SPECIAL GASES SYSTEM

POLICIES AND PROCEDURES

AUSTRALIAN NATIONAL FABRICATION FACILITY – NSW NODE
SCHOOL OF ELECTRICAL ENGINEERING AND TELECOMMUNICATIONS
UNIVERSITY OF NEW SOUTH WALES
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TABLE OF CONTENTS:

1. SCOPE

1.1 PURPOSE OF DOCUMENT

- To provide an overview of the Special Gases System (SGS), including alarms and monitoring systems.
- To provide staff and students with information concerning their responsibilities.
- To inform staff and students of the protocols and procedures associated with the Special Gases System in the Labs
- To inform any person using the SGS of the emergency procedures.
- To provide policy guidelines for the operation and safety of the ANFF-NSW Special Gases System.

1.2 OTHER RELEVANT DOCUMENTATION

- ANFF-NSW Health & Safety Guidelines.
- UNSW Workplace Health and Safety Policy
- UNSW WHS Responsibility and Accountability
- UNSW Hazardous Substances Policy and Program
- UNSW Plant Safety Policy and Program
- UNSW Accident and Hazard Reporting
- Other UNSW Corporate WHS Policy
- ANFF-NSW Safe Work Procedures and Risk Assessments
- Work Health and Safety Act 2011
- Work Health and Safety Regulation 2012

