ATTACHMENT 1
N00173013-Q-0051

NAVAL RESEARCH LABORATORY

CHEMISTRY DIVISION

SPECIFICATION FOR
HIGH PRESSURE HYDROGEN GAS BOOSTER

4555 Overlook Avenue, S.W.
Washington, D.C. 20375-5000

Table of Contents

1.0 Scope 1
2.0 Applicable Specifications 1
3.0 Requirements 2
3.1 Design 2
3.1.1 Dimensions 2
3.1.2 Color 2
3.1.3 Label 2
3.1.4 Special Marking 2
3.1.5 Materials of Construction 2
3.1.6 System State Indicators 2
3.1.7 Operator interface 2
3.1.8 System Configuration 3
3.1.9 Auxiliary Requirements 3
3.2 Performance 4
3.2.1 Operating Gas Pressure Range 4
3.2.2 Operating Gas Temperature Range 4
3.2.3 Gas Flow Rate 4
3.2.4 Cleanliness 4
3.2.5 Safety 4
3.3 Verification 5
3.3.1 Acceptance Test 5
3.3.2 Product history 5
3.4 Maintenance 5
3.4.1 Warrantee 5
3.4.2 Spare parts 5
3.5 Documentation 5
3.6 Delivery 5
3.6.1 Location 5
3.6.2 Schedule 5

1.0 Scope

This specification defines the performance, design, and verification requirements for a hydrogen gas booster, hereinafter referred to as the item, which meets the specific requirements of the program. The hydrogen gas booster will be used as a part of a system for high-pressure gas loading and storage.

2.0 Applicable Specifications

The item will be a part of a pressurized gas loading system for hydrogen. The system must also be compatible with nitrogen and helium, which will likely be used for testing and leak testing. The system must be NEMA and NFPA compliant.

3.0 Requirements

3.1 Design

3.1.1 Dimensions

The item shall have physical dimensions such that it is easily transportable on single lane US roads without the use of oversize load escorts or any other special requirements for road transport. It is recommended that the item be able to fit in the dimensions of a standard 20 ft exterior Conex shipping container.

3.1.2 Color

The primary color of the item shall be red or maroon in color. This applies to components of the item that can be colored without affecting the functionality of the item.

3.1.3 Label

The item shall contain a label that includes:

1. Manufacturer
2. Customer: Naval Research Laboratory/US Navy
3. NRL Contract number
4. Date of manufacture
5. Part Number
6. Serial Number

3.1.4 Special Marking

The item shall have the label "Hydrogen Service" clearly visible in white letters on the red background, plus list relevant safety information related to stand off distances, fire, etc.

3.1.5 Materials of Construction

This item is to be used solely for the pressurization and storage of gaseous hydrogen (GH2), though inert gases (N_2 and He) may be used for testing purposes and other fluids for cleaning purposes. All wetted materials shall be compatible with and chemically stable in environments compliant with the fluids documents referenced in Section 2.0.

3.1.6 System State Indicators

3.1.6.1 Pressure

Pressure gauges shall be implemented to identify local states for any "zone" that is capable of retaining and venting pressure. Regions that are isolated with no vent path to atmosphere without first passing through a pressure indicated zone do not require pressure gauge use.

3.1.6.2 Temperature

A temperature sensor (thermocouple, RTD, etc) shall be implemented at the gas discharge port to validate discharge state.

3.1.7 Operator interface

The system shall contain a panel (or equivalent) showing the system state indicators and including an emergency stop button.

