ULTRA LOW TEMPERATURE FREEZERS- GUIDANCE DOCUMENT

Introduction

Energy-intensive laboratories present particularly promising opportunities to help the University of Liverpool reduce its carbon emissions. **Ultra-Low Temperature (ULT) Freezers**, defined here as freezers that operate at temperatures of -80°C and below, typically make up over 66% of the energy used by all lab appliances (The University of Cambridge).

Many of our current ULT freezer stock will be using far more energy and money than needed, simply due to poor management and maintenance. These guidelines provide advice on how you and your department can manage your ULT freezers more effectively to save money, reduce carbon emissions, prolong freezer life, and safeguard samples.

This document outlines best practices, presents some how-to guides, and includes some suggested sustainable freezer models.

Did you know?

- There are over 400 ULT freezers in the Faculty of Health and Life Sciences (HLS).
- Within the University, we are aiming to reduce our carbon emissions, and one way of doing that is by assessing how much energy is used and how much carbon is emitted by our ULT freezers.
- ULT freezers become less energy-efficient over time, where “each year of a ULT freezer’s life translates in to approximately 3% increase in energy” (STORE SMART). It is also recommended that freezers older than 10 years are considered for replacement (The University of Exeter).
- We recommend that you aim to only purchase energy-efficient ULT freezers, which consume approx. 5-8 kwh per day.

Guidance

Day-to-day good practice guidance

Alarms

- Freezer alarms should be periodically checked at minimum once a year. This is to ensure the alarms are functional, and will go off in an emergency, such as when your freezer breaks down. Check your user manual for guidance on how to test your alarms.

Auditing/Inspection

- Best practices should be audited locally every 3 to 6 months.
- A maintenance checklist and tasks responsibility/frequency distribution checklist could be useful to have on each freezer front door.

Backup freezers

- Make sure you have access to a backup freezer, in case of emergencies where your normal ULT freezer may have broken or when a full freezer defrosting is required. Please make yourself familiar with the backup freezer locations and contact the tech team to make the required arrangements. During the use of backup freezers groups should be responsible for maintaining the freezer and T-Scan details should be passed to the group.
- Backup freezers should be kept empty, as they should only be used in emergencies or to support full freezer defrosts.
- If samples are inside the freezer, an inventory sheet should be kept on the door of the backup freezer. Once your normal freezer is back-up and running, the backup freezer should be emptied as soon as possible.
- Backup freezers can be lowered to -60˚C. This helps to reduce energy consumption, and lowers the duty cycle, which can extend the lifespan of the freezer.
- Periodically check backup freezers, to make sure they are running appropriately and have sufficient space to function effectively.
- Notify the technical team if you notice any issues with backup freezers.

Empty space

- Avoid leaving large empty spaces in freezers, as this can increase energy consumption. Instead, you can put empty polystyrene boxes inside of the freezer.

Internal doors

- Try to close the internal door as quickly as possible, to reduce warm air entering the ULT freezer.
- If you notice an issue with the internal door, please let the technical team know.

Inventories

- Place a sample inventory sheet/freezer map on the outside of the ULT freezer, on the outer door. This helps identify where samples are kept, and how long samples have been inside the freezer. It will also reduce the amount of time where the ULT freezer is open and reduce the amount of warm air entering the freezer.
- General freezer inventories are also particularly useful, as it helps us maintain the freezers. Some information that should be recorded would be:
    - Number of freezers
    - Lab manager/lead responsible for the freezer
    - Make/model of freezers
    - Freezer age
    - Freezer location

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- There are questions around the care and maintenance of ULT freezers in both the bronze and silver categories.
- For bronze labs must make sure that their freezers are well positioned, and filters are regularly cleaned. There must also be details of the persons responsible for the freezers displayed.
- For silver, the ULTs must be maintained, this includes defrosting, removing unwanted samples, checking seals and cleaning filters. There should be a schedule available for completing this which is communicated to all lab users.
- It is therefore highly recommended that labs introduce a maintenance checklist for the responsible persons for the ULT to complete. Please either use the template in the Appendix or edit this to meet the needs of your lab.

Malfunctioning freezers

- Any ULT freezer issues must be reported and dealt with as soon as possible.

