INDIANA CTSI Clinical and Translational Sciences Institute

STANDARD OPERATING PROCEDURE
Indiana CTSI Specimen Storage Facility

TITLE: STANDARD OPERATING PROCEDURE FOR THE LIQUID NITROGEN SYSTEM AND LIQUID NITROGEN FREEZER ROOM OPERATIONS

CHAPTER: 2-Facility

SOP #: SF-2-2.13

SUPERSEDES SOP #: N/A

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1. REVISION
   1.1. Significant changes incorporated in this version include:
      1.1.1. All references to Praxair were changed to "Praxair/Linde", since Linde purchased Praxair.
      1.1.2. Revised Section 4 to define alarm system management terminology and that alarming & response is managed by SF-2-4 and/or other validated alarm system & applicable SOP(s).
      1.1.3. All references to SF-2-4 and Siemens revised to align with Scope.
      1.1.4. Add Dräger PointGard 2100 monitor, related equipment manual, and Dräger PointGard Sensor (as applicable) in Step 5.3, Section 6.1.1.3.3, and Appendix A Step 4.4.
      1.1.5. Step 5.13 adds clarification of compressed air tank "for E-Stop", to reduce confusion.
      1.1.6. Replaced redundant Section 6.1.1.3.3 O_2 Monitor settings with a reference to Appendix A, where settings are also defined.
      1.1.7. Added Section 6.1.3.2 directives for Wall-Mounted O_2 Monitor troubleshooting.
      1.1.8. Step 6.2.2.1.5 directive to record all values in whole numbers was moved to Appendix C.
      1.1.9. Section 6.2.2.2 & Step 6.3.2.6.1 negative pressure directives revised to reflect new procedure.
      1.1.10. Step 6.2.2.3.1 streamlined by directing response to OOS pressure to Section 6.2.4.2.
      1.1.11. Corrected E-Stop air tank supply pressure upper limit in Sections 6.1.2.6 & 6.2.3.2.6.
      1.1.12. Add Section 6.2.3.2.10 response to high pressure on the E-Stop supply pressure gauge.
      1.1.13. Section 6.2.4.2 response to OOS pressure strengthened to improve safety.
      1.1.14. Sections 6.3.2 revised and 6.3.3 created to define entry directives for when Wall-Mounted O_2 Monitors are functioning or malfunctioning.
      1.1.15. Clarify in Section 6.3.2 that observer must be stationed directly outside the LN_2 room.
      1.1.16. Add Step 6.3.2.1.2 directive to record name of CFS after-hours watcher on Visitor Log.
      1.1.17. Added Step 6.3.4.3.1 directing that due to splashing risk while filling dewars with liquid nitrogen, donning a full face shield while filling dewars is preferred.
      1.1.18. Section 6.4 completely rewritten, reconfiguring alarm response directives to improve understanding, compliance, safety, and eliminate redundancy with Appendix F.

1.1.19. Step 6.4.6.7 revised to include reference to the Sensit personal O_2 monitors & SOP SF-3-3.
1.1.20. Section 7: Added Dräger technical support phone number & PointGard 2000 Manual.
1.1.21. Section 9: Added Appendix I, updated page totals, and updated Appendix titles
1.1.22. Appendix A revised to clarify that E-Stop activation occurs per pressure *in the LN_2 piping* and to add PointGard II and PointGard 2100 alarm parameters.
1.1.23. Appendix C revised to include directive to document values in whole numbers, remove erroneous LN_2 plumbing inspection remnant directive, and revise negative pressure verification procedure.
1.1.24. Appendix F completely rewritten to facilitate comprehension, compliance, and as follows:
    1.1.24.1. To reflect immediate response to alarm condition. Appendix I created to define SSF alarm response once personnel have evacuated low O_2 area.
    1.1.24.2. Reinstated the option to call 911 OR IUPUI Police
    1.1.24.3. Added response directives for C158A wall-mounted O_2 monitor alarm.
    1.1.24.4. CBP alarm response defined on page 2 of Appendix F as follows:
        1.1.24.4.1. Alarm response consolidated removing redundancy with Appendix H
        1.1.24.4.2. Add response to discovery of malfunctioning wall-mounted O_2 monitor.
        1.1.24.4.3. Add reminder not to enter LN_2 Room unless trained observer is stationed at LN_2 freezer room for safety purposes
        1.1.24.4.4. Further define SSF contact information

1.1.25. Appendix H revised as follows:
    1.1.25.1. Top section revised to align with CBP training appendices in other SOPs and define criticality of LN_2 freezer room safety.
    1.1.25.2. Added response to inadequate negative pressure at LN_2 freezer room entry.
    1.1.25.3. Added that LN_2 freezer room entry is prohibited unless a trained watcher is stationed at the LN_2 freezer room entrance
    1.1.25.4. Corrected Don a Personal O_2 Monitor directive to indicate that the trained watcher ensures **all personnel** working in the LN_2 room wear an O_2 monitor.
    1.1.25.5. PPE directive corrected indicating that personnel wear approved PPE per universal precautions, removing limiting directive "when accessing samples".
    1.1.25.6. Added Step 1.1.17 recommendation to don full face shield when filling dewars.
    1.1.25.7. Clarified dewar fill reporting directives for billing purposes.
    1.1.25.8. Move all alarm response directives to Appendix F to eliminate redundancy.
    1.1.25.9. To improve understanding of safety procedures, clarify that Wall-Mounted O_2 monitors measure and report O_2 levels in the vicinity of the unit and personal O_2 monitors measure and report O_2 levels around the user.
    1.1.25.10. Added wall-mounted O_2 monitor malfunction directive

1.1.26. Appendix I created to define alarm response when one or both wall-mounted O_2 Monitors are malfunctioning, and alarm response directives once personnel have evacuated low O_2 area were streamlined and relocated from Appendix F to Appendix I.

2. PURPOSE
2.1. This Standard Operating Procedure (SOP) defines the liquid nitrogen system utilized in the Indiana CTSI Specimen Storage Facility (SSF). This procedure satisfies guidance set forth in ISBER.

3. PRINCIPLE
3.1. The SSF has a hard-plumbed, vacuum-insulated, liquid nitrogen (LN_2) system that connects a 6000-gallon bulk tank to freezers to provide liquid and vapor phase nitrogen storage as a service to approved biorepositories and to provide bulk LN_2 to other IUPUI entities. This SOP defines the process for monitoring and maintaining the LN_2 system to include routine maintenance of the piping

system and safety components including emergency shut-off (E-Stop) and low oxygen alarm. Communications with the supplier, Praxair/Linde, are critical to the maintenance of the LN_2 system and are addressed in this SOP.

4. SCOPE
   4.1. The scope of this procedure includes all trained personnel, SSF Staff or personnel who are trained per SSF SOPs, who have access to the SSF Liquid Nitrogen Freezer Room. Low O_2 alarm off-site notifications are addressed in the Facility Alarm SOP (SF-2-4) and/or other validated alarm system and the SOP(s) corresponding to that alarm system.
   4.2. Alarm Management Definitions:
      4.2.1. Local Alarm: Alarm issued from equipment (audible, visual, or both)
      4.2.2. Remote Alarm: Alarm recorded and communicated from validated alarm system
      4.2.3. Alarm System: the SSF's validated alarm system
   4.3. The SOP defines routine maintenance and monitoring of the SSF hard-plumbed LN_2 system and the room in which the system is installed (C156).

5. MATERIALS
   5.1. Praxair/Linde bulk liquid nitrogen supply tank - Model Number: TM6000
   5.2. Emergency stop system by Chart – Model Number: 11665631
   5.3. Low O_2 Monitor(s) / Sensor
      5.3.1. Dräger Pointgard II, Model Number: LP3M
      5.3.2. Dräger Pointgard 2000 Series, Model Number: 2100
      5.3.3. DragerSensor O2 LS, part 6809630
   5.4. Personal Low O_2 Monitoring Devices – Manufactured by Dräger
   5.5. Emergency escape breathing apparatus units - Dräger QuickAir, 5 Minute, 4054953
   5.6. Cryo approved gloves
   5.7. Face Shield or Safety Goggles
   5.8. Cryo approved apron
   5.9. Protective gloves from cold temperatures
   5.10. E-Stop 3-way solenoid valve (Make: Braas Company, item #: 11785288 or equivalent)
   5.11. E-Stop regulator (.125 FPT 7-125 psi filter and gauge (Make: Braas Company, item #: 11668410 or equivalent)
   5.12. E-Stop / Mixed air tank regulator (Make: Praxair ProStar Platinum, Model: PRS1003 or equivalent)
   5.13. Praxair/Linde UN1002 compressed mixed air tanks (Size medical K) for E-Stop

6. PROCEDURE (Components of the Liquid Nitrogen System are described in Appendix A)
   6.1. **Maintenance**
      6.1.1. Quarterly
         NOTE: Quarterly does not represent a calendar quarter and is defined in SF-1-1 SOP for Writing, Reviewing, and Maintaining SOPs.
         6.1.1.1. SSF Staff checks the pipes and transfer hoses for all in service, functional units as follows:
            6.1.1.1.1. Check status of connections to determine if they are secure and tightened. Press "Start Fill" button on unit monitor and look for LN_2 leaks in the connections. If no leaks present, stop fill (if unit does not need to be filled based on digital reading). If there are leaks present, use a wrench to tighten connection. If the leak is not corrected notify SSF Management.
            6.1.1.1.2. Check integrity of hoses to determine if they are intact.

