BB-H-886C
April 10, 1978
SUPERSEDING
Fed. Spec. BB-H-886B
January 19, 1962

FEDERAL SPECIFICATION

HYDROGEN

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers gaseous hydrogen of two grades for use in cutting and welding and as a lifting medium for meteorological and other balloons (see 6.1).

1.2 Classification. The hydrogen shall be of the following grades as specified (see 6.2)

Grade A - 99.0 percent
Grade B - 99.5 percent

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Philadelphia, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Houston, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specification:

MIL-V-[illegible] - Valve, Cylinder, Gas (for Compressed or Liquefied Gases), General Specification for.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-1411 - Inspection and Maintenance of Compressed Gas Cylinders.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Laws and Regulations:

49 CFR 170-189 - Department of Transportation (DOT) Rules and Regulations for the Transportation of Explosives and other Dangerous Articles.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis by the Superintendant of Documents, U.S. Government Printing Office, Washington, DC 20402. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

3. REQUIREMENTS

3.1 Material. The material shall conform to the requirements shown in table I.

TABLE I. Requirements

Limiting Characteristics	Grade A percentage by volume	Grade B percentage by volume
Hydrogen, min.	99.0	99.5
Hydrogen Sulfide, max.	0.01	0.01
Phosphine & Arsine, max.	.02	.02
Water	none condensed	none condensed
Hydrocarbons (condensed)	-	none

3.2 Cylinders and valves. The hydrogen shall be contained in Government furnished cylinders in accordance with 49 CFR 170-190 and equipped with valves with outlet connections in accordance with MIL-V-2. When specified (see 6.2), cylinders shall be furnished by the supplier, shall be in accordance with 49 CFR 171-189, and shall be equipped with valves in accordance with MIL-V-2. When specified (see 6.2), the hydrogen shall be contained in supplier-owned DOT approved cylinders.

3.3 Cylinder and valve maintenance. Hydrogen cylinders and valves shall be inspected and maintained in accordance with MIL-STD-1411.

3.4 Leakage. Cylinders and valves shall not leak after being filled (see 4.4.4).

3.5 Capacity. Containers of gaseous hydrogen shall be filled to the rated service pressure (see Table III), as specified in the contract or order (see 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government.

4.2 Classification of inspection. Inspection shall be classified as follows:

(a) Quality conformance inspection (see 4.3).
(b) Examination of preparation for delivery (see 4.5).

4.3 Quality conformance inspection.

4.3.1 Examination. Each filled cylinder shall be examined as specified in 4.3.3.1. Presence of one or more defects shall be cause for rejection of the cylinder.

4.3.2 Tests.

4.3.2.1 Sampling. Sampling for tests shall be from filled cylinders and shall be in accordance with MIL-STD-105, inspection level S-1, unless otherwise specified.

4.3.2.2 Individual. Each filled cylinder shall be tested for leakage as specified in 4.4.4. Failure of the test shall be cause for rejection of the cylinder.

4.3.3 Inspection procedure:

4.3.3.1 Examination. The filled hydrogen cylinders shall be examined for the following defects:

101. Cylinder or valve not as specified (see 3.2).
102. Cylinder maintenance not as specified (see 3.3).
103. Capacity not as specified (see 3.5).

4.4 Test methods.

4.4.1 Phosphine, hydrogen sulfide and arsine.

4.4.1.1 Qualitative determination. A piece of white filter paper saturated with a 5-percent solution of silver nitrate shall be held in a flow of hydrogen from the valve of the cylinder for a period of at least 30 seconds. If the silver nitrate paper is stained or discolored, the hydrogen may be considered as not complying with this specification. If the qualitative determination indicates the presence of phosphine, arsine or hydrogen sulfide, the material shall be quantitatively analyzed for compliance with the requirements of 3.1 using the procedures given in 4.4.1.2.

4.4.1.2 Quantitative determination. The quantitative determination of phosphine and arsine and hydrogen sulfide shall be conducted as follows:

(a) Reagents.

(1) Two to three percent sodium hypochlorite solution. Make a 1:1 dilution with a 4 - 6 percent solution of sodium hypochlorite commercially available.

(2) Molybdate reagent. Make the molybdate reagent by the method as follows.

Solution 1: Mix 110 grams of 85 percent molybdic acid with 400 ml of distilled water, add 80 ml concentrated ammonium hydroxide, and filter when solution is complete.
Solution 2: Mix 400 ml of concentrated nitric acid with 600 ml of distilled water. Vigorously agitate solution 2 by means of a current of air and add solution 1 very slowly through a tube dipping under the surface of the agitated solution. When all of solution 1 has been added, continue the current of air for 1 to 2 hours. Let stand, filter if necessary, and store in a glass-stoppered bottle.

