

METRIC

MIL-PRF-27201C  
22 December 1995  
SUPERSEDING  
MIL-P-27201B  
30 June 1971

## PERFORMANCE SPECIFICATION

## PROPELLANT, HYDROGEN

This specification is approved for use by all Departments and Agencies of the Department of Defense

## 1. SCOPE

1.1 Scope. This specification covers the requirements for two types of hydrogen

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

1.2.1 Types The types of hydrogen are as follows

Type I - Gaseous

Type II - Liquid

## 2 APPLICABLE DOCUMENTS

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

2.2 Government documents

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to SA-ALC/SFSP, 1014 Billy Mitchell Blvd/STE 1, Kelly AFB TX 78241-5603, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

AMSC N/A

FSC 9135

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## SPECIFICATIONS

## DEPARTMENT OF DEFENSE

MIL-S-27626	- Sampler, Cryogenic Liquid
MIL-T-27730	- Tape, Antiseize, Tetrafluoroethylene, with Dispenser

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

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 29	- Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM F 307	- Practice for Sampling Pressurized Gas for Gas Analysis
ASTM F 310	- Practice for Sampling Cryogenic Aerospace Fluids

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia PA 19103-1187.)

## COMPRESSED GAS ASSOCIATION (CGA)

CGA G-5.3	- Commodity Specification for Hydrogen
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(Application for copies should be addressed to the Compressed Gas Association, Inc, 1725 Jefferson Davis Highway, Arlington VA 22202-4100.)

2.4 Order of precedence In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3 REQUIREMENTS

3.1 Grade requirements The purity and impurity concentrations shall conform to the limits of Table I when tested in accordance with the applicable test method also specified in Table I. Other limits and tests may be specified by the procuring activity (see 6.2).

3.2 Limiting values The following applies to all specified limits in this specification: For purposes of determining conformance with these requirements, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand digit used in expressing the specification limit according to the rounding-off method of ASTM Practice E 29.

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for using Significant Digits in Test Data to Determine Conformance with Specifications.

TABLE I. Limits for hydrogen

		Test Method
Purity, % by vol, min	99 995	4.4.2
Parahydrogen <sup>a</sup>	95.0	4 4.1
Impurities, ppm by vol, max	50	4.4.2
Nitrogen, water vapor, and total hydrocarbons	9 0	4 4.2 4 4 2
Oxygen and argon	1.0	4 4.2
Helium	39.0	4 4.2
Carbon monoxide and carbon dioxide	1.0	4 4.2
a Applies to type II only		

3.3 Filter. A filter with a 10-micrometer nominal and 40-micrometer absolute rating shall be installed between the manufacturer's plant system and the manifold used to fill the gas or liquid containers for delivery

3.4 Filled containers (Type I only).

3.4.1 Pressure. Cylinders and tubes shall be within 99 to 100 percent of rated service pressure when tested as specified in 4.5.1. The pressure-temperature chart (table III) in section six may be used

3.4.2 Leakage. Cylinders shall not leak when tested according to 4.5.2.

4. VERIFICATION

4.1 Points of inspection (6.2). Unless otherwise specified, acceptance tests shall be conducted at the site of filling prior to shipment or departure.

4.2 Conformance inspection. Quality conformance tests shall consist of the following:

- a. Individual tests (Type I only) . . . 4.2.1
- b. Sampling tests . . . . . 4.2.2
- c. In-stream test (Type II only). . . 4.2.3

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4 2 1 Individual tests (Type I only) Each container (cylinder or tube) shall be subjected to the following tests as described under 4 5

- a Filling pressure . . . 4 5 1
- b Leakage . . . 4 5.2

4 2.2 Sampling test The number of hydrogen containers shall be selected in accordance with Table II and subjected to the tests required by Table I except for the parahydrogen test

TABLE II Sampling for test

Number of containers in lot	Number of containers to be sampled
1	1
2 - 40	2
41 - 70	3
71 - over	4

4 2 3 In-stream test Liquid hydrogen shall be tested by an in-stream analyzer as described in 4 4 1

