

व्यापक परिचालन में मसौदा

तकनीकी समिति: एम.ई.16:

- 1 यॉन्गिक इंजिनियरी विभाग परिषद का सभी सदस्य(यॉ.वि.प.) ।
- 2 गैस सिलिंडर विषय समिति एम.ई.डी. 16, अल्प दाब गैस सिलिंडर उप समिति, एम ई डी 16:2 एष घुलित ऐसिटिलीन सिलिंडर, जनरलर, ऐसिटिलीन पाईपलाइन एष उच्च दाब गैस सिलिंडर उप समिति एम.ई.डी 16:3 का सभी सदस्य ।
- 3 अन्य रूचि रखनवाला।

निम्नलिखित प्रलख सलगन है:

प्रलख	विषय
एम.ई. 16 (1158)	भारतीय मानक मसौदा आवधिक निरीक्षण एष पुनःअर्हता - वाहनों का प्रयोग का लिए द्रवित पट्रोलियम गैस (एल पी जी) सिलिंडर - रीति सहिता (आई सी एस 23.020.30; 43.060.40; 75.160.30)
एम.ई. 16 (1159)	भारतीय मानक मसौदा गैस सिलिंडर - मोटर वाहनों, एच सी एन जी मिश्रित का लिए तथा सी एन जी का सकैड सिलिंडरों का लिए ईधन का रूप में कम्प्रेसड नष्टुरल गैस का ऑन बोर्ड भठारण का लिए उच्च दाब का आवधिक निरीक्षण एष पुनःअर्हता (आई सी एस 23.020.30; 43.060.40; 75.060)

कृपया इस मसौदाका अवलोकन करें और अपनी सम्मतियायह बताताहुए भजें कि अतत: यदि यह प्रकाशित हो जाएँ तो इस पर अमल करन में आपका व्यवसाय अथवा कारोबार में क्या कठिनाईयाँआ सकती हैं ।

सम्मतियाभजनकी अन्तिम तिथि: **15-02-2012.**

यदि कोई सम्मति हो तो कृपया अगलापृष्ठ पर दियापत्र में अद्योहस्ताक्षरी को उपरलिखित पतापर भज दें ।

यदि कोई सम्मति प्राप्त नहींहोती हैं अथवा सम्मति में कल्ल भाषा सबधी त्रुटि हुई तो उपरोक्त प्रलख को यथावत अन्तिम रूप दिया जायगा । यदि कोई सम्मति तकनीकी प्रकृति की हुई तो विषय समिति का अध्यक्ष का परामर्श साअथवा उनकी इच्छा पर आगाकी कार्यवाही का लिए विषय समिति को भजनानका बाद प्रलख को अन्तिम रूप दादिया जाएगा ।

यह मसौदाहमारी वब साईट www.bis.org.in पर भी उपलब्ध हैं ।

धन्यवाद,

भवदीय

हस्ताक्षर :

नाम : जए सिददकी

पद . वैज्ञा. 'ई' एवप्रमुख (यॉ.इंजि.)

फोन/फैक्स : 011-23232509

ई-मल: med@bis.org.in

प्रति: उपरलिखित

नोट - जहाएक सठठन का मुख्य और वैकल्पिक सदस्य एक ही स्टठान पर हैं, मसौदाकी एक प्रतिलिपि कल्ल मुख्य सदस्य को भजी जा रही है। वो मसौदाको वैकल्पिक सदस्य का साथ साझा करनका कष्ट करें ।

DRAFT STANDARDS IN
WIDE CIRCULATION

DOCUMENT DESPATCH
ADVICE

Gas Cylinders, Sectional Committee, ME 16

TO:

- a) The interested members of Mechanical Engineering Division Council, MEDC
- b) All members of Gas Cylinders Sectional Committee, ME 16 , Low Pressure Gas Cylinders Subcommittee, ME 16:2 and Dissolved Acetylene Cylinders, Generators, Acetylene Pipelines and High Pressure Gas Cylinders Sub Committee, ME 16:3
- c) All others Interested

Dear Sirs,

Please find enclosed the following document:

Doc. No.	TITLE
Doc: ME 16(1158)	Draft Indian Standard Periodic inspection and requalification - Liquefied petroleum gas (LPG) cylinders for automotive use - Code of practice (ICS 23.020.30; 43.060.40; 75.160.30)
Doc: ME 16(1159)	Draft Indian Standard Gas cylinders - Periodic inspection and requalification of high pressure cylinders for the on-board storage of compressed natural gas as a fuel for automotive vehicles, cylinders for HCNG blends and CNG cascade cylinders (ICS 23.020.30; 43.060.40; 75.060)

Kindly examine the Draft Standards and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted.

Last date for receipt of comments: **15-02-2012.**

Comments, if any, may please be made in the format as given overleaf and mailed to the undersigned at the above address.

In case no comments are received or comments received are of editorial nature, you will kindly permit us to presume your approval for the above document as finalized. However, in case of comments of technical in nature are received then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional committee for further necessary action if so desired by the Chairman, Sectional Committee.

These documents are also hosted on BIS website www.bis.org.in.

Thanking you,

Yours faithfully

(J.A. Siddiqui)
Scientist 'E' & Head (Mech Engg)
Phone/Fax: 011-23232509
E-mail: med@bis.org.in

Encl: As above

NOTE-WHERE PRINCIPAL AND ALTERNATE MEMBERS OF AN ORGANISATION ARE FROM THE SAME STATION, ONE COPY OF THE DOCUMENT IS SENT ONLY TO THE PRINCIPAL MEMBER WHO MAY KINDLY SHARE THIS WITH HIS ALTERNATE AS WELL.

Draft Indian Standard
PERIODIC INSPECTION AND REQUALIFICATION –
HIGH PRESSURE STEEL CYLINDERS FOR THE ON-BOARD STORAGE OF
COMPRESSED NATURAL GAS AS A FUEL FOR AUTOMOTIVE VEHICLES,
CYLINDERS FOR HCNG BLENDS AND CNG CASCADE CYLINDERS – CODE OF
PRACTICE

ICS 23.020.30; 43.060.40; 75.060

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**Last date for receipt of
comments is: 15 February 2012**

FOREWORD

Adoption clause to be added later on.

0.1 This Indian Standard provides information and procedure for the periodic inspection of compressed natural gas cylinders. These cylinders, installed in vehicles or cascade are certified by the manufacturer to meet the requirements of relevant standard and are designed to store compressed natural gas.

0.2 Cylinders undergo cyclic loading and it is imperative that due importance and care should be taken during its life cycle. Cylinder contains high energy contents due to gas at high pressure in it which makes the safety concern and therefore, compliance with the requirements and following the detailed procedures listed in the standard are of utmost importance.

0.3 These cylinders are certified by the manufacturer for the storage of natural gas / HCNG blend. Cylinders for storage of compressed natural gas / HCNG blend are required to maintain or improve the level of safety currently existing in practice. These requirements are achieved by following the procedures listed in the standard.

0.4 Any testing station desiring to obtain recognition for periodic testing and examination of cylinders shall provide the facilities listed in Annex A

0.5 While implementing this standard compliance with statutory regulations shall be ensured.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

This Indian Standard deals with seamless steel cylinders intended for on-board storage of compressed natural gas (CNG) as a fuel, intended to be permanently fixed to the automotive vehicle, Cylinders for HCNG Blends and CNG cascade cylinders.

This Indian standard specifies the requirement for periodic inspection and testing to verify the integrity of such gas cylinders to be re-introduced into service for further period of time.

This standard does not apply for periodic inspection and testing of composite cylinders.

2. REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate possibility of applying the most recent editions of the standards indicated below;

<i>IS No.</i>	<i>Title</i>
3224 : 2002	Valve fittings for compressed gas cylinders excluding Liquefied Petroleum Gas (LPG) Cylinders – Specification
4379 : 1987	Identification of the contents of Industrial gas cylinders
5844 : 1970	Recommendations for Hydrostatic Stretch testing of Compressed Gas Cylinders
7285 : 2004	Refillable seamless steel gas cylinders- Specification
8868 : 1988	Periodical Inspection Interval For Gas Cylinders in use
15490 : 2004	Cylinder for On–Board storage of CNG as a fuel for automotive vehicles - Specification.

3. TERMINOLOGY

For the purpose of this standard, the following definitions in addition to given in IS 7241 shall apply.

3.1 Abrasion – Damage to cylinder or equipment caused by wearing, grinding or rubbing away of material by friction.

Note : Abrasion can be the result of many cycles of something rubbing lightly on the surface of the cylinder or equipment, or due to a few cycles, perhaps only one, of heavy rubbing.

3.2 Impact - forceful blow to the surface of the cylinder that can cut, gouge or significantly indent the surface

Note: Impact can also induce such damage as de-laminations, which are not readily apparent through visual examination.

3.3 Competent Authority - Any national body or authority designated or otherwise recognized as such for any purpose in connection with this standard.

3.4 Competent Person - Person who by a combination of training, experience and supervision is able to make objective judgments on a subject, authorized by the Competent Authority.

3.5 Condemn - (cylinder or piece of equipment) in a state no longer fit for service and for which repair is not allowed

3.6 Cut – Damage caused by a sharp object coming into contact with the cylinder's surface.

3.7 Inspection Mark – Mark, label or tag placed by an inspector on the cylinder indicating acceptance of the cylinder.

3.8 Pressure Relief Device (PRD) – A device designed to reduce the possibility of failure of a charged cylinder for excessive pressure particularly when the cylinder is exposed to heat.

Note : PRD can be activated either by excessive temperature or excessive internal pressure or both.

3.9 Rejected Cylinder – Cylinder that needs to be removed from the service.

3.10 Working Pressure (P_w) / Service Pressure – Working pressure means the internal pressure of the gas in the cylinder at a temperature of 15° C.

Note : All the pressures referred to in this standard are gauge pressures.

3.11 Test Pressure (P_h) – Test pressure means the internal pressure required for the hydrostatic test or the hydrostatic stretch test of the cylinder.

3.12 Valve – Device installed in threaded openings of the cylinder that is used to regulate gas flow into or from the cylinder.

NOTE: A manual valve is turned on or off with a handle. A solenoid valve is turned on or off electrically. Some solenoid valves may have manual override and can be operated manually with special tools.

4. APPROVED TESTING STATION AND PERIODIC INSPECTION INTERVAL

4.1 All inspection and tests shall be carried out at authorised station complying with the requirements of this standard and approved by the competent authority. The inspection tests shall be carried out only by competent and authorized person.

4.2 Intervals between periodic inspection and test

All cylinders are required to be inspected and tested at interval of 5 years or the interval in accordance with the requirements in IS 8868 or as approved by the statutory authority throughout their life. The shortest of the specified interval shall be applicable. The service life of CNG ONB cylinder is fixed as 20 years under the Gas Cylinders Rules, 2004.

Copies of the original inspection and tests shall be checked to ensure that the cylinder complies with the approved design and that the retest results are in line with those obtained at the time of manufacture and that there is no departures except than what is laid down in this code.

Subsequent periodic inspections and tests shall be carried out to ensure that the cylinder is fit for further service.

4.3 Date of first retest

A cylinder shall be due for a periodic inspection and test before the first retest starts from the date of manufacture. Any practice of re-stamping the unused cylinders with a new date at the time of their sale is not permitted.

5. LIST OF PROCEDURES FOR PERIODIC INSPECTION AND TEST

Each cylinder shall be submitted to periodic inspection and test. The following procedures form the requirements for such inspection and test and are explained in detail in following clauses:

- a. Identification of cylinder and preparation for inspection & test (Clause 6)
- b. Depressurization & de-valving (Clause 7)
- c. External Visual Inspection (Clause 8)
- d. Internal Visual Inspection (Clause 9)
- e. Supplementary tests (Clause 10)
- f. Inspection of cylinder neck (Clause 11)

- g. Pressure test and Ultrasonic Examination (Clause 12)
- h. Inspection of valves and Pressure Relief Device (Clause 13 & Annex B)
- j. Cylinder Repairs (Clause 14)
- k. Final operations (Clause 15)
- l. Rejection and rendering cylinder unserviceable (Clause 16)
- m. Re-testing of rejected cylinder (Clause 17)

It is recommended that the above listed procedures be performed in the sequence. In particular, the check of internal condition (Clause 9) shall be carried out before the pressure test or ultrasonic examination. (Clause 12).

Cylinders that fail an inspection or tests shall be rejected (See Clause 16). Where a cylinder passes the previously listed procedure, but when the condition of the cylinder remains in doubt, additional tests shall be performed to confirm its suitability for continued service (see Clause 10) or the cylinder shall be rendered unserviceable.

Depending on the reason for the rejection, some cylinders may be recovered (see Annex C).

The inspections & tests shall be carried out only by competent persons.

Cylinders showing evidence of fire or excessive heat exposure shall be declared unserviceable and shall be destroyed as per the procedure. Fire damage may be evident by discoloration, darkening, charring or sooting of the surface in the area of exposure of cylinder surfaces.

6. IDENTIFICATION OF CYLINDER AND PREPARATION FOR INSPECTIONS AND TESTS

6.1 Container / Cylinder Removal

The cylinder shall be removed from the vehicle prior to any inspection and testing. Removal and reinstallation of the cylinder shall be carried out in accordance with the technical requirements of Automotive Industry Standard and / or the requirements of the relevant agencies.

The removal and re-installation shall be carried out only by competent person

6.2 Before any work is carried out, relevant cylinder data and its ownership shall be identified and recorded.

7. DE-PRESSURISATION AND DE-VALVING PROCEDURES

7.1 All cylinders shall be presumed to contain gas under pressure and following precautions shall be observed.

- a) The gas from the cylinder shall be released in a safe manner keeping in mind dangers associated with the natural gas. Cylinders shall be emptied at stations at the designated area approved by statutory authority only.

- b) Fencing shall be provided to prevent access of unauthorised person in the LPG unloading area.

7.1.1 Gas shall be emptied in a vent stack. The position of the vent stack shall be taken into account in the siting – location of the installation. While emptying the cylinder, gas level in the stack shall be monitored by gas detector.

7.2 The valve shall be opened and if no gas escapes and the port is not visibly blocked, a charge of low pressure Nitrogen or other inert gas shall be blown into the valve outlet. When no gas discharges the valve shall be treated as “obstructed”. Then the nitrogen supply is removed. Any discharge of gas from the cylinder indicates the cylinder mouth is not obstructed. At the end of completion of such discharge, the cylinder shall be considered as completely empty.

7.3 Should the valve be suspected of being obstructed, the contents of the cylinder shall be released in safe manner as mentioned in Annex D. Work on cylinders shall be carried out in the open air.

7.4 All valve fittings shall be duly identified with respect to identity of corresponding cylinders and records for the same shall be maintained.

8. EXTERNAL VISUAL INSPECTION

8.1 Preparation for external visual inspection

When necessary, the cylinder shall be cleaned and have all loose coatings, corrosion products, tar, oil or other foreign matter removed from its external surface by a suitable method, e.g. by brushing, shot blasting (under closely controlled condition), water jet abrasive cleaning, chemical cleaning or other suitable methods. The method used to clean the cylinder shall be validated and controlled process. Care shall be taken at all times to avoid damaging the cylinder or removing excess amounts of material of cylinder wall (See Annex C). If there is any plastic or insulation sticking to the surface it shall be removed.

