CHILL UP -70°C is the new -80°C

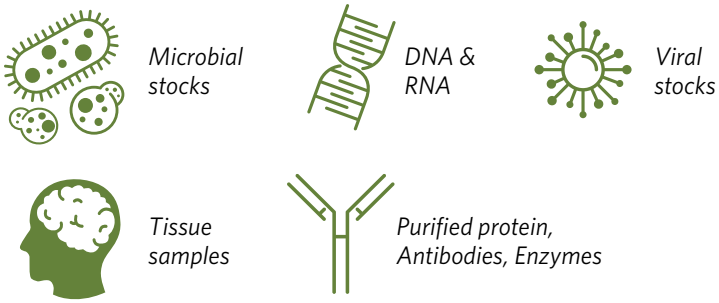
Is your -80°C freezer essential to the work you do? Ultra-Low Temperature freezers (ULTs) preserve millions of precious samples at UBC but are expensive, energy intensive, and require vigilant oversight.

UBC labs are joining the ULT Chill Up Movement. Here's why:

01

Many samples don't need to be stored at temperatures as cold as -80°C.

About 20 years ago all ultra-low freezers were set to -65°C or -70°C. The drive to lower temperatures has more to do with ULT marketing than with science. **DNA, RNA, antigens, and viruses have been shown to be stable for twenty years at -70°C** [1]. Researchers at several peer institutions have contributed to a database of samples stored at -70°C, many for over 10 years.



02

Set your ULT to -70°C to prolong its lifespan and save on expensive equipment replacement.

Your ULT's compressors run intermittently to keep samples cold. The longer the compressor has to run to maintain the set point temperature (referred to as duty cycle), the higher the risk of freezer failure. **On average ULT compressors have to work 56% more at -80°C than at -70°C** (Fig. 1) [2].

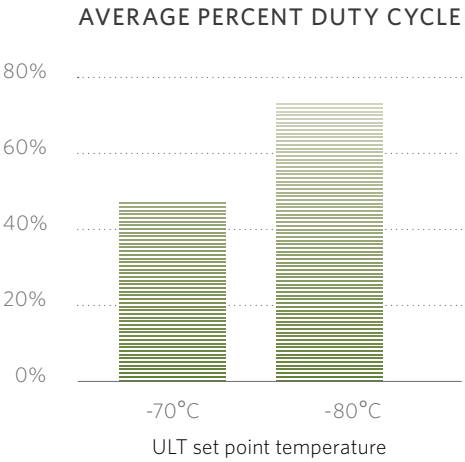


Fig. 1 (left): *A recent study compared compressor duty cycle for 15 freezers at set points of -70°C and -80°C. Duty cycle is expressed as a percentage ((run time/ total time) *100) [2].*

03

Labs use 10x more energy than other campus spaces.

Standard -80°C freezers consume as much energy as a single-family home. On average, raising a ULT's set point to -70°C reduces its energy consumption by 23% (Fig. 2).

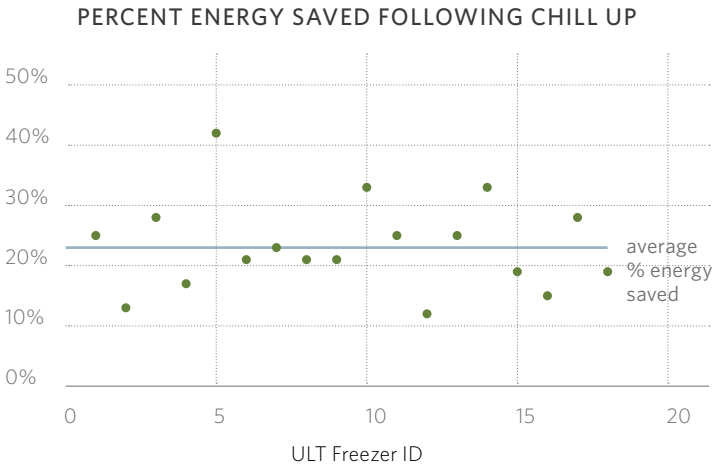


Fig. 2 (above): *Percent savings calculated based on metered energy data collected at UBC (MSL), CU Boulder, UC Riverside and PG&E study [2]. Freezers ranged in age, energy efficiency, brand, model. All were 20-30cu ft.*

