Controlled Environment Maintenance Guideline and Matrix

Unimutual Limited

Phone: (02) 9247 7333
Fax: (02) 9252 9070
Email: service@unimutual.com.au
Website: www.unimutual.com
AFS Licence No: 241 142
ABN: 45 106 564 372

Table of Contents

Introduction

This controlled environment maintenance guideline and maintenance matrix is a document designed to assist Members identify and manage the maintenance tasks that keep controlled environments operating within the parameters required to ensure the protection of valuable research.

The contents of this document are for the information of Members. It is not intended to be a detailed prescriptive guideline covering all maintenance tasks nor maintenance intervals and scheduling. Members should determine maintenance requirements for their controlled environments in consultation with relevant third-party services providers and contractors or other competent persons. Maintenance intervals for the various tasks identified may vary in relation to manufacturers specifications or the nature of the environment in which the device is located.

Definition of Maintenance

The **definition** of maintenance is:

- the process of maintaining or preserving someone or something, or the state of being maintained, or
- the process of keeping something in good condition.
- the routine and recurring process of keeping a particular machine or asset in its normal operating conditions so that it can deliver the expected performance or service without any loss or damage.

Maintenance, repair, and operations (MRO) or maintenance, repair, and overhaul involve fixing any sort of mechanical, plumbing, or electrical device should it become out of order or broken. It also includes performing routine actions which keep equipment in working order or prevents breakdowns from occurring.

MRO may be defined as, "All actions which have the objective of retaining or restoring an item in or to a state in which it can perform its required function. The actions include the combination of all technical and corresponding administrative, managerial, and supervision actions.

The Purpose of Maintenance

The **purpose** of maintenance is to achieve reliability of serviced equipment which will:

- Maximize useful life of equipment
- Keep equipment safe and prevent hazards
- Minimize frequency and severity of interruptions
- Increase reliability of the operating systems

Types of Maintenance

The **two main categories of maintenance** are preventative and breakdown maintenance, described below.

- **Preventative maintenance** involves doing a task before a failure has occurred. That task can be aimed at preventing a failure, minimising the consequence of the failure, or assessing the risk of the failure occurring.

- **Breakdown maintenance** is repairing equipment after the failure has occurred and reinstating equipment functionality.

The other types of maintenance commonly referred to include:

Periodic maintenance or time-based maintenance (TBM)

Time based maintenance consists of periodically inspecting, servicing, and cleaning equipment and replacing parts to prevent sudden failure and process problems. This is a form of preventative maintenance.

Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition-based maintenance. It manages trend values, by measuring and analysing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system. If you have a datalogger connected to your Minus 80 freezer, it may provide data to assist predictive maintenance.

Corrective maintenance

Corrective maintenance is the category of maintenance tasks that are performed to rectify and repair faulty systems and equipment. The purpose of corrective maintenance is to restore systems that have broken down. Corrective maintenance can be synonymous with breakdown or reactive maintenance.

The Benefits of Maintenance

The benefits of **preventative maintenance** include:

- More efficient operation of equipment
- Reduced likelihood of catastrophic breakdowns
- Fewer emergency maintenance incidents
- Reduced downtime
- Savings on electricity, device replacement and breakdown costs.

The **cost** of regular maintenance is very small when it is compared to the cost of a major breakdown and the potential loss of valuable research caused by the breakdown. The main purpose of regular maintenance is to ensure that all equipment is operating as efficiently as possible.

The Principles of Modern Maintenance

Whether you are developing a new maintenance program or improving the maintenance program for existing equipment, your maintenance program should consider the following "Principles of Modern Maintenance" which include:

Principle #1: Accept Failures

Not all failures can be prevented by maintenance. Some failures are the result of events beyond your control such as a power outage or poor design.

Principle #2: Most Failures Are Not Age-Related

For most failure modes the likelihood of occurrence is random and not necessarily age related. Some of the older minus 80 freezers continue to operate well past their expected life, whilst some of the newer models may fail early in their life cycle. Everything degrades with time, but some items degrade so slowly that wear out is not a practical concern. Unfortunately, this is probably not the case with equipment associated with most controlled environments.

