इंटरनेट मानक

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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.

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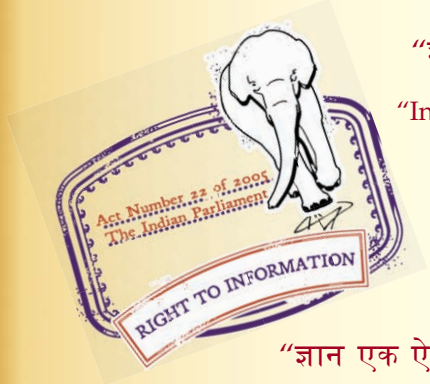
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

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

IS 1448-148 (2002): Methods of Test for Petroleum and its Products, Part 148: Determination of Electrical Conductivity of Aviation and Distillate Fules Containing Static Dissipator Additive [PCD 1: Methods of Measurement and Test for Petroleum, Petroleum Products and Lubricants]



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

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भारतीय मानक

पेट्रोलियम और उसके उत्पादों की परीक्षण पद्धतियाँ

[पी : 148]

स्थिर क्षयकारी संयोजी पदार्थ युक्त वियानन एवं आसुत ईंधनों की विद्युतीय चालकता ज्ञात करना

Indian Standard

METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS

[P : 148]

DETERMINATION OF ELECTRICAL CONDUCTIVITY OF AVIATION AND DISTILLATE FUELS CONTAINING STATIC DISSIPATOR ADDITIVE

ICS 75.160.20

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

June 2002

Price Group 4

FOREWORD

This Indian Standard [P : 148] was adopted by the Bureau of Indian Standards, after the draft finalized by the Methods of Test for Petroleum, Petroleum Products and Lubricants Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

This standard, method of test was prepared based on joint publication of ASTM D 2624 and IP 274.

The composition of the Committee responsible for formulation of this standard is given in Annex E.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHODS OF TEST FOR PETROLEUM AND ITS PRODUCTS

[P : 148]

DETERMINATION OF ELECTRICAL CONDUCTIVITY OF AVIATION AND DISTILLATE FUELS CONTAINING STATIC DISSIPATOR ADDITIVE

1 SCOPE

1.1 These test methods cover the determination of the electrical conductivity of aviation and distillate fuels containing a static dissipator additive. The test methods normally give a measurement of the conductivity when the fuel is uncharged, that is, electrically at rest (known as the rest conductivity).

1.2 Two test methods are available for field tests of fuel conductivity. These are:

a) portable meters for the direct measurement in tanks or the field or laboratory measurement of fuel samples, and

b) in-line meters for the continuous measurement of fuel conductivities in a fuel distribution system. In using either type of instrument, care must be taken in allowing the relaxation of residual electrical charges before measurement and in preventing fuel contamination. For specification purposes, conductivity measurements should be made with the portable meters.

NOTE — After pumping operations it may be necessary to wait before taking measurements to allow the fuel to become electrically at rest and reach an equilibrium conductivity. 30 minutes waiting period is normally sufficient.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 SUMMARY OF METHOD

A voltage is applied across two electrodes immersed in the fuel and the resulting current expressed as a conductivity value. With portable meters, the current measurement is made almost instantaneously upon application of the voltage to avoid errors arising from ion depletion. Ion depletion or polarization is eliminated in dynamic monitoring systems by continuous replacement of the sample in the measuring cell. The procedure, with the correct selection of electrode size and current measurement apparatus, can be used to measure conductivities from 1 picosiemens/metre or greater. The commercially available equipment referred to in this method covers a conductivity range upto 2 000 picosiemens/metre with good precision (*see* **10**) although some meters can only read to 500 or 1 000 picosiemens/metre.

3 SIGNIFICANCE

The ability of a fuel to dissipate charge which has become generated during pumping and filtering operations is controlled by its electrical conductivity, which depends upon its content of ion species. If the conductivity is sufficient high, charges dissipate fast enough to prevent their accumulation and dangerously high potentials in a receiving tank avoided.

4 DEFINITIONS

4.1 Rest Conductivity

The reciprocal of the resistance of uncharged fuel in the absence of ionic depletion or polarization. It is the electrical conductivity at the initial instant of current measurement after a DC voltage is impressed between electrodes.

4.2 Picosiemens Per Meter (symbol pS/m)

The unit of electrical conductivity is also called a conductivity unit (CU). A siemen is the SI definition of reciprocal ohm sometimes called mho.

Hence

$1\ ps/m = 1 \times 10^{-12}\ \Omega^{-1}\ m^{-1} = 1\ cu = 1$ picom ho/m.