8.2 Inspection procedure

The external surface of each cylinder shall be inspected for

- a. Dents, cuts, gouges, bulges, cracks, laminations, or excessive base wear,
- b. Heat damage, plug or neck inserts or electric arc, suspicious marks etc. (see Annex C, Table 1).
- c. Corrosion (see Annex C, Table 2) - Special attention shall be given to areas where water may be trapped,
- d. Other defects such as illegible or incorrect, unauthorized stamp marking, or unauthorized additions or modifications

The rejection criteria shall be as laid down in Annex C. Cylinders no longer suitable for future service shall be rejected and rendered unserviceable. The inspection shall be carried out in a well illuminated area. Magnifying glass may be employed to detect cracks. Any surface coating that may obstruct optimum visual inspection shall be removed.

9. INTERNAL VISUAL INSPECTION

Cylinders shall be inspected internally to complete periodic and testing requirements. Before starting the internal inspection the cylinders shall be cleaned internally under closely controlled conditions by shot blasting, water jet abrasive cleaning, steam jet, hot water jet, chemical cleaning or other suitable method. The method used to clean the cylinder shall be validated, controlled process. Care shall be taken all times to avoid damaging the cylinder or removing excess amounts of cylinder wall (See Annex C).

Each cylinder shall be inspected internally using adequate illumination to identify any defects similar to those listed in **8.2a** and **8.2c**. Precaution shall be taken to ensure that the method of illumination presents no risks to the tester while performing the operation. Any internal liner or coating that may obstruct optimum visual inspection shall be removed. The method used to clean the cylinder shall be validated, controlled process. Care shall be taken all times to avoid damaging the cylinder or removing excess amounts of cylinder wall (See Annex C).

10. SUPPLEMENTARY TEST – CHECK FOR TARE WEIGHT, WATER CAPACITY

Each cylinder shall be checked for tare weight and water capacity before proceeding for further tests. Tare weight of the cylinder to be conformed with the original tare weight punched on the cylinder and that mentioned in the certificate. Any cylinder which loses in its tare weight by over 5% shall be condemned.

Where there is doubt concerning the type and/or severity of a defect found on visual inspection, additional tests or methods of examination may be applied e.g. ultrasonic techniques or other non destructing tests. Only when all doubts are eliminated, the cylinder may be further processed (see Annex C).

If a hardness test is required it shall only be according to standard. The result shall meet, the minimum required design hardness value.

11. INSPECTION OF CYLINDER NECK

11.1 Cylinder to valve threads

After removal of valve, the valve threads shall be examined to identify the type of thread and to ensure that they are

- a) Clean and of full form
- b) Free of damages,
- c) Free of burrs,
- d) Free of cracks, and
- e) Free of other imperfections,

Cracks manifest themselves as lines that run vertically down the thread and across the thread faces. They should not be confused with tap marks (thread machining stop marks). Special attention should be paid to the bottom of the threads.

11.2 Other neck surfaces

Other surfaces of the neck shall also be examined to ensure they are free of cracks or other defects (see Annex C).

11.3 Damaged Internal thread

Where necessary and where the manufacturer or the competent authority confirms that the design of the neck permits, threads may be re-tapped or the thread type changed to provide the appropriate number of effective threads. After re-tapping or changing thread form, the threads shall be checked with the appropriate thread gauge, (see IS 9122).

12. PRESSURE TEST AND ULTRASONIC EXAMINATION

12.1 General

Each cylinder shall be submitted to hydraulic proof pressure test and ultrasonic examination.

NOTE: Take appropriate measures to ensure safe operation and to contain any energy that may be released during the hydraulic test. It should be noted that pneumatic pressure test requires more precautions than water pressure test since, regardless of the size of the container; any error in carrying out this test is highly likely to lead to a rupture under gas pressure. Therefore these tests should only be carried out after ensuring that the safety measures satisfy the safety requirements.

Each cylinder subjected to a hydraulic pressure test shall use a suitable fluid, normally water, as the test medium. The test pressure shall be in accordance with the stamp markings on the cylinder.

Once a cylinder has failed one of the above mentioned tests, none of the other test methods shall be applied to approve the cylinder.

12.2 Hydraulic volumetric expansion test

The test shall be carried out as per IS 5844.

Internal cleaning and visual internal inspection of the cylinder shall be carried out before the hydraulic volumetric expansion test. After the cylinder has been held at test pressure for a minimum period of 30s, the permanent volumetric expansion of the cylinder expressed as a percentage of the total expansion at test pressure shall not exceed the percentage given in the design specification. The cylinder shall be rejected, if it shows a permanent expansion (that is volumetric expansion after the pressure has been released) in excess of 10 percent of total volumetric expansion measured at the test pressure P_h .

Cylinder shall be thoroughly dried after Hydraulic test.

12.3 Ultrasonic examination

12.3.1 Scope

This is based on techniques used by cylinder manufacturers. Other techniques of ultrasonic inspection may be employed, provided these have been demonstrated to be suitable for the defect detection and has been approved by the statutory authority.

12.3.2 General requirements

The ultrasonic testing equipment shall be capable of at least detecting the reference standard notches as described in **12.3.3.2**. It shall be serviced regularly in accordance with the manufacturer's operating instructions to ensure that its accuracy is maintained. Inspection records and approval certificates for the equipment shall be maintained.

The operation of the test equipment shall be done by qualified and experienced personnel certified at least to NDT Level 1 and supervised by personnel certified at least to NDT Level 2.

The inner and outer surface of any cylinder which is to be tested ultrasonically shall be in a condition suitable for an accurate and reproducible test.

For flaw detection the pulse echo system shall be used. For thickness measurement either the resonance method or the pulse echo system shall be used. Either contact or immersion techniques of testing shall be used.

A coupling method which ensures adequate transmission of ultrasonic energy between the testing probe and the cylinder shall be used.

12.3.3 Flaw detection of the cylindrical parts

12.3.3.1 Procedure

The cylinder to be inspected shall have a rotating motion and the search unit shall have a translation motion relative to one another such that a helical scan of the cylinder will be described. The velocity of rotation and translation shall be constant within ± 10 percent. The pitch of the helix shall be less than the width covered by the probe (at least 10 percent overlap shall be guaranteed) and be related to the effective beam width such as to ensure 100 percent coverage at the velocity of rotational movement and a translation used during the calibration procedure.

An alternative scanning method may be used for transverse defect detection in which the scanning or relative movement of the probes and the work piece is longitudinal, the sweeping motion being such as to ensure 100 percent surface coverage with about 10 percent overlap of the sweeps. The cylinder wall shall be tested for longitudinal defects with the ultrasonic energy transmitted in both circumferential directions and for transverse defects in both longitudinal directions.

The ultrasonic sensitivity shall be set at +6 dB in order to improve the detection of defects equivalent to 5 percent of the cylindrical wall thickness in the thickened portion.

In this case or when optional testing is carried out on the transition area between the wall and neck and / or wall and base, this may be conducted manually, if not carried out automatically.

The effectiveness of the equipment shall be periodically checked by passing a reference standard through the test procedure. This check shall be carried out every four hours. If during this check the presence of the appropriate reference notch is not detected then all cylinders, tested subsequent to the acceptable test check, shall be retested after the equipment has been reset.

12.3.3.2 Reference standard

A reference standard of convenient length shall be prepared from a cylinder of similar diameter and wall thickness range and from material with the same acoustic characteristics (subjected to the same heat treatment) and surface finish as the cylinder to be inspected. The reference standard shall be free from discontinuities which may interfere with the detection of the reference notches. It is preferable that these test standards are either prepared by cutting available heat treated cylinder or shall be procured from the cylinder manufacturer.

Reference notches, both longitudinal and transverse, shall be machined on the outer and inner surface of the standard. The notches shall be separated such that each notch can be clearly identified.

