Attachment 2: Membrane Nitrogen Generator Performance Specification

PERFORMANCE SPECIFICATION
MEMBRANE NITROGEN GENERATOR

This specification is approved for use by the Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 **Scope.** This specification covers a shipboard nitrogen producer that employs membrane technology to separate nitrogen from ambient air.

2. APPLICABLE DOCUMENTS

2.1 **General.** The documents listed in this section are referenced in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of the list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 **Government documents.**

2.2.1 **Specifications, standards and handbooks.** The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see paragraph 6.2).

Federal Standards

FED-STD-595	Colors used in government procurement

Department Of Defense Specifications

MIL-S-16032	Switches and Detectors, Shipboard alarm systems
MIL-S-901	Shock test, H.I. (High Impact) shipboard machinery, and systems, requirements for
MIL-DTL-15090	Enamel, Equipment light gray, (Navy formula no.111)
MIL-DTL-24784/7B	Technical repair standards (TRS) for hull, mechanical, and electrical (HM&E) equipment, electronic equipment, and ordnance equipment
MIL-M-24784	Manual, technical, equipments and systems content, requirements for

Department of Defense Standards

MIL-STD-1472	Human Engineering
MIL-STD-777	Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships
MIL-STD-889	Dissimilar Metals
MIL-STD-167	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-1330	Standard Practice for Precision Cleaning and Testing of Shipboard Oxygen, Helium, Helium-Oxygen, Nitrogen and Hydrogen Systems
MIL-STD-38784	Standard Practice for Manuals, Technical: General Style and Format Requirements

Commercial Item Description

A-A-59155	Commercial item description nitrogen, technical

Department of Defense Handbooks

S9086-H7-STM-010/CH-262	Lubricating Oils, Greases, Specialty Lubricants and Lubricating Systems

S9074-AR-GIB-010/278	Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels
S9074-AQ-GIB-010/248	Requirements for Welding and Brazing Procedure and Performance Qualification
T9074-AS-GIB-010/271	Requirements for Nondestructive Testing Methods
0900-LP-001-7000	Fabrication and Inspection of Brazed Piping Systems
MIL-HDBK-470	Designing and Developing Maintainable Products and Systems
MIL-HDBK-2036	Preparation of Electronic Equipment Specifications
MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-STD-740B	Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment

(Unless otherwise indicated, copies of the above specifications, standards and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 **Non-Government Publications.** The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents, which are DoD adopted, are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of the documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see paragraph 6.2).

National Electrical Manufacturers Association

NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Max)

(Application for copies should be addressed to the National Electrical Manufacturers Association 1300 North 17th Street suite 1847 Rosslyn, VA 22209)

American Society of Mechanical Engineers (ASME)

Boiler and Pressure Vessel Code, Section VIII, Rules of Construction of Pressure Vessels

ASME PTD 9 – Displacement compressors Performance Test Code

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017)

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 45	Recommended Practice for Electrical Installations on Shipboard
IEEE 12207	Industry Implementation of International Standard ISO/IEC 12207: 1995 (ISO/IEC 12207) Standard for Information Technology

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, IEEE, P.O. Box 6804, Piscataway, NJ 08854-6804)

Society of Automotive Engineers (SAE International)

SAE J 1739 - Potential Failure Mode and Effects Analysis in Design (Design FMEA); Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA); and Potential Failure Mode and Effects Analysis for Machinery (Machinery FMEA)

(Application for copies should be addressed to the SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001)

Compressed Gas Association (CGA)

CGA G-10.1- Commodity specification for nitrogen

CGA G-10.1 may be obtained from the Compressed Gas Association, Inc. 1725 Jefferson Davis Highway, Arlington, VA 22202

International Organization for Standardization (ISO)

ANSI/ISO/ASQ Q9001-2000 – Quality Systems

3. REQUIREMENTS

3.1 General

3.1.1 **Requirements.** The production system shall be configured for installation in a shipboard compartment and be capable of automatically producing nitrogen meeting the flow rate, purity and quality levels specified herein. Product nitrogen will be produced using membrane generation technology assembled in a single skid package. The system shall be capable of performing its function safely in a shipboard environment, undergoing ship's motion (pitch, roll, list), and induced shock, vibrations, and Electro-magnetic interference (EMI). The producer shall contain a Programmable Logic Controller (PLC) or a similar device that monitors process conditions (pressures, temperatures, flow rates, and nitrogen purity) automatically to control the various components necessary to safely generate nitrogen at the specified pressure, flow, and purity. The producer shall be capable of operating in either manual or automatic modes. In automatic mode, the producer may go into standby mode to allow continuous operation when demand ceases or delivery pressure reaches 5000 psig. The producer shall

continue to operate for 10-15 minutes in the standby mode; if no further demand is required during the 10-15 minute standby period, the producer shall shut down. In the manual mode the producer automatically shuts down with no standby mode when 5000 psig is reached.

3.1.2 **Characteristics.** The production system equipment, components, subcomponents, assemblies and subassemblies shall be constructed for maximum reliability and from materials and construction suitable for a marine environment and the fluid being processed. The nitrogen membrane generator shall be designed for ease of maintenance by shipboard personnel. The system shall be designed so that any component or equipment failure will not cause operator injury or damage to adjacent components. The control system shall automatically detect out-of-specification conditions, record conditions, and secure the plant safely, at which time personnel actions can reestablish proper parameters. The system shall incorporate manual override features to permit operation in the event of controller failures. The system shall be constructed in such a manner as to minimize air borne noise and EMI emissions.

3.2 **First article.** When specified (see paragraph 8.2), a sample shall be subjected to first article inspection in accordance with paragraph 4.4.

3.3 **Performance Requirements.** The membrane nitrogen generator shall satisfy the following performance requirements.

3.3.1 **Capacity.** The nitrogen generator shall be capable of continuously producing not less than 99.5% purity nitrogen at a minimum storage flask accumulation rate of 24 SCFM while processing atmospheric air as specified in paragraphs 3.6.2 through 3.6.5.

3.3.2 **Purity and Quality.** Purity of the nitrogen produced shall be 99.5 % or greater, shall meet the requirements of A-A-59503, Type I (gaseous), Class 1 (oil-free), Grade B, and meet the following requirement for particulate, moisture, and hydrocarbon content: the product gas generated by the membrane nitrogen generator shall be a combination of Nitrogen, Oxygen, Argon, and trace contaminant gases normally found in ambient air; the product constituent shall not exceed 0.5% oxygen, 0.02 mg/L moisture and 50-ppm total hydrocarbons; no odor shall be detectable from the product. Use of a 10-micron filter on the discharge of the unit ensures compliance with the particulate size requirement.