NOTE — One picosiemen equals 10-12 ohm and in the SI replaces the former picomho. The term 'conductivity unit' abbreviated 'CU' is also used for the picosiemen/metre.

5 PORTABLE METER METHOD

5.1 Apparatus

5.1.1 *Conductivity Cell and Current-Measuring Apparatus*

Any suitable equipment capable of giving a conductivity

reading almost instantaneously with the application of the voltage.

5.1.2 *Thermometer*

IP49C having a range suitable for measuring fuel temperature in the field. A thermometer holder shall be available so that the temperature can be directly determined for fuel in bulk storage, rail tanks, cars and trucks.

5.1.3 *Measuring Vessel*

Any suitable cylindrical vessel capable of holding sufficient fuel to cover the electrodes of the conductivity cell. For the equipment referred to in Note 1, a minimum volume of 1 litre is required.

The following portable equipment (*see* Notes 1 to 3 below) has been recommended for this purpose.

NOTES

1 Maihak MLA-900 Conductivity Indicator Manufacturer: H. Maihak, 2000 Hamburg 60. Postiach 601709.W. Germany

U.S. Agent: Ampower Corpn. 50 Broad Street, New York, N.Y.10004

2 Ethyl Intertech Distillate Conductivity Meter Model 8150, 8151 and 8152

Manufacturer: Ethyl Intertech Corpn. 19 Rozzel Road, Princeton, N.J. 08540.

These meters are no longer available. Calibration procedures for the existing meters can be obtained from the manufacturer.

3 Emcee Conductivity Meter Models 1151 and 1152

Manufacturer: Emcee Electronics. 8875 Midnight Pass Road Sarasota, Florida 33581, USA.

6 REAGENTS AND MATERIALS

6.1 Cleaning Solvent

Analytical grade toluene. If the presence of water is suspected use isopropyl alcohol followed by toluene.

CAUTION: Toluene is a toxic, volatile hydrocarbon which is absorbed by inhaling the vapour or through the skin by contact with the liquid. Use in adequate ventilation and avoid skin contact.

7 CALIBRATION

The calibration procedure will be dependent upon the equipment used. The procedures for the instruments are described in Annexes A, B and C.

NOTE — The test method results are known to be sensitive to trace contaminations from sampling containers.

8 SAMPLING

8.1 Fuel conductivity measurements shall be made *in-situ* to avoid changes during sample shipment. If it is necessary to take samples for subsequent analysis, the following precautions shall be taken.

8.1.1 The sample size should be as large as practicable and not less than 1 litre.

8.1.2 All sample containers shall be thoroughly cleaned with cleaning solvent and dried with a stream of air. Prior to taking the samples, all containers, including caps, shall be rinsed at least three times with the fuel under test.

8.1.3 Conductivity measurements shall be made as soon as possible after sampling and preferable within 24 h.

9 PROCEDURE

9.1 The specific calibration procedures detailed in Annexes A, B and C are an essential part of the following generalized procedures. The appropriate calibration steps for the instrument used shall be followed prior to commencing the subsequent procedures.

9.2 *In-Situ* Field Measurements on Tanks, Tank Cars, Tank Trucks, etc

For field measurements the conductivity meters referred to in Note 2 of **5.1.3** are considered suitable although their use inhazardous locations may.be restricted by local safety regulations. Each meter has an extension cable or can be equipped with one to lower the cell into the tank. High impedance hand-held meters are susceptible to electrical transients caused by the extension cable flexing during measurements. Failure to hold the apparatus steady during measurements may result in significantly poorer precision than shown in **11.1.2**. The following instructions apply to the meters referenced in Note 2 of **5.1.3**.

9.2.1 Check meter calibration as detailed in Annexes A and B depending on the meter used. Earth the meter to the tank and lower the conductivity cell into the tank to the desired level, taking care to avoid partial immersion or contact with tank water bottoms, if present. Move the conductivity cell in an up-and -down motion to remove previous fuel residues.

NOTES

1 **CAUTION** : To prevent static discharge between a charged fuel and a conductive probe inserted into a tank, the appropriate safety precautions of earthing and waiting for charge dissipation should be observed. For example, the American Petroleum Institute in RP 2003 recommends that a 30 minutes interval be allowed after pumping into a storage tank before an operator mounts a tank to insert a sampling device. This cell ensure that the fuel is electrically at rest (*see Note* under **1.2**).

2 If the cell is in contact with water and the instrument is switched on, an immediate off-scale reading will be obtained. If the cell has been in contact with water, it must be thoroughly rinsed with cleaning solvent and dried with a stream of air. In hot, humid conditions, condensation on the cell can occur, which can cause abnormally high zero, calibration, and sample readings. This can be avoided by storing the cell at a temperature 2 to 5°C in excess of the maximum ambient temperature where this is practicable.

