Fire Safety Plan

Building Fire Safety Plan for:

AVIAN RESEARCH BUILDING

(Building Name)

G - 618

(Building Emergency Map Reference)

April, 2012
Building Fire Safety Plan for:

ADVANCED FACILITY FOR AVIAN RESEARCH

G - 618
(Emergency Map Reference Number)

June, 2019
## Table of Contents

1. Introduction......................................................................................................................... 4  
   Definitions............................................................................................................................ 5  
2. Contact Information........................................................................................................... 7  
3. Building Resources Audit ................................................................................................. 8  
   General................................................................................................................................. 8  
   Fire Alarm System ................................................................................................................ 8  
   Sprinkler System ................................................................................................................ 8  
   Other ................................................................................................................................. 9  
4. Building Schematics (Floor Plans) ................................................................................... 10  
5. Controlling Building Fire Hazards .................................................................................... 13  
6. Instruction to Occupants ................................................................................................... 14  
   Procedure in Event of a Fire ............................................................................................... 14  
   Provisions for Persons with a Disability ........................................................................... 15  
   Procedures for “Shelter in Place” in designated Operating and Patient Imaging Rooms .......... 18  
7. Supervisory Staff .............................................................................................................. 19  
8. Responsibilities .................................................................................................................. 20  
   Building Emergency Team (BET) ..................................................................................... 20  
   Building Emergency Coordinator (BEC) ......................................................................... 21  
   Supervisors ....................................................................................................................... 22  
   Western Fire Safety ........................................................................................................ 23  
9. Assembly Area(s) ............................................................................................................. 24  
10. Fire Drills .......................................................................................................................... 25  
11. Fire Extinguishment/Control/Confinement ..................................................................... 26  
12. Alternative Fire Safety Measures .................................................................................... 27  
13. Special Event Procedures ................................................................................................. 28  
15. Fire Alarm System and Device Information ................................................................... 36  
Appendix A: Wind Tunnel Standard Operating Procedures .............................................. 37
1. Introduction

The Ontario Fire Code, Section 2.8 requires the implementation of a Fire Safety Plan for this building/occupancy. Typically, the plan is to be kept in the building in an approved location; however, due to the large number of buildings on and off campus, the Fire Safety Plans are maintained in a central database on the Western Fire Safety website, www.fire.uwo.ca.

The implementation of the Fire Safety Plan helps to ensure effective utilization of life safety features in a building to protect people from fire. The required Fire Safety Plan should be designed to suit the resources of each individual building or complex of buildings. It is the responsibility of Western’s Fire Safety Department to ensure that the information contained within the Fire Safety Plan is accurate and complete.

The Fire Protection and Prevention Act Part VII, Section 28, states that in the case of an offence for contravention of the fire code, a corporation is liable to a fine of not more than $100,000 and an individual is liable to a fine of not more than $50,000 or imprisonment for a term of not more than one year or both.

This Official Document is to be kept readily available in the approved location for use by building occupants including; staff, fire officials, other public officials and Supervisory Staff.

NOTE: As per the letter of understanding between Western University (and its affiliates who wish to participate) and the London Fire Department received on February 5, 2014, the London Fire Department agrees with the purchasing of tablets and the provided fire safety plans via pdf or other agreed upon format as a means of alternate compliance concerning Sentence 2.8.2.1(3), [Functional statement F12 – to facilitate emergency response, Fire safety objectives 1.2 and 1.5 and Fire Protection Objective 1.2] of the Ontario Fire Code and the City of London Bylaw #F-167-159. London Fire and Western University will liaise going forward on updates of said Fire Safety Plans as required.
Definitions

**Alarm Signal:** an audible signal transmitted throughout a zone or zones or throughout a building to advise occupants that a fire emergency exists.

**Approved:** approved by the Chief Fire Official.

**Assembly:** the type of occupancy or the use of a building, or part thereof, occupancy by a gathering of persons for civic, political, travel, religious, social, educational, recreational or like purposes or for the consumption of food or drink.

**Building:** any structure used or intended for supporting or sheltering any use or occupancy.

**Check:** means visual observation to ensure the device or system is in place and is not obviously damaged or obstructed.

**Chief Fire Official:** the assistant to the Fire Marshal who is the City of London Fire Chief or a member or members of the fire department appointed by the City of London Fire Chief under Subsection 1.1.8. (of the Ontario Fire Code) or a person appointed by the Fire Marshal under Subsection 1.1.8.

**Class A:** a fire involving combustible materials such as wood, cloth and paper.

**Class B:** a fire involving a flammable or a combustible liquid, fat or grease.

**Class C:** a fire involving energized electrical equipment.

**Class D:** a fire involving a combustible metal.

**Class K:** a fire involving cooking oils.

**Exit:** that part of a means of egress, including doorways, that leads from the floor area it serves to a separate building, an open public thoroughfare or an exterior open space protected from fire exposure from the building and having access to an open public thoroughfare.

**Fire Separation:** construction assembly that acts as a barrier against the spread of fire and may or may not have a fire resistance rating or a fire protection rating.

**Incident Command:** the incident management structure used during emergencies by both Western University and municipal emergency agencies.

**Incident Commander:** the individual representing the authority having jurisdiction (London Fire Department) who is responsible for the coordination and response to a fire emergency.

**Incident Commander – Western University:** an individual authorized by the President to coordinate the University’s response to an emergency and to notify the Emergency Operations
Control Group (EOCG) in the event of a major incident and/or the municipal emergency agencies incident manager.

**Inspect (Inspection):** means physical examination to determine that the device or system will apparently perform in accordance with its intended function.

**Occupancy:** the use or intended use of a building or part thereof for the shelter or support of persons, animals or property.

**Occupant Load:** the number of persons for which a building or part thereof is designed.

**Owner:** any person, firm or corporation having control over any portion of the building or property under consideration and includes the persons in the building or property.

**Single Stage Fire Alarm System:** a fire alarm system designed so that activation of any alarm initiating device (i.e. manual pull station, smoke or heat detector, etc.) will cause a general evacuation **alarm signal** to sound on all audible signal appliances throughout the building.

**Supervisory Staff:** those occupants of a building who have some delegated responsibility for the fire safety of other occupants under the Fire Safety Plan. This includes the Building Emergency Coordinator, Building Emergency Team members, and/or Residence Life Staff.

**Test:** means the operation of a device or system to ensure that it will perform in accordance with its intended operation or function.
2. Contact Information
   a. Emergency Contact Information

      **Fire, Police, Ambulance: 9-1-1**

   b. Building Key Holder(s) Information/Emergency Contacts:

      **Building Name:** Advanced Facility for Avian Research

      **Emergency Map Identification Number (Zone/Number):** G - 618

<table>
<thead>
<tr>
<th>Name</th>
<th>Phone/Extension</th>
<th>Alternate Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus Police</td>
<td>519-661-3300 / x83300</td>
<td>9-1-1</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>519-661-3300</td>
<td>9-1-1</td>
</tr>
<tr>
<td>Fire Alarm Service (Electrical Shop)</td>
<td>519-661-3304</td>
<td></td>
</tr>
<tr>
<td>Sprinkler and Standpipe Service (Western Fire Safety)</td>
<td>661-3300</td>
<td></td>
</tr>
<tr>
<td>Elevator Service (Elevator Shop)</td>
<td>519-661-3304</td>
<td></td>
</tr>
<tr>
<td>Occupational Health and Safety</td>
<td>X82194</td>
<td></td>
</tr>
<tr>
<td>Damar Security Systems</td>
<td>1-800-265-7562</td>
<td></td>
</tr>
</tbody>
</table>

c. Building Owner Information

      Western University C/O Fire Safety & Emergency Management

      Graphics Building Room 123

      London, ON N6G 1G9

      519-661-3300
3. Building Resources Audit

General
Occupancy Type: D, F

Occupant Load (If applicable): contact western fire safety for specific room occupancy loads

Designated Fire Route: Western Road to Wellington Drive

Municipal/Private Hydrant Location: Northeast of the building by Support Services parking lot

Lockbox Location: N/A

Type of Heating: Natural Gas

Main Gas Shut-off to Building: Northwest corner of the building by RM 150/Exit 4

Main Electrical Shut-off Location: Basement Mech. RM 150

Main Domestic Water Shut-off Location: Basement Mech. RM 150

Fire Alarm System
Make: Simplex

Model: 4100U

Main Control Panel Location: Main lobby/Front entrance

Annunciator Panel Location(s): N/A

Fire Alarm Description: Addressable

Monitoring: Damar Security Systems

Sprinkler System
Type: Wet System

Connected to Fire Alarm System: Yes

Location of Shut-off/Isolation Valves: Mech. Rm 150

Fire Pump Location: N/A

Standpipe System: N/A

Location of Standpipe Shut-off/Isolation Valves: N/A

Fire Department Connection: Southwest corner of the building near main entrance
Other
Type of Specialty/Other Extinguishing System(s): N/A
Location: N/A

Portable Fire Extinguishers: Refer to Section 16, Building Diagrams

Type of Emergency Lighting: Integrated into existing building lighting

Type of Emergency Power: Diesel Generator

Generator Fuel Supply Type/Location: Diesel fuel at generator behind Graphics building

Transfer Switch Location: Mech. RM 150

Equipment/Area powered by Generator: All emergency panels throughout building (lighting/receptacles)

Extra Hazardous Area Location(s): None

Exits: Refer to Section 16, Building Diagrams

Elevators:

Type: no designation

Automatic/Manual Recall: Manual only

Location of Manual Recall Switch(es): inside elevator

Total Number of Elevators: 1

Number of Firefighter Elevators & Location: 1

Location of Recall/Operating Keys: In fire panel, front lobby

Operating Instructions: As per TSSA Standards
4. Building Schematics (Floor Plans)
5. Controlling Building Fire Hazards

A high standard of housekeeping and general maintenance is the single most important factor in the prevention of fire. Subsequently, some common fire hazards have been identified:

- Combustible materials stored improperly and in mass quantities in unapproved locations.
- Fire Doors being propped open or not closing properly.
- Improper storage of flammable liquids and gases.
- Defective wiring of appliances and electrical equipment, and/or overloading of specific outlets, power bars and extension cords.
- Improper disposal of oily rags.

In General, Occupants of a Building Should Know;

- How to alert occupants of the building of a Fire or Emergency.
- Where the exits are located.
- To call 9-1-1 in the event of an Emergency.
- The name and address of the building in which you are located.
- The Fire Alarm procedures and meeting place in the event the building needs to be evacuated.
- Who the Building Emergency Team members are within their area and who the Supervisory Staff are within the building.
- How to report any Hazard to your Supervisor, Campus Police, Fire Safety or Occupational Health and Safety.

