Research and Academic Sample Preservation

A strategic initiative for low temperature sample preservation to reduce energy cost and risk of sample loss.

Introduction:

UAF researchers and faculty require the preservation of a multitude of sample types for on-going and past research projects as well as day to day class work. Cold temperature sample preservation requires substantial energy to create reliable environments for sample storage in portable chambers. To date, UAF as a campus has not regulated, nor carefully managed, the use of cold chambers or sample storage, but has left this to individual research units to satisfy grant requirements. The current budget situation calls for the campus to look more closely at all practices in order to save money and preserve programs. The proposed initiative will provide a variety of solutions to reduce the number of cold chambers, lower energy costs, and increase operational reliability.

Background:

UAF owns hundreds of cold temperature chambers across the Fairbanks campus that provide storage for a variety of research and academic programs. The chambers include:

- residential upright and chest freezers and refrigerators (0C to 20C)
- aftermarket low(0 to -40C) and ultra-low (-40C and lower) upright and chest freezers
- walk-in coolers and freezers (+25C to -50C)
- aftermarket reach-in environmental chambers (+30C to 0C)

The inventory of chambers is expansive in location and diverse in age, brand, energy use and trouble alarming capability, and the full extent of equipment owned and operated at UAF is unknown. The variability in chamber types and condition increases cost and risk to the individual user, the department, and to UAF. These chambers house samples to support research and teaching needs such as plant sprouts, bacteria and viruses, plant and animal tissue, permafrost cores, and full size mammals. Sample storage at the correct temperature is a key tenant of UAF's research success and the infrastructure needed to support this mission must be robust and reliable. The infrastructure varies from a single power outlet to robust heat-rejection equipment, is expensive to operate, and is rapidly reaching the end of useful life. As this infrastructure fails, the equipment it supports fails, leading to sample degradation or even complete stoppage of the research or academic program.

Problem Statement:

The highest cost and highest risk units on campus are the ultra-low (UL) temperature freezers, as they hold sensitive samples at a very specific temperature to prevent degradation of the samples and have the potential to use excessive energy. UAF research and academic departments own ninety-eight (98) ultra-low (UL) temperature freezers, located across campus in labs, classrooms, and specially designed "freezer farms". This initiative focuses on solutions

to lower the operating cost of the critically useful UL freezers while improving the reliability and quality of samples stored in them.

Loss Prevention:
In 2012, the Center for Alaska Native Health Research lost hundreds of blood samples in a UL freezer that failed when the units power was inadvertently disconnected that cost the program nearly $1.0M and created a substantial gap in their multi-year data collection. Another, more recent failure of a 35-year old freezer owned by the College of Fisheries and Ocean Sciences caused the loss of valuable marine mammal material (cetacean fecal samples). The samples cannot be replicated and the research program has suffered irrevocable damage. These are just two examples of the frail integrity of UAF's UL freezer sample preservation equipment.

The risk of sample loss creates frustration for the users, leading to unapproved quick fix solutions and an increase in the number of freezers across campus in an attempt to have reliability. Some departments have been able to obtain cryopreservation (Liquid Nitrogen) equipment, one of the penultimate solutions for sample preservation with a very low operating cost. Unfortunately, the capital outlay for these systems puts most departments at a disadvantage and thus why they continue to purchase portable upright and chest UL freezers. (One LN2 plant is five times the initial cost outlay as a portable UL freezer.)

Operational Cost:
On average, each UL freezer consumes 35 kilowatt-hours per day, costing approximately $1700 a year per freezer, for a total annual campus electrical cost of approximately $166,600. This estimated cost does not include freezer maintenance, repairs, or the cost to reject the heat output from each freezer.

Facilities Services maintains and repairs the UL freezers for optimal operation. Annual maintenance averages $22,000 for UL freezers campus wide (about $225 per freezer). Over the last few years, FS has decreased the annual maintenance cost through its expanded preventative maintenance program. Due to recent budget uncertainty however, staff experienced in UL freezer maintenance have taken employment elsewhere, which will certainly shift the focus back to the more expensive reactive maintenance and repairs, further creating the need to modernize UAF's method of preserving critical samples.

A majority of the freezers have alarms through UAF's building automation system, allowing them to be monitored 24/7, and alert the chamber owners when a freezer's temperature is out of range. While the life expectancy of a UL freezer is 8-10 years, because of our ability to maintain and repair them in-house, many freezers on campus are 15 - 25 years old and still used for storing important research samples.