6.1.1.1.3. Record observations and actions on the LN_2 SYSTEM MAINTENANCE LOG: QUARTERLY ASSESSMENT (Appendix B1).
6.1.1.1.4. File records as described in Section 8.

6.1.1.2. If a functional unit is not present at a given location (i.e. the unit is either out of service or there is no unit at that location), mark as "N/A" for the connection status on Appendix B1. The integrity of the hoses, if present, must still be evaluated.

6.1.1.3. Calibrate Low O_2 Alarms
6.1.1.3.1. Notify IUPUI Environmental Health and Safety to calibrate the wall-mounted Low O_2 monitors.
6.1.1.3.2. Record their actions and results on the Appendix B1. File records as described in Section 8.
6.1.1.3.3. After IUPUI Environmental Health and Safety completes calibration, SSF personnel must verify parameters have been returned to SSF defined settings per Appendix A. Refer to the Dräger PointGard II and Dräger PointGard 2000 Series Operating Manuals as needed.

6.1.2. Annually
6.1.2.1. Schedule Campus Facilities Services (CFS) to assist with Step 6.1.2.4.
6.1.2.2. Confirm that Praxair/Linde has scheduled and completed the annual maintenance prior to due date.
6.1.2.2.1. Once completed, obtain documentation of performance from Praxair/Linde.
6.1.2.2.2. Document completed or not completed on the LN_2 SYSTEM MAINTENANCE LOG: ANNUAL ASSESSMENT (Appendix B2).
6.1.2.2.3. File records (to include Praxair/Linde-supplied documentation) as described in Section 8.

NOTE: Allow approximately 4 hours for completion of Steps 6.1.2.3 – 6.1.2.6.

6.1.2.3. Check external emergency shut-off valve as follows:
6.1.2.3.1. Check that the valve can be turned by hand.
6.1.2.3.2. Check that the flow of LN_2 liquid is stopped when the valve is in the off position.
6.1.2.3.2.1. Turn valve off.
6.1.2.3.2.2. Open dewar fill outlet and dispense residual LN_2 into a dewar.
6.1.2.3.2.3. LN_2 will stop dispensing when lines are empty, confirming that the valve is functional.
6.1.2.3.2.4. Close the dewar fill outlet.
6.1.2.3.2.5. Re-open the external emergency shut-off valve.

6.1.2.3.3. Record results and actions on the Appendix B2. File records as described in Section 8.

6.1.2.4. Check three internal vacuum piping valves as follows:
6.1.2.4.1. Supervise CFS personnel verifying that valves can be turned by hand.
6.1.2.4.2. Check that the flow of LN_2 liquid is stopped when the valve is in the off position.
6.1.2.4.2.1. Request that CFS personnel turn valve off.
6.1.2.4.2.2. SSF personnel open dewar fill outlet and dispense residual LN_2 into a dewar.

6.1.2.4.2.3. LN_2 will stop dispensing when lines are empty, confirming that the valve is functional.
6.1.2.4.2.4. SSF personnel close the dewar fill outlet.
6.1.2.4.2.5. Request that CFS personnel re-open the internal piping valve.
6.1.2.4.2.6. Repeat for other two valves.

6.1.2.4.3. Record name of assisting CFS personnel on Appendix B2.
6.1.2.4.4. Record results and actions on Appendix B2. File records as described in Section 8.

6.1.2.5. Check all seventeen valves connecting to the transfer hoses.
6.1.2.5.1. Check that valves can be turned by hand.
6.1.2.5.2. Check that the flow of LN_2 liquid is stopped when the valve is in the off position. Note: If a functional unit is not present at the location, connect a transfer hose to perform the assessment and dispense the LN_2 into a Dewar.
6.1.2.5.2.1. Turn valve off.
6.1.2.5.2.2. Disconnect transfer hose from LN_2 freezer at the freezer end.
6.1.2.5.2.3. Allow any remaining LN_2 from the transfer hose to empty into a dewar.
6.1.2.5.2.4. The LN_2 will stop draining from the transfer hose once the residual LN_2 is cleared making it possible to confirm that the valve is functional.
6.1.2.5.2.5. Reconnect the transfer hose to the freezer (if functional unit is present).
6.1.2.5.2.6. Re-open valve and check for leaks.
6.1.2.5.2.7. Repeat for other sixteen valves.
6.1.2.5.2.8. Remove transfer hose as applicable.

6.1.2.5.3. Record results and actions on Appendix B2. File records as described in Section 8.

6.1.2.6. Check E-Stop function.
6.1.2.6.1. Press red plunger button to activate E-Stop and note the time.
6.1.2.6.2. Using an empty dewar at the LN_2 fill station, dispense residual LN_2 into a dewar from the transfer hose at the filling station.
6.1.2.6.3. Observe that LN_2 liquid stops dispensing within a maximum of 10 minutes after activation of the E-Stop.
6.1.2.6.4. Reset the E-Stop by pulling out the mushroom button and press the reset button on the Chart Controller inside C156. After resetting the E-Stop ensure that the associated compressed air cylinder continues to exhibit a delivery air pressure between 500-680 kPa and supply pressure between 300-2200 psi.
6.1.2.6.5. If results meet acceptance criteria, record on Appendix B2. File records as described in Section 8.
6.1.2.6.6. If results fail to meet acceptance criteria, proceed as follows:
6.1.2.6.6.1. Anytime C156 is accessed by anyone, assign trained personnel to be posted outside the facility near the manual LN_2 valve on the bulk LN_2 tank to turn the valve manually should the need arise. Personal cell phones or the SSF's non-SOP-driven walkie talkies are used for communication

between personnel watching staff working in C156 and personnel stationed at the bulk tank.

6.1.2.6.6.2. Inform the SSF Director (or designee) and wait approximately 4 hours to repeat the steps defined above.

6.1.2.6.6.3. Document the results of the second test.

6.1.2.6.6.3.1. If the second test met acceptance criteria, the final assessment may be considered as a passing result.

6.1.2.6.6.3.2. If the second test failed to meet acceptance criteria, contact the SSF Director and Praxair/Linde.

6.1.2.6.7. Repeat testing for other red plunger button and document results as defined above.

6.1.3. As Needed

6.1.3.1. E-Stop Replacement Parts

6.1.3.1.1. Per vendor, Cryogenic Support Systems, and equipment manual recommendation, one 3-way solenoid valve and one regulator / filter should be available on site in the event of an e-stop failure.

6.1.3.1.2. Replacement parts will be maintained in or near the E-Stop system control box, located in C156, or in the supply closet in C156 (C156A).

6.1.3.1.3. A failed solenoid valve or regulator / filter may be replaced by CFS personnel per Cryogenic Support Systems.

6.1.3.2. Wall-Mounted O_2 Monitor Troubleshooting

6.1.3.2.1. The first troubleshooting step for a malfunctioning PointGard II or 2000 Series unit is replacement of the monitor's sensor (per the equipment manual). Best practice is keeping one DragerSensor O_2 LS sensor on hand.

6.1.3.2.2. Note: PointGard IIs are obsolete, cannot be repaired, and must be replaced if replacing the sensor did not rectify malfunction. Replace unit with the Drager PointGard 2000 series monitor.

6.1.3.2.3. Contact Drager technical support and provide the monitor's make (PointGard 2000 Series) and the sensor's serial number (format is likely 4 letters - 4 numbers (XXXX-####))

6.1.3.2.4. Post signage at the impacted monitor denoting that repair is underway.

6.1.3.2.5. Access to the LN_2 freezer room(s) and C158A during monitor malfunction is per Section 6.3.3.

6.2. **Routine Monitoring**

6.2.1. Initial/Annual Re-Evaluation

6.2.1.1. Establish LN_2 use expectations as defined on LN_2 System Expected Use Range Calculation Instructions (Appendix D):

6.2.1.1.1. Record value obtained as the "expected use standard" and use as comparison.

6.2.1.1.2. Re-evaluate the standard annually (or sooner if an unexplainable/unexpected change occurs). The specific weeks chosen are not defined.

6.2.1.1.3. Record results and actions on the Excel spreadsheets as described in Appendix D. A template for the Excel spreadsheet is provided in Appendix D. File records as described in Section 8.

6.2.2. Daily

6.2.2.1. Check the LN_2 level in the bulk supply tank by reading the analog gauge located near the bulk tank or via the alarm system per alarm system SOP.

NOTE: It is only permissible to obtain bulk supply tank level from the alarm system IF bulk tank level reconciliation has been completed per Section 6.2.4 within the past 6 weeks, verifying that differential between level reported by the alarm system and level from the bulk tank's analog gauge meets defined acceptance criteria.

6.2.2.1.1. If the level is above 45 inches, no action is required.

6.2.2.1.2. If the level is below 45 inches, contact Praxair/Linde to request replenishment and anticipated delivery date.

6.2.2.1.3. NOTE: Per Praxair/Linde personnel, Praxair/Linde considers low LN_2 level acceptance criteria to equal 20". Therefore, while Praxair/Linde does monitor level, they will not automatically schedule an LN_2 fill at 45".

6.2.2.1.4. If the level is below 35 inches proceed to SF-1-10 SOP for Out of Specification Condition and Notification Management.

6.2.2.1.5. Record the current level and the difference from the previous scheduled workday. Indicate if the amount of LN_2 usage calculated is within the applicable expected use range and document any actions on the monitoring log (See LN_2 System Daily Use / Weekly and Monthly System Check Log (Appendix C). File records as described in Section 8.