Principle #3: Some Failures Matter More Than Others

Understanding the consequences of failures is key to developing a good maintenance program. Not all failures have the same probability, nor do they have the same consequence. Apart from the consequence of a failure, consideration needs to be given to the likelihood of the failure occurring.

Ideally, maintenance tasks should be developed for dominant failure modes only. Those failures that occur frequently and those that have serious consequences but are less frequent to rare. A good example in a minus 80 freezer is compressor checks and maintenance and those maintenance items that can help prevent or delay a compressor failure.

Principle #4: Parts Might Wear Out, But Your Equipment Breaks Down

A 'part' is usually a simple component, something that has relatively few failure modes. Simple items often provide early signals of potential failure if you know what to look for. On this basis, it is possible to design a (predictive) maintenance task to detect potential failure early on and act prior to failure.

For those simple items which do "wear out" there will be an increase in the probability of failure past a certain age. If we know the typical wear outage for a component part, we can schedule a (time-based) maintenance task to replace it before failure.

Principle #5: Hidden Failures Must Be Found

Hidden failures are failures that remain undetected during normal operation. They only become evident when you need the item to work (failure on demand). Or when you conduct a test to reveal the failure – a failure finding maintenance task.

Hidden failures are often associated with equipment with protective functions, a high-high pressure cut-out is a good example. Protective functions like these are not normally active. They are only required to function by exception to protect your people from injury, the equipment from destruction or the environment from a pollution incident. Essentially failure finding maintenance tasks are only performed on equipment with protective functions.

Principle #6: Identical Equipment Does Not Mean Identical Maintenance

Just because two pieces of equipment are the same doesn't mean they need the same maintenance. In fact, they may need completely different maintenance tasks.

The classic example is two identical pumps, but where "Pump A" operates as a duty pump and "Pump B" as a standby pump. The have the same manufacturer and are the same model. Both pumps process the exact same fluid under the same operating conditions but have different operating contexts.

When it comes to failure modes Pump B has an important hidden failure mode: it might not start when Pump A fails or is undergoing maintenance. Pump B doesn't normally run so you wouldn't know it couldn't start until you came to start it. This is the classic definition of a hidden failure mode. If you are operating a system with (N+1) redundancy, the maintenance program should include a test to check that the standby will be reliable and operate when required.

When building a maintenance program, it is important to consider the operating context. A difference in criticality can also lead to different maintenance needs. Environment control critical equipment will need more monitoring and testing than the same equipment in low criticality service.

Principle #7: "You Can't Maintain Your Way to Reliability"

Maintenance can only preserve your equipment's inherent design reliability and performance. If the equipment's inherent reliability or performance is poor, doing more maintenance will not improve its reliability or performance. No amount of maintenance can raise the inherent reliability of a design. To improve poor reliability or performance that's due to poor design, the design needs to be changed. When encountering failures and defects that relate to design issues, try to eliminate them, or change the equipment.

Principle #8: Good Maintenance Programs Don't Waste Your Resources

Equipment is often designed to do more than what is required under normal conditions. Rather than maintaining to design capabilities, maintenance program should ideally focus on equipment meeting operating requirements. Maintenance done to ensure equipment capacity greater than needed is potentially a waste of resources. Undertaking multiple maintenance tasks to address a single failure mode can make it difficult to determine which task is most effective. Where possible identify one task per failure mode and focus efforts on it. However, for very high consequence failure modes it can be appropriate to undertake several maintenance tasks.

Often there is more maintenance to do than resources to do it with. The use of resources on unnecessary maintenance can mean not completing necessary maintenance or completing it late, which increases the risk of failures.

Principle #9: Good Maintenance Programs Become Better Maintenance Programs

The most effective maintenance programs are dynamic. When considering improvements to your maintenance program, remember that not all improvements provide equal benefit. Where possible focus on eliminating any unnecessary maintenance tasks and try to only replace parts and components when necessary.

Principle #10: Maintenance should be undertaken by a competent person

All maintenance should be undertaken by people who have the necessary skills and knowledge for the task at hand. A competent person means a person who has acquired through training, qualification or experience the knowledge and skills to carry out specific tasks. The meaning of a competent person is more clearly defined in the various legislation which relate to specific undertakings and associated competency requirements.

