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Contingency Plan for Your ULT Freezer: How to React?

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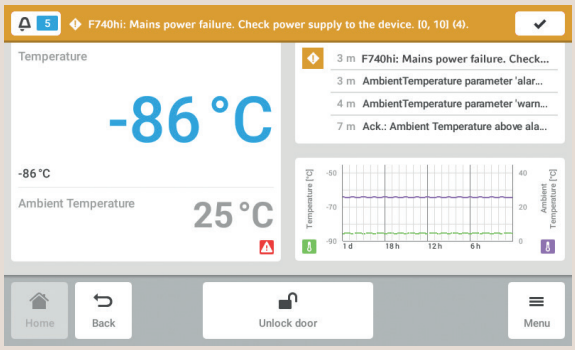
Freezers last for many years. Many samples, most of them of high value, stay in longterm storage. Failures like power blackouts are rare but if it happens, the consequences can be enormous. What to do in this situation? People panic and do not know what to do. Good preparation is recommended: Training and instructions should be mandatory in every laboratory. Well known and existing facts should be a reliable alarm system, knowledge about the samples within the concerned freezer, awareness of potential backup freezers, the alarm chain and much more.
This White paper shall give guidance on behavior if there are issues with an ULT freezer, independent from the brand.



Introduction

ULT freezers are commonly used instruments in the lab. Starting with one unit, there are many laboratories where several to many ULT freezers are installed in the laboratories, the hallways, or the basement. Especially when having several units, they are quite often located at different places within the building, have different ages, are coming from different suppliers, have different technical performance, and are managed by different members of the team(s).
All in common, ULT freezers store many tens of thousands of samples per instrument.

Power outages

ULT freezers can fail due to power outage in the building, the floor, the room, or the dedicated wall socket. Depending on the global region and country, public power failures can happen for a few minutes, some hours, or even for a day (or longer). Back-up power generators, driven by fuel, can sometimes bridge power failures although even latest freezers consume several kWh per day. Portable power generators of 2,500 or 3,000 Watt can supply three ULTs for some hours. For more freezers and a longer power supply time, far bigger industry standard power generators with large fuel tanks are required.
Besides the classic power failure, the instrument itself can have some damaged part(s) in the cooling system or in the electronics, resulting in a break-down.
Freezer failures are statistically very rare due to multiple quality checks at the suppliers as well as regular checks of power supply systems in the laboratory. Local outages based on issues with the power grid are the least influenceable factor.

What happens if?

Although the situation is rare, if the blackout happens, the users probably face harsh consequences:
Did you ever calculate the value within your freezer? All the hours, days, weeks, and months spent on your samples? More than 50,000 samples fit into large, standard ULTs of 700 L class. The value of every single sample differs – from simple buffers to high-value cell extracts, expensive enzymes, or very rare sample material. Assuming an average value of 10 Euro or Dollar per vial, the total value already reaches 500,000 Euro or Dollar.
When predominantly storing high-value samples which are a result of months of work – you easily reach a value in your freezer far beyond half a million Euro or Dollar.

Figure 1: Sample thawing caused by power failure has challenging consequences

Due to the rare occasions, many scientists are not used to this situation and do not know how to react. Everyone is aware of lurid tales like:

> »...it was 2 a.m. when the guard called me: Sir, there is an alarm in your lab, you'd better come over...«

> »...it's a nightmare, you enter the lab, the water is already dribbling down the freezer door, and you know – it's all gone...«

> »...last summer our freezer failed, we lost 2 years of work and 650,000 Euro...«

But due to this rareness, most people in the laboratories do not prepare themselves for this kind of emergency situations and probably just hope not to be in charge and/or not to be on duty if it happens.
Even for well-experienced scientists, a failure of the freezer is an extremely stressful situation. The better you are aware of the situation, the better you can react. Keep in mind, planes normally fly and touch-down without any problem, but the pilots still train themselves for emergency landings and make themselves familiar with check lists for those procedures which hopefully never happen.
But if they happen, also in the laboratory, you have no time to think and discuss potential solutions, you have to react in a proper way.
In contrast to flying a plane, the preparation and training for a freezer emergency situation does not take a lot of time and capacity. This White paper is a guidance to be better prepared.
If you are lucky, you will never need the following aspects but if it happens, it may help you:

Alarm system

A freezer alarm requires the existence of a freezer alarm system. In principle, there is one direct way and two indirect ways to be informed about a freezer/ power failure.

