1. **Definition:** Cryogens are liquid gases used to reduce temperatures below -153°C (-243°F). Their primary cooling mechanism is vaporization or latent heat as they change formation, and they have extremely high expansion ratio (average 800:1) when they change physical state from liquid to gas. Liquid nitrogen (LN2) which has a boiling point of -196°C (-321°F) is a commonly used cryogen in laboratories. Additional cryogens commonly used are: helium, argon, oxygen and methane. Although not a cryogen, solid carbon dioxide or dry ice converts directly to carbon dioxide gas at -78°C (-109°F) is also often used in laboratories. Because of those special properties, cryogens can be hazardous to workers health if they are not handled properly.

2. **Health Hazards**
   a. Asphyxiation (suffocation) from displacement of air by expanding cryogen vapors
   b. Frostbite (burns)
   c. Explosions (because of high pressure of gas because of high evaporation)
   d. Flammability (hydrogen, methane and acetylene are flammable, while oxygen will increase flammability of ordinary carbon based substances like paper)

3. **General precautions**
   a. Avoid direct contact with cryogenic liquids and un-insulated cryogenic piping systems and reservoirs
   b. Never handle dry ice or LN2 with bare hands
   c. Use cryogenic gloves, which are designed specifically for working in freezers below -80°C and to handle containers or vials stored in these freezers
   d. Cryogenic gloves need to be loose-fitting so that they can be readily removed if LN2 splashes into them or a piece of dry ice falls into them
   e. Always use a face shield in conjunction with safety glasses or goggles
   f. Do not use or store dry ice or LN2 in confined areas, walk-in refrigerators, environmental chambers or rooms without ventilation. Vapors could cause an oxygen-deficient atmosphere
   g. Never pour a cryogen on tiled or laminated surfaces because such surfaces may be severely damaged. We recommend protecting the surface with a plywood panel.
   h. Do not overfill containers and ensure all secondary containers are secured when filling
   i. Never store a cryogen in a sealed container at a temperature above the boiling point of the cryogen; the pressure resulting from the production of gaseous carbon dioxide or nitrogen can lead to an explosion.
   j. Look for choice of materials working with cryogen materials. Inadequate design or material can cause problems. Inspect and maintain cryogen equipment to meet manufacturer’s operation specifications
k. For more information about specific cryogens, read the Material Safety Data Sheet for the substance in question or call DEHS at 612-626-6002.

4. Preventive measures
   a. Information and training
   b. Safe working procedures
   c. Protective clothing
   d. Warning signs

5. Administrative controls
   a. Train employees who handle cryogens to:
      i. Use only manufacture approved containers
      ii. Use proper PPE
      iii. Do not tamper with pressure relief devices
      iv. Use appropriate spill response
      v. Know appropriate first aid measures

6. Engineering controls
   a. Under normal circumstance lab ventilation is adequate to prevent significant displacement of air by cryogen vapors
   b. MRI machines must be ducted to the outside through a purge system
   c. Rooms with NMR machines must be evaluated for adequacy of ventilation on a case by case basis.
   d. The need for O2 sensors in spaces with cryogens will be evaluated (Note: O2 sensors may be affected by high magnetic fields and prone to failure when used adjacent to such fields.)

7. Spill response
   Note: Evaluate the largest spill that could occur in the area based on the size of containers used. Liquid nitrogen expands 700 times from liquid to gas, therefore by knowing the volume of the room and the size of the largest container the risk of significant oxygen depletion can be estimated.
   a. In case of spill leave area and dial 911. Check oxygen level in room and if it is less than 18%, leave the area immediately
   b. Call 911 if after hours or DEHS at 612-626-6002 during business hours

8. First Aid
   a. In case of exposure to cryogens or dry ice, remove any clothing that is not frozen to the skin. Do NOT rub frozen body parts because tissue damage may result
   b. Place the affected part of the body in a warm water bath (not above 40°C). Never use dry heat
   c. If the victim is experiencing symptoms of hypothermia move him/her to a warm place
   d. Obtain medical assistance as soon as possible, (Call 911)