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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.

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

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

Indian Standard

ROTARY SHAFT LIP-TYPE SEALS INCORPORATING THERMOPLASTIC SEALING ELEMENTS

PART 4 PERFORMANCE TEST PROCEDURES

ICS 23.100.60; 83.140.50

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

December 2004

Price Group 7
NATIONAL FOREWORD

This Indian Standard (Part 4) which is identical with ISO 16589-4 : 2001 'Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 4 : Performance test procedures' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Basic Fluid Power Sectional Committee and approval of the Medical Instruments, General and Production Engineering Division Council.

Rotary shaft lip-type seals are used to retain fluid in equipment where the differential pressure is relatively low. Typically, the shaft rotates and the housing is stationary, although in some applications the shaft is stationary and the housing rotates.

Dynamic sealing is normally the result of a designed interference fit between the shaft and a flexible element incorporated in the seal.

Similarly, a designed interference fit between the outside diameter of the seal and the diameter of the housing bore retains the seal and prevents static leakage.

Careful storage, handling and proper installation of all seals are necessary to avoid hazards, both prior to and during installation, which would adversely affect service life.

The text of the ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (, ) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

CROSS REFERENCES

In this adopted standard reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their places are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 5598 : 1985 Fluid power systems and components —</td>
<td>IS 10416 : 1992 Fluid power systems and components — Vocabulary</td>
<td>Identical</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>(first revision)</td>
<td></td>
</tr>
</tbody>
</table>

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WARNING — Persons using this part of ISO 16589 should be familiar with normal laboratory practice. Whilst it does not purport to address all the safety problems, if any, associated with its application, attention is drawn to the need to employ sensible precautions while handling hot and cold fluids and equipment. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

ISO 16589 describes seals utilizing sealing elements manufactured from suitably formulated compounds, based on thermoplastic materials, such as polytetrafluoroethylene (PTFE).

NOTE ISO 16589 is complementary to ISO 6194 which covers elastomeric seals.

This part of the standard specifies general performance tests which can be used for seal qualification purposes. Materials quality control, dynamic testing and supplementary low temperature testing requirements are covered.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 16589. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 16589 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5598:1985, Fluid power systems and components — Vocabulary

ISO 16589-1:2001, Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 1: Nominal dimensions and tolerances


3 Terms and definitions

For the purposes of this part of ISO 16589, the terms and definitions given in ISO 5598 and ISO 16589-2 apply.

4 Pre-test procedure

4.1 Inspect all seals submitted for testing for conformity to a relevant drawing or detailed specification declared by the seal manufacturer

4.2 Ensure that the seal manufacturer has stated the material batch numbers from which the seals have been manufactured. For seals with an elastomeric component, ensure that the seal manufacturer has stated the material batch number from which the elastomeric component of the seal has been made.
4.3 To facilitate accurate analysis of the test results, determine the following data concerning the physical characteristics of the seal and test apparatus before testing:
   a) lip diameter immediately prior to assembly onto the shaft;
   b) lip thickness when measured as assembled on the test shaft;
   c) outer case mean diameter and out-of-roundness;
   d) shaft diameter, material, hardness and surface roughness;
   e) housing diameter, material and surface roughness;
   f) wiper lip diameter, when applicable.

   NOTE 1 For parts a), b) and f), measuring instruments with sharp edges should not be used.
   NOTE 2 Measurement of the radial lip load before the test is not recommended.

4.4 Ensure that the specified shaft eccentricity and housing off-set of the test apparatus have been incorporated.

5 Dynamic test

5.1 Test apparatus

The test apparatus shall be similar to the typical example shown in Figure 1 and shall consist of a suitable housing for retaining the test fluid and for positioning the test seals, as well as a rotating member having a spindle mounted horizontally on suitable bearings. The design of the housing for the seal shall be in accordance with the dimensions specified in ISO 16589-1. The housing and the rotating member shall be capable of reproducing the eccentricity and off-set referred to in 4.4.

