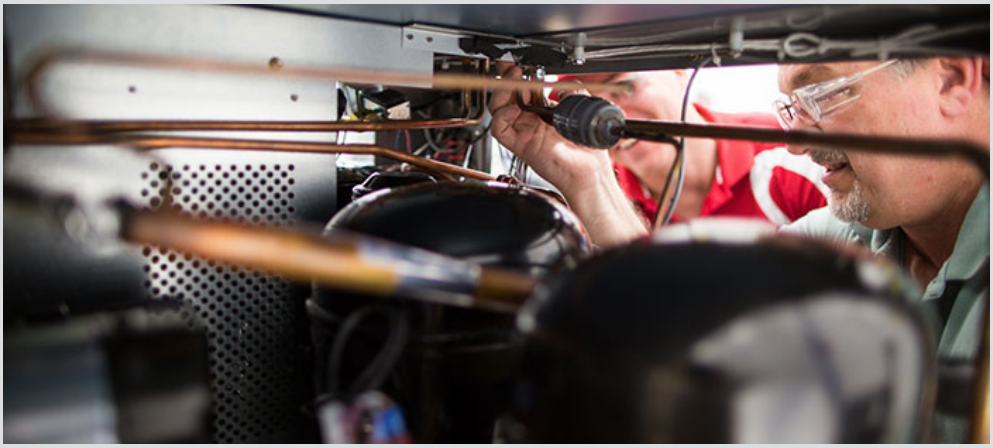
Ultra-Low Freezer Design - Reducing the Risk of Service Costs

ARTICLE



Introduction

Ultra-Low temperature freezers routinely store critical and sometimes irreplaceable clinical or research samples. Ensuring ongoing reliability of this category of equipment is a priority, and can be a challenge that laboratories often face. Unfortunately, freezer warm-ups and compressor failures are not uncommon events. In addition to the risk of losing samples, the impact of ultra-low temperature freezer reliability issues is important in terms of resources consumed, including freezer downtime, lost productivity for laboratory staff, and direct expenses to the facility.

This article evaluates the financial impact of two ultra-low freezer failure modes including compressor failures and freezer warm-ups due to oil logging. It also provides considerations for choosing reliable ultra-low freezer designs that can help reduce these risks.

Compressor Failure: Direct Financial Impact

When an ultra-low freezer does not maintain temperature properly, a facility's likely first step is to contact a service provider and schedule a troubleshooting call if internal facilities/engineering personnel cannot resolve the issue. This initial diagnostic visit by a service technician typically takes 3 to 5 hours. Depending on the region the facility is located in, service companies typically charge $80 to $125 an hour, although rates on the high end of this range are most commonly seen. Most service companies have a minimum charge of $300 for a service call, which means the troubleshooting phase can cost $300 to $625, plus travel expenses, when a service provider is required to evaluate the unit.[1]

During the troubleshooting call, if it is determined that a compressor has failed and must be replaced, a repair and replace event will be scheduled. Typically, a customer is billed 8 hours for a repair and replace event, costing from $640 to $1,000. Sometimes repair and replace is performed on-site at the facility; however, best practice is for the unit to be taken to the service company. If the unit is transferred to the service company, the user is billed

$200 each way, resulting in an additional cost of $400. In addition, the cost of the compressor itself can range from $850 for a high stage to $1250 for a low stage unit. After replacement of the compressor and any other necessary repairs, the unit is powered up at the facility and given time for the temperature to pull down to the setpoint. At this point, a technician must return to the facility to perform calibrations, typically taking 3 hours, resulting in an additional charge of $240 to $375.

Miscellaneous charges will also apply. For example, a typical evacuation charge would be $85, and additional charges for refrigerants generally run over $100.

