

CHAPTER 4. INSTRUMENTS

AIRWORTHINESS COMPLIANCE CHECK SHEET #29

1. SUBJECT: Instrument Installations - Relocating Instruments,
FAR 23

2. APPLICABLE FEDERAL AVIATION REGULATIONS

- 23.301 Loads
- 23.993 Fuel System Lines, Fittings, and Accessories
- 23.1301 Functional and Installational Requirements
- 23.1321 Arrangement and Visibility of Instrument
Installations Instrument Panel Vibration
Characteristics
- 23.1327 Magnetic Direction Indicator
- 23.1337 Instrument Lines

Fuel Quantity Indicator
Cylinder Head Temperature Indicating System for
Air-Cooled Engines

23.1547 Magnetic Direction Indicator

Relocated instrument installations which are the same as those made by the airframe manufacturer or other installations which are already approved, may be accepted without further investigation. On other accepted installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

- (1) If holes are added to the instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 23.301.)

NOTE: This may normally be determined by a visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

- (1) If powerplant instruments are relocated, are their lines (which carry inflammable fluids and gases under pressure) provided with restricted orifices or other safety devices at the source of pressure to prevent excessive escape of fluid or gas in case of line failure? (FAR 23.1337.)

c. Operating Aspects:

- (1) Are relocated flight, navigation and powerplant instruments installed in such a manner that they are easily visible for use by the pilot? (FAR 23.1321.)
- (2) Are relocated identical powerplant instruments on multiengine aircraft so located as to prevent any confusion as to the engines to which they relate? (FAR 23.1321.)
- (3) Is the relocated magnetic compass installed so that its accuracy is not affected excessively by vibration and transient magnetic fields? (FAR 23.1327.)
- (4) Is the relocated magnetic compass compensated for deviation error not exceeding plus or minus ten degrees on any heading in level flight? (FAR 23.1327.)
- (5) If the magnetic compass is relocated, is a placard installed with the compass deviation error recorded? (FAR 23.1327, and FAR 23.1547.)

d. Detail Design Standards:

- (1) Are the instrument panel vibration characteristics such as not to impair the accuracy of relocated instruments? (FAR 23.1321.)
- (2) If powerplant instruments are relocated, are their lines installed and supported to prevent excessive vibration and to withstand loads due to accelerated flight conditions? (FAR 23.993.)
- (3) If powerplant instruments are relocated, do instrument lines incorporate provisions for flexibility when the lines are connected to components of the airplane and relative motion could exist between airframe and instruments? (FAR 23.993.)
- (4) If powerplant instruments are relocated, is the use of flexible hose avoided in locations where exposure to excessive temperatures might adversely affect the hose during operation or shutdown? (FAR 23.993.)
- (5) If a fuel quantity indicator sight gauge is relocated, is it installed and guarded in a manner to preclude the possibility of breakage or damage? (FAR 23.1337.)
- (6) If a relocated fuel sight gauge forms a trap in which water can collect and freeze, is a means provided to permit drainage on the ground? (FAR 23.1337.)

- (7) Are the applicable instrument connector tubings, flexible lines, electrical conductors, and cables to relocated instruments considered satisfactory to perform their intended function and are their installations satisfactory? (FARs 23.1321, 23.1337.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #30

1. SUBJECT: Instrument Installations - Adding Instruments, FAR 23 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

23.301 Loads

Instruments and Markings

23.1301 Functional and Installational Requirements - Equipment

23.1321 Arrangement and Visibility of Instrument Installations

Instrument Panel Vibration Characteristics

23.1327 Magnetic Direction Indicator

23.1337 Instrument Lines

Fuel Quantity Indicator

Cylinder Head Temperature Indicating System for Air-Cooled Engines

23.1543 Instrument Markings

23.1547 Magnetic Direction Indicator

23.1555 Accessory and Auxiliary Controls

Added instrument installations which are the same as those made by the airframe manufacturer or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

- a. Structural Requirements:

- (1) If holes are added to instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 23.301.)

