इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 9902 (2004): Recommended practice for leak testing [MTD 21: Non-Destructive Testing]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN
IGNORANTIA JURIS NON EXCUSAT
PROTECTED BY COPYRIGHT

भारतीय मानक

रिसाव परीक्षण की अनुशंसित रीति

(पहला पुनरीक्षण)

Indian Standard

RECOMMENDED PRACTICE FOR LEAK TESTING

(First Revision)

ICS 77.040.20

© BIS 2004

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 2004 **Price Group 3**

Non-destructive Testing Sectional Committee, MTD 21

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1982. While reviewing this standard, the Committee decided to revise this standard in order to bring it in line with present practices being followed in the country. Leak detection techniques are increasingly being used in the country for inspection of fabricated equipment and components. The correct choice of a leak testing method optimizes sensitivity, cost and reliability of the test. This standard is prepared to serve as the guideline for correct and optimum formulation of a leak detection procedure.

In this revision following modifications have been made:

a) Reference clause has been added.
b) Clause **4** has been modified.
c) Range of sensitivity has been modified in **5**.
d) Annexes A, B and C have been incorporated to make this standard more comprehensive.

While preparing this standard considerable assistance has been derived from Article 10 ASME Section V.

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 value (*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.

Indian Standard

RECOMMENDED PRACTICE FOR LEAK TESTING

(First Revision)

1 SCOPE

This standard deals with various leak-testing practices, their sensitivities and sets forth recommended guidelines for their use. Both gross and fine leak-test practices have been included with emphasis on mass spectrometric helium-leak-detection practice.

2 REFERENCE

The following standard contains provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
8973 : 1991	Glossary of terms relating to leak detection techniques (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 8973 shall apply.

4 TEST REQUIREMENTS

4.1 Test Specification

The job being undertaken for leak-test shall have its leak-tightness requirements defined by the designer/purchaser. Wherever this requirement is not defined, job would be tested to a degree of leak-tightness, which is relevant to its end use. Wherever not desirable, the tendency to overspecify leak-tightness requirement should be avoided. The leak-tightness is specified as leak rate which is the quantity of fluid leaking across the boundary per unit time. It is measured in term of — Pressure × Volume/Time. Commonly used units are std cc/s and Pa.m^3/s[1)].

4.2 Choice of Method

Depending on the leak-tightness requirement, a suitable leak-test method from those given in **5** may be selected. If the job is to be leak-tight only up to gross leak range, that is, up to 10^{-4} std cc/s, only gross leak test should be performed. However if the job is to be leak-tight in fine leak range, that is, less than 10^{-4} std cc/s, then helium leak test is recommended. If the job is tested by pressure-vacuum technique of helium leak detection (*see* **9.6**) the job shall also be tested by gross-leak test method to ascertain the presence of helium inside the job.

4.3 Preparation of Job for Leak Test

4.3.1 *Cleanliness*

The areas of the job to be tested shall be cleaned thoroughly by acetone, trichloroethylene or similar degreaser, to make sure that leaks are not clogged by presence of oil, grease, paint, etc. If liquid cleaning is done, the component should be thoroughly dried prior to testing.

4.3.2 *Opening*

All openings in the job should be properly sealed using plugs, covers, sealing wax, etc, which could be easily removed after the test is over. In case of halogen-diode detector, the sealing compound should be halogen-free.

4.3.3 *Trained Personnel*

The persons carrying out leak-test should have undergone sufficient training in leak-test practices.

5 LEAK DETECTION METHODS

Some commonly used leak-test methods with their range of sensitivity are given here for guidance. Depending upon their range of sensitivity, the methods may be classified either as gross-leak or fine-leak methods.

Sl No.	*Test Method*	*Range* Pascal m^3/s
(1)	(2)	(3)
i)	Pressure drop test	10^1 to 10^{-3}
ii)	Pressure rise test	10^1 to 10^{-4}
iii)	Ultrasonic leak detector	10^1 to 10^{-2}
iv)	Bubble tests:	
	1) Air soap solution	10^1 to 10^{-4}
	2) H_2-Alcohol	10^1 to 10^{-5}
	3) Air-Glycol	10^1 to 10^{-5}
v)	Ammonia sensitized paper (ozaled)	10^0 to 10^{-5}
vi)	Halogen-diode sniffer	10^1 to 10^{-6}
vii)	Helium M.S. leak test:	
	1) Pressure (sniffer) method	10^2 to 10^{-8}

1) Pa.M^3/s = 10 std cc/s.

2) Vacuum method (Hood method)	10^{-5} to 10^{-11}
3) Pressure-vacuum test	10^{-3} to 10^{-12}
viii) Argon mass spectrometer leak test	10^{-3} to 10^{-9}
ix) Kr-85 radio active gas method	10^{-11}

In general, test methods from (i) to (v) are called gross leak-test methods and that from (vi) to (ix) are called Fine-leak test methods.

