Cold Storage Sustainability Project

Prepared by Belén Fernández Prado.

THE UNIVERSITY of EDINBURGH

Social Responsibility and Sustainability

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Executive Summary

The Department for Social Responsibility and Sustainability's (SRS) Sustainable Laboratories Programme, aims to improve the sustainability of research and teaching labs across the University.

Labs are typically more energy intensive than the equivalent area of office space, and cold storage facilities significantly contribute to lab energy consumption.

A number of Cold Storage projects have been undertaken by the SRS department, and to build on existing Cold Storage policy and guidance, an internship to assess current freezer management practices in labs was developed.

An intern was recruited for eight weeks to audit and work with four Life Science labs across the University, aiming to observe current freezer management practices and make recommendations for improvements.

The project was able to assess 12 ultra-low temperature (ULT) freezers, with similar practices observed in all labs. Based on the project's findings, the following three recommendations have been proposed:

- Establish a schedule for defrosting freezers once per year and cleaning filters/fins twice per year.
- Implement a procedure to standardise recording and labelling of samples, including use of printed sticky labels.
- Invest in racks and adequate containers to store samples inside the freezers.

The findings and recommendations have been discussed with each host lab and will be used to influence the current Cold Storage policy and guidance, and future engagement projects.

Contents

1. Introduction to the project

The University of Edinburgh is committed to making a significant, sustainable and socially responsible contribution to Scotland, the UK and the world. To achieve this, the University is working towards embedding sustainability across operations, research, learning and teaching.

The University's Department for Social Responsibility and Sustainability, through the Sustainable Laboratories Programme, aims to improve the sustainable practices of research and teaching labs across a range of target areas.

The Cold Storage Sustainability Project is a new engagement initiative focused on reducing the energy consumption associated with Cold Storage facilities in Life Science Labs.

To minimise additional demands on staff time, an intern was recruited to assist life science research laboratories to undertake vital work to improve the efficiency of storing samples.

Storage of life science samples and other materials at very low temperatures has a substantial energy impact and this work has been done to ensure that the University of Edinburgh maximizes opportunities to reduce this energy consumption.

Ultra Low Temperature (ULT) freezers are ubiquitous and necessary in life-science research, but consume a large amount of energy (up to £1000 annually) in order to maintain samples at a safe temperature. This project has involved working in partnership with University of Edinburgh research lab staff to improve the energy efficiency of their cold storage practices.

2. Project approach

The aim of the project was to identify best practices in ULT freezer management which will achieve reductions in energy consumption.

Key objectives were to:

- Assess current freezer management practices.
- Carry out freezer management actions agreed with lab users (defrosting freezers and cleaning filters/fins).
- Carry out audits of samples stored in freezers (cataloguing and safely disposing of unnecessary samples when possible).
- Report findings and provide recommendations to the Department for Social Responsibility and Sustainability and host laboratories on best practices.

The project was undertaken at the Western General Hospital and Little France campuses, where there is a high concentration of life science labs. Four labs volunteered to participate in the eight week project:

- Wellcome Trust Clinical Research Facility (WTCRF)
- Institute of Genetics and Molecular Medicine (IGMM)
- Division of Infection and Pathway Medicine (DIPM)
- Hepatology Laboratory

The number of freezers assessed in each lab is shown in Table 1. Each freezer was fully defrosted, with its filters and fins cleaned, and an overall inventory of the contents taken (where possible samples were also catalogued). Potentially redundant samples from each freezer were also identified.

Table 1. Total of freezers managed in each laboratory.

Host Laboratory	WTCRF	IGMM	DIPM	Hepatology Lab
Freezers	3xULT + 3x-20^{o}C	4xULT	4xULT	1xULT

3. Findings and recommendations

This section will discuss what was observed in relation to freezer management in the participating labs. There were many similarities between the labs, and so the findings and recommendations have been grouped into five key areas as follows. Some individual labs maintained better sustainability practices than others but there are opportunities for improvement at each lab studied.

Each finding will initially discuss the observed issues, followed by the recommended actions to improve and follow best practice.

3.1. Freezers conditions

Issue

In general, the freezers in all labs were snowy and icy. This is problematic as poorly defrosted ULT freezers use more energy to operate as often seals around doors do not operate as effectively. Some freezer doors were unable to shut properly as ice had distorted the frame alignment and seals.