4.2 4 Lot A lot shall consist of one of the following

a The hydrogen produced in not more than 24 consecutive hours from a continuous process which is used to fill shipping containers directly from the process output. A continuous process shall be the production of product by continuous input of raw materials and output of finished product by one manufacturer in one plant with no change in manufacturing conditions or materials

b The hydrogen from individual runs of a batch process which is used to fill shipping containers directly from the process output. A batch process shall be the production of product by runs from single additions of raw materials which are reacted and purified forming the product

c The hydrogen from either or both the continuous and batch processes which is held in a single storage tank and subsequently withdrawn to fill shipping containers. The product shall be homogeneous at the time of withdrawal and shall not be added to while being withdrawn. After each addition to the storage tank, the contents shall constitute a separate lot

4 2 4 Sample. Each sample shall be of sufficient size to conduct all the quality conformance tests as specified herein. Unless otherwise specified, the quality conformance tests shall be made of each required sample (6 2). When required, an equivalent sample shall be forwarded to a laboratory designated by the procuring activity for testing

4 2 4.1 Samplers The sampler for Type I (gaseous) hydrogen shall be a small compressed gas cylinder. The sampler for Type II (liquid) hydrogen shall be in accordance with MIL-S-27626 or functionally equivalent thereto. The liquid samplers convert the entrapped liquid to gas. The aliquots taken for analysis are representative samples

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4.2.4.2 Sampling methods. Unless otherwise specified (6.2), Type I (gaseous) hydrogen shall be sampled in accordance with ASTM F 307 and Type II (liquid) hydrogen shall be sampled in accordance with ASTM F 310 except for the following changes: Replace paragraph 5.1 with "5.1 Ensure that the outlet of the sampling port is clean." Replace paragraph 6.1 with "6.1 Ensure that the outlet of the sampling port is clean."

4.2.5 Cylinders. The number of cylinders (high pressure and cryogenic types) filled with Type I (gaseous) or Type II (liquid) hydrogen selected for sampling from each lot shall be in accordance with Table II. The first and last cylinders to be filled within a given lot shall be sampled. Other samples may be selected at random. The hydrogen from each cylinder sampled shall constitute a separate sample. For the purpose of selecting sample cylinders only, any one cylinder may be selected from a group of cylinders filled simultaneously from a single manifold.

4.2.6 Bulk transports. A sample shall be taken from each portable tank, cargo tank, or tank car filled with Type I (gaseous) or Type II (liquid) hydrogen.

4.2.6.1 Continuous service (6.2 and 6.5.1) Unless otherwise specified by the procuring activity, the following sample option for hydrogen shall be used for storage and transport tanks engaged in continuous hydrogen service (6.2). Contractor shall sample the contents of each transport tank engaged in continuous hydrogen service at least once every seven days at uniform intervals of time. Samples shall be taken from the filled transport tanks. Contractor shall sample the contents of each transport tank when entering continuous service and when the transport tank has remained empty for a period greater than 24 hours. When empty, all ports and vents shall remain closed to the atmosphere. While in continuous service, compliance with quality conformance tests specified herein shall be determined by sampling the filling point storage tank after each addition or, in case of continuous production, at established intervals not less frequent than once every 24 hours. When a storage tank is being filled during a change of duty shift, sampling shall be performed after filling.

4.2.7 Other containers (6.2) Unless otherwise specified, other containers of 400 liters or less water capacity shall be sampled in accordance with 4.2.5. Containers greater than 400 liters water capacity shall be sampled in accordance with 4.2.6.

4.3 Rejection. When any sample tested in accordance with 4.4 fails to conform to the requirements specified herein, the entire lot represented by the sample shall be rejected. Unless otherwise specified, disposition of rejected product shall be specified by the procuring activity (6.2).

4.4 Analytical procedures. Unless otherwise specified, samples shall be analyzed according to the procedures described below (6.2). Calibration gas standards may be required to calibrate (zero and span) analytical instruments used to determine the purity and impurity contents of the hydrogen. The accuracy of the calibration gas standards is to be traceable to the National Institute of Standards and Technology.

4.4.1 Parahydrogen Parahydrogen shall be determined by thermal conductivity type in-stream analyzers installed in the manufacturer's plant.

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system. Analyzers shall be calibrated integrally by the appropriate use of temperature-controlled catalyst beds

4 4.2 Gaseous purity and gaseous impurities Methods shall be selected from those of CGA G-5 3.

