Engineering Student Technology Committee

http://www.engr.colostate.edu/ESTC

College of Engineering

Colorado State University

1. Title of Proposal: Nitrogen Supply in the Scott Bioengineering Building

2. Proposal Participants:

Primary Contact for Proposal

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Department/Major: Chemical and Biological Engineering

Check One: __X_ **Faculty** _____ **Staff** _____ **Student**

Additional proposal participants

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Check One: _____ **Faculty** _____ **Staff** ___**X**__ **Student**

Numerous other engineering students could also speak to laboratory nitrogen use. For example, Hassan Dedayati (Ph.D student, CBE), Tara Wigmosta (Ph.D. student, BME), Natalie Rapp (Junior, CBE), Jacon De Roo (Senior, CBE), Alex Bozzo, Alex Kosmiski, Morgan Schake (BME senior design team).

3. Proposal Abstract (limit to 100 words):

The Scott Bioengineering Building is supplied in two ways from a large Nitrogen tank in the service yard of the building. Nitrogen gas is directly piped to a number of labs in the building and liquid nitrogen is available via a dispensing system in the loading dock. The liquid nitrogen is dispensed via a metering system and can be directly charged to research projects. The cost of the nitrogen gas cannot be recovered via a meter-based funding mechanism; no practical system came to light when a metering system was sought.

4. Proposal Budget

List of items to purchase and cost of each

Nitrogen tank rental and environmental fee	$5,000
Liquid Nitrogen (filling of the tank)	$6,000
Maintenance of the liquid nitrogen distribution system	$1,000
Nitrogen gas (produced by boil-off, no additional cost)	
Total	$12,000

Dollar or percentage amount requested from ESTC:
Approximately $3,500 (1/2) of the liquid nitrogen cost is covered by research projects. This proposal is to cover the balance annually. Noting that gas prices and usage varies year-over-year, the request is for the authority to spend a maximum of **$10,000** annually, the unused balance of which will be returned to the ESTC. To be specific, it is proposed that the ESTC cover the full annual cost of tank rental and the full environmental fees of one tank (the one existing tank, or it's successors), plus ½ the total cost of the liquid nitrogen each fiscal year and ½ the cost of the maintenance for the liquid nitrogen distribution system.

5. Full description of proposal:

When the Scott Bioengineering building was constructed, it was determined by the future occupants that the most cost-effective manner to provide nitrogen to the building was via a central storage tank. This allowed for the direct piping of nitrogen gas to the research and teaching labs and the dispensing of liquid nitrogen into dewars for research or teaching purposes.

In order to charge the cost of nitrogen to a research project, the exact amount needed must be measured out, recorded, and the billed. The liquid nitrogen metering system was provided during construction and gas metering systems were researched, but none were found to be practical. Post-construction, the college revisited the idea of metering the nitrogen gas, but found the cost prohibitive (approximately 10 times the cost of the gas itself). Consequently, only the cost of liquid nitrogen dispensed via the metering system can be recovered. Roughly half of the cost of filling the tank cannot be recovered, because the nitrogen is either used as a gas in the laboratories or lost to boil-off.

To-date, the cost of the tank rental, the environmental fee, the maintenance costs, and the nitrogen gas cost for the classrooms has been covered by the "Engineering II Building Fund", that is, the gift funds collected to complete construction of the building. Those funds have been almost fully expended and will not be available past the current academic year (AY18). Hence, this proposal to have those costs covered by the ESTC.

It is understood that Charges for Technology (CFT) funds may only be used for equipment, or for supplies for equipment, once purchased with CFT funds. Because Nitrogen is considered a

"supply", it is important to note that the ESTC provided $500,000 toward computing and teaching equipment when the Scott Bioengineering building was constructed. Hence, the liquid nitrogen is supplying equipment already funded by the ESTC.

Nitrogen gas is available in both research and teaching laboratories in the Scott Building thanks to the on-site liquid nitrogen tank. Liquid nitrogen is available on the first floor dispensing station. Having centralized liquid nitrogen access within the building is an excellent feature of the Scott Building, but the long term support for this feature is currently jeopardized by the lack of an established funding mechanism that can support the use of gaseous nitrogen plumbed throughout the Scott building. Liquid nitrogen is a widely useful supply for cooling samples to cryogenic temperatures. This capacity is useful for graduate student and undergraduate student researchers working in multiple departments, throughout the Scott Building (e.g. in the Systems and Synthetic Biology and Biomedical Engineering pods). For a variety of students liquid nitrogen is an indispensable part of their experiments. For example, to ship engineered biomolecular crystals to the Advanced Light Source in Berkeley California, students must use a special liquid nitrogen dewar capable of keeping the samples frozen during shipment. Alternately, for students who are engineering modified cells, liquid nitrogen storage dewars provide the most secure long term storage of cell stocks. As a third example, ready access to nitrogen gas is helpful for a variety of research scenarios that call for the use of non-oxygen-containing head space (e.g. chemical reactions sensitive to oxidation).

For the gas use in particular, research groups use the gas to purge sensitive spectroscopy equipment that must be kept free from water in the atmosphere. Liquid nitrogen gas boil off is actually a very cost-effective way to do this. For example, in the Glover building the Kipper lab had to run an expensive air dryer system on the house compressed air. This led to problems with oil and other contaminants from the compressor that they also had to try to filter out, to reduce interference with the spectroscopy.

In the event that access to the N2 gas boiloff plumbed into the labs was lost, a number of groups would likely be forced to purchase 96-liter dewars or compressed gas cylinders, and have to store them in the labs and change them regularly. This would be more expensive, less convenient, and less safe than the current system. Specifically, having large quantities of cryogenic liquid stored in or near the lab workspaces does create hazards, and require personnel time to maintain.

Beyond use in research settings by graduate and undergraduate students, the nitrogen gas plumbed into the **teaching labs** is also used. At a minimum, this is used by several CBE courses. For example, the large classes of first-year CBE students use N_2 gas to conduct two experiments in CBE101 (Fall and Spring). Specifically, N_2 gas is used on a system that uses pervaporation membranes and simulates a blood-oxygenator. (Oxygen is transferred to the "blood" solution across a membrane oxygenator, and then stripped out using pervaporation membranes. Nitrogen is exchanged for the oxygen and is replaced in the oxygenation membranes.) This experiment is used to teach material balances and mass transfer on a simulated, full-scale engineered system.

Additionally N_2 gas is used in Scott 261 for the final lab class for 4th-year CBE students taking CBE443. In that class students use N_2 gas to (1) perform pervaporation experiments, (2) conduct oxygen mass transfer studies in bioreactors, (3) calibrate the dissolved oxygen probes used in the bioreactors.

In sum, the current capabilities of the system in place in the Scott building are excellent for students in both teaching and research laboratories. ESTC support will help ensure that this resource is not lost.