Reporting Fire Hazards

Please report all fire hazards to Western Fire Safety at 519-661-3300 or extension 83300. There is no need to give your name and all hazards will be investigated if reported by phone or in person. (Please do not report fire hazards by fax or email).
6. Instruction to Occupants

Procedure in Event of a Fire

Throughout campus there are signs posted with instruction pertaining to fire procedures as well as directions to follow in the event of an emergency. A sample of this sign has been included in this plan. You should familiarize yourself with your building’s signage as well as the instructions listed on them.

When the Alarm Sounds:

- Gather your coat, keys, purse, etc. and close your door.
- Evacuate the building using the closest exit. DO NOT USE ELEVATORS
- Proceed to your predetermined meeting place and advise your supervisor, Building Emergency Team or Emergency Personnel of any pertinent information (i.e. People inside, location of the fire, etc.)
- DO NOT re-enter the building until given permission to do so.
Provisions for Persons with a Disability
Persons with a physical disability are, in many cases, limited in their ability to evacuate by means of stairwells. It is primarily for this type of disability that the following procedures apply.

For the purpose of fire safety planning, a “physical disability” is that which, even with the aid of Building Emergency Team members, would prevent that person from descending the stairs in an evacuation situation at a rate of speed consistent with the normal flow of other building occupants, or which would cause such person physical harm if they attempted to descend the stairs.

Procedure When an Alarm Sounds

Ground Level - Evacuation

If you can evacuate the building at ground level, a Building Emergency Team member (BET) or a volunteer should escort you to a safe location away from the building.

Above or below the ground floor – Shelter in Place

1. Seek a safe area with or without the assistance of a BET member.
2. When there is a fire alarm, if possible, phone Campus Police at 911 to inform them of your location, circumstance and intentions.
3. Tell the communication officer that your fire alarm is sounding but you have a disability and cannot leave your floor area. If you smell smoke, or are in immediate danger, immediately inform the communications officer.
4. The Building Emergency Team (BET) has been instructed to ask and help you to identify the location where you will wait for evacuation. They are not trained to lift and carry you out of the building. Please ask someone to remain in the building with you until trained rescue workers arrive from the fire department. Make sure someone either from the evacuation team or a volunteer has noted your location (which floor and/or stairwell/room number) and that this person will notify the authorities of your need for assistance.
5. Provide the phone number and extension you are calling from. It is IMPERATIVE that this number can receive return calls. Note that PAY telephones generally cannot receive incoming calls.
6. Campus Police have radio contact with officers at the scene and will provide you with updates on the situation via the phone number you provide. In the event that your safety could be compromised, Firefighters will assist in your safe evacuation. At any time, you can also call back for an update.

Note: The London Fire Department and Campus Community Police Services will respond to the scene within 2-3 minutes of a fire alarm.

Whenever possible, the procedures to be taken for the evacuation of a person with disability must be discussed with the individual. Co-workers are also to be informed of these procedures in order to achieve a mutual understanding of the impairment, and the procedures to initiate during an evacuation.
The person(s) with the disability is usually the best judge of his/her abilities and can provide valuable assistance in developing an evacuation plan. Persons having a sensory impairment (blindness, deafness, etc.) or a minor physical impairment can, with the assistance of their Building Emergency Team members, usually evacuate as quickly and safely as other building occupants. If this is the case, they may be permitted to carry out regular evacuation procedures. However, these persons may require at least one Building Emergency Team Member to alert them of the alarm, if necessary, and to assist them to evacuate.

In building fire evacuation exercises (i.e. fire drills), the Building Emergency Team members and persons with a disability are to carry out the actions they would normally carry out in an emergency (i.e., respond to the pre-arranged location on the floor area). In a drill situation, it is not necessary for persons with a disability to evacuate the building completely. This action could in fact pose a danger to these persons and their Building Emergency Team members, as well as for the other occupants of the building.

Upon initiation of a fire alarm, the Building Emergency Team members may respond with the persons with a disability to a pre-arranged location on the floor area that does not block other evacuation traffic.

In all situations, the Building Emergency Team members should ensure that one person is assigned to report to the Building Emergency Team Coordinator or Emergency Personnel, immediately upon evacuation, that the floor is clear and the number of persons with a disability, Building Emergency Team members, etc. evacuating at a slower rate and their location, so that assistance may be dispatched if available.

If for any reason the evacuation of a person with a disability must be suspended, and the people involved take refuge on a floor area other than their own, the Building Emergency Team members must make every effort to alert the Building Emergency Team Coordinator or other Emergency Personnel of their location. This can be done by advising other evacuees as they proceed down the stairs, by keeping a watch for would-be rescuers, searchers or fire fighters proceeding up the stairs, by using the telephone, or by waving or shouting from a window to alert bystanders and/or arriving emergency personnel.

The Building Emergency Team members or designated person should immediately advise the Building Emergency Team Coordinator or Emergency Personnel when the evacuation of persons with a physical disability has been completed.

It should be noted that telephone communications remain intact in many fire situations and an attempt should always be made to utilize this means of communication to either contact Campus Community Police Service or the Fire Department.
Occupants who require assistance in evacuating during an alarm are responsible for:

- Advising their Building Emergency Team Coordinator or Western Fire Safety so that a pre-plan can be established;
- Assisting the Building Emergency Team Coordinator or Western Fire Safety in appointing Building Emergency Team members;
- Telling their Building Emergency Team members how much help they may need; and
- Practicing the evacuation procedures.

Please send any unanswered questions or concerns to firesafety@uwo.ca
Western University Procedures for “Shelter in Place” in designated Operating and Patient Imaging Rooms during fire alarms
(Not applicable to B Occupancy Suites)

Due to the nature of operating suites and imaging rooms it may not be practical or safe for staff and patients to evacuate the building upon activation of a fire alarm. For this reason the following measures have been put in place:

1. If staff are performing surgery, or involved in an animal procedure when the alarm sounds and are unable to safely evacuate the building, they are to immediately phone 911 from a landline telephone residing in the SAME suite where the surgery is taking place and report their location and the reason for not evacuating the building to the CCPS communications operator.
2. If staff are imaging patients, or have patients with disabilities when the alarm sounds and are unable to safely evacuate the building, they are to immediately phone 911 from a landline telephone residing in the SAME suite where the imaging is taking place and report their location and the reason for not evacuating the building to the CCPS communications operator.
3. Staff unable to evacuate must also give a phone number or extension number where they can be reached if CCPS dispatch requires contact with them.
4. Campus Police will notify responding emergency personnel of the location of the surgery suite and also advise the occupants should they need to evacuate due to imminent danger. Occupants may also call CCPS communications center for updates throughout the fire alarm.

Per Ontario Fire Code 2.8, Fire Safety and Emergency Management Department is to be notified of any rooms on campus that are regularly used for these purposes so that the necessary pre-planning process can be carried out as well as noted in the building Fire Safety Plans.

All designated suites MUST have a landline telephone installed in the suite that can receive incoming calls.

All designated suites MUST create and post a Standard Operating Procedure (SOP) for their specific room/suite that outlines the individual duties of each person involved in the event of a fire alarm activation. (I.e. who will call CCPS? who will take care of the patient? etc.)

During fire evacuation exercises (i.e. fire drills), the persons staying in the surgery/imaging area are to carry out the actions they would normally carry out in an emergency (i.e. make contact with CCPS, etc.).
7. Supervisory Staff

- Campus Community Police
- Western Fire Safety
- Building Emergency Coordinator (BEC)
- Building Emergency Team members (BETs)
8. Responsibilities

Building Emergency Team (BET)

Building Emergency Teams are present in most buildings on campus. It is the function of the Building Emergency Team to assist and coordinate a prompt and organized evacuation of all building occupants in the event of an emergency. If members are in their designated area, they are to begin a sweep of the area and encourage everyone to exit and meet at the designated rally point. If members are not in their area, or they cannot get to their area, they are not to go back to do a sweep. Instead, members are to leave via the nearest exit and report this information to an official outside.

In the event of an emergency:
- Don your Building Emergency Team vest.
- Take your keys, coat, and any important information with you.
- Search your floor if you can do so safely.
- Encourage all occupants to close windows and doors to their area, and evacuate the building.
- As you leave the building, inform other occupants that they should be evacuating.
- If you know of persons who did not evacuate, notify the Building Emergency Coordinator or emergency personnel where these individuals are located upon exiting the building.
- If you see signs of smoke and/or fire, or any other emergency situation, react accordingly and report this information to your Building Emergency Coordinator and/or emergency personnel.
- If you feel confident in the operation of a fire extinguisher, and you feel it is safe to do so, first ensure the building fire alarm is activated, and then try to extinguish the fire. If you do not feel comfortable using a fire extinguisher, evacuate the fire area and ensure the building fire alarm is activated.
**Building Emergency Coordinator (BEC)**

The Building Emergency Team (BET) is coordinated by the **Building Emergency Coordinator** (BEC). The Building Emergency Coordinator has the task of recruiting and maintaining a group of people who will act as members of their Building Emergency Team. During an Emergency evacuation, the BEC will proceed to a designated meeting place to await the arrival of the responding Emergency Services. The BEC will liaise with other Building Emergency Team members in order to determine any pertinent information about the emergency. Such information may include: areas of the building which have been searched, locations of people in the building, cause of the alarm, cause of the fire, signs of smoke or fire, or any other information which they deem important for responding Emergency Personnel. The BEC will relay this information to the incoming agencies and act as a liaison. An additional duty of the BEC is to inform other team members, upon the instructions from the Incident Commander be it Police, Fire or Other, that the building can be re-occupied. In the case that it is not possible to re-occupy the building, it is the duty of the BEC to relay to other team members that they will be required to move to the pre-determined temporary shelter building.