REFERENCES

[1] *Miller L. et al., 20 Year Stability Study of HIV, HBV, Antibodies, Antigen and Nucleic Acids in Plasma. Poster at ISBER conference (2013).*

[2] *PG&E, SCE, SDG&E Study 'Ultra Low Temperature Freezers: Opening the Door to Energy Savings in Laboratories'*

UBC sustainability

Sample Safety at -70°C

- Miller L. et al. found that **DNA, RNA, antigens, and viruses are stable for 20 years at -70°C** [1].
- Genomic DNA has been shown to be stable stored over 24 months at temperatures as high as -20°C. No detectable DNA degradation was found after up to 19 freeze-thaw cycles [2].
- **Close to 75% of Michael Smith Laboratory ULT freezers are set to -70°C,** as are 60% of ULTs at CU Boulder. Researchers at Harvard, MIT, Stanford, University of Pennsylvania, UC Davis, University of Toronto, and others, are also raising set points to -70°C. A database of samples stored at -70°C is summarized in Table 1 [3].

Table 1: Summary of samples stored in ULTs with -70°C set points

Sample Type	# of Labs	Avg. Storage time (years)	Range storage time (years)
Animal tissue (including human)	31	6	1 to >10
Bacterial stocks	29	7	2 to >10
RNA	25	5	0.5 to >10
DNA (including cDNA)	24	6	2 to >10
Purified proteins	24	5	1 to >10
Competent cells	20	3	0.5 to 6
Cell extracts	17	5	1 to >10
Enzymes	13	5	1 to 10
Cell lines	12	6	1.5 to >10
Yeast stocks	11	7	10 to >10
Antibodies	7	7	3 to 10
Plant tissue	7	3	0.5 to 5
Virus stocks	5	6	3 to >10

** Based on a database of self-reported information provided by researchers at UC Davis, CU Boulder, UC San Diego and UC Riverside [3].*

Impact of door opening at -70°C set point

- Following 48 second door opening ULT freezer temperature **returned to within 4°C of the set point (-70°C or -80°C) 5 minutes post door opening,** and reached the baseline temperature within 2 hours [4].
- Evaluation of temperature variance and uniformity in response to 3 rigorous door opening schedules, found that regardless of set point (-70°C or -80°C), the front top shelf was most prone to door opening induced temperature fluctuation. Temperatures here frequently peaked above -50°C following door opening, but returned to below -50°C within several minutes [4].

Power Failure and thaw time

- It is best practice to have a **backup system** (ex CO_2) in place for ULTs regardless of set point temperature.
- In testing conducted here at UBC, it took an empty ULT 4 hours to warm from -80°C to -50°C.
- Unpublished data collected by Thermo Fisher Scientific indicates that ULTs reach -50°C 30 to 40 minutes faster following power outage or failure when set to -70°C. (Direct correspondence between Thermo Fisher Scientific and Allison Paradise at My Green Lab).

Have questions? Need assistance? Ready to Chill Up? Email green.labs@ubc.ca

FURTHER RESOURCES

- PON1 Long Term Stability
- RNA Stability at Various Storage Temperatures and Through Multiple Freeze-Thaw Cycles
- AntiOX Long Term Stability
- Long Term Stability of Viral Markers
- Minimizing Temperature Variation

REFERENCES

[1] *Miller L. et al., Twenty Year Stability Study of HIV, HBV, Antibodies, Antigen and Nucleic Acids in Plasma. Poster Presentation at the Annual ISBER conference (2013).*

[2] *Wu J. et al., Stability of Genomic DNA at Various Storage Conditions. Poster Presentation, QACO3 ISBER Meeting (2009).*

[3] *Database: Biological Samples Stored Long Term at -70C or Warmer: ULTs at -70C*

[4] *PG&E, SCE, SDG&E Study 'Ultra Low Temperature Freezers: Opening the Door to Energy Savings in Laboratories'*