GEOMETRIC DIMENSIONING & TOLERANCING

ORIENTATION TOLERANCES

PERPENDICULARITY OF ONE SURFACE TO ANOTHER. USE ONLY WHEN THE IMPLIED 90° ANGLE RULE (THE TOLERANCE OF AN UNDIMENSIONED 90° ANGLE IS CONTROLLED BY THE TITLE BLOCK TOLERANCE) WILL NOT PROVIDE THE REQUIRED CONTROL.

PERPENDICULARITY OF A FEATURE OF SIZE TO A PLANE SURFACE. THIS IS USUALLY USED AS A REFINEMENT OF A POSITIONAL TOLERANCE.

PARALLELISM OF ONE SURFACE TO ANOTHER. USE WHEN RULE 1 WILL NOT PROVIDE THE DESIRED CONTROL.

PARALLELISM OF A HOLE TO A PLANE SURFACE. CONSIDER USING A SECONDARY DATUM. THIS IS USUALLY USED AS A REFINEMENT OF A POSITIONAL TOLERANCE.

ANGULARITY OF ONE SURFACE TO ANOTHER. USE FOR ALL ANGULAR SURFACES WHERE A WEDGE SHAPED TOLERANCE ZONE IS NOT APPROPRIATE.

ANGULARITY OF OF A HOLE TO A PLANE SURFACE. CONSIDER USING A SECONDARY DATUM. THIS IS USUALLY USED AS A REFINEMENT OF POSITION.

FORM TOLERANCES

ROUNDNESS (CIRCULARITY) OF A SURFACE.

CYLINDRICITY OF A SURFACE.

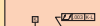
STRAIGHTNESS OF A CYLINDRICAL SURFACE.

STRAIGHTNESS OF AN AXIS AT MAXIMUM MATERIAL CONDITION. THIS PART MAY GO BEYOND THE BOUNDARY DEFINED BY RULE 1.

FLATNESS OF A SURFACE.

STRAIGHTNESS OF A FLAT SURFACE.

RUNOUT

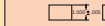


TWO SURFACES USED TO ESTABLISH A SINGLE DATUM AXIS.

A FACE AND AN AXIS USED TO ESTABLISHED A DATUM AXIS.

USE RUNOUT ON ALL ROTATING PARTS EXCEPT WHERE CONCENTRICITY IS APPROPRIATE. USE RUNOUT ON SHAFTS THAT ROTATE SLOWLY (BELOW THE FIRST CRITICAL SPEED) AND ON SHAFTS THAT ARE INHERENTLY OUT OF BALANCE (THOSE WITH FLATS OR KEY WAYS OR WHICH PULLEYS, GEARS OR OTHER SIMILAR PARTS FASTENED TO THEM WITH SET SCREWS). USE CIRCULAR RUNOUT TO CONTROL INDIVIDUAL ELEMENTS OF FEATURES AND TOTAL RUNOUT TO CONTROL COMPLETE SURFACES. RUNOUT IS A COMPOSITE TOLERANCE AND, DEPENDING ON HOW IT IS USED, CAN CONTROL FLATNESS, STRAIGHTNESS, ROUNDNESS, CYLINDRICITY AND POSITION.

RULE ONE



FORM TOLERANCES: USE FORM TOLERANCES WHEN "RULE 1" (THE LIMITS OF SIZE OF A FEATURE CONTROLS VARIATIONS IN GEOMETRIC FORM AS WELL AS VARIATIONS IN SIZE) WILL NOT PROVIDE THE REQUIRED CONTROL.

THE DIMENSIONS AND TOLERANCES SHOWN HERE CONTROL THE SIZE OF THE PARTS AND, WITHIN THESE LIMITS, THEIR GEOMETRY. THE TOP AND BOTTOM SURFACES OF THE BLOCK MUST BE FLAT AND PARALLEL TO EACH OTHER WITHIN THE LIMITS OF SIZE. THE ROD MUST BE STRAIGHT AND CYLINDRICAL WITHIN THE LIMITS OF SIZE. FORM TOLERANCES, UNLESS OTHERWISE NOTED, ARE USED TO TIGHTEN THE CONTROL PROVIDED BY RULE 1.