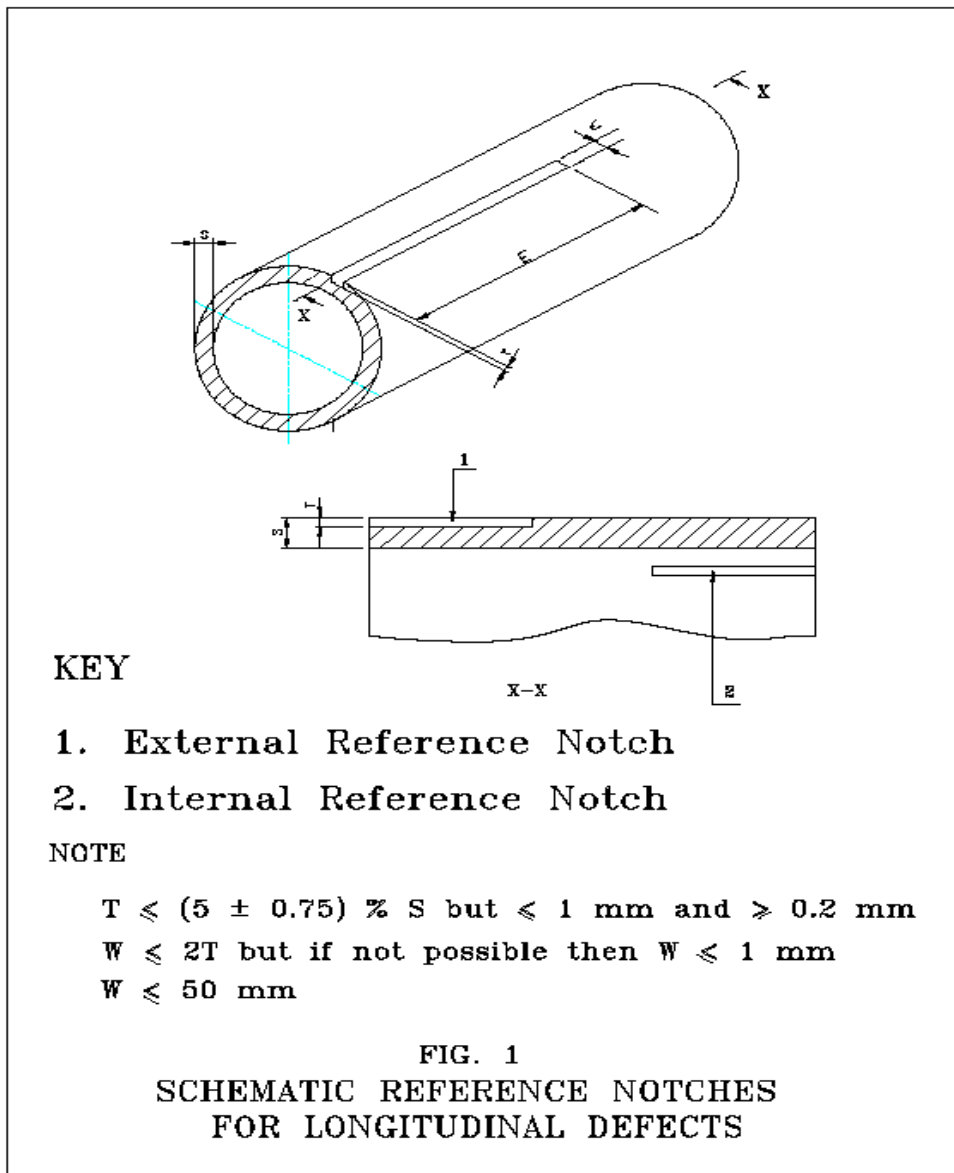
Dimensions and shape of notches are of crucial importance for the adjustment of the equipment. See Fig. 1 and Fig. 2.

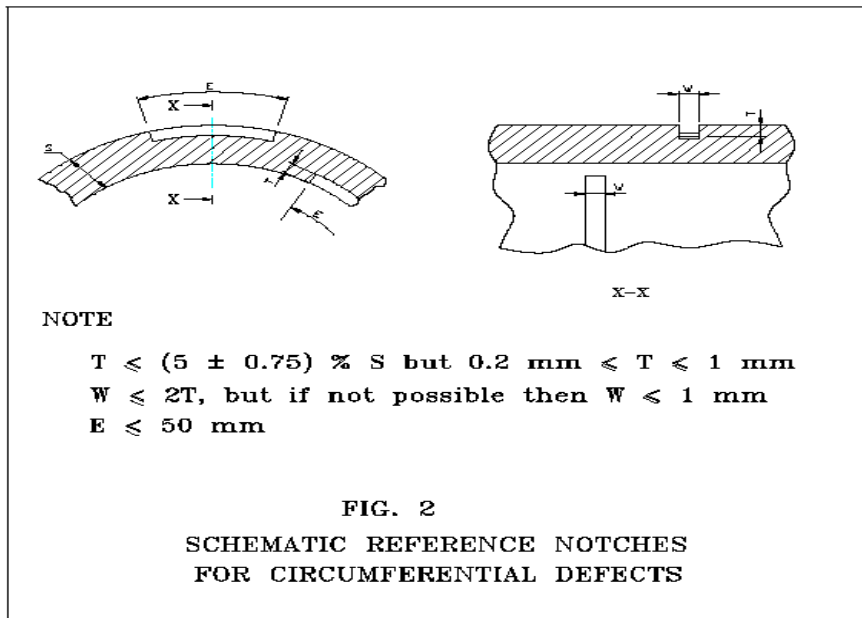
The length of the notches (E) shall not be greater than 50 mm.

The width (W) shall be not greater than twice the nominal depth (T). However, where this condition cannot be met a maximum width of 1.0 mm is acceptable.

The depth of the notches (T) shall be (5 ± 0.75) percent of the nominal wall thickness (S) with a minimum of 0.2 mm and a maximum of 1.0 mm, over the full length of the notch. Run-out at each end is permissible.

The notch shall be sharp edged at its intersection with the surface of the cylinder wall. The cross section of the notch shall be rectangular except where spark erosion machining methods are used; then it is acknowledged that the bottom of the notch shall be rounded.





12.3.3.3 Calibration of equipment

Using the reference standard described in 12.3.3.2, the equipment shall be adjusted to produce clearly identifiable indications from inner and outer surface notches. The amplitude of the indications shall be as near equal as possible. The indication of the smallest amplitude shall be used as the rejection level and for setting visual, audible, recording or sorting devices. The equipment shall be calibrated with the reference standard or probe, or both, moving in the same manner, in the same direction and at the same speed as will be used during the inspection of the cylinder. All visual, audible, recording or sorting devices shall operate satisfactorily at the test speed.

12.3.4 Wall thickness measurement

The cylindrical part shall be 100 percent examined to ensure that the thickness is not less than the guaranteed minimum value.

12.3.5 Interpretation of results

Cylinders with indications which are equal to or greater than the lowest of the indications from the reference notches shall be withdrawn. Surface defects may be removed; after removal of defects, the cylinders shall be subjected to ultrasonic flaw detection and thickness measurement.

Any cylinder which continue to show flaw or is shown to be below the guaranteed minimum wall thickness shall be rejected.

12.3.6 Certification

Every cylinder, which has passed ultrasonic testing in accordance with this specification shall be stamp marked with the symbol 'UT'. Each time the cylinder is retested such mark will be punched on the cylinder as per **15.4.1**.

13. INSPECTION OF VALVES AND PRESSURE RELIEF DEVICE

If valve or any other accessory is to be reintroduced into service, it shall be inspected and maintained to ensure that it will perform satisfactorily in service and meet the requirements of gas tightness as per valve manufacturing standard i.e. IS 3224 or any standard approved by statutory authorities.

An example of suitable method for valve inspection is given in Annex B and that for Pressure Relief Device (PRD) inspection is given in Annex E.

14. CYLINDER REPAIRS

No person shall repair or cause to repair any leakage in the body of a seamless cylinder. Refer Annex C for rejection criteria.

