STANDARDIZATION IN THE DRAWING OFFICE

BY

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General

As the word 'standardization' has come to mean many things to many people, it is defined in this context as 'A management tool to establish the desirable attributes of a minimum number of types and variety of parts, processes, materials, practices and procedures'. Standardization is a means of ensuring that unnecessary miltiplicity is avoided.

There is no better medium than that provided by drawings to ensure that multiplicity is avoided. If it is not avoided at the stage of drawing, then any multiplicity of parts, processes, materials, practices and procedures will extend through all subsequent stages of procurement, manufacture, storekeeping and maintenance.

To see that relevant standards are invoked in design may well be irksome to draughtsmen, it may entail researches for and into available and appropriate standards, and the draughtsman will achieve little or no direct benefit to his design, and little or no speeding up of his work. Nevertheless, if benefit is to accrue from standardization, then draughtsmen must be prepared to take the time and trouble to incorporate standards in their drawings, for the consequential benefits to be obtained by all subsequent users of the drawings, in order that costs may be kept to a minimum, and to ensure ready availability for first supply and later maintenance.

Presentation of Standards

It is the present practice for the Admiralty to list all standards approved for use, in an index in B.R.1943. Many of these are British Standards, but these British Standards frequently include alternatives and some quite important details are left 'for arrangement with the manufacturer'. All British Standards represent the National requirement and as such may be expected to embrace more than should be required within the confines of any one organization. Thus, in the Admiralty, requirements should be met from a selection of the alternatives offered in British Standards and from within the full ranges of types and sizes expressed to meet the full National demand.

The second part of B.R.1943 was envisaged as Admiralty Standardization Design Memoranda, in which Admiralty would set out more detailed and specific design requirements for standardization within the Service. In the event, the second part of the B.R. 1943 has for the greater part been used for expressing limitations or reservations in such general terms as 'For shore purposes only'.

Insufficient guidance has been given to Admiralty draughtsmen to enable them to know what limited selection of parts, processes and materials are approved for Admiralty purposes. The *Rate Book of Naval Stores* lists currently available items, but it is cumbersome to use for design purposes and indeed it was not compiled to meet design needs.

Another form of Admiralty Standard is called Adspec. The prime purpose of Adspecs is for use as procurement documents. They are intended to comprise complete statements of technical requirements, sometimes invoking other relevant standards and specifications, sufficient to convey all that is needed to be known to all with the need to know. Adspecs contain appendices listing pattern items held in Naval Stores. These Appendices should be, and in some instances are, divided into (*a*) items for new design and (*b*) items necessary for maintenance of existing equipment, not to be used in new design.

It was thought that Adspec publications, containing all technical information, would meet the needs of all with the need to know, including draughtsmen, but this has not proved to be the case. Adspecs contain more than the draughtsmen need to know and they are not selective for particular purposes. In consequence draughtsmen have been reluctant to use them.

An illustrated catalogue of Naval Stores is now in course of preparation, and samples which have been seen appear to give very much useful information to designers. This catalogue will provide information to designers on what is currently available in stores, in sufficient detail to enable them to decided upon its suitability for incorporation into new designs.

Consideration is now being given to a new approach to Admiralty standardization. A suggestion has been made that design authorities should create their own standardization design memoranda, as suitable for (*a*) ships, (*b*) weapons and (*c*) maintenance. It is part of this suggestion that standards for ships will not necessarily be the same as standards for weapons, and that standards for maintenance will fall into a third category, although there will be an area of overlap where some items will be common to two or more of the three purposes. It is a further part of the new thought on standardization that the total of departmental standardization design memoranda should be combined as Adspecs for procurement purposes, and that B.R. 1943 should henceforth list:

(*a*) Published standards approved by Admiralty and from within which departmental standardization design memoranda should be prepared; and

(*b*) Admiralty procurement documentation for items standardized by departmental standardization design memoranda.

It is for consideration that time spent by design authorities in preparing their standardization design memoranda will be amply repaid by eliminating draughtsmen's repetitive researches into standards and their suitability for intended purposes, and by resulting in the most economic forms of design for ships, weapons and maintenance.