3.3.3 **Product Gas Delivery Pressure.** The generator shall be capable of delivering nitrogen product gas at pressures up to 5200 psig under all ambient conditions specified herein.

3.3.4 **Air borne noise.** Continuously produced airborne noise levels shall not exceed 80 Decibels (dB) at any frequency.

3.4 **Utilities**

3.4.1 **Electrical power.** The integrated system shall require only one source of electrical power. The source power shall be 440 volts, 3 phase, 60 hertz (Hz) with a maximum voltage variation of plus 10%, minus 20% of rated voltage at 122 degrees Fahrenheit. The

maximum power demand shall not exceed 75 Kilowatts (kW). The average power demand shall not exceed 60 kW. One circuit breaker or overload protection will be provided by the installing activity. All electrical components necessary to ensure proper operation of the nitrogen producer shall be supplied and integrally mounted within the equipment. Each component making up the producer system shall be completely wired and interconnected. All required breakers and overload protection shall be supplied and integrally mounted. All control power shall be obtained from the main input power. No types of power other than electrical shall be used. The electrical insulation resistance of each independent electric circuit shall have a resistance to ground and to other independent circuits greater than 5 mega ohms. Electrical and thermocouple wire shall be clearly labeled and run through wire harnesses and/or conduits.

3.4.2 **Air supply.** Intake air at the conditions specified in paragraph 3.6.2 through 3.6.5 will be supplied to the production system from an independent ventilation supply. If air is required for operation of pneumatic systems or other equipment within the nitrogen producer, the air shall be taken from within the processing system itself.

3.4.3 **Water.** If any component or subassembly of the membrane nitrogen generator requires a shipboard-cooling medium, then that component or subassembly shall be capable of using seawater at a temperature of 97 degrees Fahrenheit maximum.

3.5 Physical Characteristics

3.5.1 **Dimensions and weight.** The system envelope dimensions shall not exceed 90 inches height, 147 inches width, and 46 inches depth. The height restriction includes the total height of the system component and the height gained by using resilient mounts including anticipated shock excursions. Maintenance clearances for any system component shall be considered as part of the dimensional restriction cited above. Total system weight shall not exceed 3 tons (6000 pounds).

3.5.2 **Operational life.** The producer shall be operated in the shipboard environment specified herein for a period of 25 years with no limit on the number of operating cycles. Minimum time between overhauls shall be 30,000 operating hours.

3.5.3 **Hatchable.** The assembled nitrogen production system shall be capable of fitting through a hatch opening measuring 66 x 26 inches.

3.6 Environmental

3.6.1 **Pitch, roll and list.** The producer shall operate at rated capacity and purity under the following specified pitch, roll, and list conditions:

Pitch - 4 degrees for an 11 second period
Roll – 15 degrees for a 15 second period
List – 5 degrees continuous

The producer shall not lose fluids or be damaged under the following conditions:

Operating at a fixed incline of up 15 degrees in any direction.
Operating while pitching at a maximum of 10 degrees up or down from its normal horizontal plane.
Operating while rolling a maximum of 30 degrees to either side of vertical.

3.6.2 **Intake air contaminants.** The producer shall produce nitrogen that will meet the purity requirements as set forth in paragraph 3.3.2 at the rate specified in paragraph 3.3.1 when the influent air contains contaminants in the concentrations listed below:

Contaminants	Concentration maximum by volume
Carbon Dioxide (CO2)	1000 p/ml
Water vapor (H2O)	Saturated
Nitrous Oxide (N2O)	5 ppm
Carbon Monoxide (CO)	20 ppm
Methane (CH4)	1 ppm
Sulfur dioxide (SO2)	1 ppm
Acetaldehyde (C2H4O)	1 ppm
Acetylene (C2H2)	2 ppm
Ozone	0.8 ppm

3.6.3 **Intake air temperature.** The producer shall produce nitrogen that will meet the purity requirements as set forth in paragraph 3.3.2 at the rate specified in paragraph 3.3.1 when operating in any ambient temperature between 40-122 degrees Fahrenheit.

3.6.4 **Intake air pressure.** The producer shall produce nitrogen that will meet the purity requirements as set forth in paragraph 3.3.2 at the rate specified in paragraph 3.3.1 when operating at any ambient sea level pressure between 14.0 to 15.0 psia.

3.6.5 **Intake Air Humidity.** The production system shall produce nitrogen that will meet the purity requirements as set forth in paragraph 3.3.2 at the rate specified in paragraph 3.3.1 when processing air at atmospheric temperatures between 40 – 122 degrees Fahrenheit and relative humidity between 0-95% RH (non condensing).

3.6.6 **Shock.** The production system shall meet Grade A, Class I and/or Class II, deck mounted equipment shock requirements in accordance with MIL-S-901. The use of previous shock tests extensions shall be used to the maximum extent practical. The use of resilient mounts requires the use of flexible interface connections for all shipboard interfaces. These interfaces shall be provided with the production system.

3.6.7 **Vibration.** The system shall meet the requirements of MIL-STD-167–1 Type I and Type II.

3.6.8 **Electromagnetic interference (EMI).** The production system shall meet and demonstrate compliance with the requirements of MIL-STD-461 Rev E (dated 20 Aug 1999) for Surface Ship, Below Deck, Metallic Hull installations.

3.7 **Materials.** The materials used shall meet the requirements specified herein. The selected material shall conform to the requirements of MIL-STD-777 with the following exceptions: brazed joints and brazed base bosses are not allowed. The materials used in the nitrogen system shall be suitable for use in a marine environment at the pressures and temperatures specified. Incompatible oil or grease shall not be used. Pipe threaded (tapered threads) materials are not approved. Materials used shall be limited to 300 series corrosion resistant steels, copper and copper alloys, silicon-bronze, 70/30 Cu-Ni, brass, or Monel. Carbon steel alloys may be used for structural supports. Materials selected shall be treated to prevent corrosion and provide a corrosion allowance for a 25-year life. Cast iron shall not be used**.**

3.7.1 **Dissimilar materials.** The use of dissimilar metals shall be minimized to preclude galvanic corrosion and shall be in accordance with MIL-STD-889 requirements for selection and protection of dissimilar materials. Where dissimilar metal joints are used, the joint construction shall preclude metal-to-metal contact and moisture entrapment at the gasket.

3.7.2 **Nonmetallic materials.** Nylon, combustible materials, or nonmetallic materials adversely affected or deteriorated by continued use shall not be used. Materials, including gaskets and valve packings, shall be compatible with cleaning solvents as specified in MIL-STD-1330.

3.7.3 **Compressor Heat Exchangers.** Material in all heat exchanger tube bundles that contact seawater shall be titanium or 70-30 Cu-Ni. Heat exchanger shells and compression cylinders contacting seawater can be made of non-corrosion resistant material if Zinc anodes are provided in the design. Heat exchangers shall be constructed to be suitable for their intended operating environment. Painted or coated carbon steel pipe and fittings shall not be used.