15. FINAL OPERATION

15.1 Drying, cleaning and painting

15.1.1 Drying and cleaning

The interior of each cylinder shall be thoroughly dried by a suitable method at a temperature not exceeding 300°C immediately after hydraulic pressure testing, so there is no trace of free water. The interior of the cylinder shall be inspected to ensure that it is dry and free from other contaminants. Immediately after this operation the interior of the cylinder shall be sprayed with an oil based corrosion inhibitor which is compatible with natural gas, so that harmful combination of the gas does not result. Cylinder valve opening shall be suitable plugged to prevent entry of water or foreign particle into the cylinder.

15.1.2 Painting and coating

Cylinders are sometimes repainted using paints that require stoving. Plastic coating may also be re-applied. Paint or coating shall be so applied that all markings stamped on the cylinder remain legible.

In no case shall the temperature of the cylinder exceed 150°C. For temperature between 100°C to 150°C the exposure time shall be limited to 30 min. If the stoving time exceeds 30 min. at a temperature between 100°C to 150°C or exceeds 150°C then a hardness test shall be conducted (Clause 10).

15.2 Re-valving of cylinder

Before re-valving the cylinder, the thread type shall be identified and conformed for accuracy. The appropriate valve accordance with IS 3224 or to any other specification approved by the statutory authority shall be fitted. Sealing tape or seal ring – as applicable for the particular thread design shall be used and torque specified by the valve manufacturer or cylinder standard shall be applied to ensure leak tight joint.

15.3 Check on cylinder tare weight

The tare weight of the cylinders shall be obtained by weighing on a scale calibrated with traceability to national or international standards. The weigh scale shall be checked for accuracy on a daily basis. The capacity of weighing scale shall be suitable for the tare weight of the appropriate cylinders.

15.4 Re-test marking

15.4.1 General

After satisfactory completion of the periodic inspection and tests, each cylinder shall be permanently marked at the cylinder neck below the original stamp marking or retest stamp marking, provided space is available or fitting a metallic disc in between the valve and cylinder. The following shall be marked

- a) Name / symbol of retesting station
- b) Mark for Ultrasonic Testing : UT
- c) Month and year of retest date : mm/yyyy
- d) Month and year next due date for retest : mm/yyyy

Other systems can also be used after getting approval from statutory authority.

15.4.2 Retest date and re-tester Symbol

The retest date is the date of the present test, which shall be indicated by the year and month. The re-tester symbol is the symbol of the inspection body or test station.

15.6 Identification of contents

Before the cylinder is reintroduced into service, if painting is required, care shall be exercised in accordance with **15.1.2** and colour coding shall be suitable for CNG as per IS 4379.

15.7 Records and Test Report Format

A record of cylinder shall be maintained for all tests, reconditioning and inspections at the cylinder re-tester's works and copies shall be made available to the inspecting authority and owner of the cylinder, if desired. A test certificate duly approved and signed by the repairer and the inspecting authority shall be forwarded to the statutory authority and the owner of the cylinder. A sample format is as per Annex F. A copy of test certificate shall be retained by the repairers for a period not less than 6 years.

16 REJECTION AND RENDERING CYLINDER UNSERVICEABLE

Any cylinder which fails to pass periodic examination or test or which loses in its tare weight by over 5 percent or for any other defect is found to be unsafe for use or after expiry of the service life of the cylinder, shall be rejected and shall be destroyed by any of the following ways under the intimation to the cylinder owner.

- (a) Flattening
- (b) Cutting into pieces in such a manner that the pieces cannot again be joined together by welding or otherwise to form a cylinder.

Records of all rejected and destroyed cylinders shall be maintained.

16.1 Disposal of rejected cylinders

The following guidelines should be adhered to.

- (a) Do not render a condemned cylinder unserviceable without the owner's permission.
- (b) Keep failed cylinders in a secure place, away from the testing area for a minimum of four weeks, unless the reason for failure is obvious.
- (c) Do not return a failed cylinder to the owner without rendering it unserviceable (see **16**)

17 RETESTING OF REJECTED CYLINDER

A cylinder that fails the inspection and test shall be condemned without re-testing, except as covered below. In general the equipment and procedures of the testing station should make a re-test unnecessary.

If the tester believes that a fault in his equipment or procedure may have invalidated a test result, then the cylinder should be retested once the fault has been corrected. Records of retesting of such rejected cylinders shall be maintained.

Note: A cylinder should not be subjected to its test pressure more than once in any 24 hour period.

Annex A
(Cl. 4.3)

FACILITIES REQUIRED FOR CYLINDER TESTING STATIONS

A-1. Management:

A-1.1 General Requirements - Personnel, organisation, equipments, inspection procedures, recording of cylinder data and test data shall be adequate and satisfactory. The test station will be operated with safe operating conditions. The systems and procedures shall ensure that cylinders, which fail to meet the requirements and intent of these rules are duly identified and is ensured that same are not returned into normal service. All personnel shall fully recognise their individual responsibilities and that the minimum inspectional requirement shall not be lowered for any reason whatsoever.

Note: The area of responsibility shall be divided into three separate function as indicated below. The numbers of personnel employed shall, however, be related to the quantum of work.

A-1.2 Manager - The manager responsible for the working of the test station shall be adequately qualified; his qualifications shall include training on the dangers associated with gas cylinders, purpose of inspection, test methods, equipment, test requirements, and recording of test results, and safety hazards associated with the gas cylinders and their retesting. He shall be a graduate in Mechanical or Chemical Engineering with atleast 3 years of experience in the examination and testing of gas cylinders. He shall also be conversant with the Codes, Specifications and / or Regulations applicable to the automotive cylinders for which the test station is approved.

A-1.3 Supervisor - The Supervisor shall possess the following qualifications —

- (i) He shall be a science graduate or diploma in Mechanical or Chemical Engineering with at least three years experience in the examination and testing of gas cylinders;
- (ii) He shall be conversant with these rules, Codes, Specifications and/or Regulations applicable to the automotive cylinders for which the test station is approved.

A-1.4 Operator - Personnel conducting inspections and tests shall have qualifications and experience suitable for the work on which they are engaged. They shall be trained to understand the dangers associated with high pressure gas cylinders and the purpose and method of inspection.

A-2. Equipment:

A-2.1 Type of equipment - The test station shall have adequate equipment to carry out inspection and testing of LP Gas cylinders as required under these rules. It shall contain -

- (i) One set of these rules, Codes, Specifications and/or Regulations applying to the automotive gas cylinders, which the test station is authorised to test. All these rules, Codes, Specifications and/or Regulations shall be maintained with all current amendments.
- (ii) Fenced area having arrangement for unloading / de-gassing the cylinders.

- (iii) Hydrostatic test apparatus comprising pressurizing equipment, pressure gauge and volumetric measuring equipment in accordance with IS:5844. The apparatus shall be equipped with at least two 15 cm. diameter (minimum) working pressure gauges. Pressure gauge shall be capable of reading to within one percent of the test pressure for pressures up to and including 15 kgf/cm² and within two percent for pressures above 15 kgf/cm². It shall be tested at regular intervals and in any case not less frequently than once in a month. It shall have accuracy of $\pm 0.5\%$.
- (iv) Non-destructive testing facilities like ultrasonic flaw detection etc. for detection of stress corrosion cracks developed during the service, and minimum wall thickness of the cylinder,
- (v) Dead-weight pressure gauge tester of appropriate pressure range or a master pressure gauge of 15 cm. minimum diameter covering the appropriate pressure range. Pressure gauge shall be capable of reading to within one percent of the test pressure for pressures up to and including 15 kgf/cm² and within two percent for pressures above 15 kgf/cm². It shall be tested at regular intervals and in any case not less frequently than once in a month. It shall have accuracy of $\pm 0.5\%$. Master pressure gauge shall be calibrated from a NABL accredited laboratory.
- (vi) Boroscope, extra-low voltage lamps (6 or 12 Volts considering human safety) to permit adequate internal viewing of cylinders and other lamps necessary for close examination of external surfaces.
- (vii) Straightedges, templates, steel scale, vernier caliper, miscellaneous tool and gauges for measurement.
- (viii) Thread gauges, taps for cleaning threads, and to correct slightly damaged threads, if any.
- (ix) Weighing equipment,
- (x) One set of standard test weights for daily calibration of the weighing machine, stamped by the relevant statutory authority.
- (xi) Adequate cylinder handling equipment.
- (xii) Adequate water storage and cylinder draining equipment.
- (xiii) Facilities for internal drying of cylinders. (electrical heater for compressed air line is recommended. Blowers are not useful for this purpose.),
- (xiv) Stamps for marking / stamping.

