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Jawaharlal Nehru
“Step Out From the Old to the New”

[MTD 3: Mechanical Testing of Metals]
Indian Standard
METALLIC MATERIALS — CHARPY PENDULUM IMPACT TEST — PREPARATION AND CHARACTERIZATION OF CHARPY V REFERENCE TEST PIECES FOR VERIFICATION OF TEST MACHINES

ICS 77.040.10

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

November 2003
FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Mechanical Testing of Metals Sectional Committee had been approved by the Metallurgical Engineering Division Council.

The suitability of a pendulum impact testing machine for acceptance testing of metallic materials usually has been based on a calibration of its scale and verification of compliance with specified dimensions, such as shape and spacing of the anvils supporting the specimen. The scale calibration is commonly verified by measuring the mass of the pendulum and its elevation at various scale readings. This procedure for evaluation of machines had the distinct advantage of requiring only measurements of quantities which can be traced to national standards. The objective nature of these traceable measurements minimized the necessity for arbitration regarding the suitability of the machines for material acceptance tests.

However, sometimes two machines that had been evaluated by the direct-verification procedures described above and which met all dimensional requirements, were found to give significantly different impact values when testing test pieces of the same material specification.

In order to avoid such disagreements, it shall be convenient if, indirectly verified by testing reference test pieces. A machine shall be considered acceptable only if the values obtained by the machine are within specified limits, with the reference test pieces.

In the preparation of this standard assistance has been derived from the following:

c) ASTM Designation: E 23-93a Standard test methods for notched bar impact testing of metallic materials

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

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

1.1 This standard covers the requirements, preparation and method of qualifying and certification of reference test pieces that are used to indirectly verify pendulum impact testing machines.

1.2 It describes notched test pieces with nominal dimensions identical to those specified in IS 1757. However, the tolerances are more stringent. The chemical composition or heat treatment or both are varied according to the energy level desired.

1.3 Reference test pieces are qualified on reference pendulum impact machines which are also described in this standard.

2 REFERENCES

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

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1757 : 1988</td>
<td>Method for Charpy impact test (V-notch) for metallic material (second revision)</td>
</tr>
<tr>
<td>3766 : 1977</td>
<td>Method for calibration of pendulum impact testing machines for testing metals (first revision)</td>
</tr>
</tbody>
</table>

3 DEFINITIONS

For the purpose of this standard the following definitions shall apply.

3.1 Industrial Machine — Pendulum impact testing machine used for industrial and most research-laboratory testing of metallic materials. These machines are not used to establish reference values. Industrial machines are verified using direct verification and indirect verification with reference to test pieces.

3.2 Reference Machine — Pendulum impact testing machine used to determine the reference energy of a reference test piece. The verification requirements for this grade of machine are most stringent than those for industrial machines.

3.3 Definition Pertaining to Energy

3.3.1 Actual Absorbed Energy (Absorbed Energy), \( A \) — The total energy required to break a test piece when tested by a pendulum impact testing machine. It is equal to the difference in the potential energy from the starting position of the pendulum to the end of the first half-swing during which the test piece is broken.

3.3.2 Indicated Absorbed Energy (Indicated Energy), \( A_i \) — The energy value indicated by the pointer or other readout device of a pendulum impact testing machine.

3.3.3 Reference Energy, \( A_r \) — The absorbed energy associated with reference test pieces, determined from tests made using reference machines. It is the mean value of the set tested (see also 6).

3.4 Lot — A definite quantity of reference test pieces manufactured under identical conditions of production.

3.5 Reference Test Piece — An impact test piece used to verify the suitability of an industrial pendulum impact testing machine by comparing the indicated energy measured by that machine to the reference energy associated with the test piece (see 8).

3.6 Certified Reference Test Piece

An impact test piece used to verify reference machines by comparing the impact energy measured by that machine to the certified reference value associated with the test piece.

NOTE — The certified reference value is the value determined by a national or international body following an intercomparison exercise carried out on a group of reference machines within its jurisdiction.