The test apparatus shall also conform to the following additional requirements:
   a) the shaft shall be capable of cycling and/or maintaining the shaft speeds to within ± 5 %;
   b) the shaft shall be capable of maintaining the specified test eccentricity under dynamic conditions to within ± 0.03 mm throughout each test;
   c) the test head shall be designed and constructed so as to maintain the housing bore alignment relative to the test shaft axis within 0.03 mm throughout the operating temperature range;
   d) the design of the test head support shall ensure minimum deformation and vibration;
   e) the test head and heat transfer system shall be capable of maintaining the temperature of the test fluid within ± 5 °C and shall be vented to atmosphere;
   f) heat shall be applied in a manner that does not subject the test fluid to high localized temperatures which could cause fluid decomposition;
   g) the test shaft shall have a surface which is free of helical machine marks and shall comply with the requirements specified in ISO 16589-1:2001, clause 7;
   h) the test housing bore shall comply with the requirements specified in ISO 16589-1:2001, clause 8;
   i) the material properties, including hardness, surface finish and dimensions of the test shaft and test housing bore, shall conform as closely as possible to the shaft and housing bore, to be used in service;
   j) a minimum quantity of 0.75 l of test fluid shall be used;
k) the level of the test fluid in the test head shall be 0,3d to 0,5d above the lowest point of the shaft diameter d;

l) where the seal housings have inboard bearings, the test housing shall be suitably relieved at the bearing supports to prevent excessive fluid pressure between the bearing and seals;

m) means shall be provided for collecting and measuring the mass of any fluid leakage from the seals during the test.

---

Figure 1 — Typical example of dynamic test apparatus

5.2 Installation

5.2.1 Thoroughly clean the test head of contaminants and extraneous matter.

5.2.2 Install the seal into the test head so that the cumulative eccentricities of the seal and the test head are known.
5.2.3 Ensure that the plane of the seal lip is perpendicular to the shaft axis, unless otherwise specified.

5.2.4 Locate the test shaft in such a position that a clean unused area of its surface is in contact with the sealing element of the test seal.

5.2.5 Introduce the test fluid, which should be identical to the service fluid, through the filler tray as shown in Figure 1.

5.2.6 If the viscosity of the test fluid is too high to flow out of the filler tray of its own accord, remove the filler tray shown in Figure 1 and replace it with an adapter incorporating a grease nipple. Pump the requisite volume of test fluid through the nipple using a grease gun. Remove the grease nipple prior to the start up, thus preventing over pressurization of the seals. Replace filler tray.

5.3 Test conditions

Apply test conditions which simulate the seal application operating conditions specified by the customer, i.e. normal operating temperature, normal operating shaft speed, maximum envisaged operating temperature and maximum envisaged shaft speed (see annex A).

5.4 Test procedure

Submit six seals to ten cycles, each of 24 h duration, consisting of 14 h at normal operating temperature and speed (see annex A), according to service conditions, and 6 h at the maximum envisaged operating temperature and speed, followed by a 4 h shut-down to allow the test machine to cool to room temperature. If applicable, each alternate cycle shall be in the reverse direction of rotation.

5.5 Post-test measurements

After completion of the test, determine the seal thickness profile, i.e. when measured on a mandrel and, where applicable, the minor lip diameter.

5.6 Recording

Record all the test data on a seal test report (an example of seal test report for the dynamic test is shown in annex A).

5.7 Acceptance criteria

Typically, the leakage from all six seals shall be not greater than 12 g and the leakage from any single seal shall be not greater than 3 g.

Since leakage is dependent on the application and the design of the seal, the allowable leakage should be agreed on between the purchaser and manufacturer.

6 Dynamic low temperature test

6.1 General

This test is applicable to all rotary shaft lip-type seals for which the minimum specified operating temperature is stated to be –10 °C or lower.

6.2 Test apparatus

This test apparatus shall be similar to the typical example shown in Figure 2.

