

MILITARY STANDARD
INSPECTION AND MAINTENANCE
OF
COMPRESSED GAS CYLINDERS

TO ALL HOLDERS OF MIL-STD-1411:

1. THE FOLLOWING PAGES OF MIL-STD-1411 HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

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2. RETAIN THIS NOTICE PAGE AND INSERT BEFORE THE TABLE OF CONTENTS.

3. Holders of MIL-STD-1411 will verify that page change indicated above have been entered. The notice page will be retained as a check sheet. This issuance, together with the appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or canceled.

FSC 8120

TABLE I. Inspection and maintenance procedure.

CYLINDER GAS SERVICE	Detailed Specifications	Inspection and Maintenance Procedures																				
		Acetylene	Fuel gas mix	Air - helium respiration	Air - helium	Argon - inert	Butane - propane	Carbon dioxide	Carbon monoxide	Chlorine	Fluorine - carbons	Helium - inert	Hydrogen	Inert nitrogen O ₂	Inert nitrogen O ₁	Oxygen ABO	Oxygen Tech.	Oxygen medical	Methy. Bromide	Sulfur hexafluoride	Aerosols	5.0
	Receiving inspection Complete Except as Listed	5.1.15 5.1.17 5.1.9	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1.15 5.1.17 5.1.10	5.1											
	Serviceability inspection	5.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2
	Residual gas and moisture	5.2.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.1
	External inspection	5.2.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.2
	Paint inspection	5.2.2.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.2.1
	Valve protection cap insp.	5.2.2.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.2.2
	Valve and safety devices	5.2.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.3
	Safety devices	5.2.3.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.3.1
	Inspection of flanges	5.2.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.4
	Inspection of foot rings	5.2.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.5
	Periodic test inspection	5.2.6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.6
	Cyl. regaining hydro test	5.2.6.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.6.1
	External vessel insp.	5.2.6.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.6.2
	Acetylene cylinder insp.	5.2.6.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.6.3
	General internal insp.	5.2.7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.7
	Hammer test	5.2.7.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.7.1
	Odor test	5.2.7.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.7.2
	Sulf. HexF. opt. Intern. insp.	5.2.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.8
	Chlorine cyl. Intern. insp.	5.2.9	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.9
	Rejection and condemnation	5.2.10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.10
	Recording required services	5.2.11	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.2.11
	Cylinder maintenance	5.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3
	Periodic testing	5.3.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.1
	Hydrostatic test	5.3.1.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.1.1
	External vessel insp.	5.3.1.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.1.2
	Acetylene cyl. qualifications	5.3.1.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.1.3
	General cyl. maintenance	5.3.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2
	Dropight testing	5.3.2.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2.1
	Cyl. structural maint.	5.3.2.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2.2
	Intern. cyl. surface cleaning	5.3.2.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2.3
	Intern. cyl. drying	5.3.2.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2.4
	Valves and safety devices	5.3.2.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.2.5
	Acetylene cyl. gen. maint.	5.3.3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.3
	Chlorine cyl. maintenance	5.3.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.4
	Special handling	5.3.5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.3.5

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3 inches from the hole centers. After extensive gunfire testing by both Government and industry, the property of fragment control (nonshatterability) has been related to variation in wall stress as defined in DOT 49CFR173.302. DOT specification 3AA limits the designed maximum wall stress to 73,000 psi. The cylinder industry, in independent investigations, have found, when wall stress designs are ranged between 50,000 psi and 60,000 psi, conservative nonshatterable properties are assured. Testing has verified that cylinders 8 inches and larger in diameter fabricated within the limits of DOT 3AA will pass gunfire fragmentation requirements and therefore, Government 3AA cylinders in excess of 8 inches in diameter have been marked "NONSHAT" by the manufacturer for a number of years. With the specification RR-C-901, Government cylinders under 8 inches in diameter fabricated in accordance with DOT 3AA cylinder specifications with a maximum wall stress under 55,000 psi are considered to be nonshatterable, and will offer controlled release of the marked service pressure. These cylinders will be permanently marked "NONSHAT".

3.12 Color code. The Government has developed its own system of color coding its pipeline and compressed gas cylinders (see MIL-STD-101). These color identification codes are mandatory along with the name of the gas, as applicable, stenciled longitudinally and opposite on the exterior surfaces of a Government-owned cylinder. When vendor-owned cylinders are used, MIL-STD-101 is not mandatory, except for medical gas cylinders which are always color coded in accordance with MIL-STD-101.

