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JOHN F. KENNEDY SPACE CENTER, NASA

SPECIFICATION FOR

RETEST AND REFURBISHMENT

OF

TYPE "K" COMPRESSED GAS CYLINDERS

FOR

GASEOUS AIR, HELIUM, HYDROGEN, NITROGEN, AND OXYGEN SERVICE

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHN F. KENNEDY SPACE CENTER, NASA
KENNEDY SPACE CENTER, FLORIDA

RETEST AND REFURBISHMENT OF TYPE "K" COMPRESSED GAS CYLINDERS FOR GASEOUS AIR, HELIUM, HYDROGEN, NITROGEN, AND OXYGEN SERVICE

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PREFACE

The Support Operations Maintenance Program involves a significant inventory of compressed gas cylinders. Monitoring of the inventory is accomplished by use of an automatic data processing (ADP) system. The purpose of this specification is to delineate minimum requirements for cylinder retest and refurbishment. Individual cylinder retest/refurbishment requirements are determined at various times; e.g., prior to filling each cylinder with product, upon receipt of product sample results, prior to certification expiration. It is the responsibility of the Support Operations operation and maintenance (O&M) support contractor to determine applicable individual retest/refurbishment function requirements, to implement appropriate work action, to maintain proper documentation, and to update the ADP records/tracking system. It is the long-range objective of this program to insure each cylinder is properly identified, configured, color-coded, and maintained to minimum cleaning and protective coating requirements to maximize cylinder serviceability in a safe, reliable, and economic fashion.

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SPECIFICATION FOR RETEST AND REFURBISHMENT OF TYPE "K" COMPRESSED GAS CYLINDERS FOR GASEOUS AIR, HELIUM, HYDROGEN, NITROGEN, AND OXYGEN SERVICE

1. SCOPE

1.1 Scope. - This specification establishes the minimum requirements for testing, stamping, cleaning, painting, color coding, and pressurizing of a specific type of compressed gas cylinder (assembly), commonly referred to as type "K".

1.2 Classification. - Type "K" compressed gas cylinders, hereinafter designated as cylinder, are Department of Transportation (DOT), formerly the Interstate Commerce Commission (ICC), Type 3A and 3AA seamless carbon steel cylinders having the following general characteristics:

(a) Height - 51 to 56 Inches

(b) Outside Diameter - 9 Inches

(c) Water Volume - 1.5 Cubic Feet

(d) Operating Pressure - 1,800 to 3,500 Pounds Per Square Inch Gage (psig)

1.3 Services. - This specification encompasses the following services:

(a) Cylinder Pickup and Return to KSC

(b) Rejection of Cylinder

(c) Cylinder Visual Inspection

(d) Cylinder Hydrostatic Test

(e) Cylinder Stamping

(f) Cylinder Internal Cleaning

(g) Cylinder External Surface Preparation

(h) Application of Cylinder Coatings/Color Coding

(i) Cylinder Valve Hydrostatic Test

(j) Cylinder Valve Visual Inspection

(k) Cylinder Valve Repair or Replacement

(l) Cylinder Valve Cleaning

(m) Cylinder Valve Functional Testing

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the date of invitation for bids or requests for proposal form a part of this specification and where referred to thereafter by basic designation only, are applicable to the extent indicated by the reference thereto.

SPECIFICATIONS

Federal

BB-N-411	Nitrogen, Technical
O-A-451	Ammonium Hydroxide, Technical
O-C-265	Chemicals, Analytical; General Specification for
O-O-670	Orthophosphoric (Phosphoric) Acid, Technical
O-S-598	Sodium Hydroxide, Technical
O-T-634	Trichloroethylene, Technical, Specification for
PPP-T-66	Tape: Pressure-Sensitive Adhesive, Vinyl Plastic Film
TT-I-735	Isopropyl Alcohol, Specification for

Kennedy Space Center

KSC-SPEC-F-0020	Coating, Organic and Inorganic Zinc Rich, Specification for
KSC-C-123	Cleanliness Levels, Cleaning, Protection, and Inspection Procedures for Parts, Field Parts, Assemblies, Subsystems, and Systems for Fluid Use in Support Equipment.

Military

MIL-L-19537	Lacquer, Acrylic-Nitrocellulose
MIL-C-81302	Cleaning Compound, Solvent, Trichlorotrifluoroethane
MIL-L-25567	Leak Detection Compound, Oxygen Systems
MIL-T-27730	Tape, Antiseize, Polytetrafluoroethylene, with Dispenser
MIL-P-27401	Propellant Pressurizing Agent, Nitrogen
MIL-P-27407	Propellant Pressurizing Agent, Helium
MIL-P-27201	Propellant, Hydrogen
MIL-P-25508	Propellant, Oxygen
MIL-V-2	Valves, Cylinder, Gas (for Compressed or Liquified Gases), General Specification for
MIL-V-2/5	Valve, Cylinder Gas: Air for Human Respiration, Outlet 1341
MIL-V-2/11	Valve, Cylinder Gas: Argon, Helium, Nitrogen, Neon, and Xenon (Inert-Oil Free), Outlet 581
MIL-V-2/29	Valve, Cylinder Gas: Hydrogen, Outlet 351
MIL-V-2/39	Valve, Cylinder Gas: Oxygen, Outlet 541

Johnson Spacecraft Center

SD-A-0019	Breathing Air, Specification for
SN-C-0037	Trichlorotrifluoroethane Solvent, Use Requirements

Aerospace Materials Specifications

AMS 3649A	Polytrifluorochloroethylene Film Unplasticized

STANDARDS

Federal

FED-STD-595 Colors

Kennedy Space Center

KSC-STD-S-0002 Identification and Color Coding of Compressed Gas Cylinders, Standard for

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General

3.1.1 Location. - Cylinders shall be received at and returned to Building K7-614, Kennedy Space Center (KSC), Florida.

3.1.2 Pressurization. - When received by the contractor, the cylinders shall be pressurized, with gaseous nitrogen, to 25 plus or minus 20 psig. The cylinders shall be depressurized and the cylinder valve shall be removed prior to any retest and refurbishment activity. The cylinders shall be pressurized per 3.15 prior to return to KSC.

3.1.3 Rejection of Cylinder. - Work on a cylinder shall be terminated when the cylinder is determined unsafe for continued service. A red danger tag shall be affixed to the rejected cylinder(s). The cause(s) of rejection shall be documented by cylinder serial number. The rejected cylinder shall be returned to Building K7-614, KSC. The rejected cylinder(s) shall be dispositioned by the contracting agency.

3.2 Visual Inspection of Cylinder. - Visual inspection of a cylinder shall include external and internal inspections. Visual inspection of a cylinder shall be performed by personnel with experience in inspecting DOT or ICC cylinders. Cylinders manufactured prior to 1 January 1941 shall be rejected.

3.2.1 External Inspection Requirement. - Each cylinder shall be inspected externally. The inspector shall record, for all defects, the type of equipment used, the defect location and description, and any measurements made. The categories of external defects are listed in 3.2.1.2.

3.2.1.1 External Inspection Equipment. - External corrosion, dents, bulges, cuts, digs, or gouges may be measured with a straightedge, scale, caliper, and depth gage. Ultrasonic, magnetic particle, or dye penetrant methods may be used to detect flaws.

3.2.1.2 External Defects. - Judgment, in addition to the specific requirements, shall be used in evaluating defects.

3.2.1.2.1 General Corrosion. - In addition to visual examination, general corrosion shall be evaluated by a hydrostatic test (3.3). Local pitting or line corrosion in the cylinder wall shall be cause for cylinder rejection when the depth exceeds 0.03 (1/32) inch.

3.2.1.2.2 Isolated Pits. - An isolated pit in the cylinder wall having a diameter smaller than 0.25 (1/4) inch shall be cause for rejection of the cylinder when the pit depth exceeds 0.06 (1/16) inch. An isolated pit in the cylinder wall having a diameter greater than 0.25 (1/4) inch shall be cause for cylinder rejection when the pit depth exceeds 0.03 (1/32) inch.

3.2.1.2.3 Dents. - Dents in the cylinder wall shall be acceptable to a depth of 0.06 (1/16) inch when the largest dent surface dimension is greater than 32 times the depth of the dent. Cylinders with sharper dents shall be rejected.

3.2.1.2.4 Bulges. - Bulges shall be evaluated by comparing a series of circumferential measurements. Cylinders shall be rejected if a variation greater than 1 percent is found in the measured circumferences.

3.2.1.2.5 Cuts, Digs, or Gouges. - Cuts, digs, or gouges shall be measured with a depth gage. Upset metal shall be compensated for to permit true measurement. Cuts, digs, or gouges in the cylinder wall exceeding a depth of 0.03 (1/32) inch shall be cause for cylinder rejection.