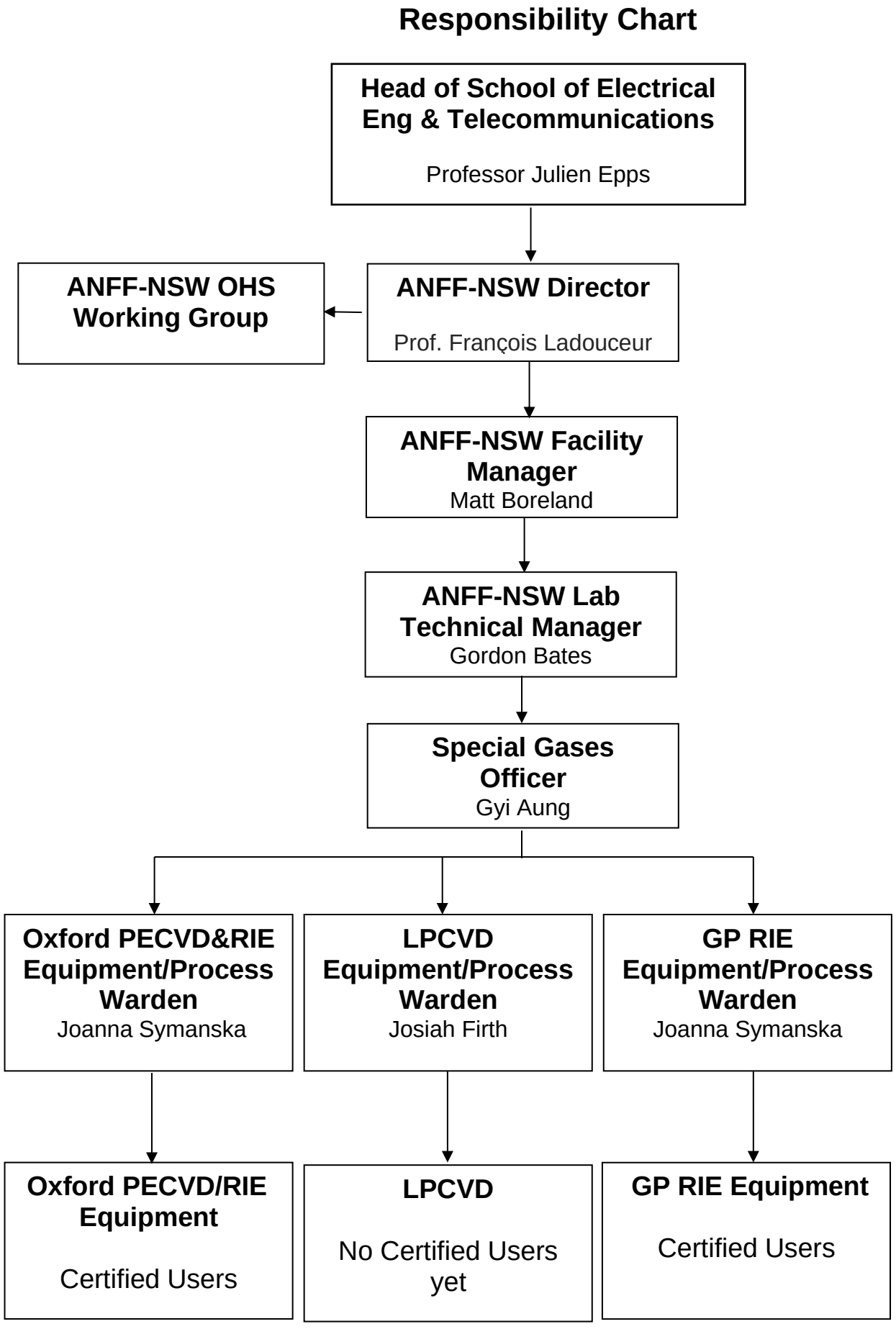
1.3 AREAS AND SYSTEMS COVERED IN THIS DOCUMENT

- The gas shed on the roof of the ANFF-NSW laboratory.
- The plumbing from the gas shed to the plasma processing tools in the laboratory.
- The exhaust system from the plasma processing tools to the CS Clean.
- The exhaust system from the gas cabinets in the gas room.
- The exhaust fan on Newton building roof.
- The Life Safety System (LSS).
- The SGS alarm system.

1.4 GLOSSARY OF TERMS

ESO	Emergency Shut-Off (valve)
EWIS	Emergency Warning Intercommunication System
PECVD	Plasma Enhanced Chemical Vapour Deposition (process)
TGM	Toxic Gas Monitor(ing) (System)
RIE	Reactive Ion Etch(er) (process / machine)
SGS	Special Gases System
ANFF-NSW	Australian National Fabrication Facility in NSW
UNSW	University of New South Wales
HazOp	Processing equipment (Haz)ard and (Op)erability assessment with regard to safety and process flow problems.
SDS	Safety Data Sheet. Document listing hazards associated with a substance.
LOWER LAB	Eastern Laboratory – Located on ground floor of Newton
UPPER LAB	Eastern Laboratory – Located on first floor of Newton

2. RESPONSIBILITIES



2.1 HEAD OF SCHOOL ELECTRICAL ENG & TELECOMMUNICATIONS

- Responsible for ensuring the Special Gases System policies and procedures in force provide an adequate level of safety.
- Must be confident that the Special Gases System policies and procedures are adhered to, following advice from the ANFF-NSW Director.

2.2 ANFF-NSW DIRECTOR

- Responsible for ensuring that the Special Gases System operates safely, within the School and University framework.
- Responsible for policy issues associated with the Special Gases System.
- Responsible for overseeing ANFF-NSW Facility Managers duties.
- Must remain familiar with policies and procedures and ensure they are adhered to.

2.3 ANFF-NSW FACILITY MANAGER

- Responsible to the Director for ensuring that the Special Gases System operates safely, within the School and University framework.
- Responsible for maintaining policy in collaboration with the Director.
- Has caretaker role in decision making when Director is absent.
- Oversight of ANFF-NSW Lab Technical Managers duties.
- Reports to the ANFF-NSW Director on issues related to the SGS.
- Must remain familiar with policies and procedures and ensure they are adhered to.

2.4 ANFF-NSW LABORATORY TECHNICAL MANAGER

- Responsible for implementation of policy and safety procedures.
- Responsible for any new processing tools connected to the special Gases System and incident review.
- Responsible for day-to-day operations and upgrades of the SGS System.
- Ensuring SGS maintenance contractor carries out scheduled maintenance on the system.
- Sign-off on changes to processes, or equipment.
- Works with security, emergency services and maintenance contractors when any gas alarm is triggered.
- Responsible for overseeing ANFF-NSW Special Gases Operations Officers duties.
- Reports to the ANFF-NSW Facility Manager.
- Must be familiar with the relevant SDS’s.