4 5 Containers of Type I hydrogen.

4.5.1 Filling pressure. Samples shall be tested for proper filling pressure by attaching a calibrated Bourdon-tube gauge or equivalent to the valve outlet and by attaching either a thermocouple or thermometer to the container wall. The gauge shall have scale divisions not greater than 100 kPa (15 psi). If a thermometer is used, tape or putty shall be applied to the bulb to protect it from extraneous temperatures. Putty shall not be applied between the bulb and the cylinder wall. The thermometer shall have scale divisions not greater than 1°C (2°F). The containers shall be stabilized to ambient temperature. Then the valve shall be opened and the internal pressure observed on the gauge.

4 5.2 Leakage. Each Type I hydrogen container shall be tested for leaks at the neck threads, stem packing, and safety device of the valve with leak-detection fluid. Valve seat leakage shall be tested after filling has been completed. This shall be done by applying the leak-detection fluid sparingly across the outlet of the valve. Only leak-detection fluid that leaves no residue shall be used on the outlet.

5 PACKAGING

5 1 Packaging For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6 2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6 NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use. The propellant covered by this specification is intended for use as a fuel in rocket engines and other space applications.

6.2 Acquisition requirements Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. Type of hydrogen required (see 1 2).

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c Issue of DoDISS to be cited in the solicitation, and, if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).

d. When other limits or tests are required (see 3.1).

e When a variation in the points of inspection is required (see 4.1)

f When a variation of the quality conformance tests to be performed on each sample is required (see 4.2.4)

g When a variation to the sampling method is required (see 4.2.4.2).

h When a variation to the continuous service option is required (see 4.2.6.1)

i When a variation to the 400 liter criteria for sampling is required (see 4.2.7)

k When a variation to the disposition of rejected product is required (4.3)

j When a variation of the analytical procedures is required (see 4.4)

l Packaging requirements (see 5.1 and 6.4)

6.4 Packaging requirements Guidance for cylinders may be found in the following documents:

a RR-C-901 - Cylinder, Compressed Gas, High Pressure, Steel DOT 3AA, and Aluminum Applications, General Specification For

b MIL-V-2/29 - Valve, Cylinder, Gas, Hydrogen Outlet 351

c. MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders

d. MIL-STD-1411 - Inspection and Maintenance of Compressed Gas Cylinders

e 49 CFR 171 - 199 - Code of Federal Regulations

## 6.5 Definitions.

6.5.1 Continuous service Continuous service applies to continuous deliveries under Government contract of hydrogen complying with the quality conformance tests specified herein.

6.5.2 In-stream analyzer An analyzer with its sensor in the product stream or which receives samples directly from the product stream

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TABLE III Pressure - temperature conversion

Temperature (°F)	Service pressure (psig)					
	1800	2000	2015	2200	2265	2400
-40	1419	1576	1587	1733	1783	1889
-38	1426	1583	1594	1741	1792	1898
-36	1433	1591	1602	1750	1801	1908
-34	1440	1599	1610	1758	1809	1917
-32	1447	1606	1618	1767	1818	1926
-30	1454	1614	1626	1775	1827	1936
-28	1461	1622	1633	1784	1836	1945
-26	1468	1630	1641	1792	1844	1954
-24	1474	1637	1649	1801	1853	1963
-22	1481	1645	1657	1809	1862	1973
-20	1488	1653	1665	1818	1871	1982
-18	1495	1660	1672	1826	1879	1991
-16	1502	1668	1680	1835	1888	2001
-14	1509	1676	1688	1843	1897	2010
-12	1516	1684	1696	1852	1906	2019
-10	1523	1691	1703	1860	1914	2028
-8	1530	1699	1711	1869	1923	2038
-6	1537	1707	1719	1877	1932	2047
-4	1544	1714	1727	1886	1941	2056
-2	1551	1722	1735	1894	1949	2066
0	1557	1730	1742	1903	1958	2075
2	1564	1738	1750	1911	1967	2084
4	1571	1745	1758	1920	1976	2093
6	1578	1753	1766	1928	1985	2103
8	1585	1761	1774	1937	1993	2112
10	1592	1768	1781	1945	2002	2121
12	1599	1776	1789	1954	2011	2131
14	1606	1784	1797	1962	2020	2140
16	1613	1792	1805	1971	2028	2149
18	1620	1799	1813	1979	2037	2159
20	1627	1807	1820	1988	2046	2168
22	1634	1815	1828	1996	2055	2177
24	1640	1822	1836	2005	2063	2186
26	1647	1830	1844	2013	2072	2196
28	1654	1838	1851	2022	2081	2205
30	1661	1846	1859	2030	2090	2214
32	1668	1853	1867	2039	2098	2224
34	1675	1861	1875	2047	2107	2233
36	1682	1869	1883	2056	2116	2242
38	1689	1876	1890	2064	2125	2251
40	1696	1884	1898	2072	2134	2261
42	1703	1892	1906	2081	2142	2270
44	1710	1900	1914	2089	2151	2279