3.2.1.2.6 Arc or Torch Burns. - An arc or torch burn on a cylinder shall be cause for cylinder rejection.

3.2.1.2.7 Neck Defects. - Cracks, folds, and flaws in the neck threads may be cause for cylinder rejection.

3.2.1.2.8 Other Defects. - Wall cracks or evidence of a leak shall be cause for cylinder rejection. Wear may be acceptable on the edges of the bottom of the cylinder.

3.2.2 Internal Inspection Requirements. - Each cylinder shall be inspected internally prior to the cleaning operation. The inspector shall record, for all defects, the type of equipment used, the defect location and description, and any measurement made. The categories of internal defects are listed in 3.2.2.2.

3.2.2.1 Internal Inspection Equipment. - A light shall be used to illuminate the interior wall. The light shall be of sufficient intensity to produce a luminous flux density of 50 Lumen per square foot (Ft^2) at the cylinder wall. A boroscope may also be used for internal inspections. Thread gages may be used to measure effective internal threads.

3.2.2.2 Internal Defects. - When the extent of defect cannot be determined visually, the defect may be examined with a boroscope. Judgment, in addition to specific requirements, shall be used in evaluating internal defects.

3.2.2.2.1 Corrosion. - Corrosion may be cause for cylinder rejection.

3.2.2.2.2 Cylinder Internal Threads. - The number of effective threads shall be determined. A reduction in effective threads to less than 7 full threads shall be cause for cylinder rejection.

3.3 Hydrostatic Test of Cylinder. - Each cylinder shall be hydrostatic tested by the water jacket leveling burette method. The water jacket leveling burette method is discussed in 3.3.5. The hydrostatic test may be performed prior to or following the internal cleaning and external surface preparation. Refer to 3.3.7 for specific requirements based upon the sequence of performance of the hydrostatic test.

3.3.1 Test Water. - Water used for hydrostatic testing shall contain no visible contaminants and shall be inhibited with 0.5 plus or minus 0.1 percent by weight of sodium nitrite (Specification O-C-265) for rust prevention. Water temperatures inside the cylinder and in the water jacket should be equal within 5° Fahrenheit (F).

3.3.2 Test Pressure. - Each cylinder shall be evaluated by a hydrostatic test at five-thirds the service pressure stamped on the cylinder. Typical test pressures are as follows:

SERVICE PRESSURE	TEST PRESSURE
1,800 psig	3,000 psig
2,200 psig	3,667 psig
2,400 psig	4,000 psig
3,500 psig	5,833 psig

Any rerun of a hydrostatic test on a cylinder shall be performed at the test pressure plus 100 psig.

3.3.3 Test Apparatus. - The test apparatus shall consist of a test panel, a hydrostatic test pump, a water jacket, and associated piping. The test panel shall contain the expansion indicator, the pressure gage, the pressure recorder, and all control valves. The test apparatus (see Figure No. 1) must be certified in accordance with the requirements of 4.1.1. The following conditions are essential for accurate determination of the percent permanent expansion:

(a) The apparatus shall be so arranged that the water level in the expansion indicator will be the same during zero, the total expansion, and the permanent expansion readings. The expansion indicator water level shall be above the highest point of water in the jacket and connecting piping.

(b) Expansion indicator (burette) shall be accurate to within 1 percent of the total cylinder expansion.

(c) The pressure gage shall have an accuracy of 0.5 of 1 percent at the test pressure. The pressure gage shall have a sufficient number of divisions that enable reading to an accuracy of 1 percent at test pressure. The pressure gage shall have true zero marked on the dial. The accuracy of the pressure gage shall be verified by a deadweight testing apparatus at least once per year. An acceptable substitute, although less desirable, would be to test the pressure gage with a master gage deadweight tested during the past year.

(d) The pressure recorder shall have an accuracy of 0.5 of 1 percent at the test pressure. The pressure recorder shall agree with the pressure gage reading within 1 percent.

(e) The cylinder, under test, shall be suspended from the cover of the jacket or otherwise supported so that the cylinder is free to expand in all directions.

(f) Test apparatus shall be constructed and used so as to eliminate the presence of air pockets. Valves, piping fittings, and all connections shall be tight and free of leaks while cylinder is under test. The head of the jacket and all connecting pipes to the burette shall be designed with a continuous upward slope and with an air vent at the highest point. No air shall remain trapped in the jacket when the jacket is filled with water.

(g) The water jacket shall be constructed so that a connection can be made from the cylinder inlet port to the test apparatus. Seals shall be provided between the connector and the water jacket housing, and the water jacket housing and the cover. The water jacket shall be kept clean.

(h) A burst disc type safety device shall be provided on the water jacket.

3.3.4 Calibration Requirements. - Each day, before testing, the accuracy of the test apparatus shall be verified with a calibrated cylinder. If the test results with the calibrated cylinder do not agree with the certified test results within 1 percent, the cause of error shall be determined and corrected before further testing.

3.3.4.1 Calibrated Cylinder Description. - A calibrated cylinder is a cylinder that has been stretched permanently by means of hydraulic pressure greater than the maximum intended operating pressure. After the cylinder has been prestretched, the cylinder will have a definite expansion for a specific test pressure if the prestretched hydraulic pressure is not exceeded. A calibrated cylinder shall be considered an instrument.

3.3.4.2 Calibrated Cylinder Chart. - The calibrated cylinder shall be laboratory calibrated. The expansion increments shall be cubic centimeters (cc) versus test pressure (psig). A certified chart or curve shall be provided with the cylinder.

3.3.4.3 Care of Calibrated Cylinder.

(a) A calibrated cylinder shall not be used for any purpose other than calibrating or checking the accuracy of the test apparatus.

(b) Test water shall be sealed in the calibrated cylinder between calibration tests.

(c) A calibrated cylinder shall not be stored in any location subjected to freezing temperatures.

3.3.5 General Description of Test Method. - The water jacket leveling burette method (see Figure No. 1) requires that the cylinder be enclosed in a water jacket. The volume of water forced from the jacket is measured when the test pressure is applied to the interior of the cylinder. The pressure is released and the volume of water remaining displaced is measured. The two listed volumes represent the total and permanent expansion, respectively. The permanent expansion divided by the total expansion shall be used as a criterion for cylinder rejection (3.3.7).

3.3.6 Hydrostatic Test Procedure (see Figure No. 1). - The test pressure of each cylinder shall be recorded on a chart. The chart shall indicate each cylinder serial number and the date. The following hydrostatic test procedure shall be used.

(a) Fill cylinder (A) with water and attach the one piece test plug and suspension assembly (E) to the cylinder. Temporarily attach a J-shaped air tube into the concave section in the bottom of the cylinder and secure to the cylinder outside wall.

(b) Using hoist device, insert assembly (A&E) into water jacket (B). Ensure no air is trapped in the concave section, then remove J-shaped air tube. Secure assembly on jacket supports (C), then disconnect hoist.

(c) Attach high-pressure internal flex hose (F) to test plug (E).

(d) Close cover (Q); ensure tight gasket (T) by tightening cover clamps.

(e) Set zero of the burette (J) at the zero reference point (U). The zero reference point should be at the inspector's eye level.

(f) Open petcock (P), then open valve (I). After water flows from petcock (P), close petcock. When water in burette (J) rises to zero reference point (U), close valve (I). The water level in burette (J) may be adjusted to zero with petcock (P).

(g) Open valves (L and G), start pump (S) by depressing switch (M). Open valve (H) and close valve (G). Increase the cylinder pressure to 75 percent of test pressure. Close valve (H) and open drain valve (G).

(h) Examine test apparatus for leakage. Dropping pressure, falling water level in burette, or beads of water at connection points are indications of leakage.

(i) If no leaks occur, open valve (H), close drain valve (G), increase cylinder pressure to the test pressure, close valve (H), open drain valve (G), and stop pump (S) by depressing switch (M).

(j) Maintain the test pressure for a minimum of 30 seconds to allow complete cylinder expansion.

(k) Adjust the burette (J) so that the water level is at the zero reference point (U). Read the total expansion on the burette (J). Record the result per requirements of 4.2.

(l) Release the test pressure by opening valve (H). Adjust the burette (J) so that the water level is at the zero reference point (U). Read permanent expansion on the burette. Record the result per requirements of 4.2.

(m) After test is completed, unclamp the jacket cover (Q) and disconnect the high-pressure hose (F). Attach the hoist device to the test plug and suspension assembly (E) and remove the assembly (A&E) from the water jacket (B). Disconnect the lifting device. Remove the test plug and suspension assembly (E).

(n) Seal cylinders using a metal or plastic plug. The test water shall remain in the cylinder until the cleaning phase.

3.3.7 Hydrostatic Test Results.

3.3.7.1 Percent Permanent Expansion. - Determine the percent permanent expansion by dividing the recorded permanent expansion, 3.3.6 (l), by the recorded total expansion, 3.3.6 (k). Record results per the requirements of 4.2.

