneath the geographic South Pole.

The Enhanced Hot Water Drill equipment from IceCube construction will be resurrected to support drilling operations for the Upgrade. Much of this equipment has been long-term stored at South Pole since completion of IceCube construction in 2010-11, and some subsystems need major upgrade work and/or will become replaced completely.

REQUIREMENTS	
Hole Depth	2600 m
Hole Size	> 52 cm diameter for 55 hr lifetime
Hole Spacing	22 m
Hole Quantity	7 holes in 1 season (25/26)
Drill Team	28 (3x shifts of 9 + 1 drill manager)
Logistics	vessel, traverse, LC130
SPECS	
Capacity	5 MW (4.7 MW thermal, 0.3 MW electric)
Water Flow	200 GPM (760 LPM), 88°C (190°F), 1100 psig (76 barg)
Max Drilling Speed	2.2 m/min
Estimated System Weight	1.4 million lb (636,000 kg)
Predicted Performance, per Hole	53 hr drill duration, 8500 gal (32,200 L) of AN8 fuel

System Schematic

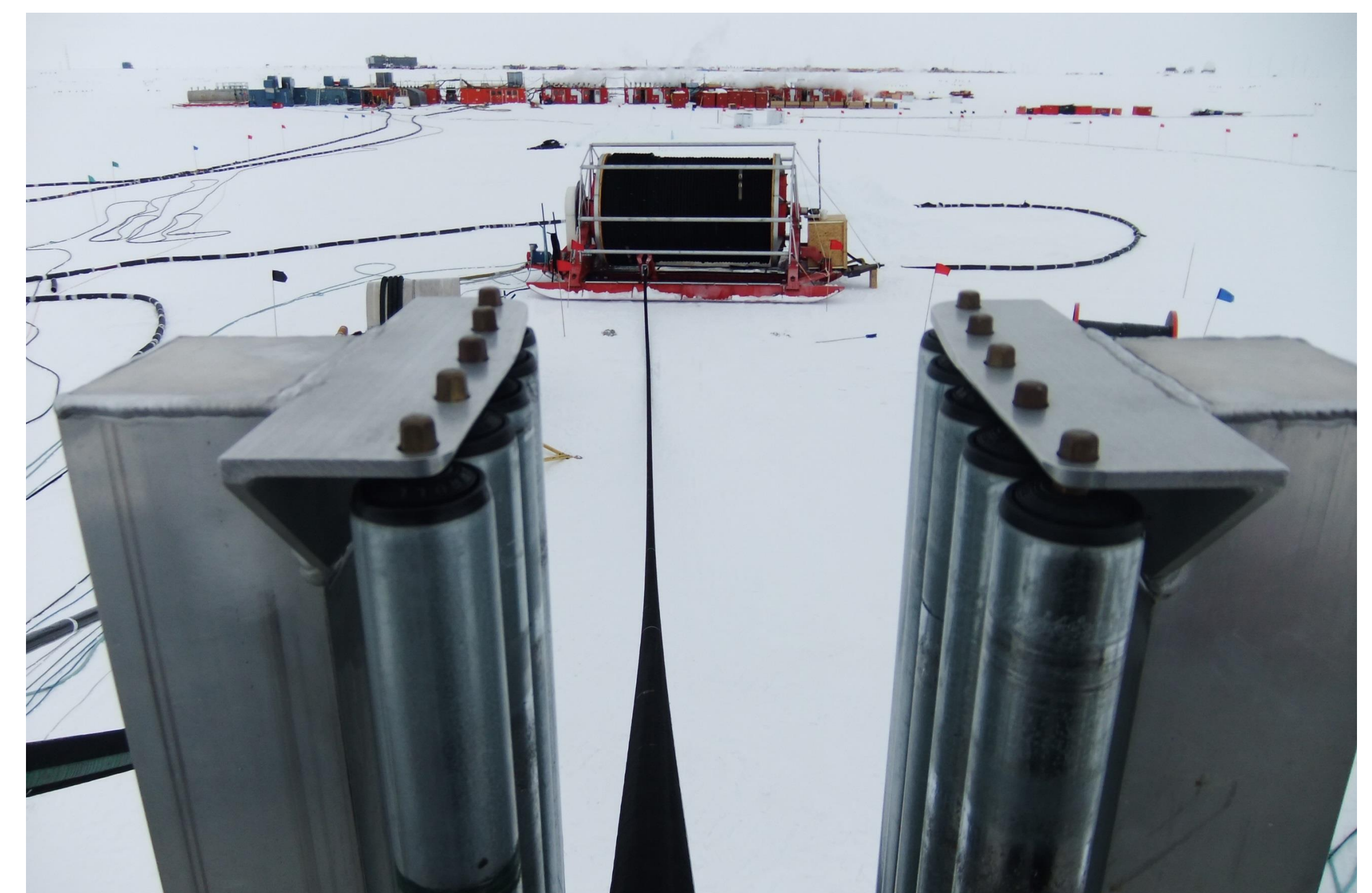
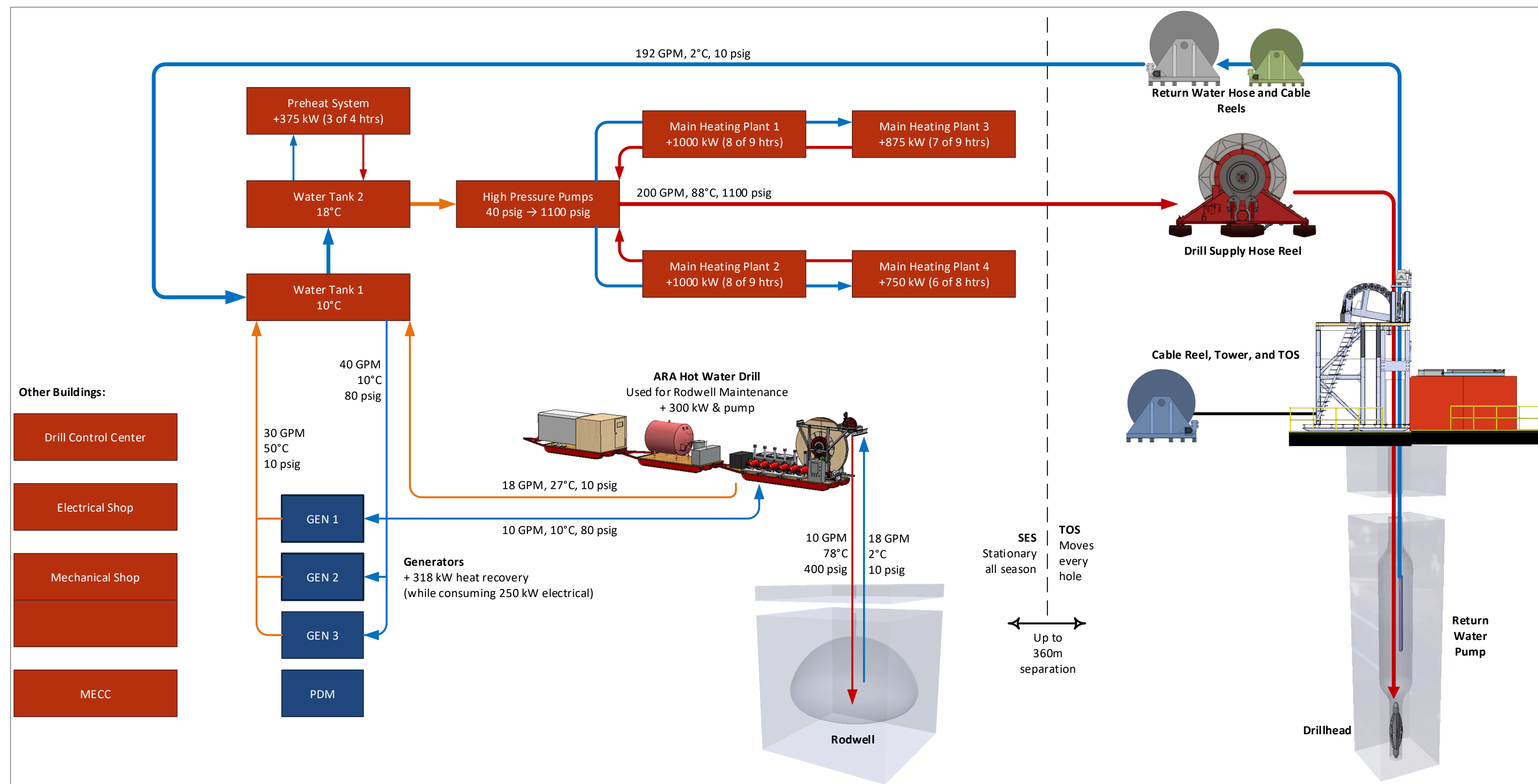


Photo from top of drill tower, Main Supply Hose Reel in foreground, Drill Camp in background



Aisle of Drill Camp, Main Heating Plants in background



Tower Operations Site, top of borehole is inside tower structure



Main Supply Hose Reel

Work Breakdown Structure

1. IceCube Upgrade Project	
1.1 Project Office	
1.2 Implementation	1.2.1 Implementation Management and SE
	1.2.2 Thermal Plant - Off-Ice
1.3 Sensors	1.2.3 Tower Operations Site (TOS) - Off-Ice
	1.2.4 Computing and Control System - Off-Ice
1.4 CPT	1.2.5 Power Generation and Distribution
	1.2.6 Water Handling Systems - Off-Ice
1.5 Characterization and Calibration	1.2.7 Support Equipment - Off-Ice
	1.2.8 Drill Field Seasons - Antarctica
1.6 Data Systems Integration	1.2.9 Installation - Off-Ice
	1.2.10 Installation Field Seasons - Antarctica