The test shaft and seal housing shall simulate the envisaged maximum eccentricities specified by the customer. The test shaft diameter, the test shaft surface roughness and the seal housing dimensions shall also be those specified by the customer or as specified in ISO 16589-1.
6.3 Installation

The requirements of 5.2.1, 5.2.2 and 5.2.3 shall be followed.

6.4 Test procedure

Submit two seals to the following procedure.

a) Correctly locate the seal in the test fixture.

b) Fill the test fixture with the test fluid to submerge the wetted side of the seal lip.

c) Place the test fixture in a cold box and soak for 16 h at the minimum temperature specified by the customer.

d) With the test fixture still in the cold box, rotate the shaft 10 revolutions by hand at an approximate speed of 60 r/min, pausing once every 180°.

e) Remove test fixture from cold box and allow to stand at room temperature for a minimum period of 6 h.

f) Remove seal from test fixture.

---

**Key**

1. Handle
2. Seal housing
3. Test fluid
4. Test shaft
5. Plain hexagonal nut
6. Washer
7. Test seal
8. Washer
9. Base
10. Holes to locate with pins in baseplate of refrigeration unit

**Figure 2 — Typical example of low temperature test fixture**
6.5 Post-test measurements

Inspect for any leakage that may have occurred during the test and visually inspect the seal lip, noting any cracks, tears, splits or any imperfections that may have appeared as a result of the test.

6.6 Recording

Record all test data on a seal test report (an example of a seal test report for the dynamic low temperature test is shown in annex B).

6.7 Acceptance criteria

There shall be no visible damage to the lip and there shall be no leakage greater than that specified by the customer.

7 Material testing of the rotary shaft seal components

7.1 General

Quality control tests shall be carried out on all batches of material from which the test seals are manufactured. In order to ensure that the materials used for production seals do not vary significantly from those of the test seals, subsequent production batches may need to be tested, subject to agreement between purchaser and manufacturer.

7.2 Metallic components (cases)

The type of material (e.g. steel, aluminium) from which the cases or housings are manufactured shall be recorded, together with its specification batch number and, if applicable, heat treatment. This will establish the physical characteristics of the metal cases. Additional information shall be quoted, if applicable and required by the purchaser.

7.3 Non-metallic components

7.3.1 Sealing elements

Thermoplastic sealing elements are usually manufactured from polytetrafluoroethylene (PTFE) compounded with suitable fillers. The type of filler, if required, should be specified together with the supplier's reference. This should be stated together with the physical properties relevant to the compound.

7.3.2 Gasket and sealant

The material(s) from which the internal sealing gasket and any additional sealants have been manufactured shall be stated together with any physical and compatibility characteristics considered relevant.

8 Identification statement (Reference to this part of ISO 16589)

Manufacturers are strongly recommended to use the following statement in test reports, catalogues and sales literature when electing to comply with this part of ISO 16589.

"The performance test procedures described in this document are in accordance with ISO 16589-4:2001, Rotary shaft lip-type seals incorporating thermoplastic sealing elements — Part 4: Performance test procedures."
An example of seal test report for the dynamic test

A.1 General data

Test report reference: 

Seal drawing reference or specification: 

Seal type: 

The material properties listed below shall be the measured values included in the test reports exemplified in annexes C and D.

<table>
<thead>
<tr>
<th>Thermoplastic</th>
<th>Compound:</th>
<th>Density(^a): g/cm(^3)</th>
<th>Tensile strength(^b): MPa</th>
<th>Elongation at break(^b): %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomer</td>
<td>Compound:</td>
<td>Density(^a): g/cm(^3)</td>
<td>Hardness(^c): IRHD</td>
<td>Compression set(^d): %</td>
</tr>
</tbody>
</table>

\(^a\) In accordance with ISO 2781  
\(^b\) In accordance with ISO 37  
\(^c\) In accordance with ISO 48  
\(^d\) In accordance with ISO 815  