NOTE

If the hydrostatic test is performed after internal descaling (3.5.2.3.1), external surface preparation (3.6), and derusting and passivation (3.5.2.4.1), the cylinder shall be rejected if the permanent expansion exceeds 10 percent. This is the basic requirement for compliance to the DOT Regulations.

NOTE

If the hydrostatic test is performed prior to internal descaling (3.5.2.3.1.), and external surface preparation (3.6), and derusting and passivating (3.5.2.4.1), the cylinder shall be (a) acceptable for service if the permanent expansion does not exceed 7 percent, (b) rejected for service if the permanent expansion exceeds 9 percent, and (c) retested if the expansion is greater than 7 percent but is 9 percent or less. The acceptance of 7 percent expansion is limited to cylinders that undergo 5 minutes or less of dry blasting. Exceeding 5 minutes of dry blasting shall necessitate retest of the particular cylinder prior to placing in service.

NOTE

If the hydrostatic test is performed after internal descaling (3.5.2.3.1) or external surface preparation (3.6), but prior to derusting and passivating (3.5.2.4.1) the cylinder shall be rejected if the permanent expansion exceeds 9 percent. Any such cylinder showing 9 percent or less permanent expansion shall be acceptable for service. This is a KSC departure from the basic DOT requirement and compensates for possible cylinder wall reduction after performance of the hydrostatic test. Cylinder cleanliness levels would be destroyed if the hydrostatic test were performed after all cleaning activities.

3.3.7.2 Elastic Expansion. - Determine the elastic expansion by subtracting the recorded permanent expansion from the recorded total expansion. Record the results per the requirements of 4.2.

3.4 Cylinder Stamping.

3.4.1 Test Date. - Each cylinder that passes the hydrostatic test shall be stamped with the month and year of the test. The date shall be permanently stamped in the metal of the cylinder. For example: 1-71 for January 1971. The date stamp shall be located on the cylinder head near the previous test markings. The inspection agency symbol may be substituted for the dash mark between the month and the year.

3.4.2 Identification - Each cylinder shall be stamped with a four-digit number. The first digit shall indicate the product as shown below. For example, cylinder numbered 3525 would indicate the 525th GN_2 cylinder to be processed. This number is used as the tracking number in the ADP systems.

TRACKING NO.	PRODUCT
0001-0999	Gaseous Oxygen
1001-1999	Gaseous Hydrogen
2001-2999	Gaseous Helium
3001-3999	Gaseous Nitrogen
4001-4999	Breathing Air
5001-5999	(Reserved)
6001-6999	Gaseous Oxygen
7001-7999	Gaseous Nitrogen
8001-8999	(Reserved)
9001-9999	Nonroutine Used Cylinders

3.4.3 Stamp Size - The numeral height shall not be smaller than the previous marking or greater than 0.5 inch.

3.4.4 Existing Test Stamps - Existing test date stamps shall not be obliterated.

3.5 Internal Cleaning of Cylinders - Each cylinder with the exception of welding oxygen cylinders, shall be cleaned to meet visual inspection requirements (3.5.2.7) and shall conform to the particulate population and nonvolatile residue (NVR) requirements of 3.13.1 and 3.13.2 respectively, prior to being returned to service. Welding oxygen cylinders will not be cleaned unless they fail to meet the visual inspection requirements of 3.5.2.7. After cleanliness verification, the cleanliness level shall be maintained, otherwise the cylinder shall be rejected until compliance is obtained.

3.5.1 Cleaning Materials.

3.5.1.1 Biodegradable Detergent - Detergent, used in the cleaning process, shall be biodegradable.

3.5.1.2 Demineralized Water - Demineralized water used in the flushing operation shall have a pH between 6.0 and 8.0 and shall be maintained at a minimum specific resistance of 50,000 ohms per centimeter. The demineralized water shall be checked daily for conformance to the requirements.

3.5.1.3 Isopropyl Alcohol - Isopropyl alcohol, used in the cleaning process, shall conform to Specification TT-I-735.

3.5.1.4 Nitrogen - Nitrogen gas, used for drying, purging or preservation, shall conform, as a minimum, to Specification BB-N-411 (Type 1, Class I, Grade B), shall be filtered with a 25-micron absolute filter, and shall have a minimum dewpoint of minus 65° F.

3.5.1.5 Oakite 33. - Oakite 33, used in the cleaning process, shall be supplied by Oakite Products, Incorporated, 50 Valley Road, Berkeley Heights, New Jersey.

3.5.1.6 pH Paper. - The pH paper, used for pH determinations, shall be supplied by Anachemia Chemical Limited, Montreal, Champlain, New York.

3.5.1.7 Phosphoric Acid. - Phosphoric acid, used in the cleaning process, shall conform to Specification O-O-670.

3.5.1.8 Sodium Hydroxide. - Sodium hydroxide, used in the cleaning process, shall conform to Specification O-S-598.

3.5.1.9 Solvent. - Trichlorotrifluoroethane, conforming to Specification MIL-C-81302, or trichlorotrifluoroethane, conforming to JSC Specification SN-C-0037, shall be used as the flushing solvent. Before using, the solvent shall be filtered with a 25-micron absolute filter and shall be sampled and analyzed for NVR. The NVR result shall be used as the base for determining the NVR of the cylinder sample. See 3.13.2 for NVR analysis procedure.

3.5.2 Cleaning Procedure. - The following cleaning procedure shall be used to clean the cylinder internally.

3.5.2.1 Preparation and Inspection.

3.5.2.1.1 Draining. - Drain all liquid or purge gas from the cylinder.

3.5.2.1.2 Drying. - If cylinder contained liquid, purge with GN_2 until visibly dry.

3.5.2.1.3 Cleaning Methods. - Using a light of sufficient intensity to produce a luminous flux density of 50 Lumens/Ft^2 at the cylinder wall, inspect internal surface of cylinder. If oils or grease are present, perform 3.5.2.2. If scale, slag, or heavy oxides are present, perform 3.5.2.3. If cylinder has been processed by 3.5.2.3 or if rust is present, perform 3.5.2.4 through 3.5.2.11. If cylinder is free of oil, grease, slag, scale, rust, and heavy oxides, perform 3.5.2.8 through 3.5.2.11.

3.5.2.2 Cleaning Method No. 1.

3.5.2.2.1 Degreasing. - Degrease cylinder internally with solvent (3.5.1.9) or with a solution of sodium hydroxide, 10 plus or minus 2 percent by weight and non-ionic detergent, 0.01 plus or minus 0.002 percent by weight in potable water. Temperature of the solution shall be maintained at 180° plus or minus 10° F. Contact shall be 30 minutes minimum. Temperature of solvent shall be ambient and contact time shall be 15 minutes minimum.

3.5.2.3 Cleaning Method No. 2.

3.5.2.3.1 Descaling (Interior only).

3.5.2.3.1.1 Abrasive Blast Cleaning. - Dry abrasive blasting shall be used. The abrasive blasting material shall be a 20 to 30 grit silica sand, or mineral aggregate as manufactured by SAF-T-BLAST. The abrasive blasting equipment shall deliver 95 psig minimum continuous nozzle pressure throughout the abrasive blasting operation. Compressed air used for abrasive blasting shall be free of any moisture or oil. Surfaces shall be dry prior to abrasive blasting. Moisture condenses on any surface colder than the dewpoint of the surrounding atmosphere. Abrasive blast cleaning shall not be conducted when the steel surface is less than 5° F above the dewpoint of the surrounding atmosphere.

3.5.2.3.1.2 Internal Neck Thread Inspection. - The contractor shall inspect the cylinder internal neck threads prior to and following abrasive blasting operations to verify that threads were not damaged. Damaged threads shall be cause for cylinder rejection.

3.5.2.3.1.3 Safety Consideration. - The contractor shall take necessary precautions and comply with established standards to perform abrasive blasting operations in a safe manner.

3.5.2.3.2 Procedure for Internal Abrasive Blasting.

3.5.2.3.2.1 Interior Blasting. - The contractor shall use suitable probe/nozzle and shall abrasive-blast interior of cylinder, and remove all scale, slag, and heavy oxide. The duration shall not exceed 5 minutes. If total duration to remove scale, slag, or heavy oxides exceeds 5 minutes, the cylinder must be hydrostatic tested prior to verifying the cylinder fit for service.

3.5.2.3.2.2 Internal Neck Threads. - The internal neck threads shall be wire brushed. The discharge of the abrasive blast equipment shall not hit the neck threads.

3.5.2.3.2.3 Not used.

3.5.2.3.2.4 Cylinder Inspection. - After abrasive blasting, each cylinder shall be purged with gaseous nitrogen in an inverted position to remove loose grit or aggregate. The cylinder shall be purged with gaseous nitrogen until visibly dry. Reinstall cylinder plug upon completion of Paragraph 3.5.2.3.2.5.

