

Coordinate measuring machines —

Part 3: Code of practice

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Committees responsible for this British Standard

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- Advanced Manufacturing Technology Research Institute
- British Telecommunications plc
- Cranfield Institute of Technology
- Department of Trade and Industry (National Engineering Laboratory)
- Department of Trade and Industry (National Physical Laboratory)
- Gauge and Tool Makers' Association
- Institution of Production Engineers
- Ministry of Defence
- University of Manchester Institute of Science and Technology

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Foreword

This Part of BS 6808 has been prepared by the Advanced Manufacturing Technology Assembly (AMT/-/8) at the request of manufacturers and users of coordinate measuring machines (CMMs).

BS 6808-2:1987, which covered the performance assessment of coordinate measuring machines, has been superseded by BS EN ISO 10360-2:1996. Amendment No. 1 to BS 6808-3:1989 deletes all reference to BS 6808-2:1987, which has been withdrawn.

This Part of BS 6808 provides the user and supplier with more information about further testing recommendations for variable environmental conditions.

A glossary of terms is given in BS 6808-1.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 6808 gives recommendations to the user and supplier on the more detailed testing recommended if the environmental conditions give rise to problems.

This standard is not intended for coordinate measuring machines that have working volumes, any dimension of which is significantly greater than the dimension of the mechanical reference artefact, or for those having more than three non-redundant axes.

2 Definitions

For the purposes of this Part of BS 6808, the definitions given in BS 6808-1 apply.

3 General

The CMM under test should have validated software capable of determining from a series of data points the orientation in space of a best-fit plane. This ability will enable a much closer scrutiny of the measurement capability of the CMM to be made.

4 Environmental conditions

4.1 Vibration analysis

4.1.1 Principle. The vibration survey establishes the vertical and horizontal vibration environment at the interface between the CMM and its foundations and support system provided by the user, in order to allocate responsibility for faults between user and supplier.

4.1.2 Procedure. Make the vibration survey using a directionally sensitive, low frequency (0.5 Hz to 100 Hz) transducers capable of discriminating a peak-to-peak motion amplitude of 0.25 μm .

A band-pass filter of corresponding frequency range having variable high and low cut-off frequencies should be used to condition the transducer signals prior to recording on an oscilloscope, a chart recorder or in some other way agreed between the user and the supplier.

In the case of a contacting analogue probe, vibration between the mechanical probe and the workpiece can result from forces external to the CMM, or from forces generated within the CMM itself. Therefore, a test should first be made to see if the CMM is the vibration source, prior to conducting a full measurement and analysis of vibration. If the CMM is motorized, the power to all motors should be removed and the CMM tested to determine if the vibration is still present. If the CMM uses air bearings, the air pressure to the bearings should be varied sufficiently to establish whether air-bearing instability is causing vibration.

If the CMM is not the source of the vibration, a complete vibration analysis at the CMM-to-support interface should be performed and the frequency spectrum analysed to determine if frequencies and amplitudes are present that exceed the CMM supplier's defined limits. Measurements should be made by transducers mounted on the CMM support in the direction of the vertical axis and the two mutually perpendicular horizontal directions that approximately correspond to the principal axes of the CMM.

Care should be taken that the survey is undertaken during a period representative of the CMM operating conditions.

4.1.3 Analysis. If any of the vibration parameters measured during the survey (see 4.1.2) exceed the supplier's specification, the user should correct the problem in order to conform to the specification or else accept a performance derating to be negotiated between supplier and user. If the vibration parameters are within the supplier's specification, it should be the sole responsibility of the supplier to correct the performance of the CMM in order to meet the specification.

4.2 Air supply

4.2.1 Procedures are described for testing the air supply if there is evidence of excessive pressure fluctuation, inadequate supply pressure at the specified flow rate, excessive CMM thermal drift, or bearing contamination. Responsibility for correction of faults is allocated between the user and supplier according to the analysis of the test results.

4.2.2 Test equipment. For the tests on the air supply, it is recommended that an air pressure gauge, air flow gauge, and a temperature measuring system should be used. The air pressure gauge should be calibrated to cover the range between the minimum and maximum air supply pressure specified by the CMM supplier.