3.7.4 **Toxic chemicals, hazardous substances, or Ozone Depleting Chemicals (ODC's).** The use of toxic chemicals, hazardous substances, or ODCs shall be avoided whenever feasible. Materials used in the construction of the producer shall have no effect on the health of personnel when the materials are used for their intended purpose. Regardless of other requirements, materials and parts containing asbestos, cadmium, lithium, mercury or radioactive materials shall not be used.

3.7.5 **Recycled, recovered or environmentally preferable materials.** Recycled, recovered or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.8 **Compressors.** All compressors shall be an oil free design. The compressor shall be capable of operating continuously at the maximum delivery pressure (5000 psig) under environmental conditions specified herein without having to stop for cool-down. The lubricants

used shall be of an approved type listed in NAVSEA Technical manual S9086-H7-STM-010/CH-262.

3.9 **Nitrogen Separation Modules.** Membrane modules used in the generator shall be semi-permeable membrane gas separation modules capable of processing air from a suitable oil free air compressor and through its selectivity, permeability and solubility characteristic output a product gas conforming to the capacity and quality requirements indicated in paragraphs 3.3.1 and 3.3.2. The modules shall be capable of withstanding the environment in which they will be used. Otherwise, they shall be protected against chemical attacks from atmospheric contaminants, using known state of the art technology for their separation, such as dust filter, coalescent filter, ozone eliminators, etc.

3.10 **Piping, valves and fittings.** Unless otherwise specified, all piping, valves and fittings shall be in accordance with MIL-STD-777. Glass Reinforced Pipe (GRP) shall not be used. Pipe or tube made from Bessemer steel shall not be used. Piping, valves and fittings containing tapered pipe threads are not approved. Piping/tubing joints and terminals shall use straight threads with a face type O-ring seal, gasket or equivalent. O-rings used in the system piping shall be made of fluorocarbon material. Flexible hose connections are acceptable where installation on resilient mounts is required.

3.11 **Vessels.** Pressure containing vessels shall be in accordance with the ASME Boiler Pressure Vessel Code Section VIII for unfired pressure vessels.

3.12 **Pressure Gauges.** If used to manually operate the system, pressure gauges shall be simplex for indicating gauge pressure. Only pressure gauges utilizing a C-type bourdon tube as the elastic element shall be used for nitrogen service. The bore diameter throughout the element shall be not less than .025 inch. Liquid filled gauges shall not be used for nitrogen service. The gauge shall have a circular scale; dial configuration, style, pointer rotation and pointer interface shall be in accordance with ANSI B40.1.

3.13 **Pressure transmitters.** Pressure transmitters shall be 4-20 mA, two-wire, loop powered type. Dedicated pressure transmitters shall be provided to measure critical pressures.

3.14 **Flow meters.** Flow meters shall be two-wire differential pressure cell transmitter type, employing a rupture proof bellows design. Flow meters shall have a LCD indicator and shall generate a 4-20 mA output. Meters will read in inches of water or pounds per hour and shall be accurate to within plus or minus 4 percent of actual flow measurements. Normal operating readings shall be indicated within the middle one-third range of the indicator. The indicator shall be installed on a common instrumentation panel and/or the PLC display and measure, as a minimum, the production rate of the system in SCFM.

3.15 **Temperature indicating system.** A temperature indicating system measuring critical temperatures within the system shall be provided for automatic and manual operation. The system shall consist of individually installed resistance temperature detectors (RTDs) which are connected to one common temperature indicating unit mounted on the front of the generator components and to the PLC input/output modules.

3.16 **Intake filter.** Adequate intake filters shall be used to prevent particulate matter, fluids and other contaminants from potentially damaging membrane modules. The filter shall be removable and cleanable.

3.17 **Product filter.** A 10-micron product filter shall be provided to prevent contaminating the shipboard nitrogen distribution system. The filter shall contain a removable and cleanable CRES 300 series filter element.

3.18 **Product purity analyzer.** The producer shall be provided with a gaseous analyzer that is capable of measuring the nitrogen gas streams. The analyzer shall be of paramagnetic type (Servomex Model X540A or equivalent) accurate to within plus or minus 0.1 percent for measuring nitrogen purity. When nitrogen purity drops below 99.5 percent, the analyzer shall send a signal to dispose of or recycle the impure nitrogen. The delivery of nitrogen to storage when within purity specifications shall be automatic. Analyzer calibration equipment suitable for ship operator use and stowage shall be provided with the nitrogen producer, and shall include: calibration gas, cylinders, associated hoses, fittings, regulators, etc.

3.19 **Programmable Logic Controller (PLC).** A PLC or similar device programmed for complete, safe and reliable operation shall be contained within the oxygen generation and storage system. The PLC shall automatically sense control system parameters (temperature, pressure, bulk purity, etc,) and energize the system, produce and store nitrogen product in accordance with the capacity and purity requirements of this specification. The PLC shall be designed so that installation, operation, inspection, maintenance and adjustments can be accomplished without causing injury or damage to equipment. It shall be designed so that one failure will not cause or produce an unsafe condition nor shall it cause a ripple effect. The PLC's electrical system shall provide built-in safety features comprised of both hardware and software to guarantee safe system operation. The controller shall incorporate safety features for out of tolerance electrical voltages, and current. The PLC shall automatically detect out-of-specification conditions, record conditions, and secure the plant safely, at which time personnel actions would reestablish proper parameters. All software executables (PLC and PC), PLC ladder logic and PC source code; software tools (and/or licenses if applicable) and other software support information shall be provided with the producer. If PLC is password protected those passwords shall be supplied with the producer.

3.19.1 **Program Requirements.** The PLC shall be programmed to include functionality for Controlling, Alarming, and Data Storage (alarms and data). Data values shall be scaled in standard U.S. engineering units (PSI, Deg F, Gallons, Pounds, Feet/Inches etc.) in the PLC throughout the program, and made available to the operator interface and network as such. The PLC shall detect and record alarm conditions and shutdown data (i.e. overpressure conditions, controller memory faults, controller execution faults, heater over temperature and out of specification product purity levels) in the central processing unit for failure analysis. The failure data (time and date of system failure/shutdown as well as vital information on temperature, pressure, flow, liquid levels and valve position) shall be available for downloading.

