

DRAWINGS AND INTERCHANGEABILITY

TO FIT OR NOT TO FIT

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When a ship-fitted equipment requires repair *in-situ*, it almost invariably results in a loss of operational capability. The policy of upkeep-by-exchange coupled with line overhaul is aimed at minimizing this undesirable situation. An essential feature of upkeep-by-exchange is that complete equipments, sub-assemblies, and components that fall into this category must be completely interchangeable.

There are three prerequisites to ensuring interchangeability and they are:

- (a) that the designer specifies interface tolerances in a clear and unambiguous way and of such a magnitude as will always permit assembly;
- (b) correct manufacture within these tolerances;
- (c) validation of manufacture by inspection techniques.

Failure to comply with these prerequisites can lead to misassembly which in turn can result in:

- (a) damage to equipments, e.g. undue strain on fasteners, shafts, seals, bearings, etc.;
- (b) the need to fit by hand which may damage protective finishes and is wasteful of manpower and resources;
- (c) distortion of resilient mounts which can reduce their flexibility and absorb vital shock clearance.

It will be evident that the designer must give a clear statement on the end-product drawings to the manufacturers and inspectors of what they are required to achieve. In the author's experience, this is frequently not the case and badly dimensioned and toleranced drawings are all too common. It is, therefore, important that those concerned with producing and checking drawings should pay particular attention to this vital aspect.

Contracts for defence equipment specify compliance with DEF Standard 05-10, *Drawing Procedure*, which in turn invokes BS 308, *Engineering Drawing Practice*. Part 3 of the latter specification explains in detail the agreed International Standards Organization (ISO) method to be used for specifying geometric tolerances of form and position. The characteristics are given in symbol form thus removing language barriers, clearly necessary within NATO. We have, therefore, a unique and international method for designers to express the end-product requirements related to interchangeability and, if this is applied correctly, the jig and tool designer, manufacturer, and inspector will have a clear statement to enable them to produce acceptable hardware. FIG. 1 shows the symbols used in BS 308, Part 3, *Geometrical Tolerancing*.

CHARACTERISTIC	SYMBOL	CHARACTERISTIC	SYMBOL
STRAIGHTNESS		ANGULARITY	
FLATNESS		RUN OUT	
ROUNDNESS		POSITION	
CYLINDRICITY		CONCENTRICITY	
PROFILE OR ANY LINE		SYMMETRY	
PROFILE OR ANY SURFACE		DATUM	
PARALLELISM		TRUE POSITION (DIMENSION)	
SQUARENESS		MAXIMUM MATERIAL CONDITION (MMC)	

FIG. 1—GEOMETRICAL TOLERANCE SYMBOLS

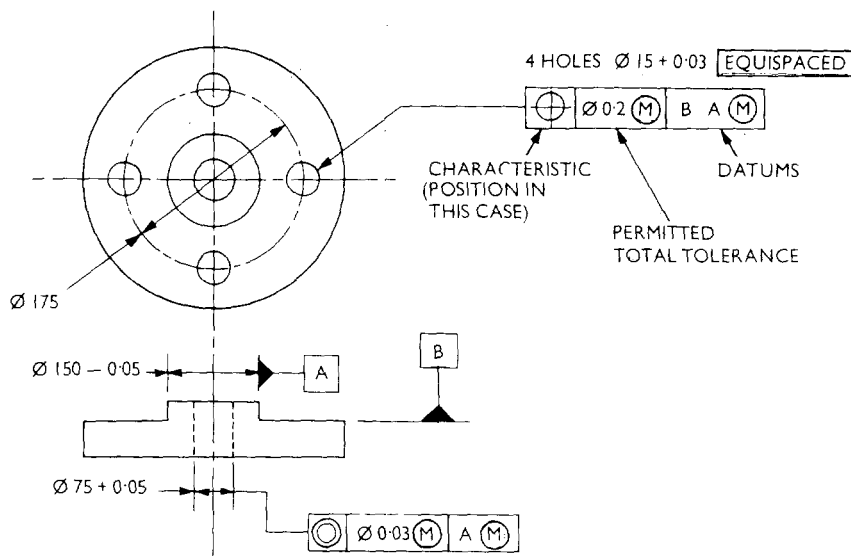


FIG. 2—EXAMPLE TOLERANCED DRAWING

FIG. 2 illustrates a common interface feature showing the application of geometric tolerancing. This shows the specification for the position of the four holes relative to their functional data and the bore concentricity to the spigot diameter. Clearly these are only two of the characteristics encountered and reference to BS 308, Part 3 will show examples of the method used to cover all those shown in the table in FIG. 1.

There is much that can be done within the MOD to improve adherence to the disciplines detailed in the foregoing which at present so often go by default. Those concerned with the specification and interpretation of end-product drawings should be familiar with BS 308 and apply it intelligently. With regard to contractors, the onus for quality, which includes drawings, is their responsibility once they have been successful in being included in the Defence Contractors List at DEF Standard 05-21 level. Ministry assessors have the opportunity to satisfy themselves that these aspects are part of company design policy during the period of Contractor Assessment.

It is hoped that this short article has highlighted where potential difficulties with interchangeability can arise in respect of drawing definition and has pointed the way to preventing them.