A-2.2 Range and Accuracy. —The range and accuracy of equipment shall be as follows: -

- (i) Any measuring instrument / equipment shall have range which is 1.5 to 2 times the measured value.
- (ii) Hydrostatic test apparatus in accordance with IS:5844.
- (iii) Weighting equipment error not greater than +0.1 per cent.
- (iv) Working pressure gauge error not greater than 1 per cent of the pressure.
- (v) Master pressure gauge error not greater than 0.25 per cent of the full-scale deflection.

A-2.3 Calibration — Calibration of equipment shall be carried out at periods not exceeding the following—

- (i) Working pressure gauge -1 month.
- (ii) Master pressure gauge- 6 months.
- (iii) Weighing equipment-checked by test weight daily when in service.
- (iv) Test weights - 2 years or as per the requirements of weight and measure certification, whichever is lesser.

A-3 Working conditions - Working conditions for the test stations shall be conducive to satisfactory, accurate and safe inspection and testing of gas cylinders. The test station shall comply with the following conditions:-

- (i) It shall have good lighting to permit ready external examination of gas cylinders, preferably including natural lighting.
- (ii) It shall have adequate ventilation to remove residual gases from cylinders,
- (iii) The painting area shall also have sufficient ventilation.
- (iv) It shall provide sufficient space to permit safe working,
- (v) It shall be maintained in a clean dry condition.
- (vi) It shall have adequate fire safety measures as per the statutory requirements.

A-4 Quality management system – The cylinder testing station shall have in quality management system according to IS/ISO9001 duly certified from Bureau of Indian Standards or any other internationally reputed agency.

Note : The test station shall adopt procedures, which fully comply with the requirements of these rules and guidelines issued by statutory authority from time to time.

Annex B
(Cl. 13)

**Inspection and maintenance of valves and their junctions :
Recommended procedures**

~~Remove the valve from the cylinder and disassemble the parts. Inspect the disassemble parts visually and then re-assemble, provided there are no visual defects.~~

All threads shall be checked to ensure that thread diameters, form, length, and taper are satisfactory.

If threads show sign of distortion, deformation or burring, these faults shall be rectified. Excessive thread damage or the serious deformation of the valve body, hand wheel, spindle or other components is cause for replacement.

Maintenance of the valve shall include general cleaning together with replacement of elastomers and worn or damaged components, packing and safety devices, where necessary.

Where the use of lubricants / elastomers is permitted, only those approved for the gas service shall be used, particularly for oxidizing gas service.

The PRDs must be replaced with new. The specification of new PRD shall be suitable to the working pressure of the cylinder. Old PRDs shall be destroyed and the records shall be maintained.

After the valve has been reassembled, it shall be checked for correct operation and shall be subjected to either a pneumatic test at working pressure of cylinder, using air or any inert gas or hydraulic test at 1.5 times the working pressure of the cylinder with the valve seat closed and outlet open and then with the valve seat open and the outlet plugged to confirm there are no internal or external leaks. This may be done prior to the valve being refitted to the cylinder.

Annex C
(Clauses 5, 8.1, 9, 10 and 11.2)

Description, evaluation of defects and conditions for rejection of seamless steel CNG cylinder at the time of visual inspection

C.1 General

CNG cylinder defects may be physical, material or due to corrosion as a result of environmental or service conditions to which the cylinders has been subjected during its life.

The object of this annex is to give general guidelines as to the application of rejection criteria.

C.2 Physical or material defects

Evaluation of physical or material defects shall be in accordance with table 1

Table 1 – Rejection limits relating to physical and material defects in the cylinder shell.

Type of defects	Definition	Rejection limit¹⁾
Bulge	Visible swelling of the cylinder	All cylinders with such a defects
Dent	A depression in the cylinder that has neither penetrated nor removed metal and is greater in depth than 1% of the outside external diameter.	When the depth of the dent exceeds 3% of the external diameter of the cylinder OR when the diameter of the dent is less than 15 times its depth.
Cut or gouge	A sharp impression where metal has been removed or redistributed and whose depth exceeds 5% of the cylinder wall thickness. (See Fig. 3)	When the wall thickness is less than the minimum design thickness.
Crack	Split or a rift in the metal (see Fig.4)	All cylinders with such defects.
Damage	Excessive general or localized heating of a cylinder usually indicated by ; (a) partial melting of the cylinder (b) distortion of the cylinder (c) charring or burning of paint	All cylinders in categories (a) & (b) All cylinders in category (c) may be acceptable after inspection and / or testing.
Stamping	Marking by means of a metal punch.	All cylinders with illegible, modified or incorrect markings.
Arc or torch burns	Partial melting of the cylinder, the addition of weld metal or the removal of metal by scarfing or cratering.	All cylinders with such defects.
Suspicious marks	Marks introduced other than by the cylinder manufacturing process and approved	All cylinders with such defects.
Vertical stability		Deviation from verticality which may present a risk during service (especially if fitted with foot ring).

1) When applying the rejection criteria given in Table 1, the conditions of use of cylinders, the severity of the defects and safety factors in the design shall be taken into consideration.

C.3 Corrosion

C.3.1 General

The cylinder may be subjected to the environmental conditions that could cause external corrosion of the metal.

Internal corrosion of the metal may also occur owing to service conditions.

There is difficulty in presenting definite rejection limits in tabular form for all sizes and types of cylinders and their service conditions. The limits of rejection are usually established following considerable field experience.

Extensive experience and judgment are required in evaluating whether cylinders that have corroded internally are safe and suitable for return to service. It is important that the surface of the metal is clean of corrosion products prior to the inspection of the cylinder.

C.3.2 Types of corrosion

The types of corrosion generally may be classified as in table 2.

Table 2 – Rejection criteria for corrosion of the cylinder wall

Type of corrosion	Definition	Rejection limit in accordance with clause 8
General corrosion	Loss of wall thickness over an area of more than 20% of either the interior or exterior total surface area of the cylinder (See Fig. 5)	If the depth of penetration exceeds 10 percent of original thickness of wall, or If the wall thickness is less than the minimum designed wall thickness
Local corrosion	Loss of wall thickness over an area of less than 20% of either the interior or exterior total surface area of the cylinder, except for the other types of local corrosion described below.	If the depth of penetration exceeds 20 percent of the original thickness of the cylinder wall, or If the wall thickness is less than the designed thickness .
Chain pitting or line corrosion	Corrosion forming, a narrow longitudinal or circumferential line or strip or isolated craters or pits which are almost connected (see Fig. 6)	If the wall thickness is less than the designed thickness .
Isolated Pits	Corrosion forming isolated craters, without significant alignment (see Fig. 7)	If the diameter of the pits is greater than 5 mm, refer to the “local corrosion” row. If the diameter of the pits is less than 5 mm, the latter, the cylinder should be assessed as carefully as possible in order to check that the remaining thickness of the wall or base is inadequate for the intended use of the cylinder.
Crevice corrosion	Corrosion associated with taking place in, or immediate around, an aperture.	If, after thorough cleaning, the depth of penetration exceeds 20% of the original wall thickness.

