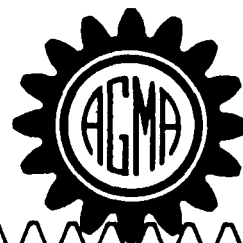


Traceability Strategies for the Calibration of Involute Spline Gauges

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American Gear Manufacturers Association



TECHNICAL PAPER

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

Much is being reported about the form and shape of running gears, little, however, about the same features of splines and serration, although the latter, too, are installed in every automobile. It is, of course, a well-known fact that the permissible geometrical tolerances for spline and serration gauges are often as narrow as those for running gears. According to ISO 17025 (draft), measuring and test equipment – among which spline and serration gauges are counted – must have been linked up with recognized national or international primary standards through an unbroken traceability chain. Since the sixties, national standards and standard measuring devices have, therefore been available in Germany for running gears, for example for the elements: profile, helix, pitch, tooth thickness, radial run-out of gearing, roughness. On the other hand no direct link-up with the SI unit *metre* has so far been made at PTB for splines and serration, nor has a laboratory been accredited within the framework of DKD. In contrast to this, several laboratories have been accredited in the United Kingdom, one of which may calibrate up to 70 measurands that have been embodied on spline and serration gauges. If one would proceed according to the DKD traceability criteria valid within the DKD for other geometrical measurands, a large number of PTB calibrations on reference standards or comparison measurements with the PTB on spline and serration gauges would be necessary, and this would, of course, involve relatively high cost. It might, therefore, be an alternative to ensure traceability for the measuring instrument only (e.g. a CMM) – here referred to as category A – and to estimate the uncertainty budget for the individual measurands. However, the smallest possible uncertainty of measurement according to ISO 15530-4 (draft) would not be achievable in this way.

Examples will be given in the paper which prove that, in view of the narrow tolerances, it will often be necessary to trace splines and serration gauges back with the smallest possible uncertainty (here referred to as category B). The task-specific uncertainty of measurement must then be determined, which is obtained through measurements on a CMM for which traceability has been ensured, in combination with traced-back, precise gear standards applying the so-called substitution method (ISO 15530-4). By bringing up this topic, the author wishes to put up for discussion whether internationally uniform traceability criteria in compliance with ISO 17025 should be specified to achieve comparability and mutual recognition of measurement results on the international level.

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Traceability strategies for the calibration of involute spline gauges

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1. Introduction

Splines are used for torque transmission (in the same axis). They are needed when (a) the driven component must be shifted on the driving component (in the case of change speed gears and clutches) and (b) when two components for torque transmission must be separated for reasons of manufacture (for example, in the case of steering mechanisms).

Splines are to be centred as well as possible. They are to have little backlash, low noise and a low rate of wear. From this it follows that the geometric tolerances, too, must be relatively small, similar to those of gearings (depending on the accuracy class). The following distinctions are made:

- involute splines (Fig. 1); they are side-fit, and contact is via an area (Fig. 2);
- straight-sided splines for the transmission of high torques; they are diameter-fit, and contact is practically along a line (Fig. 3);
- serration splines (Fig. 4); they are side-fit, and contact is practically along a line.

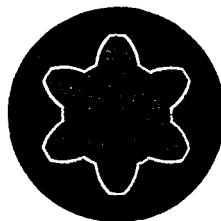


Fig. 1: Involute spline

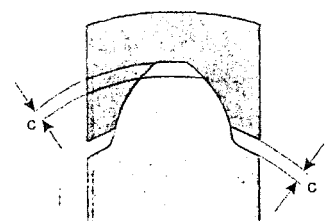


Fig. 2: Involute spline (side-fit)

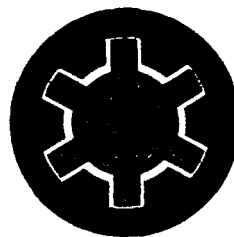


Fig. 3a: Straight-sided spline

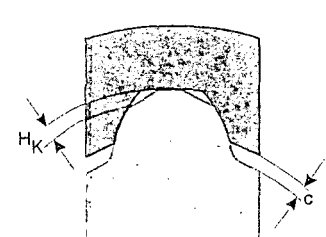


Fig. 3b: Straight-sided
(external diameter fit)



Fig. 3c: Straight-sided spline (with line contact)