Adapted from 9 Principles of Modern Maintenance by Erik Hupje

https://www.roadtoreliability.com/reliability-centered-maintenance-principles/

Documenting Maintenance

Most Unimutual Members have formal maintenance systems and programs which are overseen by the facilities maintenance and management teams. These typically address scheduled preventative maintenance on HVAC, walk-in temperature-controlled rooms, electrical systems, fire detection and protection and buildings as well as reactive maintenance tasks on request.

Often, the maintenance of fridges and freezers and the range of equipment associated with controlled environments is the responsibility of faculties, schools, various individual laboratory managers and technical officers. The degree of formalised maintenance planning and documentation will vary from faculty to faculty, school to school and across the sector.

To meet the mitigation requirements for maintenance, it is critical to document the completion of maintenance tasks for equipment that controls the environment in which research material is kept. Ideally, this will include the development of a preventative maintenance plan or schedule detailing the:

- equipment to be maintained
- maintenance tasks to be undertaken
- frequency of maintenance
- person responsible for undertaking a maintenance task.

More important however, is recording what was done, when and by whom, so that evidence of completion of maintenance is available should it be required.

Where maintenance tasks are not scheduled in the institutions scheduled/preventative maintenance software/platform, faculties, schools, and individual laboratories may need to develop processes and documentation to record maintenance activities.

How to use the Maintenance Matrix

The maintenance matrix is designed to assist users to identify key maintenance tasks for each class and type of controlled environment. To use the matrix, **first** identify the class of controlled environment for which you wish to develop a maintenance program. The classes of controlled environments addressed in the matrix are:

- Ultra-low Temperature Freezers
- Cryogenic storage
- Fridges and Freezers

- Controlled Temperature rooms and Cabinets
- Animal Facilities
- Plant facilities
- Laboratories and Clean rooms

Second, identify the type of controlled environment. The types of controlled environments addressed in the matrix are:

- Minus 80 and 30 ULT Freezers
- Liquid Nitrogen Dewar
- Vapour phase dewars (Auto fill)
- Minus 20 Freezers upright and chest
- Fridges
- Walk-in Fridges and Freezers
- Growth Chambers
- Rodent houses
- Lizard Terraria
- Aquaria
- Insectaries
- Greenhouse/Hothouse
- Herbaria
- Seed Stores
- Laboratories

Third, find the component or part and **fourth** find the maintenance task associated with that component or part. It is possible that some types of controlled environments or components/parts may require maintenance tasks that are not listed in the matrix. Members should ensure that any tasks not listed in the matrix that are required to be undertaken are incorporated into their controlled environment maintenance program.

The **fifth** item is to determine who is an authorised or competent person to undertake the task and the **sixth** item is the frequency for conducting the task. The frequency for each task listed in the matrix is an indicative frequency only. Members should determine frequency of maintenance tasks based on the nature of the operating environment. In dusty, hot, or high humidity and exposed locations, maintenance tasks may need to be undertaken more frequently.

Additional information has also been provided in relation to failure modes for certain components and parts. Again, this is indicative information and additional failure modes may arise depending upon the nature of the environment, the design capacity of equipment and a range of other factors.

Finally, maintenance notes have been provided to provide an indication of how the maintenance task may be undertaken. Again, this is indicative only and a range of other techniques and options may be available. To ensure that maintenance tasks are correctly and appropriately delivered (bearing in mind the operating context and environment), consult with competent persons which may include your contractors, service providers or staff.

Great reference material

Minus 80 freezers

https://www1.eere.energy.gov/buildings/publications/pdfs/alliances/ulf_freezer_user_guide.pdf