Proposal to reduce cost and increase preservation reliability:

FS developed this proposal in coordination with a group of interested stakeholders: Dan Uliassi and Phil Harrington from IAB and Kyndall Hildebrant from the UA Museum of the North. The

group believes a multi-pronged approach is needed to successfully reduce the cost and risk of sample preservation on campus. While maintenance and energy cost is certainly a burden on shrinking operating budgets, risk of sample loss is the biggest driver for procedural changes and chamber replacement especially as more chambers age out, fail, and create significant losses for the user. The best value for UAF to reduce our cost and increase reliability for sample preservation is summarized below in order of proposed implementation:

1. Create a cold temperature sample preservation committee (like the Deer Yard Committee) who can help advocate for centralized long-term storage (such as grant writing), assist with sample housing in non-traditional locations, and develop best practices related to sample preservation.
2. Craft and implement a policy, possibly coupled with a subsidy that requires all new purchased electrically driven ultra-low chambers must be of a low-energy model, less than 7kWh/day. UAF has implemented previous purchasing restrictions on equipment, such as autoclaves, based on the need to develop consistency of parts, service technicians, and certain design parameters. Further precedent is established in our building construction standards where we have implemented policy that requires new construction and major renovations exceed national energy guidelines.
3. Incentivize reduction of long term storage through:
    a. Meter every freezer. The meter will serve as a good indicator of failure (i.e. an alarm) and units that consume power more than an average low-energy model can be direct billed to the department/unit/PI.
    b. Working with EHSRM or OGCA to clarify grant requirements, handle disposal of the samples properly, or ship the samples to another location for another use (best example is marine mammal tissue that must be disposed of in a culturally correct manner.)
    c. Develop policy for long term storage (storage beyond the life of the grant or program) to move into leased chambers or cryo-vats which have lower operating cost.
    d. Purchase and maintain a site license for an off-the-shelf database and incentivize or mandate its use. This will help managers keep track of long term storage and alert when samples are no longer needed, be disposed of, or can be moved to cryopreservation.
4. Utilizing one-time ICR, central funds, or the like, to run an incentive program for exchanging old freezers (over 10-years old, more than 10 kWh/year) with new models that are ultra-efficient (similar to the FNSB wood stove exchange program.) This assumes we are not concerned with payback so much as we are about risk to the user for loss of samples. This proposal may require metering the electrical cost and billing the department/unit/PI for utility if the user decides to keep their old freezer (a tax).
5. Alternative to #4 above would be shifting ownership of all ultra-low portable freezers to Facilities Services to manage, repair, and replace in a recharge center model. With an initial investment of $200,000, we can purchase 6-7 new freezers, replacing the oldest ones first. The recharge rate would be about $160 a month which would cover repair of

existing units and build a recharge account sufficient to purchase 5-6 new freezers each year (assuming utility cost as still paid for by Central).

6. For long term storage, like marine mammal tissue, FS would use one-time funds to purchase a cryogenic plant (LN2 likely) for Murie and AHRB where we have infrastructure in place for cryo-preservation. FS would run the plant and users can lease space in the storage vats based on number of vials or by cubic foot. Through other incentives such as the database, vacancy/occupancy of the vats should be easily managed to ensure we do not end up with the same perpetual storage of samples we no longer need.

Proposed Best Value Option	Cost	Savings
Best Value #1-management committee	No cost	As the committee develops strategies, there is a potential of $10k-$15k savings a year through consolidation, sharing resources, etc.
Best Value #2-Policy	No initial cost, but will increase purchase cost	As units are purchased, there is a savings of $1200 a year in operating cost.
Best Value #3-Incentives	$25,000 for meters, $30,000 for management database.	Potentially $166k utility cost shifted to departments depending on the structure of the subsidy. Management systems may save $10k a year as samples are removed.
Best Value #4-Exchange Program	$27,000 for low energy model, $2,646,000 for complete fleet replacement assuming 100% of the cost paid by Central.	$115,000 cost reduction per year, a 23-year payback.
Best Value #5 -FS Ownership	$200,000 in 1st time cost, $160/month/freezer rental cost for the recharge model.	Approximately $10,000 a year energy savings but savings increases as recharge center can fund new freezers. Ultimately $115,000 after about 16 years.
Best Value #6 Cryo-preservation	$300,000 for two LN2 plants(installed), $28,000 per vat purchase/installation	Approximately $40,000 energy savings a year assuming 30 electric ultra-

		lows are eliminated. Provides most reliable preservation.