3.5.2.3.2.5 Cylinder Inspection. - The cylinders shall be inspected using an inspection light of sufficient intensity to produce a luminous flux density of 50 Lumens/Ft^2 at cylinder wall and must be free from scale, slag, or heavy oxides. Repeat 3.5.2.3.2.1 through 3.5.2.3.2.5 until cylinder is free of scale, slag, or heavy oxides.

3.5.2.4 Cleaning Method No. 3

3.5.2.4.1 Derusting and Passivation. - Circulate through cylinder or fill cylinder and allow to dwell a solution of 40 plus or minus 10 percent by weight of phosphoric acid, or a solution of 50 plus or minus 5 percent of Oakite 33. Contact time shall be 5 to 30 minutes. Empty cylinder of solution after completion.

3.5.2.5 Alcohol Rinse. - Rinse the interior of each cylinder with isopropyl alcohol. Ensure all internal surfaces are wetted by the isopropyl alcohol and the wetted surfaces have a pH of 6.0 to 8.0.

3.5.2.6 Initial Drying. - Each cylinder shall be dried in an inverted position. Nitrogen shall be purged into each cylinder until the cylinder is visibly dry.

3.5.2.7 Internal Inspection. - The interior of each cylinder shall be visually inspected. A light shall be used to illuminate the interior wall. The light shall be of sufficient intensity to produce a luminous flux density of 50 Lumens/Ft^2 at the cylinder wall. Precautions shall be used to prevent contamination from use of inspection light. The cylinder(s) shall be recleaned per 3.5.2.3.2 if contamination is present inside the cylinder. Scale-free discoloration and passivation residues are permitted.

3.5.2.8 Solvent Flushing and Testing. - Each cylinder that meets the requirements of 3.5.2.7 shall be solvent flushed in an inverted position. Solvent used in the flushing process shall enter the cylinder through piping designed to give full spray coverage over the entire internal surface. After flushing, spray a measured amount of solvent (maximum 100 ml/Ft^2 of internal surface) and collect a representative sample, 500 ml or greater, at the effluent point of each cylinder. Analyze the sample per 3.13.1 and 3.13.2. Any cylinder failing to meet the cleanliness requirements shall be reflushed and resampled. A gaseous nitrogen purge shall be maintained in cylinder(s) while awaiting sample results.

3.5.2.9 Cylinder Drying. - Upon completion of cleaning level requirements, each cylinder shall be dried with gaseous nitrogen until effluent dewpoint is minus 65° F minimum. The cylinder(s) shall be dried in an inverted position.

3.5.2.10 Sealing and Preservation. - Each cylinder shall be pressurized to 15 plus or minus 5 psig gaseous nitrogen pressure. This shall be accomplished by using a Schrader-type valve or by installing the cleaned cylinder valve handtight and then pressurizing the cylinder. The valve shall be torqued prior to pressurizing to service pressure. See 3.14 for requirements for installation of cylinder valve.

3.5.2.11 Integrity Control Requirement. - Failure to maintain a positive pressure on cylinder(s) during performance of subsequent work shall be cause for cylinder(s) cleaning rejection and shall require sample analysis to verify cleanliness.

3.6 External Surface Preparation of Cylinder. - Each cylinder serviced by the contractor shall be externally cleaned by abrasive blasting. The cylinder cap shall be abrasive-blasted internally and externally.

3.6.1 Abrasive Blasting Preparation. - The cylinder neck threads and the cylinder cap internal threads shall be wire brushed. The threads shall be masked during blasting to prevent thread damage.

3.6.2 Abrasive Blast Cleaning. - Dry abrasive blasting shall be used. The abrasive blasting material shall be a 20 to 30 grit silica sand, or mineral aggregate as manufactured by SAF-T-BLAST. The abrasive blasting equipment shall deliver•95 psig minimum continuous nozzle pressure throughout the abrasive blasting operation. Compressed air used for abrasive blasting shall be free of any moisture or oil. Surfaces shall be dry prior to abrasive blasting. Moisture condenses on any surface that is colder than the dewpoint of the surrounding atmosphere. Abrasive blast cleaning shall not be conducted when the steel surface is less than 5° F above the dewpoint of the surrounding atmosphere.

3.6.3 External Surface Cleaning Requirement. - The cleaned surface shall be free of oil, grease, dirt, mill scale, rust, corrosion, oxides, paint, and other foreign matter. Slight discolorations caused by stain are acceptable. Cylinders failing to meet the cleaned surface requirement shall be reprocessed.

3.7 Application of Coatings/Color Coding of Cylinder.

3.7.1 General Requirements. - Each cylinder serviced by the contractor shall be painted with a protective coating (primer) and a colored topcoat. Each cylinder shall be lettered and color coded to depict the cylinder service medium.

3.7.1.1 Manufacturer's Instructions. - Manufacturer's instructions for thinning, mixing, and handling form a part of this specification.

3.7.1.2 Mixing Requirements. - The topcoat and prime coat may be from different manufacturers. The entire topcoat on an individual cylinder shall be from the same manufacturer. The entire primer coat, on an individual cylinder, shall be from the same manufacturer. Coating components from different manufacturers shall not be intermixed.

3.7.1.3 Finished Surfaces. - Finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish.

3.7.1.4 Container Requirements. - Coating shall be purchased in unbroken containers not larger than 5 gallons. The container shall be marked with the coating formula, specification number, batch number, color, date of manufacture, application instructions, and the manufacturer's name and address.

3.7.2 Protective Coating. - Each cylinder shall be painted with a protective coating of inorganic zinc primer.

3.7.2.1 Material Requirements. - The following requirements shall apply:

(a) Approved Sources of Supply for Inorganic Zinc Primer

NOTE

Any other product used shall require prior approval of the contracting officer and must comply with Specification KSC-SPEC-F-0020.

PRODUCT	MANUFACTURER NAME AND ADDRESS
D-6	Amercoat Corp. 201 N. Berry St. Brea, Calif. 92621
Carbo-Zinc 11	Carboline Co. 328 Hanley Industrial Ct. St. Louis, Mo. 63144
RB-1397	DeVoe Raynolds Co. 414 Wilson Ave. Newark, N.J. 07105
Mobil Zinc 7	Mobil Chemical Co. Edison, N.J.
Plasite 1000	Wisconsin Protective Coating Corp. 614 Elizabeth St. Green Bay, Wis. 54305

(b) Color Requirement. - A tint may be added that provides a color contrast with the base metal.

3.7.2.2 Application Requirements. - The external cylinder surface, including the bottom of the cylinder and neck threads, shall be painted with a protective coating. The cap shall be primed internally and externally. The following application requirements shall apply:

(a) Time Requirement. - External surfaces shall be painted with a protective coating within 6 hours after the external surface preparation. When the time interval exceeds 6 hours or the surface becomes contaminated, the surface shall be recleaned per 3.6.

(b) Preparation. - Before the protective coating is applied, all lint and dust shall be removed from the cylinder surface.

(c) Coating Thickness. - Protective coatings shall be applied to a dry film thickness of 3 to 4 mils. Verification of dry film thickness shall be accomplished with a calibrated film thickness gage. A calibrated thickness gage, such as that manufactured by Nordson Corporation, Amherst, Ohio, may be used.

(d) Damaged Surfaces. - Any damaged portion of the protective coating shall be recleaned and repainted. The damaged surface shall be cleaned with a power tool wire brush. Edges of the coating adjacent to the cleaned area shall be feathered so that the recoated surface has a smooth appearance. The cleaned surface shall be coated to a dry film thickness of 3 to 4 mils with an organic zinc primer.

3.7.3 Colored Topcoat. - Each primed cylinder shall be painted with a colored topcoat.

3.7.3.1 Material Requirements. - The following material requirements apply:

(a) Type. - The topcoat paint shall be a laquer, acrylic nitrocellulose material conforming to Specification MIL-L-19537.

(b) Color. - The color of the topcoat(s) shall conform to Federal Standard 595.

COLOR	COLOR NUMBER
Black	17038
Buff	17855
Gray	16187
Green	14110
White	17886
Yellow	13655

3.7.3.2 Application Requirements.

3.7.3.2.1 General. - Colored top coating shall be spray applied to all surfaces previously coated with zinc primer. The contractor shall verify that the zinc-primed surfaces are cured, dust free, and cleaned of all grease or other foreign matter prior to the colored topcoat application.

3.7.3.2.2 Tie-Coat. - A tie-coat shall be used if recommended by the primer or topcoat manufacturer. The tie-coat thickness shall be as recommended by the manufacturer.

3.7.3.2.3 Coating Thickness. - Colored topcoats shall be applied in accordance with manufacturer's instructions. Film thickness shall be as required to obtain uniform color and shall exhibit a high gloss appearance. Surface texture may feel rough due to the characteristics of the primer used.