Greenhouse/Hothouses

https://edis.ifas.ufl.edu/publication/AE024

https://www.gvzglasshouses.co.uk/common-greenhouse-maintenance-problems/

Animal houses

https://www.nap.edu/read/5140/chapter/4

Controlled Environments - Maintenance Matrix

Class of CE	Type of CE	Component/Part	Task	Authorised or competent Person	Frequency	Failure Mode and Performance Issues	Notes
Ultra-low Temperature Freezers	Minus 80 and 30 ULT Freezers	Door gasket	Remove ice from door gasket and check for splits or perishing	staff	Fortnightly	Perishing and splitting due to excessive ice build up	Use a cloth and gently remove ice
		Internal doors	Remove ice build up	staff	Fortnightly	Damage to hinges and latches	Use an ice scraper to remove excess ice
		Vacuum relief port	Remove ice build up	staff	Fortnightly	Damage to door gasket	Use a cloth and gently remove ice
		Air Filters	Clean air filters of dust and built up grit	staff	Every 1 or 2 months	Overheating and additional pressure on compressors	Gentle use of a vacuum cleaner
		Condensers	Clean condenser coils	contractor/staff	Every 6 months	Increased electricity usage Overheating and additional pressure on compressors	Vacuum the condenser coils to remove dust build up
			Clean condenser filters	contractor/staff	Every 3 months	Overheating and additional pressure on compressors	Shake off dust and wash
			Check condenser fan operation	contractor/staff	Every 6 months	Overheating and additional pressure on compressors	If not working replace immediately
		Compressor	Clean and check compressors	contractor	6 -12 months	Overheating -Secondary compressors tend to fail more often	Compressors can be replaced
		Batteries	Check battey charge and life	contractor	6 -12 months	Flat battery	Test with a voltometer - if less than 10 amps- replace
Cryogenic storage	Liquid Nitrogen Dewar	Cannister	Visual check of cannister integrity	staff	monthly at least	Weld seam cracks due to variation in temperature when cannisters are allowed to empty and are then refilled	These are often hairline cracks
			Check lid tightness	staff	After use	Human error - leakage of LN	Ensure lid is properly closed
			Check levels	staff	Several time a week	Human error - leakage of LN	Top up as per lab procedure
	Vapour phase dewars (Auto fill)	Cannister	Visual check of cannister integrity	staff	Monthly at least	Weld seam cracks due to variation in temperature when cannisters are allowed to empty and are then refilled	These are often hairline cracks
			Check levels and temperature	staff	Weekly	Low levels increase temperature leading to potential spoilage of samples	Check the auto filler is operational
			Check alarm function (if installed)	staff	Monthly at least	Electrical or probe malfunction	Repair as required
Fridges and Freezers	Minus 20 Freezers upright and chest	Door/lid gasket	Remove ice from door gasket and check for splits or perishing	staff	Monthly	Perishing and splitting due to excessive ice build up	Use a cloth and gently remove ice
		Air intake	Clear areas around the air intake	staff	Monthly	Motor overheating and compressor failure	use a vacuum cleaner, not compressed air
		Air Filter	Clean air filter	staff	Quarterly	Motor overheating and compressor failure	use a vacuum cleaner, not compressed air
		Condenser	Replace air filter	staff	As required	Motor overheating and compressor failure	use a vacuum cleaner, not compressed air
			Clean Condenser coils	staff/Contractor	6 monthly	Increased electricity usage possible overheating and additional pressure on compressor	Vacuum the condenser coils to remove dust build up
			Clean condenser filters	staff	3 monthly	Overheating and additional pressure on compressor	Shake off dust and wash
			Check condeser fan operation	staff	3 monthly	Overheating and additional pressure on compressor	If not working replace immediately
		Compressor	Clean and check compressors	contractor	6 -12 months	Overheating and additional pressure on compressor	Compressors can be replaced
	Fridges	Door/lid gasket	Check for splits or perishing	staff	monthly	Perishing and splitting due to excessive ice build up	Use a cloth and gently remove ice
		Air intake	Clear areas around the air intake	staff	monthly	Reduced air flow	Remove any obstructions and ensure free air flow
		Air Filter	Clean air filter	staff	Quarterly	Motor overheating and compressor failure	use a vacuum cleaner, not compressed air
			Replace air filter	staff	As required	Motor overheating and compressor failure	Install new filter
		Condenser	Clean condenser coils	staff	6 monthly	Dirty coils reduced heat exchange and force the compressor to work harder	ideally vacuum the coils, then coil cleaner, plastic brush and hot water
			Clean condenser filters	staff	6 monthly	Reduced heat exchange due to reduced air flow	Shake off dust and wash
			Check condenser fan operation	staff	6 monthly	Overheating and additional pressure on compressor	If not working replace immediately
		Compressor	Clean and check compressors	contractor	6 -12 months	Overheating and additional pressure on compressor	Compressors can be replaced