3.13. Periodic test status. Cylinders are periodically tested by hydrostatic test procedures, or subjected to an external visual examination. Cylinders may be refilled for a period of 5 years before retesting or complete examination is required. The Code of Federal Regulations has approved the use of a 10 year test period for high pressure cylinders by special testing and these cylinders are marked with a star following the test date. The Government is presently using the 5 year retest period but is considering the application of 10 year requirements. The US Air Force and US Navy intend to retain a 5 year retest period. The CFR also makes provision for 5 year complete external visual inspection of cylinders used in exclusive noncorrosive liquified gas service. The Government permits external visual examination of low pressure cylinder services for liquified petroleum gases, and some fluorocarbon gas cylinders. These cylinders are permanently marked with the Letter "E" after the date of the inspection. Certain low pressure cylinders may be retested after 12 years, then every 7 years by the modified hydrostatic test method with the test date followed by the symbol "S".

3.14 Hydrostatic testing. The hydrostatic pressure tests are performed on cylinders every 5 years for most services to determine fitness for further use. During the hydrostatic test, a cylinder is stressed with water pressure to a value determined by the cylinder specification and the marked service pressure. The total expansion of the cylinder and the value of permanent expansion after the pressure is released are recorded. The permanent expansion is subtracted from the total expansion to calculate the elastic expansion. An acceptable cylinder will have a permanent expansion less than 10 percent of its total expansion. A proper hydrostatic test is the basis for a valid estimate of the average wall thickness of the cylinder and therefore a measure of the erosion of the walls in corrosion processes. Details for hydrostatic test procedures are presented in the CGA Pamphlet C-1, Methods for Hydrostatic Testing of Compressed Gas Cylinders.

3.14.1 Calibrated cylinder. The calibrated cylinder is a cylinder that has been prestressed until the expansion pattern becomes reproducible up to a given predetermined pressure. A cylinder with known expansion characteristics for given pressures is used as a standard to calibrate a hydrostatic test set-up. A calibrated cylinder is an instrument of calibration and must be handled with care to guard against dents, overpressurizing, and corrosion.

3.14.2 Registered facility. The Code of Federal Regulations requires that each hydrostatic test facility be registered with the Department of Transportation before it is placed in operation testing cylinders. This registration is a control on the installed equipment for safety and accuracy. Generally, any system can be registered if its repetitive tests compare with known values for a calibrated cylinder.

3.16 Authorized repair and rebuild facilities. CFR, Title 49, Para. 173.34 limits repair and rebuild activities very specifically. Repair

5.1.1.6 Tare weight. Each cylinder used in liquified gas service shall be weighed before each charging. Cylinders without permanently marked tare weights shall be scheduled for weighing and marking at maintenance.

5.1.1.7 Water capacity. Water capacity is an optional marking on Government-owned cylinders (see 3.9).

5.1.1.8 Periodic test status. Cylinders in Government service shall be inspected for valid or expired periodic test dates. Cylinders in noncorrosive liquified gas service may qualify for external visual examination in lieu of hydrostratic testing. Cylinders with expired test dates shall be scheduled for testing or examination as applicable. Test dates followed with a star indicate that a specific cylinder is in a specific service on a 10 year rather than on a 5 year retest program. Test dates followed with a (+) sign have been approved for special filling limits 10 percent above the marked service pressure.

5.1.2 Dimensions. Government-owned cylinders shall be inspected for cylinder dimensions or capacity in accordance with the item description. Cylinders rejected for excessive variation with the item description shall be reported to the Government agency.

5.1.3 Color code, paint, and stenciling. The cylinders shall be inspected for proper color coding and stenciling in accordance with MIL-STD-101 as specified in the item description. Cylinders with improper color, peeling paint, and improper or illegible stenciling shall be scheduled for external maintenance.

5.1.4 Cylinder valve protection cap. Each cylinder designed for a protection cap shall be inspected for the presence of a valve protection cap that will run free on its threads and be free of cracks or dents. Cylinders lacking caps or with damaged caps shall have them replaced or scheduled for necessary maintenance. Cylinders with capacity less than 625 cubic inches capacity do not require a valve protection cap in Government service except for medical gas applications.