NOTE: This may normally be determined by a visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

- (1) If powerplant instruments are added, are their lines which carry inflammable fluids and gases under pressure provided with restricted orifices or other safety devices at the source of pressure to prevent excessive escape of fluid or gas in case of line failure? (FAR 23.1337.)

c. Operating Aspects:

- (1) Are added flight, navigation and powerplant instruments installed in such a manner that they are easily visible for use by the pilot? (FAR 23.1321.)
- (2) Are added identical powerplant instruments on multiengine aircraft so located as to prevent any confusion as to the engines to which they relate? (FAR 23.1321.)
- (3) Is the added magnetic compass installed in the aircraft so that its accuracy is not affected excessively by vibration and transient magnetic fields? (FAR 23.1327.)
- (4) Is the added magnetic compass compensated for deviation error not exceeding plus or minus 10 degrees on any heading in level flight? (FAR 23.1327.)
- (5) If a magnetic compass is added, is a placard installed with the compass deviation error recorded? (FAR 23.1327, and FAR 23.1547.)

d. Detail Design Standards:

- (1) Are the instrument panel vibration characteristics such as not to impair the accuracy of added instruments? (FAR 23.1321.)
- (2) Are the applicable instrument connector tubings, flexible lines, electrical conductors, and cables to the added instruments, considered satisfactory to perform their intended function and are their installations satisfactory? (FARs 23.1301, 23.1321, and 23.1337.)
- (3) Are instruments properly range marked or placarded? (FAR 23.1543, and FAR 23.1583.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #31

1. SUBJECT: Instrument Installations - Relocating Instruments, FAR 25 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS:

25.301	Loads
25.1301	Functional and Installational Requirements- Equipment
25.1309	Equipment, Systems, and Installations
25.1321	Arrangement and Visibility of Instrument Installations
25.1323	Flight and Navigation Instruments
25.1325	Flight and Navigation Instruments
25.1327	Flight and Navigation Instruments
25.1329	Flight and Navigation Instruments
25.1331	Flight and Navigation Instruments
25.1337	Powerplant Instruments
25.1433	Vacuum Systems
25.1541	Markings and Placards
25.1543	Instrument Markings
25.1545	Air Speed Indicator
25.1547	Magnetic Direction Indicator
25.1549	Powerplant Instruments
25.1551	Oil Quantity Indicator
25.1553	Fuel Quantity Indicator

Relocated instrument installations which are the same as those made by the airframe manufacturer or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST:

a. Structural Requirements:

- (1) If holes are added to the instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 25.301)

NOTE: This may normally be determined by a visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

- (1) If powerplant instruments are relocated, are their lines which carry inflammable fluids and gases under pressure provided with restricted orifices or other safety devices at the source of pressure to prevent excessive escape of fluid or gas in case of line failure? (FARs 25.993, 25.1337)

c. Operations Aspects

- (1) Are relocated flight, navigation and powerplant

instruments installed in such a manner that they are easily visible for use by the pilot? (FAR 25.1321)

- (2) Are relocated identical powerplant instruments on multiengine aircraft so located as to prevent any confusion as to the engines to which they relate? (FAR 25.1321)
 - (3) Is the relocated magnetic compass installed so that its accuracy is not affected excessively by vibration and transient magnetic fields? (FARs 25.1323, 25.1325, 25.1327, 25.1329 and 25.1331)
 - (4) Is the relocated magnetic compass compensated for deviation error not exceeding plus or minus ten degrees on any heading in level flight? (FARs 25.1323, 25.1325, 25.1327, 25.1329, 25.1331)
 - (5) If the magnetic compass is relocated, as a placard installed with the compass deviation error recorded? (FARs 25.1323, 25.1325, 25.1327, 25.1329, 25.1331 and 25.1547)
- d. Detail Design Standards
- (1) Are the instrument panel vibration characteristics such as not to impair the accuracy of relocated instruments? (FARs 25.1323, 25.1325, 25.1327, 25.1329 and 25.1331)
 - (2) If powerplant instruments are relocated, are their lines installed and supported to prevent excessive vibration and to withstand loads due to accelerated flight conditions? (FAR 25.1337)
 - (3) If powerplant instruments are relocated, do instrument lines incorporate provisions for flexibility when the lines are connected to components of the airplane and relative motion could exist between airframe and instruments? (FAR 25.1337)
 - (4) If powerplant instruments are relocated, is the use of flexible hose avoided in locations where exposure to excessive temperatures might adversely affect the hose during operation or shutdown? (FAR 25.1337)
 - (5) If a fuel quantity indicator sight gauge is relocated, is it installed and guarded in a manner to preclude the possibility of breakage or damage? (FAR 25.1337)
 - (6) If a relocated fuel sight gauge forms a trap in which water can collect and freeze, is a means provided to permit drainage on the ground? (FAR