3.7 Sets — A group of test pieces chosen at random from a lot.

3.7.1 Characterization Set — A set of test pieces taken from a lot in accordance with 6 and used to determine the reference energy of the lot.
3.7.2 Reference Set — A set of test pieces chosen in accordance with 6 and 8 and used to verify a pendulum impact testing machine.

3.8 Definitions Pertaining to the Test Piece Placed in the Test Position on the Supports of the Machine (see Fig. 1 and Fig. 2)

3.8.1 Height — The distance between the notched face and the opposite face.

3.8.2 Width — The dimension perpendicular to the height and parallel to the notch.

3.8.3 Length — The largest dimension at right angles to the notch.

4 SYMBOLS

The symbols used in this standard are as indicated in Table 1.

5 REFERENCE TEST MACHINE

5.1 Characteristics

The geometrical characteristics of reference machines used to determine the reference energy of reference test pieces shall be as specified in Table 2 and Fig. 1 and Fig. 2. Other characteristics shall however, comply with the requirements of IS 3766.

5.1.1 The radius at the base of the notch shall be tangential to the notch angle.

5.1.1.1 The surface finish shall not exceed 1.6 μm on the notched surface or 3.2 μm of the other surface.

5.1.1.2 Identification marks shall not be placed in any

Table 1 Symbols and Their Meanings
(Clause 4)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Symbol</th>
<th>Unit</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>i)</td>
<td>( A_c )</td>
<td>J</td>
<td>Actual absorbed energy, absorbed energy</td>
</tr>
<tr>
<td>ii)</td>
<td>( A_r )</td>
<td>J</td>
<td>Indicated absorbed energy, indicated energy</td>
</tr>
<tr>
<td>iii)</td>
<td>( A_h )</td>
<td>J</td>
<td>Reference energy of a set of Charpy reference test pieces</td>
</tr>
</tbody>
</table>

Table 2 Geometrical Characteristics (see Fig. 1 and Fig. 2)
(Clause 5.1)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Number in Fig. 1</th>
<th>Designation</th>
<th>Size</th>
<th>Tolerance</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>i)</td>
<td>1</td>
<td>Length of test piece</td>
<td>55.00</td>
<td>+0</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– 0.30</td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td>2</td>
<td>Half-length of test piece</td>
<td>27.5</td>
<td>± 0.20</td>
<td>mm</td>
</tr>
<tr>
<td>iii)</td>
<td>3</td>
<td>Height of test piece</td>
<td>10.00</td>
<td>± 0.06</td>
<td>mm</td>
</tr>
<tr>
<td>iv)</td>
<td>4</td>
<td>Width of test piece</td>
<td>10.00</td>
<td>± 0.075</td>
<td>mm</td>
</tr>
<tr>
<td>v)</td>
<td>5</td>
<td>Ligament length</td>
<td>8.00</td>
<td>± 0.06</td>
<td>mm</td>
</tr>
<tr>
<td>vi)</td>
<td>6</td>
<td>Angle of notch</td>
<td>45</td>
<td>± 1</td>
<td>deg</td>
</tr>
<tr>
<td>vii)</td>
<td>7</td>
<td>Radius of curvature of base of notch</td>
<td>0.250</td>
<td>± 0.025</td>
<td>mm</td>
</tr>
<tr>
<td>viii)</td>
<td>8</td>
<td>Angle between adjacent faces</td>
<td>90</td>
<td>± 0.15</td>
<td>deg</td>
</tr>
<tr>
<td>ix)</td>
<td>9</td>
<td>Angle between plane of symmetry of notch and longitudinal axis</td>
<td>90</td>
<td>± 2</td>
<td>deg</td>
</tr>
<tr>
<td>x)</td>
<td>10</td>
<td>Radius of anvils</td>
<td>1</td>
<td>± 0.1</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– 0.1</td>
<td></td>
</tr>
<tr>
<td>xi)</td>
<td>11</td>
<td>Angle of taper of anvils</td>
<td>11</td>
<td>± 1</td>
<td>deg</td>
</tr>
<tr>
<td>xii)</td>
<td>12</td>
<td>Distance between anvils</td>
<td>40.0</td>
<td>± 0.1</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– 0</td>
<td></td>
</tr>
<tr>
<td>xiii)</td>
<td>13</td>
<td>Distance of striking edge from plane of symmetry of anvils</td>
<td>–</td>
<td>± 0.25</td>
<td>mm</td>
</tr>
<tr>
<td>xiv)</td>
<td>14</td>
<td>Angle of striker</td>
<td>30</td>
<td>± 1</td>
<td>deg</td>
</tr>
<tr>
<td>xvi)</td>
<td>15A</td>
<td>Radius of curvature of striking of 2 mm striker</td>
<td>2.0</td>
<td>± 2.5</td>
<td>mm</td>
</tr>
<tr>
<td>xvi)</td>
<td>15B</td>
<td>Radius of curvature of striking edge of 8 mm striker</td>
<td>8.0</td>
<td>± 0.05</td>
<td>mm</td>
</tr>
<tr>
<td>xvi)</td>
<td>15C</td>
<td>Radius of shoulder of 8 mm striker</td>
<td>0.2</td>
<td>± 1.0</td>
<td>mm</td>
</tr>
<tr>
<td>xvi)</td>
<td>15D</td>
<td>Width of striking edge of 8 mm striker</td>
<td>4.0</td>
<td>± 0.05</td>
<td>mm</td>
</tr>
</tbody>
</table>
Types of striker