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TABLE III. Pressure - temperature conversion - continued

Temperature (°F)	Service pressure (psig)					
	1800	2000	2015	2200	2265	2400
46	1717	1907	1922	2098	2160	2289
48	1723	1915	1929	2106	2169	2298
50	1730	1923	1937	2115	2177	2307
52	1737	1930	1945	2123	2186	2316
54	1744	1938	1953	2132	2195	2326
56	1751	1946	1961	2140	2204	2335
58	1758	1954	1968	2149	2212	2344
60	1765	1961	1976	2157	2221	2354
62	1772	1969	1984	2166	2230	2363
64	1779	1977	1992	2174	2239	2372
66	1786	1984	1999	2183	2247	2381
68	1793	1992	2007	2191	2256	2391
70	1800	2000	2015	2200	2265	2400
72	1806	2008	2023	2208	2274	2409
74	1813	2015	2031	2217	2283	2419
76	1820	2023	2038	2225	2291	2428
78	1827	2031	2046	2234	2300	2437
80	1834	2038	2054	2242	2309	2447
82	1841	2046	2062	2251	2318	2456
84	1848	2054	2070	2259	2326	2465
86	1855	2062	2077	2268	2335	2474
88	1862	2069	2085	2276	2344	2484
90	1869	2077	2093	2285	2353	2493
92	1876	2085	2101	2293	2361	2502
94	1883	2092	2108	2302	2370	2512
96	1889	2100	2116	2310	2379	2521
98	1896	2108	2124	2319	2388	2530
100	1903	2116	2132	2327	2396	2539
102	1910	2123	2140	2336	2405	2549
104	1917	2131	2147	2344	2414	2558
106	1924	2139	2155	2353	2423	2567
108	1931	2146	2163	2361	2432	2577
110	1938	2154	2171	2370	2440	2586
112	1945	2162	2179	2378	2449	2595
114	1952	2170	2186	2387	2458	2604
116	1959	2177	2194	2395	2467	2614
118	1966	2185	2202	2404	2475	2623
120	1972	2193	2210	2412	2484	2632
122	1979	2200	2218	2421	2493	2642
124	1986	2208	2225	2429	2502	2651
126	1993	2216	2233	2438	2510	2660
128	2000	2224	2241	2446	2519	2670
130	2007	2231	2249	2455	2528	2679

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6.6 Part or identifying number (PIN) The PINs to be used for hydrogen acquired to this specification are created as follows:

M 27201 - X      Example of PIN: M27201-2

└───┬───┬───┐  
 │    │    │    │  
 │    │    └───┬───┐ Type (see 1.2.1). Use 1 for type I; 2 for type II  
 │    └───┬───┬───┐  
 │        │    └───┬───┐ Specification number.  
 └───┬───┬───┬───┐  
 │    │    └───┬───┐ Prefix for military specification

6.7 Subject term (key word listing).

Aerospace  
 Cryogenic  
 Cylinders  
 Hydrogen  
 Propellant  
 Rocket engines

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

6.9 Temperature-pressure relation. Table III has been derived using the values of NBS (now NIST) Technical Note 1079 and the relations for thermal expansion and cylinder stretch of Bureau of Mines publication IC 8367.

Custodians  
 Army - MI  
 Navy - AS  
 Air Force - 68

Review Activities  
 Air Force - 19

Preparing Activity  
 Air Force - 68

Civil Agency Interest  
 NASA

(Project 9135-0135)