3.19.2 **Inputs/Outputs (I/O).** The controller shall have sufficient I/O capability to input all process variables required for safe operation and output all manipulated variables required to completely and safely control the nitrogen production system. In addition, inputs for the following process variables are required to be entered into the controller for monitoring and remote data acquisition purposes: temperature, pressure, flow rate, and product purity. The PLC and its enclosure shall be designed with future expansion capability (and space) for at least two additional I/O modules of the same design as the base PLC without requiring modification to original enclosure or PLC rack. The generation system shall be provided with all necessary analog and digital interfaces to enable safe control of nitrogen production at the specified purity and rates. Provisions shall also be made to accept the analog/digital interface necessary as follows:

3.19.2.1 A remote emergency stop (kill) switch located just outside of the nitrogen producer compartment.

3.19.2.2 Signal interface from and to Damage Control (DC) Central to alert personnel staffing this space of an abnormal operational condition.

3.19.2.3 Ventilation failure alarm interlock.

3.19.3 **Network.** The PLC shall be provided with network interfaces for both Ethernet and Serial interfaces. The Ethernet interface must support both TCP/IP and UDP/IP protocols. The serial interface must support IEEE 1174 standard which adds interface functionality to serial communication links. This communication port shall allow temporary installation of a portable laptop to enable displaying information in the event of display failures.

3.19.4 **Memory.** The PLC shall be equipped with sufficient memory to perform all of the above functions and have at least 50 % excess capacity. The PLC microprocessor shall operate the producer, store pertinent data and transmit data to a graphical display via the computer.

3.19.5 **Programming interface.** The PLC shall be equipped with a local programming interface for a standard laptop computer using programming software. Software shall conform to requirements detailed in section 3.19.8. Controller software shall not be used as a final safety check for over temperature and over pressure fault detection. The controller shall be programmed for data acquisition from pressure and temperature transducers, differential pressure transducers, analog inputs and outputs and any other pertinent data points. The PLC shall input system parameters and shall use this data to provide operator prompting for system start up, operation, shutdown, emergency start up and shut down via a PC computer interface.

3.19.6 **Power Supply.** The PLC power supply shall be sufficient to power all the modules (Processor, I/O, Network) with 50% excess capacity. Controller, computer and graphics display power shall be obtained from the main input power of the producer. These power supplies shall be able to withstand/tolerate a 10% to 15% variation in line voltage and frequency change. When the voltage or frequency exceeds 1 to 3 AC cycles in duration the power supply shall issue a shutdown command to the processor.

3.19.7 **Operator Interface (OI).** The PLC shall be equipped with a direct interface to a programmable OI display. The OI shall be a flat panel color touch screen display

with programmable screen views. The OI shall contain graphical (programmable) pushbuttons and data displays as required for an operator to start, stop, manually control and view all processes required for safe nitrogen producer operation, such as failure messages and diagnostic information to assist in operation and trouble-shooting. The OI shall have separate screen views for alarming, trending, operator control and process monitoring of the nitrogen producer. Furthermore, the following OI are required: Power ON/OFF, Auto/Manual, Start, Stop, and as a minimum four lights to indicate Power ON, Warm-up Mode, Running, Stand By, etc. The PLC shall be capable of accepting input from the operator to allow for emergency operation. The operator shall be able to monitor and modify maintenance requirement messages, access troubleshooting test functions and monitor alarm set points and incident histories. The controller shall also be capable of interfacing with a computer and a touch screen display to enable transmission of real time data when prompted. The data recorder shall be able to download and record information from the controller processor via a suitable and portable communication interface (i.e. an RS-232 port).

3.19.7.1 **Operator Screen View.** The operator screen view shall provide a means for the operator to control the nitrogen producer. It shall have the ability to start and stop the producer via soft pushbuttons, and to manually take control of start up and shut down.

3.19.7.2 **Alarm Screen View.** The alarm screen view shall provide a display of all relevant alarm conditions associated with the nitrogen producer. The alarm screen shall provide a means for the operator to acknowledge and clear alarm conditions as appropriate.

3.19.7.3 **Trend Screen View.** The Trend screen view shall provide a means to graphically view several processes in real-time.

3.19.7.4 **Process Monitoring Screen View.** The process monitoring screen view shall provide a graphical view of the most relevant process variable to provide the operator a quick view of the nitrogen producer operation. It shall contain only the most relevant parameters (purity, pressures, temperatures, flows) needed to assess operation. Secondary level graphical views may be provided for display of additional detailed data parameters.

3.19.8 **PLC/PC Software Documentation.** All software (PLC and PC) shall be developed in compliance with IEEE/EIS 12207. If commercially available software meets all requirements specified herein, compliance to IEEE/EIS 12207 is not required. This would only be allowed if the commercially available software is utilized “as is” and NO software changes are required. Compliance with IEEE 12207 requires that all software development shall be planned, managed and documented appropriately throughout the software development life cycle. Those requirements of IEEE/EIS 12207 that are to be adhered to during the software development lifecycle shall be identified in the Statement of Work (SOW), Contract Deliverable Requirements Lists (CDRLs) and the associated Data Information Descriptions (DIDs). All developed software must have defined software requirements that are traceable from design to code and test. All software requirements must be consistent, feasible and verifiable. All developed software executables, source code and documentation shall be the property of the US Navy. The software shall NOT be considered proprietary. If passwords or other security measures are employed, those passwords, security measures and codes shall be delivered with

the producer. Commercially available software for PC and PLC communication can be used to enable the prompts/interactions stated herein. If this option is pursued, the government shall be supplied with all rights and licensing agreements for use of said software. All embedded software shall not be susceptible to potential viruses when using communication ports specified herein.

3.20 **Hour Meters.** A cumulative hour meter capable of recording up to a minimum of 999,999 hours shall be provided.

3.21 **Master switch shutdown.** The producer shall be provided with a master switch to shutdown all production equipment in the event of an emergency.

3.22 **Motors and controllers.** Motors and controllers shall be in accordance with paragraph 33.6 of IEEE 45: "Electrical equipment in hazardous locations should be of a type suitable for such locations (Class, Division, or Zone and Group) and be type tested and certified or listed to a specific American national product standard by an independent testing laboratory acceptable to the regulatory authority (authority having jurisdiction)".

3.23 **Enclosures.** Enclosures shall be NEMA 3 as defined by NEMA 250.

3.24 **Valves.**

3.24.1 **Control valves.** Valves shall be in accordance with MIL-STD-777 and as specified herein. Gate valves shall not be used in any throttling service. Valves shall have replaceable seats and discs. All control valves shall be equipped with an actuator-positioner assembly for automatic operation.

3.24.2 **Drain Valves.** A valve for oil sampling with locking device on the valve or cap shall be included on the compressors. Drain valves shall also be supplied to enable draining the heat exchangers.

3.24.3 **Automatic shut off and safety valves.** Electrically operated automatic shut-off valves shall be furnished with pneumatic actuators at the producer or compressor air inlet. The generation process shall be protected from abnormal pressures by safety valves. Safety valves shall be located in one region to facilitate inspection and shall be equipped with flanged or union type outlets connected to a single vent header. Safety valves shall conform to MIL-S-16032 or be approved by NAVSEA.