2 mm striker

8 mm striker

Line of strike

Fig. 1 Dimensions of Test Pieces, Anvils and Strikers
area of the test piece that contacts the striker edge, anvils or test piece supports, or within 5 mm of the notch.

5.1.2 Capacity

The capacity of a reference machine shall be 300 J or greater.

5.1.3 Hardness

The portions of the striker and the anvils (see Fig. 1) which contact the specimen and apply or react to the impacting force shall have a minimum hardness of 56 HRC.

5.1.4 Vibration

Ensure that the reference machine is not subjected to external (random) vibrations induced by other equipment in close proximity, such as forging hammers, presses, moving vehicles.

NOTE — Such vibrations can be detected by placing a small container of water at any convenient location on the machine framework, the absence of ripples on the water surface indicates that this requirement is met. Excessive vibration in a machine firmly fastened to the floor indicates the need for a separate foundation and/or the use of vibration isolators.

5.1.5 Energy Indicating Mechanism

The resolution shall be at least 1/400th of the nominal energy.

5.2 Qualification of Reference Test Machine

Direct verification shall be carried out in accordance with IS 3766 and with the additional requirements of 5.1.
5.2.1 Indirect verification shall be carried out using certified reference test pieces. The repeatability and the error shall be as specified in Table 3.

Table 3: Repeatability and Error of Reference Pendulum Impact Machines

(Clause 5.2.1)

<table>
<thead>
<tr>
<th>SI No</th>
<th>Energy, $E$</th>
<th>Repeatability</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(All Values in Joules)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i)</td>
<td>&lt; 40</td>
<td>≤ 3</td>
<td>≤ 2</td>
</tr>
<tr>
<td>ii)</td>
<td>&gt; 40</td>
<td>≤ 7.5% of $A_k$</td>
<td>≤ 5% of $A_k$</td>
</tr>
</tbody>
</table>

NOTE — Repeatability is given by: $A_{r,\text{ave}} - A_{r,\text{min}}$; and Error is given by: $A_{r} - A_{k}$

where

$$A_{r} = \frac{A_{r,1} + A_{r,2} + A_{r,3} + \ldots + A_{r,n}}{n}$$

5.3 Use of Reference Test Machine

The procedure for the operation of the reference machine shall conform to the requirements of IS 1757 and IS 3766 and to the following additional requirements.

5.3.1 The angular position of the pendulum at the extremes of its swing or the impact energy calculated therefrom shall be automatically recorded in digital or graphical form. These records shall be in permanent form suitable for evaluation at any time until one year after the entire batch of reference test pieces has been distributed.