3.7.3.2.4 Inspection. - The contractor shall ensure that all material requirements are met and that all finished surfaces are free from runs, drops, ridges, waves, laps, brush marks, bubbles, and variations in color, texture, and finish. Coatings shall be sufficiently dry before cylinders are handled. It may be desirable to allow a cure time of several days.

3.7.4 Touchup Refurbishment of Carbon Steel Surface. - The following is applicable to carbon steel surfaces with damaged primer coating or surfaces with local corrosion. Local corrosion is defined as corrosion concentrated in a given area.

3.7.4.1 Surface Preparation. - Damaged surfaces (primer or local corrosion) shall be prepared by power tool wire brushing.

3.7.4.1.1 Heavy Oil Deposits. - Prior to wire brushing, heavy deposits of oil or grease shall be removed by scraping and by wiping or scrubbing the surface with rags or brushes wetted with solvent. Final wiping shall be accomplished using clean solvent and clean rags or brushes that leave no residue on the surface. Small quantities of oil or grease may be removed by the wire brushing operation. Detergent steam cleaning for removal of oil or grease is permitted.

3.7.4.1.2 Wirebrushed Surface Finish. - The following defines the method for preparing a surface using power tool wire brushing:

> The metal surface is cleaned by using a commercial air or electric wirebrushing machine operated at a speed under load of 3,450 RPM and equipped with a 6-inch diameter cup brush, of double row knotted construction, made of No. 20 gage music wire (Osborn Manufacturing Co., Cleveland, Ohio, Brush No. 4503 or equal). The brush shall be held against the steel surface with a force of 16 pounds and the rate of cleaning shall be 2 square feet of surface per minute.

3.7.4.1.3 Adjacent Surfaces. - Edges of coating adjacent to power-tool-wirebrush-cleaned areas shall be feathered so that the recoated surface has a smooth appearance.

3.7.4.2 Inorganic Protective Coating. - Power-tool-wirebrush-cleaned areas shall be coated with an inorganic zinc primer.

3.7.4.2.1 Material Requirements. - The requirements specified in 3.7.2.1 are applicable

3.7.4.2.2 Application Requirements. - Organic coating shall be coated to a dry film thickness of 4 plus or minus 1 mil. Edges shall be feathered so that recoat has a smooth appearance.

3.7.5 Color Coding. - Each cylinder shall have a color code consisting of a base body color, an upper shoulder color and one or more 3-inch bands. The bands shall be separated by a 1-inch band of the body color. The exterior of all caps shall be painted black. The cylinder coding shall denote the service medium. No top coat is required for the lower 4 inches of the cylinder. See Figure 2 for an example of color coding.

SERVICE MEDIUM	SHOULDER	FIRST BAND	SECOND BAND	BODY
Air	Black	Green	None	Black
Helium	Buff	None	None	Gray
Hydrogen	Yellow	Black	None	Yellow
Nitrogen	Gray	Black	Black	Gray
Oxygen	Green	None	None	Green

NOTE

> Cylinders used in any service other than those specified shall be color coded in accordance with KSC-STD-S-0002.

3.7.5.1 Lettering. - Each cylinders shall be identified with the name of the service medium. See Figure 2 for an example of lettering.

(a) Location. - The service medium identification shall be painted twice on the cylinder wall. The identification shall be located parallel to the longitudinal axis of the cylinder and 180° apart.

(b) Type. - Identification shall consist of uppercase letters. The height of the letters shall be 1-3/4 to 2 inches.

(c) Color. - Cylinders having a body painted black, gray, or green shall be identified with white lettering. Cylinders having a body painted yellow shall be identified with black lettering.

3.7.6 Pallet Refurbishment. - Cylinder pallets shall be refurbished as required per the foregoing paragraphs prior to returning refurbished cylinders. The inorganic zinc coating will be gray in color when cured and have a dry film thickness of 4 to 6 mils. All faying surfaces, joint open less than 1/2-inch, and skip welded joints shall be totally sealed. The sealant shall be a self-curing, single component, polysulfide rubber type, and shall be gun-applied to the joint after coating material is dry. Color of sealant shall be gray.

3.8 Hydrostatic Test of Cylinder Valve. - Each cylinder valve serviced by the contractor shall be hydrostatic tested at 1.5 times the cylinder service pressure. The hydrostatic test shall be performed prior to disassembly. Cylinder valves failing the hydrostatic test shall be repaired or replaced. Cylinder valves passing the hydrostatic test shall have a seal affixed indicating the test pressure and date. Rejected cylinder valves shall be returned to Building K7-614, KSC.

3.9 Visual Inspection of Cylinder Valve. - Each cylinder valve shall be disassembled and visually inspected. Damaged, worn, or defective parts shall be repaired or replaced per the requirements of 3.10.

3.10 Repair or Replacement of Cylinder Valve. - All valve soft goods shall be replaced on valves being repaired or refurbished. Soft goods of new replacement valves will be cleaned and reinstalled. The soft goods for the valve shall be obtained from the manufacturer of that valve. Only Sherwood Selpac type TV valves will be used. Replacement valves and valve components shall conform to one of the following as required by the cylinder service medium and meet the requirements of NHB 8060.1 for material compatibility.

(a) Air Service. - Cylinder valves used on air cylinders will be Sherwood Selpac valve Part No. TV5865-28. The valve seat will be made of Kel-F 81 homopolymer material, Sherwood Selpac Part No. 1250-40K. Valves will have "AIR" electro-etched on the valve body.

(b) Helium or Nitrogen Service. - Cylinder valves used on helium or nitrogen cylinders will be Sherwood-Selpac valve Part No. TV5865-28.

(c) Hydrogen Service. - Cylinder valves used on hydrogen cylinders will be Sherwood-Selpac valve Part No. TV3565-28.

(d) Oxygen Service. - Cylinder valves used on oxygen cylinders will be Sherwood Selpac valve Part No. TV5445-28. The valve seat will be made of Kel-F 81 homopolymer material, Sherwood Selpac Part No. 1250-40K. Valves will have "GOX" electro-etched on the valve body.

(e) Outlet Plug. - All cylinder valves shall have a brass outlet cap or plug and an outlet ring-chain assembly. The outer edge of the cap or plug may be drilled with a No. 40 (0.0980 inch) bit to permit affixing lead seals on the valve. Stick on seals are permitted.

3.11 Cleaning of Cylinder Valve. - Cylinder valve components shall be cleaned while the valve is disassembled.

3.11.1 Cleaning Materials.

3.11.1.1 Biodegradable Detergent. - Detergent, used in the cleaning process, shall be biodegradable. Amway LOC, supplied by the Amway Corporation, Ada, Michigan, may be used.

3.11.1.2 Demineralized Water. - Demineralized water, used in the flushing operation, shall have a pH between 6.0 and 8.0, shall be filtered with a 25-micron absolute filter, and shall be maintained at a minimum specific resistance of 50,000 ohm-cm. The demineralized water shall be maintained at a minimum specific resistance of 50,000 ohm-cm. The demineralized water shall be checked daily for conformance to the requirements.

3.11.1.3 Nitrogen. - Nitrogen gas, used for drying, purging, or preservation, shall conform, as a minimum, to Specification BB-N-411 (Type I, Class I, Grade B), shall be filtered with a 25 micron absolute filter, and shall have a minimum dewpoint of -65° F.

3.11.1.4 pH Paper. - pH paper shall be used for pH determinations. pH paper supplied by Anachemia Chemical Limited, Montreal, Champlain, New York, may be used.

3.11.1.5 Phosphoric Acid. - Phosphoric acid, used in the cleaning process, shall conform to Specification O-O-670. Oakite 33, supplied by Oakite Products Incorporated, 50 Valley Road, Berkeley Heights, New Jersey, may be used.

3.11.1.6 Solvent. - Trichloroethylene conforming to Specification MIL-T-27602B, trichlorotrifluoroethane, conforming to Specification MIL-C-81302, or trichlorotrifluoroethane, conforming to JSC Specification SN-C-0037, shall be used as the flushing solvent. Before using, the solvent shall be filtered with a 25-micron absolute filter. The solvent shall be sampled and analyzed for NVR. The NVR result shall be used as a base for determining the NVR of the valve sample. See 3.13.2 for NVR analysis procedure.

NOTE

Trichloroethylene absorbs moisture.

3.11.1.7 Trichloroethylene. - Trichloroethylene, used in the cleaning process, shall conform to Specification MIL-T-27602B.

3.11.2 Brass and Bronze Components Cleaning Procedure. - Valve components made from brass or bronze shall be cleaned as follows:

(a) Degrease interior and exterior of all components in Type II trichloroethylene.

