

Comparison of Energy Efficient -80°C Freezers for Biorepository Storage

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Abstract

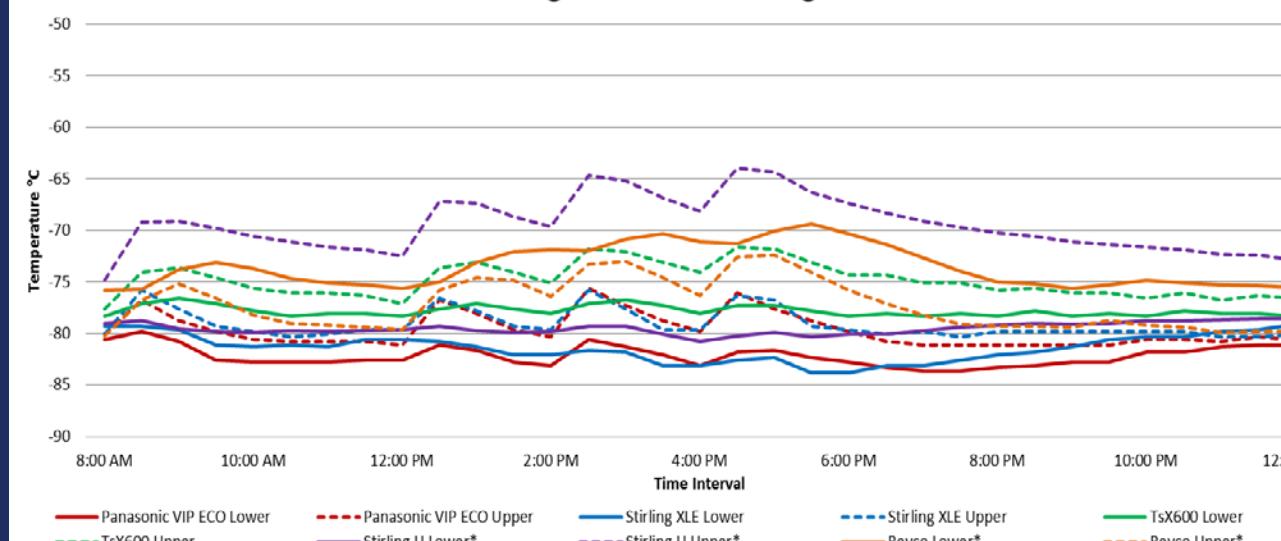
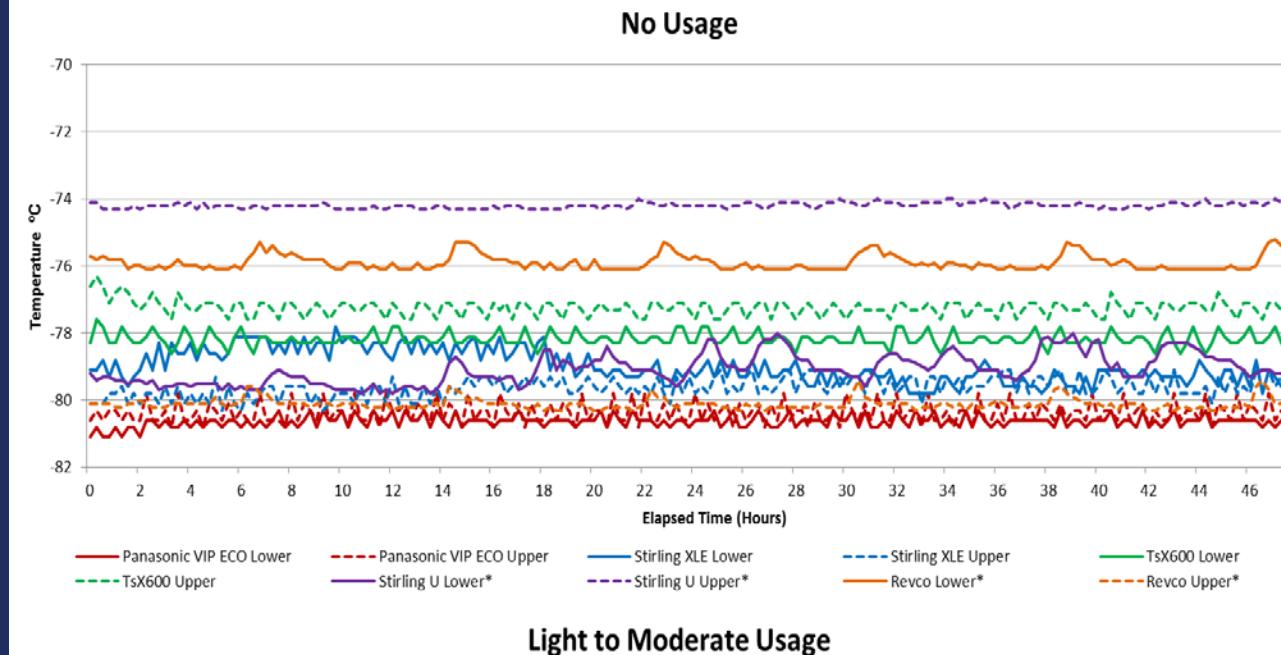
Background: The Mayo Clinic Biorepository Program Biospecimens Accessioning and Processing (BAP) Core Laboratory has a variety of storage options with a capacity of over 30 million samples, including 4 automated -80°C freezers, 150+ upright -80°C freezers, and 12+ liquid nitrogen freezers. As our biorepository continues to grow, energy efficient options are being considered to replace the aging -80°C freezers, but must maintain adequate performance characteristics and storage capacity. The purpose of this study is to compare the performance characteristics and cost effectiveness of the 3 newest energy efficient upright -80°C freezer models.