5.1.5 Cylinder valves. Each cylinder shall be inspected for a functional valve threaded into its neck threads. Broken valves or obviously nonfunctional valves shall be scheduled for replacement at maintenance.

5.1.6 Change in service. When specified in the contract, cylinders at receiving inspection which have an acceptable DOT specification and service pressure in accordance with the requirements of the item description, but in a different noncorrosive gas service shall be scheduled for change of service procedures.

5.1.7 Damaged cylinders. Cylinders shall be inspected for bent or torn footings in low pressure applications and for loose flanges in DOT 3A or 3AA applications. These types of defects shall be scheduled for maintenance in general metal working shops where the pressure bearing portion of the cylinder is not subject to the heat of welding activity. Repair work requiring independent welds of less than 3 inches or rebuild work requiring welds greater than 3 inches in length on the pressurized portion of the cylinder shall be scheduled for maintenance in shops with proper Bureau of Explosives authorization. Cylinders showing evidence of being subjected to fire shall be condemned and returned to the Government agency for disposal. When proper repair, rebuild, or remanufacture is not available a cylinder requiring such maintenance shall be rejected and returned to the Government agency.

5.1.8 Foreign cylinders. Foreign cylinders generally cannot meet the requirements of the Code of Federal Regulations because records of fabrication are not available. Foreign cylinders found at receiving inspection in CONUS service shall be condemned and returned to the Government agency for disposal.

5.1.9 Substandard cylinders. Cylinders that are listed by Government agencies or in industrial publications, declaring them in nonconformance to the current Code of Federal Regulations shall be rejected, marked "condemned", and returned to the Government for disposition.

5.1.10 Recording of services at receiving inspection. Receiving inspection should include the number of cylinders received in duplicate (DD Form 250) indicating acceptance or rejection.

5.2 Serviceability inspection.

5.2.1 Residual gas and moisture control. Cylinders shall be inspected for residual gas pressure. The level of pressure shall be 5 psi (great enough to produce an audible hiss when the valve is slightly cracked open). Any cylinder suspected of containing water shall be inverted and drained of its contents for not less than 10 minutes, and shall be considered an open cylinder. Cylinders with

cylinders are dated for a 5 year service period. When low pressure cylinders are used for a gas service commercially free of corroding components, the test period may be extended from 5 years to 10 years. DOT 3A, DOT 3AA or DOT 4AA480 specification cylinders in noncorrosive anhydrous ammonia service may be retested every 10 years instead of every 5 years repeating the hydrostatic test method used in making the cylinder. DOT 4B, DOT 4BA, DOT 4BW and DOT 4E specification cylinders in exclusive noncorrosive gas service, such as liquified petroleum, fluorocarbon refrigerants and fuel gas mixtures as listed in the CFR, Title 49, Para. 173.34 (g) may have the original test period extended to 12 years. These cylinders may be retested by the modified hydrostatic test (2 times the service pressure without expansion measurements and examined for leaks or other harmful defects). Approved cylinders shall be marked following the test date with the symbols denoting a 7 year service period. The CFR Title 49 Para. (10) lists cylinder specifications in noncorrosive gas services which qualify for external visual inspection in lieu of hydrostatic testing. Cylinders approved by external visual inspection shall be marked with the symbol E after the test date denoting a 5 year service period. At any time, cylinders maintained by external visual inspection may be hydrostatic tested in accordance with the applicable DOT fabrication specification and approved for a 10 year service period due to the noncorrosive quality of the gas service. Cylinders shall be separated into the following categories and scheduled for periodic testing as applicable.

5.2.6.1 Hydrostatic testing.

- (a) 3A and 3AA cylinders in high and low pressure services with expired service periods. When specified in the contract, wall stress evaluation shall be made and approved cylinders shall be marked with a star (*) for a 10 year service period. This option shall not be utilized for cylinders in US Air Force and US Navy Service.
- (b) Chlorine cylinders with expired 5 year service periods.
- (c) Cylinders used overseas and returned for CONUS service.
- (d) Cylinders under reconditioning contracts.
- (e) When specified in the contract, cylinders requiring hydrostatic testing for storage or overseas with less than 1 year service period remaining.

- (f) Low pressure cylinders with expired test periods may be retested either by hydrostatic test in accordance with the fabrication specification or by modified hydrostatic test when authorized by specification and service listed in the CFR and identified by the Symbol S after the test date.

