TECHNICAL NOTE

NEW BIO GUARD -86°C 690L ULT FREEZER : IMPROVED PERFORMANCES AND LOWER POWER CONSUMPTION

[Technical Note 2026-002] /
Olivier VARET

FROILABO SUCCEED TO IMPROVE PERFORMANCES AND TO DECREASE POWER CONSUMPTION BY -19%

INTRODUCTION

Ultra-low temperature freezers operating at −80 °C play a critical role in the long-term preservation of sensitive biological and industrial materials. They are widely used in hospitals for the storage of biological samples, in biobanks for the conservation of valuable collections, in research laboratories for samples related to scientific and biomedical research, and in industrial environments for the storage of finished products or key components involved in manufacturing processes.

In all these applications, maintaining a stable and reliable ultra-low temperature environment is essential to ensure the integrity, traceability, and safety of stored samples and materials. Any temperature deviation or equipment failure may lead to irreversible degradation, loss of critical data, or significant economic and regulatory consequences.

ULT freezer is considered as the safety box of the lab by users and they do not want any compromise on performances.

To take care of environnemental impacts of the use of ULT freezers, for many years, Froilabo is involved in a continuous process to offer best performances with the lowest impact on environnement. The purpose of this technical note is to demonstrate that Bio Guard, the new generation of -86°C ULT freezer, offers best-in class performances with a lower power consumption than previous generations of FROILABO's freezers.

TEST CONDITIONS

To measure the performance of the Bio Guard -86°C 690L, following tests have been conducted:

- Pull down test (from ambient temperature to -80 °C). Temperature distribution has been recorded using 9 probes mapping based on NFX 15-140 standard.
- We have reviewed the power consumption and temperature distribution of the fully empty freezer based on the Energy Star and NFX 15-140 temperature mapping protocols.
- In addition to the Energy Star protocol, we have conducted additional temperature recovery testing based on a more realistic door opening time for customer reference.
- We have conducted a defrosting process to evaluate the loss of cold during the emergency shutdowns.
- We calculated temperature homogeneity. Temperature distribution has been recorded using 9 probes mapping based on NFX 15-140 standard.

For all tests, we used : set temperature -80°C or -70°C, offset 0, hys. ±0.5, ex. 1-2-3 -40 and ex. 4-20.

The test was carried out in an air-conditioned room tempered between 20°C and 21°C. Nine PT100 probes were placed within the tank as shown in figure 1 : 4 probes were placed on the highest shelf, 4 probes were places on the base of the freezer and 1 probe was placed in the centre of the freezer.

The freezer was connected to a power consumption measuring device (OceaSoft).

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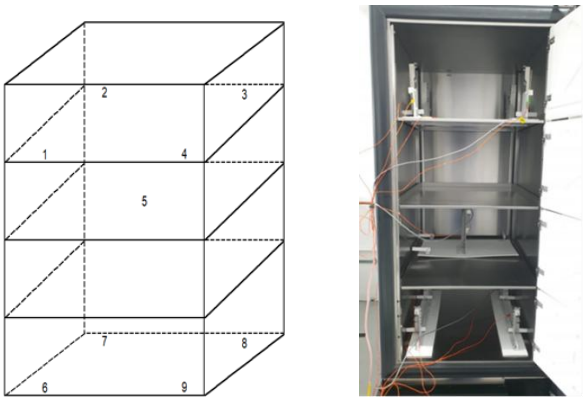


Figure 1: Positioning of all the 9 probes inside the tank.

PULL DOWN TEST

The freezer underwent the "PullDown" test to determine the lowest achievable temperature and the time taken for the freezer to reach -80°C (+/-5°C) was also monitored. Figure 2 displays temperature profiles for average of Top probes, Center probe and average of Bottom probes. Bio Guard -86°C 690L ULT freezer reaches -80°C (+/-5°C) in 4 h 40 min. To reach -60°C (+/-5°C), it takes Bio Guard 690 unit 2 h 45 hours. This rapid pull-down time makes the Bio Guard unit a reliable solution as a backup freezer, as the freezer can be ready to use in as little as 3 hours, less than meantime of a defaulted unit to reach -60°C from -80°C. You can transfer all samples into Bio Guard before your sample reach a critical temperature in a defaulted unit.

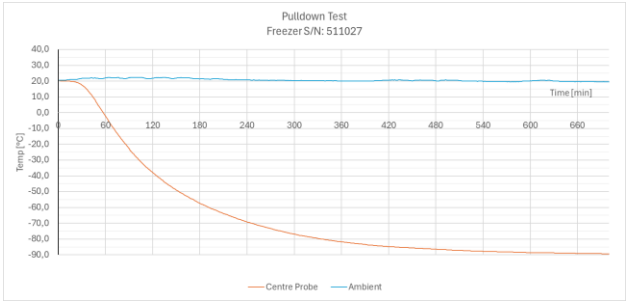


Figure 2: PullDown test, temperature profile for average value of Top probes, value of Center probe and average value of Bottom probes

TEMPERATURE HOMOGENEITY ANALYSIS

A good temperature stability inside the tank of a freezer guarantees safety for all samples whenever the position of the sample into equipment. With 3 internal temperature probes (instead of one in the previous -86°C 690L ULT freezer generation) and with new optimized algorithm, management of the compressor cycling is improved, and efficiency of the cooling circuit is better. Analysis of temperature variation, figure 3, demonstrates a regular cycling of temperature for all probes. The compressors are working with an optimized cycling to guarantee a longer lifetime.