All Building Emergency Team members and Building Emergency Coordinators are issued vests which are to be donned in the event of an emergency. These vests assist responding Emergency Agencies as well as building occupants in identifying their designation as Building Emergency Team members.
Supervisors

○ Keep the doors in fire separations closed at all times.
○ Ensure that the doors to stairways are kept closed at all times (or will close on activation of a fire alarm)
○ Keep access to exits and exit doors, inside and outside, clear of any obstructions at all times.
○ Ensure that stairways, landings, hallways, passageways, and exits, inside and outside, are kept clear of any obstructions at all times.
○ Ensure that combustible materials are not accumulated in any part of a stairway, fire escape or other means of egress, or near elevator and ventilation shafts.
○ Ensure that combustible waste materials do not accumulate in locations that may constitute an undue fire hazard.
○ Promptly remove all combustible waste from your area.
○ Keep access roadways, fire routes and fire department connections clear and accessible for fire department use.
○ Participate in fire drills.
○ Have a working knowledge of fire alarm procedures and the building fire and life safety systems.
○ Ensure the building fire and life safety systems are in operating condition.
○ Maintain fire protection equipment visibility and access.
○ Arrange for an alternate person to be responsible for your duties in the event of your absence.
○ Comply with the Ontario Fire Code.
Western Fire Safety

Western Fire Safety has numerous responsibilities related to fire safety and must ensure that the following measures are enacted:

- Establishment of emergency procedures to be followed at the time of an emergency.
- Instruction of supervisory staff and other occupants so that they are aware of their responsibilities for fire safety.
- Conducting fire drills in accordance with the Ontario Fire Code, incorporating Emergency Procedures appropriate to the building.
- Control of fire hazards in the building.
- Provisions of alternate measures for safety of occupants during shut down of fire protection equipment.
- Assuring that checks, tests and inspections as required by the Ontario Fire Code are completed on schedule and that records are retained for the required period.
- Ensure that the information in the Fire Safety Plan is current.
- Train sufficient building supervisory staff and alternates
- Maintain the provisions of the Fire Safety Plan.
9. Assembly Area(s)
The following table indicates the assembly areas for the building:

<table>
<thead>
<tr>
<th>Advanced Facility for Avian Research</th>
<th>Assembly Area</th>
<th>South parking lot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Shelter</td>
<td>Support Services Building</td>
</tr>
<tr>
<td></td>
<td>Secondary Shelter</td>
<td>University Community Centre</td>
</tr>
</tbody>
</table>
10. Fire Drills

Campus fire drills are conducted in accordance with the Ontario Fire Code. This Code states that a fire drill, for at least supervisory staff, must occur once per year in all buildings equipped with fire alarm systems, every six months in buildings that have laboratories that use flammable or combustible liquids, every three months in high rise buildings, and monthly for day-care facilities.

A fire drill is a tool that can be used to train employees who have supervisory duties, expose building occupants to fire evacuation procedures, identify concerns that affect the occupants’ ability to evacuate, and increase the general fire safety awareness among building occupants.

As the name implies, a fire drill is just that, a “drill”, or a “practice” that is conducted during a non-emergency time. Building occupants are given the opportunity to carry out any “fire alarm duties” assigned to them without the danger presented by an actual fire. Fire Drills also prove to be good practice for all Building Emergency Team members. This provides all occupants the opportunity to give feedback that can be used to alter and modify plans, routines and habits in an effort to make a real emergency as safe as possible.

A fire drill may also be used as a diagnostic tool that can help emergency planners understand the strengths and weaknesses of each building’s reaction to a fire alarm/emergency situation. These findings can then be used to make adjustments to fire safety plans, training programs, and future fire drills.

Fire drills identify to the occupants the audible and visual evacuation devices and emergency tones that are heard and seen during an alarm as well as reinforce the procedures that are to take place during an alarm.

Participation in fire drills is mandatory, and each person within a building is expected to evacuate when the fire alarm sounds.

Fire drills will be held at least annually in this building to ensure efficient execution of the Emergency Procedures. Fire drill records are required to be retained for a period of one year.
11. Fire Extinguishment/Control/Confinement

Ensure that the Fire Alarm System has been activated and that the Fire Department has been notified prior to an attempt to extinguish a fire. Only those persons who are trained and familiar with extinguisher operation should attempt to fight a fire. In the event that a small fire cannot be extinguished with the use of a portable fire extinguisher or the smoke presents a hazard for the operator, the door to the area should be closed to confine and contain the fire and the building should be evacuated.

**Portable Fire Extinguisher Operation**

Remember the acronym **P.A.S.S**.

P - Pull the safety pin

A - Aim the nozzle

S - Squeeze the trigger handle

S - Sweep from side to side (watch for fire restarting)

Never re-hang or put back extinguishers after they have been used. Ensure that discharged fire extinguishers are reported to Western Fire Safety and that a replacement extinguisher is provided.

Keep extinguishers visible and unobstructed.

Throughout campus there is signage posted indicating instructions pertaining to operation of fire protection equipment (Commercial Kitchen Suppression Systems, Special Fixed Extinguishing Systems, Fire Hose Stations, etc.) as well as directions to follow in the event of an emergency. The fire extinguisher procedure sign has been included in this plan. You should familiarize yourself with your building’s/area’s signage as well as the instructions provided. Contact Western Fire Safety for any further training.
12. Alternative Fire Safety Measures

Alternative fire safety measures will be implemented for any shutdown of fire protection equipment and systems or parts thereof. The London Fire Department will be notified of any shutdowns lasting longer than 24 hours.

All attempts to minimize the impact of malfunctioning equipment will be initiated. Where portions of a sprinkler or fire alarm system are placed out of service, service to remaining portions must be maintained, and where necessary, the use of fire watch personnel, radios, procedures, etc. will be employed to notify concerned parties of emergencies. Assistance and direction for specific situations are to be sought from Western Fire Safety & Emergency Management.

Procedures to be followed in the event of shutdown of any part of a fire protection system are as follows:

1. Adhere to all relevant University policies and procedures.
2. The London Fire Department is to be notified by Western Fire Safety of shutdowns lasting longer than 24 hours.
3. When required, persons/occupants in affected areas will be notified by the means identified by Western Fire Safety & Emergency Management.
4. When deemed necessary by Western Fire Safety & Emergency Management staff, or other reliable person(s), will conduct a Fire Watch within the affected area(s). All normally occupied areas shall be inspected and a log will be maintained via radio communication with CCPS radio system logging.
5. Alternative notification system(s) may need to be employed to evacuate occupants at the request of Western Fire Safety & Emergency Management or the London Fire Department.
6. During an emergency or unscheduled shutdown notify the Manager of Western Fire Safety & Emergency Management (or designate) via Campus Community Police Service Communications (519-661-3300). The notification is to be made by the employee or contractor creating the shutdown. Provide your name, address, phone number and/or location and a description of the problem including when you expect it to be corrected. Notify Community Campus Police Services again when repairs have been completed and systems are restored to normal.

Note: All shutdowns will be confined to as limited an area and duration as possible.

All hazardous operations (labs working with flammable and combustible liquids and gases) should be suspended in non-protected areas due to shutdowns.
13. Special Event Procedures

All Special Events are to have fire and life safety procedures developed if the provisions of the approved fire safety plan cannot be met. All special event organizers are to develop these plans in conjunction with Western Fire Safety.

The following are examples of special event items that would require the need for special procedures:

- Blocked exits
- Large quantities of combustibles
- Large number of persons with a physical disability
- High profile speaker(s)
- Change in building use
- Change in normal occupancy
- High occupancy loads

Check/Test/Inspect requirements of the Ontario Fire Code (OFC):

- Fire safety Officers check to ensure that the necessary checks, inspections, and/or tests are being conducted during their inspections.
- This list has been prepared for the purpose of convenience only, for accurate reference please consult the OFC or Western Fire Safety.
- The OFC states that records of all tests (and corrective measures required) be retained for a period of two years. For all documented records contact Western Fire Safety.
- All maintenance and testing of building fire and life safety systems are the responsibility of Western Fire Safety & Emergency Management.
General

- Fire hydrants shall be readily available and unobstructed for use at all times
- Doors in fire separations are to be checked as frequently as necessary to ensure that they remain closed
- Exit signs are to be clearly visible and maintained in a clean and legible condition
- Internally illuminated exit signs are to be kept clearly illuminated at all times when the building is occupied

Weekly

- When subject to accumulation of combustible deposits, hoods, filters, and ducts are to be checked weekly and be cleaned when such deposits create an undue fire hazard

Monthly

- Doors in fire separations are to be inspected monthly for proper operation

Yearly

- Hydrants shall be inspected annually after each use
  - Ensure hydrants are equipped with port caps, secured wrench tight. The port caps shall be removed annually and inspected for wear, rust, or obstructions
  - The hydrant barrel shall be inspected annually to ensure that no water has accumulated
  - The drain valve shall be inspected for operation if water is found in the hydrant barrel when main valve is closed
  - Hydrant water flow shall be inspected for operation annually and a record shall be kept
  - Yearly inspection and maintenance of hydrants is the responsibility of the City of London
- Fire dampers and fire-stop flaps are to be inspected annually, or based on a schedule, via contractor, acceptable to the Chief Fire Official
- Every chimney, flue and flue pipe are to be inspected annually and cleaned as often as necessary to keep them free from accumulations of combustible deposits
- Disconnect switches for mechanical air-conditioning and ventilating systems are to be inspected annually to establish that the system can be shut down
- Spark arresters are to be cleaned annually or more frequently where accumulations of debris will adversely affect operations. Burnt-out arresters should be repaired or replaced
Portable Fire Extinguishers

General

- Each portable extinguisher is to have a tag securely attached to it showing the maintenance or recharge date, the servicing agency, and the signature of the person who performed the service.
- A permanent record containing the maintenance date, the examiner’s name, and a description of any work or hydrostatic testing carried out is to be prepared and maintained for each portable extinguisher.
- All extinguishers are to be recharged after use or as indicated by an inspection or when performing maintenance. When recharging is performed, the recommendations of the manufacturer are to be followed.

Monthly

- Portable fire extinguishers are to be inspected monthly.

Yearly

- Extinguishers are to be subject to maintenance not more than one year apart or when specifically indicated by an inspection.
- Maintenance procedures are to include thorough examination of the three basic elements of an extinguisher:
  - Mechanical parts
  - Extinguishing agent
  - Means of expulsion

5 Years

- Every five years, pressurized water and carbon dioxide extinguishers are to be hydrostatically tested.

6 Years

- Every six years, stored pressure extinguishers that require a 12 year hydrostatic test are to be emptied and subjected to the applicable maintenance procedures.
Fire Alarm

General

- Fire alarm and voice communication system components are to be kept unobstructed
- Fire alarm control and annunciator panels are to be kept unobstructed
- Fire alarm system power supply disconnect switches are to be locked on in an approved manner

Daily

- The following daily checks should be conducted, and if a fault is established, appropriate corrective action should be taken
  - The fire alarm panel is monitored 24/7 by Security for any alarms, faults, or trouble which will result in the immediate dispatch of persons to investigate.