25.1337)

- (7) Are the applicable instrument connector tubings, flexible lines, electrical conductors, and cables to relocated instruments considered satisfactory to perform their intended function and are their installations satisfactory? (FARs 25.993, 25.1309, 25.1323, 25.1325, 25.1327, 25.1329, 25.1331 and 25.1337)

AIRWORTHINESS COMPLIANCE CHECK SHEET #32

1. SUBJECT: Instrument Installations - Adding Instrument, FAR 25 Aircraft

2. APPLICABLE FEDERAL AVIATION REGULATIONS

25.301 Loads
25.1301 Functional and Installation Requirements - Equipment
25.1309 Equipment, Systems, and Installations
25.1321 Arrangement and Visibility of Instrument Installations
25.1323 Flight and Navigation Instruments
25.1325 Flight and Navigation Instruments
25.1327 Flight and Navigation Instruments
25.1329 Flight and Navigation Instruments
25.1331 Flight and Navigation Instruments
25.1337 Powerplant Instruments
25.1433 Vacuum Systems
25.1541 Markings and Placards
25.1543 Instrument Markings
25.1545 Air Speed Indicator
25.1547 Magnetic Direction Indicator
25.1549 Powerplant Instruments
25.1551 Oil Quantity Indicator
25.1553 Fuel Quantity Indicator

3. CHECKLIST

a. Structural Requirements:

- (1) If holes are added to instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 25.301.)

NOTE: This may normally be determined by a visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

- (1) If powerplant instruments are added, are their lines which carry inflammable fluids and gases under pressure

provided with restricted orifices or other safety devices at the source of pressure to prevent excessive escape of fluid or gas in case of line failure? (FARs 25.993, and 25.1337.)

c. Operating Aspects:

- (1) Are added flight, navigation and powerplant instruments installed in such a manner that they are easily visible for use by the pilot? (FAR 25.1321.)
- (2) Are added identical powerplant instruments so located as to prevent any confusion as to the engines to which they relate? (FAR 25.1321.)
- (3) Is the added magnetic compass installed in the aircraft so that its accuracy is not affected excessively by vibration and transient magnetic fields? (FARs 25.1323, 25.1325, 25.1327, 25.1329, and 25.1331.)
- (4) Is the added magnetic compass compensated for deviation error not exceeding plus or minus 10 degrees on any heading in level flight? (FARs 25.1323, 25.1325, 25.1327, 25.1329, and 25.1331.)
- (5) If a magnetic compass is added, is a placard installed with the compass deviation error recorded? (FARs 25.1323, 25.1325, 25.1327, 25.1329, 25.1331, and 25.1547.)

d. Detail Design Standards:

- (1) Are the instrument panel vibration characteristics so as not to impair the accuracy of added instruments? (FARs 25.1323, 25.1325, 25.1327, 25.1329, and 25.1331.)
- (2) Are the applicable instrument connector tubings, flexible lines, electrical conductors, and cables to the added instruments considered satisfactory to perform their installations satisfactorily? (FARs 25.993, 25.1309, 25.1323, 25.1325, 25.1327, 25.1329, 25.1331, and 25.1337.)
- (3) Are instruments properly range marked or placarded? (FARs 25.1541, 25.1543, 25.1545, 25.1547, 25.1549, 25.1551, and 25.1553.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #33

1. SUBJECT: Gyroscopic Instrument System Installations, FAR 23 Aircraft
2. APPLICABLE FEDERAL AVIATION REGULATIONS

- 23.301 Loads
- 23.1301 Functional and Installational Requirements
- 23.1321 Arrangement and Visibility of Instrument Installations
- 23.1331 Gyroscopic Indicators

Gyroscopic instrument installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory.