A.2 Pre-test measurement

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th>Seal lip thickness: mm (when measured prior to assembly)</th>
<th>Seal outer case</th>
<th>Mean diameter: mm</th>
<th>Out-of-round: mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seal minor lip (where applicable)</td>
<td>Mean diameter: mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7
### A.3 Test conditions

<table>
<thead>
<tr>
<th>Description:</th>
<th>Normal operating temperature: °C</th>
<th>ISO viscosity grade:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum operating temperature: °C</td>
<td>ISO classification:</td>
</tr>
</tbody>
</table>

**Shaft:**

<table>
<thead>
<tr>
<th>Diameter: mm</th>
<th>Material:</th>
<th>Hardness:</th>
<th>Surface roughness, $R_a$: μm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eccentricity: mm</th>
<th>Normal operating speed: r/min</th>
<th>Maximum operating speed: r/min</th>
</tr>
</thead>
</table>

**Housing:**

<table>
<thead>
<tr>
<th>Diameter: mm</th>
<th>Material:</th>
<th>Off-set: mm</th>
<th>Surface roughness, $R_a$: μm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test cycle (if different from that specified in 5.4):**

### A.4 Post-test measurement

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th>Seal lip thickness mm (when measured after removal from test fixture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean diameter: mm (where applicable)</td>
</tr>
</tbody>
</table>

### A.5 Test results

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th>Leakage: g</th>
<th>All seals:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total: g</td>
<td></td>
</tr>
</tbody>
</table>

Comments on seal condition, before and after test:
Annex B
(informative)

An example of a seal test report for the dynamic low temperature test

B.1 General data

Test report reference: ____________________________

Seal drawing reference or specification: ____________________________

Seal type: ____________________________

The material properties listed below shall be the measured values included in the test reports exemplified in annexes C and D.

<table>
<thead>
<tr>
<th>Thermoplastic Compound:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Density(^a): g/cm(^3)</td>
<td>Tensile strength(^b): MPa</td>
<td>Elongation at break(^b): %</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elastomer Compound: (if used)</th>
<th>Density(^a): g/cm(^3)</th>
<th>Hardness(^c): IRHD</th>
<th>Compression set(^d): %</th>
</tr>
</thead>
</table>

\(^a\) In accordance with ISO 2781
\(^b\) In accordance with ISO 37
\(^c\) In accordance with ISO 48
\(^d\) In accordance with ISO 815

B.2 Pre-test measurement

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal lip thickness: mm (when measured prior to assembly)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seal outer case Mean diameter: mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-round: mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor lip (where applicable) Mean diameter: mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


B.3 Test conditions

<table>
<thead>
<tr>
<th>Test fluid:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal operating temperature:</td>
<td>ºC</td>
</tr>
<tr>
<td>Maximum operating temperature:</td>
<td>ºC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shaft:</th>
<th>Diameter: mm</th>
<th>Material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness:</td>
<td>Surface roughness, Ra:</td>
<td>µm</td>
</tr>
<tr>
<td>Eccentricity</td>
<td>Normal operating speed:</td>
<td>r/min</td>
</tr>
<tr>
<td></td>
<td>Maximum operating speed:</td>
<td>r/min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing:</th>
<th>Diameter: mm</th>
<th>Material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-set</td>
<td>Surface roughness, Ra:</td>
<td>µm</td>
</tr>
</tbody>
</table>

Test cycle
(if different from that specified in 5.4)

B.4 Post-test measurement

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th>Seal lip thickness mm</th>
<th>(when measured after removal from test fixture)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor lip Mean diameter: mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(where applicable)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.5 Test results

<table>
<thead>
<tr>
<th>Test seal No.</th>
<th>Leakage: g</th>
<th>All seals:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total: g</td>
</tr>
</tbody>
</table>

Comments on seal condition, before and after test:
An example of a material test report (thermoplastic)

C.1 General data

Test report reference: 