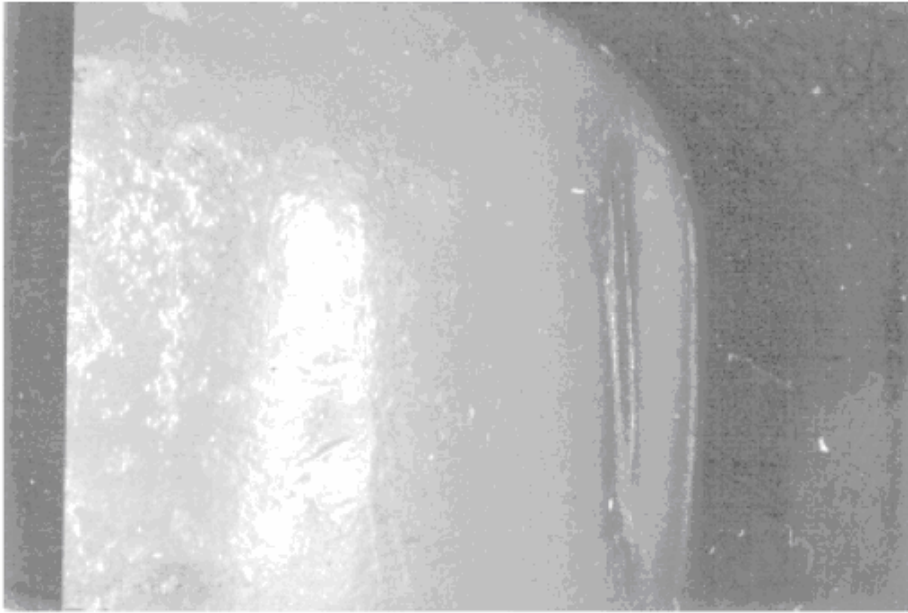


Fig. 3 — Cut or gouge



Fig. 4 Crack

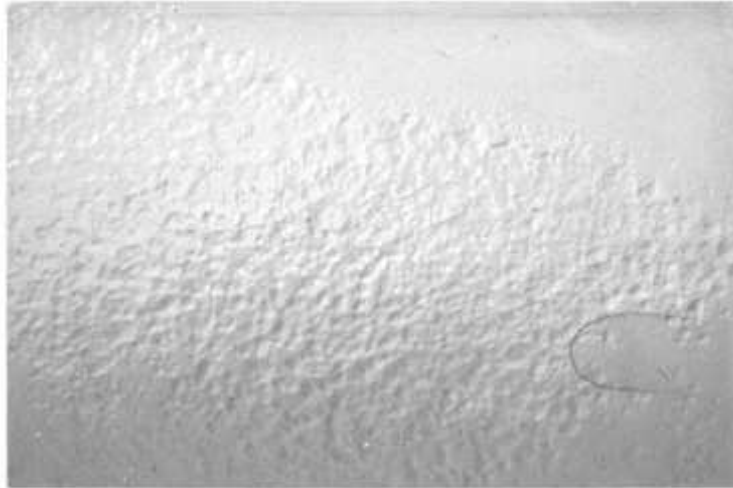


Fig. 5 General Corrosion



Fig. 6 Line Corrosion



Fig. 7 Isolated Pits

Annex D
(Cl. 7.3)

**Procedure to be adopted when de-valving and when it is suspected
that a cylinder is obstructed**

D.1 Check for obstructed valve

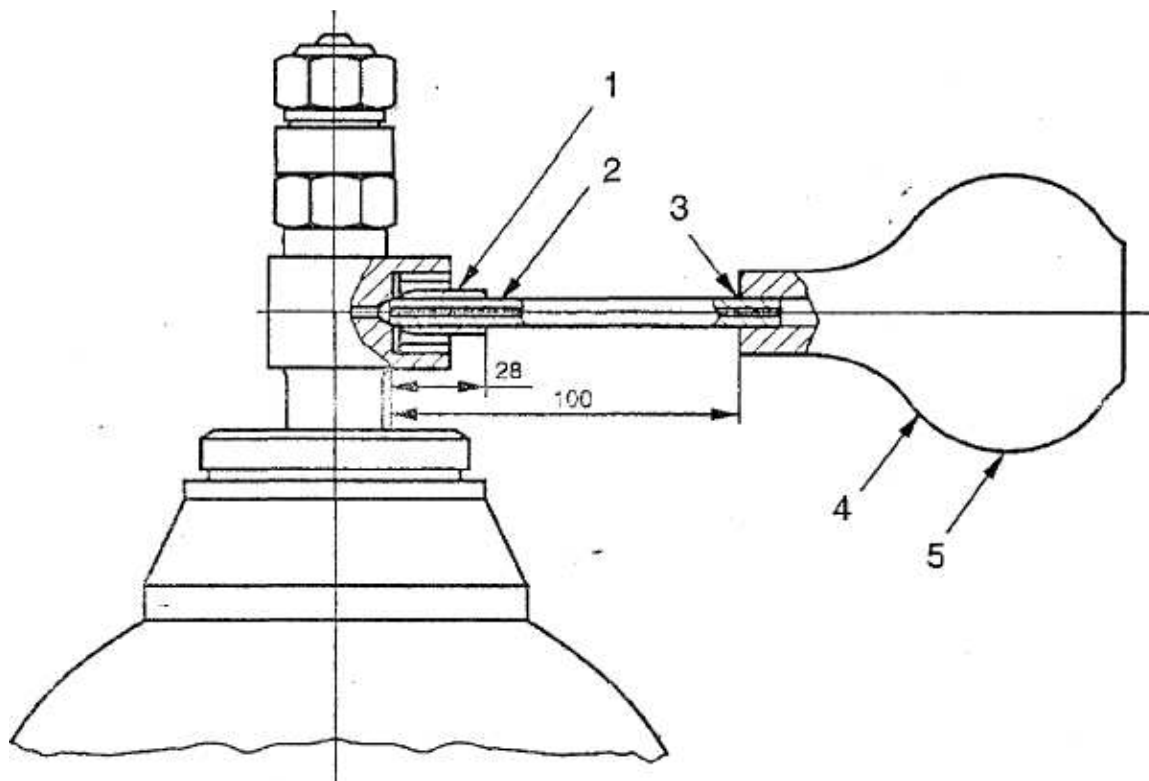
The following procedures shall be carried out only by trained personnel. In view of the potential hazards in cylinders, this operation can lead to injury from stored energy release and fire, hence personnel shall take such precautions as deemed necessary for the work to be performed. When the gas, if any, has been released and the pressure within the cylinder reduced to atmospheric pressure and when there is no frost or dew on the outside of the cylinder, the valve may be removed after an additional check is made to establish that there is free passage through the valve.

As indicated in 7, a systematic check shall be made to establish that the passage through the valve is unobstructed. The method adopted shall be a recognized procedure such as one of the following or one that provides equivalent safeguards:

- by introducing inert gas at a pressure up to 5 bar and checking its discharge;
- by using the device shown in Fig. 8 to hand pump air into the cylinder;

D.2 Valve unobstructed

Only when it is established that there is no obstruction to gas flow in the cylinder valve, the valve may be removed.