DRAWING OFFICE STANDARDS

B.S. 308—Engineering Drawing Practice

B.S. 308 is a main standardization tool for the draughtsman. This standard represents many years of thought and has been proved in practice. It does not differ in any major particular from the equivalent standards of the U.S.A. and

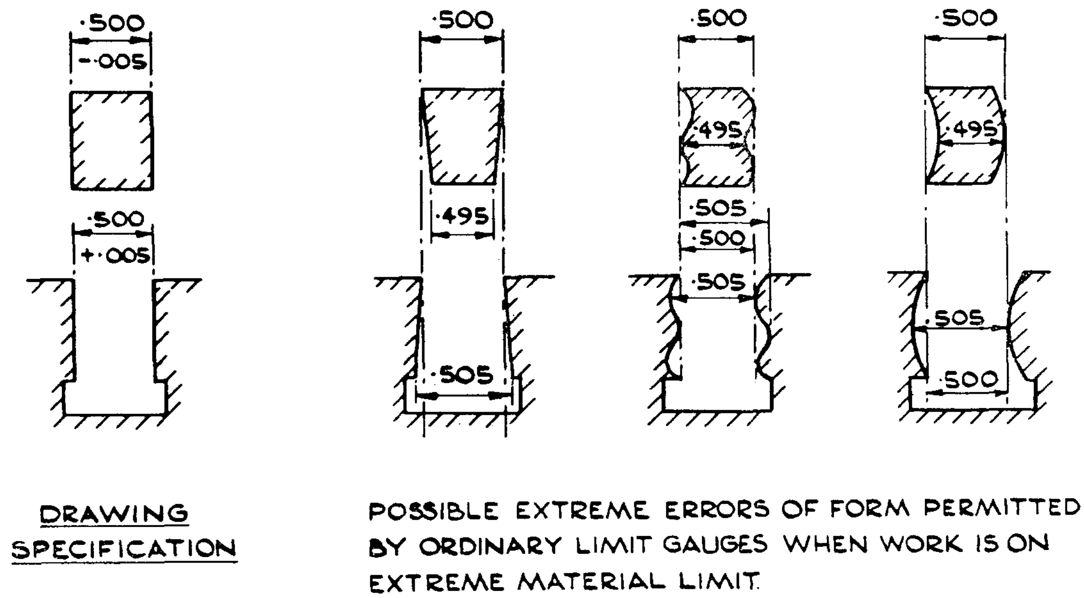


FIG. 1—INTERPRETATION OF LIMITS OF SIZE. THE FINISHED SURFACES MUST NOT CROSS THE PLANES DEFINING THE MAXIMUM MATERIAL LIMITS OF FORM (SHOWN BY CHAIN LINES)

Canada, and most of its recommendations are in line with equivalent European standards. It embodies the substance of all I.S.O. recommendations for drawing practice.

B.S. 308 recommends good practice for expressing design requirements. It does not make recommendations for process drawings. All draughtsmen have to give clear indication of their ultimate requirements, and benefit will result from a common method of indicating those requirements. Not all draughtsmen have to provide process drawings, and where they do their process drawings have to be related to the processes of the manufacturer who will be processing the work. This is not to say that process drawings are not required, nor yet that a measure of standardization of process drawings is not a desirable thing, but for Service purposes it is better to have drawings expressing design requirements for the end product enabling such drawings to be used for competitive tender and subsequent manufacture, irrespective of the particular processes of particular manufacturers.

Like most other British Standards, B.S. 308 has a number of permissible alternatives to encompass the National requirement. As an example—most methods of expressing dimensions are permitted. All methods have the same meaning. They have been made permissive because they are currently employed and different organizations represented on the committee responsible for B.S. 308 have not been able to agree that any one of the methods is sufficiently outstanding to warrant changing from their existing practices. This is not standardization in the true sense of that word. It should not be necessary to show particular advantage for any one method when it can be shown that there is disadvantage in having more than one method. There would be distinct advantage in Admiralty selecting one standard from the alternatives which are now permitted in B.S. 308. One such selection has already been made by Joint Service agreement, i.e. to use Third Angle Projection, whereas B.S. 308 permits both First and Third Angle Projection.

TOLERANCES OF FORM AND POSITION

B.S. 308 should be well known to all draughtsmen, but as the tolerancing of form and position does not appear to be fully understood, some explanation follows.