The filters and fins of almost all freezers were dusty/dirty. When these filters and/or fins are dusty the removal of heat is less effective and the compressor mechanisms for heat removal need to work harder. This results in overall greater energy consumption by the freezer.

See Figure 1 for before and after examples.

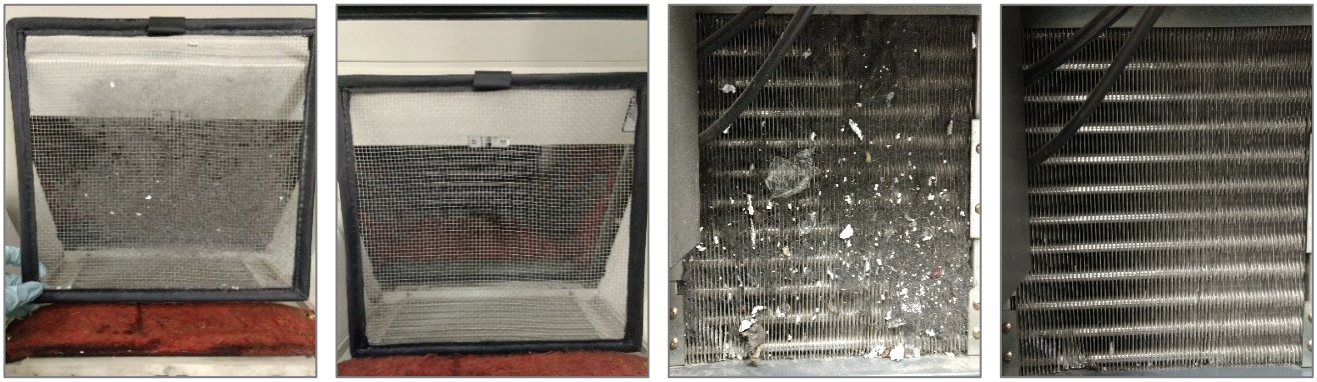

Figure 1. Before and after of defrosting/cleaning freezers.

Recommendation

Defrosting and filter/fin cleaning was comprehensively carried out on 11 ULT freezers, with expected energy cost savings of £1,700 - £2,400 annually in total.

Based on this potential impact, it is recommended that labs implement a rota to ensure defrosting the cabinet occurs once per year and cleaning the filters/fins occurs twice per year. These actions can save up to £200/year and £250/year (1), respectively.

When planning to defrost a freezer there are two requirements to ensure the defrost takes place efficiently:

- A spare freezer – In order to store the contents of the defrosted freezer while working.
- Two days – In order to let the freezer reach the set (correct) temperature after being defrosted.

Cleaning the filters and fins takes less than 30mins to carry out and no specialist equipment other than a clean cloth or vacuum cleaner.

3.2. Freezers maintenance

Issue

When inspecting the freezers after they had been fully defrosted, some maintenance issues were discovered (Figure 2.). This included: doors not closing correctly, holes in the cabinets, broken door seals and damaged frameworks.

Figure 2. Examples of poor maintenance in freezers

Recommendation

Check the interior of the freezer when defrosting and carry out any maintenance required.

During daily working, more careful usage practices should be considered to avoid causing damage, and to keep the equipment running effectively and efficiently. This should also reduce the need to purchase new ULT freezers to replace damaged freezers.

3.3. Freezer rooms

Issue

On multiple occasions it was observed that items were being stored on top of the freezers, which could impair the ventilation of the freezer. The floors of these freezer rooms were often found to be dirty and appeared to be cleaned less frequently than other rooms (Figure 3.).

Action was taken to remove items from the tops of freezers, however, some items were on top of the freezers again the following day. Along the same lines, filters were cleaned but some became clogged in less than 24 hours due to the dirty floors.

Figure 3. Observed lack of organisation in freezer rooms

Recommendation

Communications highlighting the importance of keeping at least 15cm of clear space around the sides, back and top of the freezer should be disseminated, to ensure proper ventilation is maintained. Installing shelves or cupboards to help with storage in the freezer rooms could be a solution for this issue.

A cleaning rota for the freezer rooms should be initiated or an agreement reached with the building's cleaning staff to ensure the rooms are cleaned once per week.