6.2.2.1.5.1. Mark "NA" if the day before was:

6.2.2.1.5.1.1. Not a scheduled workday

6.2.2.1.5.1.2. A day off for weather conditions

6.2.2.1.5.1.3. The day following a holiday

6.2.2.1.5.1.4. The first day of the work week

6.2.2.1.5.2. Or, the bulk tank was filled since the last daily level check

6.2.2.1.6. Notify the SSF Director if an unexplainable increase in usage (>2SD from that calculated in Step 6.2.1.1.3) is noted.

6.2.2.1.7. Praxair/Linde monitors the bulk supply tank level via a cellular modem connection.

6.2.2.2. Check for negative pressure differential as indicated by the Ball in Wall (BIW) comparing C156 to C158A and C156 to C199.

6.2.2.2.1. Observe whether BIW in C156 to C158A is visible in C156 (yes = negative pressure = expected result). Record on Appendix C.

6.2.2.2.2. Observe whether BIW in C156 to C199 is visible in C156 (yes = negative pressure = expected result). Record on Appendix C.

6.2.2.2.3. If either of above observations are "no":

6.2.2.2.3.1. Notify SSF Management.

6.2.2.2.3.2. Notify Campus Facility Services.

6.2.2.2.3.3. Post sign indicating that repairs are underway.

6.2.2.2.3.4. Record actions on Appendix C.

6.2.2.2.4. When resolved, remove signage.

6.2.2.3. Check the LN_2 pressure in the bulk supply tank by reading the analog gauge located near the bulk tank or via the alarm system (per alarm system SOP).

NOTE: It is only permissible to obtain bulk supply tank pressure from the alarm system IF bulk tank *level* reconciliation has been completed as directed in Step 6.2.2.1 and per Section 6.2.4 within the past 6 weeks.

6.2.2.3.1. Record the pressure reading on Appendix C.

6.2.2.3.1.1. If outside of expected range (25-40 psig), proceed to Section 6.2.4.2 and record actions on Appendix C.

6.2.3. Weekly

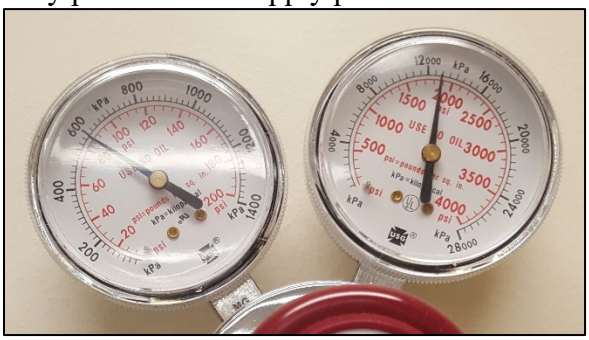
6.2.3.1. Check piping in LN_2 room for any visible leaks.

6.2.3.1.1. Look for frost rings which indicate a LN_2 leak.

6.2.3.1.2. Record on LN_2 Weekly System Check (Appendix G).

6.2.3.1.2.1. If frost rings are present, notify SSF Management.

6.2.3.2. Check delivery pressure and supply pressure of the E-Stop system air cylinder tank.



6.2.3.2.1. **Delivery Pressure:** Read the left-hand gauge of the compressed air tank connected to the E-Stop system.

6.2.3.2.1.1. The compressed air tanks are located next to the Chart Controller in C156.

6.2.3.2.2. If the reading is between 500-680 kPa, no action needs to be taken.

6.2.3.2.3. If the reading is <500 kPa:

6.2.3.2.3.1. Change out the spent compressed air tank with the backup compressed air tank.

6.2.3.2.3.2. Contact Praxair/Linde to order an additional cylinder to replace the backup cylinder.

6.2.3.2.4. Record results and actions on Appendix G.

6.2.3.2.5. A tank regulator ensures that pressure does not exceed 680 kPa. Should the regulator malfunction and pressure exceed 680 kPa:

6.2.3.2.5.1. Post a sign to not enter C156.

6.2.3.2.5.2. Notify SSF Management and proceed to SF-1-10.

6.2.3.2.5.3. Contact Choice Mechanical or Cryogenic Support Systems to evaluate and/or repair e-stop system.

6.2.3.2.6. **Supply Pressure:** Read the right-hand gauge of the air tank connected to the E-Stop system.

6.2.3.2.7. If the reading is between 300-2200 psi, no action needs to be taken.

6.2.3.2.8. If the reading is <300 psi:

6.2.3.2.8.1. Change out the spent mixed air tank with the backup mixed air tank.

6.2.3.2.8.2. Contact Praxair/Linde to order an additional cylinder to replace the backup cylinder.

6.2.3.2.9. Low supply pressure in the air tank will cause the E-Stop system to shut down, discontinuing LN_2 supply to C156.

6.2.3.2.10. If reading is >2200 psi:

6.2.3.2.10.1. Close supply valve on the air tank.

6.2.3.2.10.2. Change out the air tank with the backup mixed air tank.

6.2.3.2.10.3. Notify SSF Management and proceed to SF-1-10.

6.2.3.2.10.4. Contact Praxair/Linde to replace tank.

6.2.3.2.11. Record results and actions on Appendix G.

6.2.4. After each bulk supply tank fill or as needed

6.2.4.1. Check the gauge on the bulk supply tank as follows:

6.2.4.1.1. Check the LN_2 supply level, obtained from the analog gauge at the bulk tank, measuring in inches of water.

6.2.4.1.1.1. LN_2 Supply level values are recorded in inches of water column, with approximation of pressure recorded the nearest whole number.

6.2.4.1.2. Compare the level from the tank to the alarm system level, if applicable.

6.2.4.1.2.1. If the difference is < 7.0 inches, no action is required.

6.2.4.1.2.2. If the difference is > 7.0 inches, notify the SSF Director.

6.2.4.1.3. Record results (rounding to the nearest whole number) and actions on Appendix E. File records as described in Section 8.

6.2.4.2. Pressure level

6.2.4.2.1. Check the bulk supply tank pressure level, measured in psig.

6.2.4.2.1.1. Normal pressure range is 25-40 psig. No action is required if the pressure level on the tank is within this range.

6.2.4.2.1.2. If pressure is above 40 psig:

6.2.4.2.1.2.1. Activate E-Stop

6.2.4.2.1.2.2. Post signage indicating that LN_2 freezer room entry is prohibited and notify impacted personnel.

6.2.4.2.1.2.3. Turn off LN_2 supply at LN_2 bulk tank.

6.2.4.2.1.2.4. Notify Praxair/Linde to release pressure and resolve issue.

6.2.4.2.1.2.5. Re-entry prohibited until pressure meets acceptance criteria. Re-entry may occur prior to Praxair/Linde inspection IF pressure meets acceptance criteria.

6.2.4.2.1.2.6. Document OOS condition per SF-1-10.

6.2.4.2.1.3. If pressure is below 25 psig, contact Praxair/Linde, notify SSF Management, and document OOS condition per SF-1-10.

6.2.4.2.2. Record results and actions on LN_2 Systems Post-Fill Observation Log (Appendix E). File records as described in Section 8.

6.3. Entry Into LN_2 Freezer Room

6.3.1. An authorization for access is obtained as described in the Controlled Access Operations SOP SF-2-3.

6.3.2. During operations in which *all Wall-Mounted O_2 Monitors are functioning as expected*, before staff enter the LN_2 Freezer Room, perform the following:

6.3.2.1. Post an observer at the C158A/C156 door to monitor personnel who have entered the LN_2 freezer room. The observer must be stationed directly outside the LN_2 freezer room.

6.3.2.1.1. Prior to serving as an observer, the individual must receive verbal instruction on emergency response procedures per Section 6.4 and Appendix F of this SOP, unless the observer has documented training on the current required version of SF-2-2.

6.3.2.1.2. CFS personnel may serve as observers after hours. Record name of observer on Visitor Log, SF-2-3 Appendix D.

6.3.2.2. Obtain a personal O_2 monitor for each personnel entering the room according to the following priorities and exceptions:

6.3.2.2.1. If the number of personnel entering the LN_2 Freezer Room at a given time exceeds the number of functional O_2 monitors, the personal O_2 monitors will be utilized by personnel who will:

6.3.2.2.1.1. Be in the LN_2 freezer room for the longest duration AND

6.3.2.2.1.2. Have the closest proximity to an open liquid nitrogen source.

6.3.2.2.2. If the number of functional O_2 monitors fall below 2, entry into the LN_2 freezer room will be limited to 1 personnel unless a deviation is approved by SSF Management and IUPUI Environmental Health and Safety.

6.3.2.3. If there are available additional unused personal O_2 monitors, personnel entering the LN_2 Freezer Room will wear a low O_2 monitor until either (a) all personal O_2 monitors are in use or (b) each person in the LN_2 Freezer Room is wearing a personal O_2 monitor. Priorities are as described in Step 6.3.2.2.1.

6.3.2.4. Verify that the oxygen level on the low O_2 alarm registers above 19.5%,

6.3.2.5. Verify that the bulk liquid nitrogen tank is not being filled (DO NOT ENTER WHILE THE BULK TANK IS FILLING DUE TO POTENTIAL FOR WHITE OUT CONDITION IF THE SYSTEM MALFUNCTIONS).

6.3.2.6. Verify negative pressure differential by observing that the Ball in Wall (BIW) indicator is visible on the C156 side of the wall and NOT IN C158A.

6.3.2.6.1. If negative pressure is inadequate, follow Section 6.2.2.2 directives.

6.3.3. Entry is limited per the following directives when <u>*Wall-Mounted O_2 Monitor(s) Malfunction*</u>:

6.3.3.1. Malfunction of C158A Wall-Mounted O_2 Monitor:

6.3.3.1.1. Personnel may continue working in C158A, since the personal O_2 monitors housed below the monitor will continue measuring O_2 level in its vicinity.