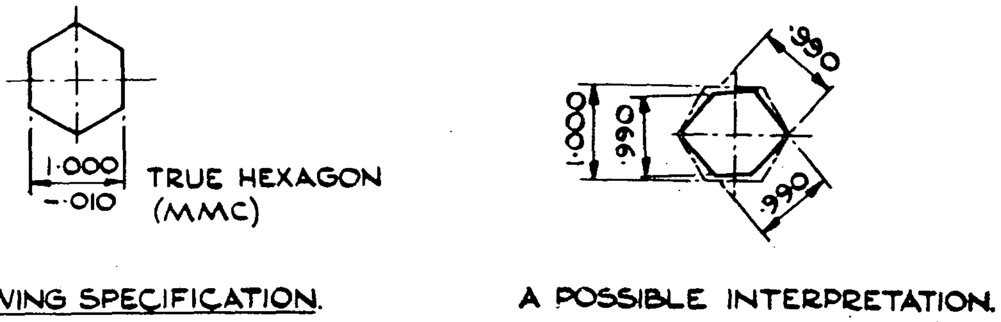


FIG. 2—TYPE OF NOTE USED TO SPECIFY THAT THE FORM IS TO BE CORRECT IF THE FEATURE IS IN ITS MAXIMUM MATERIAL CONDITION

Taylor Principle

There is indisputable evidence that in some circumstances customary dimensioning and tolerancing, however well applied and with due regard to economical manufacture, does not necessarily ensure that components will assemble or function correctly. To ensure suitability for intended purpose it will sometimes be necessary to apply tolerances to such geometrical characteristics as straightness, flatness, parallelism, squareness, angularity, concentricity, symmetry and position.

A toleranced dimension specifies either directly or by implication, the limits of size of the feature concerned. Although the object of specifying limits of size on features is to obtain interchangeability and correct functioning, they do not provide inherent control on the form of the feature concerned, e.g. a shaft which has a specified maximum limit of size of 2 ins. could exhibit this size at any cross-section, but the shaft might still be bent. This could preclude both interchangeability and correct functioning. The Taylor principle, which was formulated in 1906 by William Taylor, established a conventional interpretation of ordinary limits of size which does include a type of form control. By this convention, it is understood that if a feature is defined only by limits of size, this should be interpreted in the sense that if the feature is everywhere at its maximum material limit of size (i.e. the high limit of size of an external feature or the low limit of size of an internal feature), it must be of perfect form. At the other extreme, it implies that no single measurement of the feature should be less in magnitude than the specified minimum material limit. Clearly, if this convention is strictly observed, interchangeability is guaranteed, it being assumed that the specified tolerances are so chosen that satisfactory function is also guaranteed.

If the Taylor principle is to be strictly implemented, it follows that a particular gauging system must be employed, comprising a full form GO gauge large enough to cover at one time the entire surface of the workpiece and equal in size to the specified maximum material limit. To be satisfactory, the workpiece must fully enter or be entered by such a gauge. Furthermore, the minimum material limit of size must be checked by a point contact gauge, i.e. a snap gauge or pin gauge. It is clear that in these circumstances, the form of the feature can vary provided that the two gauging requirements set out above are satisfied.

In practice, although the Taylor principle is often acknowledged, fixed gauges of standard length are usually employed. This means that in some cases the GO gauge which is actually used, is insufficiently large to cover at one time the whole of the surface of the feature. However, in view of the inherent accuracy of modern machining methods, this is not generally of great consequence. FIG. 1 illustrates typical extreme errors of form, which although unlikely to arise in modern machining practice, could be accepted by full form GO gauges without contravening the Taylor principle.

The Taylor principle does not apply to the surface of standard stock materials such as bars, sheets, tubes, etc.; in the 'as delivered' condition. There, established industry standards prescribe the accuracy of the surfaces of the material. If these established standards are sufficiently precise, then form tolerances need not be applied to the unmachined surfaces of parts to be manufactured from those materials.

If it is essential for the Taylor principle to be observed in a particular case, a note to this effect must be added to the specified limits, i.e. 'TRUE FORM M.M.C.'. In those cases where it is important that the form of a feature, if it is in its maximum material condition, must be accurate and it is doubtful whether ordinary manufacturing technique and equipment will ensure sufficient accuracy of form, a statement of true form followed by the letters M.M.C. (maximum material condition) should be used, as illustrated in FIG. 2 of a hexagon. This shows the requirements imposed by tolerancing a dimension in conjunction with such a note, the chain dotted lines representing the maximum material limits of form in section. The finished surfaces should not lie outside these limits and the size across the flats should nowhere be less than 0·990.