(b) Using a brush, scrub the interior and exterior of all components in a detergent solution of 2 to 3 ounces of biodegradable detergent per gallon of demineralized water. Maintain temperature of the solution at 140° plus or minus 10° F during scrubbing.

(c) Flush the components with demineralized water. Wet all surface areas during the flushing process.

(d) Immerse the components for 2 to 3 minutes in a phosphoric acid solution consisting of phosphoric acid, 15 percent by volume, per gallon of demineralized water.

(e) Flush the components with demineralized water heated to a temperature of 140° plus or minus 10° F. Wet all surface areas during the flushing process. After flushing, check the surface of each valve component for a pH reading between 6.0 and 8.0. Reflush and recheck valve components that do not meet the pH requirement.

3.11.3 Other Components Cleaning Procedure. - Valve components that are not made from brass or bronze shall be cleaned as follows:

(a) Using a brush, scrub the interior and exterior of all components in a detergent solution of 2 to 3 ounces of biodegradable detergent per gallon of demineralized water. Maintain the temperature of the solution at 140° plus or minus 10° F during the scrubbing process.

(b) Flush the components with demineralized water heated to a temperature of 140° plus or minus 10° F. Wet all surface areas during the flushing process. After flushing, check the surface of each valve component for a pH reading between 6.0 and 8.0. Reflush and recheck valve components that do not meet the pH requirement.

3.11.4 Initial Drying. - The interior and exterior of all valve components shall be dryed with gaseous nitrogen.

3.11.4.1 Initial Inspection. - The interior and exterior of all valve components shall be inspected. Contaminated components shall be recleaned per 3.11.2 or 3.11.3 as applicable.

3.11.5 Solvent Flush and Testing. - The interior and exterior of each valve component shall be flushed. The components from four valves shall be flushed with 500 ml of solvent. The solvent shall be collected and analyzed per 3.13.1 and 3.13.2. Valve components failing to meet the cleanliness requirements may be reflushed and resampled. Valve components failing to meet the cleanliness requirements on the second sampling must be recleaned per 3.11.2 or 3.11.3 as applicable.

3.11.6 Final Drying. - The interior and exterior of valve components that meet the requirements of 3.11.5 shall be dryed with gaseous nitrogen.

3.12 Functional Testing of Cylinder Valve. - The valve shall be reassembled, functionally tested, and sealed in an area with controlled environment. The area shall be totally enclosed and air-conditioned. No smoking shall be permitted in the area.

3.12.1 Reassembly. - Each valve shall be reassembled per the valve manufacturer's instructions.

3.12.2 Test Procedure. - Valves for helium or hydrogen cylinders shall be tested with helium per Specification MIL-P-27407. Valves for nitrogen, oxygen, or air cylinders shall be tested with nitrogen per Specification MIL-P-27401.

(a) Connect inlet of closed test valve to test medium supply.

(b) Connect outlet of closed test valve to vent.

(c) Apply cylinder service pressure to test valve and cycle valve from fully closed to open three times.

(d) Shut off pressure supply to test valve and close test valve.

(e) Tube outlet of test valve to a beaker of water.

(f) Apply test pressure to the closed test valve.

(g) Apply leak detection compound conforming to Specification MIL-L-25567 to the stem packing and safety device assembly.

(h) Ensure no seat leakage is observed through the tube and water set up in (e) above, or external leakage through stem and safety device assembly for a minimum of 1 minute.

(i) Shut off supply pressure to test valve and remove the tube from outlet port.

(j) Repeat steps (b) through (i) two more times.

(k) Plug test valve outlet port.

(l) With test valve in open position, apply test pressure.

(m) Apply leak detection compound to the stem packing safety device assembly and body joints. Ensure no leakage is observed from these areas for a minimum of 1 minute.

(n) If valves do not meet the requirement of steps (h) and (m), repair and retest, or replace.

3.12.3 Sealing. - The inlet and outlet connection of a cylinder valve that passes the functional test shall be sealed. The seal shall consist of a layer of nylon, cleaned to KSC-C-123 LEVEL 300A film material over, around and on the opening, and secured with a complete covering of pressure-sensitive tape. The film material for oxygen and air service valves shall conform to Specification AMS 3649A. The pressure-sensitive tape shall conform to Specification PPP-T-66. The sealed valve shall be placed in a clean polyethylene bag and stored until the valve is installed in the cylinder. Bags for air service valves shall be tagged "FOR AIR SERVICE". Bags for oxygen service valves shall be tagged "FOR OXYGEN SERVICE".

3.13 Sample Analysis Procedures. - All chemicals specified in the sample procedures shall be reagent grade.

3.13.1 Particulate Analysis Procedure. - The following procedure shall be used to determine the particulate size and population:

NOTE

A contaminated atmosphere may cause erroneous results.

(a) From the original sample, take a representative 500-ml sample.

(b) Filter a 500-ml sample using millipore equipment with a 0.45-micron millipore pad. Analyze the filtrate per 3.13.2.

(c) Examine the residue collected on the millipore pad with a microscope having a power factor of at least 45. Size the particles and fibers with a calibrated filar micrometer.

NOTE

A fiber is defined as a particle having a length to width ratio greater than, or equal to, 10 to 1.

(d) Determine the number of particles and fibers in each range listed in step (g).

(e) Divide the number of particles and fibers in each range by the number of square feet represented by the sample. The 500-ml from the original 1,000-ml sample taken from one cleaned cylinder shall represent 5 square feet. The 500-ml sample taken from the components of four cleaned cylinder valves shall represent 1 square foot.

(f) Record the results calculated for each of the particle and fiber ranges listed in step (g) per requirements of 4.2.

(g) Verify sample meets the following requirements:

PARTICLE SIZE	MAXIMUM PARTICLE POPULATION PER SQUARE FOOT
0-175 microns	No Limit
176-540 microns	40
541-950 microns	10
951-1,270 microns	3
1,271-1,635 microns	2
1,636-2,000 microns	1
2,001 microns plus	0

FIBER LENGTH	MAXIMUM FIBER POPULATION PER SQUARE FOOT
0-175 microns	No Limit
176-2,000 microns	10
2,000-4,000 microns	1
4,001 microns plus	0

3.13.2 Nonvolatile Residue Analysis Procedure. - The following procedure shall be used to determine NVR:

(a) Transfer the filtrate sample collected in 3.13.1 to a clean, degreased 800-ml beaker.

(b) Evaporate the sample to a volume of 15 plus or minus 5 ml in a steam bath or on a hotplate maintained at a maximum temperature of 220° F.

(c) Transfer the sample to a constant weight 30-ml weighing bottle having a constant tare weight within 0.3 milligrams (mg) and weighed to the nearest 0.1 mg. Record the tare weight on work sheet.

(d) Place the weighing bottle in a constant-temperature oven normalized between 221° to 230° F. Leave the weighing bottle in the oven for 1.5 hours, or until the sample has evaporated to dryness.

(e) Remove the weighing bottle from the oven, and cool in a desiccator.

(f) When cool, weigh the weighing bottle to the nearest 0.1 mg. Record the results on work sheet.

(g) Place the weighing bottle back in the normalized oven, step (d). After 30 minutes, remove the weighing bottle and cool in the desiccator. When cool, weigh the weighing bottle to the nearest 0.1 mg.

(h) Repeat step (g) until two consecutive results are equal within 0.3 mg. Record the results on work sheet.

(i) Subtract the tare weight of the weighing bottle from the result obtained in step (h). Record the results on work sheet.

(j) Subtract the base solvent NVR content (Reference 3.5.1.9 or 3.11.1.6) from the NVR result obtained in step (i). Record the result on work sheet.

(k) Divide the result obtained in step (j) by the number of square feet represented by the sample. (Use 5 square feet for cylinder samples, and 1 square foot for valve sample.) Record the result per requirements of 4.2.

(l) Verify sample has NVR result that does not exceed 1 mg per square foot.

3.14 Installation of Cylinder Valve.

3.14.1 Cylinder Requirement. - The cylinder shall have a positive pressure when the seal is broken. Cylinders without a positive pressure shall be recleaned per 3.5.

3.14.2 Valve Requirement. - At time of reinstallation, any valve that has broken seals on the inlet or outlet connectors shall be recleaned per 3.11.

3.14.3 Sealant. - The external inlet threads of the valve shall have one wrap of Teflon thread tape as the sealant. The tape shall conform to Specification MIL-T-27730.

3.14.4 Torque. - The valve shall be installed in the cylinder, and torqued to 175 plus or minus 25 foot-pounds.

3.15 Pressurization of the Cylinder.

3.15.1 Hydrostatic Test Date. - Verify cylinder has been stamped per requirements of 3.4.

3.15.2 Visual Inspection. - Inspect cylinder for evidence of damage. Damaged cylinders shall be further evaluated per the requirements of 3.2.