6 PRESSURE TEST

6.1 Pressure Gauges

Pressure gauge should be connected when carrying out pressure tests. The gauge should face the operator controlling the pressure.

6.2 Range

The pressure-range indicated in the gauge should preferably be twice the intended maximum pressure, but in no case should the range be less than 1.5 times and more than 4 times that of the test pressure.

6.3 Calibration

All gauges shall be calibrated by suitable means and recalibrated at least once in six months.

6.4 Test Pressure

Unless otherwise specified, components which are to be pressure leak-tested should be pressurized to a minimum of 0.42 MPa (60 psi) or 15 percent maximum allowable design pressure, whichever is less, and held at this pressure for sufficient time till equilibrium is reached.

7 BUBBLE TESTS

7.1 In bubble tests the gas escaping from a pressurized or sealed container is allowed to form bubbles, with the help of suitable solution. The bubbles are examined visually under suitable light conditions with magnifying lenses, if necessary. This test helps to locate the leak. The gas used normally is air; however, helium, nitrogen and hydrogen may also be used. The solution used normally shall have good wetting properties, allow easy bubble formation and retain bubbles for sufficient time to allow viewing. It should have low viscosity and good surface-tension, to allow easy formation of bubble and retention of bubbles for sufficient time.

7.2 Some usual compatible combinations are air-soap solution, hydrogen-alcohol and air-glycol.

7.2.1 *Air-Soap Solution Test*

The pressure shall be held for a minimum of 15 min prior to examination. The bubble forming solution should be applied to the surface to be tested by flowing the solution over the examination areas. The leak would be shown by the formation of bubbles. If the job is repaired at leaky location, it shall be again tested in similar way to ensure that there is no leak present.

7.3 Air-Glycol Leak Test

The sealed component having air inside is immersed in glycol and the transparent chamber is evacuated by the help of vacuum pump. Because of pressure difference, air comes out through leak in the job and forms bubble in glycol. After rèpair, if any, the job shall be tested again for acceptance.

8 HALOGEN-DIODE SNIFFER

8.1 General

This method uses the general principles of a heated platinum element (anode) and an ion collector plate (cathode) where halogen vapour is ionized by the anode and the ions are collected by the cathode. A current proportional to the rate of ion-formation is indicated on the meter. The relative concentration of halogen present can be measured by comparing the meter reading for the gas leakage of a component with that for a standard gas leakage.

8.2 Calibration Standard — A capillary type halogen leakage standard shall be used with a leak rate of around 9×10^{-5} atm cc/s of refrigerant 12 or any other gas listed in **8.3**.

8.3 Tracer Gas

Normally Refrigerant 12, that is, Dichlorodifluoromethane (CCl_2F_2) is recommended for use as the tracer gas. Other gases which could be used are:

a) Refrigerant 11 — Trichloromonofluoromethane (CCl_3F);
b) Refrigerant 21 — Dichloromonofluoromethane ($CH\,Cl_2F$);
c) Refrigerant 22 — Chlorodifluoromethane ($CH\,Cl\,F_2$);
d) Refrigerant 114 — Dichlorotetrafluoromethane ($C_2\,Cl_2\,F_4$); and
e) Methylene chloride — Dichloromethane (CH_2Cl_2).

The concentration of the tracer gas by volume at the test pressure should be 10 percent.

8.4 Test Procedure

8.4.1 *Soak Time*

A minimum of 30 min should be allowed for dispersion of the halogen gas throughout the component.

8.4.2 *Instrument Calibration*

a) The diode detector should be allowed to warm up at least 30 min prior to calibrating with capillary leak standard.

b) The detector should be calibrated before and after testing and at intervals of 2 h minimum of scanning. If the sensitivity has gone down, all areas tested after the last satisfactory calibration are to be retested.

8.4.3 *Normal Scanning*

The scanning rate is determined by passing the probe across the orifice of the capillary leak standard. The scanning rate should not exceed that which can detect leakage of 1×10^{-5} std cc/s from the calibration standard. The probe tip should be kept within 3 mm of the test surface during scanning.

9 HELIUM MASS-SPECTROMETER LEAK TEST

9.1 General

The equipment is a portable mass-spectrometer normally turned for helium. The method is highly sensitive, reliable and repeatable. There are three different modes of operation:

a) Pressure tests or sniffer method (Semi-quantitative);
b) Vacuum tests or Hood method; and
c) Pressure vacuum tests.

9.2 Auxiliary Equipment

9.2.1 *Sampling Probe or Sniffer*

A sniffer is a device which sucks in traces of helium leaking from a job under helium pressure, when the job is scanned through the fine nozzle of the sniffer. Typically it consists of a 15 cm long and 25 µm bore capillary tube, whose response is around 10 s. The hose length should normally be restricted to about 2 to 3 m.