Tolerances of Form and Position

The primary object of the specification of tolerances of form and of position is to ensure satisfactory functioning and interchangeability of mating features. These tolerances are commonly known as geometrical tolerances and should be indicated where they are essential to ensure the fitness of the part for its purpose and where material advantages will accrue from the increased work entailed.

During the conception of a design, the designer may be aware that normal manufacturing methods are not accurate enough to produce features sufficiently free from geometrical errors to suit the functional requirements of his design. Since the free assembly of components depends on the combined effect of the actual finished sizes and the geometrical errors of the mating features, the minimum clearance occurs when both features are in their maximum material condition and the maximum permissible geometrical errors are present on both. The designer should, therefore, consider all the possibilities of the interrelation of mating features and if material advantages will accrue, add the appropriate geometrical tolerances.

The tolerance zone for geometrical accuracy may be specified regardless of feature size or may be related to the maximum material limit of size.

Geometrical Tolerances Specified 'Regardless of Feature Size' (RFS)

It is sometimes necessary or maybe expedient to specify a geometrical tolerance regardless of feature size. It must be appreciated in these circumstances the size control exercised by the specified limits of size can be checked by ordinary limit gauging but the geometrical deviations *must* be found by direct measurement which may often prove to be a time-consuming and expensive operation.

Should it be necessary to control the geometrical error regardless of the feature size, this is achieved by stating the requirement in the form of a note or by symbols on the drawing. This is interpreted as meaning that the actual size of the feature must still lie within the limits of size specified, but that there is an independent additional control applied to its form.

A simple example of the use of this principle may be observed in the case of an engineer's surface plate. The overall height of the plate, from base to working surface, is of relative unimportance, it only being essential that the latter is flat to some specified degree of accuracy and capable of being levelled. In this example the geometrical tolerance (for flatness) is certainly less than the size tolerance applicable to the overall height.

Geometrical Tolerances Specified in Relation to the 'Maximum Material Condition' (M.M.C.)

In this case the permissible geometrical error is added to the drawing as a note followed by the abbreviation M.M.C. or may be quoted in terms of symbols.

It must be stressed that a geometrical tolerance qualified by M.M.C. represents the maximum geometrical error which may occur when the feature is at its maximum material condition. It will be appreciated that more clearance for assembly will be present if the actual sizes of the mating features are away from the maximum material limits of size. It follows therefore that if the actual sizes of the mating features are away from the maximum material limits of size, the specified tolerance of form or position can be exceeded without endangering the possibility of assembly. This increase of tolerance amounts to the difference between the actual size of the feature and its maximum material limit of size. Obviously the amount of this increase can never exceed the amount of the size tolerance on the feature. Clearly the use of the M.M.C. concept is advantageous from the manufacturing point of view, and it also confers the additional advantage that gauging can be used as the inspection method.

Application of Geometrical Tolerances

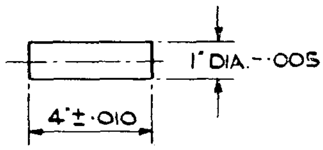
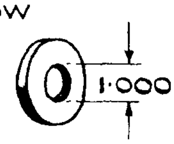
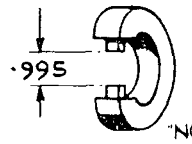
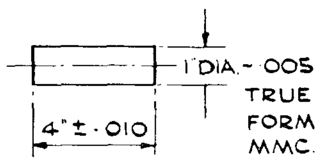
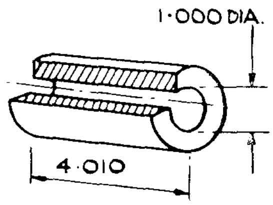
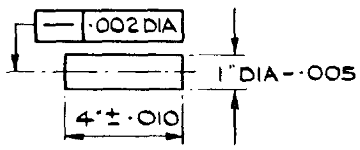
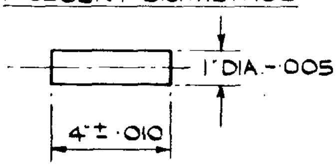
Geometrical tolerancing need only be applied if the circumstances indicate that material advantages will accrue from the increased work entailed. It rests with the design organization to decide how far it is necessary to specify geometrical tolerances in each particular instance, having regard to functional requirements and also to decide whether or not advantage can be taken of the greater freedom given by the use of the M.M.C. concept. *In the absence of an M.M.C. qualification, R.F.S. must be assumed.*

Drawings prepared for widespread production within Admiralty, outports and for sub-contracting in workshops with widely varying equipment and experience, may be quoted as cases in which the most complete and explicit tolerances may be considered as desirable, and in fact necessary. In such circumstances, reference back to the designer by those responsible for production and inspection is often quite impracticable, and the information given on the drawing must be complete in dimensional and geometrical requirements to enable the part to be made and inspected to suit the full functional requirements of the design.

