COMPENDIUM OF INDIAN STANDARDS ON MACHINE TOOLS

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INTRODUCTION

Machine tools are mechanical devices used to shape or machine metal or other rigid materials by cutting, boring, grinding, shearing, or other forms of deformation. These machines are essential in the manufacturing industry for producing components with precision, repeatability, and efficiency.

Common types of machine tools include lathes, milling machines, drilling machines, grinders, shaping machines, and machining centers. Each tool is designed to perform specific operations and can be manually operated or computer-controlled (CNC) for advanced automation and productivity.

This compendium aims at providing an overview of Indian Standards related to CNC/NC machine tools, offering insights into the test methods for geometric and positioning accuracy.

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1. IS 2063 SERIES — TEST CODE FOR MACHINE TOOLS

This series of standards specifies the test code for machine tools, focusing on the determination of accuracy and repeatability, thermal effects, noise emission, and vibration of numerically controlled axes under no-load or quasi-static conditions. It applies to various types of machine tools and is used to verify their geometric and positioning accuracy. The tests involve moving the machine through specified points and measuring deviations from target positions. Standards published in this series are:

IS 2063 (Part 1) : 2016	*Geometric accuracy of machines operating under no-load or quasi-static conditions*— This part specifies methods for testing the accuracy of machine tools, operating either under no-load or under quasi-static conditions, by means of geometric and machining tests
IS 2063 (Part 2) : 2016	*Determination of accuracy and repeatability of positioning of numerically controlled axes*— This part specifies methods for testing and evaluating the accuracy and repeatability of positioning of numerically controlled machine tool axes by direct measurement of individual axes on the machine. These methods apply equally to linear and rotary axes.
IS 2063 (Part 3) : 2023	*Determination of thermal effects*— This document defines four tests: i) an environmental temperature variation error (ETVE) test; ii)a test for thermal distortion caused by rotating spindles; iii) a test for thermal distortion caused by moving linear axes; iv) a test for thermal distortion caused by rotary motion of components.
IS 2063 (Part 4) : 2023	*Circular tests for numerically controlled machine tools*— This standard specifies methods of testing and evaluating the bi-directional circular error, the mean bi-directional radial error, the circular error and the radial error of circular paths that are produced by the simultaneous movements of two linear axes.
IS 2063 (Part 5) : 2016	*Determination of the noise emission*— This part specifies methods for testing the noise of stationary floor-mounted machine tools and related auxiliary equipment directly on the shop floor. The purpose of the measurements is to obtain noise-emission data for machine tools.
IS 2063 (Part 6) : 2016	*Determination of positioning accuracy on body and face diagonals (diagonal displacement tests)*— This standard specifies diagonal displacement tests which allow estimation of the volumetric performance of a machine tool. Complete testing of the volumetric performance of a machine tool is a difficult and time-consuming process. Diagonal displacement tests reduce the time and cost associated with testing the volumetric performance.
IS 2063 (Part 7) : 2023	*Geometric accuracy of axes of rotation*— This part is aimed at standardizing methods of specification and test of the geometric accuracy of axes of rotation used in machine tools. Spindle units, rotary heads, and rotary and swivelling tables of machine tools constitute axes of rotation, all having unintended motions in space as a result of multiple sources of errors.
IS 2063 (Part 8) : 2016	*Vibrations*— This part of IS 2063 is concerned with the different types of vibration that can occur between the tool-holding part and the workpiece-holding part of a machine tool. These are vibrations that can adversely influence the production of both an acceptable surface finish and an accurate workpiece.

IS 2063 (Part 9) : 2016	*Estimation of measurement uncertainty for machine tool tests according to series IS 2063, basic equations*— This part of IS 2063 provides information on a possible estimation of measurement uncertainties for measurements according to IS 2063.
IS 2063 (Part 10) : 2023	*Determination of the measuring performance of probing systems of numerically controlled machine tools*— This document specifies test procedures to evaluate the measuring performance of probing systems integrated with a numerically controlled machine tool.
IS 2063 (Part 11**) *under development***	*Measuring instruments suitable for machine tool geometry tests (Under development)* — The aim of this document is to document the characteristics of precision measuring instruments for testing the geometric accuracy of machine tools, operating either under no-load or under quasi-static conditions.
IS 2063 (Part 12) : 2024	*Accuracy of finished test pieces*— This document specifies methods for defining machining tests for manufacturing accurate test pieces, and for evaluating the influence of quasi-static geometric errors of linear axes and rotary axes, and the influence of the synchronization error of simultaneously controlled multiple axes.