(b) Preparation of sample. Approximately 1 cubic foot of hydrogen from the sample cylinder shall be passed at a rate of 0.03 cubic foot per minute through two glass-stoppered Milligan bottles connected in series and each containing 100 milliliters of a 2 to 3 percent solution of sodium hypochlorite. (CAUTION: The effluent gas should be vented to outdoor spaces to avoid explosive atmospheres.) The volume of gas shall be measured by means of a wet test meter after the gas has passed through the absorption bottles. At the conclusion of the run, the flow of gas shall be shut off, and the volume of gas used, the barometric pressure, and the temperature recorded. Remove the tops from the Milligan bottles and rinse down with a few milliliters of distilled water, allowing the rinsings to fall into the bottle. Transfer the solutions from both bottles into a 500-milliliter volumetric flask. Rinse each bottle and glass inner parts with two 25-milliliter portions of distilled water, and add the rinsings to the flask. Dilute to the mark with distilled water, mix thoroughly, and pipette 250 milliliters into a 400-milliliter beaker. Transfer the remaining solution to a second 400-milliliter beaker together with rinsings from the flask and pipette.

(c) Determination of phosphine and arsine. To the first beaker of solution obtained in (b) above, add 30 milliliters concentrated nitric acid and boil down to 100 to 125 milliliters. Transfer the solution to a 300- milliliter glass-stoppered Erlenmeyer flask, cool, and cautiously add 10 milliliters concentrated ammonium hydroxide. Adjust the temperature to approximately 80°C and add 100 milliliters of molybdate reagent. Stopper, shake vigorously for 5 to 10 minutes, and let settle for 10 to 30 minutes. Filter on a small Gooch crucible and wash the flask and crucible with 1-percent potassium nitrate solution until acid-free. Place the crucible in the flask, add a known volume of standard sodium hydroxide solution until the precipitate is completely dissolved, as shown by the absence of yellow color. Add a few drops of phenolphthalein indicator solution and back titrate with standard hydrochloric acid solution to the disappearance of indicator color. Record the number of milliliters used. Repeat the above procedure, using sodium hypochlorite solution and reagents only, to obtain a blank determination. Record the number of milliliters used. Calculate the percentage by volume of phosphine and arsine as phosphine, as follows:

$$1 \text{ mol NaOH} = 1/23 \text{ mol } PH_3 = \frac{22.412}{23} \text{ liters}$$

$$1 \text{ millimol NaOH} = 0.9744 \times 10^{-3} \text{ liters } PH_3$$

$$\frac{(\text{ml NaOH} \times N - \text{ml HCl} \times N) - B \times 0.9744 \times 10^{-3} \times (273 + T) \times 760 \times 2^{*} \times 100}{V \times P \times 273} =$$

$$\frac{(\text{ml NaOH} \times N - \text{ml HCl} \times N) - B \times (273 + T) \times 0.543}{V \times P} = \text{percent } PH_3 \text{ (by vol.)}$$

* Factor of "2" introduced because aliquot used represents 1/2 original sample.

where:
B = value obtained in blank determination.
T = temperature (°C) of gas.
V = measured volume of hydrogen in liters.
P = barometric pressure in millimeters.
N = normality of respective solutions.

The maximum allowance for phosphine is 0.02 percent. Quantities in excess of these respective amounts shall constitute failure of this test.

(d) Determination of hydrogen sulfide. To the second beaker of solution obtained as specified in (b) above, add 30 milliliters of concentrated hydrochloric acid and boil down to 100 to 125 milliliters. Carefully neutralize with ammonium hydroxide to the methyl orange end point and add 1 milliliter of concentrated hydrochloric acid. Heat to boiling and add 10 milliliters of 10-percent barium chloride solution while stirring vigorously. Let stand at the side of a steam bath for 30 minutes. Filter, wash, and ignite to constant weight. Record the weight of barium sulfate in grains. Repeat the above procedure, using sodium hypochlorite solution and reagents only, to obtain a blank determination. Record the weight of barium sulfate in grains. Calculate the percentage, by volume, of hydrogen sulfide as follows:

$$1 \text{ mol } BaSO_4 = 1 \text{ mol } H_2S$$

$$1 \text{ g. } BaSO_4 = \frac{1 \text{ mol } H_2S}{233.42} = \frac{22.412}{233.42} = 0.09602 \text{ liter } H_2S$$

$$\frac{(\text{wt. } BaSO_4 - \text{wt. blank}) \times 0.09602 \times (273 + T) \times 760 \times 2^{*} \times 100}{V \times P \times 273} =$$

$$\frac{(\text{wt. } BaSO_4 - \text{wt. blank}) \times (273 + T) \times 53.5}{V \times P} = H_2S \text{ (by volume)}$$

*Factor of "2" introduced because aliquot used represents 1/2 original sample.

where:
T = temperature (°C) of gas.
V = measured volume of hydrogen in liters.
P = barometric pressure in millimeters.