Ownership

- Ownership of freezers and freezer space should be established, and a database maintained, using the Faculty Asset Management System. A freezer representative within each group, must be allocated and ensure that best practices are followed. The design/model, age and location of each freezer must be included.

Positioning

- Where possible, keep ULT freezers away from heat sources, such as ovens and incubators.
- Place ULTs in well-ventilated rooms.
- Pull ULT freezers slightly away from the wall, as this allows the vents of the freezer to properly draw/expel air.
- Make sure nothing is stored on top of the ULT freezer, as this can impede cooling.

Sample storage

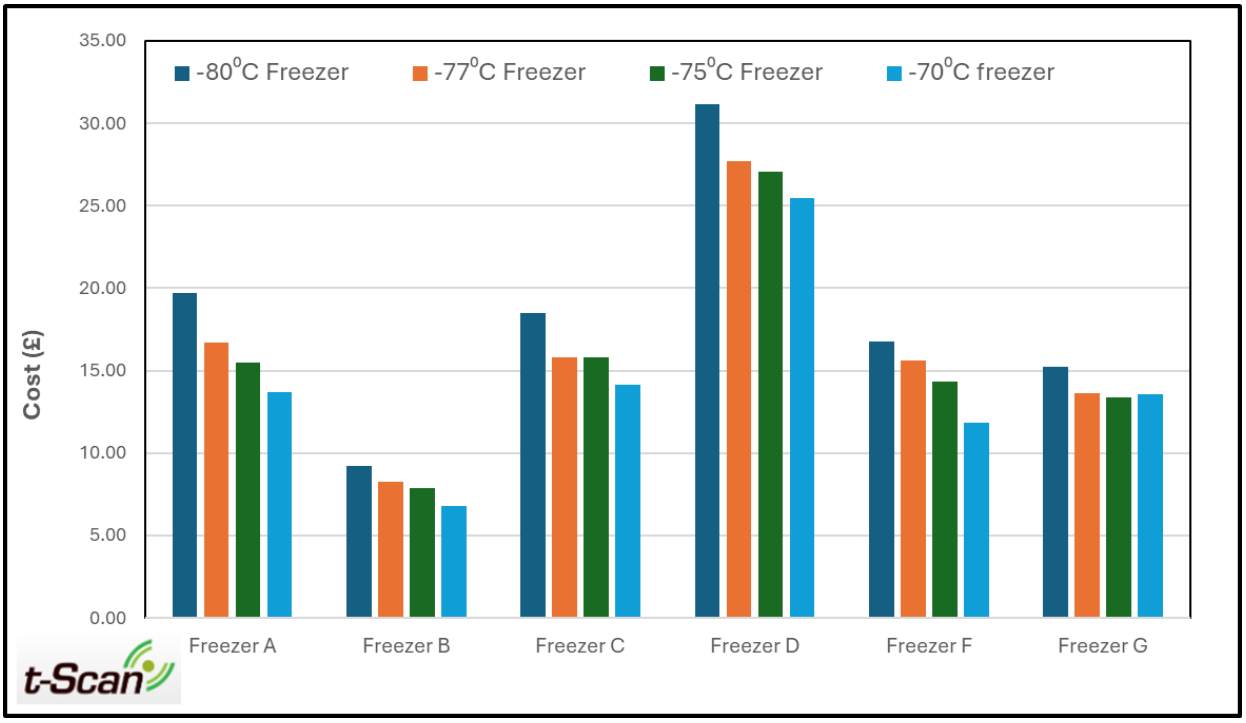
- Keep samples in boxes and place boxes in racking, to allow for quick retrieval. Tubes must be stored vertically to avoid leaks. If there is a requirement that samples need to be wrapped in blue roll; these should then be stored and properly labelled in a box.
- Clearly label your samples, including sample type, owner details, collection date and an 'expiry date'. Samples must be only kept if needed. Regularly review what samples you have and ensure that samples are removed when no longer necessary.
- Any unknown or samples that are not clearly labelled, should be disposed of, but before you do, make sure an email is sent around with a deadline so samples can be claimed before disposal.
- Ensure that ULT freezers are used to store samples that require this temperature. Keep samples at the correct storage temperature.
- Do not overfill freezers. Samples should not block grills, vents or obstruct the airflow to and from the coolers, as this will compromise temperature control.
- Clinical waste bags should only be used when samples are waiting to be disposed of and properly labelled for that aim, otherwise, samples can be accidentally disposed of. Bio-bins should also not be used to store samples, these are very expensive and must be use for their main purpose, dispose of pipette tips and/or serological pipettes.

