Appendix C

HAZARD MANAGEMENT – SAFE OPERATING PROCEDURE (SOP)

Only to be completed where required as a control measure under a Risk Assessment

NAME OF THE TASK/ACTIVITY	**MERCURY VAPOUR LAMPS FOR FLUORESCENCE MICROSCOPY**	**DATE:**
LOCATION	ADELAIDE MICROSCOPY, HELEN MAYO NORTH AND WAITE FACILITY AFW WEST (BUILDING 19)	Insert photo (Optional)
RISK ASSESSMENT (RA) NAME		
Residual risk rating on the RA	☐ **Low** ☒ **Medium** ☐ **High** ☐ **Very High**	
Hazards identified on the RA	**Contact with electricity or potential for electric shock** **Exposure to non-ionising radiation (UV light)** **Mercury lamp breakage and vapour or liquid leak**	

PERSONAL PROTECTIVE EQUIPMENT

	Eye protection: ☒ Safety glasses ☐ Eye shields ☐ Safety goggles ☐ Other:
	Hand protection: ☐ Rubber ☐ Cut resistant ☐ Leather ☐ Vinyl ☐ Neoprene ☒ Nitrile ☐ Barrier creams ☐ Other:
	☒ Enclosed footwear: ☐ Footwear that is resistant to spills of hazardous substances ☐ Boots with steel caps ☐ Other:
	Protective clothing: ☒ Lab coat ☐ Gown ☐ Long sleeves ☐ Long pants ☐ High visibility ☐ Helmet ☐ Sun protection ☐ Other:

DESCRIBE, IN SEQUENCE, STEPS TO COMPLETE THE ACTIVITY SAFELY

Pre-operational checks

YOU MUST NOT USE THIS MACHINE UNTIL YOU HAVE HAD APPROPRIATE TRAINING BY TRAINED ADELAIDE MICROSOCPY STAFF. Unauthorised use may result in damage to the instrument.

Operational checks/steps to complete the activity from start to finish (including transport and waste disposal where relevant)

General

Mercury vapour lamps are used to provide a UV light source for epifluorescence microscopy. The mercury short-arc lamps commonly used in fluorescence microscopy are gas-discharge lamps that contain a mixture of liquid mercury and an inert gas (argon or xenon) together with a pair of closely spaced electrodes, housed within a glass envelope. When current is applied to the electrodes a discharge electrical arc occurs in the gap, which produces enough heat to vaporize the mercury and create a high pressure internal atmosphere. The temperature heats up in the arc between the electrodes to around 10,000 °C and on the inside wall of the bulb to around 800 °C. The arc is only a few millimetres in size; therefore arc discharge lamps approximate an ideal point source that is useful for microscopy.

Mercury lamps require a warm-up period. During the starting process a low pressure discharge in the gas heats the liquid mercury but produces very little light until it vapourizes. As this happens, the pressure increases, and light is produced by the discharge through the high pressure metal vapour. Light output increases dramatically over a minute or more, and the warm-up may require 3-5 minutes. After the warm-up period the arc emits both visible and UV light. When thermal equilibrium is reached (which may take from 1 to 10 minutes after the lamp has been switched on, depending on the type of lamp) the mercury vapour exerts a pressure of about 30 to 70 bar on the bulb, depending on the type of lamp. As with all short-arc lamps, material is lost from the tips of the electrodes in HBO lamps during normal operation. This not only causes the bulb to blacken but also increases the gap between the electrodes and therefore increases the lamp voltage.

Two types of mercury vapour lamp are most frequently encountered. The first type requires alignment of the burner and mirror (for example a Leica MZ16 FA stereo microscope with a Leica 106z lamp housing and an Osram HBO 100W short-arc mercury lamp).The second newer type is pre-centered (for example Leica AS LMD laser dissection microscope with a Leica EL6000 UV light system and an Osram HXP-R 120W/45C VIS short-arc mercury lamp)

Hazards

Mercury burners generate ultraviolet radiation. Incorrect use of the system can lead to inflammation, burns and cancers in eyes and skin. The eyes are most at risk of damage.

Breakage of a warm or hot lamp. Mercury burners operate at high pressure and temperature and there is a very low risk that one may unexpectedly burst, releasing toxic mercury vapour. Inhalation of high concentrations of mercury vapour for brief periods can cause acute pneumonitis, chest pain, shortness of breath, coughing, gingivitis, salivation and stomatitis, and may cause redness and irritation of skin and eyes.

Breakage of a cold mercury burner can result in release of liquid mercury.

Broken or used burners constitute Hazardous Waste.

Covering ventilation slots on mercury lamp housing can lead to fires.

There is a risk of burns or electric shock when using any electrical equipment.

Risk Control Measures

Engineering controls:

All microscope systems have some inbuilt safety features to protect against exposure to UV light. Engineering controls include UV protection screens and shields, shutters and software controls. Some engineering controls require manual use. Refer to details in individual SOPs for the relevant microscope system.

The UV light source is contained and shielded in a box which cannot be opened accidentally. Stray-light protection is fitted to lamp housings to prevent UV light shining through slots in the housing.

Pre-centered lamps (for example Nikon Intensilight C-HGFIE) require no alignment, reducing the risk of overheating and explosion. There is no risk of incorrectly aligning a pre-centered lamp. The lamp does not have overpressure when cool.