6.3.3.1.1.1. Station a personal O_2 monitor as close as possible to the malfunctioning monitor to measure O_2 level in its vicinity.

6.3.3.1.1.2. Personnel access to C156 is thereby limited based on the remaining number of available personal O_2 monitors per Section 6.3.2.2.

6.3.3.1.2. Personnel may continue accessing C156.

6.3.3.1.3. Alarm response is per Appendix F, *Emergency Contacts, Wall-Mounted Low O_2 Monitors Immediate Actions & Response, and Collaborating Biobank Personnel (CBP) Alarm Response and Malfunction Response Directives*.

6.3.3.2. Malfunction of LN_2 Freezer Room Wall-Mounted O_2 Monitor(s):
6.3.3.2.1. Post signage at LN_2 Freezer Room entry doors stating that "LN_2 Freezer Room access is restricted - See SSF personnel," or similar.
6.3.3.2.2. Rescind CBP access to the LN_2 Freezer Room per SF-2-3 until both wall-mounted O_2 monitors are functioning as expected.
6.3.3.2.3. Notify CBP of safety issue and that CBP access is only permitted with SSF assistance and SSF watcher until both wall-mounted O_2 monitors are functioning as expected. Provide CBP with safe access directives via notification email and in person when accessing facility.
6.3.3.2.4. Place a personal O_2 monitor as close as possible to the malfunctioning monitor to measure O_2 level in its vicinity.
6.3.3.2.5. Personnel access is limited based on the remaining number of available personal O_2 monitors.
6.3.3.2.6. Only SSF personnel can serve as safety watchers.
6.3.3.2.7. Alarm response is per Appendix I.

6.3.4. Personnel entering the cell repository must comply with the following directives:
6.3.4.1. Gown and glove per universal precautions when accessing samples or performing freezer monitoring or maintenance.
6.3.4.2. Wear a personal O_2 monitor. (See Drager Pac 5500 Personal O_2 Monitor SOP SF-3-15)
6.3.4.3. When working with liquid nitrogen in the liquid phase, wear chemical splash goggles or a full face shield; wear approved cryogenic gloves and an apron.
6.3.4.3.1. Since splashing can occur while filling dewars with liquid nitrogen, donning a full face shield while filling dewars is preferred.
6.3.4.4. When working with liquid nitrogen in the vapor phase, wear appropriate heavy gloves (i.e. nitri-flex lite gloves, cryogloves, or similar).
6.3.4.5. Personnel accessing samples should minimize sample exposure to room temperature by returning racks to the LN_2 freezers as soon as possible.

6.3.5. Instruct visitors to don lab coat, gloves, face or eye protection, and personal low oxygen monitor if indicated in Section 6.3.2.2. Provide information regarding alarm locations, alarm responses, LN_2 safety precautions, and emergency escape breathing apparatus units before entering the LN_2 freezer room.

6.4. **SSF Alarm Actions and Response**
6.4.1. Emergency Contacts, Wall-Mounted Low O_2 Monitors Alarm Immediate Actions & Response, and Collaborating Biobank Personnel (CBP) Alarm Response and Malfunction Discovery Directives are defined in Appendix F.
6.4.1.1. While the Table of Contents and SOP SF-1-6 for Controlled Document Management define that Appendix F is posted at SSF LN_2 freezer rooms and adjacent spaces, the following table defines locations for posting each page of Appendix F. NOTE: Appendix F Pages 1, 2, and 7 are not required postings.

Page	Title	Posting Requirement
1	Appendix F Table of Contents	Not posted
2	Collaborating Biobank Personnel Alarm Response and Malfunction Response Directives	Not posted
3	Immediate Alarm Response for Personnel Working in LN_2 Freezer Room	At each wall-mounted O_2 monitor in an LN_2 freezer room
4	Alarm Actions & Response for Staff Monitoring Personnel Working in LN_2 Freezer Room	At LN_2 freezer room entrances
5	Immediate Alarm Response for C158A Wall-Mounted O_2 Monitor	At the wall-mounted O_2 monitor in R3-C158A
6	Alarm Actions & Response following alarm on C158 Wall-Mounted O_2 Monitor	At each entrance to R3-C158A
7	SSF Personnel Response to C158A Wall-Mounted Low O_2 Monitor - SSF Personnel Follow-Up Actions	Not posted
8	Emergency Contacts	At LN_2 freezer room entrances

6.4.2. Appendix I defines *SSF Wall-Mounted Low O_2 Monitors Alarm Monitoring / Notification and Alarm Malfunction Response Actions*, and Appendix I directives are followed only once Appendix F directives have been carried out.

6.4.2.1. Response to wall-mounted low O_2 monitor alarms (whether functional or malfunctioning) is per Appendix I. Directives are applicable only once all personnel have vacated the low O_2 area.

6.4.3. Personal low O_2 monitor alarm response

6.4.3.1. If the audible and/or vibrating alarm activates, stop all activity and move away from the nitrogen source.

6.4.3.2. Check O_2 monitor on wall to verify that reading is greater than or equal to 19.5%.

6.4.3.3. Once confirmed that the room O_2 is within acceptable range above, press the green OK button to silence the audible alarm.

6.4.6.3.1. Personal O_2 monitor alarm will not clear until it's reading ≥19.5% O_2.

6.4.6.4. Once the personal O_2 monitor is within range and is not in alarm, resume activities.

6.4.6.5. If alarm recurs more than two times successively, vacate the room. Verify the O_2 level in room is within range.

6.4.6.5.1. If O_2 level is demonstrated to be adequate by the wall mounted oxygen monitors, obtain an alternate O_2 monitor and return to room.

6.4.6.6. CLARIFICATION: Best practice is for O_2 monitors to be worn near the user's head. On occasion, personal O_2 monitors will alarm because the monitor's air intake has been obstructed or a monitor suspended from around the neck descends into an LN_2 freezer. O_2 monitors should NOT be placed in the user's pocket and should NOT be worn suspended by the lanyard from around the user's neck. Personal O_2 monitor alarm response is per Steps 6.4.4.1 – 6.4.4.5.

6.4.6.7. Operation of the low oxygen monitors is described in the Sensit P100 Personal O_2 Monitors SOP, SF-3-3, and the Drager Pac 5500 Personal O_2 Monitors SOP, SF-3-15.

6.4.7. **CBP Alarm Actions and Response** - Refer to Appendix F and Appendix H, Collaborating Biorepository Personnel Training.

6.5. **Liquid Nitrogen Dispensation**

6.5.1. Requests to fill LN_2 Dewars are completed as follows:

6.5.1.1. PI staff submit LN_2 requests to SSF staff (which may be hard copy or web-based) to include the following:

6.5.1.1.1. Number of dewars to be filled.

6.5.1.1.2. The size of the dewar(s) to be filled.

6.5.1.1.3. Date and time requested for fill.

6.5.1.1.4. Contact person's email.

6.5.1.2. Weigh the dewar on the scale before dispensing LN_2.

6.5.1.3. Weigh the dewar after the dispensing is completed.

6.5.1.4. Calculate the pounds (lbs) of LN_2 used.

6.5.1.5. Invoice per the IUSOM recharge policy for the LN_2 rate.

6.5.1.6. Note: Invoicing policies and rates are determined by the Operations Oversight Committee and approved by Indiana University.

6.5.2. If LN_2 fails to be dispensed

6.5.2.1. Check that the E-stop is not activated.

6.5.2.2. Confirm adequate delivery and supply air pressure in the E-stop compressed air cylinder (refer to Section 6.2.3.2 for instructions on how to confirm and corrective actions).

6.5.2.3. Confirm adequate LN_2 pressure in the supply tank (refer to Section 6.2.4.2 for instructions on how to confirm and corrective actions).

6.5.3. If LN_2 still fails to be dispensed, notify SSF Management.

6.6. **Non-Routine Monitoring**

6.6.1. Documentation of OOS conditions that occur at times other than routine monitoring which DO NOT generate an alarm is optional.

7. REFERENCES

7.1. ISBER Best Practices (current version)

7.2. Campus Facilities Services (CFS) Switchboard: 317-278-1900

7.3. Choice Mechanical: 317-885-0200, Toll Free 1-877-885-9200 or www.choicemechanical.net

7.4. Cryogenic Support Systems: 765-884-0031; 5790 N 100 E Fowler, Indiana 47944

7.5. IUPUI Police: 317-274-7911

7.6. Dräger technical support at 800-437-2437

7.7. Dräger PointGard II Operating Manual

7.8. Dräger PointGard 2000 Series Operating Manual

7.9. Praxair/Linde Local: 317-554-2200; National: 1-800-772-9247

8. DOCUMENTATION

8.1. LN_2 System and LN_2 Freezer monitoring logs are reviewed by SSF Management and are maintained per SF-1-6 Controlled Document Management SOP.

8.2. LN_2 System and LN_2 Freezer maintenance logs (including Praxair/Linde supplied documentation) are reviewed by SSF Management and are maintained for two years in the SSF Operations Office per SF-1-6 Controlled Document Management SOP.

8.3. Deviations are managed and documented per SF 1-9 Deviation Management SOP

8.4. Storage space in the SSF LN_2 Room or Liquid Nitrogen freezers is managed as defined per SOP SF-1-4 Managing Storage Space.