Methods: The Thermo Fisher TsX600, Panasonic VIP ECO, and Stirling Ultracold freezers were installed in our facility for comparison. The method from the study performed in 2014 was recreated for this study. Power usage, power surges, capacity, temperature fluctuation, temperature gradient, recovery time, and warm-up profile were measured. Idle to heavy usage conditions were simulated over a 3 week period. A financial analysis using our results with local power costs was completed to determine operating cost of each freezer over time.

Results: The Mayo Clinic BAP Core Laboratory determined how the new energy efficient -80°C freezer models compared to one another and whether or not they outperformed standard upright and liquid nitrogen freezers from our study performed in 2014. We determined whether, at a reduced energy cost, these new models are the best -80°C storage option for biorepositories looking to save on operating costs and reduce their energy consumption.

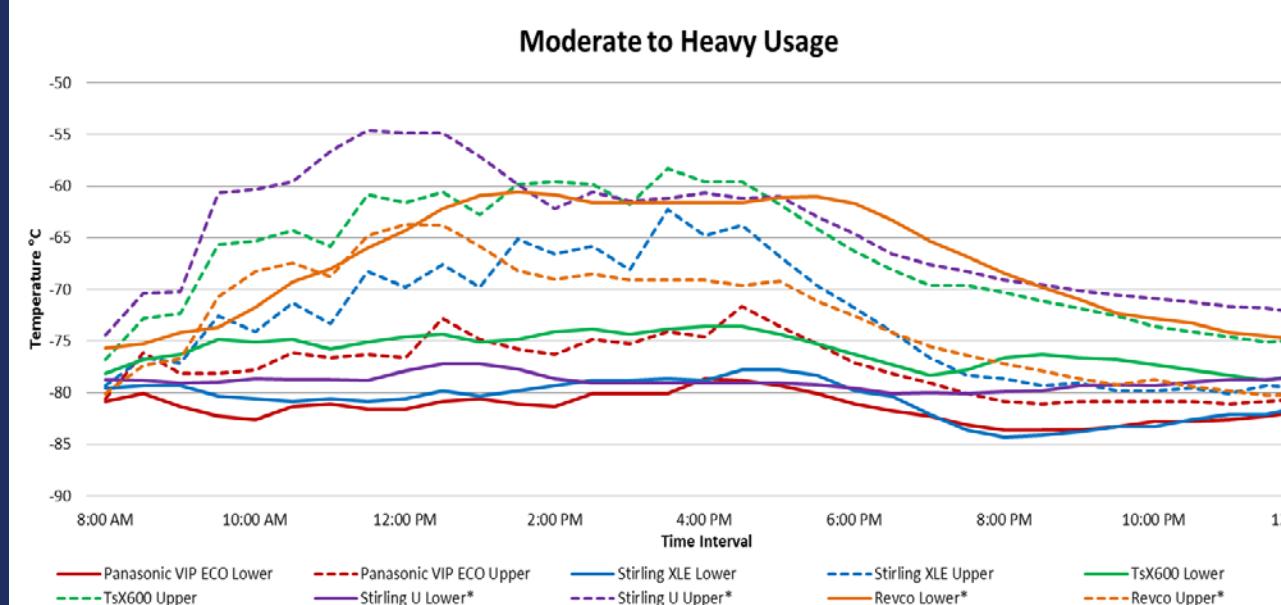


Freezer Temperature Stability



Method: outer door opened fully, then 2 inner doors opened for 2 minutes.