9.2.2 *Calibration Standards*

9.2.2.1 *Permeation type standard*

This shall be a calibration leak standard with a leak rate in the range of 1×10^{-8} std cc/s to 1×10^{-9} std cc/s for helium.

9.2.2.2 *Capillary type standard*

This shall be a calibration leak standard with a leak rate of about 1×10^{-5} std cc/s.

9.2.3 *Spray Probe*

This is a hand-held spray device having a valve connected to the regulator of helium cylinder by PVC tubing to spray helium on the jobs to be tested.

9.3 Calibration

The equipment is started up as per manufacturer's operating manual. After more than half an hour, when requisite vacuum of around 10^{-5} torr has been achieved the permeation type of standard calibrator is coupled to the port of the leak detector. The reading on the indicator meter is taken with calibrator valve fully open. The valve is then closed and background reading noted. The difference of the two readings is the actual signal displayed by the meter. The scale of leak-indicator meter is linear and hence, numerically each division is thus calibrated by dividing the actual leak rate (std cc/s) of the calibrator by number of divisions so obtained on the meter due to helium leaking inside the spectrometer tube.

9.3.1 The smallest division on the meter, thus calibrated in std cc/s is the sensitivity of the equipment. Normally the working sensitivity of a leak-detector should be around 1×10^{-10} std cc/s for helium or normally two decades better than the required leak to be detected.

9.4 Pressure (Sniffer) Tests

9.4.1 The job is pressurized with helium. If required due to large volume, the tracer gas concentration could be 20 percent by volume. The component should be allowed to soak for more than an hour under pressure as outlined in **6.4** before being tested. The sniffer method, however, is a semi-quantitative method.

9.4.2 *Scanning Rate*

The scanning rate is determined by passing the sniffer probe connected to leak-detector across the orifice of the capillary leak standard, and should not exceed that with which 1×10^{-5} atm cc/s leakage from the calibration standard can be detected. The tip of the probe should be within 3 mm of the surface being scanned. Normally, a sniffer probe speed of around 25 cm/min is adequate.

9.4.3 *Acceptance Criteria*

Leakage rate acceptance criteria shall be specified by the designer/purchaser. Correction for concentration of tracer gas (helium) could be carried out by the relation:

$$\frac{MLR}{\text{Percent He}} \times 100 = ALR$$

where

MLR = measured leak rate as seen on the meter,

ALR = actual leak rate of component, and

Percent He = helium concentration.

9.5 Vacuum Methods (Hood Test)

The job is connected to leak-detector and evacuated by its pumping system. If the job is of such large volume, that cannot be evacuated by the pumping system of the leak detector, auxiliary fore-line vacuum system could be utilized for maintaining the required vacuum of around 10^{-5} torr. Helium is sprayed over joints through a spraying-probe connected to helium cylinder pressure-regulator.

Alternatively, the job could be covered by a hood made out of polythene bag, plastic box, etc, and a helium gas atmosphere just above atmosphere pressure maintained in the hood for around 10 to 15 min. If the situation be such that the line joining (rubber hose, metallic tube, etc) the leak detector and job be longer than 2 to 3 m, exact response time of the system should be determined experimentally. This would help in determining time of test and location of leak, while spraying the job.

The leak detector is calibrated according to **9.3**. The acceptance of the job would be as per designer's/purchaser's specifications. However, in most cases leaks equal to or greater than 100^{-7} std cc/s would be cause for rejection.

The actual leak-rate could be determined, if required, by determining the concentration of helium in the hood and by applying the correction factor for helium concentration.

9.6 Pressure Vacuum Method

In this method the job to be tested is filled with helium gas at around atmospheric pressure and hermetically sealed. This is placed in a chamber or bell-jar and evacuated by the pumping system of the leak-detector. Any helium, leaking out from the job is indicated on the meter.

The leak detector is calibrated according to **9.3**. Since, in this technique there is no dilution of helium, before getting detected by the mass-spectrometer tube, the method is quantitative and hence, actual leak-rate could be determined by this technique. If the concentration of helium inside the job is less than 100 percent, correction for dilution could be applied.

Acceptance of the job would be guided by designer's/purchaser's specifications. However, in most cases, jobs showing leak greater than 1×10^{-8} std cc/s should be rejected.

10 TEST REPORTS

Proper reports shall be maintained of all leak-tests done. The report should normally contain the following:

a) Date of test;
b) Name of operator;
c) Description of test equipment, calibration standards employed;
d) Details of component under test;
e) Tracer gas used and its concentrations;
f) Test pressure; and
g) Test results.