9. APPENDICES
   9.1. The current version of each of the following appendices is used to guide and/or implement this SOP:
   - Appendix A: Components of the Liquid Nitrogen System (2 Pages)
   - Appendix B1: LN_2 System Maintenance Log - Quarterly Assessment (1 Page)
   - Appendix B2: LN_2 System Maintenance Log - Annual Assessment (2 Pages)
   - Appendix C: LN_2 System Daily Use/Weekly and Monthly System Check Log (1 Page)
   - Appendix D: LN_2 System Expected Use Range Calculation Instructions (2 Pages)
   - Appendix E: LN2 Systems Post-Fill Observation Log (1 Page)
   - Appendix F: Emergency Contacts, Wall-Mounted Low O_2 Monitors Immediate Actions & Response, and Collaborating Biobank Personnel (CBP) Alarm Response and Malfunction Response Directives (8 Pages)
   - Appendix G: LN_2 Weekly System Check (1 Page)
   - Appendix H: Collaborating Biorepository Personnel Training (2 Pages)
   - Appendix I: SSF Wall-Mounted Low O_2 Monitors Alarm Monitoring / Notification and Alarm Malfunction Response Actions (2 Pages)

10. COLLABORATING BIOBANK TRAINING DIRECTIVES
   10.1. CBP comply with Read and Understand training on SOP SF-2-2, SOP for LN_2 System and LN_2 Freezer Room Operations per SF-2-3, SOP for Controlled Access Operations, by continuing to and reading **Collaborating Biorepository Personnel Training,** Appendix H, of this SOP.
   10.2. CBP comply with directives defined in Appendix H.

Components of the Liquid Nitrogen System

1.0 Bulk Supply Tank

1.1 The liquid nitrogen (LN_2) is stored in a bulk supply tank to the exterior and adjacent to the LN_2 Freezer Room (C156).

1.1.1 The key to access the LN_2 bulk tank is located in the SSF Management Office.

1.1.2 The manual shut off is located outside of the building to the eastside of room C156 in the LN_2 Bulk Supply Gate on the left, bottom side of the tank and is labeled as such.

1.2 Bulk Supply Source

1.2.1 Liquid nitrogen is supplied by Praxair/Linde Healthcare Services at 144 Polco Street, Indianapolis, IN 46222; 1-800-PRAXAIR.

1.2.1.1 Praxair/Linde is contracted to monitor and replenish the supply when the bulk tank reaches a defined level.

1.2.2 Remote access for monitoring the LN_2 level of the bulk tank is provided via the alarm system.

2.0 LN_2 Piping

2.1 The LN_2 is piped into the building via vacuum-insulated piping.

2.1.1 The piping runs through the room with the venting point being at the highest level.

2.1.2 The piping has separately controlled access valves.

2.2 The LN_2 is dispersed into transfer hoses which connect to the liquid nitrogen freezers.

3.0 E-Stop System

3.1 The E-Stop System is located inside the liquid nitrogen freezer room on the south wall.

3.1.1 The E-Stop system is connected to the bulk tank. A solenoid valve stops the supply of LN_2 to the vacuum-insulated piping when there is a loss of pressure. The valve opens and closes based on pneumatic activation of pressure supplied by a compressed air tank.

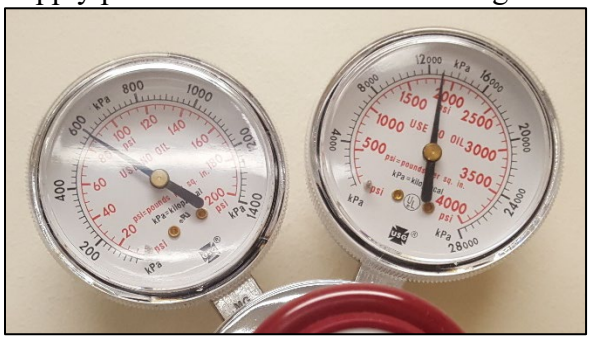
3.1.1.1 The E-Stop activates automatically when pressure in the LN_2 piping is too low or high and/or the Low O_2 alarm is activated.

3.1.1.2 The E-stop may be activated manually by depressing the red plunger button located inside the LN_2 freezer room (C156) or inside the processing lab (C158A).

3.1.1.3 A regulator monitors delivery and supply pressure in the compressed air tank.

3.1.1.3.1 Delivery pressure indicates pressure to the E-Stop and is monitored by the left-hand gauge on the regulator (see picture in Step 3.1.1.3.3.

3.1.1.3.2 Supply pressure indicates air remaining in air tank.



3.1.2 Press the E-Stop red reset button to reset the E-Stop system.

4.0 Low Oxygen Alarms (Wall-Mounted)

4.1 There are three Low oxygen alarms: two are located inside the LN_2 Freezer room, and the third is located in the adjacent processing lab. The three alarms are **not** networked.

4.2 Alarms activate when oxygen levels in the immediate area of the alarm location reaches a defined critical level.

4.2.1 When oxygen level reaches a critical level (<19.5%) on the unit connected to the alarm system, a remote notification is dispatched.

4.2.2 The unit connected to the alarm system is on the south wall of C156.

4.3 These units must maintain 4 critical parameters to ensure safety for all personnel.

4.3.1 Latching: Unit will remain in alarm even after the alarm condition has returned to normal until the alarm is reset manually.

4.3.2 Non-acknowledgeable / Not Acknowledgeable: The alarm cannot be reset while the O_2 level is below or at alarm conditions.

4.3.3 Alarm point 1 (A1) is triggered by a drop in O_2 at or below 19.5% concentration.

4.3.4 Alarm point 2 (A2) is triggered by a drop in O_2 at or below 19.0% concentration.

4.3.5 Programming for the Drager PointGard II and Drager PointGard 2100 Parameters:

4.3.6 PointGard II Parameters:

4.3.6.1 A1 Lat = Latching

4.3.6.2 A2 Lat = Latching

4.3.6.3 A1 Acn = Non-acknowledgeable

4.3.6.4 A2 Acn = Non-acknowledgeable

4.3.6.5 A1-Adj = 19.5

4.3.6.6 A2-Adj = 19.0

4.3.7 PointGard 2100 Parameters:

4.3.7.1 A1 Alarm = Enabled

4.3.7.2 A2 Alarm = Enabled

4.3.7.3 A1 Alarm Setpoint = 19.5

4.3.7.4 A2 Alarm Setpoint = 19.0

4.3.7.5 A1 Latch Mode Setpoint = Latching

4.3.7.6 A2 Latch Mode Setpoint = Latching

4.3.7.7 A1 Acknowledgement Mode = Not Acknowledgeable

4.3.7.8 A2 Acknowledgement Mode = Not Acknowledgeable

4.4 Refer to Dräger PointGard II and Dräger PointGard 2000 Series Operating Manuals.

5.0 Emergency Escape Breathing Apparatus Units are located within C156.

6.0 System features for dispensing LN_2 manually

6.1 One hose is available for dispensing liquid nitrogen manually.

6.2 A scale featuring an attached meter with a digital readout is used to weigh the amount of LN_2 dispensed.

LN_2 System Maintenance Log: QUARTERLY ASSESSMENT Quarter_____ Year: _____					
QUARTERLY ASSESSMENT **Acceptance Criteria**:	Connection to freezer is Secure & tight* *Document Result (√)* **Met**	Integrity of Hose is intact** *Document Result (√)* **Met**	Initials	Date	Comments / Corrective Actions
Valve for Freezer A1	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer A2	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer A3	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer B1	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer B2	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer B3	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer B4	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer B5	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer C1	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer C2	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer C3	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer C4	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer C5	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer D1	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer D2	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer D3	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			
Valve for Freezer D4	❑ Met ❑ ❑ Not Met N/A	❑ Met ❑ Not Met			

Low Oxygen Alarm Calibration	**EHS Calibration Completed (Tech/Date)**	**Confirmation Settings Returned to As Found Values (Tech/Date)**	**EHS Report Rec'd/attached (Tech/Date)**	**EHS Report acceptable**	
C156 North				❑ Yes ❑ No	
C156 South				❑ Yes ❑ No	
C158A				❑ Yes ❑ No	
Reviewed By / Date:					

*For locations where units are out of service or absent, document "N/A."
**For locations where units are out of service or absent, integrity of hose, if applicable, must still be evaluated.

Year: _____

LN_2 SYSTEM MAINTENANCE LOG: ANNUAL VALVE ASSESSMENT				
ANNUAL VALVE ASSESSMENT	*Document Result (√): Note: Expected Result = Yes*	Initials	Date	Comments/Corrective Actions
External valve Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve #1 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve #2 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve #3 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A1 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A2 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A3 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B1 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B2 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B3 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B4 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B5 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C1 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C2 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C3 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C4 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C5 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D1 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D2 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D3 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D4 Turned by Hand	❑ Yes ❑ No ❑ Not Applicable			

Name of CFS Personnel Assisting with Internal Valve #1-3 Testing		Initials / Date	

Reviewed By / Date:

Year: _____

LN_2 SYSTEM MAINTENANCE LOG: ANNUAL VALVE ASSESSMENT, cont.				
ANNUAL VALVE ASSESSMENT	*Document Result (√): Note: Expected Result = Yes*	Initials	Date	Comments/Corrective Actions
External valve LN2 Flow* Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve # 1 LN2 Flow* Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve # 2 LN2 Flow* Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Internal Valve # 3 LN2 Flow* Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A1 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A2 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer A3 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B1 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B2 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B3 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B4 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer B5 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C1 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C2 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C3 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C4 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer C5 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D1 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D2 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D3 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
Valve for Freezer D4 LN2 Flow Stopped in Off Position	❑ Yes ❑ No ❑ Not Applicable			
ANNUAL Monitoring and PM	*Document Result (√) Note: Expected Result = Yes*	Initials	Date	Comments/Corrective Actions
Praxair PM Acceptable	❑ Yes ❑ No			
C156 E-Stop stops flow of LN_2* within 10 minutes of activation	❑ Yes ❑ No			
C158A E-Stop stops flow of LN_2* within 10 minutes of activation	❑ Yes ❑ No			
Reviewed By / Date:				

* In order to meet acceptance criteria, flow of *liquid* LN_2 must stop.