3.24.4 **Check Valve.** A check valve shall be supplied and installed on the nitrogen compressor discharge to protect the compressor from nitrogen distribution system surges.

3.25 **Pressure Switch.** A pressure switch capable of interacting with the PLC and the shipboard distribution system pressure shall be supplied with the unit to enable automatic start and stop of the generating system.

3.26 **Welding/Brazing.** Welding shall be in accordance with NAVSEA S9074-AR-GIB-010/278. All welding procedures and personnel shall be qualified in accordance with S9074-AQ-GIB-010/248. All brazing shall be performed in accordance with NAVSEA 0900-LP-001-7000. No component or piping system shall be soldered.

3.27 **Paint.** When tested the color shall match color number 26307 of FED-STD-595.

3.28 **Flexibility.** When tested in accordance with MIL-DTL-15090 the enamel shall show no evidence of cracking or flaking.

3.29 **Ergonomics.** MIL-STD-1472 takes precedence for ergonomics requirements not provided in this section.

3.29.1 **Access.** Adequate space shall be provided for personnel, their equipment, and free volume for the movements and activities that are required during operation and maintenance tasks under normal and emergency conditions.

3.29.2 **Fail-safe.** A fail-safe design shall be provided in those areas where failure can cause catastrophe through damage to equipment, injury to personnel, or inadvertent operation of critical equipment.

3.29.3 **Simplicity of design.** The equipment shall represent the simplest design consistent with functional requirements and expected service conditions. It shall be capable of being operated, maintained and repaired in the specified operational environment by personnel with a minimum of training.

3.29.4 **Functional use of colors.** Where not in conflict with color codes specified herein, colors used for functional purposes (e.g. visual displays, controls, workspaces, equipment connections) shall accommodate users with color deficient vision.

3.29.5 **Hazard protection.** Personnel protection from thermal, toxicological, radiological, mechanical, electrical, electromagnetic, pyrotechnic, visual, and other hazards shall be provided.

3.30 **Reliability and Maintainability.** The Mean Time between Failure (MTBF) shall not be less than 10,000 hours and a Mean Time to Repair (MTTR) of not greater than 4 hours. The scheduled general overhaul periodicity shall be at a minimum 10,000 operating hours for all wear parts excluding valves, rings, and filters. The minimum run time before maintenance of filters shall be 1000 hours. No more than 200 man-hours shall be required for all maintenance, planned and unplanned, between 10,000 hour overhauls. Required skill level for all maintenance, excluding overhauls, shall be shipboard level. Required skill level for overhauls shall be intermediate level.

3.31 **Operating Cycle.** The producer shall generate nitrogen at rated capacity within 15 to 20 minutes of start-up at ambient temperature. Upon starting the producer, it shall be capable of operating continuously and in a steady-state mode of operation for at least six hours at a time,

with up to six start-ups per 24 hours. The producer shall power up automatically when system pressure drops to 4,000 psig and shall run until system pressure is restored to 5,000 psig. At that time, the producer shall run for 10-15 minutes in standby mode in anticipation of further demand. If no such demand is created, the producer shall safely shut down.

3.32 **Identification plates and placards.** Identification plates and placards shall be provided for the identification of all piping, valves, vessels and subcomponents in the system, for emergency shutdown and start-up operating procedures and flow schematic of the process components. The placards are to be installed on the generating system panels.

3.33 **Logistics.** The logistic data shall be provided in electronic formats as follows:

3.33.1 **Drawings.** System drawings shall be provided in Auto Cad format. Other formats may be acceptable with NAVSEA written approval.

3.33.2 **Provisioning list.** A detailed list of maintenance and repair parts shall be provided in electronic format, including all the drawings required to catalog parts in the US Navy supply system.

3.33.3 **Technical Manual.** The technical manual shall include information for installation, operation, troubleshooting, lubrication, outline drawings showing overall dimensions and motor and controller drawings. Also included shall be exploded views, list of repair parts down to the lowest level, electrical data and diagrams, repair procedures, maintenance procedures and programmable controller program sequence. Installation instructions shall also be provided. The manual shall be in digital format. It shall contain links to the various sections in the technical manual for illustration purposes or for increased understanding of the matter being discussed. In order to demonstrate complicated maintenance items, a video link may be included. The manual shall be in accordance with MIL-STD-38784 and MIL-M-24784. (See paragraph 8.5)

4 VERIFICATION

4.1 **Purpose.** The purpose of the testing specified herein is to verify that the generation and storage system delivered to the US Navy conforms to all requirements specified.

4.2 **General Inspection Requirements.**

4.2.1 **General provisions for inspection.** Inspection, as used herein, shall be understood to mean the examination and applicable testing of materials, fabricated components, the manufacturing processes and the completed assemblies to determine and ensure conformance to the specifications set forth in the contract or purchase order.

4.2.2 **Responsibility for inspection.** The contractor shall provide and maintain a written inspection system which will assure that all supplies and services submitted to the Government for acceptance conform to contract requirements whether manufactured or processed by the contractor, or procured from subcontractors or vendors. The contractor shall

perform or have performed the inspections and tests required to substantiate product conformance to drawings, specifications, and contract requirements and shall also perform or have performed all inspections and tests otherwise required by the contract. The contractor's inspection system shall be documented and shall be available for review by the Naval Surface Warfare Center Carderock Division - Philadelphia Site, Naval Business Center, Bldg. 4, Philadelphia, PA 19112-5083, Attn. Code 9212, via the DCMC, fifteen (15) days after award of contract and throughout the life of the contract. The contractor shall notify the Naval Surface Warfare Center Carderock Division - Philadelphia Site in writing of any change to the inspection system. The inspection system shall be subject to disapproval if changes thereto would result in nonconforming product. Contractors currently operating under ANSI/ISO/ASQ Q9001-2000 or MIL-I-45208 quality system will be deemed acceptable under this provision.

4.2.3 **Responsibilities for compliance.** All items shall meet all requirements of section 3. The inspection set forth in this specification shall become part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract or purchase order. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of defective material, either indicated or actual, nor does it commit the Government to accept defective material. Requests for waivers or deviations shall be submitted using Forms DD 1694 and MIL-STD-973 as a guide. A "Request for Waiver" shall be used for government acceptance of all Type I and Type II nonconformance.

4.2.4 **Government Participation.** The contractor shall notify the procuring activity regarding the starting date of tests and examinations as soon as it is determined.