2.5 SPECIAL GASES OPERATIONS OFFICER

- Responsible for ensuring that operating and safety procedures exist and are safe, for process tools and each of their processes.
- Responsible for ensuring safe operation of connected plasma tools.
- Responsible for overseeing the construction, maintenance and upgrade of any equipment connected to the hazardous gases.
- Assumes responsibility for working with security and maintenance contractor when any alarm is triggered, and ANFF-NSW Lab Technical Manager is not available.
- Must be familiar with the relevant SDS’s.
- Reports to the ANFF-NSW Lab Technical Manager.

2.6 EQUIPMENT/PROCESS WARDEN

- A Process Team member with processing expertise and knowledge in operating one or more process tools connected to the Special Gases system in the ANFF-NSW lab.
- Has overall tool level responsibility for the equipment.
- Responsible for organising the maintenance of the equipment with the Technical Team and updating the maintenance log(s).
- Responsible for the safe operation of, and proper use of, the processing equipment as in the guidelines for that particular item of equipment.
- No modifications to processes or equipment can be performed, nor any new materials be introduced, without referring to the ANFF-NSW WHS Working Group, which meets weekly.
- Responsible for the training of staff or students who have permission to use the equipment and updating user training records ie Task Certification Checklists.
- Must ensure safe operating procedures and practices are adhered to by all equipment users.
- Responsible for maintaining the Operating Logbook and Gas Logbook.
- Equipment Warden must report all faults to Special Gases Operations Officer or ANFF-NSW Lab Manager.
- Must ensure all risk assessments are up to date and recommendations for process tool updates are carried out.
- Reports to the ANFF-NSW Lab Facility Manager.
- Must be familiar with the relevant MSDS’s for the gases the processing tool uses.

2.7 CERTIFIED USERS

- Authorisation to use the SGS and the connected tools is gained after suitable training by the Equipment Warden and testing (certification) by a (preferably different) Process Team member.
- Responsible for the correct and safe operation of the ANFF-NSW laboratory equipment while it is under their control.
- Responsible for the proper use of the equipment as per the guidelines and SWPs for the approved process/materials they are running on the equipment.
- Responsible for recording usage in the equipment Operating Logbook and Gas Logbook.
- Must be familiar with the relevant MSDS’s for the gases the processing tool uses.
- Must immediately inform the Equipment Warden or the Process or Technical Team member of any mishap or unusual event during a processing run.
- If the user is uncertain about their use of the equipment, REQUEST HELP

3. PROCESSING TOOLS

3.1 TYSTAR LPCVD – EAST LABS

- The LPCVD has two tubes in process verification stage, running DCS, Silane and Ammonia. One tube is in the process of commissioning, and it will offer 3 tubes when fully setup and operational. The LPCVD is not available to users yet. Contact the ANFF Facility Manager for further information.