On the other hand, a large proportion of workpieces can be produced quite satisfactorily without resorting to tolerances on geometrical form, or even without the necessity for tolerancing the bulk of dimensions which need not be machined to very fine limits. This is particularly true where products are specially made in small quantities in a self-contained workshop, in which manufacturing technique, machine tool equipment and inspection organizations have been built up through years of specialized experience.

It is considered, however, that when the principles of geometrical tolerancing become more widely known, an increasing number of cases will be found where the full or partial application of the more complete geometrical tolerancing system will enable the functional design requirements to be expressed more exactly than hitherto, with ultimate advantages to design, manufacturing and inspection functions.

When the geometrical accuracy of a feature is defined by one single type of tolerance, other deviations of this feature will in some cases also be controlled by this tolerance. Thus it will rarely be necessary to symbolize all of these characteristics since the other deviations are included in the zone of tolerance defined by the symbol specified.

SPECIFICATION	INTERPRETATION	INSPECTION
	TAYLOR PRINCIPLE NOT REQUIRED TO BE OBSERVED THEREFORE SHAFT CAN BE BENT.	
	MAX. LIMIT OF SIZE 1·000 DIA.	NARROW "GO" RING GAUGE 
(A)	MIN. LIMIT OF SIZE ·995 DIA.	 "NOT GO" CALIPER GAUGE
	TAYLOR PRINCIPLE MUST BE OBSERVED, THEREFORE IF SHAFT IS AT MMC IT MUST BE STRAIGHT.	
	MAX. LIMIT OF SIZE 1·000 DIA.	"FULL FORM RING GAUGE"
(B)	MIN. LIMIT OF SIZE ·995 DIA.	"NOT GO" CALIPER AS AT (A)
I.S.O. METHOD  PRESENT B.S. METHOD 	A STRAIGHTNESS ERROR OF UP TO ·002 MAY BE PRESENT REGARDLESS OF ACTUAL SIZE OF FEATURE. THIS MEANS THAT THE SHAFT MAY BE BENT BY THIS AMOUNT EVEN AT MMC.	STRAIGHTNESS MUST BE CHECKED BY DIRECT MEASUREMENT.
TO BE STRAIGHT WITHIN ·002.	MAX. LIMIT OF SIZE 1·000 DIA.	A NARROW "GO" RING GAUGE AS AT (A)
(C)	MIN. LIMIT OF SIZE ·995 DIA.	"NOT GO" CALIPER AS AT (A)