4.2.5 **Inspection System/Design Verification Test Plan.** A test and inspection system program plan shall be prepared and approved by the procuring agency prior to commencement of all tests and examinations required herein. The test plan shall address all required test procedures for verification of performance and functional compliance with the stated requirements of the complete system. The test plan shall also include all instrumentation, electrical hookups, test sequences, facilities, etc., which the contractor intends to use. All special test equipment shall be fully identified and provided to the government upon request as an accessory of the system. All special tools shall be identified and recommended as a requirement for the maintenance of the system. The use of special tools shall be kept to a minimum. In addition, the contractor shall perform a Failure Mode and Effects Criticality Analysis (FMECA), which shall be reviewed during the critical design review phase. The FMECA shall be performed in accordance with SAE J 1739. The analysis shall indicate clearly the design approach to mitigate all risk areas found during the FMECA analysis.

4.3 **Classification of inspections.** The Inspection requirements specified herein are classified as follows:

a. First article inspection (see paragraph 4.4)
b. Capacity conformance inspection (see paragraph 4.5)

4.4 **First article inspection.** First article inspection is accomplished for verification purposes to validate the vendor's conformance to this specification. The first article inspection shall consist of examinations and tests specified in paragraphs 4.6.1 through 4.6.21 (see paragraph 8.2).

4.5 **Capacity conformance inspection.** This inspection shall consist of examination and tests specified in paragraphs 4.6.2 through 4.6.4, 4.6.6, 4.6.7, 4.6.9, 4.6.12 through 4.6.17, 4.6.19 and 4.6.21 (See paragraph 8.2). Software quality assurance shall be developed, reviewed, tested and controlled in accordance with tailored requirements of IEEE/EIS 12207. Nonconformance to one or more requirements of this specification or failure of any one or more tests shall be cause for rejection.

4.6 **Testing.** Testing shall be conducted as specified herein. Upon completion of each test, all parts damaged by that test shall be replaced. A plan outlining procedures for all tests included herein shall be submitted to the government prior to commencement of any test.

4.6.1 **Membrane module compatibility to Ozone and other contaminants testing.** A small breadboard size membrane module shall be tested separately to verify conformance with the shipboard environment, as specified in paragraph 3.9. This test shall be performed before beginning the system manufacturing process. Air containing contaminates cited in paragraph 3.6.2 shall be supplied to the sample membrane modules to verify conformance with the operational life, as specified in paragraph 3.5.2. At specified intervals, the modules' polymeric fibers shall be tested for deterioration, as detected through loss of elasticity (embrittlement) and average molecular weight analysis of the fibers. Deterioration of the membrane modules' polymeric fibers under these environmental conditions, which can cause the material to deteriorate and flow downstream or become ineffective, resulting in potential system efficiency losses, shall constitute grounds for rejection and authorization to proceed with manufacturing will be negated. Evidence of prior ozone and air contaminant compatibility testing of the membranes, proving the integrity of the fibers under the shipboard environment, could be submitted for government review in lieu of accomplishing this test.

4.6.2 **Welded and silver brazed joint inspections.** All nondestructive test inspections shall be performed in accordance with T9074-AS-GIB-010/271. Inspection procedures and personnel shall be certified in accordance with T9074-AS-GIB-010/271. Silver brazed joints shall be tested in accordance with NAVSEA 0900-LP-001-7000.

4.6.3 **ASME BPVC section VIII vessels.** Presence of ASME Official code U-Symbol stamped or marked and a copy of ASME data sheet (Form U-1) will be accepted as evidence that pressure vessels and connections conform to ASME rules for construction of pressure vessels. This will be verified in accordance with paragraphs 3.11.

4.6.4 **Leak testing.** No leakage is permitted. Leak testing shall ensure the integrity of the assembled components and shall be accomplished during fabrication, assembly and on the completed assembled units. At the time of assembly, all vessels, piping, components and subassemblies shall be pressure tested with dry oil-free air or nitrogen and examined for leaks using a leak detector solution. The completed assembled unit shall be leak tested to expose

all leaks that are detrimental to the operation of the system, including leaks through the seat of valves, through the body of valves and through other piping components. All leaks shall be repaired prior to further testing. After final assembly, each producer shall be leak tested at normal operating pressure for a minimum of 8 hours. The pressure drop shall not exceed 2 percent of the test pressure after compensating for ambient pressure and temperature changes.

4.6.5 **Hydrostatic testing/cleaning.** The producer shall be hydrostatically tested to 150 percent of design pressure and held for 30 minutes or more. The hydrostatic testing may be accomplished immediately prior to cleaning using the cleaning fluid in accordance with MIL-STD-1330. After completion of the hydrostatic test, the generation system shall be cleaned and purged in accordance with the requirements of MIL-STD-1330. All consumables incompatible with the authorized solvent used shall be replaced after cleaning operations.

4.6.6 **Endurance Testing.** The first article producer shall be tested as follows to determine its capabilities to meet capacity, purity and delivery pressure requirements under the specified environmental conditions. During this test, the producer shall be operated in the manner outlined in the technical manual. The system shall be operationally tested for a minimum of 720 hours to determine conformance to the capacity, purity, delivery pressure, duty cycle and start up time specified in section 3. During this time, the producer shall be operated for a minimum of 4 hours under each of the conditions listed in paragraph 4.6.6.1 through 4.6.6.6 to demonstrate conformance to the required capacity, purity and delivery pressure. The capacity of the nitrogen generator shall be determined by the ASME flow nozzle method as outlined in ASME PTD 9. Alternately, the generator can be set up to fill a container of known volume to 5000 psig. The elapsed time to fill the container and the purity of the gas shall then be recorded and the fill rate calculated. The test is considered a failure if the fill rate is less than that specified in paragraph 3.3.1 at the purity requirement of paragraph 3.3.2. Nitrogen samples shall be taken and tested in accordance with CGA G-10.1 every 8 hours and forwarded to a certified laboratory for testing to ensure that the nitrogen purity is in accordance with paragraph 3.3.2. Additionally, the producer shall be subjected to the combined contaminant levels noted in paragraph 3.6.2 to determine its conformance with paragraph 3.3.2. Throughout the test the producer shall demonstrate its capability to deliver the product at the pressure requirements of paragraph 3.3.3.

4.6.6.1 **Pitch, roll and list.** The producer shall demonstrate its capacity to meet the pitch, roll and list conditions specified in paragraph 3.6.1. Failure to meet the capacity, purity and delivery pressure requirements shall be grounds for rejection. During the test, there shall be no excessive heating of any part.

4.6.6.2 **Intake air contaminants.** The system shall meet the requirements of paragraph 3.3.3, verified by chemical analysis of a nitrogen sample taken before discharge to storage. The sample shall be taken after the producer has been operating for 1 hour while being subjected continuously to the maximum intake contaminants, as listed in paragraph 3.6.2.