5.3.2 The combined windage and friction loss during 11 successive half swings shall be measured before and after testing each characterization set and the values recorded.

5.3.2.1 To ensure that total friction and windage losses are within the permissible limit following steps of checking may be employed:

a) Secure the pendulum in its maximum energy position and release it without a specimen in the machine, the energy reading should show 0 Joule.

b) Again release the pendulum from its maximum energy position without re-setting the stage pointer and allow it to swing 11th half cycles; and as the pendulum starts its 11th half cycle, shift the stage pointer to between 5 to 10 percent of scale range capacity and note the energy value. The value obtained divided by 11 should not exceed 0.4 percent of scale range capacity.

5.3.3 The anvils and striker shall be removed from the machine annually for a complete inspection. If any parts are found to be damaged, they shall be replaced and the machine shall be re-qualified (see 5.1 and 5.2).

5.3.3.1 During the annual inspection of the reference machine, the flatness of the anvils surfaces (which absorb the force transmitted through the test piece) and the adjacent radii shall be examined for local wear or damage or both. The results of this examination shall be retained until the anvils are replaced or re-machined.

The radius (radii) of the striking edge of the striker and the radii of the anvils surfaces which are contacted by the test piece shall be measured and documented in the same manner.

If it becomes necessary to repair the recording system, it shall be recalibrated before additional tests are made (see 5.2).

NOTE — This examination can be done, for example, by making impressions of the surfaces in silicone rubber or another low-shrinkage material, or by holographic methods.

5.4 Calibration of Inspection, Measurement and Test Equipment

All equipment used by the supplier for final inspection and testing shall be calibrated and shall have a certified traceability to the SI system (the international system of units). The supplier shall maintain calibration records for all inspection, measurement and test equipment.

5.5 Log Book

The dates and details of all inspection and repairs shall be documented in a log book maintained for each reference machine.

6 REFERENCE TEST PIECES

6.1 Material

6.1.1 All the test pieces from a lot shall come from a single ingot or melt.

6.1.2 All test pieces shall be made of steel. The composition of the test pieces is not specified. Lots with different energy levels may have different compositions.

6.1.3 All test pieces from a lot shall receive the same heat treatment.

6.1.4 For each lot, the reference energy shall fall within one of the following ranges:

- Low : $< 30$ J
- Medium : $\geq 30$ J to $< 110$ J
- High : $\geq 110$ J to $< 220$ J
- Ultra High : $\geq 220$ J
6.2 Dimensions

The reference test pieces shall meet the dimensional requirements given in Table 2.

6.3 Marking

All test pieces shall be permanently marked so that each test piece can be distinguished from all the others.

6.4 Qualification of Reference Test Pieces

6.4.1 Any group of test pieces meeting the requirements of 6.1, 6.2 and 6.3 may be used as the lot from which reference test pieces are randomly selected.

6.4.2 To determine the reference energy of a lot, draw one or more sets of at least 25 test pieces at random from the lot and test them on a reference machine.

6.4.3 Take the reference energy of the lot as the average of the values obtained for the 25 or more test pieces. Also calculate the standard deviation. The standard deviation shall be as specified in Table 4.

<table>
<thead>
<tr>
<th>Table 4 Standard Deviation Permitted for Reference Test Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Clause 6.4.3)</td>
</tr>
<tr>
<td>(All Values in Joules)</td>
</tr>
<tr>
<td>Sl No.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>i)</td>
</tr>
<tr>
<td>ii)</td>
</tr>
</tbody>
</table>

6.4.4 The report on the impact tests on the reference test pieces shall include the following information:

a) Reference machine on which the tests were performed;

b) Striker geometry;

c) Temperature at which the tests were conducted;

d) All details necessary for the identification of each test piece;

e) Energy value, corrected for windage and friction, of each test piece; and

f) Reference energy value for the set, and the standard deviation.

6.5 After the set(s) to be tested by the reference machine have been drawn from the lot, draw the remaining test pieces in sets of five. These are the reference test piece sets. Each reference test piece set shall remain intact with no substitution permitted.