3.4. Storage inside the freezer

Issue

One of the key issues preventing staff applying good freezer management in the labs, is the lack of organisation of samples within the freezer. It was observed that most freezers do not make enough use of racks or appropriate internal storage, with many samples being stored in various sizes and shapes of boxes or in bags.

Further investigations discovered other poor storage practices including: storing samples as loose tubes, not using storage boxes correctly (some boxes becoming overly full and others less than half full), storing tubes without caps, and keeping samples which could be stored at -20 ^{o}C instead (Figure 4.). Boxes and samples

trays are currently the main method used to store samples inside the freezer. However bags are also in use, which greatly reduces the space available and also hinders the search of samples.

Figure 4. Examples of poor storage practices

Recommendation

When storing samples, lab staff should plan ahead and consider the most efficient way to store samples according to their shapes and temperature requirements before storing them. This will not only reduce the time spend looking for samples at later, but will help reduce the chance of losing samples or damaging them through poor storage practices.

It is recommended that labs invest in purchasing additional racks in order to keep freezers organised. This will allow lab users to find their samples more quickly, reducing the time freezer doors are kept open and thereby minimising a rise in freezer temperature. Also, by maximising the space and filling freezers to capacity, there will be less space inside the freezer for warmer air to circulate when the doors are open.

3.5. Labelling and recording

Issue

There are currently no standardised protocols for recording samples across the labs. Consequently, more freezers do not have a clear or consistent database of their contents.

The WTCRF displays some good labelling practices as they use the Laboratory Information Management System (LIMS) to keep track of their samples. However, in most labs, freezer users follow the example of their colleagues and if there is no clear procedure to follow, then samples are unlikely to be labelled and recorded consistently.

In addition to this, inadequate methods of sample labelling risk other lab users being unable to tell what the samples are. Hand written labels, samples with only minimal information about the contents, and a lack of labels on some samples all prevent other freezer users being able to identify the contents. When tracking or looking for samples, such poor labelling slows the process greatly, wastes time and potentially results in errors.

Most of the labs stated that they do not regularly remove unnecessary samples from ULT freezers. When defrosting the freezers, an inventory of the samples contained in each was made. Host labs were then asked if any were redundant and able to be disposed of. All of the labs were reluctant to dispose of samples, in case they turned out to be required at a later date. Thus redundant samples were only able to be removed from 2 out of 12 ULT freezers, equivalent to approximately 5% of the space in each freezer.