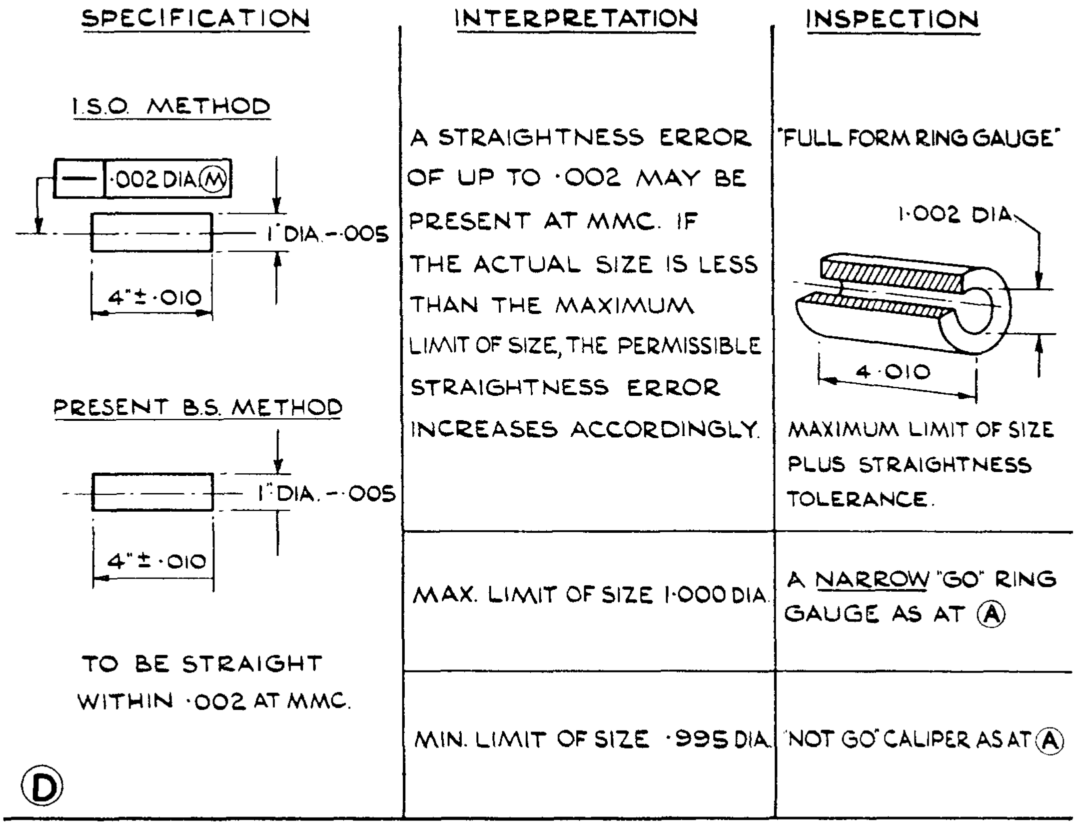


FIG. 3—THE FOUR ALTERNATIVE METHODS OF SPECIFYING A SIMPLE CYLINDRICAL SHAFT

Note: The checking of the 4 in. ± ·010 dimension has been omitted and gauge sizes quoted are nominal only

Control on straightness is illustrated in FIG. 3 with the simple cylindrical shaft.

Surface Texture and Machining Symbols

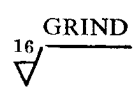
At the 1962 A.B.C. Conference in New York agreement was reached on methods of expressing machining and surface texture on drawings, and this is likely to be accepted for I.S.O. purposes. The new agreement is being incorporated in a revision of B.S. 308, now nearing completion and details are set out below, with a comparison between B.S. 308 : 1953 symbols and those which will appear in the new edition.

New System

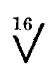

Basic symbol


Symbol to indicate a machining requirement

To indicate the surface texture value to be obtained by machining

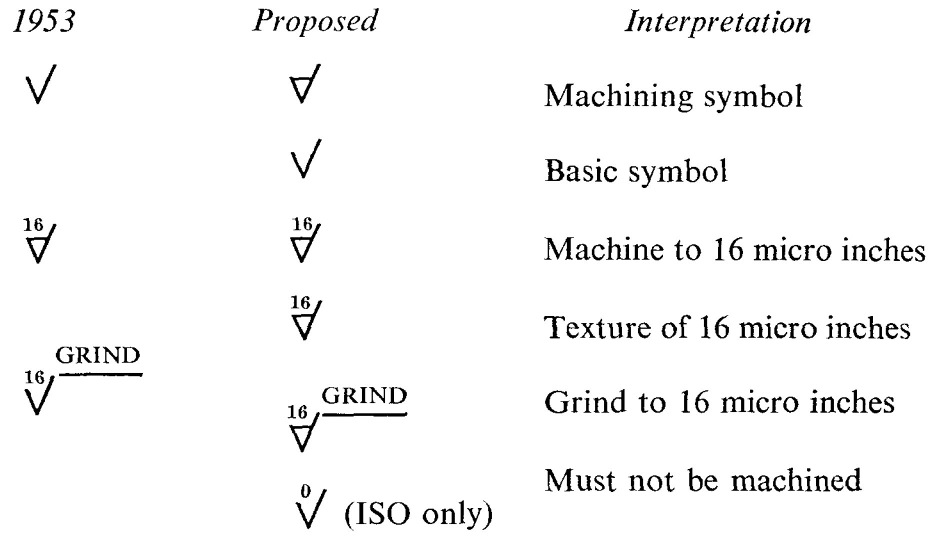


To indicate the texture to be obtained by the specified machining process



Texture by any process (design requirement)

Comparison with old system



Consideration is being given to an extension of this symbolization to include such things as cut-off length, direction of lay and machining allowance.

Although there is considerable inference in the changes, it appears that insofar as is required for Service purposes (to express the design requirement), the continued use of 16√ will be satisfactory.