3.2 OXFORD PECVD – EAST LABS

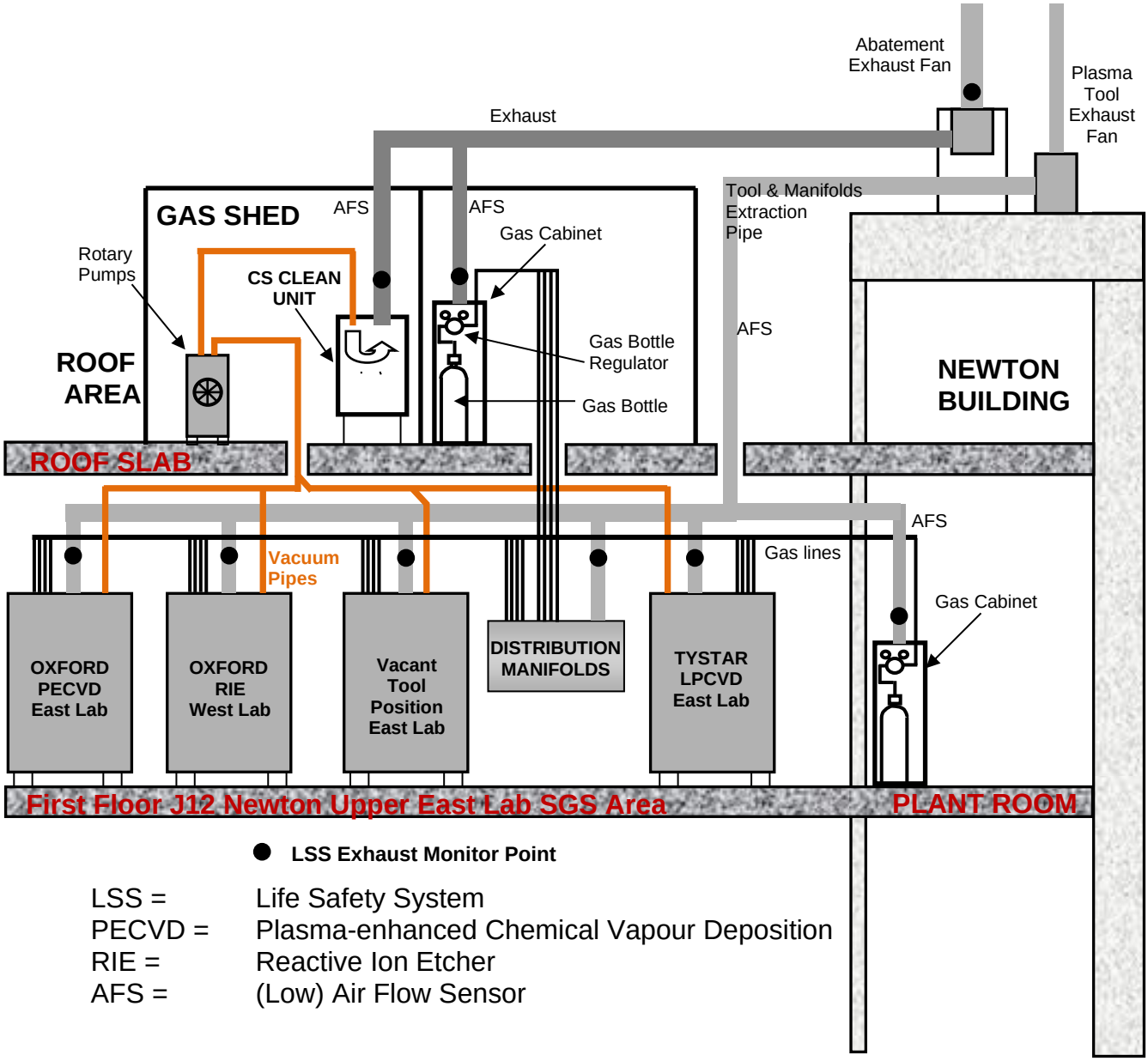
- The Oxford Plasma Enhanced Chemical Vapour Deposition (PECVD) process tool is used to deposit various thin films, using an RF plasma gas mixture, on top of a silicon wafer.
- This is a single chamber processing tool with the advantage of a load lock. It has two rotary pumps and two turbo pumps, is a commercial low level production tool and is fully automated.
- Gases connected to this tool are: Silane (SiH_4), Germane (GeH_4), Phosphine (PH_3), Diborane in Hydrogen (B_2H_6/H_2), Oxygen (O_2), Argon (Ar), Carbon Tetraflouride (CF_4), Sulphur Hexafluoride (SF_6).
- The plasma is generated by a variable high wattage RF power supply.

3.3 OXFORD RIE – WEST LABS

- The Oxford Reactive Ion Etch (RIE) process tool is designed to etch through various materials on the top of a silicon wafer using an RF plasma gas mixture. It is a physical and chemical etching process.
- This is a single chamber processing tool with a load lock. It has two rotary pumps and two turbo pumps. It is a commercial low level production tool, and is fully automated.
- Gases connected to this tool are: Oxygen (O_2), Argon (Ar), Carbon Tetraflouride (CF_4), Trifluoromethane (CHF_3), Sulphur Hexafluoride (SF_6)
- The gas plasma is generated by a variable high wattage RF power supply.