7 CERTIFICATES FOR REFERENCE TEST PIECES

Each set of reference test pieces shall be accompanied by:

a) Certificate which gives the following information:
   1) Reference to this standard;
   2) Name, trade-mark of reference number of the supplier;
   3) Reference energy of the set and its standard deviation;
   4) Striker geometry;
   5) Temperature at which the reference energy was determined, and all details necessary for the identification of the reference machine(s) used to determine the reference energy; and

b) When necessary, information concerning the use of the reference test pieces.

8 PROCEDURE FOR USING SETS OF REFERENCE TEST PIECES

8.1 Indirect verification of an industrial machine shall be performed in accordance with procedure given in Annex A using the reference test pieces and the striker and temperature specified by the supplier of the test pieces.

8.2 All the reference test pieces in each set shall be used for a single, indirect verification of the pendulum impact testing machine, testing the test pieces in random order and including all the results in the average. Substitution or replacement of individual test pieces by test pieces from another reference set is not permitted.
ANNEX A

(Clause 8.1)

INDIRECT VERIFICATION BY USE OF REFERENCE TEST PIECES

A-1 INDIRECT VERIFICATION BY USE OF REFERENCE TEST PIECES

A-1.1 Indirect verification consists of verifying points on the measuring scale using reference test pieces. These reference test pieces are used:

a) for comparison between tests performed in the machine under consideration and tests performed in a reference machine; and

b) to monitor the performance of a machine over a period of time, without reference to any other machine.

A-1.2 The indirect verification shall be performed at minimum of two absorbed energy levels within the range of use of the machine. Set of reference test pieces should be so selected that the reference energy should be between 10-80 percent of scale range of the machine to be verified.

A-1.3 It is recommended that a limited direct/static verification be performed as per IS 3766 before each indirect/dynamic verification. This limited direct verification shall include:

a) Inspection of the machine in accordance with 3.2.2, 3.2.3 and 3.2.4 of IS 3766;

b) Measurement of:
   1) Anvils; radius and gap (see 3.4.1.1 and 3.4.1.2 of IS 3766);
   2) Striker: edge radius position within anvil gap, angularity (see 3.3.7.1, 3.3.7.2 and 3.3.8 of IS 3766);
   c) Friction losses due to bearings and pointer (see 5.3.2.1); and
   d) Loss due to wind resistance (see 5.3.2.1).

A-2 FREQUENCY OF VERIFICATION

A-2.1 Direct verification and indirect verification shall be performed at the time of initial installation or after moving the machine.

A-2.2 When parts which are subject to war are replaced, a direct verification in accordance with clauses describing the affected part(s) shall be performed. An indirect verification shall also be performed.

A-2.3 Indirect verification shall be performed at intervals not exceeding 12 months.

A-2.3.1 More frequent indirect verifications may be necessary based on one or more of the following:

a) Large number of tests have been performed;

b) Absorbed energy required to fracture the individual test pieces is large compared to the nominal energy; and

c) Quality-control programme established by the test house requires more frequent indirect verification.

A-2.3.2 Indirect verification shall be performed after changing strikers.

A-2.4 Direct verification shall be performed when the results of an indirect verification are unsatisfactory. A limited direct verification shall be performed prior to performing an indirect verification (see A-1.3).

A-2.5 A simple, direct verification consisting of the procedure given in 5.3.2.1 shall be performed at the beginning of each day during which the machine issued because it provides a quick indication as to whether the performance of the machine has been impaired, for example by dirt in the bearings.

A-3 ERROR AND REPEATABILITY

$A_{v1}, A_{v2}, \ldots, A_{v5}$ are the absorbed energies at rupture of the five reference test pieces of a set numbered in order of increasing value.

A-3.1 Repeatability

The repeatability of the machine under the particular controlled conditions is characterized by the number.

Repeatability = $A_{v5} - A_{v1}$, that is $A_{v_{\text{Max}}} - A_{v_{\text{Min}}}$

The maximum repeatability values are given in Table 5.