DEF-33-A—Drawing Procedure

It is expected that all draughtsmen will have some knowledge of DEF-33 but as it was not universally adopted as a procedure some of its principles and details may not be known or appreciated. Upon revision to DEF-33-A, now agreed and ready for endorsement and publication, it is to be given comprehensive implementation as a condition of its issue and it will be relevant to explain its aims and objects.

The procedure is basically a system for relating detail drawings, assembly drawings and associated lists in methodical order to provide the greatest degree of benefit to the largest number of potential users of the drawings. The DEF-33-A system is not claimed to be better than some other systems, but it is claimed to be the one most likely to be accepted in the widest possible sphere. As is not unusual to attain standardization in any sphere, some drawing offices will have to change their previous well-tried and perhaps proven procedures. Unless these changes are made standardization will not be effected and the benefit, without which the project would not have been undertaken, will be lost. DEF-33-A has been compiled and agreed by representatives of all industrial associations design contracting to Government Departments and by representatives of the Government Departments.

Industries and departments have accepted DEF-33-A with the proviso that its terms and conditions will be consistently applied and be implemented by all. It has been made clear that local variations will nullify the advantages otherwise to be gained. The Ministry of Defence will be requested to have DEF-33-A made as mandatory as possible, and to require its strict implementation over the field to which it is intended to apply, i.e. to convey design requirements for purposes of manufacture and/or inspection.

Drawings prepared to DEF-33-A will cost rather more and take rather longer than some of the less satisfactory procedures hitherto employed. This is no accident. DEF-33-A is a comprehensive procedure designed to place responsibility and costs where they belong, in the drawing office, whereas an appreciable part of the proper cost has on previous occasions been allocated to production costs and has not been shown as a drawing office charge.

DEF-33-A is based upon a single part drawing sheet system. This is because each part has to be made separately. It is as wrong to provide more information than is required on one piece of paper at any given time, as it is to provide less information than is required; to show two or more details on one drawing or by showing details on an assembly drawing is to provide an excess of information to the maker of each part or to the assembler of those parts respectively. It is not only wrong in principle to show too much information, it is wasteful in materials (print paper), space (for storage) and time for retrieval of data.

From single parts each drawn separately, the system proceeds through as many stages of sub-assembly and assembly as is considered to be desirable or necessary. No motor car could be constructed economically from one kit of parts; it consists of a number of assemblies and sub-assemblies such as the engine, chassis, body, carburettor, generator and wheels. These assemblies consist of sub-assemblies. In cases of small quantity production far less sub-assembly and major assembly need be undertaken, but even for an equipment such as a one-off steam turbine, details should be drawn on separate sheets and the rotor and the two halves of the casing would be drawn as separate sub-assemblies, together with a final assembly of the whole.

There are two types of assemblies and these may be given either of two forms of treatment. One type is a 'replacement assembly' of the kind held as a spare against wear or defect—this type of assembly requires a drawing list and an item list. The other type of assembly is, for manufacturing convenience, a suitable stage between details and final assembly but not one which would be likely to be required as a replacement assembly. As this latter type of assembly is unlikely to be sub-let or to be made a store holding, the set of drawings relating to it need not be made on a separate drawing list. The set of items will be required to be listed on an Item List, but the part drawings may be shown on the Drawing List of the next assembly which is provided as a replacement or spare.

Drawing and Document and Item Lists

In the DEF-33-A system each part shown on assembly drawings is required to be identified by an item number (which may be supplemented by the part or drawing number if so desired). Item lists are required for ready reference indentification of all items for the intended sub-assembly or an assembly. Similarly a drawing list is required to provide ready reference to the set of drawings and lists which are relevant to that which is to be manufactured.

Item lists and drawing lists are themselves 'called up' on the lists as they need to be issued to those concerned and unless themselves listed may be overlooked. A Print Room manager may be instructed to send all shown on the drawing list to Messrs. XYZ for that firm to manufacture the assembly. The drawing list is itself listed on the drawing as one of the things to be sent to Messrs. XYZ.

Drawing Size and Layout

Drawing sizes and layout are specified with considerable flexibility. No benefit will be derived from standardizing to the nth degree and where latitude can be expressed without loss of benefit this has been done. The standardized Drawing Layouts are designed to achieve consistency where this will show benefit, and do not give details of format where these can vary without detriment.