Month: **Year:**

LN_2 SYSTEM DAILY LN_2 USAGE LOG

Note: Liquid Nitrogen Level Expected Result ≥ *45.0 inches*
Liquid Nitrogen Pressure Expected Range = *25-40 psig*

Enter Current Expected Use Range (Avg. ± 2 SD)*:* _____

Note: Pressure and level values are recorded in whole numbers.

DAILY

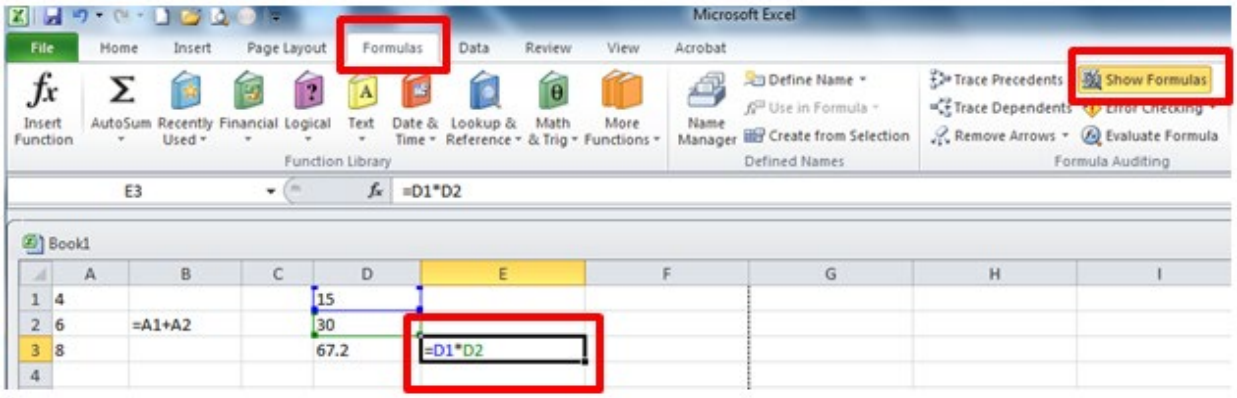
Day	Ball in Wall Visible in C156		Current LN_2		Level Change from Previous Day	LN_2 use is within the Expected Use Range:	Tech Initials	Comments/ Corrective Actions
	158A -156	199 - 156	Pres-sure (psig)	Level (inches)				
	(Y/N) If "No", refer to SOP & document actions in comment field							
1						❑Yes ❑No ❑NA		
2						❑Yes ❑No ❑NA		
3						❑Yes ❑No ❑NA		
4						❑Yes ❑No ❑NA		
5						❑Yes ❑No ❑NA		
6						❑Yes ❑No ❑NA		
7						❑Yes ❑No ❑NA		
8						❑Yes ❑No ❑NA		
9						❑Yes ❑No ❑NA		
10						❑Yes ❑No ❑NA		
11						❑Yes ❑No ❑NA		
12						❑Yes ❑No ❑NA		
13						❑Yes ❑No ❑NA		
14						❑Yes ❑No ❑NA		
15						❑Yes ❑No ❑NA		
16						❑Yes ❑No ❑NA		
17						❑Yes ❑No ❑NA		
18						❑Yes ❑No ❑NA		
19						❑Yes ❑No ❑NA		
20						❑Yes ❑No ❑NA		
21						❑Yes ❑No ❑NA		
22						❑Yes ❑No ❑NA		
23						❑Yes ❑No ❑NA		
24						❑Yes ❑No ❑NA		
25						❑Yes ❑No ❑NA		
26						❑Yes ❑No ❑NA		
27						❑Yes ❑No ❑NA		
28						❑Yes ❑No ❑NA		
29						❑Yes ❑No ❑NA		
30						❑Yes ❑No ❑NA		
31						❑Yes ❑No ❑NA		

Reviewed By / Date:

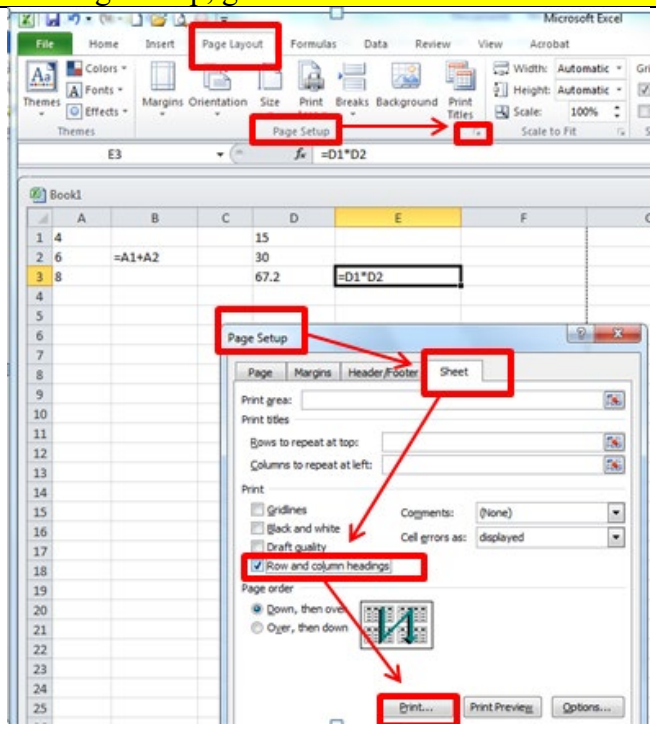
LN_2 Expected Use Range Calculation Instructions

1. Determine the amount of LN_2 used by subtracting the LN_2 level of the previous day from the current LN_2 level.
2. Enter this data as day 1 usage in an Excel spreadsheet. Include a column in which to document the actual date (a spreadsheet template is provided on page two).
3. Perform the same calculation for the next 27 consecutive days
   - 3.1. Omit the following days:
     - 3.1.1. All days marked "N/A" per Steps 6.2.2.1.4.1 – 6.2.2.1.4.2.
     - 3.1.2. Days greyed out on SF-2-2, Appendix C by SSF personnel (i.e. weekends, holidays)
   - 3.2. Since the days above are omitted, to obtain 27 more days it is acceptable to continue into the next month omitting the same days listed above.
4. After 28 days of data have been obtained, use Microsoft Excel to determine the average amount used over 28 days
5. Use Excel to calculate the standard deviation
6. Multiply the standard deviation by 2.
7. Calculate the upper limit of the expected use range as "= average + (2*stdev)" (rounding up to the nearest whole number)
8. Calculate the lower limit of the expected use range as "= average - (2*stdev)" (rounding down to the nearest whole number)
9. Print the numerical spreadsheet data.
10. Print the same spreadsheet, but displaying the formulas instead of the data.
11. Initial and date both spreadsheets. Enter comments as applicable and submit for review and approval.
12. To print the spreadsheet formulas (using MS Excel 2010), perform the following steps:

1. Go to Formulas Tab -> Toggle "Show Formulas" Button on



2. Go to Page Layout Tab, From Page Setup, go to Sheet -> Row & column headings (enable) -> Print



LN_2 Expected Use Range Calculation Instructions (cont.)

Example Spreadsheet showing Data ↓

Book1

	A	B	C	D
1	SSF LN2	Levels - Annual Verification of LN2 Use Range		
2	Day #	Date	Amt of LN2 Used	
3	1	04.01.13	8	
4	2	04.02.13	9	
5	3	04.03.13	7	
6	4	04.04.13	7	
7	5	04.05.13	6	
8	6	04.08.13	9	
9	7	04.10.13	8	
10	8	04.11.13	8	
11	9	04.12.13	9	
12	10	04.15.13	6	
13	11	04.16.13	4	
14	12	04.17.13	9	
15	13	04.18.13	7	
16	14	04.19.13	6	
17	15	04.22.13	6	
18	16	04.23.13	6	
19	17	04.24.13	5	
20	18	04.25.13	9	
21	19	04.26.13	9	
22	20	04.29.13	7	
23	21	04.30.13	8	
24	22	05.01.13	8	
25	23	05.02.13	7	
26	24	05.03.13	6	
27	25	05.06.13	5	
28	26	05.08.13	9	
29	27	05.09.13	5	
30	28	05.10.13	7	
31			Average	7.14286
32			Std Dev	1.45686
33			2 Std Dev	2.91373
34			Avg + (2 Std Dev)	10.0566
35			Avg - (2 Std Dev)	4.22913
36			Range	4-11
37				