Class of CE	Type of CE	Component/Part	Task	Authorised or competent Person	Frequency	Failure Mode and Performance Issues	Notes
Fridges and Freezers (continued)	Walk-in Fridges and Freezers	Pressure release vent if applicable	Remove ice or debris build up as required and lubricate vents	staff	monthly	difficutly opening the door and damage to door gasket	Use a cloth and gently remove ice
		Test duress button and alarm	Ensure the emergency exit and alert systems are operating	Staff	monthly	staff could be seriously injured	contolled test with observer
		Evaporator/Air handling	Check fans, pulleys and belts for alignment and operation	staff/contractor	quarterly	Ineffficient fan operation reduces heat exchange	Manually turn fans and pulleys
			Clean fan blades (including bolts and screws and evaporator coils	staff/contractor	quarterly	affects optimal performance	Use warm water and a mild detergent - do not use acid based products
			Check drain line, pan and trap	staff/contractor	quarterly	ice build up and blockages in the drain flush	Flush with hot water as required
			Clear any blockage in the drain line	staff/contractor	quarterly	ice build up and blockages in the drain flush	Flush with hot water as required
			Clean the evaporator coils and fins	staff/contractor	quarterly	Increases energy usage and reduces heat exchange	ideally vacuum the coils, then coil cleaner, plastic brush and hot water
		Condenser	Check and clean fins and coils	staff/contractor	quarterly	Reduced heat exchange	ideally vacuum the coils, then coil cleaner, plastic brush and hot water
			Check fans, pulleys and belts for alignment and operation	staff/contractor	quarterly	Ineffficient fan operation reduces heat exchange	Manually turn fans and pulleys
			Check and clean the strainer	staff/contractor	quarterly	blockages will result in ice build up and reduced performance	Flush the strainer with warm/hot water
			For water cooled condenser, check and replace the sacrificial anodes	staff/contractor	quarterly	Reduced performance	Change out
		Refrigerant	Check and record the refrigerant operating pressure and temperature	contractor	quarterly	Pressure value problem, worn gaskets, reduced performance	Top up refrigerant and change out gaskets
			Check moisture indicator/sightglass for flash gas	staff/contractor	quarterly	Potential reduction in the efficiency of the refrigeration cycle and increase superheating at the evaporator.	Contractor
			Check for refrigerant leaks in pipework, components and connections	contractor	quarterly	Smell of gas or ice build up on evaporator coils	Engage qualified technician - hot work may be required
		Compressors	Check compressor sight glass for oil level	staff/contractor	quarterly	excessive compressor wear or catastrophic failure due to no or low oil levels	Top up compressor oil as required
		Suction accumulator	Check for leaks and corrosion	staff/contractor	quarterly	liquid refrigerant flood back leading to compressor damage	Contractor
		Oil	Test oil	Contractor	Annually	viscosity and water contamination tests will indicate other potential failure modes	Contractor
		Electrical	Check electrical connections	Contractor	quarterly	electrical short circuit or loose connections	Contractor
			Check integrity of wiring	Contractor	quarterly	electrical short circuit or loose connections	Contractor
Controlled Temperature rooms and Cabinets	Growth Chambers	Air filters	Remove dust and grit from filters using a vacuum cleaner	staff/contracor	quarterly	Overheating and additional pressure on compressors	Vacuum it - Don't use compressed air
		Condenser coil	Remove dust and grit from the condenser coil using a vacuum cleaner	staff/contracor	quarterly	Reduced heat transfer	ideally vacuum the coils, then coil cleaner, plastic brush and hot water
		Fans	Remove dust and grit from the fan blades	staff/contracor	quarterly	Ineffficient fan operation reduces heat exchange	Use a vacuum cleaner and wipe down with cloth
			Check fan operation	staff/contracor	quarterly	Ineffficient fan operation reduces heat exchange	Use a piece of paper to gauge air intake
		Evaporator fan motor	Check airflow and remove dirt	staff/contracor	quarterly	Overheating and additional pressure on the motor	Use a vacuum cleaner and wipe down with cloth
		Relative Humidity Calibration	Check calibration	staff/contracor	quarterly	Humidity that is too high or low may invalidate the experiment	Check probes and re-calibrate
		Pan humidifier	Clean and check for mould	staff/contracor	quarterly	Build up of mold	Use diluted bleach or similar in hot water to clean
		Condensate line	Check for obstructions and flush	staff/contracor	quarterly	Reduced performance	Use diluted bleach or similar in hot water to clean
		Lights	Check bulbs and clean	staff/contracor	quarterly	Variable light intensity may invalidate experiments	Replace blown bulbs
		Chamber walls	Check for mould and algae	staff/contracor	quarterly	Introduction of contaminants to experiments	Wipe down
		Wiring	Check for fraying	staff/contracor	quarterly	Electrical short circuit or loose connections	Repair by an electrician