Monthly

- Every month the following tests are to be conducted under battery back-up power and if a fault is established, appropriate corrective action if to be taken:
  - One manual fire alarm initiating device is to be operated, on a rotating basis, and should initiate an alarm condition
  - Function of all signal devices should be ensured
  - The annunciator panel is to be checked to ensure correct annunciation
  - Intended function of the audible and visual trouble signals are to be ensured
  - Fire alarm batteries are to be checked to ensure that:
    - Terminals are clean and lubricated where necessary
    - Terminal clamps are clean and tight
    - Electrolyte level and specific gravity, where applicable, meet manufacturer’s specification
  - Voice paging capability to one zone is to be tested monthly on a rotational basis
  - One emergency telephone is to be tested monthly on a rotational basis for operations and correct indication at control unit
  - Loudspeakers are to be tested monthly as an all-call signal to ensure they function as intended
  - At least one firefighter’s emergency telephone is to be tested monthly, on a rotational basis to ensure communication with the control unit. All telephones are to be tested each year

Yearly

- Yearly tests are to be conducted by a certified fire alarm technician as required by The Ontario Fire Code. Tests should be in conformance with CAN/ULC S536, “Inspection and Testing of Fire Alarm Systems”.
- Voice communications between floor areas and the central alarm control facility are to be tested annually, as required for fire alarm initiating and signalling devices.
Sprinkler System (Wet)

General

- Auxiliary drains are to be inspected as required to prevent freezing

Weekly

- Except for electrically supervised valves, all valves controlling water supplies to sprinklers and alarm connections should be checked weekly to ensure that they are sealed or locked in the open position
- Water supply pressure and system air or water pressure should be checked weekly by using gauges to ensure that the system is maintained at the required operating pressure

Monthly

- On all sprinkler systems, an alarm test, using the alarm test connection located at the sprinkler valve, should be performed monthly

Two Months

- All transmitters and water flow devices should be tested at two month intervals

Six Months

- Gate-valve supervisory switches and other sprinkler system supervisory devices should be tested at six month intervals

Yearly

- Exposed sprinkler piping hangers should be checked yearly to ensure that they are kept in good repair
- Sprinkler heads should be checked at least once per year to ensure that they are kept in good repair
- Sprinkler heads should be checked at least once per year to ensure that they are free from damage, corrosion, grease, dust, paint, or whitewash. They are to be replaced where necessary as a result of such conditions
- On wet sprinkler systems, water-flow alarm test, using the most hydrostatically remote test connection, should be performed annually
- Sprinkler system water pressure should be tested annually or after any sprinkler system control valve has been operated, with the main drain valve fully open, to ensure that there are no obstructions or deterioration of the main water supply
- Plugs or caps on Fire Department connections should be removed annually and the threads inspected for wear, rust, or obstruction. Re-secure plugs or caps wrench tight. If plugs or caps are missing, examine the Fire Department connection for obstructions, back flush if necessary and replace plugs or caps
Emergency Lighting System

Daily

- Check pilot lights for indication of proper operation

Monthly

- Batteries should be inspected monthly and maintained as per manufacturer’s specifications
- Ensure that the battery surface is clean and dry
- Ensure that the terminal connections are clean, free of corrosion and lubricated
- Ensure that the terminal clamps are clean and tight as per manufacturer’s specifications
- Emergency lighting equipment should be tested monthly to ensure that the emergency lighting will function upon failure of the primary power supply

Yearly

- Emergency lighting equipment should be tested annually to ensure that the units will provide emergency lighting for duration equal to the design criteria under simulated power failure conditions
- After completion, the charging conditions for voltage and current and the recovery period will be tested annually to ensure that the charging system is in accordance with the manufacturer’s specifications
Emergency Power Systems

General

- Emergency power systems should be inspected, tested and maintained in conformance with CSA C282, “Emergency Electrical Power Supply for Buildings”.
- To ensure continued reliable operation, the emergency power supply equipment should be operated and maintained in accordance with manufacturer’s instructions
- At least two copies of the instruction manual should be maintained

Monthly

- The emergency electrical power should be completely tested monthly as follows:
  o Simulate a failure of the normal power supply
  o Arrange so that:
    ▪ An engine generator set operates under at least 30% of the rated load for 60 minutes and;
    ▪ All automatic transfer switches are operated under load
  o Include an inspection for correct function of all auxiliary equipment such as radiator shutter control, coolant pumps, fuel transfer pumps, oil coolers, and engine room ventilation controls
  o Record all instrument readings associated with the prime mover and generator and verification that they are normal
  o Log and report as further prescribed in the manual of instruction for operation and maintenance
  o Check fuel supply for sufficient quantity

Annually

- Test the generator, control panel, and transfer switch in conformance with CSA C282, “Emergency Electrical Power Supply for Buildings”.
15. Fire Alarm System and Device Information

Simplex 4100U
Single Stage Fire Panel

Automatic Devices:
- Smoke detectors
- Duct detectors
- Sprinkler heads

Manual Devices:
- Manual Pull Stations
Appendix A: Wind Tunnel Standard Operating Procedures

Wind Tunnel Standard Operating Procedures

Revision 1.1
This SOP in its entirety has been approved as of 13 November 2013.

Approved: ________________________
Andrew Gould
Facility Manager

Approved: ________________________
Chris Guglielmo
AFAR Co-Director
Table of Contents

SECTION 1: Introduction

1.1: Purpose
1.2: Responsibilities

SECTION 2: Personnel

2.1: Positions and Responsibilities
2.2: Personnel Requirements under Operational Conditions
2.3: Health and Safety Requirements for Personnel
2.4: Usage Windows
2.5: Oxygen Requirements

SECTION 3: Checklists

3.1: Wind Tunnel Pre-Flight Inspection Checklist
3.2: Wind Tunnel Post-Flight Shutdown Checklist

SECTION 4: SOPs for Normal Operations

SOP 001: Normal Operating Configuration when at Altitude – Personnel Inside
SOP 002: Normal Operating Configuration when at Altitude – No Personnel Inside
SOP 003: Plenum Entry SOP While at Altitude
SOP 004: Plenum Exit SOP While at Altitude

SECTION 5: Emergency SOPs

ESOP 001: Emergency Descent from Altitude
ESOP 002: Crash Descent from Altitude
ESOP 003: Fire Discovered Outside the Chamber
ESOP 004: Fire Detected Inside the Chamber
ESOP 005: Medical Emergency When at Altitude (External)
ESOP 006: Medical Emergency When at Altitude (Internal)
ESOP 007: Animal Emergency When Plenum at Altitude but Not Occupied
ESOP 008: Mechanical Failure – Vacuum Pump
ESOP 009: Mechanical Failure – Uncontrolled Ascent or Descent
ESOP 010: Mechanical Failure – Loss of Compressed Air
ESOP 011: Mechanical Failure – Loss of Power
ESOP 012: Mechanical Failure – Door Glass or Window Seal Leak
ESOP 013: Mechanical Failure - Flight Instruments
ESOP 014: Mechanical Failure - Communication Systems
ESOP 015: Mechanical Failure - Oxygen System
ESOP 016: Mechanical Failure – Enriched Oxygen in the Plenum

Appendix 1: Hand Signals
Appendix 2: Altitude Conversion Tables
Appendix 3: Oxygen Meter Reading – Non-enriched conditions
Revision List

v1.0  First approved copy of operating SOPs.
V1.1  Added Section 2.2 (d) regarding reduced manning for low altitude experiments
AFAR Wind Tunnel Standard Operating Procedures

* Please Note: Throughout this document, the term “altitude” refers to the apparent altitude of the depressurized chamber as indicated by the Wind Tunnel control systems.

SECTION 1: Introduction

1.1 Purpose

To provide a set of Standard Procedures governing the operation of the AFAR Wind Tunnel under both normal and emergency conditions, for the purpose of ensuring appropriate and immediate responses under potentially stressful and/or dangerous conditions.

1.2 Responsibilities

a) **Facility Co-Directors**: Responsible for the overall management and funding of the AFAR Wind Tunnel facility.

b) **Facility Manager**: Responsible for the operations and maintenance of the Wind Tunnel and facility, as well as the implementation of management direction.

c) **Supervisors and Operators**: Responsible for knowledge of and adherence to the SOPs covered in this book, as well as more general standards of Occupational Health and Safety as specified by the University of Western Ontario.

SECTION 2: Personnel

2.1 Positions and Responsibilities

a) **Wind Tunnel Operator**:

- Chief Safety Officer for any operations requiring humans at altitude
- Responsible for the operation of the Wind Tunnel Control Systems.
- Responsible for the proper training and conduct of personnel using the Wind Tunnel Facility.
- The final authority on whether an experiment will proceed in the event of equipment failure.
- In the event of equipment failure and experiment cancellation, responsible for actioning a plan to recover the plenum personnel safely.

b) **Crew Chief**:

- Second-in-command after the Wind Tunnel Operator
- Responsible for acting for the Operator so that the Operator may stay at the control desk at all times.
c) In-flight Supervisor

- Senior experimenter in the chamber under sealed altitude conditions.
- Responsible for the immediate safety of other personnel in the plenum.
- Responsible for hands-on direction of other plenum personnel in the event of emergency.
- Responsible for technical troubleshooting in the event of equipment failure on the inside of the chamber at altitude.
- Responsible for (in concert with the Operator) deciding whether to proceed with the experiment in the event of equipment failure.

2.2 Personnel Requirements under Operational Conditions

Wind Tunnel operations can be generally sub-divided into three different manning states, dependent on whether the chamber is sealed and who is contained within the chamber.

a) **Chamber Unsealed:** No excess manning required. Only the investigators involved in the experiment in progress need be present.

b) **Chamber Sealed, Animals inside:** No excess manning required unless animal care personnel need to access the chamber while it is sealed and at stable altitude. Should personnel need to access the chamber while sealed, full manning (as per bullet (c) below is required).

c) **Chamber Sealed, Personnel inside:** Four personnel are required in this configuration. A minimum of two personnel inside the sealed chamber, and two operators (Operator and Crew Chief) on the outside.

d) **Chamber Sealed, Personnel inside for less than an hour and Altitude is held to no more than 1000m:** Under these specific circumstances, the chamber may be operated with three personnel. Two personnel inside the sealed chamber and one Operator on the outside. (This specific configuration is normally used for performing animal care for organisms undergoing experiments involving ambient pressure manipulations)

* Any deviation from these manning requirements is at the sole discretion of and is the responsibility of the Facility Manager and/or Co-Directors.
2.3 Health and Safety Requirements for Personnel

If not operating at simulated altitude, no special health and safety standards need be observed.

If operating at any altitude, personnel must be cleared by a Civil Aviation Medical Examiner prior to any operations. Currently AFAR personnel have been seen by Dr. W. Bates at 190 Wortley Road (Suite 208), 519-438-5101.

The Civil Aviation Medical Certificate assessment used for Wind Tunnel altitude work is equivalent to a Category 3 certificate, costs approximately $120 (in cash), and should be renewed every 5 years or after significant changes in health.

If personnel are scheduled to be operating at altitude, they cannot have gone SCUBA diving within 48 hours prior to ascent.

Experiments that require altitudes greater than 5,500m should be limited to 25 minutes or less, and personnel involved in such experiments should not go back up in altitude for at least 48 hours post-experiment.