Example Spreadsheet showing Formulas ↓

	A	B	C	D
1	SSF LN2 Levels			
2	Day #	Date	Amt of LN2 Used	
3	1	04.01.13	8	
4	2	04.02.13	9	
5	3	04.03.13	7	
6	4	04.04.13	7	
7	5	04.05.13	6	
8	6	04.08.13	9	
9	7	04.10.13	8	
10	8	04.11.13	8	
11	9	04.12.13	9	
12	10	04.15.13	6	
13	11	04.16.13	4	
14	12	04.17.13	9	
15	13	04.18.13	7	
16	14	04.19.13	6	
17	15	04.22.13	6	
18	16	04.23.13	6	
19	17	04.24.13	5	
20	18	04.25.13	9	
21	19	04.26.13	9	
22	20	04.29.13	7	
23	21	04.30.13	8	
24	22	05.01.13	8	
25	23	05.02.13	7	
26	24	05.03.13	6	
27	25	05.06.13	5	
28	26	05.08.13	9	
29	27	05.09.13	5	
30	28	05.10.13	7	
31			Average	=AVERAGE(C3:C30)
32			Std Dev	=STDEV.P(C3:C30)
33			2 Std Dev	=2*D32
34			Avg + (2 Std Dev)	=D31+D33
35			Avg - (2 Std Dev)	=D31-D33
36			Range	4-11

			Date of Fill:	
LN_2 Systems Post-Fill Observation Log				
AFTER EACH FILL	*Note: Expected Result = Completed and/or Acceptable, Not Applicable*	Initials	Date	Comments/ Corrective Actions
LN_2 Level from Gauge	❑ Completed _____ inches ❑ Not Completed			
LN_2 Level from Alarm System, if applicable	❑ Completed _____ inches ❑ Not Completed ❑ Not Applicable			
Calculate LN_2 Level Difference, if applicable: *Note: Expected Result is ≤ 7 Inches*	_____ inches ❑ Acceptable ❑ Not Acceptable ❑ Not Completed ❑ Not Applicable			
Pressure Level *Note: Expected Result: 25-40 psig*	❑ Completed _____psig ❑ Acceptable ❑ Not Acceptable ❑ Not Completed			
Reviewed By / Date:				

Emergency Contacts, Wall-Mounted Low O_2 Monitors Alarm Immediate Actions & Response, and Collaborating Biobank Personnel (CBP) Alarm Response and Malfunction Response Directives

Contents:

- Table of Contents .....Page 1
- Collaborating Biobank Personnel Alarm Response and Malfunction Response Directives .....Page 2
- Immediate Alarm Response for Personnel Working in LN_2 Freezer Room .....Page 3
- Alarm Actions & Response for Staff Monitoring Personnel Working in LN_2 Freezer Room .....Page 4
- Immediate Alarm Response for C158A Wall-Mounted O_2 Monitor .....Page 5
- Alarm Actions & Response following alarm on C158 Wall-Mounted O_2 Monitor .....Page 6
- Response to C158A Wall-Mounted Low O_2 Monitor - SSF Personnel Follow-Up Actions .....Page 7
- Emergency Contacts.....Page 8

Collaborating Biorepository Personnel Alarm Response & Malfunction Response Directives:

LN_2 Freezer Room Wall-Mounted O_2 Monitor Audible Alarm and Flashing Lights

Watcher – Safety Observer	Personnel Working in LN_2 Room

• Must observe personnel working in LN_2 Freezer Room from position next to wall-mounted red plunger, labeled "LN_2 EMERGENCY STOP" (E-Stop)
• Refer to Page 4 of this Appendix F for Alarm response
• Directives are posted at:
  ○ Entrance to LN_2 Freezer Room
	• Refer to Page 3 of this Appendix F for Alarm response
	• Directives are posted at:
	  ○ Each Wall-Mounted O_2 Monitor
	• **NOTE:** LN_2 Freezer Room entry **PROHIBITED** unless a **trained** observer is stationed next to wall-mounted red plunger, labeled "LN_2 EMERGENCY STOP" (E-Stop), observing your LN_2 Freezer Room access for safety purposes.

Personnel must NOT RE-ENTER the LN_2 Freezer Room until the alarm has been resolved

Contact SSF Personnel for assistance per Page 8 of this Appendix F.

R3-C158A Lab Wall-Mounted O_2 Monitor Audible Alarm and Flashing Lights

- Refer to Pages 5 & 6 of this Appendix F for Alarm response directives
  - Page 5 directives are posted at the C158A Wall-Mounted O_2 Monitor
- **Directives applicable only after all personnel have vacated C158A** are per Page 6 of this Appendix F, and Page 6 is posted at C158A entries. Re-entering the Lab is prohibited until SSF personnel direct that re-entry is permitted.

Discovery of Malfunctioning Wall-Mounted O_2 Monitor

• Evacuate space • Report malfunction to SSF Personnel	• DO NOT re-enter space • Further directives will be provided by SSF personnel

Personal O_2 Monitor Alarm Response

Watcher – Safety Observer	Personnel Working in LN_2 Room

• Monitor that personnel working in the LN_2 Room follow all safety procedures	• Immediately move away from LN_2 source
	• Verify Wall-Mounted O_2 Monitor reads ≥ 19.5%
	  ○ If the O_2 level is **≤ 19.5%**, immediately vacate the room
	• Verify Personal O_2 Monitor reads ≥ 19.5%
	• Press green OK button on Drager Pac 5500 personal O_2 monitor to silence alarm.
	  ○ For Sensit P100 personal O_2 monitors used at the TK facility, audible alarm automatically silences when O_2 level reads ≥ 19.5%.
	• If alarm recurs more than two times successively:
	  ○ Vacate the room
	• Verify Wall-Mounted O_2 Monitor reads ≥ 19.5%
	  ○ If O_2 level in the room is ≥ 19.5% per the wall-mounted O_2 monitors, you may obtain an alternate O_2 monitor & return to the LN_2 room.
	• Contact SSF Personnel

Flashing Lights & Audible Alarm?

VACATE THE ROOM

Use an Emergency Escape Breathing Apparatus (EEBA) Only As Necessary

Inside LN_2 Freezer Room Posting

Watcher (Safety Observer) Directives:
LN_2 Freezer Room Low O_2 Alarm Actions & Response

1. **DO NOT ENTER LN_2 Room**
2. **Press E-STOP**
3. **Ensure ALL PERSONNEL HAVE VACATED Room**
4. **CALL 911 or IUPUI Police at 317-274-7911 if Personnel Rescue Is Needed**
5. **Ensure ALL DOORS ARE CLOSED**
6. **Manually CLOSE VALVE AT BULK TANK**
   (May be done by any SSF Staff, Campus Facilities Services Personnel, Collaborating Biobank Personnel, IUPUI Campus Police)
7. **Contact SSF Personnel for Assistance:**
   a. **ictsissf@iupui.edu**
   b. **317-274-2213 – Management Office**
   c. **317-946-6477 – Manager Cell Phone**
   d. **317-274-3569 – Technician Office**
   e. **317-696-9925 – Director Cell Phone**
   f. **Page SSF at 317-541-5481**
8. **Report any wall-mounted O_2 monitor malfunction to SSF personnel.**

Flashing Lights & Audible Alarm?

VACATE THE ROOM

Contact SSF Personnel for Assistance

Activate E-Stop ONLY if Immediately Accessible

R3-C158A
Posting

Alarm Actions & Response to C158A Wall-Mounted Low O_2 Monitor

Directives applicable only from spaces adjacent to C158A

1. **DO NOT ENTER C158A**

2. **Ensure ALL PERSONNEL HAVE VACATED ROOM**

3. **CALL 911 or IUPUI Police at 317-274-7911 If Personnel Rescue Is Needed**

4. **Ensure ALL DOORS ARE CLOSED**

5. **Obtain bulk tank key from C158A main entrance (SSF administrative space) or SSF Key lockbox**
   - **5.1. DO NOT ENTER C158A to obtain bulk tank key**

6. **Manually CLOSE VALVE AT BULK TANK**
   (May be done by any SSF Staff, Campus Facilities Services Personnel, Collaborating Biobank Personnel, IUPUI Campus Police)

7. **Notification:**
   - **7.1. Contact SSF Personnel for Assistance:**
     - **7.1.1. ictsissf@iupui.edu**
     - **7.1.2. 317-274-2213 – Management Office**
     - **7.1.3. 317-946-6477 – Manager Cell Phone**
     - **7.1.4. 317-696-9925 – Director Cell Phone**
     - **7.1.5. 317-274-3569 – Technician Office**
     - **7.1.6. Page SSF at 317-541-5481**
   - **7.2.** SSF Personnel Notify Emergency Contacts per Page 8 of Appendix F

8. Report any wall-mounted O_2 monitor malfunction to SSF personnel

Posted at R3-C158A entrances & at C158A O_2 Monitor

SSF Personnel Response to C158A Wall-Mounted Low O_2 Monitor Alarm– SSF Personnel Follow-Up Actions

1. SSF personnel may return to C158A and investigate Wall-Mounted Low O_2 Monitor alarm and equipment malfunction **ONLY IF** both conditions 1.1 and 1.2 can be confirmed *FROM SPACES ADJACENT TO C158A* and permission is obtained per condition 1.3:
   1.1. If no nitrogen vapor or nitrogen liquid are visible in C158A
   1.2. If personal O_2 monitors beneath the wall-mounted O_2 monitor are NOT alarming
   1.3. With SSF Management permission

2. Investigation of malfunction and facility re-entry is per the Wall-Mounted O_2 Monitor Troubleshooting section of this SOP.