Class of CE	Type of CE	Component/Part	Task	Authorised or competent Person	Frequency	Failure Mode and Performance Issues	Notes
Controlled Temperature rooms and Cabinets (continued)	Incubators	Pressure gauge	Check the two stage pressure gauge on the gas regulator	staff	Daily	Pressure should not be below 15psig	Replace tank - if pressure is inadequate
		External surfaces	Clean and disinfect	staff	Weekly	Prevent contamination of future experiments	Use a general purpose laboratory disinfectant
		Inner Chamber	Decontaminate incubator	staff	As required	Prevent contamination of future experiments	Use high heat sterilization or moist heat decontamination
		Humidity pan	Check water levels and refill as required	staff	Weekly	Ensure adeqaute humidity levels	Refill with distilled wate
		Inlet filters	Replace filters	staff/contractor	Annually	Prevent contamination of future experiments by ensuring no contamination of CO2 OR N2	Insert new filters
		HEPA filters	Replace filters	staff/contractor	Annually	Ensure contaminant free air entering the incubator	Insert new filters
		Calibration	Calibrate incubator	staff/contractor	Annually	Ensures optimal incubator performance	Use probe and flat cable or pump
Animal Facilities	Rodent houses	Check bulbs	Inspect lights and replace bulbs as required	staff	Daily	Variable light intensity may invalidate experiments	Replace bulbs
		Light cycles	Ensure light cycles are appropriate	staff	weekly	Variable light cycles may invalidate experiments	Ensure timers are corrrectly set
		Temperature/ HVAC	If using a centralised HVAC system - monitor temperature and humidity and system functionality	Contractor	As per scheduled maintenance agreement	Room temperatures outside parameters (usually 18-26 degrees C)	Ensure the system is on the scheduled maintenance program
		Portable Dehumidifiers	Check water levels and top up	staff	Regularly	Reduced performance	Add as much water as required
			Clean or replace the filters	staff	6 monthly	Reduced performance	Use vacuum clear and wash the filter in warm water
			Clean the water tank	staff	Monthly	Can introduce contaminants and mould	Wash in warm water and detergent
			Clean the air intake and grille	staff	6 monthly	Reduced performance	Use a vacuum clean with brush attachment
		Ventilation filters (HEPA)	Clean the pre filter	Staff	2-3 weeks	Reduced air flow and filter effectiveness	Use a vacuum cleaner and wash in warm water
			Clean the filter module fan	staff	2-3 weeks	Reduced air flow and filter effectiveness	A vacuum cleaner and wipe with a cloth
			Replacing the HEPA and/or carbon filters	staff/contractor	3 – 6 months	Contamination of facility	Follow manufacters instructions
	Lizard Houses	HVAC systems	If using a centralised HVAC system - monitor temperature and humidity and system functionality	Contractor	As per scheduled maintenance agreement	Room temperatures outside parameters	Ensure the system is on the scheduled maintenance program
		Dehumidifiers	Check water levels and top up as required	staff	Regularly	Reduced performance	Add as much water as required
			Clean or replace the filters	staff	6 monthly	Reduced performance	Use vacuum clear and wash the filter in warm water
			Clean the water tank	staff	Monthly	Can introduce contaminants and mould	Wash in warm water and detergent
			Clean the air intake and grille	staff	6 monthly	Reduced performance	Use a vacuum clean with brush attachment
		Ventilation	Clean the pre filter	Staff	2-3 weeks	Reduced air flow and filter effectiveness	Use a vacuum cleaner and wash in warm water
			Clean the filter module fan	staff	2-3 weeks	Reduced air flow and filter effectiveness	A vacuum cleaner and wipe with a cloth
			Replacing the HEPA and/or carbon filters	staff/contractor	3 – 6 months	Contamination of facility	Follow manufacturers instructions
		Heat lamps	Check bulbs and replace as required	staff	weekly	Insufficient heat	Replace as required
		Pad heaters	Check fuses	staff	As required	Insufficient heat	Replace as required
			Replace pad	staff	As required	Insufficient heat	Replace as required