2.4 Usage Windows

Normal unrestricted usage windows for the altitude chamber will be during working hours, Monday through Thursday. This is to ensure maximal response in the event of an emergency situation. Altitude work at higher than 3000m is not advised on Fridays as personnel could potentially develop altitude-related symptoms over the weekend.

Usage of the altitude chamber on nights and weekends is not advisable if going above 3000m altitude, owing to anticipated longer emergency response times. Explicit permission for high-altitude usage during these times must be obtained from Dr. Chris Guglielmo.

2.5 Oxygen Requirements

Prior to any experiment, all individuals going to altitude should properly fit and leak test an appropriate size of Gentex oxygen mask and have it set up and ready in the chamber before any altitude work begins. Use of the Gentex masks is not required at all altitudes, but must be available as a secondary system even if the experimenters plan to use the Mountain High oxygen tanks. Proper mask fit and testing will be conducted as part of training by the Wind Tunnel Operator.

Below 2400m altitude (8,000ft) supplemental oxygen is not required. Personnel in the chamber are free to use or not use the oxygen systems available to them as they see fit. Above 2400m, supplemental oxygen is required to prevent any symptoms of altitude sickness from manifesting.
SECTION 3: Checklists

3.1 Wind Tunnel Pre-Flight Inspection Checklist

Note: Please refer to individual manuals or the AFAR General Manual for specific instructions as to how to carry out each of these actions.

Same Day of Experiment

☐ Power up all systems (Fan, Vacuum, Temperature, Humidity).
☐ Power up Camera Monitor and set all cameras to Continuous Recording.
☐ Open regulator valves on both Oxygen tanks. Check tank levels and change tanks if one is low.
☐ Bring Mountain High systems and Bail-out bottles into plenum, store somewhere easily accessible.
☐ Confirm Main Fan starts and goes to desired speed without hesitation or odd sounds.
☐ Confirm Vacuum system starts up on demand. Seal Inner Door and depressurize Plenum somewhat, check for leaks around seal.
☐ Confirm Chiller system cooling to operating temperature. Manually activate Heater and Mixing Valves to confirm function.
☐ Activate Steam Generator and confirm operation.
☐ Verify MUA operation.
☐ Turn on all wall-mounted oxygen regulators. Check all on-demand masks for Oxygen flow. Start up and check Mountain High tanks for Oxygen levels. Check Bail out bottle levels.
☐ Verify easy operation of Manual descent valves inside and outside the chamber.
☐ Shut down all systems and wait for experiment to begin.

Immediately Before Experiment

☐ Calibrate Oxygen sensor to ambient (with both doors and breather valve open).
☐ Calibrate variometers in Airlock and in Plenum to match altitude reading on FCS.
☐ Conduct communications check with experimenters using all communication systems in Plenum and in Airlock. Confirm with experimenters what the Primary and Secondary communication systems will be.
☐ Double check conditions and specifications of the flight with experimenters going into the Plenum before they enter.
☐ Close the 3000m-plus lock-out valve if required by experiment, otherwise ensure it is in the open position.
☐ Check for an existing data log. Rename if present and start Data Logging.
3.2 Wind Tunnel Post-Flight Shutdown Checklist

Note: Please refer to individual manuals or the AFAR General Manual for specific instructions as to how to carry out each of these actions.

☐ Shut down Vacuum system and open both airlock doors. If conditions of high humidity were used, allow the fan and MUA to run for a short period (with Breather Valve open) to clear some of the humidity. When humidity is approximately 50% or lower, shut down the rest of the systems (Fan, Temperature, Humidity).

☐ Shut off data logging. Find the data file and rename to something appropriate to the experiment. Move the file to a separate directory or to a clean (preferably freshly formatted) USB key.

☐ Stop camera recording. If needed, save the video files to the local hard drive and shut down the camera computer.

☐ Switch all wall-mounted oxygen regulators off. Close the regulators on the Mountain High system and turn off the electronics. Remove all tank systems and store appropriately. If levels are low, arrange for tanks to be filled as soon as possible.

☐ Close regulator valves on both Oxygen tanks. Check tank levels and change tanks if one is low.

☐ If the flight was above 3000m, re-open the lock-out valve in the Vacuum Pump room.

☐ Make note of any mechanical anomalies (noises, leaks, etc.) that occurred during the run for follow-up investigation.
SECTION 4: SOPs for Normal Operations

SOP 001: Normal Operating Configuration When at Altitude – Personnel Inside

Purpose: To define the normal and usual configuration of wind tunnel doors when plenum is at altitude with personnel inside.

SOP: When operating at altitude, the normal configuration of the doors to the Plenum will be that the OUTER DOOR is SEALED and the INNER DOOR is UNSEALED.

Rationale: When personnel are inside the chamber and the chamber is at altitude, the primary concern is the safety and expedient evacuation of personnel from the chamber. For this reason, the normal operating configuration of the Plenum at altitude will be to have the Outer Door sealed and the Inner door open. As such, the whole of the Tunnel structure will be depressurized (plenum and airlock).

In such a configuration there is a minimum of delay should it be necessary to evacuate personnel from the chamber (i.e. as soon as the chamber pressure is equalized to the exterior, personnel may escape. Additionally, should a hazardous condition occur within the plenum itself (e.g. potential fire), personnel may evacuate the plenum to the airlock area immediately and close the inner door to separate themselves from the hazard.
SOP 002: Normal Operating Configuration When at Altitude – No Personnel Inside

Purpose: To define the normal and usual configuration of wind tunnel doors when plenum is at altitude without personnel inside (i.e. experimental subjects only are within the chamber).

SOP: When the chamber is at altitude, but no personnel are inside (e.g. weather front studies) the normal configuration of the doors to the Plenum will be that both the OUTER DOOR and the INNER DOOR are SEALED, but that the airlock remains at ambient pressure.

Rationale: This is the only configuration that allows personnel to access the chamber while the subjects of the experiment remain at altitude. Both doors are kept sealed as this type of configuration is normally used for long term (overnight) manipulation of conditions within the plenum, and should the inner door seal fail the outer door seal should prevent catastrophic failure of the experiment and/or injury to the subjects within the plenum.

Bear in mind that should personnel need to access the chamber while at altitude (barring circumstances outlined in ESOP 007) personnel requirements from Section 2.2 c) must be observed.
SOP 003: Plenum Entry SOP While at Altitude

Purpose: To define the procedure used to gain access to the Plenum from outside the Tunnel when the Plenum is depressurized.

SOP:

a) Operator will contact Plenum personnel (if present) to advise someone will be entering the chamber.

b) Plenum personnel (if present) will close and seal the INNER DOOR using the Plenum door seal controls (yellow button on communication box).

c) Once INNER DOOR seal is verified, the Crew Chief will pressurize the airlock using the bleeders intake (yellow handle) located to the left of the OUTER DOOR. The Crew Chief will monitor the descent of the airlock using the variometer mounted inside the airlock. *(this may require assistance from the personnel inside the airlock as the vario can be difficult to see / read from outside the airlock)*

d) When the airlock pressure reaches ambient, the green light on the outside wall of the chamber should illuminate. If it does not, the Crew Chief will check the variometer and open the OUTER DOOR if the altitude is stable and close to ambient.

e) The Crew Chief will then CLOSE the bleeders intake on the OUTSIDE of the tunnel.

f) Entering personnel will enter the airlock, ensuring they have all needed equipment with them. Entering personnel will conduct a communications check with the Operator using either the wall-mount microphone or a headset (Operator's choice depending on the systems in use in the plenum).

g) Entering personnel will close and seal the OUTER DOOR (which may require help from the Crew Chief outside).

h) Airlock personnel will SLOWLY OPEN the bleeders intake on the SOUTH WALL of the airlock (above the oxygen regulators). They will observe rate of ascent using the variometer; open the bleeders intake more to ascend faster, close a little to hover if pressure changes start to hurt personnel's ears.

i) The indicator light on the inner wall of the airlock should in theory go green when the airlock pressure equals the interior pressure of the plenum. In practice, leaking air into the airlock usually keeps the airlock stable at several meters below the plenum altitude. Verify airlock altitude is stable and near to the plenum altitude and proceed to step J. If altitude is stable but not close to the operational altitude, airlock personnel will report AIRLOCK MALFUNCTION to Operator desk.

j) Airlock personnel will deflate the INNER DOOR seal using the block-and-bleed valve located on the NORTH wall of the airlock (thin yellow handle with plastic tubing attached; on the left if facing the Inner Door). Rotate the block-and-bleed valve handle 90 degrees to the 6-o'clock position and listen for air to leave the door seal (usually accompanied by the sound of the seal pulling away from the doorframe).

k) Once the seal is deflated, airlock personnel will UNLATCH and OPEN the INNER DOOR fully.
I) Prior to exiting the airlock for the Plenum, airlock personnel will ensure that the block-and-bleed valve is returned to its original position by rotating the handle 90 degrees to the 3-o’clock position.

AIRLOCK MALFUNCTION

- Operator will instruct Crew Chief to verify airlock altitude on the variometer inside the airlock and check bleeder valve positions. Operator will instruct airlock personnel to check internal bleeder valve (to ambient) to verify it is fully closed (handle perpendicular to path of flow).

- Crew Chief will verify the variometer reading, will physically verify the external bleeder intake to the airlock is fully closed and will visually double-check that the internal bleeder valve (to the plenum) is in the proper position.

- Crew Chief will listen to the outer door to verify no audible leaks are evident. If a leak is heard, Crew Chief will localize and determine if there is a quick-fix possible.

No Fault Found Action

Operator will instruct airlock personnel to descend to ambient and advise the Plenum that the airlock is out of commission. Once airlock is at ambient and personnel have exited, the Crew Chief or Operator will investigate to determine cause of failure and possible solutions.

If still no fault found, Operator and In-Flight Supervisor will discuss ramifications for experiment and make a decision on continuing or terminating the experiment and descending the entire chamber to ambient pressure.
SOP 004: Plenum Exit SOP While at Altitude

Purpose: To define the procedure used to properly exit the Plenum while keeping the Plenum depressurized. This SOP assumes the chamber is in standard operating configuration as per SOP 001.

* Note: A minimum of two personnel should remain in the Plenum at all times while at altitude. If necessary, the Crew Chief can substitute for one person on a short-term basis.