4.6.6.3 **Intake air temperature/PLC thermal testing.** The requirements of paragraph 3.6.3 shall be demonstrated. The production system shall clearly demonstrate its ability to operate continuously in the temperature range specified in paragraph 3.6.3. The PLC,

PC, graphical display and all interface cards/modules shall be subjected to thermal tests as specified in MIL-HDBK-2036. Temperature measuring instruments shall be placed at critical points throughout the endurance test. Failure criteria are defined in MIL-HDBK-454.

4.6.6.4 **Intake air pressure**. The requirements of paragraph 3.6.4 shall be demonstrated. The production system shall clearly demonstrate its ability to operate continuously in the pressure range specified in paragraph 3.6.4.

4.6.6.5 **Cooling medium**. The requirements of paragraph 3.4.3 shall be demonstrated. The production system shall clearly demonstrate its ability to operate continuously using cooling water set at the maximum temperature as specified in paragraph 3.4.3.

4.6.6.6 **Operational cycle/demonstration**. The production system shall be operated as specified in paragraph 3.30 to demonstrate its capabilities to meet the minimum operating duty cycle requirements. The demonstration shall meet the requirements of paragraphs 3.3.2, 3.3.3 and 3.3.4.

4.6.7 **Quality Conformance Operational Demonstration Test**. Each production and generation system built after the first-article-tested producer shall be tested as follows, to determine its capability to meet all capacity, purity and delivery pressure requirements under the specified normal atmospheric conditions while undergoing pitch, roll and list. The operational cycle shall demonstrate the production system capability to meet duty cycle and start-up time requirements. The test shall be conducted for a period of 110 hrs. These demonstrations can be accomplished, as outlined above in paragraph 4.6.6.6, but operating for a shorter amount of time as approved by the government. The capacity of the nitrogen generator shall be determined by the ASME flow nozzle method as outline in ASME PTD 9. Alternately, The generator can be set up to fill a container of known volume to 5000 psig. The elapsed time to fill the container and the purity of the gas shall then be recorded and the fill rate calculated. The test is considered a failure if the fill rate is less than that specified in paragraph 3.3.1 at the purity requirement of paragraph 3.3.2. Nitrogen samples shall be taken and tested in accordance with CGA G-10.1 every 8 hours and forwarded to a certified laboratory for testing to ensure that the nitrogen purity is in accordance with paragraph 3.3.2. Additionally, the producer shall be subjected to the combined contaminant levels noted in paragraph 3.6.2 to determine its conformance with paragraph 3.3.2. Throughout the test the producer shall demonstrate its capability to deliver the product at the delivery pressure requirements of paragraph 3.3.3.

4.6.8 **Airborne noise**. Each producer shall be tested in accordance with the requirements of MIL-STD-740B to determine conformance to paragraph 3.3.4. Testing shall include all modes of operation. Exceeding the specified noise level at any frequency will constitute failure to pass this demonstration.

4.6.9 **Electric power**. The producer shall be operationally demonstrated to conform to the requirements in paragraph 3.4.1. The power consumption requirement of the system shall be measured in kW to demonstrate the specification requirement.

4.6.9.1 **Electrical Insulation Resistance Test**. To determine conformance to Paragraph 3.4.1, an insulation resistance test shall be performed for the producer using the resistance function of a standard multimeter with current calibration. The test shall be conducted at temperatures between 40 and 122 degrees Fahrenheit. The system shall be divided into independent circuits. Each circuit shall have resistance to ground and to other independent circuits greater than 5 mega ohms.

4.6.10 **Dimensions and weight**. The dimensions and weight of the producer and all accessories shall be as described in paragraph 3.5.1. This will be verified by review of drawings and final assembly measurements.

4.6.11 **Shock**. The system shall meet the requirements of paragraph 3.6.6 and verified to be in accordance with MIL-S-901. Shock test extensions shall be used where possible and be in accordance with MIL-S-901.

4.6.12 **Vibration.** The system shall meet Type I (environmental) test requirements of MIL-STD-167-1. Vibration test requirement up to 25 hertz (Hz) shall be conducted.

4.6.13 **Electromagnetic interference**. The system shall demonstrate compliance with the requirements of MIL-STD-461 Rev E (dated 20 Aug 1999) for Surface Ship, Below Deck, and Metallic Hull installations. This includes the following methods: CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103. All documentation shall be in accordance with the respective Data Item Descriptions cited in 461E Section 6:

Electromagnetic Interference Control Procedures (EMICP): DI-EMCS-80199B
Electromagnetic Interference Test Procedures (EMITP) DI-EMCS-80201B
Electromagnetic Interference Test Report (EMITR) DI-EMCS-80200B

Testing however, is not required if the manufacturer can show by analysis, previous application data or other means that the equipment complies with the requirements specified, or that design is consistent with written guidelines intended to minimize conducted and radiated emissions and susceptibilities. The vendor shall provide EMI test documentation, analysis and/or design data to demonstrate compliance with this requirement in accordance with the documentation requirements specified above and/or the purchase order.

4.6.14 **Materials.** Materials used in the producer shall meet the requirements of paragraph 3.7. The materials shall be verified by drawing, specification and record reviews.

4.6.15 **Piping, valves and fittings.** The producer shall meet the requirements of paragraph 3.10 and shall be verified visually and by drawing, specification and record reviews. Use of unauthorized fittings (pipe threads or explosion bonded, inertial welded, or any other dissimilar metal fitting using a silver interlayer) constitutes failure to meet the requirements of paragraph 3.10. Integrity of the assembled components shall be verified through hydrostatic and leak testing in accordance with paragraphs 4.6.4 and 4.6.5.

4.6.16 **System component verification**. The producer components listed below shall be verified through visual inspection and where applicable through review of detail or source control drawings. Component operation within the integrated system shall be demonstrated during the quality conformance test.

4.6.16.1 **Product purity analyzer**. The producer analyzer shall meet the requirements of paragraph 3.18 and all shock, vibration and EMI requirements specified herein. The requirements of paragraph 3.18 shall be demonstrated in conjunction with paragraph 4.6.6.

4.6.16.2 **Programmable Logic Controller**. The PLC shall meet the requirements of paragraph 3.22 and be tested as specified in paragraphs 4.6.17 and 3.19.

4.6.16.3 **Hour meter**. The hour meter shall be verified visually to meet the requirements of paragraph 3.20.

4.6.16.4 **Master switch shutdown**. Operational demonstration of the switch and ability of the plant to respond to emergency shall be tested during endurance testing. The switch shall shut down the system without causing any damage to the system, components or subassemblies.

4.6.16.5 **Motors and enclosures**. Motors and enclosures shall meet the requirements of paragraphs 3.21 and 3.22 and verified in accordance with IEEE 45 and NEMA 250 respectively.