3. CHECKLIST

a. Structural Requirements:

- (1) If holes are added to the instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 23.301.)

NOTE: This may normally be determined by visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

- (1) Are instruments securely mounted?

c. Operating Aspects:

- (1) Do the instruments perform adequately the function for which they were intended? (FAR 23.1301.)
- (2) Are the instruments installed in such a manner that they are easily visible for use by the pilot? (FAR 23.1321.)

d. Detail Design Standards:

- (1) Is the suction power source of sufficient capacity to operate all of the air operated gyro instruments installed at all airplane speeds above the best rate of climb speed? (FAR 23.1331.)
- (2) Is an indicating means provided which will indicate that the instruments are receiving adequate suction for their required performance? (FAR 23.1331.)
- (3) If the airplane is multiengine, does the suction air system provide satisfactory protection, in case of line breakage or leakage to an instrument, so as not to impair the performance of the other instruments? (FAR 23.1331.)

- (4) Is the electrical power supply of adequate capacity to operate all of the electrically operated gyro instruments installed? (FAR 23.1331.)
- (5) Does the power failure warning indication provide adequate warning to indicate when proper power is not being received by the instruments? (FAR 23.1331.)
- (6) If the airplane is multiengine, are two completely independent power sources provided which are actuated by separate means? (FAR 23.1331.)
- (7) If the airplane is multiengine, is the power source circuitry such as not to impair the operation of the instruments should breakage of an electrical conductor to an instrument occur? (FAR 23.1331.)
- (8) If the airplane is multiengine, is a positive means provided for selecting either power source? (FAR 23.1331.)
- (9) If the airplane is multiengine, is a means provided for indicating the power source output? (FAR 23.1331.)
- (10) Are the gyroscopic instruments and their systems installed to preclude malfunctioning due to rain, oil, and other detrimental elements? (FAR 23.1331.)
- (11) If an engine-driven suction air pump(s) is installed, is it compatible with the engine mounting pad and drive provided for such pumps? (FAR 23.1301.)
- (12) If an engine-driven suction air pump(s) is installed, are flexible type pump connector lines provided? (FAR 23.1301.)
- (13) Are the shock absorbing characteristics of the instrument panel satisfactory after adding equipment? (FAR 23.1321.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #34

1. SUBJECT: Gyroscopic Instrument System Installations, FAR 25
2. APPLICABLE FEDERAL AVIATION REGULATIONS

25.301	Loads
25.1163	Powerplant Accessories
25.1303	Flight and Navigational Instruments

- 25.1321 Arrangement and Visibility of Instrument Installations
- 25.1331 Functional and Installational Requirements
- 25.1433 Vacuum Systems

Gyroscopic instrument installations which are the same as those made by the airframe manufacturer, or other installations which are already approved, may be accepted without further investigation. On other installations, the following points should be checked to determine that the installation is satisfactory:

3. CHECKLIST

a. Structural Requirements:

- (1) If holes are added to the instrument panel, is the structural integrity of the panel or its supporting structure impaired? (FAR 25.301)

This may normally be determined by a visual check. If the panel or its supporting structure is an integral part of the airplane structure, caution should be used in the evaluation.

b. Hazards to the Aircraft or its Occupants:

None

c. Operating Aspects:

- (1) Do the instruments perform adequately the function for which they were intended? (FAR 25.1303)
- (2) Are the instruments installed in such a manner that they are readily visible for use by the pilot? (FAR 25.1321)

d. Detail Design Standards:

- (1) Is the power source of sufficient capacity to operate all of the air operated gyro instruments installed adequately during flight? (FAR 25.1331)
- (2) Is an indicating means provided which will indicate that the instruments are receiving adequate suction for their required performance? (FAR 25.1331)
- (3) If the airplane is multiengine, does the suction air system provide satisfactory protection, in case of line breakage or leakage to an instrument, so as not to impair the performance of the other instruments? (FAR 25.1331.)
- (4) Is the power supply of adequate capacity to operate all of the electrically operated gyro

instruments installed? (FAR 25.1331.)