5.2.6.2 External visual inspection. DOT 3A, 3AA, 4AA480, 4B, 4BA, 4BW and 4E cylinders in low pressure noncorrosive gas services as listed in the CFR with expired test periods may be evaluated by external visual inspection in lieu of the hydrostatic test method applicable and are identified by the symbol E after the test date.

5.2.7 General internal cylinder evaluation. At general internal evaluation cylinders accepted at receiving inspection not requiring valve removal except for sulfur hexafluoride and chlorine (see 5.2.8 and 5.2.9) shall be inspected for serviceability by the following procedures. Acetylene cylinders shall be evaluated in accordance with 5.3.3 for general service.

5.2.7.1 The hammer test. Each cylinder shall be subjected to a hammer test to assure viable structural integrity and that internally the surface is free of heavy corrosion residue. The clear ringing sound of acceptable cylinders will readily separate out the cylinder with a dull or dead response. Dull or dead sounding cylinders or a cylinder with a peculiar sound shall be scheduled for devalving, droplight inspection, and maintenance, as applicable. The hammer test is a recommended pre-filling gas cylinder inspection procedure which is mandatory for all 3A, 3AA, 3AX, and 3AAX cylinders in accordance with the Department of Transportation regulations. Cylinders with heavy corrosion deposits will have a muted or "dead" ring when struck a light blow with a wrench or light hammer. Cylinders to be inspected must be standing vertically without touching other cylinders or objects which might deaden the sound. A pigtail connecting the cylinder to a manifold is allowable. Strike each cylinder a light blow with a one-half-pound machinists ball peen hammer, wrench, or similar tool on the side wall about one-half or two-thirds down the cylinder. The blow

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Cylinders shall be accepted for service with a specified gas commodity application, when the integrity of the cylinder is assured to be in accordance with the applicable DOT specification and the cylinder is assured to maintain the purity level of the gas of specified use. Cylinders not acceptable by this standard shall be processed for applicable maintenance to restore acceptability in accordance with the item description. Cylinders that cannot be restored by approved maintenance procedures, shall be condemned and returned to the Government agency. Unrepairable valves are Government property and shall be returned to the Government.

5.2.11 Recording of required services at serviceability inspection. Serviceability inspection requires the listing of the number of cylinders inspected on duplicate (DD Form 250) indicating acceptance, rejection, and required maintenance. The DD Form 250 shall identify the activities required in process.

5.3 Cylinder maintenance. Cylinders received and found to be deficient at inspection or at charging shall be scheduled for necessary maintenance before returning to compressed gas service. A record of maintenance shall be kept current on DD Forms 250. After scheduled maintenance has been performed, the cylinder shall pass inspection standard in accordance with 5.1 and 5.2 of this standard. Cylinders should be grouped as follows:

- (a) Periodic testing.
 - (1) Cylinders requiring hydrostatic testing.
 - (2) Cylinders requiring external visual examination.
- (b) General cylinder maintenance.
- (c) General acetylene cylinder maintenance.
- (d) Chlorine cylinders.
- (e) Cylinders requiring special handling.
- (f) Cylinders requiring external surface maintenance.

5.3.1 Periodic testing. Cylinders in maintenance for periodic testing are generally cylinders with expired or invalid periodic test dates. Exceptions would be a requirement for 100 percent testing specified in a reconditioning contract or a cylinder which has undergone rebuild procedures. Cylinders shall be subjected either to hydrostatic testing or external visual inspection.

5.3.1.1 The hydrostatic test. The hydrostatic test shall be performed in accordance with the Compressed Gas Association Pamphlet C-1, "Hydrostatic Testing". To pass the hydrostatic test, a 3A or 3AA cylinder subjected to 5/3 times its marked service pressure internally shall have a permanent expansion which will be less than 10 percent of its total expansion. The cylinder elastic expansion (EE) will be its total expansion less its permanent expansion. Low pressure welded cylinders shall be hydrostatic tested at two times the marked service pressure. Permanent volumetric expansion must not exceed 10 percent of the total volumetric expansion. DOT 4B, DOT 4BA, DOT 4BW and DOT 4E cylinders used in services such as liquified petroleum, fluorocarbon refrigerants and fuel gas mixtures or as listed in the CFR Title 49 Para. 173.34 (9) may be tested by the modified hydrostatic method at two times the marked service pressure and examined for leaks or other defects without measurement of the volumetric expansion. Cylinders approved by the modified hydrostatic method shall have a retest period of 7 years and shall be permanently marked with the symbol S after the test date. The hydrostatic test shall always be preceded by a droplight test (see 5.3.2.1). Any cylinder displaying contamination such as grease, corrosion, or oxidation deposits shall be scheduled for cleaning or mechanical removal of the offending deposits before hydrostatic testing. Cylinders that fail at droplight test procedures or cylinders that fail hydrostatic test requirements shall be rejected, marked condemned, and returned to the Government agency for disposal. Cylinders passing internal visual examination and cylinders approved in hydrostatic testing shall be drained and dried in accordance with 5.3.2.4 and revalved as quickly as practical.