ANNEX A

(Foreword)

GUIDE FOR SELECTION OF LEAK-TESTING METHOD

A-1 LEAK RATE REQUIREMENTS

If the designer/purchaser's specification calls for gross-leak-testing (that is up to 10^{-6} Pa.m^3/s), then gross leak testing methods like bubble tests, ultrasonic leak detection, pressure-rise, pressure decay, etc, should be used. However, if the specification calls for fine leak-testing (that is below 10^{-6} Pa.m^3/s), then fine leak testing methods like — Helium leak detection, halogen leak detection, etc, should be used.

A-2 LEAK LOCATION

If it is required to locate leaks, then bubble tests, hot water test, ultrasonic tests, liquid penetrant, He-sniffer tests, He-spray tests, halogen tests, etc, may be used. For pressurized systems — bubble ultrasonic liquid penetrant, helium sniffer, halogen etc, may be used.

A-2.1 For Vacuum System

Pressure charge, ultrasonic helium spray, halogen, etc, may be used for systems of atmospheric pressures on both sides. High source inside the vessel in dark room and seeing for any light rays coming out from inside. Liquid penetrant filled inside and leaks detected visually by fluorescence and colouration may be used, for sealed objects at atmosphere pressure, dipping the object in hot water (temperature around 60°C) for few minutes and watching for any bubbles, emanating from leaks may be used for gross-leaks.

A-3 LEAK MEASUREMENT

For measurement of leak-rate methods like — helium, halogen, back pressure helium tests, gauge-pressure measurements, etc, should be used.

A-4 SENSITIVITY OF TEST-EQUIPMENT AND SYSTEM SENSITIVITY

It is important to distinguish between instrument sensitivity and system sensitivity. For example — the sensitivity of a helium leak detector instrument may be 1×10^{-11} Pa.m^3/s but the sensitivity of a sniffer test is only around 1×10^{-7} Pa.m^3/s. Similarly in accumulation test method, where tracer gas helium is allowed to accumulate in a known volume for sufficient time to build up increased concentration the system sensitivity may be increased up to 1×10^{-14} Pa.m^3/s.

It is important to realize that range of temperature, pressures, types fluid flow, air draft directions, etc, influence both the instruments sensitivity and system sensitivity.

ANNEX B

(Foreword)

GUIDE FOR PREPARATION OF LEAK-TESTING SPECIFICATIONS

B-1 Ideally, it is impossible to fabricate a component a system, which is absolutely leak-tight. In other words, everything leaks only the order of leakage may be big or small. For example, a system which has been determined to be leak-tight up to 10^{-6} Pa.m^3/s, may be leaking in the range of 10^{-8} Pa.m^3/s, but that leak-rate may be alright for the purpose for which the item is intended to be put to use. Hence leak-tightness of an object is only a relative statement.

Hence, a designer/purchaser before specifying leak-tightness requirements must determine taking into account quantity of fluids, pressure, temperature, environmental safety aspects, etc, and arrive at an optimal level of leak-tightness. It may be mentioned here, higher the degree of leak-tightness required, higher is the cost of leak testing in terms of instrument, man power time, etc.

In general quantity of fluid leaking from one enclosure to another per unit time is calculated by the formula:

$$\frac{\text{Pressure} \times \text{Volume}}{\text{Time}}$$

Various pressure units like — Standard atmospheres, torr, micron, Pa, etc, Vacuum units — m^3, l, cc Time units — h, min, s, etc, are in use. Hence various leak rate measuring units are std, atm, cc/s, torr-l. s, micron l/s current practice is to use only SI units — that is — Pa.m^3/s. [1 Pa.m^3/s = 10 std. cc/s.]

NOTE — ASME-V gives calculation of refrigerant leaking through the circuit relevant for halogen leak-detection, which may be used for reference by refrigerator industry.

ANNEX C

(Foreword)

LEAK TESTING

C-1 CONVERSION UNITS

a) SI Pressure Unit

Pa (pascal) = Newton/square metre, that is, Pa = N/m^2

Atmospheric pressure = 101.3 KPa or 10^5 Pa (approximately) or 1 atmospheric = 15 Psi = 1 kg/cm^2 = 10^5Pa = 0.1 MPa or 1 MPa = 10 atmospheric

b) SI Leak Rate Unit

1 Pa.m^3/s = 9.87 Std. cc/s or approximately 1 Pa.m^3/s = 10 std.cc/s

c) Vacuum Units

1 atmosphere = 760 mm (torr) of Hg = 1 bar

1 micron = 10^3 mm or 10^{-3} torr = 1 m bar

Rough vacuum — up to 10^{-3} torr

High vacuum — 10^{-4} torr to 10^{-6} torr

Ultra high vacuum (UHV) — Below 10^{-7} torr

NOTE — In He-leak testing vacuum up to high vacuum range that is up to 10^{-6} torr only is used.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc: No. MTD 21 (4255).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *website* : www.bis.org.in

Regional Offices:		**Telephones**
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843, 260 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. NALAGARH. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Simco Printing Press, Delhi