**Key**

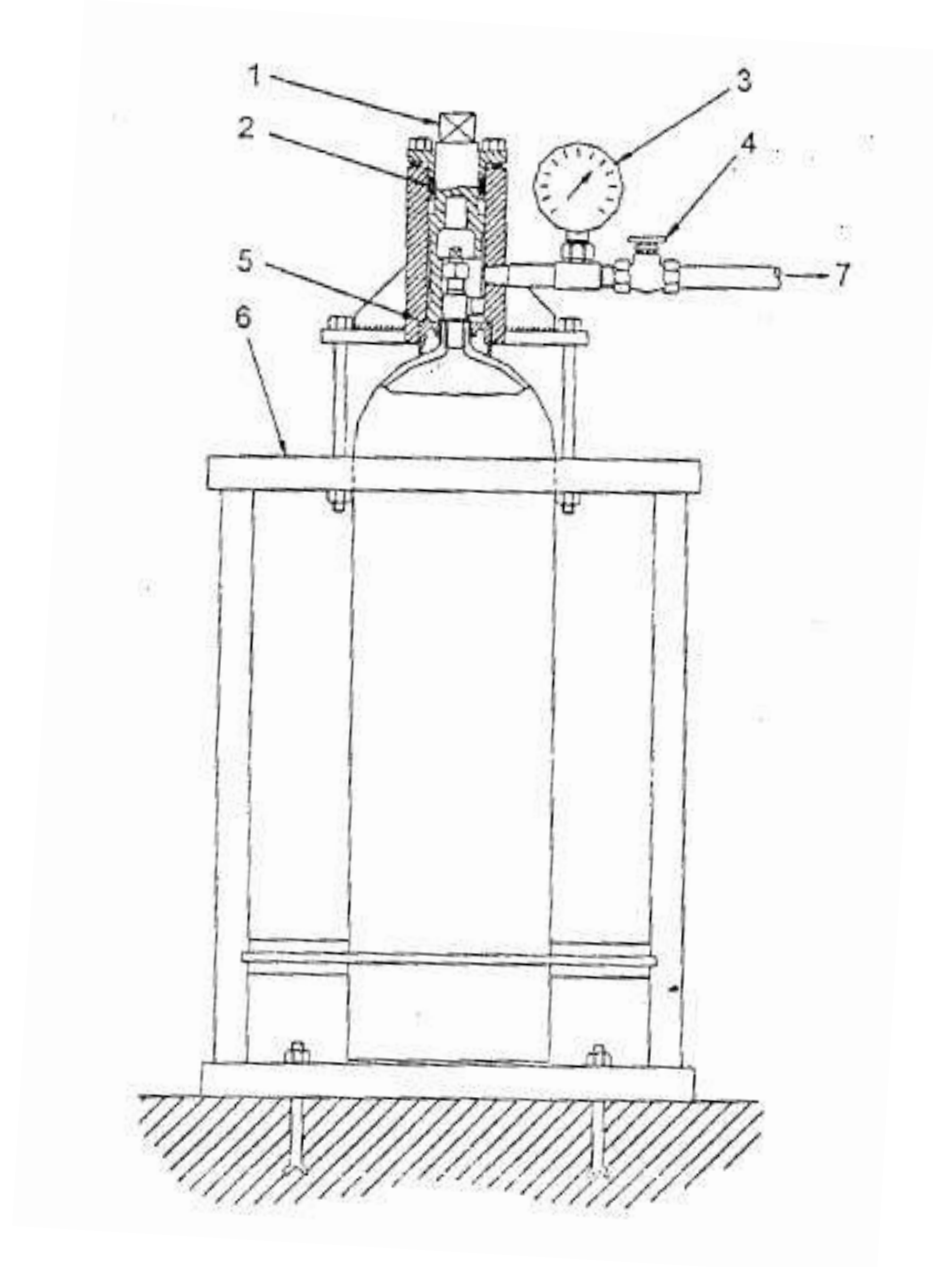
1. Rubber tube (Φ int. 8 mm. Φ ext. 13 mm.) ground to olive shape and bonded.
2. Tube (Φ int. 3 mm. Φ ext. 8 mm.)
3. Bonded
4. Rubber bulb
5. Hand pressure

Fig. 8 – Typical device for detecting obstructed cylinder valve

D.3 Valve obstructed

When a cylinder is found to have an obstructed gas passage in the valve, the cylinder shall be set aside and handled by specially trained personnel in this task as follows:

The preferred method is to partially unscrew the valve within a glanded cap, secured and joined to the cylinder and vented to a safe discharge. The principles of a suitable device is illustrated in Fig. 9. This procedure shall be performed in a controlled manner in such a way as to avoid personal injury.



Key

1. Drive for de-valving machine
2. Gas-tight gland
3. Pressure gauge
4. Vent valve
5. Gas-tight seal
6. Cylinder frame and clamping device
7. To gas disposal system

Figure 9 – Typical device for the removal of a damaged gas cylinder valve

Annex E
(Cl. 13)**Pressure Relief Device (PRD) Inspection****E.1 General**

The CNG cylinder is equipped with a cylinder valve with a PRD in the threaded opening at one end of the cylinder. All PRDs shall be in direct communication with the contents of the cylinder, regardless of whether the cylinder valve is open or closed..

E.2 Requirements

The vent line may need to be removed from the ends of the cylinder for this inspection. The PRD and tubing shall be cleaned as necessary with a rag and mild detergent solution to allow inspection of their external surface and any orifices. The choice of detergent shall be compatible and non-reactive with the materials with which it comes into contact, e.g. the use of ammoniacal compounds on brass can cause stress corrosion, hence detergents containing ammonia shall not be used on brass components. Inspection of the valve and plug/PRD shall include the following aspects.

- a) Examination of the valve and PRD assemblies for damage: the valve and PRD assemblies shall not be deformed or show other signs of damage. Damaged valves and PRD assemblies shall be replaced.
- b) Examination of the interface between the valve and cylinder port, the PRD and cylinder port and any other plug and cylinder port: these interfaces shall be tightly seated with no gaps or looseness. If there is evidence of looseness or seal damage, the cylinder shall be depressurized, the suspicious area disassembled and the seal shall be replaced, as necessary (see Annex B). The components shall be reassembled / reinstalled in accordance with the torque limits recommended by the cylinder manufacturer.
- c) Leak testing of all the connections between the valve and cylinder port, and the plug / PRD(s) and cylinder port. All PRD connections and the valve shall be checked for leakage. These connections shall be serviced if any leakage from these areas is detected.
- d) External inspection of PRDs for corrosion, damage, rust, bulging, plugging of the PRD vent system and mechanical defects, such as leakage, extrusion of fusible metal or looseness of attachments: this shall be done each time a CNG cylinder is inspected.

E.3 Approved equipment

The inspector shall verify that the PRD(s) in use with the cylinder is (are) approved and specified by the manufacturer for the cylinder type.

E.4 Damaged equipment

Dents, gouges and scratches whose depth is greater than or equal to 0,50 mm. in locations other than the hexagonal torque nut shall be reviewed as per the PRD manufacturer's recommendations to determine what action, if any, should be taken with regard to the PRD.

E.5 Replacement

Once removed, PRDs shall not be installed on any other cylinder but may, if they are appropriate and pass inspection, be reinstalled on the same cylinder from which they were removed, as recommended by the cylinder manufacturer.

Annex F
(Cl. 15.7)

REPORT FORM

This annex provides guidance on the range of information to be included in the documentation associated with re-tested cylinder approval. Example of suitable format is provided below. Each report shall be signed by the re-tester.

Name and address of the Retesting station -----

Name and address of the cylinder manufacturer -----

Name and address of the cylinder owner -----

Cylinder Description :
Manufacturing Standard ----- Serial Number -----
Outside Diameter ----- mm;
Guaranteed minimum wall thickness ----- mm; Length ----- mm;
Maximum Working Pressure ----- Test pressure -----
Water capacity marked on cylinder ----- Ltr.
Tare weight marked on the cylinder ----- Kg.
Date of original hydrostatic/hydrostatic stretch test of cylinder -----
Name of the gas -----
Cylinder thread type -----, its condition ----- and
Conformation with gauge -----.

Actual water capacity ----- Ltr.
Actual weight ----- Kg.
Variation in tare weight i.e. Weight marked on the cylinder and actual weight ----- Kg.
Cylinder actual wall thickness observed ----- mm.
Total volumetric Expansion ----- cc, Permanent volumetric expansion ----- cc
Condition of cylinder surfaces -----
Test reports and certificates furnished by the manufacturer, if available.
Detail of Valve fitted on the cylinder
Make -----
Type -----
Thread condition -----
Remarks -----

Supervisor's name and signature -----

Approved by : Name, designation and signature -----

Place ----- Date -----