3. If (a) nitrogen vapor or nitrogen liquid ARE visible in C158A and/or (b) personal O_2 monitors beneath the wall-mounted O_2 monitor ARE alarming:
   3.1. **C158A RE-ENTRY PROHIBITED** until LN_2 system is evaluated by safety personnel (EHS, Praxair/Linde, other qualified vendor) and all safety concerns are addressed.
   3.2. **Manually CLOSE VALVE AT BULK TANK**
   (May be done by any SSF Staff, Campus Facilities Services Personnel, Collaborating Biobank Personnel, IUPUI Campus Police)
   3.3. Notify Emergency Contacts per Appendix F, page 8

EMERGENCY CONTACTS

SSF Operations Manager:	Name Pager: Office: Phone:
SSF Facilities Manager:	Name Pager: Office: Phone:
SSF Director	Name Phone:
Campus Facilities:	317-278-1900
Environmental Health and Safety:	317-274-2005
IUPUI Police:	4-7911 (from an IU phone) 317-274-7911
Police:	911

Date Effective:	
Obsolete Date:	

Month: _____ **Year:** _____

LN_2 WEEKLY SYSTEM CHECK

System Observation

WEEK	*Observable Frost Rings Present? (Yes / No)*	Tech Initials / Date	
1	❑ Yes ❑ No		
2	❑ Yes ❑ No		
3	❑ Yes ❑ No		
4	❑ Yes ❑ No		
5	❑ Yes ❑ No ❑ NA		

Comments

Mixed Air Cylinder Gauge Readings for E-Stop

WEEK	*Delivery Pressure (kPa) – Acceptable Range: 500-680 kPa*	Acceptable (Yes / No)	*Supply Pressure (psi) – Acceptable Range: 300-2200 psi*	Acceptable (Yes / No)	Tech Initials / Date
1		❑ Yes ❑ No		❑ Yes ❑ No	
2		❑ Yes ❑ No		❑ Yes ❑ No	
3		❑ Yes ❑ No		❑ Yes ❑ No	
4		❑ Yes ❑ No		❑ Yes ❑ No	
5		❑ Yes ❑ No ❑ NA		❑ Yes ❑ No ❑ NA	

Comments

Reviewed By / Date:	

Collaborating Biorepository Personnel (CBP) Training

The SSF has a hard-plumbed, vacuum-insulated, liquid nitrogen (LN_2) system that connects a 6000-gallon bulk tank to freezers, providing liquid & vapor phase nitrogen storage to users. Routine maintenance and monitoring of the SSF LN_2 system is completed by SSF personnel. This SOP defines safety procedures and entry directives for access to R3-C156, the SSF LN_2 room.

******LN_2 Room safety directives are critical, because in an atmosphere filled with nitrogen gas, oxygen is easily displaced and can result is asphyxiation. Therefore, there are several safety procedures in place to assure adequate oxygen supply when working in the LN_2 room.******

Responsibility	Watcher – Safety Observer	Personnel Entering the LN_2 Room
Room Entry	1. Must be positioned next to wall-mounted red plunger, labeled "LN_2 EMERGENCY STOP" (E-Stop) 2. Verify personnel entering LN_2 room is wearing a personal O_2 monitor. 3. Verify O_2 level is above 19.5% per the wall-mounted O_2 monitor. 4. Verify LN_2 bulk tank is not being filled 5. Verify Negative pressure differential by observing that the Ball in Wall indicator is not visible inside C158A	1. DO NOT ENTER unless trained observer is stationed next to wall-mounted red plunger, labeled "LN2 EMERGENCY STOP" (E-Stop), observing your LN2 room access for safety purposes. 2. Don a personal O_2 monitor prior to entering the LN_2 room per directives in "Don a Personal O_2 Monitor" section below. 3. Verify O_2 level is above 19.5% per the wall-mounted O_2 monitor 4. Verify the LN_2 bulk tank is not being filled 5. Verify Negative pressure differential by observing that the Ball in Wall indicator is not visible inside C158A
	If negative pressure differential indicator, ball-in-wall, is visible in C158A and repair signage is not already posted, notify SSF personnel. Entry into C156 IS NOT prohibited.	
Don a Personal O_2 Monitor	1. Verify personnel entering LN_2 room is wearing a personal O_2 monitor.	1. Obtain a personal O_2 monitor for each personnel entering the room according to the following priorities and exceptions: a. Personal O_2 monitor must display O_2 level above 19.5% <u>AND must not display</u> low battery symbol or [!] (indicating an error), per SF-3-15 SOP for Drager Pac 5500 Personal O_2 Monitors b. If the number of personnel entering the LN_2 Freezer Room at a given time exceeds the number of functional O_2 monitors, DO NOT access a freezer or fill a dewar until a personal O_2 monitor is available 2. See SSF Personnel for Assistance
Personal O_2 Monitor DOs and DON'Ts	• Personal O_2 monitors alarm because personnel are surrounded by LN_2 vapor. • DO wear the monitor near your head. • DON'T hang the monitor from your neck by the attached lanyard. The monitor will descend into an LN_2 freezer and alarm. • DON'T place the monitor in your pocket, where its air intake will be obstructed, and the monitor will alarm.	

Responsibility	Watcher – Safety Observer	Personnel Entering the LN_2 Room
Sample Access	1. Keep a constant eye on personnel working in the LN_2 room 2. Wall mounted mirrors facilitate tracking of personnel out of direct line of sight	1. Personnel must be wearing approved and proper PPE per universal precautions 2. Don cryogenic gloves when working with liquid nitrogen in the vapor phase 3. When working with liquid nitrogen in the liquid phase, don: a. chemical splash goggles or full face shield i. Since splashing can occur, a full face shield is preferred for filling dewars b. cryogenic gloves c. cryogenic apron
LN_2 Dispensing and Dewar Fills	1. Monitor that personnel in C156 adhere to safety procedures defined at right	1. LN_2 may only be dispensed by personnel trained to fill dewars by trained-CBP or SSF staff 2. Before dispensing LN_2, personnel must don: a. chemical splash goggles or full face shield (Full face shield recommended) b. cryogenic gloves c. cryogenic apron 3. Report all dewar fills in iLab for billing purposes
Wall-Mounted O_2 Monitors Measure and Report O_2 Levels in the Vicinity of the Wall-Mounted O_2 Monitor		
Refer to Appendix F for directives for responding to: • Wall-Mounted O_2 monitor Alarms • Discovery of Wall-Mounted O_2 monitor Malfunction is per Appendix F		
Personal O_2 Monitors Measure and Report O_2 Levels Around the User		
Refer to Appendix F for response to Personal O_2 Monitor Alarm		
LN_2 Freezer Room Access when a Wall-Mounted O_2 Monitor is Malfunctioning:		
LN_2 Freezer Room access will be limited per SSF Directives – SSF personnel will contact CBP		

Additional Appendices Requiring Review:

Appendix A: Components of the Liquid Nitrogen System defines critical components of the LN_2 room, also covered during on-site technical training with SSF personnel.

Appendix F: Emergency Contacts and Wall-Mounted Low O_2 Monitors Alarm Actions Template

SSF Wall-Mounted Low O_2 Monitors Alarm Monitoring / Notification & Alarm Malfunction Response

SSF Directives - Low O_2 Alarm Resolution during Normal Function of Both Wall-Mounted O_2 Monitors in the LN_2 Freezer Room

Directives applicable only following appropriate alarm response per Appendix F

1. **SSF Monitoring Following Alarm**
   - 1.1. Alarm Lights Flashing & Intermittent Audible
     - 1.1.1. Re-Entry Prohibited Until O_2 Level Rises To ≥ 19.5%
   - 1.2. Alarm Lights Flashing & Continuous Audible
     - 1.2.1. Re-Entry Prohibited Until O_2 Level Rises To ≥ 19.5%
     - 1.2.2. Manually Close Valve at LN_2 Bulk Tank If Not Already Done
     - 1.2.3. Notify Emergency Contacts Per Appendix F If Reading Decreases Below 18.5% (Appendix F, Page 8)
   - 1.3. White-Out Conditions
     - 1.3.1. Defined as vapor density that blocks view of room or sections of the room.
     - 1.3.2. Re-Entry Prohibited until LN_2 system is evaluated by safety personnel (EHS, Praxair/Linde, other qualified vendor) and all safety concerns are addressed
     - 1.3.3. Following White-Out Conditions, Notify Emergency Contacts per Appendix F, page 8

SSF Directives - Low O_2 Alarm Resolution With <u>One or Both</u> LN_2 Freezer Room Wall-Mounted O_2 Monitor(s) Malfunctioning

Directives applicable only following appropriate alarm response per Appendix F

Directives Applicable to:

- **Alarm Lights Flashing & Audible Alarm**
- **White-Out Conditions**
- **Alarm From *Personal O_2 Monitor Stationed At Malfunctioning Wall-Mounted O_2 Monitor***

Monitoring Following Alarm on:

1. ***MALFUNCTIONING* Wall-Mounted O_2 Monitor**
   - 1.1. Alarm Lights Flashing & Audible Alarm: Re-Entry Prohibited Until O_2 Level Rises To ≥ 19.5%
   - 1.2. White-Out Conditions
     - 1.2.1. Defined as vapor density that blocks view of room or sections of the room.
     - 1.2.2. Re-Entry Prohibited until LN_2 system is evaluated by safety personnel (EHS, Praxair/Linde, other qualified vendor) and all safety concerns are addressed
     - 1.2.3. Following White-Out Conditions, Notify Emergency Contacts per Appendix F, page 8

2. ***Personal O_2 Monitor Stationed At Malfunctioning Wall-Mounted O_2 Monitor***
   - 2.1. Alarm Lights Flashing & Audible Alarm: Re-Entry Prohibited Until O_2 Level Rises To ≥ 19.5%
   - 2.2. White-Out Conditions
     - 2.2.1. Re-Entry Prohibited until LN_2 system is evaluated by safety personnel (EHS, Praxair/Linde, other qualified vendor) and all safety concerns are addressed
     - 2.2.2. Following White-Out Conditions, Notify Emergency Contacts per Appendix F, page 8