4. INTRODUCTION TO THE SPECIAL GASES SYSTEM

4.1 SIMPLIFED VIEW OF LAB GAS SYSTEM LAYOUT



LSS = Life Safety System
PECVD = Plasma-enhanced Chemical Vapour Deposition
RIE = Reactive Ion Etcher
AFS = (Low) Air Flow Sensor

4.2 GASES

- The Special Gases System (SGS) supplies a number of ultra-pure gases for deposition and/or etching process reactors located in the ANFF-NSW East and West laboratories.
- These gases are: Silane (SiH_4), Germane (GeH_4), Phosphine (PH_3), Diborane in Hydrogen (B_2H_6/H_2), Hydrogen (H_2), Methane (CH_4), Ammonia (NH_3), Oxygen (O_2), Argon (Ar), Carbon Tetraflouride (CF_4), Trifluoromethane (CHF_3), Nitrous Oxide (N_2O), Sulphur Hexafluoride (SF_6) and Nitrogen (N_2).
- Of these, the following are considered toxic, corrosive and/or highly flammable: Silane, Germane, Phosphine, Diborane in Hydrogen, Hydrogen, Methane and Ammonia.
- The other gases, Oxygen, Argon, Carbon Tetraflouride, Trifluoromethane, Nitrous Oxide, Sulphur Hexafluoride and Nitrogen, present little hazard beyond being simple asphyxiants.
- Refer to the ANFF-NSW Laboratory MSDS's for details.

4.3 GAS SHED

- The Gas Shed is a building located on the roof of the ANFF-NSW laboratories, to separate the primary hazard of gas bottles from the laboratory users. This enables the safe storage, safe delivery to the process tools, removal of waste products from the reactors and safe disposal.
- Access to the roof area site is only by prior arrangement with the Laboratory Technical Manager.

4.4 GAS ROOM

- This is a separate room in the left-hand side of the gas shed.
- All gas bottles, gas cabinets and regulating equipment is housed in this half.
- There is also the SGS alarm system and gas monitoring system in this room.

4.5 PUMP ROOM AND ABATEMENT

- This is a separate room in the right-hand side of the gas shed.
- The Pump Room contains rotary vacuum pumps for the process reactors and abatement technology; a ‘CS Clean’ unit to decompose toxic fumes from the rotary pumps before they are drawn through the exhaust abatement fan.

4.6 LIFE SAFETY SYSTEM (LSS)

- The LSS is a distributed setup, located in the gas room and the East and the West Labs. It monitors various points throughout the gas delivery system, the labs and the exhaust plumbing for hazardous gas leaks, fire and other unusual gas system conditions.
- Should the LSS detect any abnormal condition, an audible and visible alarm may sound and a be signal sent to UNSW Security, who will contact the Lab Technical Manager and/or the Fire Brigade.
- There are two levels of alarm – **Critical,** will sound lights and sirens and means lab users should immediately leave the labs.
  Non-Critical, will be flashing lights alone and users should inform the Lab Technical Manager. Security will also be informed and contact the Lab Technical manager and others on the lab emergency call out list.
- Critical alert level will shut off all the hazardous gas cylinders in the SGS.
- The system is programmed to send the correct notification for critical or non-critical alerts.

5. ALARMS

5.1 SGS NON-CRITICAL ALARM

- In a non-critical alert event, the red lights on the gas shed and inside the labs will flash. There is no audible alarm.
- This alarm alerts Security who contact the SGS Maintenance Contractor.
- If this occurs the ANFF-NSW Lab Manager or Special Gases Operations Officer must be informed immediately.
- This may involve an orderly evacuation if it is assessed that there is a danger.
- If there is an evacuation, then ensure all processing is in a safe state before exiting.