Class of CE	Type of CE	Component/Part	Task	Authorised or competent Person	Frequency	Failure Mode and Performance Issues	Notes
Animal Facilities (continued)	Aquaria	Pumps	Clean the magnet and impeller (large external pumps)	Staff	6 monthly	Pump may slow down, pump less water and possibly sieze	Use steel wool to remove built up grime on the magnet. Clean the impeller with a toothbrush
			Clean the air intake (external pump)	Staff	6 monthly	Reduces pump performance	Wipe clean or use compressed air
			Check pipes and clamps and replace as required	Staff	Monthly	Split pipes and loose clamps lead to water leaks	Visual inspection
		Filters	Clean or replace filters - note there are different types of filters	Staff	Weekly - monthly depending on load	Too much ammonia and nitrite in the tank creates a toxic environment	Use tank water - not water from the tap
			Clean the inlet cage	Staff	Weekly - monthly depending on load	Reduce blockages and improves flow	Use tank water - not water from the tap
			Clean the impeller	Staff	Weekly - monthly depending on load	Improved pump performance and water flow	Use tank water - not water from the tap
		Skimmers	Clean skimmer glass	Staff	Weekly	improves skimmer performance	wash with luke warm water and a toothbrush
			Clean skimmer body	Staff	6 monthly	Reduced air flow and contamination of water	Use vinegar and water 1:15 and bottlebrush
			Clean skimmer pump and impeller	Staff	6 monthly	Improved pump performance and water flow	Use warm water and a toothbrush
			Clean injector	Staff	Monthly	maximum oxygenation	Use vinegar and water solution 1:15
		Air pump	Check and clean the filter	staff	regularly	maximum oxygenation	Wash in tank water till clean
	Insectaries	See Controlled Temperature rooms and Growth cabinets					
Plant facilities	Greenhouse/Hothouse	HVAC	If using a ducted HVAC system - monitor temperature and humidity and system functionality	Contractor	As per scheduled maintenance agreement	Glasshouse temperatures outside parameters	Ensure the system is on the scheduled maintenance program
		Evaporative coolers	Clean cooling pads	Staff	6 monthly	Reduced cooling efficiency	Use a Fungicide to treat algae build up on the pads, replace if badly cracked.
			Check fans	staff/contractor	6 monthly	Inadequate air flow and volume	Lubricate moving parts (includning vents), check fan belts
		Boiler fired heaters	Check for pipe leaks and keep pipes clean	Staff/contractor	12 monthly	Accumulation of dust can decrease efficiency significantly	Repair leaks and clean pipes with rags and soapy water
			Check fan operation	Staff/contractor	6-12 monthly	Inadequate air flow and volume	Lubricate moving parts (includning vents), check fan belts
			Boiler maintenance	Contractor	As per scheduled maintenance agreement	Glasshouse temperatures outside parameters	Ensure the system is on the scheduled maintenance program
		Other heater types	Dependent upon the type of heater used				
		General ventilation	Lubricate vents	Staff	6-12 monthly	Inappropriate natural air flow	Lubricate and exercise vents
			Check window and door seals	Staff	6-12 monthly	Ingress of non controlled air and temperature differences	Replace split or perished seals
			Clean and lubricate pinion gear and housing as well as the rack	Staff	6-12 monthly	Failure to fully open vents	Clean pinion gear and housing and rack with cloth or brush, spray with lubricant
			Service electric motors	Staff/contractor	6-12 monthly	No drive to open vents	Standard electric motor maintenabnce tasks
			Calibrate thermostats and humidistats	Staff	6-12 monthly	Incorrect temperature and humidity could compromise experiments	Adjust following manufacturers instructions