9.2.2 After flushing the cell, hold it steady and after activating the instrument record the highest reading after initial stabilization. This should occur within 3 seconds. On instruments with more than one scale range, select the scale which gives the greatest sensitivity for the conductivity value being determined. Ensure that the appropriate scale multiplying factor (or scale range) is used. Record the fuel temperature.

9.3 Laboratory and Field Measurements on Sample Fuels

9.3.1 *Preparation of Containers (Metal or Glass)*

Prior to taking samples, take extreme care to ensure that all containers and measuring vessels have been thoroughly cleaned. It is preferable that containers are laboratory cleaned prior to shipment to the field for sampling (*see* **8**).

9.3.2 *Measurement*

Rinse the conductivity cell thoroughly with the fuel under test to remove fuel residues remaining on the cell from previous tests. Transfer the fuel to the measuring vessel and record the conductivity of the fuel using the procedure applicable to the particular apparatus. If one of the conductivity meters referenced in Note 2 of **5.1.3** is used, follow these instructions.

9.3.2.1 Rinse the cell concurrently with the rinsing of the measuring vessel. Then transfer the sample to be tested to the clean, rinsed measuring vessel. Check meter calibration as detailed in Annex A, B or C. Fully immerse the conductivity cell into the test fuel and measure the conductivity following the procedure detailed in **9.2.2** and the appropriate Annex. Record the fuel temperature.

NOTE — In order to avoid erroneous readings, it is important to ensure that the bottom of the conductivity cell does not touch the sample container. This is applicable to all containers, whatever the material of construction.

10 REPORT

Report the electrical conductivity of the fuel and the fuel temperature at which measurement was made. If the electrical conductivity reads zero on the meters report less than 1 ps/m.

NOTE — It is recognized that the electrical conductivity of a fuel varies with temperature and that the relationship differs for various types of aviation fuel. If it is necessary to correct conductivity readings to a particular temperature, each laboratory would have to establish this relationship for the fuels and temperature range of interest.

11 PRECISION AND BIAS

11.1 The precision of this test method as determined by statistical analysis of test results obtained by operator-instrument pairs at a common test site is as follows.

11.1.1 *Repeatability*

The difference between successive measured conductivity values obtained by the same operator with the same apparatus under constant operating conditions on identical test material at the same fuel temperature would, in the long run, in the normal and correct operation of the test method, exceed the values in Table 1 only in one case in twenty.

Table 1 Precision [1),3)]

Conductivity (pS/m)	Repeatability	Reproducibility[2)]
(1)	(2)	(3)
50	3	10
100	5	17
200	10	32
300	14	45
400	18	—
500	21	69
600	25	—
800	32	—
1 000	39	125
1 500	55	177

1) The precision limits in Table 1 are applicable at room temperature. Significantly higher limits (X2) may be applicable at temperatures near –20°C. Underlined values in the repeatability columns are interpolated.

2) The reproducibility values above were estimates from results obtained at the same location on the same day, by different operator/instruments testing identical samples. Results obtained at different times and locations may not be comparable according to the above reproducibility estimates, since they may contain errors due to sampling and environmental factors.

3) The data used to determine the precision of this test method were obtained without extension cables on hand-held meters.

11.1.2 *Reproducibility*

The difference between two single and independent measurements of conductivity obtained by different operators working at the same location (*see* Note under **10**) on identical test material at the same fuel temperature would, in the long run, in the normal and correct operation of the test method, exceed the values in Table 1 only in one case in twenty.

11.2 In 1987 a test programme was carried out to investigate reproducibility of results when samples are shipped between laboratories. While repeatability values were similar to those in Table 1, it was concluded that adequate reproducibility values were not obtained due to changes in conductivity of samples during shipment and storage. In the event of dispute or concern regarding shipped sample conductivity, it is recommended that operators come to the bulk fuel storage site to measure conductivity on bulk fuel or on freshly obtained samples according to cited

procedures. This assures that a sample indentical to the bulk supply is tested by either or both parties and the precision data shown in Table 1 shall apply.

11.3 Bias

Since there is no accepted reference material or suitable test method for determining the bias of the procedure given in ASTM D 2624 for measuring electrical conductivity, no statement on bias is being made.

12 APPARATUS

Continuous measurements can be made with the equipment listed in **12.1** where suitable precautions have been taken to remove static charges before the representative fuel stream is passed through an in-line measuring cell. A controlled, continuous flow through the cell prevents ion depletion, thereby providing the equivalent of rest conductivity as a continous measurement.