Reproduction of Drawings

There is considerable need for improvement in the standard of quality of drawings for purposes of reproduction. Investigation has shown that up to

30 per cent of existing drawings prepared or accepted by Admiralty are less than satisfactory for the reproduction of prints from microfilm. The microfilm system will have to be used for certain purposes in the near future, and eventually that system may supersede present dyeline methods for the bulk of Admiralty work. Many of today's drawings are unsatisfactory for today's methods of reproduction, but whereas the existing dyeline processes enable some of the less critical deficiencies to be overcome, no similar facility exists for the microfilm process.

A specification is about to be written on the preparation of drawings to meet requirements for satisfactory reproduction, and this specification is to be made mandatory for Admiralty and its contractors. No attempt will be made to anticipate details of the specification, but they can be summarized as:

(*a*) Restriction to within specified drawing sizes

(*b*) Consistent and adequate density of line

(*c*) Adequate spacing of lines and lettering

(*d*) Adequate size of lettering

(*e*) Open plan presentation.

Draughtsmen are urged to use open plan presentation, single part drawings, clear dense lines, figures and letters all well spaced. The character of any subsequent modification should be the same as the character of the original drawing. It is very false economy to endeavour to crowd more on to one sheet of paper than can be accommodated on that sheet with unquestionable ease. It is equally wrong to use one large sheet where necessary data can be given on two or more smaller sheets without loss of clarity or ease of reference. It is quite wrong to crowd unnecessary detail on assembly drawings. It is equally wrong to omit any data from detail drawings.

Drawing Control

If full benefit is to be derived from standardization in the drawing office, it will be incumbent upon the Admiralty to establish a system of drawing control. It is the present condition for each department, if not each drawing office, to be autonomous. Different methods of drawing control have arisen from the practice of departmental preferences, limitations of staff, space, equipment and from lack of appreciation of what can be attained from centralized control.

In the optimum, probably impracticable for Admiralty purposes for geographical reasons, there should be one drawing store in which all masters should be retained under proper plan filing conditions. All drawings in this store should be identified in a common system, for ease of retrieval.

Master drawings from the central store should only leave that store for two purposes:

(*a*) For reproduction, or

(*b*) For amendment.

After either such action they should be immediately returned to store.

Reproduction facilities should be adjacent to the drawing store and all work, other than amendment of the masters, should be carried out on prints supplied for the purpose, against requisition from the demanding authority.

Where traffic in prints so warrants, sufficient copies should be held in a print store, again adjacent to, or as part of, the drawing store.

Prints should be regarded as expendable, to be replaced as and when necessary, but copies required for reference only should be returned to print store.

Such centralized drawing control would entail high initial expenditure for subsequent long term savings. It would demand planning and foresight. Without centralized control there is considerable local advantage, to be paid for at high cost in materials, manpower and space.

If a microfilm system ever comes to be employed in Admiralty, it will be for savings in space, time and money. These savings cannot be achieved from microfilm as such, but only through the administrative processes which such a system would entail. These processes could be applied for Admiralty purposes now, using existing drawing and reproduction methods, but due to the geographical dispersal of Admiralty, it may need to be on a regional basis, where regions would hold either the masters or reproducible translucencies of all the drawings with which they were likely to be concerned.

There is no doubt that centralized or regional drawing control such as has been described, would not be readily accepted by any department which places its own interests before the overall interests of the Service as a whole. Departments would lose some part of their autonomy and would have to become better organized to meet their needs from the degree of centralization decided upon. That centralized drawing control may prove unpopular does not seem to be a good reason for failing to refer to the advantages which would accrue from it, and it has, therefore, been included in this paper on standardization for drawing offices. There is little doubt that the degree of control will come to be increased, and reference herein may help to speed that day.

Conclusion

The work of the draughtsman is a professional skill and an art which must satisfy its creator and all who are to have subsequent use of it. It will not do to achieve economies in the drawing office at the expense of any potential user of the drawings. The draughtsman is more than one link in the chain of events from the designer to the end product. By the methods he employs he can bring considerable influence to bear upon every link in that chain. His responsibility is great, the necessity for his proper reward is receiving increased recognition, and he must learn to accept the disciplines which go with responsibility and reward. Standardization is one of those disciplines.

Acknowledgement

Permission of Messrs. Philips Electrical Industries to use and transcribe the paragraphs on Tolerances of Form and Position is gratefully acknowledged.