- (5) Does the power failure warning indication provide adequate warning to indicate when proper power is not being received by the instruments? (FAR 25.1331.)
- (6) Is the power source circuitry such as not to impair the operation of the instruments should breakage of an electrical conductor to an instrument occur? (FAR 25.1331.)
- (7) If the airplane is multiengine, are two completely independent power sources provided which are actuated by separate means? (FAR 25.1331.)
- (8) Is a positive means provided for selecting either power source? (FAR 25.1331.)
- (9) Is a means provided for indicating the power source outputs? (FAR 25.1331.)
- (10) Are the gyroscopic instruments and their systems installed to preclude malfunctioning due to rain, oil, and other detrimental elements? (FAR 25.1331.)
- (11) If an engine-driven suction air pump(s) is installed, is it compatible with the engine mounting pad and drive provided for such pumps? (FAR 25.1163.)
- (12) If an engine-driven suction air pump(s) is installed, are fire resistant flexible type pump connector lines provided? (FAR 25.1433.)
- (13) If an engine-driven suction air pump(s) is installed, is a means provided to automatically relieve unsafe air temperatures on the exhaust (high pressure) port side of the pump? (FAR 25.1433.)
- (14) If engine oil is used as a lubricant and seal in a suction airpump, is the exhaust (high pressure) port outlet connected directly to an air/oil separator with a fire resistant line? (FAR 25.1433.)

AIRWORTHINESS COMPLIANCE CHECK SHEET #35

1. SUBJECT: Installation of Liquid Nitrogen Air Conditioners.
2. APPLICABLE REGULATIONS.
 - a. Federal Aviation Regulations, Part 23
 - 21.1(b) Applicability

21.16 Special conditions
21.21 Issue of T.C.; normal, utility, etc.
21.303 Replacement or modifications parts
21.305 Approval of materials, parts, processes, etc.
23.21 Proof of compliance
23.23 Local distribution limits
23.301 Loads
23.303 Factor of safety
23.305 Strength and deformation
23.307 Proof of structure
23.561 Emergency landing conditions
23.603 Materials and workmanship
23.605 Fabrication methods
23.609 Protection of structure
23.611 Accessibility
23.613 Material strength properties & design values
23.777 Cockpit controls
23.787 Cargo compartments
23.1357 Circuit protective devices
23.1365 Electric cables
23.1367 Switches
23.1519 Weight & center of gravity
23.1541 General (marking & placards)
23.1555 Control markings
23.1581 Airplane Flight Manual (General)
23.1589 Loading information
43.13 Performance rules (General)

b. Civil Aeronautics Manual, Part 3

3.0 Applicability
3.18 Approval of materials, parts, processes, and appliances
3.71 Weight & balance
3.76 Center of gravity position
3.171 Loads
3.172 Factor of safety
3.173 Strength and deformations
3.174 Proof of structure
3.292 Materials and workmanship
3.293 Fabrication methods
3.295 Protection
3.296 Inspection provisions
3.301 Material strength properties and design values
3.384(a) Cockpit controls
3.392 Cargo compartments
3.690 Fuses or circuit breakers
3.693 Electric cables
3.694 Switches
3.748 Airplane weight
3.755 Markings & placards
3.762 General - control markings
3.777 Airplane flight manual

c. Referenced Federal Regulations Other Than Federal Aviation Regulations

CFR Title 49 - Transportation, Chapter 1.