A-3.2 Error

The error of the machine under the particular controlled conditions is characterized by the number

$$
\text{Error} = \overline{A} - A_k
$$

where

$$
\overline{A} = \frac{A_{v1} + A_{v2} + A_{v3} + A_{v4} + A_{v5}}{5}
$$

NOTE — $A_k$ is the value of the reference energy of the set of test pieces. The maximum error values are given in Table 5.

| Table 5 Values for Repeatability and Error |
| (All Values in Joules) | |
|------------------------|---|---|---|
| SI No. | Energy, $E$ | Repeatability | Error |
| (1) | (2) | (3) | (4) |
| i) | $< 40$ | $\leq 6$ | $\leq 4$ |
| ii) | $\geq 40$ | $\leq 15\%$ of $A_k$ | $\leq 10\%$ of $A_k$ |
A-4 REPORT

The report of verification shall include at least the following information:

a) Reference to this standard;
b) Identification of the machine; manufacturer’s name, model and serial number;
c) Radius of striker;
d) Name of owner and address of place of installation;
e) Name of mark of organization performing the verification;
f) Date of the verification;
g) Nominal potential energy of the pendulum;
h) Velocity of pendulum at impact;
i) Identification of the reference test pieces used in the indirect verification including the reference values and the actual, observed energy values of these test pieces;
j) Results of the indirect verification;
k) Energy lost due to windage and friction;
l) Repeatability;
m) Error; and
n) Statement that the machine does or does not conform to the requirements of this standard.
ANNEX B
(Foreword)

COMMITTEE COMPOSITION

Mechanical Testing of Metals Sectional Committee, MTD 3

Organization

Research & Development Centre for Iron and Steel (SAIL), Ranchi
AIMIL Ltd, New Delhi
Bharat Heavy Electricals Ltd, Hyderabad/ Bhopal
Blue Star Ltd, New Delhi/ Mumbai
Central Boilers Board, New Delhi
Civil Aviation Department, New Delhi
Consumer Protection Council, Rourkela
Directorate General of Supplies & Disposals, New Delhi/Bhopal
Fuel Instrument & Engineer Pvt Ltd, Ichalkamji
Hindalco Industries Ltd, Renukoot
Indian Register of Shipping, Mumbai
ITI Ltd, Bangalore
M. N. Dastur & Co Ltd, Kolkata
MECON (India) Ltd, Ranchi
Ministry of Defence (DGQA), Ichapur
Ministry of Defence, DGAQA, New Delhi/Bangalore
Ministry of Defence (DMRL), Hyderabad
Ministry of Defence (OFB), Muradnagar/Kanpur
Ministry of Railways, RDSO, Lucknow
Mukund Ltd, Mumbai
National Aerospace Lab, Bangalore
National Metallurgical Lab, Jamshedpur
National Test House, Ghaziabad
National Physical Laboratory, New Delhi
SAIL, Bhilai Steel Plant, Bhilai
SAIL, Bokaro Steel Plant, Bokaro
SAIL, Durgapur Steel Plant, Durgapur
SAIL, R&D Centre for Iron and Steel, Ranchi
SAIL, Rourkela Steel Plant, Rourkela
SAIL, Salem Steel Plant, Salem
Shriram Institute for Industrial Research, New Delhi

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Dr S. K. Sen (Chairman)

Shri S. P. Gupta
Shri S. C. Jain (Alternate)
Shri C. R. K. Prasad
Shri J. K. Qureshi (Alternate)
Shri S. F. Rustgi
Shri P. N. Choudhary (Alternate)
Shri V. K. Goel
Shri M. L. Ahuja (Alternate)
Shri Lalit Gupta
Shri A. K. Tiwari (Alternate)
Shri B. Vaidyathan
Shri B. S. Rana
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Dr J. C. Patte
Shri S. V. Kulkarni (Alternate)
Shri J. P. Singh
Shri D. D. Misra (Alternate)
Shri S. Kumar
Shri V. V. Prasun
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