The maximum allowance for hydrogen sulfide is 0.01 percent. Quantities in excess of these respective amounts shall constitute failure of this test.

4.4.2 Hydrogen determination. Hydrogen shall be determined by combustion method (see 4.4.2.1).

4.4.2.1 Hydrogen (by combustion).

4.4.2.1.1 Apparatus. The apparatus shall consist of a combustion pipette of conventional design, a gas measuring burette, and a leveling bulb. Mercury shall be used as the confining agent.

4.4.2.1.2 Procedure. Draw approximately 100 milliliters of the sample into the measuring burette with the volume measured at atmospheric pressure and 25° ± 2°C. Transfer the sample to the combustion pipette. Prepare a mixture of approximately equal parts of pure oxygen and air in the measuring burette (approx. 100 ml) and then connect to the combustion pipette. Heat the platinum wire to dull redness by means of an electrical current controlled by a rheostat and slowly pass the air-oxygen mixture from the burette to the pipette. When nearly all of the air-oxygen mixture has been added to the pipette, stop the addition but continue to heat the platinum wire to dull redness for approximately 1 minute. Cool the pipette and return the residual gas to the measuring burette and measure the residual gas.

$$\text{Percent hydrogen} = \frac{(A + B - C) \times 100}{1.5A}$$

Where:
A = milliliters of hydrogen.
B = milliliters of air-oxygen mixture.
C = milliliters of residual gas.

The minimum hydrogen content shall be 99.0 percent for grade A and 99.5 percent for grade B. Otherwise, compliance of the minimum requirements has not been met and shall constitute failure of this test.

4.4.3 Water and hydrocarbons (condensed). Support the cylinder in an inverted position (valve at the bottom) for five minutes. The cylinder and contents should be at room temperature or above 32°F (0°C). The cylinder valve is then opened slightly (use caution) while the cylinder remains inverted, and the hydrogen is vented with a barely audible flow into an open dry container for one minute. (NOTE: A rapid gas flow may cause any liquid to disperse and not collect in the container). Any free water or condensed hydrocarbons (oil) issuing from the valve shall be sufficient cause for rejection.

4.4.4 Leakage. Each cylinder, after filling, shall be tested for leakage by applying a soap solution to all portions of the valve, the junction of the valve and cylinder, and the safety device on the cylinder. Care shall be taken to ensure that the solution utilized does not contaminate the valve outlet. Any evidence of leakage of gas as evidenced by bubbling of the soap solution shall constitute failure of this test.

4.5 Examination of preparation for delivery. An examination shall be performed to determine compliance with the packing and marking requirements of section 5. Defects shall be scored as specified in table II. Sampling shall be in accordance with MIL-STD-105. The sample unit shall be one container fully prepared for delivery. The lot shall be the number of containers offered for examination at one time. The inspection level shall be S-2 with an AQL of 4.0 expressed in terms of percent defective.

Table II. Examination of preparation for delivery

Examine	Defect
Container	Not as specified
Content	Not as specified.
Marking	Omitted; incorrect; illegible; improper size, location, sequence or method of application.
Workmanship	Bulging or distortion of container.

5. PREPARATION FOR DELIVERY

5.1 Packaging. The hydrogen of one grade shall be preserved and packaged in accordance with normal commercial practice. The complete package shall be designed to protect the item against damage during shipment, handling and storage.

5.2 Packing. The cylinders shall be packed to insure safe delivery at destination, to provide for safe redistribution by the initial receiving activity, and shall be acceptable by common carrier under National Motor Freight Classification or Uniform Freight Classification.

5.3 Marking. The cylinder shall be marked in accordance with 49 CFR 170-189 and as specified in the contract or order.

6. NOTES

6.1 Intended use. Grade A hydrogen is intended for use in cutting, welding and as a lifting medium for meteorological and other balloons. Grade B hydrogen, a higher purity grade, is intended for use where freedom from hydrocarbons is necessary.

6.2 Ordering data. Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Grade required (see 1.2).
(c) Type of container and valve (see 3.2).
(d) Amount of hydrogen required in the cylinder (see 3.5).
(e) When supplier is to furnish cylinders (see 3.2).
(f) When hydrogen is to be contained in supplier-owned cylinders (see 3.2).
(g) When Government-furnished replacement valves are to be utilized (see 3.3.2).
(h) Marking required (see 5.3).