3.15.3 Evacuation. - Each cylinder shall be evacuated to a minimum vacuum of 200 microns before pressurization.

3.15.4 Service Pressure. - Each cylinder shall be pressurized to the stamped service pressure on the cylinder.

3.15.5 Leak Check. - The cylinder valve shall be leak checked at the service pressure. Leak detection compound complying with Specification MIL-L-25567 shall be used. Leaking valves shall be repaired or replaced. The cylinder valve shall be leak checked after repair or replacement.

3.15.6 Cap. - The cap shall be installed on each pressurized cylinder.

3.16 Gas Sampling and Content Requirements.

3.16.1 Gas Sampling Requirement. - A 3-liter, laboratory-certified, stainless steel, sample bottle shall be used for collecting gas samples. The bottle shall be purged prior to collecting the sample. A sample bottle pressurized to 950 plus or minus 50 psig should be sufficient to perform all analyses.

3.16.1.1 Helium and Nitrogen Sample Requirement. - Cylinders filled with either helium or nitrogen may be lot sampled. A lot shall consist of twenty cylinders on the pallet. Each cylinder shall be sampled if the lot sample shows non-conformance to the requirements of 3.16.2.2 or 3.16.2.4.

3.16.1.2 Air, Hydrogen, and Oxygen Sample Requirements - Each cylinder filled with air, hydrogen, or oxygen shall be sampled. If it is more convenient to take cylinders to a laboratory for analyses, the sample technique of 3.16.1 may be waived.

3.16.2 Content Requirements. - Cylinder content shall meet the color code identification as specified in 3.7.5. The outlet of the cylinder valve shall have a seal affixed. A certification sticker verifying that the contents conform to the specification shall be affixed to the cylinder valve.

3.16.2.1 Air Cylinders. - Air cylinder samples shall be analyzed and certified as meeting the requirements of JSC Specification SD-A-0019.

3.16.2.2 Helium Cylinders. - Helium cylinder samples shall be analyzed and certified as meeting the requirements of Specification MIL-P-27407.

3.16.2.3 Hydrogen Cylinders. - Hydrogen cylinder samples shall be analyzed and certified as meeting the requirements of Specification MIL-P-27201.

3.16.2.4 Nitrogen Cylinders. - Nitrogen cylinder samples shall be analyzed and certified as meeting the requirements of Specification MIL-P-27401.

3.16.2.5 Oxygen Cylinders. - Oxygen cylinder samples shall be analyzed and certified as meeting the requirements of Specification MIL-P-25508.

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4. QUALITY ASSURANCE REQUIREMENTS

4.1 Certifications.

4.1.1 Hydrostatic Test Facility. - The hydrostatic test facility shall be approved by the Bureau of Explosives, 1920 "L" Street Northwest, Washington, D. C. 20036. The contractor shall be responsible for coordination with the Bureau of Explosives to have a representative inspect the test apparatus and witness the test procedure. Approval, by the Bureau of Explosives, shall not exceed an interval of 5 calendar years.

4.1.2 Chemicals and Materials. - All chemicals and materials shall be certified and maintained to applicable referenced government specifications. Certifications shall be maintained on file and be available to the contracting officer.

4.1.3 Calibrations. - The calibration interval for all measuring and testing equipment used in performance of this specification shall not exceed 1 calendar year. The calibrations shall be traceable to the National Bureau of Standards.

4.2 Documentation. - The contractor shall furnish the data forms used to document the work completed in accordance with this specification. All inspection and analysis data shall be prepared by the contractor, and stamped by the contractor's inspector. A data package shall be compiled for each pallet of twenty cylinders. A copy of each data package shall be furnished the customer. The data package shall contain an individual "Test and Inspection Report" for each of the twenty cylinders.

4.2.1 General. - The individual "Test and Inspection Report" shall include the following:

(a) Date of Report

(b) Report and Contract Number

(c) Cylinder Serial Number

(d) Valve Manufacturer's Name and Part Number

(e) Service Medium

(f) Service Pressure Stamped On Cylinder

(g) Acceptance for Continued Service or Reasons for Rejection

(h) Inspector's Stamps

(i) Authorized Contractor's Signature

4.2.2 Visual Inspection. - The individual "Test and Inspection Report" shall contain the results obtained in 3.2.1 and 3.2.2.

4.2.3 Hydrostatic Test. - The individual "Test and Inspection Report" shall include a copy of the pressure recording chart (Reference 3.3.6) and the test results as recorded in 3.3.6 and calculated per 3.3.7.

4.2.4 Cylinder Cleaning. - The individual "Test and Inspection Report" shall contain the results of cylinder cleaning as determined in 3.13.1 and 3.13.2.

4.2.5 Cylinder Painting/Color Coding. - The individual "Test and Inspection Report" shall contain the following:

(a) Protective Coating Data (Reference 3.7.1.4)

(1) Manufacturer.

(2) Specification Number.

(3) Batch Number.

(4) Color.

(5) Date of Manufacture.

(b) Application Requirements (Reference 3.7.2.2)

(1) Time in hours between blasting and applying coating.

(2) Protective coating film thickness expressed in mils.

4.2.6 Valves. - The individual "Test and Inspection Reports" shall contain the following data for the cylinder valve:

(a) Hydrostatic Test Pressure expressed in psig (Reference 3.8).

(b) Results of Visual Inspections (Reference 3.9).

(c) Description of Replacement Items (Reference 3.10).

(d) Results of Cleaning (Reference 3.13.1 and 3.13.2).

4.2.7 Cylinder Assembly. - The individual "Test and Inspection Report" shall contain the following data:

(a) Fill pressure in psig prior to sampling.

(b) Pressure in psig after sampling.

(c) Purity of cylinder contents.

(d) Applicable specification number.

4.2.8 Inspections. - The individual "Test and Inspection Report" shall contain the following verifications as a checksheet:

(a) Cylinder is stamped in accordance with 3.4.

(b) Cylinder blasted surface meets requirements of 3.6.

(c) Cylinder is color coded and lettered per the requirements of 3.7.5.

(d) Cylinder valve has hydrostatic stamp affixed (Reference 3.8).

(e) Cylinder valve was functionally checked per requirements of 3.12.

(f) Cylinder cleanliness integrity was maintained (Reference 3.14.1).

(g) Valve cleanliness integrity was maintained (Reference 3.14.2).

(h) Valve threads have Teflon tape (Reference 3.14.3).

(i) Valves were torqued (Reference 3.14.4).

(j) Cylinder was evacuated per requirements of 3.15.3.

(k) Cylinder was leak checked per requirements of 3.15.5.

(l) Cylinder has cap (Reference 3.15.6).

(m) Sticker certifying conformance to applicable specification has been affixed, and the outlet valve has been sealed (Reference 3.16.2).

4.3 Handling and Storage. - Controls shall be maintained on Government-furnished equipment (GFE) to maintain integrity of the GFE and prevent damage, deterioration, or loss of GFE. All GFE shall be readily identifiable; nonconforming or rejected items shall be identified and controlled to prevent inadvertent usage.

4.4 Contamination Control. - Controls shall be established and maintained to ensure that a quality accepted cleanliness level of a cylinder and gas purity is not degraded through subsequent processing and delivery of cylinder to KSC.

4.5 Cylinder Rejection. - Cylinders shall be evaluated by the contractor for continued service not only from specific tests but also from an overall evaluation of hydrostatic test data, visual inspections, amount of cleaning done, and other inspections or tests performed. The cylinder report shall include all information related to cause for rejection.

4.6 Acceptance/Inspection. - The Government reserves the right to perform for inspection purposes, any cylinder disassembly, after delivery to KSC and prior to acceptance.

4.7 Acceptance/Testing. - The Government reserves the right to perform for acceptance purposes, any chemical or physical testing on the cylinder, after delivery to KSC.

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5. PREPARATION FOR DELIVERY

5.1 Final Inspection. - The contractor shall make a final inspection and shall ensure all conditions specified in this specification have been conformed to prior to transporting the cylinders to KSC. The contractor shall take whatever precautions necessary to ensure that the cylinders arrive at KSC in the same condition as they were in during the final inspection prior to delivery.

5.2 Packaging. - The contractor shall receive and return cylinders on pallets holding twenty cylinders. The pallets shall be provided by the contracting agency. All cylinders on a pallet shall contain the same service medium.

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6. NOTES

6.1 Exceptions and Deviations. - Request for exceptions and/or deviations from the requirements of this specification shall be submitted to the contracting agency for review on KSC Form 8-69 or KSC Form 23-364, as applicable.

NOTICE. - The KSC-SO series of specifications is intended for use by KSC Support Operations and associated contractors. The specifications apply to those systems under the design responsibility of KSC Support Operations.