Procedural controls:

For protection against UV exposure refer to individual SOPs for the relevant microscope system. Make sure manual shields are in place when using UV light. Do not place the specimen on a white or highly reflective background. Never look into the eyepieces unless there is an excitation filter in the beam path. Always keep dummy filter carriers in the unoccupied positions of the filter changer.

Mercury vapour lamps require warmup and cooldown time. Mercury vapour lamps should always be cold when turned on; do not attempt to start a warm or hot lamp. Allow a warm or hot mercury lamp to completely cool for at least 30 minutes before re-starting. The lamp should be left on if it is to be used again the same day. Repeated restarting clouds the glass, shortens the life of the lamp and increases the risk of bursting. Although the risk of a lamp bursting is very low, there is an increased risk as a mercury lamp ages.

The maintenance schedule for each microscope fitted with a mercury vapour lamp must include replacement of the lamp after the lifetime specified by the manufacturer.

HBO-style lamps generally have a short lifetime of around 200-300 hours. The lifetime of a pre-centered mercury lamp is generally longer at around 2-3,000 hours. Lamp life time is generally monitored by an automated counter on the front or back of the lamp housing. Where no counter exists, the life time should be monitored by use of a log book.

Do not use the lamp beyond its life expectancy. If the lamp is used over the life expectancy, or is damaged, there is a risk that a hot lamp may burst and leak mercury vapour.

The mercury lamp should also be changed when the burner becomes discoloured, or there is a drop in brightness.

Before transporting a mercury vapour lamp, remove the burner and place it in its original packaging. Use the transport peg in place of the burner, to secure movable parts within the lamp housing.

Replacement of a mercury lamp:

Only trained Adelaide Microscopy staff are to change mercury vapour lamps. Staff must follow the instructions in the manual for the particular brand and model of lamp, in addition to the safe operating procedure for mercury vapour lamps. Incorrectly fitted and aligned burners create a risk of explosion due to overheating of the glass envelope.

For each microscope system refer to the manufacturer's instructions for the brand of lamp housing and type of mercury lamp used.

Never open a mercury lamp housing while bulb is lit. Turn off mercury lamp and remove electrical plug from wall before changing bulb. Allow a minimum of 30 mins for the lamp housing to cool before changing the bulb.

Burners are very fragile and must be replaced correctly to avoid breakage. Always wear gloves when handling the mercury bulb; oil and acids from fingerprints weaken the glass envelope, reduce light quality and shorten the burner life.

A cold lamp may accidentally be broken during replacement. Mercury in the solid form can be cleaned up using a mercury spill kit.

When aligning an HBO-style lamp, do not look directly at the UV light.

Explosion of lit burner:

Osram 50/100W short arc burners contain a maximum of 20 mg mercury.

With normal operation a lamp burst is very unlikely. However, in the unlikely event of a lamp exploding, inhaling mercury or mercury compounds in vapour or powder form can lead to serious health problems.

Post the following instructions next to a microscope equipped with a mercury burner:

MERCURY VAPOUR LAMP

HAZARD

Mercury burners operate at high pressure and temperature and very rarely may burst, releasing toxic mercury vapour into the room.

- Read the safe operating procedure.
- The lamp must be cold when it is turned on.
- Leave a mercury lamp on for a minimum of 30 minutes. Leave the lamp on if it is to be used again the same day.
- Mercury burners are to be replaced or moved by authorized personnel only.
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If you hear a bang from the mercury burner housing and the light goes out:

- Hold your breath and switch off the lamp
- Leave the room, shut the door and do not enter it again without permission
- Alert personnel in the immediate vicinity to leave the building at once.
- Immediately contact Adelaide Microscopy staff
- Contact fire warden to activate building evacuation alarm, and turn off any air-conditioning shared with other rooms.
- Contact OH&S and first aid officers immediately.

When all personnel are evacuated shared air-conditioning can be reactivated to vent the building, under instruction of Emergency Services. Thoroughly ventilate the room for a minimum of 30 minutes (instruct Emergency Services to open door of room).

Once the lamp housing has cooled down and before it is used again, all residual mercury must be thoroughly removed from the inside (see instructions below for breakage of cold burner).

Breakage of cold burner:

Commercial mercury spill kits are available on the market.

Liquid mercury is toxic and can be absorbed through the skin. When dealing with broken lamps, avoid contact with the skin; wear safety glasses, goggle or face shield, and disposable puncture-resistant gloves to avoid glass cuts. After handling broken lamps, wash thoroughly before touching food or skin.

On completion of work – steps to make safe (including clean up, any waste disposal & service/maintenance requirements)

Follow the shut down procedure in the relevant microscope manual. Leave the mercury burner on if it is to be used again the same day. Turn the mercury burner off at the end of the day.

Used or broken burners are to be disposed of via Hazardous Waste as for liquid mercury, through a licensed waste agency.

Emergency and Spill Procedures, Transport or storage requirements (where relevant), First aid/Medical

In the event of an injury, please advise an Adelaide Microscopy staff member and first aid officer for treatment and the local HSW representative to report the incident.

Contact first aid officer for treatment in the case of glass cuts or exposure to mercury liquid or vapour.

Before transporting a mercury vapour lamp, remove the burner and place it in its original packaging. Use the transport peg in place of the burner, to secure movable parts within the lamp housing.

Prepared by			
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This SOP must be reviewed after any incident/injury associated with this activity or when a Risk assessment is reviewed.