PLANNING A LIQUID-NITROGEN STORAGE ROOM

TECHNICAL GUIDANCE

What needs to be decided before the room layout and building services are fixed

A liquid-nitrogen storage room is more than a laboratory with cryogenic freezers placed in it. The choice of room affects how the equipment will be delivered, how liquid nitrogen will reach each freezer, where gas will be discharged and how people can leave safely in an emergency. It also determines whether there is room for the facility to grow.

These points are much easier to resolve before the room layout and building services are fixed. When the cryogenic requirements arrive late, we often see awkward pipe routes, too little space around the freezers, ventilation in the wrong place and controls supplied by different companies without anyone defining how they are meant to work together.

Start with what is being stored

Before drawing the room, establish what the facility will store and how staff will use it.

That means knowing the sample type, storage temperature, liquid- or vapour-phase requirement, container and rack format, starting quantity, likely growth and frequency of access. A catalogue capacity figure is of little use if it assumes a different vial, box or rack arrangement from the one used by the laboratory.

There also needs to be some resilience. If every freezer space is occupied on opening day, where will samples go while a vessel is being repaired? Where will the next freezer be installed? BCGA CP45 notes that cryogenic storage facilities frequently outgrow their original capacity. A realistic allowance for growth can avoid disruptive building work later.

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Choosing a suitable room

The best location is not necessarily the nearest vacant room. It needs to work for equipment movement, liquid-nitrogen distribution, ventilation, emergency access and the everyday movement of staff and samples.

Before settling on a room, check:

- whether the floor structure can support the freezers at their operating weight and the concentrated loads imposed through wheels or feet
- whether doors, corridors, lifts, thresholds and turning spaces can accommodate delivery and future replacement of the largest item
- whether there is enough working space to open lids, remove racks, connect services and carry out maintenance safely
- whether the room is separated from incompatible or contaminating activities and can be secured without obstructing emergency escape
- whether the LN_2 source, pipework and safe vent routes can be kept reasonably short and direct
- whether future freezers and their associated services can be added without blocking access or compromising airflow.

The access route should be checked against the equipment as delivered, not only its nominal operating dimensions. Packaging, lifting frames, pallet trucks and handling equipment all need room. A narrow doorway or a lift with insufficient capacity can become an expensive problem at the end of the project.

The LN_2 supply affects the room

Liquid nitrogen may come from a bulk tank, transportable cryogenic vessels, smaller dewars or an on-site source. Consumption, refill frequency, delivery access, pressure, resilience, available space and future demand all influence the choice. We cover this separately in our guide to bulk tanks and liquid cylinders.

For a piped system, the source should generally be kept as close as reasonably practicable to the storage room. Long or unnecessarily elevated pipe runs increase heat input and product loss. The route also needs suitable supports, access for inspection and maintenance, protection from damage and coordination with the building fabric and other services.

Vacuum-insulated pipework reduces heat gain and helps deliver liquid, rather than a mixture of liquid and gas, to the freezers. It is not the whole answer. Thermal movement, trapped liquid, isolation, pressure relief, venting and the condition of the line after an emergency valve closes still have to be dealt with in the design.

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Every discharge needs somewhere safe to go

A cryogenic installation can have several different discharges: freezer vents, line-cooling or phase-separator vents, pressure-control vents and pressure-relief devices. They do not necessarily operate for the same reason or at the same rate.

Agree these locations while the building design is still flexible. BCGA CP45 states that pressure-relief devices on the distribution system should discharge to a safe outdoor location. Other vents also need a safe discharge point. Cold gas or liquid must not endanger people, enter an air intake, affect an escape route or create ice and poor visibility where people may be present.

Simply discharging into the storage room and expecting the room ventilation to deal with it is not a sound default. It adds a predictable nitrogen load to the occupied space and can turn a routine operation into an oxygen-depletion event.

Ventilation cannot be chosen from a standard figure

Liquid nitrogen expands rapidly as it warms, and the gas displaces air. The ventilation duty therefore depends on the room's free volume and the releases that can occur there—not on a standard air-change figure copied from another project.

Normal evaporation, freezer filling, open lids, manual dispensing and equipment faults do not release nitrogen in the same way. Airflow through the room, replacement air, oxygen monitoring and the response to a failed fan also matter. Our separate article, Planning ventilation for a cryogenic storage room, deals with this in more detail.

Where appropriate, the room can use a background ventilation rate when unattended and increase it when occupied or during filling. Presence detection allows that increase to happen before people begin opening freezers or dispensing liquid nitrogen. Oxygen monitoring remains a separate warning and protective layer; it should not be treated as the normal means of calling for ventilation.