PROFILE TOLERANCES

PROFILE APPLIED TO A CAM. THE TOLERANCE APPLIES ALL AROUND.

PROFILE OF A CONE. IN THIS EXAMPLE THE CONTOL IS SIMILAR TO CYLINDRICITY OF A CYLINDER. THE TOLERANCE ZONE IS INSIDE THE BASIC PROFILE.

PROFILE BETWEEN TWO POINTS.

PROFILE USED TO CONTROL COPLANARITY.

PROFILE OF A LINE.

PROFILE TOLERANCES: THE TOLERANCE ZONE IS EVENLY DISTRIBUTED ON BOTH SIDES OF THE BASIC PROFILE UNLESS ITS LOCATION IS SHOWN BY A PHANTOM LINE ON THE DRAWING. PROFILE, WHEN USED WITH A DATUM, ACTS AS AN ORIENTATION TOLERANCE. WHEN USED WITHOUT A DATUM IT ACTS AS A FORM TOLERANCE. FEATURES DEFINED BY PROFILE ARE DEFINED BY BASIC DIMENSIONS.

LOCATION TOLERANCES

CLEARANCE HOLES: USE POSITION AT MAXIMUM MATERIAL CONDITION.

FOR COAXIAL FEATURES ON PARTS THAT DO NOT ROTATE. USE POSITION. USE MAXIMUM MATERIAL CONDITION IF THE PART FITS WITH CLEARANCE. USE REGARDLESS OF FEATURE SIZE IF THE PART FITS LINE TO LINE OR WITH INTERFERENCE.

THREADED HOLES: USE POSITION REGARDLESS OF FEATURE SIZE WITH A PROJECTED TOLERANCE ZONE.

SLOTS, TABS, KEY WAYS AND SIMILAR FEATURES: USE POSITION. USE MAXIMUM MATERIAL CONDITION IF THE PART FITS WITH CLEARANCE. USE REGARDLESS OF FEATURE SIZE IF THE PART FITS LINE TO LINE OR WITH INTERFERENCE.

HOLES FOR A PRESS FIT: USE POSITION REGARDLESS OF FEATURE SIZE WITH A PROJECTED TOLERANCE ZONE.

COAXIAL FEATURES ON ROTATING PARTS: USE CONCENTRICITY ON PARTS THAT ROTATE AT HIGH SPEED AND WHERE VIBRATION MAY BE A PROBLEM. (NOTE: CONCENTRICITY IS AN AXIS TO AXIS RELATIONSHIP AND IS DIFFICULT AND TIME CONSUMING/EXPENSIVE TO INSPECT. CONSIDER USING RUNOUT.)

HOLES FOR SPRING PINS: USE POSITION AT LEAST MATERIAL CONDITION WITH A PROJECTED TOLERANCE ZONE.

SYMMETRICAL FEATURES: USE SYMMETRY FOR NON COAXIAL PARTS WHERE BALANCE IS IMPORTANT. (NOTE: EXCEPT FOR THE SHAPE OF THE TOLERANCE ZONE, SYMMETRY AND POSITION ARE IDENTICAL, AND THE CAUTION EXPRESSED FOR CONCENTRICITY APPLIES HERE AS WELL. CONSIDER USING POSITION.)

WHERE WALL THICKNESS IS CRITICAL USE POSITION AT LEAST MATERIAL CONDITION.

CHOOSE DATUMS BASED ON THE FUNCTION OF THE PART. THE DATUMS SHOWN HERE ARE SUGGESTIONS ONLY. USE MAXIMUM MATERIAL CONDITION FOR ALL DATUM FEATURES OF SIZE THAT HAVE CLEARANCE IN THE COMPLETED ASSEMBLY.

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