The accuracy of the air pressure gauge should be $\pm 5\%$ of the permissible air supply pressure fluctuation as specified by the supplier.

The air flow gauge should have an accuracy of $\pm 20\%$ of the maximum flow rate specified by the supplier.

The temperature measuring system should be calibrated to an accuracy of $\pm 0.1\text{ }^{\circ}\text{C}$.

NOTE An accuracy of $\pm 0.1\text{ }^{\circ}\text{C}$ is acceptable in most cases but would be dependent upon the specification of the CMM.

4.2.3 Methods

4.2.3.1 Pressure fluctuation. Mount an air pressure gauge in the supply line upstream of the CMM air filter. Observe the pressure under the condition(s) that resulted in evidence of excessive pressure fluctuation.

4.2.3.2 Supply pressure and flow. Using the gauge arrangement as described in 4.2.3.1, observe the pressure under the condition(s) that resulted in evidence of inadequate pressure. If the pressure is inadequate, mount an air flow gauge in the supply line upstream of the CMM air filter. Observe flow under the condition(s) that resulted in evidence of inadequate pressure.

4.2.3.3 Air supply temperature. Mount a temperature measuring system pickup in the air line downstream of the CMM air filter or, if this is impractical, on a metallic part of the supply line as close to the inlet point on the CMM as possible. If the pickup is mounted on the line, the line and pickup should be insulated from ambient air to ensure that the temperature of the air supply is being measured. Measure the temperature under the condition(s) that resulted in evidence of excessive CMM thermal drift.

4.2.3.4 Contamination. Examine surfaces near air exhaust points for water, oil, or solid particulates, at a frequency dependent upon the frequency of use of the CMM but normally at least once per week.

4.2.4 Test analysis

4.2.4.1 Pressure fluctuation. If the supply line fluctuation exceeds the supplier's specification, it should be the responsibility of the user to correct the problem by, for example, installing an accumulator.

4.2.4.2 Supply pressures and flow. If the flow rate exceeds the supplier's specification, it should be the responsibility of the supplier to reduce the flow required by the CMM, provided it can be demonstrated by the user that no significant leaks exist in the supply. If the flow rate meets the supplier's specification but the line pressure does not, it should be the responsibility of the user to increase the supply pressure, for example by removing other devices using air from the line or by increasing its diameter.

4.2.4.3 Air supply temperature. If the temperature of the air supply line does not meet the supplier's specification, it should be the responsibility of the user to correct the temperature, for example by installing a heat exchanger to enable the supplier's specification to be met.

4.2.4.4 Contamination. If contamination is present, it should be the responsibility of the user to change the air filter cartridge, clean the CMM air system using procedures recommended by the supplier, and correct the supply contamination problem. Two methods of correction are preferred:

- a) reduction of supply contamination; or
- b) decrease of the intervals between servicing the filter.

NOTE External sources of dust, for example from air-conditioning and from ineffective cleaning procedures should be carefully controlled. Unexpectedly large variations in the values obtained from a series of measurements could arise from a contamination problem.

4.3 External temperature influences

Temporal and spatial temperature changes within the working volume of the CMM will affect the accuracy capabilities of the CMM and whenever possible such variations should be minimized. Among the influencing factors are heat radiation from: sunlight, neighbouring machines, lighting and, where applicable, the proximity of the operator.

The deviation of the CMM and/or the workpiece from a reference temperature will also produce measurement errors even when the temperature remains constant with time, unless the effective thermal coefficient of expansion and the temperature of the CMM are the same as the expansion coefficient and temperature of the workpiece. It is recommended that the CMM and workpiece should be fitted with temperature sensors.

The effects of temperature should be corrected by calculation based upon the known thermal parameters of the CMM and workpiece. It is recommended that such computations are based on the assumptions that the temperature is steady with time and is uniform in space.

Careless handling of mechanical reference artefacts can cause significant errors. For example, if a 400 mm length bar is grasped with unprotected hands for about 10 s, its length could be in error by more than 15 μm even after 15 min.