6.3 Basis of purchase. The basis of purchase should be the cubic foot, based upon normal atmospheric conditions. Hydrogen is commercially available in cylinders with rated capacities of 100 and 200 cubic feet. Normally hydrogen cylinders will be filled to the following standard conditions: 1800, 2000, 2265, or 2400 p.s.i.g. at 70°F. To determine if cylinders have been filled to full rated capacity specified by contract or order, the pressure in the cylinders should be checked in accordance with table II.

TABLE III. Pressure-Temperature Conversion Chart for Hydrogen

Settled Temp. °F	Container Service Pressure (expressed in psig) 1800	2000	2265	2400
-50	1375	1527	1727	1830
-48	1382	1535	1736	1938
-46	1389	1543	1745	1849
-44	1396	1550	1754	1858
-42	1403	1558	1763	1868
-40	1410	1566	1772	1877
-38	1418	1574	1781	1887
-36	1425	1582	1790	1896
-34	1432	1590	1799	1906
-32	1439	1598	1808	1915
-30	1446	1606	1817	1925
-28	1453	1614	1826	1934
-26	1460	1621	1835	1944
-24	1467	1629	1844	1953
-22	1474	1637	1853	1963
-20	1481	1645	1862	1972
-18	1488	1653	1871	1982
-16	1496	1661	1880	1991
-14	1503	1669	1889	2001
-12	1510	1677	1898	2010
-10	1517	1685	1907	2020
-8	1524	1692	1916	2029
-6	1531	1700	1925	2039
-4	1538	1708	1934	2048
-2	1545	1716	1943	2058
0	1552	1724	1952	2067
+2	1559	1732	1961	2077
4	1566	1740	1969	2086
6	1573	1748	1978	2096
8	1581	1756	1987	2105
10	1588	1763	1996	2115
12	1595	1771	2005	2124
14	1602	1779	2014	2134
16	1609	1787	2023	2143
18	1616	1795	2032	2153
20	1623	1803	2041	2162
22	1630	1811	2050	2172
24	1637	1819	2059	2181
26	1644	1827	2068	2191
28	1651	1834	2077	2200
30	1658	1842	2086	2210
32	1665	1850	2095	2219
34	1673	1858	2104	2229
36	1680	1866	2113	2238
38	1687	1874	2122	2248
40	1694	1882	2131	2257
42	1701	1890	2140	2267
44	1708	1898	2149	2276
46	1715	1905	2158	2286
48	1722	1913	2167	2295
50	1729	1921	2176	2305

Settled Temp. °F	Container Service Pressure (expressed in psig) 1800	2000	2265	2400
52	1736	1929	2184	2315
54	1743	1937	2193	2324
56	1750	1945	2202	2334
58	1758	1953	2211	2343
60	1767	1962	2220	2353
62	1772	1968	2229	2362
64	1779	1976	2238	2372
66	1786	1984	2247	2381
68	1793	1992	2256	2391
70	1800	2000	2265	2400
72	1807	2008	2274	2409
74	1814	2016	2283	2419
76	1821	2024	2292	2428
78	1828	2032	2301	2438
80	1835	2039	2310	2447
82	1842	2047	2319	2457
84	1850	2055	2328	2466
86	1857	2063	2337	2476
88	1864	2071	2346	2485
90	1871	2079	2355	2495
92	1878	2087	2363	2504
94	1885	2095	2372	2514
96	1892	2102	2381	2523
98	1899	2110	2390	2533
100	1906	2118	2399	2542
102	1913	2126	2408	2552
104	1920	2134	2417	2561
106	1927	2142	2426	2571
108	1934	2150	2435	2580
110	1942	2158	2444	2590
112	1949	2166	2453	2599
114	1956	2173	2462	2609
116	1963	2181	2471	2618
118	1970	2189	2480	2628
120	1977	2197	2489	2637
122	1984	2205	2498	2647
124	1991	2213	2507	2656
126	1998	2221	2516	2666
128	2005	2229	2525	2675
130	2012	2236	2533	2685
132	2019	2244	2542	2694
134	2026	2252	2551	2704
136	2034	2260	2560	2713
138	2041	2268	2569	2723
140	2048	2276	2578	2732
142	2055	2284	2587	2742
144	2062	2292	2596	2751
146	2069	2299	2605	2761
148	2076	2307	2614	2770
150	2083	2315	2623	2780

6.4 Classification changes. The relationship between the classification changes of this specification and the superseded specification is as follows:

BB-H-886B	BB-H-886C
Type I	Grade A
Type II	Grade B

Military Custodians:

Army - ME
Navy - SH
Air Force - 68

Civil Agency Coordinating Activities:

COM - NBS
GSA - FSS
HEW - FDA
NASA - JFK, LRC
VA - DMS

Preparing Activity:

GSA - FSS

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