5.3.1.1.1 Special filling limit test. DOT 3A and 3AA cylinders that meet the requirements of the CFR, Title 49, 173.302 may be marked with a (+) sign and filled to a pressure 10 percent above the marked service pressure. These requirements including a wall stress analysis, shall be made at each retest of a given cylinder. High pressure cylinders DOT 3A and 3AA specifications, size 9 inches x 51 inches, with a nominal water capacity of 2640 cubic inches may be tested for special filling limits, 10 percent above the marked service pressure (see special filling limits CFR Title 49, 173.43 and as specified herein). Approved cylinders shall be marked permanently by a (+) mark following the last periodic hydrostatic test date. If a cylinder has been in service at the special filling limit and marked with a (+) and is retested by regular hydrostatic test, the date is not to be followed by a (+) and it shall be returned to service at the marked service pressure. Government cylinders specified for special filling limit shall

be restricted to cylinders manufactured after 1960, except for cylinders made by Taylor-Wharton or Harrisburg Steel Co. which shall be limited to cylinders made since 1920. The practice of testing for special filling limits should be reserved for use only when justification for the additional capacity is made by the procuring agency. Each manufacturer controls his production by a given "K" factor and a maximum Elastic Expansion (EE) at hydrostatic testing. This information is listed below. K factors shall be used to calculate the average or the maximum wall stress when a corresponding cylinder is retested to be approved for filling 10 percent above the marked service pressure.

Mfg & Date Cylinder	Type size - Cu in	K-Factor	Max (EE)
Pressed steel TK. 1960 * present	3AA2015 - 2640	1.24×10^{-7}	220
	3AA2265 - 2640	1.24×10^{-7}	221
Harrisburg Steel Taylor-Wharton	3A2015 - 2640	1.31×10^{-7}	178
	3AA2015 - 2640	1.30×10^{-7}	220
	3AA2265 - 2640	1.30×10^{-7}	220
Marison Cylinder	3AA2015 - 2640	1.30×10^{-7}	220
	3AA2265 - 2640	1.32×10^{-7}	230

NOTE: Before 1960, Pressed Steel Tank Company made many cylinders from plate stock. Though these cylinders are reliable at marked service pressures, they shall not be tested and used at 10 percent over marked service pressures.

5.3.1.1.2 10 year periodic test. DOT 3A and 3AA cylinders that have been used exclusively in a noncorrosive gas service can be inspected in accordance with the CFR and be approved for 10 year retest periods. When specified in the contract, Government-owned cylinders may be approved for 10 year test periods in accordance with the CFR, Title 49, 173.43. This privilege should only be used when the history of a cylinder is known or by special testing. Historic information is not generally available for Government-owned cylinders. Special application may justify 10 year retesting such as overseas service. DOT 3A and 3AA cylinders approved for 10 year periodic testing shall have the test date followed by a star (*) permanently marked in the metal of the shoulder immediately following the test date. Cylinders in US Air Force and US Navy service shall always be subjected to a 5 year retest period.

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5.3.1.2 External visual inspection. Cylinders made in accordance with, and used exclusively in the noncorrosive gas services listed in the CFR Title 49, Para. 173.34 (10), may be evaluated by an external visual inspection in lieu of the periodic hydrostatic retest. External visual inspection shall be required 5 years after the first inspection and periodically at the 5 year intervals thereafter. Procedures and requirements shall be in accordance with the Compressed Gas Association Pamphlet C-6, "Standards for Visual Inspection of Gas Cylinders". Cylinders approved at external visual inspection, shall be permanently marked with the month and year of the inspection date followed with the letter "E".