> As direct notification, the instrument itself starts to buzz or beep, red lights are flashing. The alarm sound and light are powered by a backup battery of the freezer. The alarm sound is penetrative. You can still notice it several rooms away. Make the team aware not to ignore any beeping freezer. Wherever you are in the building, any beeping freezer should catch your attention and should be addressed by quickly checking the situation. Keep in mind, it could also be your freezer and your samples. Also teach the facility cleaning team not to ignore or even switch off a beeping freezer but to immediately inform the owner resp. the guard at the security desk. Some freezers even block the access to the alarm button/ alarm backup battery to prevent any ignoration of the alarm by switching it off.

> The classic indirect way is a call by the security desk about some beeping or flashing freezer in the laboratory or a hallway. Quite often, the freezer is connected to a building management system (BMS) which is some simple alarm contact where a low voltage line is interrupted or closed in case of an alarm. This alarm is then transferred to the security desk. Normally, you do not get any further information besides "there is an alarm" about the situation. As a result, you have to go to the laboratory to check the situation. During day time, this is ok. At 2 a.m. in the morning that kind of a call is not everyone's favorite.

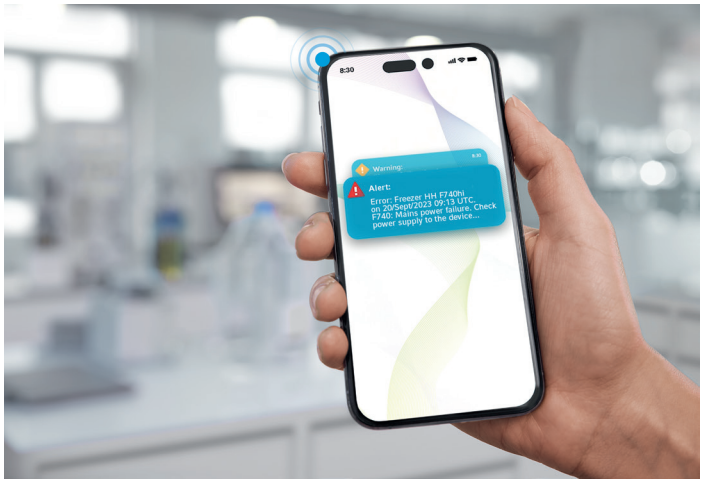


Figure 2: Online notification of equipment alarm via VisioNize

> The second indirect way of information about an alarm is a personal message on your smartphone about a freezer alarm. This type of alarm is based on a cloud-based monitoring and notification system. The freezer sends the alarm message to this notification system. Email addresses and/ or phone numbers of contact people are stored in the system. In contrast to a pure alarm, this system enables a remote check of the situation: After receiving the alarm notification, you log into the system remotely from any mobile device, and you can check different parameters.

Figure 3: Online monitoring of equipment via VisioNize Lab Suite Software

Every freezer should be equipped with an external alarm system.

Backup systems

Backup systems are some kind of boosters in case of a warming up of the freezer. Basically, the system contains a gas bottle, some valves, a temperature sensor, and a back-up battery in a control instrument. There are mainly two systems available:

> CO_2 can maintain temperatures between -50 °C and -70 °C
> LN_2 can go down to -85 °C

The principle is the following: The temperature sensor of the backup system is located within the freezer chamber and detects a potential loss of temperature. By opening the valve, pressured gas from the gas bottle is evaporated into the freezer chamber. By this evaporation process, cold air is generated. An integrated back-up battery enables this process even during a power failure in the building.

The time a back-up system can counteract the warm up/ thawing of the freezer depends on the size of the connected gas bottle. Keep in mind to check the bottle pressure once a week/ month as gas bottles and related tubes may show micro leaks which can empty the CO_2/ LN_2 over time.

Figure 4: Sample storage without boxes and racks can result in difficulties when samples need to be evacuated

Sorting system within freezer

Sorting of samples in the ULT freezer is often a lively discussion in lab teams. Freelance storage with single 50 mL conical tubes or microtubes in a plastic bag can create at least irritation in the lab team. Even piled freezer boxes are suboptimal if you store four piles in a row and six piles side-by-side.