Well-labelled and racked freezers

Temperature

- We generally recommend you consider turning up from -80°C to -70°C.
- If going to -70°C does not feel feasible, consider reducing your ULT freezer temperature to just a bit lower, such as from -80°C to -77°C, or from -80°C to -75°C. This gives a substantial saving, is stable and gives a more comfortable temperature buffer zone. Moreover, and for some freezer brands, when looking at the T-Scan system, sensor readings show freezers are in general cooler when compared to the temperature set on the freezer door. Even small temperature changes can help to reduce energy use.

Data demonstrating energy costs vs freezer temperatures



Graph 1. -80°C Freezers consumption project conducted by Dr Carol Jolly and Dr Sandra Cachinho using t-Scan energy monitors. A range of brands from our current freezers were selected to be set at -80°C, -77°C, -75°C and -70°C at the freezer door. Data shows a 10-15% energy cost savings when freezer temperatures were dropped to just -77°C.

T-Scan

- ULT freezers should all be linked up to T-Scan. Periodically review T-Scan to identify temperature, and performance trends. Ensure all personnel assigned to the alarm are aware of their responsibilities and review the call out list regularly. T-scan alarms should be manually challenged biannually to ensure the system is working effectively.

Freezer disposal guidance

As ULT freezers are classed as WEEE (Waste, electrical, and electronic equipment) waste, they must be disposed of carefully, due to various components found inside the ULT freezers.

If you have an ULT freezer that you need to dispose of or simply no longer need, there are only a couple of steps that need to be followed:

- Reach out to other research groups to see if they need a spare ULT freezer. You can use the LEAF Teams site to do this (contact Jenna Lowe (jenna.lowe@liverpool.ac.uk) to arrange access to the site).
- Contact your local Heavy gang to arrange for the disposal of your ULT freezer.
- From there, the Heavy gang will collect the freezers and will arrange with Suez to have them collected. Suez then pass the ULT freezer onto Neales, who specialise in hazardous waste disposal.

Procurement guidance

At the university, there are currently no set guidelines on how to procure ULT freezers, however we aim to set out sufficient procurement guidance for the University. When purchasing a new ULT freezer, please consider the following:

- Are there any spare ULT freezers available at the University?
- Do you need a new freezer, or would additional racking be suitable?
- If you are replacing an older ULT freezer, ensure that the new make and model you are considering is energy-efficient, or is more efficient than the ULT freezer you are replacing.
- If you are buying a new ULT freezer and are not replacing an older model, ensure the make and model of the new ULT freezer are energy efficient.
- Academics are encouraged to write into grants applications to replace freezers greater than 10 years old as these freezers are inefficient.

Some recommended energy-efficient models can be found here:

Recommended freezer makes and models				
Freezer models	**Energy per day (kWh)**	**Capacity (Litre)**	**Internal dimensions (W x D x H, in mm)**	**External dimensions (W x D x H, in mm)**
MDF-DU503VH-PE VIP	5	528	630 x 600 x 1400	790 x 882 x 1993
MDF-DU703VH-PE VIP	5.4	729	870 x 600 x 1400	1030 x 882 x 1993
CryoCube 570H	7.4	570	765 x 575 x 1256	1094 x 897 x 1940
SU780XLE	6.7	780	740 x 705 x 1542	915 x 870 x 1994