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5.3.2. General cylinder maintenance. These cylinders require valve maintenance, repair or rebuild, cleaning, or external maintenance as scheduled. Valve service life is extended by a system to preserve the identity of the valve and its mated cylinder. Valves requiring replacement shall be rejected. Repairable valves or acceptable valves shall be forwarded for valve maintenance and revalving as applicable.

5.3.2.1 Droplight testing. Any time that a valve is removed from a cylinder for any reason, the cylinder shall be given an internal droplight examination in accordance with the following procedure: A light source of sufficient intensity to clearly illuminate the interior walls should be provided. (NOTE: For safety, this light should be low (3-12) voltage with an isolation transformer (no common ground) and the bulb should be protected with some form of a safety shield. If the bulb should break, it could ignite flammable liquids or vapors in the cylinder, resulting in possible damage to the eyes and face.) Before introducing the light, purge the cylinder thoroughly of all residual vapors with dry nitrogen or dry, oil-free air. Then invert it to remove all loose rust and scale and liquid contaminants. Drop the light into the cylinder slowly, positioning the light and the cylinder so that the entire inside surface of the cylinder, except for the blind area just below the neck, can be examined. Tilt the cylinder several degrees from vertical to get the best view of the cylinder wall. Stop the movement of the light as required to permit prolonged inspection of suspect areas. Hold the light so that it first shines directly on a suspect area and then so that any irregularities will produce shadows to improve the examiner's perception of the suspected area. Continue the examination while the light is being withdrawn from the bottom of the cylinder as some defects show up best at this time. The unavoidable blind area just below the cylinder neck cannot be inspected except with sophisticated inspection devices. The wall thickness in this area is heavier than the rest of the cylinder and, because of its location, seldom corrodes as fast as the other interior portions of the cylinder. Contamination in this area can be inferred by an examination of the cylinder neck threads near the bottom of the neck opening and of the visible portions of the upper areas of the cylinder. If the examination discloses substantial internal deposits which make it impossible to inspect the cylinder wall itself, these deposits shall be removed in accordance with mechanical restoration.

The cylinder shall be reinspected after the deposits are removed. The interpretation of the visual internal inspection must be left to experience. (Surface irregularities may appear greater in height or depth than they really are because of the shadows they cast.) Harmless mill scale and metal discoloration can be misinterpreted as heavy contamination. When in doubt, however, the safe and desirable procedure is to clean by a procedure appropriate to the nature of the apparent impurity. When significant corrosion or possible flaws are suspected, the cylinder shall be further inspected in accordance with the requirements of CGA Pamphlet C-5. A desirable inspection device which can be of great assistance in inspecting questionable cylinders is a boroscope. This optical device, which is similar to a periscope, can, by a system of lenses, mirrors, and high intensity light, effectively place the eye inside the cylinder and even magnify the surface under inspection.

5.3.2.2 Cylinder structural maintenance. Cylinder structural deficiencies shall be grouped as follows: Neck, flange and threads, collar and footing, sidewalls, shoulder and bottom heads.

5.3.2.2.1 Government cylinders DOT 3A and 3AA. Cylinders greater than 625 cubic inches in water capacity are supplied with a neck flange in accordance with MIL-C-17376/3. The flange is installed by press fit or by peening into place. Heat cannot be applied to the cylinder, either in removal of the flange or in replacement, as the temper of the steel in the 3A or 3AA cylinder may be changed. Flanges shall be peened tight when found to be loose. Flanges, stretched by abuse shall be replaced in accordance with MIL-C-17376/3. Any permanent markings on a replaced flange shall be permanently marked in the steel of the shoulder of the same cylinder. DOT 3A and 3AA specification cylinders with service pressures over 500 psi are seamless in construction and welding or heating the cylinder is prohibited, but 3A and 3AA specification cylinders with service pressures up to 500 psi are often equipped with welded footings to protect the bottom areas and to provide a flat surface for upright stability. Repair of 3A or 3AA cylinders shall be restricted to similar cylinder fabricators.