SOP:

a) The leaving personnel will enter and close and seal the INNER DOOR using the yellow control button on the wall of the airlock.
b) The bleeder valve inside the airlock, closest to the OUTER DOOR will be opened to pressurize the airlock.
c) The personnel in the airlock will monitor their descent using the variometer on the airlock wall. When the airlock reaches ambient pressure, the indicator light on the outer wall of the airlock will go green. If it does not, airlock personnel will check the variometer. If the variometer reads stable a few meters above ambient pressure then proceed to step (d), otherwise report AIRLOCK MALFUNCTION.
d) When equalization occurs, airlock personnel will open the OUTER DOOR (possibly requiring assistance from the Crew Chief) and exit the airlock.
e) If the leaving personnel will be re-entering the chamber within a short period, the airlock may remain at ambient pressure in this configuration. Re-entry will occur in accordance with SOP 003.
f) If no personnel are re-entering the chamber shortly, the Crew Chief will re-seal the OUTER DOOR and advise the Operator that the airlock is clear and sealed.
g) The Operator will instruct personnel in the Plenum to depressurize the airlock using the bleeder controls in the Plenum.
h) The Crew Chief will monitor the depressurization of the airlock using the variometer and will notify the Operator and Plenum personnel when the airlock stabilizes at close to Plenum altitude.
i) Once the airlock is near the operating altitude, the Plenum personnel will deflate the INNER DOOR seal using the block-and-bleed valve inside the Plenum.
j) Once the seal is deflated, Plenum personnel will fully open the INNER DOOR and return the block-and-bleed valve to its original position (in-line with the tubing at the 3-o’clock position).

AIRLOCK MALFUNCTION

- Operator will instruct Crew Chief to verify airlock altitude on the variometer inside the airlock and check bleeder valve positions. Operator will instruct airlock personnel to check internal bleeder valve (to ambient) to verify it is fully open (handle parallel to path of flow).
- Crew Chief will verify the variometer reading, and will visually double-check that the internal bleeder valve (to the plenum) is in the proper position (i.e. closed). The Crew Chief will then slowly open the external bleeder valve to determine if descent can be re-established.

- If descent is re-established, the Crew Chief will advise the Operator that they will be controlling the descent and will communicate with the airlock personnel via hand-signals to maintain a comfortable rate of descent.

**No Fault Found Action**

Operator will instruct airlock personnel to re-ascend to operating altitude and re-enter the Plenum. Operator will advise the Plenum personnel that the airlock is out of commission. Once airlock is at operating altitude and personnel have exited, the In-Flight Supervisor should investigate if possible to determine cause of failure and possible solutions.

If still no fault found, Operator and In-Flight Supervisor will discuss ramifications for experiment and make a decision on continuing or terminating the experiment and descending the entire chamber to ambient pressure.
Section 5: Emergency SOPs

ESOP 001: Emergency Descent from Altitude

Report: CAUTION – STARTING EMERGENCY DESCENT

Description: This is a descent controlled by the aperture of the manual emergency descent valve, which can be activated from either outside or inside the chamber. Rate of descent is proportional to the pressure differential, with a measured initial rate of descent of 38 m/s at altitudes above 6000m and decreasing in rate as the pressure approaches ambient. This maximal rate of descent has the potential to cause trauma to the eardrum or sinuses and as such descent from high altitudes should be undertaken as carefully as the situation allows. For sake of comparison, skydivers in freefall generally descend at between 50-60 m/s at terminal velocity.

From maximum altitude, an Emergency Descent should take approximately 7 to 8 minutes to reach ambient pressure.

Action:

- If applicable, notify the Plenum personnel by reporting CAUTION – STARTING EMERGENCY DESCENT
- Set FCS altitude control to OFF if activating from outside the chamber.
- If activating from inside the chamber, press an Emergency Stop button.
- Open the manual dump butterfly valve handle by rotating to the 6-o’clock position.
- Personnel inside the chamber may cover their ears firmly with their hands and keep their mouth open to lessen the chance of overpressure damage to their eardrums.
ESOP 002: Crash Descent from Altitude

Report: CRASH CRASH CRASH

Description: This is a descent at the fastest rate possible for the chamber. It allows air in through the Breather Valve, a large bore aperture in the NORTH WEST corner of the chamber. A Crash rate of descent has been measured in excess of 152 \( \text{m/s} \), significant risk of personnel injury exists during a Crash descent, both from overpressure and from light debris being tossed around by the air flow. Crash descents must ONLY be used under conditions of extreme danger to the personnel inside the chamber and only the Operator can initiate them.

Action - Operator:

- Notify Plenum personnel by reporting CRASH CRASH CRASH
- Operator will set Vacuum Pump control button to OFF.
- Operator will count to 5 to permit Plenum personnel to prepare themselves.
- Operator will set the Breather Valve Control to Open.

Action – Plenum Personnel:

- Plenum personnel will repeat CRASH CRASH CRASH to warn any personnel that did not hear or were not listening.
- Plenum personnel will immediately move to the SOUTHEAST corner of the Plenum (i.e. furthest from the Breather Valve), kneel down and face the wall. Personnel will cover their ears firmly, close their eyes firmly, and open their mouths.
- Once at ambient pressure and the immediate emergency has been dealt with, ALL personnel exposed to a Crash descent must be checked out by a medical professional for hearing damage / trauma to the inner ear.
ESOP 003: Fire Discovered Outside the Chamber

Condition: Smoke or fire is detected in either the mechanical rooms or in the Wind Tunnel Room proper OR building fire alarm sounds.

Report: EXTERNAL FIRE

Immediate Action – Chamber not at Altitude:

a) Provided it is safe to do so, personnel will exit the chamber and see if there is immediate visible danger. If smoke or fire is seen immediately, personnel will activate the nearest Fire Alarm Pull Station (on the NORTH wall of the Wind Tunnel room next to the emergency exit. If the fire is smaller than a basketball in size, personnel will attempt to fight the fire using the closest extinguisher if possible. If the fire is extinguished, personnel will report the incident immediately by calling 911 from the nearest campus phone.

b) If no evidence of fire or immediate danger exists, personnel will render their experiment safe (e.g. catch and contain birds from the wind tunnel) and exit the tunnel, closing the OUTER DOOR and the door to the tunnel room on the way out to protect any animals within. Personnel will then evacuate the building by the double doors on the NORTH wall of the wind tunnel room.

c) If immediate danger exists (e.g. heavy smoke or fire seen at the exit to the chamber), personnel will close and lock the OUTER and INNER airlock doors, inflate the INNER DOOR seal, and dial 911 from the phone inside the plenum. Report to emergency responders: situation and number of people inside the chamber. Supplemental oxygen should be used if available (i.e. if the oxygen cylinders are turned on or if the Mountain High systems are present).

Immediate Action – Chamber at Altitude:

a) Operator will report to Plenum personnel EMERGENCY: EXTERNAL FIRE, and will increase the interior lights to maximum.

b) Crew Chief will investigate source of smoke and determine whether immediate danger exists and report back to Operator. If a fire is found and is smaller than a basketball, the Crew Chief will report to the Operator and proceed to fight the fire using the nearest extinguisher. If the fire is extinguished, the Operator will immediately report the incident by calling 911. Their direction will determine whether to scrub the experiment or not.

c) If the fire is too large or impossible to fight, the Operator will activate the nearest pull station and then commence an EMERGENCY or CRASH descent as per ESOP 001 or 002 as deemed necessary.
d) If no time exists for a descent, the Operator will advise Plenum personnel that Operator and Crew Chief must evacuate. The Operator will leave the chamber systems in a stable configuration and all external personnel will evacuate the room via the nearest exit – activating the pull station if not active already. The In-flight Supervisor will immediately close and seal the INNER DOOR and call 911 from the interior phone – advising emergency personnel of the situation and number of personnel in the chamber. All personnel will go on supplemental oxygen and await rescue.

e) If no evidence of immediate danger exists, the In-flight supervisor will render the experiment safe and the Operator will initiate an Emergency Descent as per ESOP 001. The Crew Chief will close the doors to the wind tunnel room to protect the room from smoke elsewhere in the building.

f) Once returned to ambient pressure, Plenum personnel will exit the chamber and close the OUTER DOOR behind them to protect any animals within. All personnel will then evacuate the wind tunnel room via the NORTH emergency exit.

g) During Emergency Operations, the Crew Chief will maintain watch over the general area to ensure the situation does not change during descent. If the situation changes, the Crew Chief will advise the Operator who must then decide whether to initiate a Crash descent or to immediately evacuate the room (as per points (c) or (d) above).
ESOP 004: Fire Detected Inside the Chamber

Condition: Smoke or fire is detected inside the altitude chamber.

Report: INTERNAL FIRE

Immediate Action – Chamber not at Altitude:

a) If it is safe to do so, personnel will investigate the source of visible smoke. If a fire is seen or discovered and is smaller than a basketball in size, personnel will attempt to fight the fire using a nearby extinguisher. If the fire is extinguished, the incident will be reported immediately by the Operator to 911. Their direction will determine whether to scrub the experiment or not.

b) If the fire is too large or the smoke is too thick, personnel will immediately evacuate the Plenum, closing the INNER DOOR and OUTER DOOR as they exit.

c) Personnel will shut down the Main Fan and then LOGOUT of the tunnel software to shut off the MUA system and close the Breather Valve.

d) Personnel will call 911 from the Control Desk to report location and severity of the fire.

e) Personnel will then evacuate the Tunnel room by the nearest exit and activate the building alarm from the nearest pull station.

Immediate Action – Chamber at Altitude:

a) In-flight supervisor will report EMERGENCY: INTERNAL FIRE to the Plenum personnel and Operator. Operator will turn interior lights to maximum. Plenum personnel will immediately don oxygen masks.

b) In-flight supervisor will investigate source of visible smoke. If a fire is seen or discovered and is smaller than a basketball in size, Plenum personnel will attempt to fight the fire using the extinguisher in the Plenum. NOTE: Oxygen equipment must be kept as far from the source of fire as possible.

c) The Operator will turn OFF the Vacuum Pump and MUA system to limit oxygen in-flow and prepare for Crash Descent if necessary. Operator or Crew Chief will call 911 on the Control Desk phone and report the situation and number of personnel inside the chamber.

d) If the fire is too large or smoke is too thick, all Plenum personnel will immediately evacuate the Plenum into the airlock and close and seal the INNER DOOR. Personnel in the airlock will don oxygen masks if possible, open the bleeder valve to ambient fully and crouch near the floor. If airlock contains a great deal of smoke, it should be possible to clear it somewhat by opening the bleeder valve to the Plenum briefly.
e) If the fire is such that evacuation is impossible, the In-Flight Supervisor will request a Crash descent by reporting **CRASH CRASH CRASH**. The In-Flight Supervisor will repeat to the Plenum personnel **CRASH CRASH CRASH**, and personnel will prepare as per **ESOP 002**.

f) The Operator will repeat **CRASH CRASH CRASH**, and will proceed as per **ESOP 002** with a 5 second count.

g) The Crew Chief will take position at the OUTER DOOR to unseal it as quickly as possible and prepare to assist in evacuation of personnel. **NOTE: Personnel might be disoriented and/or the fire might be fueled by the inrushing oxygen. Be prepared.**

h) Once the airlock is at ambient and personnel are safely evacuated, the OUTER DOOR will be closed and all personnel will evacuate the Wind Tunnel room via the nearest exit, activating the closest pull station if not already done.
ESOP 005: Medical Emergency When at Altitude (External)

Condition: One or more personnel external to the chamber suffers a critical health event during a time where the chamber is at altitude.