Besides the daily routine work challenge, freelance storage of sample hinders fast evacuation of samples in an emergency situation as you need to grab all these bags and boxes individually which takes (too much) time.
We highly recommend to store your samples in freezer storage boxes and these storage boxes within organized freezer racks. These metal racks optimize your freezer space and make it easy to find the desired items. In general, there are two rack styles available to make your freezer usage the most efficient: Side access racks or drawer racks.

Figure 5: Drawer racks provide a higher level of handling safety due to lateral fixation of the boxes if you need to remove the rack from the freezer

Side-access racks
The side-access rack is an open rack with access from the side. When using side access racks, accessing samples means removing a good portion of the side access rack completely removed from the ULT freezer.

Drawer racks
A drawer rack contains a multiple of drawers. This type of racks works like a dresser where you pull-out that very drawer where you expect your object of interest. When using racks with drawers, only that relevant drawer with the freezer boxes of interest is pulled-out. All other freezer boxes, incl. all samples, safely stay in the cold interior of the ULT freezer. Drawer racks are mostly heavier than side-access racks but as most of the weight is not moved when pulling out the drawer-of-interest, this is less relevant.
Despite their higher weight, they are easier to handle in case of an evacuation as the boxes can not fall out of the rack.

Backup freezer for evacuation situations

To avoid the unexpected need to find free space in freezers which are normally used (and filled) by other departments, some institutions invest in so-called “backup freezers”.
These single freezers are not in regular use but are reserved for dedicated emergency situations. Some people keep them running 24/7 at -80°C due to long pulldown times. Other laboratories benefit from models like the CryoCube® Freezers which provide a very short pull-down within 4 hours from ambient room temperature to -80°C. This usage-on-demand saves a lot of power. Still, all back-up freezers should be maintained regularly.
Available backup freezers should be checked regarding rack compatibility (compartment height and depth) as well as free access. If the backup freezer is locked, the location of the key or the access code must be available.

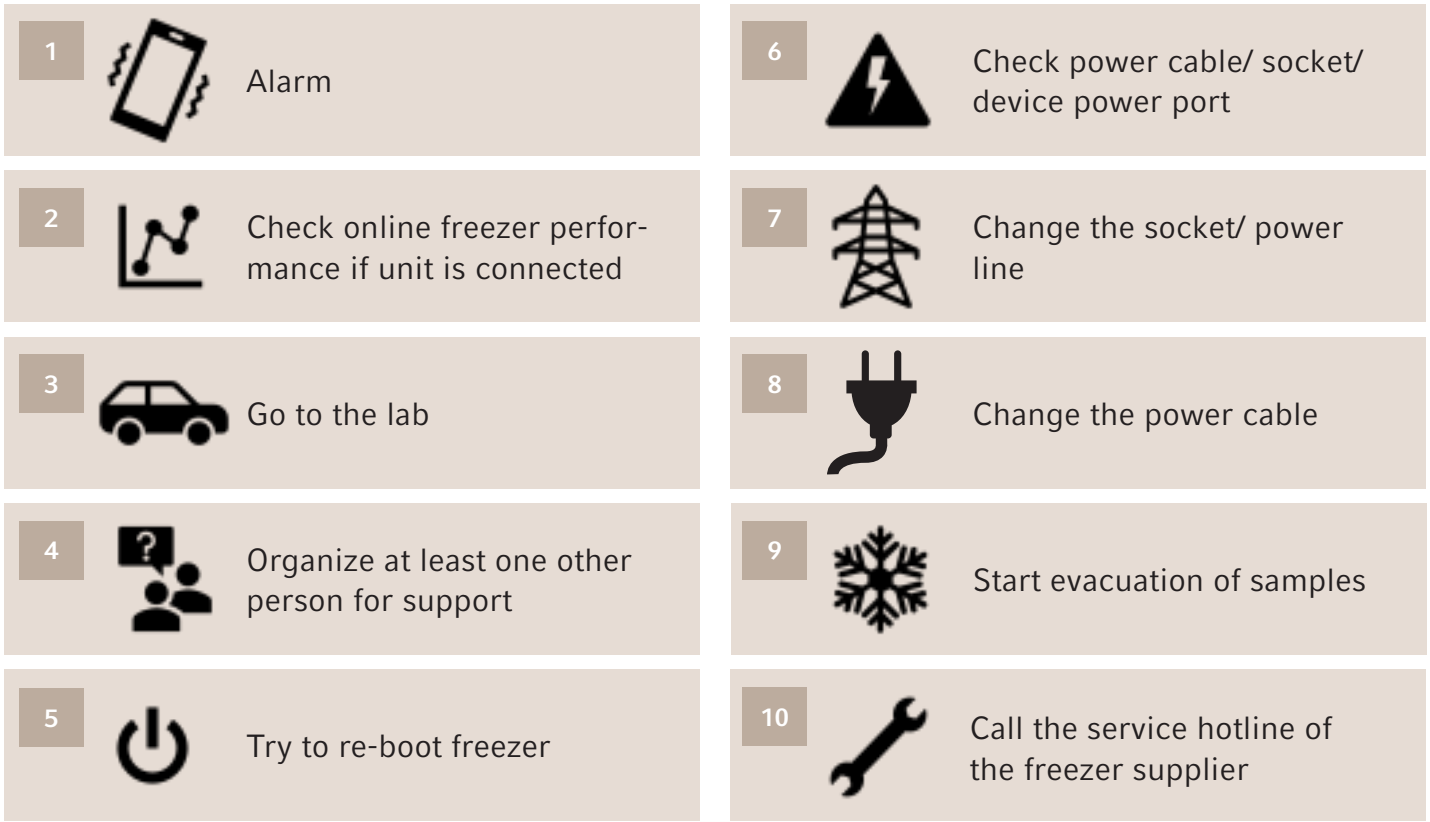
What to do?