5.3.2.2.2 Government cylinders DOT series 4 and series 8. Cylinders requiring maintenance shall be grouped into those requiring "repair" maintenance and those requiring "rebuild" maintenance. These services shall be performed only by properly certified shops which shall function in accordance with the procedures and limits specified in the Code of Federal Regulations, Title 49, and as specified herein. Repairing or

cylinder contamination. The use of fluorocarbon lubricants stable in oxygen atmospheres may be used to increase the effectiveness of the polytetra/fluoroethylene tape. Hydrocarbon lubricants are prohibited in compressed gas service. All valves should be installed and torqued until a maximum of five and not less than one full thread shows above the cylinder. New valves should have as near five threads showing as is possible to effect a tight seal. When a valve is reinstalled in its mated cylinder, a reliable seal can be achieved by torquing the valve one-half to one full thread into the cylinder beyond its previous installation. Used valves should seal displaying one to two threads less than with any previous installation. If a gas-tight seal cannot be achieved through a reasonable application of the above guidelines, the cylinder shall be rejected and marked condemned for enlarged neck threads. Except for chlorine service, oversized valve inlet threads are not approved in the Government system.

5.3.2.5.4 Valve replacement and disposal. Improper or rejected valves that cannot be reconditioned shall be condemned and replaced with valves in accordance with MIL-V-2. Condemned valves shall be returned to the Government for disposal, as condition condemned property. A simple control may be achieved by tying the unrepairable valve to the installed new valve to be returned with the service cylinder.

5.3.2.5.5 Cylinder plugs in lieu of valve. When specified by the item description tapered plugs or plugs with flange and gasket shall be installed in the cylinder neck opening. Plugs shall have National Gas Threads provided with wrench flats for easy removal. The plug must effect an airtight seal to preserve the internal surfaces of the cylinder from oxidation and corrosion in storage.

5.3.3 General maintenance of acetylene cylinders. Acetylene cylinders accepted shall be scheduled for maintenance as follows:

- (a) The acetone shall be adjusted to reflect the marked tare weight of the cylinder (see 5.3.3.1).
- (b) Safety relief devices shall be 8-3 with a fusible metal melting point of 212° F (see 5.2.3, 5.2.4 and 5.3.2.5.3).
- (c) Valves shall be maintained in accordance with 5.3.2.5.
- (d) The external cylinder surfaces shall be maintained in accordance with 5.3.6.
- (e) The valve protection cap shall be maintained in accordance with 5.3.6.1.

5.3.3.1 Acetone adjustment. Excessive weight is indicative of water absorption by the acetone in the filler. Poor acetylene absorption is another indication of water vapor trapped in the porous filler. Either condition requires bleeding of the acetylene gas, heat evaporation of the acetone, baking dry the porous filler, and recharging with dry acetone to the tare weight of the cylinder. A low tare weight indicates excessive corrosion and wasting of the steel cylinder, or loss of acetone by fast withdrawal of the acetylene by the user. Each cylinder shall be weighed and checked against its marked tare weight.

- (a) Cylinders under weight will require adjustment of the acetone in quantities up to 20 percent of the authorized weight of the acetone charge. Cylinders with greater deficiencies shall be rejected and returned to the Government for disposition.
- (b) Cylinder over weight may be handled by the contractor's standard practice for removing excess acetone or small accumulations of moisture. Cylinders with excess moisture, heavy enough to inhibit the absorption of acetylene shall be rejected and returned to the Government for disposition.
- (c) When specified in the work order or contract, cylinders rejected for deficiency and low weight or for excessive moisture and heavy weight shall be corrected by evaporation of acetone, baking dry and recharging with acetone to proper tare weight.

5.3.4 Chlorine cylinder maintenance. Each chlorine cylinder shall have its valve removed, the residual chlorine gas purged with atmospheric air, and shall be internally inspected by drop light test. Cylinders rejected for internal corrosion must be subjected to a cleaning process to remove any corrosion residue for a determination of internal cylinder damage. Excessive eroding is an indication for hydrostatic testing regardless of the periodic test status of the cylinder before returning to chlorine gas service. The cylinder rejected for eroded neck threads must be retapped with the applicable NCO tapered threads to a depth of up to 4 threads according to need for full roots and crests in the female thread forms. Such a cylinder shall be refitted with a valve with inlet threads machined from one to four threads oversized as applicable and in accordance with the chlorine valve specification sheet MIL-V-2/20. Chlorine cylinders are the only cylinders that are authorized to be fitted with valves with oversized inlet threads by MIL-V-2. Neither chlorine liquid nor gas will attack and corrode iron or steel unless a slight amount of water is trapped within the cylinders. When moisture is present, the water will hydrolyze with the chlorine to produce small amounts of hypochlorous and hydrochloric acid. The