Report: EXTERNAL MEDICAL EMERGENCY

Immediate Action:

a) Unaffected personnel (Operator or Crew Chief) immediately report to the Plenum EXTERNAL MEDICAL EMERGENCY.

b) Unaffected personnel do an immediate assessment of the nature of the emergency.

c) If life-saving intervention is necessary (e.g. CPR), unaffected personnel will call 911 on the Control Desk phone ON SPEAKERPHONE, and will begin intervention.

d) In-flight supervisor will assess the situation as best possible and decide whether to terminate the experiment or not. Options available would be to render the experiment safe and exit the Plenum via the airlock, or terminate the experiment and initiate an Emergency Descent via the manual valve in the Plenum.

e) Experiments cannot continue normally until the personnel requirements outlined in Section 2.2 above are re-established.
ESOP 006: Medical Emergency When at Altitude (Internal)

Condition: One or more personnel within the Plenum suffer a critical health event during a time where the chamber is at altitude.

Report: INTERNAL MEDICAL EMERGENCY

Immediate Action:

a) Unaffected Plenum personnel (if available) immediately report to the Operator INTERNAL MEDICAL EMERGENCY. Operator will increase Plenum lighting to maximum.

b) Unaffected Plenum personnel will do an immediate assessment of the nature of the emergency.

c) If life-saving intervention is necessary (e.g. CPR), unaffected personnel will call 911 on the Plenum phone ON SPEAKERPHONE, and will begin intervention.

d) If the victim is having trouble breathing, they will don or be helped to don an oxygen mask, and the regulator will be switched to 100% Oxygen.

e) Operator will assess the situation as best possible and begin an appropriate descent of the chamber.

f) Crew Chief will move to the main entrance of AFAR to rendezvous with emergency medical personnel and lead them to the chamber. Operator will be standing by to assist with evacuation as soon as chamber is at ambient.

g) If all Plenum personnel are incapacitated, Operator will immediately initiate an Emergency or Crash descent according to their best judgement. Once the chamber is descending, Operator will call 911 and report the situation. Crew Chief will stand by to assess the medical situation and begin intervention as required. Operator will rendezvous with emergency medical personnel.
ESOP 007: Animal Emergency When Plenum at Altitude but Not Occupied

Condition: During unattended altitude experiments with animals in the chamber, one or more animals show signs of distress.

Report: <not applicable>

NOTE: Owing to the personnel requirements outlined in Section 2.2 above, it is likely that animal distress will be discovered by a single individual doing periodic health checks. This person may not be qualified (medically cleared, familiar with altitude operations) to go to altitude. As such, at least one qualified individual must be found to access the chamber – preferably two. If only one qualified individual is available, they will be the one entering the chamber.

Action:

a) Once qualified individuals are present, they will assess the situation in the Plenum for probable causes of animal distress, and safety issues for entering personnel.

b) Once the situation is assessed and a plan of action is made, one qualified individual may access the Plenum following SOP 003, starting at step (f) with the other acting as Operator. NOTE: This emergency situation is the ONLY situation where a single person may access the Plenum while at altitude.

c) If only one qualified individual was found, the unqualified individual who found the animal in distress (who by definition must be at least somewhat familiar with the operations of the FCS) will act as Operator. Owing to their inexperience, the unqualified individual must be instructed to immediately begin an EMERGENCY descent by activating the outside manual descent valve if anything should go wrong inside the chamber.

d) Upon accessing the Plenum, personnel will again immediately assess whether the cause of animal distress represents a personal danger to them. If so, they will immediately reseal the INNER DOOR and descend. Once returned to ambient, the experiment will be terminated and the chamber descended to ambient to remedy the hazard.

e) If no personal danger appears to exist, Plenum personnel will proceed to remedy the cause of animal distress and as quickly as possible exit the Plenum as per SOP 004.

f) Should any emergency happen while a single person is in the Plenum, proceed with the appropriate ESOP or in the case of an unqualified Operator, immediately open the manual descent valve and evacuate the Plenum personnel ASAP.
ESOP 008: Mechanical Failure – Vacuum Pump

**Condition:** The Vacuum pump or a part of the vacuum system fails during an altitude experiment.

**Report:** VACUUM PUMP FAILED

**Immediate Action:**

a) Operator will report to Plenum personnel VACUUM PUMP FAILED and increase Plenum lighting to maximum.

b) Operator will switch the MUA system to OFF in the FCS to minimize the chamber descent rate.

c) Crew Chief will investigate and, if no obvious fault found, will switch off power to pump at either the VFD panel or the circuit breaker.

d) Operator will advise Plenum personnel of the situation and will instruct them to make safe their experiment and prepare for descent.

e) Once Plenum personnel are ready, Operator will instruct them to begin descent using the manual descent valve in the Plenum at a comfortable rate (monitored on the variometer in the Plenum window).

f) Once the chamber returns to ambient, the Crew Chief will assist in evacuation of the chamber and all the systems in the FCS will be shut down pending investigation of the mechanical failure.
ESOP 009: Mechanical Failure – Uncontrolled Ascent or Descent

Condition: Failure of one or more software or hardware components results in the chamber not responding to FCS inputs and ascending or descending uncontrolled.

Report: ALTITUDE UNCONTROLLED

NOTE: Uncontrolled ascent is the most dangerous situation for personnel inside the plenum. As such, there are two hardware valves that will open at set altitudes to prevent the chamber from ascending to dangerous altitudes. The first valve will open at ~3500m and is in place for low level altitude work and locked out for work above 3000m. The second will open at ~7500m and cannot be bypassed unintentionally.

Immediate Action:

a) Operator reports to Plenum personnel ALTITUDE UNCONTROLLED and increases Plenum lighting to maximum. Plenum personnel prepare for descent by making their experiment safe.

b) Operator immediately switches Vacuum system to OFF in the FCS.

c) If system does not respond, Operator will press the Emergency Stop on the PLC cabinet.

d) If system still does not respond (or shut down in this case) the Crew Chief will go to the Pump room and shut down the pump via the switch on the VFD or the circuit breaker.

e) Operator will advise Plenum personnel of the situation and will instruct them to make safe their experiment (if not already done so) and prepare for descent.

f) Once Plenum personnel are ready, Operator will instruct them to begin descent using the manual descent valve in the Plenum at a comfortable rate (monitored on the variometer in the Plenum window).

g) Once the chamber returns to ambient, the Crew Chief will assist in evacuation of the chamber and all the systems in the FCS will be shut down pending investigation of the mechanical failure.
ESOP 010: Mechanical Failure – Loss of Compressed Air

Condition: The compressed air system that serves the chamber goes offline.

Report: COMPRESSED AIR FAILED

NOTE: Failure of the compressed air system will most likely be detected by the unexplained actuation of all valves serving the altitude chamber and wind tunnel. All valves should be set to fail safe (i.e. to move to their safest position in the event of loss of supply air). This means that all the air inlet valves will likely fail open and make maintaining altitude impossible.

Immediate Action:

a) Operator will report to Plenum personnel COMPRESSED AIR FAILED and increase Plenum lighting to maximum.

b) Plenum personnel will immediately make safe their experiment and prepare for a possibly rapid descent.

c) Crew Chief will immediately lock out the lower altitude safety valve if not locked out already (i.e. experiment was operating at an altitude higher than 3000m). This is to limit the rate of descent to that of one dump valve not both.

d) Operator will keep the Vacuum pump running to try to moderate the descent, but the opening of the air inlet valves will overwhelm the ability of the pump to maintain altitude by a significant amount.

e) Operator and Crew Chief will stand by as the chamber comes down to ambient to assist in evacuation. Note: Depending on actual rate of descent, Plenum personnel might be disoriented and/or injured.
ESOP 011: Mechanical Failure – Loss of Power

Condition: Main electrical power to the chamber systems is lost.

Report: ELECTRICAL FAILURE

NOTE: Failure of building power will immediately result in the loss of the Main Fan, Vacuum Pump, Heating and Cooling systems, the MUA system, and most of the lights in the Plenum. Owing to the UPS and Emergency power, the FCS will remain active and the Operator will retain control of the pneumatic valves, emergency lighting in the Plenum, the Oxygen system, communications, and the door seals.

Immediate Action:

a) Operator reports to Plenum ELECTRICAL FAILURE and turns all light switches to maximum to ensure emergency lighting is active.
b) All personnel wait 1-2 minutes to see if power is restored. Operator will switch altitude control to MANUAL and set the Dilution valve to closed to limit the rate of chamber descent.
c) If power is restored, Operator will advise the Plenum personnel and will clear all FCS faults and restart all affected systems. Operator will execute an altitude hold at the present altitude.
d) Operator and In-flight supervisor will determine how they wish to proceed and the chamber settings they wish to establish for the remainder of the experiment
e) If power is not restored within a short period, Operator will instruct Plenum personnel to prepare for descent by making their experiment safe.
f) Once Plenum personnel are ready, Operator will instruct them to begin descent using the manual descent valve in the Plenum at a comfortable rate (monitored on the variometer in the Plenum window).
g) Once the chamber returns to ambient, the Crew Chief will assist in evacuation of the chamber and all the remaining systems in the FCS will be shut down pending restoration of power.
**ESOP 012: Mechanical Failure – Door Glass or Window Seal Leak**

**Condition:** A noticeable leak develops in a pressure door glass seal or window seal while the chamber is at altitude and personnel are in the Plenum.

**Report:** AIR LEAK DETECTED

**NOTE:** A minor leak will not impact the ability of the vacuum system to maintain altitude, but due to pressure differentials may potentially proceed to catastrophic failure rapidly and unpredictably. Catastrophic failure will likely lead to serious injury to personnel in the Plenum.