ICU Drill Field Seasons Schedule

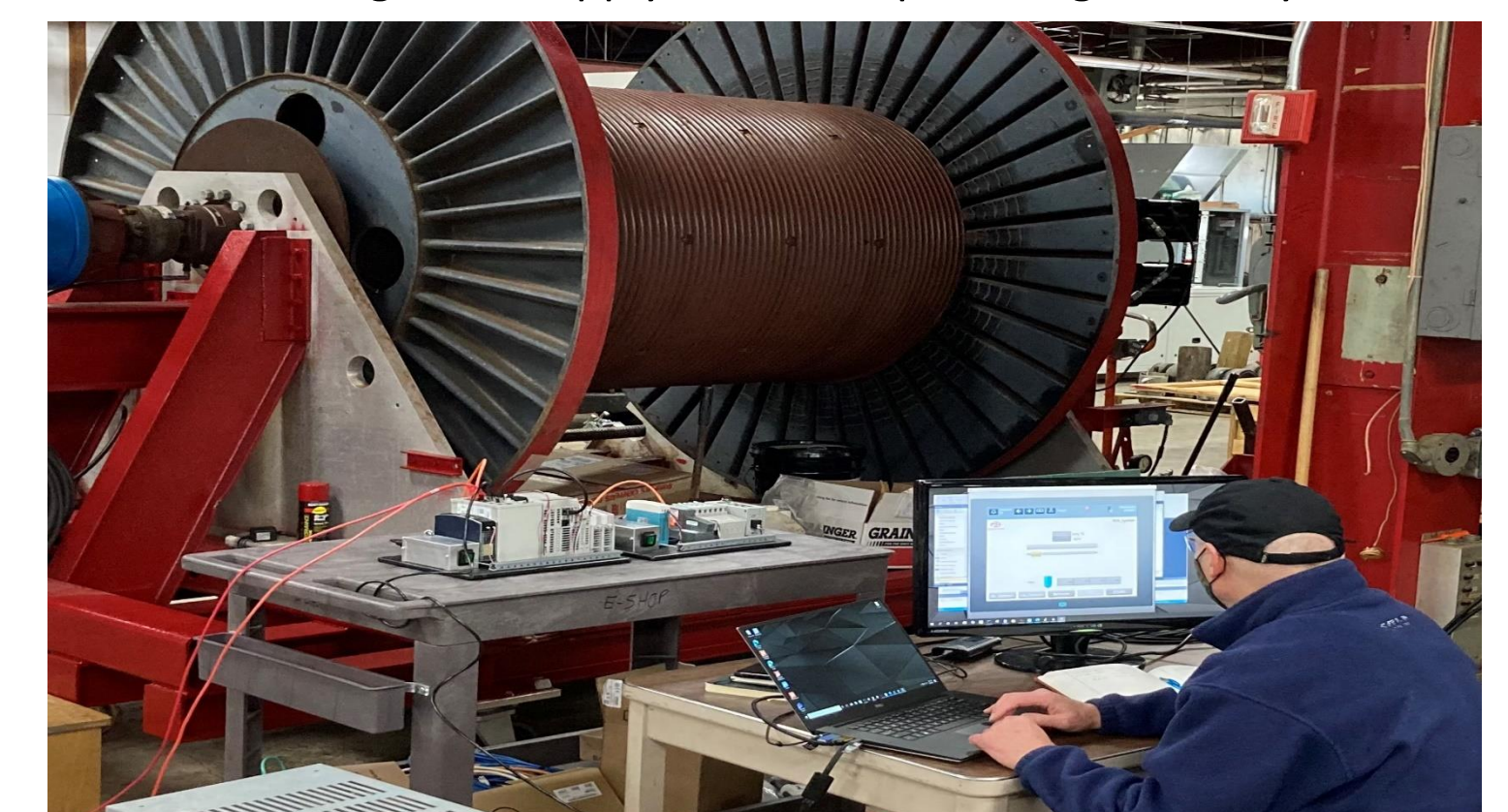
TODAY

	PY1 2018/2019	PY2 2019/2020	PY3 2020/2021	PY4 2021/2022	PY5 2022/2023	PY6 2023/2024	PY7 2024/2025	PY8 2025/2026
Original Baseline	Recon	Eval & Retro	Upgrades	Integrate & Test	Drill			
PY4 Re-Baseline	Recon	Eval & Retro	X*	X*	X*	Upgrades	Integrate & Test	Drill

*Field seasons cancelled due to COVID-19 pandemic



Pressure testing Main Supply Hose Reel plumbing assembly



Main Drill Cable Reel testing