173.304(b)(2) Relief valve setting

178.57-20 LN2 pressure vessel markings

- (1) This ACCS has been developed with assumptions that the Liquid Nitrogen Air-Conditioning System would be permanent. However, it is not intended that any part of the checklist be deleted for so-called portable or temporary installations.
- (2) In general, systems installations which are the same as those made by the airframe manufacturer, or other installations which are already approved may be accepted without a detail investigation so long as the inspector satisfies himself that the system is the same.
- (3) On other installations, the following checklist is designed to guide the inspector to the criteria deemed necessary for the inspector to approve the system installation.

3. CHECKLIST.

a. Structural Requirements

- (1) Is the liquid nitrogen supply pressure vessel (the most common one in use is a Dewar, which is defined as a double walled vacuum bottle) located in a suitable location that places it as close as practical to the evaporator unit? (FAR 23.609, .611), (3.295)
- (2) Is the supply pressure vessel and evaporator unit mounted securely to a frame member or other structure so as to withstand the required inertial force levels? (FAR 23.301, .303, .307, .603, .605), 3.171, 3.18, 3.174, 3.292, 3.293). This determination may be made by direct comparison with an existing approved modification which has the same or similar weight, size, and design, or by structural analysis or static test.
- (3) Are the lines connecting the supply pressure vessel and the evaporator unit free of sharp or unusual bends or obstructions? (FAR 23.603, .605), (3.292, .293)
- (4) Are there adequate procedures taken to insure the integrity of the structure if installed in a pressurized aircraft? (FAR 23.303, .305, .603, .605, .607, .609), (3.18, 3.292, 3.293, 3.295). It is suggested that the inspector check with the controlling T.C. region for special considerations and supplementary special design conditions when

he is in doubt due to some unusual aspect of the aircraft.

- b. Hazards to the Aircraft or Occupants. Perhaps the greatest hazard involved in an LN2 system is the possibility of cold-liquid burns or the discharge of sufficient quantities of LN2 into poorly ventilated occupied areas as to reduce the oxygen content to dangerously low levels. The approving inspector should keep this in mind when inspecting LN2 installations. It is important that all components and plumbing be suitable for the handling of LN2.

(1) Does the LN2 supply pressure vessel or vessels have the proper markings? (Note: There are two acceptable markings. Federal Regulations Title 49 - Transportation Specification 4L or American Society of Mechanical Engineers Boiler and Pressure Vessel Code Standard for Unfired Pressure Vessels.)

- (a) 4L Specification pressure vessels will be marked DOT-4L followed by a number which indicates the design service pressure, i.e., DOT-4L200. This bottle could be operated at working pressures up to 200 PSI.
- (b) Pressure vessels manufactured to A.S.M.E. standards will be marked with a U or UM symbol stamped inside a shield.
- (c) The markings shall be stamped plainly and permanently on shoulder or top head of jacket or on a permanently attached plate or head protective ring.
- (d) In the event the pressure vessels are not marked as above the inspector should require proof that the components meet the requirements of FAR 43.13. (Reference AC 20-62A, paragraph 5 and 6)

(2) Are the valves, lines, fittings, and/or other hardware capable of withstanding the maximum pressures and flows the systems may be subjected to? (i.e., cylinders must be limited by a pressure control valve so sized and set that the pressure can never exceed 15 PSI lower than one and one fourth (1 1/4) times the marked service pressure. (Ref. Code of Federal Regulations, Title 49-Transportation, Section 173.304(b)(2). The working pressure of the LN2 system is likely to be considerably below the service pressure markings on the bottle. The service pressure is the pressure up to which the vessel is considered safe to operate while the working pressure is that which the particular system may be expected to

reach in normal operations.