12.1 The following continuous measuring equipment has been found satisfactory for this purpose:

Staticon Conductivity Monitor (Model 1150), manufactured by Emcee Electronics 8875 Midnight Pass Road Sarasota, Florida 33581, USA.

13 INSTALLATION

In general this instrument is designed for permanent installation in the fuel distribution system. The manufacturer's recommendations concerning installation and flow control must be followed, particularly with respect to the provision of adequate relaxation time. The sample tapping point should be installed at least 30 m downstream of any additive injection system, unless a mixing device is used which has been shown to give adequate mixing of the additive concerned prior to sampling. A thermometer having a suitable range for measuring fuel temperature in the field shall be installed downstream of the test cell.

14 PROCEDURE

Flush the cell thoroughly by initiating a controlled flow of the fuel to be measured. Purging of air from the cell and adequate flushing is normally achieved in a few minutes but a longer flush is recommended when calibrating the instrument. The controlled flow must conform to the manufacturer's recommendation. Too fast or too slow a flow will result in inaccuracies in the conductivity measurement.

15 CALIBRATION

The specific calibration procedure detailed in Annex D is an essential part of the general procedure and should be completed prior to initiating automatic monitoring and control of the continuous fuel streams. The high and low level alarm circuits can be calibrated as recommended by the manufacturer.

16 MEASUREMENT

After calibration, select the instrument scale of the approximate range anticipated for the fuel stream and initiate continuous measurements of fuel conductivity. Measurements are made at the test cell temperature (indicated by the installed thermometer) which should approximate to the temperature of the fuel in the system.

17 REPORT

Report the electrical conductivity of the fuel and the fuel temperature at which measurement was made [*see* Note under **10**].

18 PRECISION

18.1 The repeatability of the continuous meter has been established to be within the range given for the portable instruments (*see* **11.1.1**).

18.2 The reproducibility has not been established.

18.3 Bias

The bias statement is being developed.

ANNEX A

(*Clauses* 7 *and* 9)

CALIBRATION OF THE MAIHAK METER

A-1 Before carrying out the calibration procedure the conductivity cell must be clean and dry (*see* Note *under* **9.2.1**).

A-2 The Maihak meter has been built in four models or series with different characteristics. The corresponding instrument numbers are as follows:

Series	*Instrument Number*
1	64001 to 64068, 64070
2	64069, 64071 to 64171
3	Prefix 2 –
4	Prefix 3 –

Series 2 and 3 instruments should have been subsequently modified with parts supplied by the manufacturer; in this case, the instrument numbers bear the suffix 'M'.

A-3 CHECKING THE CALIBRATION

To check the calibration reading, press the green READ button with the conductivity cell in the rest position against the calibration resistor in the housing. A meter reading of 465+10 pS/m shall be obtained. For confirmation press the red 2X button and then also the green READ button, as above. The meter shall read 232+10 pS/m. To check the live zero reading, lift the conductivity cell slightly in the housing to break contact with the calibration resistor. Press the green READ button. Repeat while pressing the red 2X button. For series 3 and 4 instruments a reading of zero shall be obtained. For Series 1 and 2 instruments a positive reading of about 10 to 30 pS/m shall be obtained. This value must be subtracted from all measured conductivity reading.

If readings within these limits are not obtained, the instrument requires servicing.

NOTE — If the pointer of the meter oscillates during measurement, it is likely that the battery needs replacing.

A-4 VERIFYING PERFORMANCE OF THE METER

Fully immerse the conductivity cell into the test fuel, holding it steady and then press the green READ button and record the highest reading after the needle has recovered from the initial overswing caused by inertia. The initial recovery shall not exceed 20 pS/m and will be completed in less than one sec. For conductivities in the range 500 to 1 000 pS/m the red 2X button shall be pressed and kept pressed while the READ button is pressed. Multiply the resultant scale reading by 2 to obtain the correct conductivity reading (This technique is also applicable for conductivities less than 500 as a check on the direct reading).

NOTE — It has been found that the early series instruments don't work properly at very low ambient temperatures. However, Series 3 and 4 instruments operate satisfactorily at temperatures down to –29°C provided that the exposure time is limited to 30 minutes maximum.

ANNEX B

(*Clauses* 7 *and* 9)

CALIBRATION AND USE OF THE EMCEE ANALOGUE CONDUCTIVITY METER (MODEL 1151 A)

B-1 INTRODUCTION

The principal operating parameters of the Emcee Conductivity Meter have been properly adjusted before shipment. Nevertheless, readjustment may become necessary from time-to-time. The following adjustments cover those that can be made conveniently in the field.