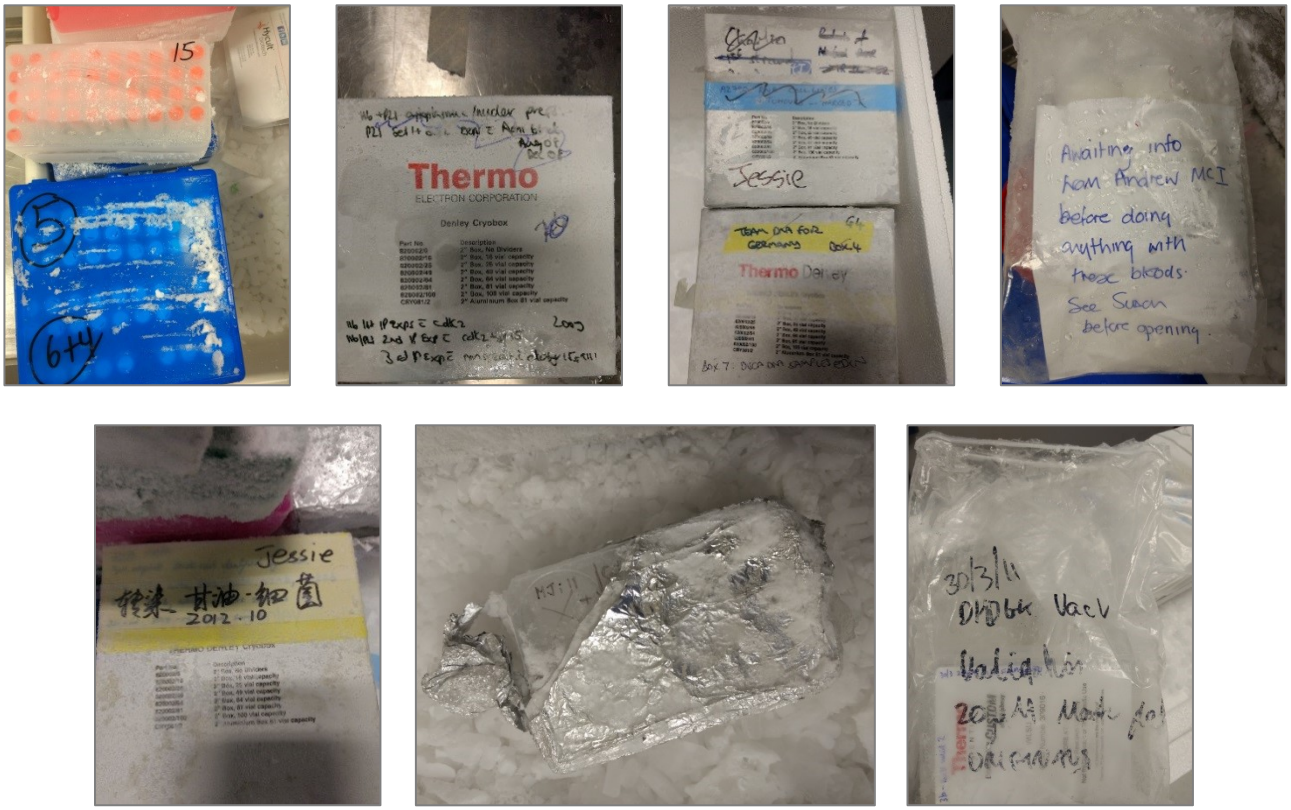

Figure 5. Examples of poor labelling

Recommendation

Good organisation minimizes the risk of exposing samples to fluctuating temperatures, as for every minute a freezer door is open, it takes around 10 minutes for the freezer to recover to its set temperature (2). If freezer doors are open for a shorter length of time, this will also help reduce the energy demand to bring it back to the correct set temperature.

To help improve freezer organisation and speed up locating samples, a standardised and consistent labelling system appropriate for each lab should be implemented.

Implementing a unique system – like a software package - for all the samples stored would be extremely helpful, and should include printed high quality and easily legible sticky labels bearing the following details:

- Information about the sample (possibly a code)
- Date (when the sample came in and when it expires)
- Owner of the sample and project/group

In the same way, it might be useful for the lab staff to have a poster detailing and mapping the contents of the actual freezer in order to make searching for samples easier. This could be placed on the outside of the freezer and in offices.

Labs are also strongly recommended to review their freezer contents every 6 months to a year, to assess if any samples are unnecessary and able to be removed. It may be possible to remove samples if a member of staff leaves the group, or if samples are required infrequently and could be moved to archive type shared storage. This would increase the space available within the freezer and avoid the need to buy new freezers.

4. Conclusions

This project has helped identify how life science research laboratories across the University of Edinburgh are utilizing their cold storage equipment like ULTs.

As many of the observations and issues were common to all of the labs investigated, it may be worthwhile to undertake a wide-spread communications campaign, including face-to-face workshops to highlight the issues to lab staff and the actions they can take.

It is recommended that the following three main actions be implemented:

- Establish a schedule for defrosting freezers once per year and cleaning filters/fins twice per year.
- Implement a procedure to standardise recording and labelling of samples, including use of printed sticky labels.
- Invest in racks and adequate containers to store samples inside the freezers.

Additional actions which will contribute to improved best practice are ensuring physical maintenance of the freezers is carried out properly and regularly cleaning freezer rooms.

These finding and recommendations have been presented to and discussed with each of the four participating labs. Each lab has committed to discussing the findings with their lab users and there is a high level of interest and motivation to make improvements to freezer practices.

References

1. *Factors affecting the performance, energy consumption, and carbon footprint for ultra low temperature freezers: case study at the National Institutes of Health.* **Gumapas, Leo Angelo M. and Simons, Glenn.** 2013, World Review of Science, Technology and Sust. Development, Vol. 10, pp. 129-141. 1/2/3.

2. **Ackerman, Ryan, et al.** Cold Storage Resource Guide. *Lab Manager.* [Online] 2018.

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Email: SRS.Department@ed.ac.uk

Phone: 0131 650 4065