Class of CE	Type of CE	Component/Part	Task	Authorised or competent Person	Frequency	Failure Mode and Performance Issues	Notes
Plant facilities (continued)	Greenhouse/Hothouse (continued)	Fans	Clean fan blades housing and shutters	staff	6-12 monthly	Inadequate air flow and volume	Lubricate and exercise vents
			Lubricate bearings, motors and shutters	staff	6-12 monthly	Inadequate air flow and volume	Lubricate moving parts (includning vents), check fan belts
			Check fan belts and blade rotation	staff	6-12 monthly	Inadequate air flow and volume	Tighten belts and exercise blade shaft
		Irrigation system	Check Solenoids	staff	Weekly	No water flow	Manually operate the solenoid to ensure it is working
			Regulators	staff	Weekly	No water flow	Check that the regulators are in sufficiently open
			Clean filters	staff	3-6 monthly	reduced water flow and	Wash the plates and filter in fresh water with dilute detergent
			Fertilizer injector	staff	monthly	No fertilizer in the water	check value is on and clean pick up filter
			Misting system, LPD's and tips	staff	Inspect regularly	No water or direct stream	Replace LPDs or tips as required
			Inspect pumps for leaks	staff	Monthly	Indicates pump wear	Visual inspection
			Inspect wire connections	staff	12 Monthly	Loose connections may cause short circuits or no poweerr to pump	Inspect and restore connections
			Check fuses and replace as required	staff	12 Monthly	Ensures power input	Check fuses with a multimeter or a test light
			Grease bearings on turbine motors	staff	12 Monthly	ungreased bearings may cause excessive wear	Use a grease gun and clean excess grease from the purge valve
			Inspect and test motor windings	Contractor	12 monthly	Ensures longevity of the motor	Test resistance with a multimeter.
			Check and clean impeller	Contractor	12 monthly	Impeller wear reduces pump efficiency	Look for impeller wear and clean
	Herbaria	HVAC	If using a ducted HVAC system - monitor temperature and humidity and system functionality	Contractor		16°C and 45% Relative Humidity	Ensure the system is on the scheduled maintenance program
		Dehumidifiers	Check water levels and top up	staff	Regularly	Reduced performance	Add as much water as required
			Clean or replace the filters	staff	6 monthly	Reduced performance	Use vacuum clear and wash the filter in warm water
			Clean the water tank	staff	Monthly	Can introduce contaminants and mould	Wash in warm water and detergent
			Clean the air intake and grille	staff	6 monthly	Reduced performance	Use a vacuum clean with brush attachment
		Split system air conditioners	Clean air filters	staff	Monthly	Reduced air flow motor and compressor stress	Clean with cold water
			Clean the coils	staff	Monthly	Reduced air flow motor and compressor stress	Use a vaccum cleaner with brush attachment
			Clear the condensate line	staff	Monthly	Dripping water	Drain the line and use a vacuum cleaner to suck out the blockage
	Seed Stores	Dehumidifiers	Check water levels and top up	staff	Regularly	Reduced performance	Add as much water as required
			Clean or replace the filters	staff	6 monthly	Reduced performance	Use vacuum clear and wash the filter in warm water
			Clean the water tank	staff	Monthly	Can introduce contaminants and mould	Wash in warm water and detergent
			Clean the air intake and grille	staff	6 monthly	Reduced performance	Use a vacuum clean with brush attachment
		Split system A/C	Clean air filters	staff	Monthly	Reduced air flow motor and compressor stress	Clean with cold water
			Clean the coils	staff	Monthly	Reduced air flow motor and compressor stress	Use a vaccum cleaner with brush attachment
			Clear the condensate line	staff	Monthly	Dripping water	Drain the line and use a vacuum cleaner to suck out the blockage
		Walk in fridges	See maintenance notes for walk -in fridges				
Laboratories and Clean rooms	Laboratories	HVAC	If using a centralised HVAC system - monitor temperature and humidity and system functionality	Contractor	As per scheduled maintenance agreement	Room temperatures outside parameters	Ensure the system is on the scheduled maintenance program
		Split system A/C	Clean air filters	staff	Monthly	Reduced air flow motor and compressor stress	Clean with cold water
			Clean the coils	staff	Monthly	Reduced air flow motor and compressor stress	Use a vaccum cleaner with brush attachment
			Clear the condensate line	staff	Monthly	Dripping water	Drain the line and use a vacuum cleaner to suck out the blockage