- (3) Are the vent lines and the supply pressure vessel protected from the possibility of damage to the system by cargo or baggage placement or loading operation? (FAR 23.609, .787), (3.295, 3.292)
 - (4) Are the vent lines, pressure vessel lines, etc., located and supported properly in case of a crash landing giving due consideration to occupants survival? (FAR 23.561, .603, .605, .613, .787), (3.292, .293, .301, .392)
 - (5) Are the vent and burst tube discharge ends located where the escaping gas will not directly enter any cabin air or critical system intakes? (FAR 23.561, .603, .605, .613, .787), (3.292, .293, .301, .392)
 - (6) Are personnel protected from contact with the lines, liquid or gaseous nitrogen? (FAR 23.561)
 - (7) Are the evaporator moisture collecting pan-drain tube, burst disc-escape tube, and exhaust tube vented outside the aircraft without sharp tube bends what will restrict free flow? (FAR 23.603, .605, .609, (3.292, .293, .295)
 - (8) Are the ends of drain and vent lines accessible so they may be inspected and/or cleaned of obstructions and are they in a nonpositive pressure area so that adequate gas escape is possible? (FAR 23.603, .609), 3.292, .293, .295)
 - (9) Has the weight-and-balance effect including weight limitations been considered? Have appropriate placards and manuals been changed if necessary? (FAR 23.21, .23, .1589), (3.171, .748)
- c. Operating Aspects.
- (1) Is a gauge provided to show the pressure in the supply vessel? (FAR 23.1541), (3.755)
 - (2) Are the system controls readily accessible to the crew? (FAR 23.1367, (3.695)
 - (3) Is there a vent to discharge the LN2 overboard after the refrigeration is spent and to route excess overboard during refilling operations? (FAR 23.609), (3.295)
 - (4) Are controls properly placarded and visible and is the operating information available? (FAR 23.611, .1555, .1581), (3.755, 3.777)
- d. Detail Design Standards.

An important design consideration that must be considered in the design and installation of any cryogenic system is the hazard associated with line or tank rupture whenever liquified gas is trapped. Pressures can theoretically reach extremely high values if provisions are not made to furnish adequate relief. These provisions should take into account the possibility that relief, automatic or manual, valves may malfunction to trap LN2.

- (1) Are at least two methods of relieving excessive pressure in the cryogenic system provided? (FAR 23.603, .605, .609), (3.292, .293, .295). These must consist of at least one pressure relief valve that may be adjustable and a burst disc with a fixed rupture pressure.
- (2) Is the pressure relief valve set at a value not to exceed 15 PSI lower than one and one-fourth (1 1/4) times the pressure vessel marked service pressure? (FAR 23.609, .613, .1555, .1581), (3.295, .301, .755, .777) (Code of Federal Regulations Title 49 - Transportation, 1, 173, .304(b)(2).)
- (3) Is the burst disc rupture value not in excess of 150% of the working pressure of the pressure vessel. (FAR 23.603, .605, .609, .613), (3.292, .293, .295, .301)
- (4) Are the pressure relief valve and vent valve vented overboard? Is the burst disc vented overboard so that in event it should burst the cryogenic fluid will not strike personnel, damage essential equipment, structure, or deplete the oxygen level in the passenger compartment to dangerous levels. (FAR 23.609), (3.295)

NOTE: Safety precaution guides of commercial companies handling LN2 state that the oxygen level should not fall below 16% in spaces occupied by personnel. It would be difficult to make such a determination but the inspector should keep in mind that the expansion coefficient of LN2 is approximately 696 to 1 at 72 degrees F. Therefore, if a full supply vessel discharged rapidly into a passenger cabin area, it is possible dangerous oxygen levels could result.

- (5) Are the supply pressure vessel lines, relief valve and burst disc designed to operate at cryogenic temperatures at the pressure setting of the burst disc? (FAR 23.603, .605, .609, .613), 3.292, .293, .295, .301)

This may be determined by direct comparison with an existing approved installation which has the same or similar design. Material markings are specified in other sections of this ACCS. In the event direct comparison cannot be made the inspector should require proof that the systems valves and plumbing will withstand the pressures and temperatures involved.

- (6) Is the electric power supply properly connected to the fan and not overloading the electrical system when operating? (FAR 23.1357, .1351), (3.690, .693, .694)
- (7) Is the system installed so as to permit inspection without removal of other unrelated equipment? (FAR 23.611)