**Immediate Action:**

a) Personnel detecting the leak will advise the Operator by reporting **AIR LEAK DETECTED**, Operator will increase the Plenum lighting to maximum.

b) Depending on leak location, either the Crew Chief or the In-flight supervisor will investigate the source and location of the leak. Plenum personnel will make safe the experiment if at all possible.

c) If it is possible, Crew Chief will attempt to temporarily patch the leak location with whatever materials may be on hand (plastic bags, putty, etc).

d) **Further action will depend on leak location:**

i. If the leak is in the **Plenum window**, Plenum personnel will move immediately to the airlock, close and seal the INNER DOOR, and descend to ambient pressure. Once personnel are in the airlock, Operator will initiate an **EMERGENCY** descent of the plenum to ambient pressure.

ii. If the leak is in the **OUTER DOOR window**, Plenum personnel will close and seal the INNER DOOR and the Crew Chief will descend the airlock using the outer bleeder valve. Operator and In-flight supervisor will determine whether to continue the experiment or scrub it.

iii. If the leak is in the **INNER DOOR window**, any personnel in the airlock will immediately descend to ambient and exit as quickly as possible, and personnel in the Plenum will take shelter behind or in the Diffuser section of the wind tunnel (depending on whether the forward net is in place). Operator will initiate an **EMERGENCY** descent of the Plenum to ambient.

e) Should the glass catastrophically fail during this procedure, altitude will immediately return to ambient. Operator or Crew Chief will immediately call 911, advise them of the situation and immediately begin assisting casualties as appropriate.
ESOP 013: Mechanical Failure - Flight Instruments

**Condition:** Failure of a crucial sensor or software results in altitude holding steady but uncontrollable and/or the Operator has no means of determining altitude.

**Report:** INSTRUMENTS FAILED

**Immediate Action:**

a) Operator advises Plenum personnel by reporting **INSTRUMENTS FAILED** and increases Plenum lighting to maximum. Plenum personnel prepare for descent by making experiments safe.

b) Operator will press the Emergency Stop on the PLC.

c) Once Plenum personnel are ready, Operator will instruct them to begin descent using the manual descent valve in the Plenum at a comfortable rate (monitored on the variometer in the Plenum window).

d) Once the chamber returns to ambient, the Crew Chief will assist in evacuation of the chamber and all the systems in the FCS will be shut down pending investigation of the mechanical failure.
ESOP 014: Mechanical Failure - Communication Systems

Condition: One or more of the communication systems serving the chamber stop working.

Report: COMMS FAILED <SPECIFIC SYSTEM FAILED> or by hand signal / written note.

NOTE: Communications are essential to safe altitude work as such there are three separate and redundant means of communication in/out of the Plenum, and two in/out of the airlock. It is a known deficiency that the wall mounted microphones become more difficult to operate as pressure in the Plenum decreases. High altitude work should not rely on the wall microphones for communication out of the Plenum unless absolutely necessary. Ideally the telephone system should not be used for routine communication when at altitude as it might be needed in an emergency.

Immediate Action:

a) The affected person reports communication failure to the Operator by whatever means possible. Operator will inform all other personnel by reporting COMMS FAILED followed by the specific system / person affected.

b) If the failure is in the overhead speaker system, Operator will call into the Plenum on the telephones to re-establish communication. Operator and In-flight Supervisor will then determine how to proceed.

c) If the failure is in one headset, the individual may attempt to troubleshoot or switch headsets as possible, but as long as one person retains communication ability the experiment can proceed.

d) If both headsets have failed, Operator will call into the Plenum on the telephones to re-establish communication and discuss how to proceed.

e) If all communications systems between the Control Desk and Plenum have failed or are unreliable, the experiment must be scrubbed. Via hand signals or written communication, the Operator will indicate that the Plenum personnel should prepare for descent. Once the Plenum indicates they are ready, Operator will initiate a normal descent.

f) If communications are lost in the airlock, personnel should immediately switch to the other means. If it is unavailable (i.e. the overhead system is active to the Plenum and the headset has failed), the airlock personnel will proceed to the closest altitude (Plenum or ambient as applicable) and advise the Operator of the failure. Communication choices will be reworked to account for the failure and allow use of the airlock again.
ESOP 015: Mechanical Failure - Oxygen System

Condition: Some element of the supplemental oxygen system has stopped working.

Report: OXYGEN FAILED

NOTE: Above 3000m without supplemental oxygen, the potential for hypoxic symptoms exists (slow reactions, poor decision making, etc). Above 5400m there is potential for serious hypoxia with useful consciousness disappearing within 10-20 minutes with any moderate exertion.

Immediate Action:

a) Any affected personnel inform the Operator by reporting OXYGEN FAILED. The Operator will increase Plenum lighting to maximum and the Crew Chief will access the oxygen storage closet to check both tanks are on and determine tank levels.

b) If oxygen tanks are depleted, Crew Chief will inform the Operator and if a spare exists, will change out tanks.

c) If the failure is with the on-demand mask system (including tank depletion), Operator will instruct Plenum personnel to switch to Mountain High systems. If Plenum personnel appear to be having difficulty switching, Operator will begin an immediate automated descent to 2500m. If serious symptoms develop, Operator will initiate an Emergency Descent to ambient and Crew Chief will evacuate the Plenum personnel.

d) If the Mountain High system has failed, Operator will instruct Plenum personnel to switch to the on-demand mask systems. If Plenum personnel appear to be having difficulty switching, Operator will begin an immediate automated descent to 2500m. If serious symptoms develop, Operator will initiate an Emergency Descent to ambient and Crew Chief will evacuate the Plenum personnel.

e) If all oxygen systems have failed, Operator will instruct Plenum personnel to switch to on-demand mask systems (if not on them already) and breathe from the bail-out bottles attached. Operator will begin an immediate automated descent to ambient pressure, maintaining careful watch of the Plenum and initiating an EMERGENCY descent if needed.

f) Once the situation has been assessed, as long as one oxygen supply is functional the experiment can proceed if desired. If the on-demand mask system has failed and personnel are using the Mountain High systems, Crew Chief will turn off the oxygen cylinders at the regulators to prevent the possibility of leaking oxygen.
ESOP 016: Mechanical Failure – Enriched Oxygen in the Plenum

Condition: Oxygen meter shows that the Percentage of Oxygen in the Plenum atmosphere has risen above 23.5% (normal should be 20.9% – 21%)

Report: ENRICHED OXYGEN

NOTE: The oxygen sensor in the Plenum (if properly calibrated before the experiment) should read-out to the Display Monitor a constant % of oxygen and a steady decrease in Meter Reading as altitude increases. It is possible that some manipulations of the vacuum system will cause this reading to error and the % oxygen will read the same as the Meter Reading. This is not ideal and should be cause for discussion with the In-flight Supervisor.

Immediate Action:

a) Operator advises Plenum personnel by reporting ENRICHED OXYGEN and instructs them to prepare for possible pressure changes. Plenum personnel may choose to make experiments safe until the situation is remedied.

b) While leaving altitude controls in AUTO mode, the Operator will SLOWLY open the manual descent valve to let fresh air into the chamber while monitoring the % Oxygen reading. The Vacuum pump should increase RPM to maintain altitude, drawing the enriched atmosphere out of the chamber.

c) If the wind tunnel fan is not in use, the Operator may activate it to promote mixing of the atmosphere in the plenum.

d) If this does not reduce the % Oxygen stat within a few minutes, the Operator will instruct Plenum personnel to prepare for descent.

e) Once plenum personnel are ready, the Operator will initiate an automated descent at maximal rate. Crew Chief will turn off Oxygen tanks at regulators once Plenum is below 3000m to prevent possibility of a leak adding to the enriched atmosphere.

f) If at any point the % Oxygen spikes above 23.5% and climbs, the Operator will initiate an immediate EMERGENCY descent and the Crew Chief will immediately turn off the oxygen tanks at the regulators (as this is symptomatic of a leak in the system somewhere in the Plenum).
Appendix 1: Hand Signals

If communications are disrupted, the following hand signals may be used for rudimentary communication between the Plenum and Operator. Use of hand signals should be considered a fallback and/or supplementary means of communication, not a primary method.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>A clenched fist. Used to as a request to achieve a certain altitude level.</td>
</tr>
<tr>
<td>Altitude Indication</td>
<td>Can be used in conjunction with Altitude request to indicate a specific altitude (e.g. 4000m)</td>
</tr>
<tr>
<td>Descend</td>
<td>A clenched fist with thumb pointing down. Used to indicate a desire to / confirmation of descent.</td>
</tr>
<tr>
<td>Ascend</td>
<td>A clenched fist with thumb pointing up. Used to indicate a desire to / confirmation of ascent.</td>
</tr>
<tr>
<td>Level Off</td>
<td>Open hand, palm down and swept side-to-side. Used as a command from inside the chamber to halt at the current altitude (usually for ear problems).</td>
</tr>
<tr>
<td><strong>Okay:</strong></td>
<td>Used as a request / confirmation that personnel in the chamber are doing fine (e.g. during a descent).</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Problem:</strong></td>
<td>Open hand, palm down and rocked side-to-side. Followed by an indication of what the problem is (e.g. point to ears = problem equalizing pressures).</td>
</tr>
</tbody>
</table>
## Appendix 2: Altitude Conversion Tables

### Convert Meters to Feet Altitude

<table>
<thead>
<tr>
<th>Meters</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>820</td>
</tr>
<tr>
<td>500</td>
<td>1,640</td>
</tr>
<tr>
<td>1,000</td>
<td>3,280</td>
</tr>
<tr>
<td>1,500</td>
<td>4,920</td>
</tr>
<tr>
<td>2,000</td>
<td>6,560</td>
</tr>
<tr>
<td>2,500</td>
<td>8,200</td>
</tr>
<tr>
<td>3,000</td>
<td>9,840</td>
</tr>
<tr>
<td>3,500</td>
<td>11,480</td>
</tr>
<tr>
<td>4,000</td>
<td>13,120</td>
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<tr>
<td>4,500</td>
<td>14,760</td>
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<tr>
<td>5,000</td>
<td>16,400</td>
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<tr>
<td>6,000</td>
<td>19,680</td>
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<tr>
<td>6,500</td>
<td>21,320</td>
</tr>
<tr>
<td>7,000</td>
<td>22,960</td>
</tr>
</tbody>
</table>

### Convert m/s to ft/min of Climb or Descent

<table>
<thead>
<tr>
<th>Meters per Second</th>
<th>Feet per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>197</td>
</tr>
<tr>
<td>2</td>
<td>393</td>
</tr>
<tr>
<td>5</td>
<td>984</td>
</tr>
<tr>
<td>8</td>
<td>1,574</td>
</tr>
<tr>
<td>10</td>
<td>1,970</td>
</tr>
</tbody>
</table>

**Standard Military Ascent = 25 m/s (5000 ft/min)**

**Standard Military Descent = 15 m/s (3000 ft/min)**
Appendix 3: Oxygen Meter Reading – Non-enriched conditions

Oxygen Meter Reading - Non-Enriched Conditions

Curve is provided for occasions where the oxygen meter corrected percentage values error out.

Line indicates the meter reading for a non-enriched atmosphere corresponding to approximately 20.9% oxygen.

If the corrected reading errors and starts matching the meter reading as altitude increases, refer to this chart for maximum meter reading at any given altitude. If the reading is substantially over the upper (grey) line, there is a risk of oxygen enrichment in the Plenum atmosphere. Refer to Wind Tunnel ESOP 016 for proper response.