Starting from the alarm, keep calm: You have several hours after the first alarm until the temperature inside the freezer reaches a critical level. Based on data from an external test house, Eppendorf CryoCube freezers like the F440h or F570h with a 2/3 filling require about 10 hours to (passively) warm-up their chamber temperature from -80°C to -50°C after power failure.
Be aware, critical temperature levels for samples strongly depends on type of samples.

If the alarm is activated via a convenient up-to-date digital system, you can log-in from home or wherever you are when the alarm occurs. The real situation can be pre-checked like temperature within the freezer, time of failure, indications about the causes and other parameters.

When you finally decide to go to the laboratory, there are different aspects to consider:

> Keep the freezer door closed until you really start the sample evacuation - everyone checking the samples inside the freezer does not help, it only speeds up the warming inside the freezer.
> Check the power supply (power cable at instrument side as well as at socket side), try to re-boot the freezer
> Change the socket/ power line
> Change the power cable and try to restart the instrument. If this also fails, continue:
> Use your "Sample evacuation plan": Where are free locations in other freezers in the building for complete racks or boxes with high value samples? If you are lucky, there is a back-up freezer in the building. The location should be noted on your own freezer.
> Organize ice (at least wet ice, better dry ice) when transportation of super-critical samples takes longer than a few minutes
> Organize a trolley for safe and fast transfer of cold racks
> After taking care of the samples, call the service hotline of the freezer supplier



Graphic 1: Proposed action plan when there is a power failure at your ULT freezer

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Name of freezer: .....

Type/ model of freezer: .....

Serial number of freezer: .....

Room number of freezer location: .....

Owner team of freezer:: .....

Room of owner: .....

Emergency contact name 1: .....

Emergency contact phone 1: .....

Emergency contact person 2:: .....

Emergency contact person 2 .....

Location of back up freezer: .....

Graphic 2: Sticker proposal for ULT freezer to handle emergency situations in a well-organized process

Graphic 2 provides you some proposal for important information which should be listed at each ULT freezer.
Eppendorf CryoCube ULT freezers are equipped with a dedicated automated re-start function after power blackouts. To avoid overloading of the lines, the units have a delayed contingency-controlled re-start function.

The more valuable samples you store, the more attention you should spend on an evacuation plan.
Train this situation in the team. Everyone should be aware of the basic rules of what to do with the samples.

References

White papers deliver arguments that one particular technology, product or method is superior for solving a specific business problem. They may also present research findings, list a set of questions or tips about a certain business issue, or highlight a particular product or service.

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