Duration: 8 am, 2 minute; 10 am, 2 minutes; Noon, 2 minutes; 2 pm, 2 minutes 4 pm, 2 minutes

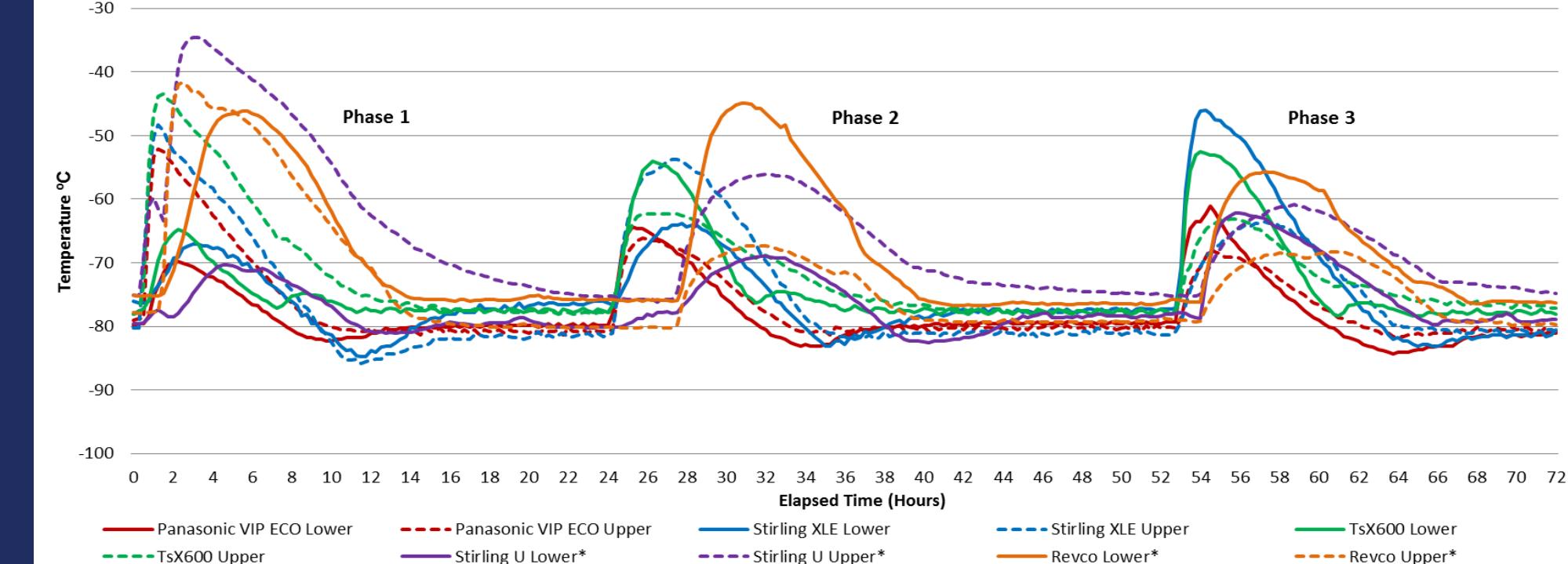


Method: outer door fully opened, then 2 inner doors opened for 3 minutes alternated each hour with outer door fully opened for 10 minutes

Duration: 8 am, 3 minutes; 9 am, 10 minutes; 10 am, 3 minutes; 11am, 10 minutes; Noon, 3 minutes; 1 pm, 10 minutes; 2 pm, 3 minutes; 3 pm, 10 minutes; 4 pm, 3 minutes

*Data for the Stirling U and Revco freezers comes from the 2014 study

Freezer Loading Temperature Profile



Financial Analysis

	kW/Hr	Annual Power Cost (\$0.1026/kWh)
Stirling XLE	0.337	\$303.25
Panasonic VIP ECO	0.351	\$315.12
TsX600	0.475	\$426.55
Stirling U*	0.393	\$353.42
Revco*	0.798	\$717.38

Test Preparation

- Each freezer was filled with racks and 2 inch 81-cell card board freezer boxes to maximum capacity.
- Once loaded, each freezer contained the same ratio based on capacity of the following box types:
 - 52% boxes containing dividers only
 - 35% boxes containing single freezer bag filled with 100 ml of water
 - 13% boxes containing 10 DNA specimens tubes
- Boxes were preloaded into ambient freezer racks.
- Freezers were installed according to specifications.
- TempTrak temperature monitoring system was installed using a probe placed at the top and bottom of each freezer.
- Power meters were installed. Freezers were powered on and allowed to stabilize to -80°C for 48 hours.

Discussion

This evaluation showed that the new energy-efficient upright freezer models perform better than previous models in temperature stability throughout the unit, temperature stability during times of heavy usage, temperature recovery, capacity, energy efficiency, and cost of use.

- The Panasonic VIP ECO performed best in maintaining temperature throughout the tests with little variation in temperature throughout the unit. It performed a close second in energy efficiency, comparable to Stirling.
- The Stirling XLE showed more variability in maintaining temperature, but was the most energy-efficient.
- The Thermo TsX600 showed the most variability in temperature of the new units and was significantly less energy efficient.

Conclusions

The new energy efficient models have features that improve their ease of use and on-board monitoring over previous standard upright models. Comparison of these storage units has helped our program evaluate the most efficient and cost-effective storage units for our continually expanding biorepository.