5.2 SGS CRITICAL ALARM

- If it is a critical alert then the red flashing lights and sirens will start.
- This alarm alerts Security who summon professional assistance from the Fire Brigade, and the Gas System Contractor.
- If not disabled, after a short delay the building EWIS will be started by Security.
- ANFF-NSW users must immediately evacuate the ANFF-NSW laboratories.
- Only if it is possible to stop any hazardous process without delaying your exit, then do so.
- Do not return to your equipment.

5.2 SGS EMERGENCY BUTTON

- There is one emergency button on each tool connected to the SGS.
- In case of malfunction of a processing tool connected to the SGS any lab user may push this button and the system will enter into critical alarm mode and shutdown the tool.

5.3 (ADDITIONAL) STATUS LIGHTS

- There is a blue light in the SGS processing area, which when illuminated indicates that there is a minor equipment fault in the Gas Shed that does not necessitate a system shutdown. The ANFF-NSW Lab Technical Manager or Special Gases Officer must be informed promptly by anyone observing this light.
- There is a green light outside the gas shed that, when illuminated, indicates the mitigation exhaust fan is running.

5.4 POWER FAILURE TO THE SGS AND/OR LABS

- The ANFF-NSW is to be evacuated in an orderly manner.
- If a power failure occurs, the SGS has been designed to shut-off all hazardous gas bottles. An alarm will also be forwarded to UNSW Security.
- Emergency lighting will be illuminated to indicate exits. Follow these signs.
- After a power failure, system start-up procedure is then to be followed.
- Equipment must not be restarted until the gas system and pumps have been properly restarted and the ANFF-NSW Lab Technical Manager or Special Gases Officer has approved the switch-ON.

5.5 NOTIFICATION OF BUILDING OCCUPANTS

- After an evacuation, all Newton and OMB personnel will be notified when an all-clear is given.

- In the event of a false alarm or short burst of siren due to electrical work or accidental trip, building occupants must be informed of the situation, particularly those on second floor of Newton and Physics on the gas shed level.

6. STANDARD OPERATING PROCEDURES

6.1 SYSTEM STARTUP

- System Start-up or Restart (after alarm or planned shutdown eg for UNSW Xmas break) will be carried out by Maintenance Contractor.

6.2 MANUAL SYSTEM SHUTDOWN

- The Maintenance Contractor will carry out all planned System Shutdowns.
- The ANFF-NSW Lab Technical Manager, Special Gases Operations Officer, can turn off the ESO valves or a person authorised to do so by the ANFF-NSW Lab Technical Manager.

6.3 DAILY OPERATION

- Gas lines should be left charged.
- Manifold shut-off valves on hazardous gas lines running to the process tools are to be closed at the VMB at the end of each process run by the operator using the process tool.
- The Special Gases Operations Officer or ANFF-NSW Lab Technical Manager must be informed of any problems.
- Lab shut-off valves on hazardous gas lines must not be opened if the pressure gauge in the ANFF-NSW lab gas safety cabinet indicates a pressure other than the nominated pressure for that line. (Refer to Safe Work Procedure). The Special Gases Operations Officer or ANFF-NSW Lab Manager must be informed immediately.
- Operators are required to report any problems relating to their equipment immediately and must not continue operation until the problem is investigated by the Special Gases Officer or ANFF-NSW Lab Technical Manager. Suspect equipment will be locked-out and tagged with the inspecting officer's name and date.
- No person is to attempt any manipulation of the gas system in any way other than to activate the emergency shutdown if required.
- In the Gas Shed, an ESO valve on a hazardous gas line will only be opened, if it is safe to do so, by either the Special Gases Officer or ANFF-NSW Lab Technical Manager. Equipment/Process Wardens or Certified Users must request this at the start of processing.
- ESO valves will be closed, the cylinders isolated at the valves and the system shutdown at the end of each days processing by either the Special Gases Officer or ANFF-NSW Lab Technical Manager.
- Daily operating procedures to be reviewed as required by ANFF-NSW Lab Technical Manager and Special Gases Officer.

6.4 INSPECTION OF ANFF-NSW GAS SHED

- The Special Gases Operations Officer or Lab Technical Manager performs this inspection.
- This is a general status inspection – checking for unusual meter readings, noises, burning odours, alarms, TGM status, fan motors, LC displays.