The following table summarizes the range of hourly rates, length of each step of the process, and direct financial impact to facility when an ultra-low freezer compressor must be replaced:

Ultra-Low Freezer Compressor Replacement – Direct Financial Impact

Service Activity or Part	Hourly Rate – Low End	Hourly Rate - Typical	Billable Hours	Cost – Low End	Cost - Typical
Troubleshooting	$80.00	$125.00	3-5	$300.00[2]	$625.00
Transportation to and from Service Company	N/A	N/A	N/A	N/A	$400.00
Compressor	N/A	N/A	N/A	$850.00	$1,250.00
Repair & Replace Event	$80.00	$125.00	8	$640.00	$1,000.00
Calibration	$80.00	$125.00	3	$240.00	$375.00
Evacuation	N/A	N/A	N/A	$85.00	$85.00
Refrigerant	N/A	N/A	N/A	$100.00	$100.00
TOTAL				**$2,215.00**	**$3,835.00**

The total direct cost of replacing an ultra-low freezer compressor is more than $2,000 in the lowest cost scenario; however, more typically, the expenditure can exceed $3,500. Expenses can run even higher, depending on the competence level of the service technician and additional charges applied.

In addition to the direct financial impact of having an ultra-low compressor replaced, there is indirect impact, including the freezer downtime and having to utilize a back-up or loaner freezer. Samples may be lost if they have been exposed to adverse temperatures. Even if samples are not lost, there is a risk of exposing them when they are moved to an alternative freezer. In addition, there is the lost time and distraction of laboratory personnel which can be a drain on facility resources.

Freezer Warm-Ups: Risks and Implications of “Oil Logging”

It should be noted that freezer warm-ups caused by the phenomenon known as “oil logging” can also result in facilities incurring significant expense for service calls. The compressor, which moves the refrigerant through the copper coils, requires oil to function properly. However, oil that sits idle in an ultra-cold environment will form clogs that prevent the refrigerant from moving through the system (also known as “oil logging”). These clogs produce warm-ups because the refrigerant is unable to maneuver through the system to cool. The warm-ups result in service calls, during which the technician turns the unit off and the frozen oil thaws. When the unit is restarted, it seems to be working properly until the oil clumps and freezes again, and the whole cycle repeats itself. Many costly service calls can be attributed to poor oil management.

Ultra-Low Freezer Design Considerations: Reducing the Risk of Compressor Failure and Oil Logging

One of the most important concepts in developing a reliable ultra-low freezer is designing an optimized refrigeration system that protects the compressor. This helps reduce the risk of compressor failures, resulting in a positive impact on total cost of ownership by limiting the need to replace compressors over the life of the freezer. An optimized refrigeration system for an ultra-low freezer should also provide maximum heat exchange and effective oil management in order to prevent oil logging. This reduces stress on the compressor and increases the reliability of the freezer.

The i.Series line of Ultra-Low Freezers from Helmer Scientific was developed with these principles in mind. The refrigeration system was designed for maximum heat exchange, which protects the compressor by reducing stress. Maximum heat exchange is achieved by the following:

- A split evaporator that evenly cools the cabinet from top to bottom. This supports temperature uniformity throughout the cabinet and faster recovery times.
- Precisely placed hand-wrapped coils that maximize surface area contact. This improves heat transfer, increasing overall efficiency and reducing compressor run time.
- Utilizing a large, robust condenser that provides a greater cooling surface area, improving low-stage performance for demanding applications.

In addition, Helmer Scientific's ultra-low freezers were designed to address the issue of oil management, which causes freezer warm-ups and can lead to compressor failure. In order to achieve this design goal, the freezers utilize:

- A specially engineered, high efficiency oil separator that removes virtually all of the oil from the refrigeration lines.
- A mixed refrigerant that has been optimized to ensure proper flow rate at extremely low temperatures.
- Precise placement of the coils that avoids bends and maintains a downward angle, ensuring that the refrigerant will keep moving.

Conclusion

Preventing compressor failures and warm-ups can help laboratories reduce the total cost of ownership of an ultra-low freezer by limiting costly service calls. The design of an ultra-low freezer is important to minimize the risk of these types of events occurring. A freezer design that protects the compressor and eliminates the phenomenon called "oil logging" helps reduce the risk of direct financial impact due to service events, and helps avoid other consequences such as downtime, compromised samples, and consuming the time of laboratory staff. It should also be noted that approximately 15% of all failure calls could have been prevented with regular preventative maintenance.

1 Estimates are based on information collected from the Helmer Scientific Technical Service Department.

2 Most service companies have a minimum charge of $300.00 for a service call.