People must be able to get out

Security is important where valuable or regulated samples are stored, but it must not prevent escape. CP45 says personnel must be able to leave during an alarm or incident and that doors should open in the direction of escape. The arrangements should also prevent untrained people entering while an alarm remains active, except under an approved emergency procedure.

The emergency plan cannot cover only the regular laboratory staff. Lone workers, visitors, cleaners, maintenance contractors, people nearby and the emergency services may all be affected. Alarms should be apparent before someone enters the room as well as while they are inside it. If an alarm is sent remotely, it needs to reach

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someone who knows what to do with it.

Observation panels, access control and CCTV may help with supervision and security, but none of them makes entry safe during an oxygen alarm. Re-entry should follow an agreed procedure based on confirmed atmospheric conditions—not on somebody looking through the door and deciding that the room appears normal.

Decide how the controls will work before ordering them

A typical facility may include freezer controllers, automatic fill valves, emergency isolation, oxygen detectors, ventilation controls, airflow proving, alarms, access control, a BMS connection and backup power. These packages are often supplied by different companies.

Before orders are placed, agree what each system must do and what it must prove to the others. For example:

- What must be proved before an automatic fill can start?
- What happens if airflow is lost while a freezer is filling?
- Which oxygen alarm warns people, and which initiates protective action?
- Which valves close, how is their position confirmed and how is trapped liquid protected?
- Where are faults and alarms reported when the room is unattended?
- What state does the installation adopt after loss of electrical power, control communications or compressed air?

Control panels and reset facilities are normally better placed outside the storage room, where their status can be checked without entering a potentially unsafe atmosphere. Settings and resets also need controlled access so that safety functions cannot be casually altered.

Do not overlook the everyday details

Cryogenic equipment affects more services than the LN_2 pipe. Electrical supplies, data connections, alarm cabling, compressed air for pneumatic valves, ventilation power and condensate or ice management may all be required. The room finishes and lighting should support cleaning, inspection and safe access without creating fragile details around heavy mobile equipment.

Noise, heat from ancillary equipment, lighting and the position of sockets and controls all affect day-to-day use. So do mundane details: where a sample trolley is left, how a lid is held open, how racks are lifted and where protective equipment is kept. If these things are not planned, staff will find their own workarounds.

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Test the room as a whole

A freezer can fill correctly, a fan can run and an oxygen detector can pass calibration while the completed facility still has gaps between those systems. Commissioning must therefore test the agreed operating and fault sequences as a whole.

Testing will usually cover measured airflow, detector calibration, alarms inside and outside the room, permission to fill, valve operation and feedback, emergency stops, remote signalling, access control, utility failures and recovery after a fault. It should be carried out on the final configuration, with the settings, software versions, results and any departures recorded.

The user also needs operating procedures, training, maintenance arrangements and clear ownership of the complete system. Under CDM, designers must eliminate foreseeable risks where reasonably practicable and reduce or control those that remain. CP45 likewise expects the user, designer and installers to agree responsibility for assembly, testing, commissioning and handover.

Where LABMODE fits in

LABMODE deals with the cryogenic side of the project: freezer and capacity planning, selection of the LN_2 supply, pipework, controls, installation, commissioning and service support. The exact scope depends on the project.

We also provide the information needed by the building, structural, ventilation and electrical designers, and agree the interfaces between their work and the cryogenic equipment. Each appointed designer remains responsible for their own design unless the agreed scope says otherwise.

Planning a new facility or reviewing an existing room?

Discuss your cryogenic storage requirements with LABMODE.

IMPORTANT LIMITATION

This article gives general guidance on matters to consider when planning a liquid-nitrogen storage room. It is not a project-specific risk assessment, structural assessment, ventilation design, pressure-system design or operating instruction. The facility should be designed and assessed by competent persons using the actual equipment, building, supply arrangement and working practices.

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Technical and legal basis

UK legislation establishes the duties; HSE and industry publications provide guidance on applying them. The relevance and scope of each source must be considered for the particular project.

1. Management of Health and Safety at Work Regulations 1999
2. Workplace (Health, Safety and Welfare) Regulations 1992
3. Construction (Design and Management) Regulations 2015
4. Provision and Use of Work Equipment Regulations 1998
5. Pressure Systems Safety Regulations 2000
6. BCGA CP45 (2021): Biomedical cryogenic storage systems—design and operation
7. BCGA CP52 (2023): The management of risks from gases in the workplace

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