2. IS/ISO 13041 SERIES — TEST CONDITIONS FOR NC TURNING MACHINES AND TURNING CENTRES

The objective of this series of standards is to provide wide and comprehensive information on geometrical, positional, contouring, thermal and machining tests for NC Turning Machines/Turning Centres, which can be carried out for comparison, acceptance, maintenance or for any other purpose. Standards published in this series are:

IS/ISO 13041 (Part 1) : 2020	*Geometric tests for machines with horizontal work holding spindles*— This document specifies the geometric tests on normal accuracy numerically controlled (NC) turning machines and turning centres with horizontal work spindles
IS/ISO 13041 (Part 2) : 2020	*Geometric tests for machines with a vertical work holding spindle*— This document specifies the geometric tests for general purpose normal accuracy numerically controlled (NC) turning machines and turning centres with vertical workholding spindles, as well as the corresponding applicable tolerances.
IS/ISO 13041 (Part 3) : 2009	*Geometric tests for machines with inverted vertical workholding spindles*— This standard specifies the geometric tests on general-purpose, numerically controlled (NC) turning machines and turning centres with inverted vertical workholding spindles, as well as the corresponding applicable tolerances.
IS/ISO 13041 (Part 4) : 2004	Accuracy and repeatability of positioning of linear and rotary axes— This part specifies the tolerances which apply to the positioning tests for linear axes, up to 2 000 mm in length, and rotary axes of numerically controlled (NC) turning machines and turning centres.
IS/ISO 13041 (Part 5) : 2015	*Accuracy of speeds and interpolations*— This part specifies certain kinematic tests for numerically controlled (NC) turning machines and turning centres, concerning the spindle speeds, the feed speeds of the individual NC linear axes, and the accuracy of the paths described by the simultaneous movement of two or more NC linear and/or rotary axes.
IS/ISO 13041 (Part 6) : 2009	*Accuracy of a finished test piece*— This part specifies a series of cutting tests, under finishing conditions, of standard test pieces. It also specifies the characteristics and dimensions of the test pieces themselves.

IS/ISO 13041 (Part 7) : 2004	*Evaluation of contouring performance in the coordinate planes*— This standard of describes a method of checking the contouring performance of turning centres (or numerically controlled turning) by conducting circular tests and by evaluating the radial deviation F and circular deviation G
IS/ISO 13041 (Part 8) : 2004	*Evaluation of thermal distortions*— This standard specifies the tests which apply for the evaluation of thermal distortions of the machine structure and positioning system, up to 2 000 mm in length, of numerically controlled (NC) turning machines and turning centres.

3. IS 15250 SERIES — TEST CONDITIONS FOR MACHINING CENTRES

A machining centre is a numerically controlled machine tool capable of performing multiple machining operations, including milling, boring, drilling, and tapping, as well as automatic tool changing from a magazine or similar storage unit in accordance with a machining program. The objective of IS 15250 (all parts) is to supply information as wide and comprehensive as possible on tests which can be carried out for comparison, acceptance, maintenance, or any other purpose deemed necessary by user or manufacturer/supplier. IS 15250 series of standards specifies, with reference to the relevant parts of IS 2063, several families of tests for machining centres with horizontal spindle, standing alone or integrated in flexible manufacturing systems. Standards published in this series are:

IS 15250 (Part 1) : 2024	*Geometric tests for machines with horizontal spindle (horizontal z-axis)*— This standard applies to machining centres having three numerically controlled linear axes (X-axis up to 5 000 mm length, Y-axis up to 3 200 mm length, and Z-axis up to 2 000 mm length), but refers also to supplementary movements, such as those of rotary, tilting, and swivelling tables.
IS 15250 (Part 2) : 2024	*Geometric tests for machines with vertical spindle (vertical z-axis)* — This document specifies the geometric tests for machining centres with vertical spindle (i.e. vertical Z-axis). This document also establishes the tolerances for the test results corresponding to general purpose and normal accuracy machining centres. This document applies to machining centres having three numerically controlled linear axes (X-axis up to 5 000 mm length, Y-axis up to 2 000 mm length, and Z-axis up to 2 000 mm length), but refers also to supplementary movements, such as those of rotary, tilting, and swivelling tables.
IS 15250 (Part 3) : 2018	*Geometric tests for machines with integral indexable or continuous universal heads (vertical z - axis)*— This part applies to machining centres having basically six numerically controlled axes, of which three are linear (X, Y and Z) up to 2 000 mm in length, and three are rotary (A or D and B on the head, and C' on the table).
IS 15250 (Part 4) : 2018	*Accuracy and repeatability of positioning of linear and rotary axes*— This part specifies the tolerances which apply to the positioning tests for linear axes, up to 2 000 mm in length, and rotary axes of machining centres.
IS 15250 (Part 5) : 2018	*Accuracy and repeatability of positioning of work-holding pallets*— This part of specifies the tests intended to assess the repeatability of positioning of individual pallets and the total accuracy of positioning of a batch of pallets associated with a specific machine.
IS 15250 (Part 6) : 2018	*Accuracy of speeds and interpolations*— This part specifies certain kinematic tests for machining centres, concerning spindle speeds, feed and the accuracy of the paths

described by the simultaneous movement of two or more numerically controlled (NC) linear and/or rotary axes.

IS 15250 (Part 7) : 2023	*Accuracy of finished test pieces*— This document specifies several families of tests for machining centres with horizontal or vertical spindle or with universal heads of different types, standing alone, or integrated in flexible manufacturing systems.
IS 15250 (Part 8) : 2018	*Evaluation of contouring performance in the three coordinate planes*— This part specifies a method of checking the contouring performance of machining centres (or numerically controlled milling machines, etc., where applicable) by conducting circular tests in the three coordinate planes (XY, YZ and XZ) and by evaluating the radial deviation and circular deviation.
IS 15250 (Part 9) : 2018	*Evaluation on the operating times of tool change and pallet change*— This part specifies certain standard test conditions for assessing the conventional length of the operating times spent by the machine to carry out different metal cutting functions. It considers two types of operating times, namely- automatic tool change and automatic pallet change.
IS 15250 (Part 10) : 2024	*Evaluation of thermal distortions*— This document specifies four tests: i) environmental temperature variation error; ii) thermal distortion caused by a rotating spindle; iii) thermal distortion caused by moving linear axes; iv) thermal distortion caused by rotary motion of components.

4. IS 11958 SERIES — MACHINE TOOLS — TEST CONDITIONS FOR TESTING THE ACCURACY OF BORING AND MILLING MACHINES WITH HORIZONTAL SPINDLE

IS 11958 series of standards specifies, with reference to relevant part of IS 2063, geometric tests, machining tests, spindle tests and tests for checking the accuracy and repeatability of positioning by numerical control of general purpose, normal accuracy, horizontal spindle boring and milling machines. Horizontal spindle boring and milling machines fall into three categories characterized by their particular configuration: a) machines with fixed column and movable table; b) machines with movable column and fixed table; and c) machines with movable column and movable table. Standards published in this series are:

IS 11958 (Part 1) : 2018	*Machines with fixed column and movable table*— This part specifies geometric tests, machining tests, spindle tests and tests for checking the accuracy and repeatability of positioning by numerical control of general purpose, normal accuracy, horizontal spindle boring and milling machines having a fixed column and movable table
IS 11958 (Part 2) : 2019	*Machines with movable column as long the X - Axis (Floor type)*— This part specifies geometric tests, spindle tests and tests for checking the accuracy and repeatability of positioning by numerical control of horizontal spindle boring and milling machines having a movable column along the X-axis and also specifies the applicable tolerances corresponding to general-purpose, normal accuracy machines.
IS 11958 (Part 3) : 2022	*Machines with Movable Column and Movable Table*— This part specifies geometric tests, machining tests, spindle tests and tests for checking the accuracy and repeatability of positioning by numerical control of general purpose, normal accuracy, horizontal spindle boring and milling machines having a movable column and movable table.