Custodian:

NASA-John F. Kennedy Space Center
Kennedy Space Center, Fla. 32899

Preparing Activity:

John F. Kennedy Space Center
Support Operations
Engineering Division

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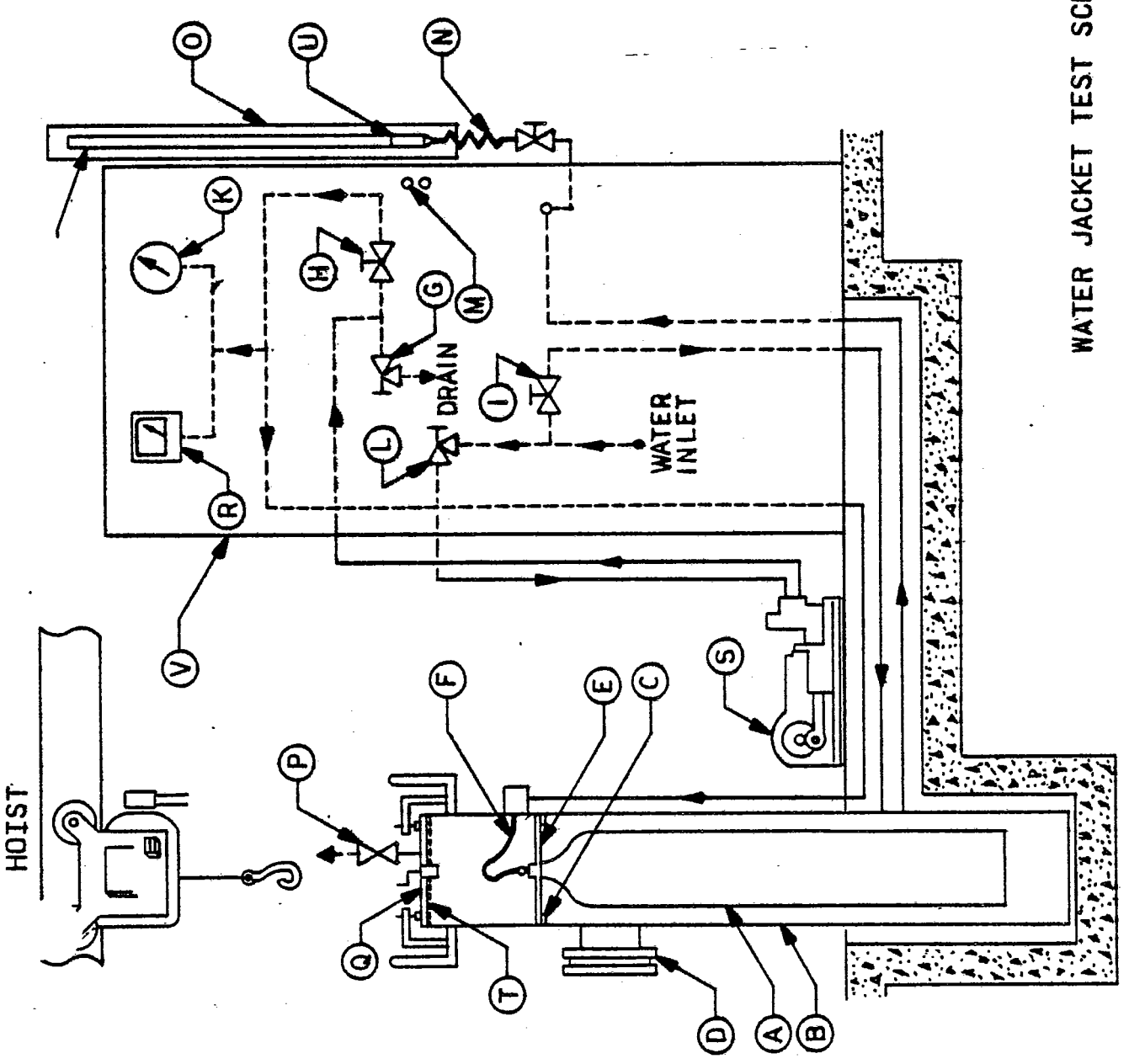
A. CYLINDER
B. WATER JACKET
C. SUPPORTS
D. SAFETY DEVICE
E. TEST PLUG AND SUSPENSION ASSEMBLY
F. HIGH-PRESSURE INTERNAL HOSE
G. HIGH-PRESSURE BYPASS VALVE DISCHARGES TO DRAIN
H. HIGH-PRESSURE INDICATOR VALVE
I. JACKET FILL VALVE
J. BURETTE
K. PRESSURE GAGE
L. PUMP FEED VALVE
M. PUMP CONTROL SWITCH
N. BURETTE FEED FLEX HOSE
O. BURETTE HOLDER
P. PETCOCK
Q. JACKET COVER
R. PRESSURE RECORDER
S. PUMP
T. COVER GASKET
U. ZERO REFERENCE
V. TEST PANEL



WATER JACKET TEST SCHEMATIC

FIGURE 1

KSC-SO-S-4

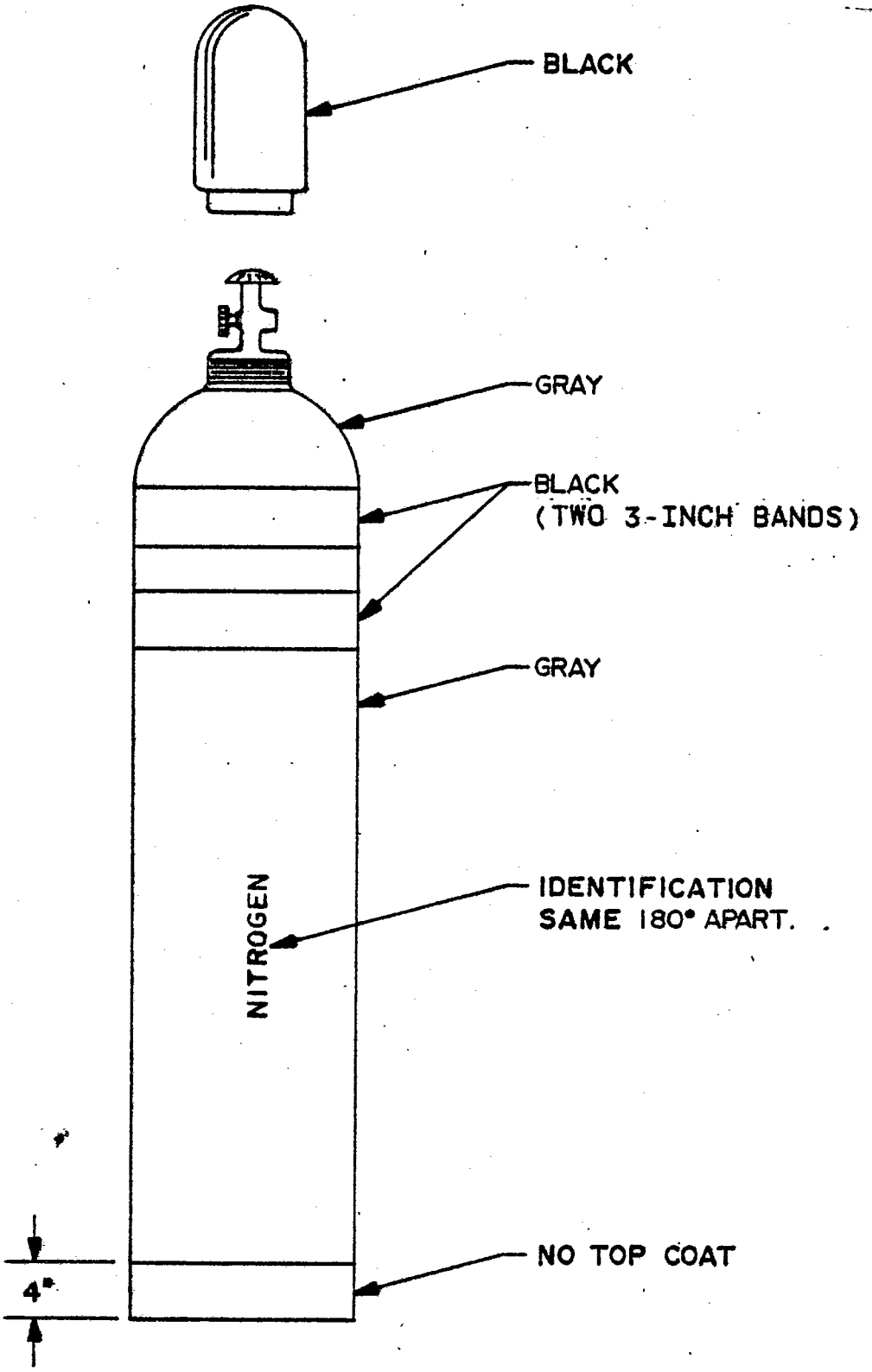


FIGURE 2

SAMPLE OF GAS CYLINDER COLOR CODING