3.1.8 System Configuration

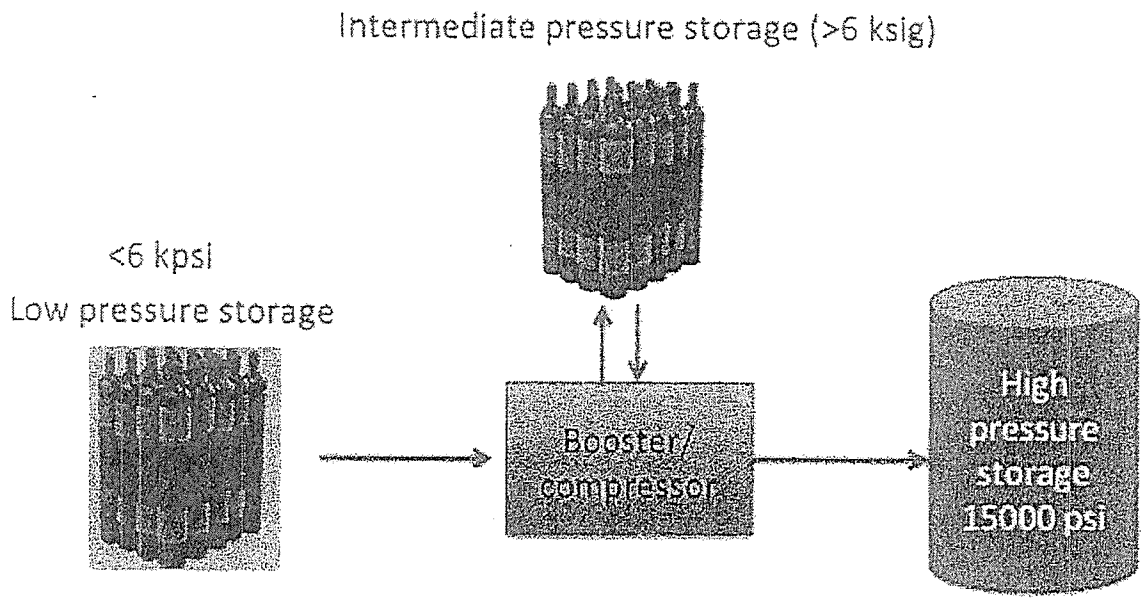

Figure 1 – System Configuration

The item shall be capable of operating in the configuration shown in Figure 1. i.e., valve control panel is sufficient for flow rerouting without having to break pneumatic connections.

3.1.8.1 Flow Bypass

The item shall be capable of flow bypass across the boosting device to allow pressure equalization between storage volume and loading volume prior to boost phase initiation.

3.1.9 Auxiliary Requirements

It is understood that typical gas boosters require auxiliary infrastructure and machinery to operate, including but not limited to closed loop water chiller, drive gas compressors, electrical transformers, etc. If such auxiliary devices are required for normal and proper operation of the gas booster, they shall be considered as part of the "item" to be provided by the manufacturer.

3.1.9.1 Auxiliary Electricity

If the item requires electrical power, a suitable interface for electrical connection shall be required. The system voltage shall be 480 VAC/3-phase or 230-VAC/3-phase. Electrical generator, or electrical power plant, is not considered part of auxiliary equipment.

3.1.9.2 Auxiliary Compliances

All auxiliary equipment shall comply with applicable ratings for operation in which they operate. e.g., electrical connections shall be NEMA compliant for hydrogen systems.

3.1.9.3 Shelter

3.1.9.3.1 Shelter Size

An outdoor shelter must be provided for housing the unit to protect it from the environment. It shall be large enough to allow a maximum of three persons to enter for comfortable operation and servicing of the item. It shall be truck-transportable.

3.1.9.3.2 Shelter Accommodations

The shelter be equipped with proper confined space monitoring equipment, such as but not limited to, gas concentration monitors, smoke/fire detectors, ventilation, etc.

3.2 Performance

3.2.1 Operating Gas Pressure Range

3.2.1.1 Inlet Pressure

The item shall be capable of operation with the inlet port at a minimum pressure of 500 psig to a maximum pressure of 6,000 psig. A lower minimum pressure of 100 psig is preferred.

3.2.1.2 Outlet Pressure

The item shall be capable of operation with the outlet port at a minimum pressure of 500 psia to at least 15,000 psia.

3.2.2 Operating Gas Temperature Range

3.2.2.1 Inlet Gas Temperature Range

The item shall be capable of operation with inlet gas temperatures at a minimum temperature of 5 °C to a maximum of 40 °C.

3.2.2.2 Outlet Gas Temperature Range

The item shall be capable of discharging outlet gas at no more than 100 °C.

3.2.3 Gas Flow Rate

The item shall be capable of flowing 500 standard liters per minute (sL/min) of GH2 at 15000 psi assuming 100% duty cycle operation. (One standard liter of GH2 is defined as one SI liter of GH2 at 14.7 psi and 20 °C.)

3.2.4 Cleanliness

3.2.4.1 Manufacturing.

The item's fluid paths and wetted surfaces shall be kept free from visible dirt and debris during the manufacturing process and prior to delivery.

3.2.4.2 Operation

The item shall be equipped with a high-capacity 5 micron absolute filter at the fluid inlet(s) and discharge outlet to provide particle free gas to the loading vehicle.

3.2.5 Safety

The item shall be equipped with a method to completely and safely discharge all trapped pressure for situations such as storage and maintenance.

3.2.5.1 Relief valves

Relief valves shall be implemented on inlet and outlet lines to make sure that no overpressure conditions occur.

3.3 Verification

3.3.1 Acceptance Test

The manufacturer shall perform an acceptance test to validate the general workmanship of the item. The acceptance test shall include, at a minimum:

1. Inspection of Product
2. Weight
3. Proof Pressure
4. Flow Rate
5. Internal Leakage
6. External Leakage
7. Electrical integrity (e.g., dielectric strength, insulation resistance)
8. Proper Cooling (if applicable)
9. External Leakage

3.3.2 Product history

The product must have a history of 10+ units delivered in the past 5 years and with unit operational histories of over one year.

3.4 Maintenance

3.4.1 Warrantee

The system shall come with a warrantee for 100 hrs of operation

3.4.2 Spare parts

The system shall be delivered with 2 spare parts kits.

3.5 Documentation

The system shall be delivered with the following documentation:

- Operation manuals
- Service manuals
- Electrical drawings
- Dimensions
- Plumbing schematics

3.6 Delivery

3.6.1 Location

The system shall be delivered to the Naval Research Laboratory in Washington DC.

3.6.2 Schedule

The system shall be delivered within 32 weeks of contract award.