B-2 CALIBRATION CHECK PROCEDURE

B-2.1 Check zero. Set CU RANGE Switch to X-1. Hold meter with probe vertical and depress MEASURE switch. The meter shall deflect and gradually go to zero (approximately 3 seconds). If the meter does not go to zero (within 1 division) remove the probe and repeat zero test. If meter does not go to zero insert a small screwdriver into side panel upper hole or that marked ZERO and adjust for 0 CU+1 division. If zero adjustment is OK without probe but not when probe is attached, the probe shall be thoroughly rinsed with isopropyl alcohol and allowed to air dry before retesting for zero.

NOTE — Certain models with one hold in the side panel do not have a facility for zero adjustment without reference to the service manual.

B-2.2 Check Calibration

The CU RANGE switch position for calibration differs with certain models.

Those meters with serial number on front panel — Set the CU RANGE switch to CAL.

Those meters with internal serial numbers — Set the CU RANGE switch to X-1.

Depress both MEASURE and CALIBRATE switches at the same time. Allow meter pointer to stabilize (approximately 3 seconds). The meter reading shall be equal to the calibration number stamped on the probe

(+1 division). If necessary insert a small screw driver in the side panel hole and adjust meter pointer to the number stamped on the probe. If, as with certain models, two holes are available in the side panel then the lower one shall be used.

B-2.3 Battery Replacement

If preliminary calibration check procedures cannot be achieved, the batteries shall be checked or changed.

B-3 CONDUCTIVITY MEASUREMENT

Insert probe into fuel sample until fuel level is aligned with the centre of the holes nearest the top of the probe.

Set CU RANGE switch to X-10. Depress MEASURE switch and allow meter pointer to stabilize (approximately 3 sec). If meter reading is between 5 and 50 multiply by 10 and record result.

If meter reading is between 0 and 5 set CU RANGE switch to X-1. Depress MEASURE switch and allow meter pointer to stabilize (3 seconds). Record meter reading.

ANNEX C

(*Clauses* 7 *and* 9)

CALIBRATION OF THE EMCEE DIGITAL CONDUCTIVITY METER (MODEL 1152)

C-1 Connect probe to connector on the Emcee Digital Conductivity Meter and depress the MEASURE switch (M) with the probe out of the fuel sample. Zero reading shall be 000 + 001 (in approximately 3 seconds).

C-2 If the instrument does not meet the specification, remove the probe and depress MEASURE switch (M). If the instrument meets the specification without the probe attached, the probe shall be thoroughly rinsed with isopropyl alcohol and allowed to air dry before retesting for zero. If the instrument does not meet the specification without the probe attached, then the adjustment procedure of **C-4** shall be performed.

C-3 Note the calibration number stamped on the probe. Depress the CALIBRATION switch (C) with the probe out of the fuel sample. The reading shall be ten times the number stamped on the probe +0.005 (after approximately 3 s).

For example: Probe number equals 40, meter reading must be 400+005 (395 to 405). If instrument does not meet specification, proceed to **C-5**.

C-4 Zero adjustment is performed without the probe attached and the MEASURE switch (M) depressed. Insert a screwdriver in the hole marked 'Zero' and adjust the control until the DISPLAY reads 000+001.

C-5 Calibration is performed without the probe attached and with the CALIBRATION switch depressed. Insert a screwdriver in the hole marked 'CALIBRATE' and adjust to within +002 of ten times the number stamped on the probe.

ANNEX D

(*Clause* 15)

CALIBRATION OF THE STATIC ON CONDUCTIVITY MONITOR

D-1 Before carrying out the calibration procedure, the installed conductivity cell shall be flushed and the fuel flow adjusted to the recommended level.

D-2 Before calibrating, turn the power switch to 'ON' and adjust the meter zero as directed. Turn the function switch to 'Calibrate'. Meter should indicate 100 pS/m on each of three scales. If not, adjust as instructed. Turn function switch to 'low alarm'. Adjust alarm level as required. The high level alarm may be calibrated in a similar manner. Turn function switch to 'Operate' and lift the reset switch (The alarm light will go out). The recorder will then indicate the conductivity of the fuel stream. The alarm will be activated and the pumping circuits disabled if the conductivity drops below (or above) the pre-set level.

ANNEX E

(Foreword)

COMMITTEE COMPOSITION

Methods for Measurement and Test for Petroleum, Petroleum Products and Lubricants Sectional Committee, PCD 1

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Liquid Fuels and Solvents Tests Subcommittee, PCD 1: 3

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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. PCD 1 (1483).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

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