6.5 ANNUAL SHUTDOWN

- The hazardous gas lines to individual machines are to be pumped down, clear of gases at the end of the last process run for the year, by the Special Gases Officer(s) via the process tool.
- The ESO valves on all hazardous gas lines will be closed by the ANFF-NSW Special Gases Officer(s) or the ANFF-NSW Lab Technical Manager
- The ANFF-NSW Lab Manager will request that the SGS Maintenance Contractor pump down and seal all hazardous gas lines at the Gas Shed before the Christmas break, until such time as the Special Gases System is needed to be brought back on line in the next year.

7. MAINTENANCE

7.1 GAS SYSTEM MAINTENANCE

- Fortnightly, monthly and annual maintenance will be carried out by the Maintenance Contractor on all system components up to the point of supply to the processing tools.
- No SGS processing of any kind will take place during maintenance periods
- If required, the processing equipment will be shut down.

7.2 GAS CYLINDER CHANGE

- Connection and disconnection of gas bottles in the Gas Room will be carried out by the Maintenance Contractor.
- Process equipment is not to be used during gas bottle changes. The ANFF-NSW Laboratory Technical Manager or Special Gases Officer (who initiate work with maintenance contractor) to ensure system is shutdown and machines are labelled with "Do Not Start" tags.
- Gas lines which have either new gas bottles attached or have had work done to them are to be vacuum purged from the process equipment using high vacuum pumps before bottles are opened.
- Appropriate liaison with the Maintenance Contractor will be required during this operation.

7.3 SGS GAS CYLINDER HANDLING AND TRANSPORTATION

- The moving of gas bottles to and from the Gas Room can be carried out by the Maintenance Contractor, ANFF-NSW Laboratory Technical Manager, or Special Gases Operations Officer.
- Gas bottles are not allowed to be carried in a lift unless the lift is equipped with lockout facilities to stop anyone travelling in lift with bottles.
- The crane on the roof next to the Gas Shed is to be used for moving bottles to and from the Gas Shed, with the purpose built bottle trolley, which resides in the Black Area.
- Please refer to the crane operating manual for details of crane operation. Only people authorised by the ANFF-NSW Lab Technical Manager can operate the crane.
- When the crane is in use, a member of staff must be at ground level to keep people clear of the area during lifting and lowering of bottles or trolley and a sign placed on the inside of the plant room door to warn anyone about to walk out.

7.4 VACUUM PUMP MAINTENANCE (PUMP ROOM)

- A FACE RESPIRATOR, SUITABLE FOR GASES AND OIL MISTS, MUST BE WORN WHEN OPENING ANY CONNECTION TO A HAZARDOUS GAS ROTARY PUMP, EXHAUST OR VACUUM LINE. (NB Do not use a shared respirator. If in doubt, use a new one or clean with disinfectant).
- Maintenance is to be carried out by the SGS Maintenance Contractor, another appointed contractor or staff member.
- Do not open any connections to a pump, or turn it off, for 30 minutes after it has been used for a process. Prior to opening any connections to the pump, turn off pump and shut off any purge nitrogen.

7.5 GP RIE

- Maintenance is only to be carried out on this tool in consultation with the Equipment Warden and ANFF-NSW Lab Technical Manager.
- All breakdowns must be reported immediately to the Equipment Warden and ANFF-NSW Lab Technical Manager.
- Routine and preventative maintenance is to be carried out according to the tool **safe work procedures and task instructions**.

7.6 OXFORD PECVD

- Maintenance is only to be carried out on this tool in consultation with the Equipment Warden and ANFF-NSW Lab Technical Manager.
- All breakdowns must be reported immediately to the Equipment Warden and ANFF-NSW Lab Technical Manager.
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7.8 TYSTAR LPCVD

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- All breakdowns must be reported immediately to the Equipment Warden and ANFF-NSW Lab Technical Manager.
- Routine and preventative maintenance is to be carried out according to the tool **safe work procedures and task instructions**.

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