4.6.16.6 **Automatic shut off and safety relief valves**. Automatic shut off and safety relief valves shall meet the requirements of paragraph 3.24.3. Relief valves shall be set at the desired relief pressure on a test stand and the setting recorded prior to installation. Minimum recorded data shall be: valve identification, desired relief set point, actual relief set point, desired reset point, actual reset point, test medium used, person performing tests, pressure gauge range and scale increments, pressure gauge serial numbers and pressure gauge calibration date.

4.6.17 **Software verification and documentation**. The PLC shall meet the requirements of paragraph 3.19, verified by means of document reviews, unit testing (testing of the controller and PC software separately) and system testing (integrated into the entire system) via formal approved test procedures. Test procedures must identify the software requirements that are being tested. All passwords and security codes shall be demonstrated. All software documents and software test results shall be delivered with the producer.

4.6.18 **Paint**. The producer shall meet the requirements of paragraph 3.27 and verified in accordance with MIL-DTL-15090.

4.6.19 **Reliability and Maintainability**. To verify compliance with the requirements of paragraph 3.30, the manufacturer shall perform a FMECA in accordance with SAE J 1739 or MIL-STD-1629 as approved by NAVSEA, documented by a report provided to the government. To verify maintainability, a demonstration shall be conducted in accordance with MIL-HDBK-470. The government will select 10 maintenance items to be performed to verify the actual repair time.

4.6.20 **Identification plates and placards.** The producer shall meet the requirements of paragraph 3.32, verified visually. Operating instructions shall be validated during operational test.

4.6.21 **Logistics.** Drawings, provisioning list, and technical manuals shall meet the requirements of paragraph 3.33 and shall be physically validated through hand over hand comparisons between system drawings and the producer. Technical manual validation shall be performed by actual operation of the producer in accordance with the technical manual. All preventive and corrective maintenance tasks listed in the technical manual shall be performed in accordance with the technical manual. Any discrepancies discovered during validation shall be corrected before delivery.

5. INSTALLATION SUPPORT SERVICES

As specified in the contract, the contractor shall provide personnel with the necessary knowledge and expertise to assist with the onsite installation, start up and performance testing for each membrane nitrogen generator.

6. FIELD TRAINING SERVICES

As specified in the contract, the contractor shall provide personnel with the necessary knowledge and expertise to perform on-the-job training instructions to Navy personnel on-site. One class with approximately 16 students will be held for each membrane nitrogen generator unit installed. The contractor shall develop training aids and handouts for training and provide a certificate of award for all students who complete the training. Submittal of preliminary handouts shall be in accordance to DD Form 1423-1, Sequence No. A028.

7. PACKAGING AND CLEANING

7.1 **Packaging**. Packaging requirements shall be as specified in the Section D of the contract.

7.2 **Cleaning.** The system shall be cleaned per the requirements of MIL-STD-1330. The procedure shall be included in the test plan and submitted for review and approval. The system shall be shipped with a nitrogen pressure to prevent contamination of the system during shipping.

8. NOTES

(This section contains information of a general or explanatory nature that maybe helpful, but is not mandatory)

8.1 **Intended use**. The nitrogen producer covered by this specification is intended for shipboard use. The producer built to this specification is intended to replace the existing producer built to MIL-P-24344 (cancelled) or new acquisitions.

8.2 **Acquisition requirements**. Acquisition documents should specify the following:

8.2.1 Title, number and date of this specification.

8.2.2 Issue of DoDISS to be cited in the solicitation and if required, the specific issue of individual documents referenced (see paragraphs 2.2 and 2.3).

8.2.3 When first article is required. (See paragraph 3.2).

8.2.4 Supercession data. This specification does not supersede any other specification (see paragraph 8.1).

8.2.5 Specify required DFAR for the acquisition of all rights and data for all software and PLC codes developed under this specification.

8.2.6 The contractor shall submit to the government for review and approval an analysis of the proposed PLC interface. This report shall include a detailed description of each function, mode of operation and interaction between these modes. The report shall also describe the proposed operator interface for each of these functions and what will occur if the interface is used improperly or fails. For interactive interface, the report shall detail the conditions under which the operator can initiate actions.

8.2.7 The contractor shall provide a detailed test plan including test procedures intended to prove that its design is in compliance with the requirements of this specification.

8.2.8 The procurement activity shall require design reviews for the selection of hardware and software.

8.3 **Subject term (key word) listing**

NGEN
Inert gas generator
Hollow-fiber membrane
Nitrogen membrane
N2 generator
Nitrogen generator

8.4 **General information**. The equipment should be constructed for maximum reliability and operated, maintained and repaired by personnel with a minimum of training. The producer shall be hatchable and have as small a footprint as practicable but shall not exceed the dimensions listed in paragraphs 3.5.1 and 3.5.3.

8.5 **Technical manuals.** If technical manuals are required, specifications and standards that have been cleared are listed in DOD 5010.12-L. Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

8.5.1 Unless otherwise specified in the contract or order (see paragraph 6.2), technical manuals shall be prepared in accordance with MIL-M-24784. Preliminary manuals shall be submitted to the design review agency for approval and shall include all proposed sections completed. Unless otherwise specified in the contract or order, manuals shall include system components, assemblies, subassemblies and applicable drawings. Performance curves shall be furnished with the final manuscript.

8.5.2 Manuals shall include master drawings and certification data covering the complete operation, maintenance, and calibration instructions of all electrical equipment and instrumentation, including the controller/PLC, software instructions, etc.

8.5.3 Each manual shall include not less than the following illustrations covering the IMP:

8.5.3.1 Sectional assembly drawing.
8.5.3.2 Outline drawing.
8.5.3.3 Complete list of material corresponding to the sectional assembly drawing.
8.5.3.4 Certification data.

8.5.4 A minimum of two drawings of the complete system, taken 180 degrees apart on a horizontal plane shall be provided.

8.5.5 The calibration and alignment instructions in the manual shall describe in complete detail the means by which the required calibration and alignment are to be established. Exceptions to any part of those requirements may be granted only by providing a written technical justification for the said exception for the design review agency's approval.

8.5.6 The quantity and distribution of the technical manuals shall be as specified in the contract.

8.6 **Technical Repair Standard (TRS).** A TRS shall be provided upon initial introduction of new equipment. In addition, when configuration changes to in-production equipment are approved that would affect the adequacy of the TRS for repairs, a new TRS shall be provided.

8.6.1 TRS technical content shall include sufficient technical details to enable a repair, maintenance, or overhaul activity to restore the equipment's dimensions, clearances, and tolerances such that the equipment is capable of performing its function as originally specified and is capable of being logistically supported by the DOD logistics support system.

8.6.2 The TRS format and content shall conform to MIL-DTL-24784/7B and shall be approved and validated in accordance with this standard.

8.7 **Changes from previous issue**. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.