How-to guides

How to carry out routine ULT freezer maintenance

- Check for any loose screws and lubricate door handles and hinges. Note: some freezers form an airlock once closed and handles locked into position, making the freezers inaccessible for 5-10 minutes. Do not try to force open the freezer door during this period.
- Gaskets and rubber seals around the door should be checked for any issues, cleaned, and kept free from ice. Brush or scrape away any ice-build up regularly. Keep in mind, if facing significant ice build-up that resists easy removal, door seals or gaskets can easily tear or break, so a full defrost might be required instead. Door seals must be replaced immediately if they are broken, to avoid air leaks and temperature fluctuations.
- Check to see if there is a maintenance contract programme. Your technical team is the best first point of contact. If there is a contract, message the contractors to arrange for the coils to be cleaned.
- Check filters, fans, and vents, for dirt and dust and keep them clean or replace them as required. Either dust, vacuum or rinse the freezer filter. If you are uncertain on how to remove the filter, follow the 'How to Clean Filters' section below.
- Routinely remove frost and ice buildup (once a month or more often if required). You can use a simple ice scraper and a brush to do this.
- Clean the rear of the freezer. Keep the radiator at the back clean and free from dust.

Example of sealant issues and a dusty filter

How to clean the filter

- To remove the filter, you need to open up the ventilation hood. This is normally on the front of the ULT freezer, close to the bottom of the freezer.
- You can then lift up the filter and take it out of the freezer.
- You can use a brush or a handheld vacuum to remove any dust or rinse the filter using running water.
    - If you choose to rinse the filter, make sure you use clean water and then allow it to fully dry before replacing it.
- Once the filter is dry and clean, you can reinstall the filter.

An example of how to take out and vacuum a filter

How to fully defrost your freezer

- Notify all lab users well in advance your intention to defrost. You will need to let others know the date that the freezer will be defrosted and how long the freezer will be out of use for.
- Ask all users of the freezer to relocate their samples during this time. Please contact the tech team in case a backup freezer is required, so the necessary arrangements are made.
- Any samples that have not been removed must be relocated. Keep track of where the samples will be relocated to, and ensure they are replaced back to the ULT freezer, once the defrost is completed.
- After switching off the freezer, make sure you de-ice it.
- Unplug the freezer, leave the door open and wait for the ice to melt; this process will take several hours.
- Place absorbent pads around base of unit to prevent slip hazards as the floor might become wet and set up warning signs, to alert other lab users.
- After defrosting the freezer, wipe down the freezer and remove excess water allowing unit to dry
- Check that all doors, door clips, hinges and seals are in good condition to help reduce the build-up of ice. Report any faults to the technical team or to maintenance.
- Switch the freezer back on and allow the unit to pull down to operating temperature! It may take up to 24 hours for the freezer to get down to temperature, so wait 24 hours before replacing samples back inside.

A freezer defrost: Before and After

What we aim to avoid!

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Guide information

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Appendix

Ultra-low freezer maintenance checklist guidance

Remove ice build up

- Frost and ice build-up should be removed from inside the freezer and around the doors/seals at a minimum of once a month on all ULT freezers, this can be cleared with a soft brush and plastic scraper.
- However, each time you use the freezer you should visually check for frost and ice build-up and if the build-up is becoming excessive you should remove this as required.

Check doors and seals

- Check door handles and hinges for any loose screws and lubricate hinges if required.
- Check seals for any tear's, detachment from frame or ice build-up and replace any damaged seal. Clean the seals and remove any ice build-up.

Clean filters

- The filters on the ULT freezers should be cleaned on a quarterly basis. Clean the dust by using a vacuum cleaner and/or by washing the filter in warm soapy water. Dry the filter completely before placing it back. For a full guide on how to clean the filters see page 8 of this ultra-low temperature freezer guidance document.

Proper spacing

- Inspect for any items that have fallen behind or are pushed up against freezer units or stored above as they will block airflow.

Defrost, dispose of unwanted samples and update freezer inventories

- All ULT freezers should be defrosted annually, for a full guide on how to defrost see page 9 of this ultra-low temperature freezer guidance document. At the point of defrost it is a good time to update freezer inventories and remove and unwanted samples.

Ultra-low freezer maintenance checklist

BUILDING		**FLOOR**			**ROOM NUMBER**	
T-SCAN NUMBER					**OWNER**	

Please complete the tasks below, sign the form and add any comments

- **Complete as required but at least monthly**

Date	Remove ice build up	Check doors and seals	Signed	Comments

- **Quarterly checks**

Date	Clean Filters	Proper spacing	Signed	Comments

- **Annual checks**

Defrost freezer, dispose of any unwanted samples and update freezer inventories

Defrosted on_____ by _____ Next defrost due _____