5. IS/ISO 8636 SERIES — MACHINE TOOLS — TEST CONDITIONS FOR BRIDGE-TYPE MILLING MACHINES

A bridge-type milling machine is a numerically controlled machine tool capable of performing multiple machining operations, including milling, boring, drilling and tapping, as well as automatic tool changing from a tool magazine or similar storage unit according to a machining program. This series of standards specifies, with reference to relevant parts of IS 2063, geometric tests and tests to check the accuracy and repeatability of positioning of numerically controlled axes for general-purpose, normal accuracy bridge-type milling machines. This series also specifies the applicable tolerances corresponding to the above-mentioned tests. Standards published in this series are:

IS/ISO 8636 (Part 1) : 2000	*Fixed bridge (Portal-Type) machines*— This part specifies geometric tests, machining tests and tests for checking accuracy and repeatability of positioning of numerically controlled axes for general purpose, normal accuracy, bridge-type milling machines with a fixed bridge (portal type).
IS/ISO 8636 (Part 2) 2007	*Traveling Bridge (Gantry-Type) Machines*— This part specifies geometric tests, machining tests, and tests for checking accuracy and repeatability of positioning of numerically controlled axes for general-purpose normal accuracy bridge-type milling machines with a travelling bridge (gantry-type).

6. IS 11398:2018 MACHINE TOOLS — TEST CONDITIONS FOR HORIZONTAL SPINDLE TURRET AND SINGLE SPINDLE AUTOMATIC LATHES — TESTING OF THE ACCURACY

This Indian Standard describes geometric tests, machining tests and tests for accuracy and repeatability of numerically-controlled positioning axes on general purpose and normal accuracy turret and single spindle automatic lathes. It also specifies the applicable tolerances corresponding to the above-mentioned tests. This standard should be used with reference to IS 2063 (Part 1) and IS 2063 (Part 2).

7. IS 13552 : 2019 MACHINE TOOLS — TEST CONDITIONS FOR SURFACE GRINDING MACHINES WITH VERTICAL GRINDING WHEEL SPINDLE AND RECIPROCATING TABLE — TESTING OF THE ACCURACY

This Indian Standard specifies both geometric and machining tests on general purpose, normal accuracy, manually, and numerically controlled (NC) surface grinding machines with reciprocating table and vertical grinding wheel spindle. It also specifies the applicable tolerances corresponding to the above-mentioned tests. This standard should be used with reference to IS 2063 (Part 1) and IS 2063 (Part 7).

8. IS 17249 SERIES — TEST CONDITIONS FOR DIE SINKING ELECTRO-DISCHARGE MACHINE (DIE SINKING EDM) — TESTING OF THE ACCURACY

IS 17249 series specifies, with reference to IS 2063 (Part 1) and IS 2063 (Part 2), geometric and machining tests and tests for checking accuracy and repeatability of numerically controlled positioning axes for normal accuracy and general-purpose die sinking electro-discharge machines (die sinking EDM). It also specifies

the applicable tolerances corresponding to the above-mentioned tests. Standards published in this series are:

IS 17249 (Part 1) : 2019	*Single-column machines (cross-slide table type and fixed-table type)*— This part specifies, geometric and machining tests and tests for checking accuracy and repeatability of numerically controlled positioning axes for normal accuracy and general-purpose die sinking electro-discharge machines (die sinking EDM) with single column (cross-slide table type and fixed-table type).
17249 (Part 2) : 2021	*Double-column machines (slide-head type)*— This part specifies, geometric and machining tests and tests for checking accuracy and repeatability of numerically controlled positioning axes for normal accuracy and general-purpose die sinking electro-discharge machines (die sinking EDM) with double column (slide-head type).

9. IS 17250 : 2019 TEST CONDITIONS FOR WIRE ELECTRICAL-DISCHARGE MACHINES (WIRE EDM) — TESTING OF THE ACCURACY

This Standard specifies geometric tests, tests of accuracy and repeatability of numerically controlled positioning axes, machining test and circular test for general purpose and normal-accuracy wire electro-discharge machines (wire EDM). It also specifies the applicable tolerances, corresponding to the above-mentioned tests. This standard should be used with reference to IS 2063 (Part 1), IS 2063 (Part 2) and IS 2063 (Part 4).