Seal drawing reference or specification: 

Seal type: 

Thermoplastic

<table>
<thead>
<tr>
<th>Compound reference:</th>
<th>Grade:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base material:</td>
<td></td>
</tr>
</tbody>
</table>

C.2 Test conditions

Normal ambient laboratory conditions, typically:

Temperature: 23 °C ± 2 °C

Relative humidity: (60 ± 5) %

C.3 Test results

<table>
<thead>
<tr>
<th>Density:</th>
<th>Specified</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength:</td>
<td>Specified</td>
<td>Results</td>
</tr>
<tr>
<td>Elongation at break:</td>
<td>Specified</td>
<td>Results</td>
</tr>
</tbody>
</table>

C.4 Comments
An example of a material test report (elastomer)

The elastomeric components for outer covering, minor lip or gasket are not dynamic sealing parts, tests are only required to establish their suitability. Their relevance is to be established by user and manufacturer.

D.1 General data

Test report reference: 

Seal drawing reference or specification: 

Seal type: 

Elastomer 

Compound: 

Type: 

D.2 Test conditions

In the following tests, the times and temperatures depend on the material being used and should be the subject of agreement between manufacturer and purchaser.

a) Compression set

Time: 

Temperature: °C 

b) Fluid immersion

Fluid immersion 

Test fluid: 

Time: 

Temperature: °C 

c) Dry heat ageing in air

Time: 

Temperature: °C 

d) Stiffness at low temperature

Température: °C 

12
D.3 Test results

<table>
<thead>
<tr>
<th></th>
<th>Specified:</th>
<th>Results:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile strength:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elongation break:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compression set:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid immersion:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry heat ageing:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stiffness at low temperature:</td>
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<td></td>
</tr>
</tbody>
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D.4 Comments
Under the general title, Rotary shaft lip-type seals incorporating thermoplastic sealing elements, there are five parts as per following:

IS 15545 (Part 1) : 2004 Nominal dimensions and tolerances
IS 15545 (Part 2) : 2004 Vocabulary
IS 15545 (Part 3) : 2004 Storage, handling and installation
IS 15545 (Part 4) : 2004 Performance test procedures
IS 15545 (Part 5) : 2004 Identification of visual imperfections

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.
Bureau of Indian Standards

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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. MGP 14 (395).

Amendments Issued Since Publication

<table>
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<th>Date of Issue</th>
<th>Text Affected</th>
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</tbody>
</table>

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Regional Offices :

<table>
<thead>
<tr>
<th>Regional Office</th>
<th>Address</th>
<th>Telephone</th>
</tr>
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<tbody>
<tr>
<td>Central</td>
<td>Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002</td>
<td>2323 7617, 2323 3841</td>
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<tr>
<td>Eastern</td>
<td>1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700 054</td>
<td>2337 8499, 2337 8561</td>
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<td>2337 8626, 2337 9120</td>
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<td>Northern</td>
<td>SCO 335-336, Sector 34-A, CHANDIGARH 160 022</td>
<td>260 3843</td>
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<td>260 9285</td>
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<td>Southern</td>
<td>C. I. T. Campus, IV Cross Road, CHENNAI 600 113</td>
<td>2254 1216, 2254 1442</td>
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<td>2254 2519, 2254 2315</td>
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<td>Western</td>
<td>Manakalaya, E9 MIDC, Marol, Andheri (East) Mumbai 400 093</td>
<td>2832 9295, 2832 7858</td>
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Branches: AHMEDABAD, BANGALORE, BHOPAL, BHUBANESHWAR, COIMBATORE, FARIDABAD, GHAZIABAD, GUWAHATI, HYDERABAD, JAIPUR, KANPUR, LUCKNOW, NAGPUR, NALAGARH, PATNA, PUNE, RAJKOT, THIRUVANANTHAPURAM, VISAKHAPATNAM.

Printed at New India Printing Press, Khurja, India