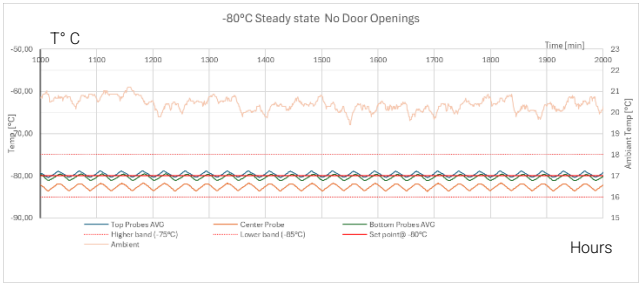


Figure 3: Temperature variation for a setpoint of -80°C for 9 probes

Quality of insulation is the second most important parameter for temperature homogeneity. FROILABO improved foaming process to get foam with perfect homogenous density, and the tank now includes new VIP vacuum insulation to guarantee the best efficiency. Temperature homogeneity reference in ULT freezer market is maximum +/-5°C. Results shown in figure 4 demonstrate that temperature homogeneity is +/- 4°C. Bio Guard offers better temperature homogeneity than value of reference in the market. Maximum Temperature stability is 2,07°C.

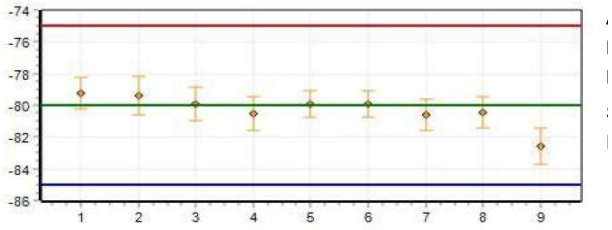


Figure 4: Temperature homogeneity for a set point of -80°C for 9 probes.

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Thermal camera equipment has been used to monitor the freezer's external body temperature in order to investigate the quality of the foaming process and vacuum-insulated panels (datas not shown). Temperature measured on each side of the freezer is between 20 to 22°C, same as room temperature during the test.

POWER CONSUMPTION

The freezer runned at -80 °C and -70 °C for the duration of 24 hours for each. The power consumption has been captured and calculated based on the energy start protocol for each door opening time test. Based on results shown in Table 1, the power consumption decreases of 19% compared to our previous versions of -86°C ULT freezers, without any comprise on the performances.

Test	Power consumption [kw / 24hr]
	Energy Star
24hr door closed	11.30
15sec door opening	12.48

Table 2: Power consumption based on energy star potocol

DOORS OPENINGS

In the case of daily use of a freezer, the user will have to open the freezer doors frequently. To ensure the safety of the samples, it is important to make sure that the freezer can quickly return to the set temperature. This way, the storage temperature of the samples is maintained, and the security is optimal.

The test was conducted to observe the impact of freezer door openings. During a one-day test, the freezer main door and top internal door were kept open for a duration of 15sec, 1, 2, and 3 min. After closing the door, the temperature recovery time to the acceptable range (-80°C ± 5°C and -70°C ± 5°C) has been monitored. Data was collected based on the "NFX 15 140" method (9-probe mapping method).

In table 1, 15 sec door opening of main door and top internal door does not affect the temperature in the center and at the botton of the tank. 5 minutes are needed to recover -80°C in the top compartment of the tank. When doors opening reachs 1 min the maximum time recovering is 14 min in the top of the tank when 4 minutes are required for center of the tank and bottom keeps -80°C.

	Freezer S/N: 511027		
Probe Location	Recovery Time for Each Specific Opening Duration @ -80°C (+/- 5°C)		
	15 sec Opening	1 min Opening	3 min Opening
Top Probes (T1,T2,T3,T4):	5 min	14 min	46 min
Centre Probe (T5):	0 min	4 min	30 min
Bottom Probes (T6,T7,T8,T9):	0 min	0 min	30 min

Table 1: Temperature homogenity for a set point of -80°C for 9 probes.

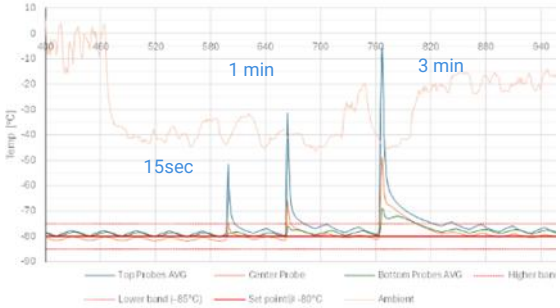


Figure 5: Recovery time to set point of -80°C (+/-5°C) for 15 sec, 1 min and 3 min door opening.

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The test demonstrates that the freezer can recover target temperature homogeneity quickly to secure sample preservation, even in a normal daily use.

CONCLUSION

Across medical, scientific, and industrial sectors, –80 °C freezers are mission-critical equipment for the secure preservation of sensitive samples and materials. Their performance directly impacts sample integrity, regulatory compliance, operational continuity, and overall risk management. –80 °C ULT freezers are a cornerstone of secure cold storage in laboratories and industry.

As a result, the selection and use of ultra-low temperature freezers must prioritize reliability, temperature stability, performance consistency, and robust safety features.

This technical note demonstrates that Bio Guard offers high end performances in sample storage at -80°C with a significant decrease in power consumption.

True to its reputation as a manufacturer of robust equipment, FROILABO developed a new -86°C 690L ULT freezer that will work for a decade.

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