PURCHASE – CENTRAL
MATERIALS MANAGEMENT
BHARAT HEAVY ELECTRICALS LIMITED
HEAVY ELECTRICAL EQUIPMENT PLANT
HARDIWAR-249 403, Uttrakhand
Fax: 01334-226462; Ph. No. 9899003053
E-mail: apoorv.agrawal@bhel.in

REF NO. 894/C/F233/2021/1301

SUB: OPEN E-TENDER ENQUIRY NO.: 894/C/F233/2021/1301

Dear Sir/Madam,

We are pleased to invite your offer in **TWO PARTS** strictly as per enclosed terms and conditions and general instructions and standard terms & conditions (GISTC) (latest revision) **through E-procurement system** for the under mentioned items.

Important Note:

1. The offers are invited through E-procurement System. Please visit our website https://eprocurebhel.co.in/nicgep/app for participation in tender. Tenders can be submitted using DSC (digital signature certificate).

2. To secure the bids/quotations submitted by you, BHEL uses PKI (Public Key Infrastructure) Technology for authentication which uses Digital Signature Certificates (DSC-Class 3b, SHA2, 2048bit).

3. We therefore need you to be ready with your Digital Signature Certificates (DSC-Class 3b, SHA2, 2048bit), as it is a mandatory requirement to participate in our e-tendering process. If you do not have DSC and you are not our registered vendor, you are requested to arrange the same immediately and register yourself in E-procurement System in order to participate in the tender.

For further information, / queries related to e-tendering system, you can contact helpline number of e-procure portal or send an E-mail at support-eproc@nic.in.

4. Other terms and conditions will be as per tender documents.

Sl. No.	Description of Item	Qty. (NO)	Delivery Required	EMD (Earnest Money Deposit)
1	AA7111122232 BOLTS, HEXAGON HEAD, PRODUCT GR. A, COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3-M16) SPEC: AA7111122 REV: 08 DIMENSIONS, REQUIREMENTS & GENERAL REQUIREMENTS: AS PER IS:1364(PT.1)-2002 MECHANICAL PROPERTIES:TO CONFORM TO PROPERTY CLASS 8.8 AS SPECIFIED IN TABLE-3 OF IS:1367(PT.3-2002.PERMISSIBLE HARDNESS 238-350 HB FOR SIZE-M6 TO M10THREDS: PITCH- COARSE TO IS:4218(PT.2). TOLERANCE QUALITY - MEDIUM TOLERANCE CLASS - 6G. IDENTIFICATION MARKING: AS STATED IN CLAUSE 9 OF IS :1367(PT.3). SURFACE DISCONTINUITY: AS PER IS:1367, PT.9 FINISH: ZINC PLATED IN ACCORDANCE WITH IS 1367 (PT.11) IN BRIGHT FINISH WITH YELLOW IRIDESCENT COLOUR (DESIG. L, TABLE D.3) HAVING MINIMUM COATING THICKNESS 5 MICRONS.' SIZE: M12X110	600	25.10.2022	NIL

2	AA7111122496 BOLTS, HEXAGON HEAD, PRODUCT GR. A, COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3-M16) SPEC: AA7111122 REV: 08 DIMENSIONS, REQUIREMENTS & GENERAL REQUIREMENTS: AS PER IS:1364(PT.1)-2002 MECHANICAL PROPERTIES:TO CONFORM TO PROPERTY CLASS 8.8 AS SPECIFIED IN TABLE-3 OF IS:1367(PT.3-2002.PERMISSIBLE HARDNESS 238-350 HB FOR SIZE-M6 TO M10THREDS: PITCH-COARSE TO IS:4218(PT.2). TOLERANCE QUALITY - MEDIUM TOLERANCE CLASS - 6G. IDENTIFICATION MARKING: AS STATED IN CLAUSE 9 OF IS :1367(PT.3). SURFACE DISCONTINUITY:AS PER IS:1367, PT.9 FINISH: ZINC PLATED IN ACCORDANCE WITH IS 1367 (PT.11) IN BRIGHT FINISH WITH YELLOW IRIDESCENT COLOUR (DESIG. L, TABLE D.3) HAVING MINIMUM COATING THICKNESS 5 MICRONS.' SIZE: M12X120	200	25.10.2022	NIL
3	AA7111122267 BOLTS, HEXAGON HEAD, PRODUCT GR. A, COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3-M16) SPEC: AA7111122 REV: 08 DIMENSIONS, REQUIREMENTS & GENERAL REQUIREMENTS: AS PER IS:1364(PT.1)-2002 MECHANICAL PROPERTIES:TO CONFORM TO PROPERTY CLASS 8.8 AS SPECIFIED IN TABLE-3 OF IS:1367(PT.3-2002.PERMISSIBLE HARDNESS 238-350 HB FOR SIZE-M6 TO M10THREDS: PITCH-COARSE TO IS:4218(PT.2). TOLERANCE QUALITY - MEDIUM TOLERANCE CLASS - 6G. IDENTIFICATION MARKING: AS STATED IN CLAUSE 9 OF IS :1367(PT.3). SURFACE DISCONTINUITY:AS PER IS:1367, PT.9 FINISH: ZINC PLATED IN ACCORDANCE WITH IS 1367 (PT.11) IN BRIGHT FINISH WITH YELLOW IRIDESCENT COLOUR (DESIG. L, TABLE D.3) HAVING MINIMUM COATING THICKNESS 5 MICRONS.' SIZE: M16X60	5000		
4	AA7111122305 BOLTS, HEXAGON HEAD, PRODUCT GR. A, COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3-M16) SPEC: AA7111122 REV: 08 DIMENSIONS, REQUIREMENTS & GENERAL REQUIREMENTS: AS PER IS:1364(PT.1)-2002 MECHANICAL PROPERTIES:TO CONFORM TO PROPERTY CLASS 8.8 AS SPECIFIED IN TABLE-3 OF IS:1367(PT.3-2002.PERMISSIBLE HARDNESS 238-350 HB FOR SIZE-M6 TO M10THREDS: PITCH-COARSE TO IS:4218(PT.2). TOLERANCE QUALITY - MEDIUM TOLERANCE CLASS - 6G. IDENTIFICATION MARKING: AS STATED IN CLAUSE 9 OF IS :1367(PT.3). SURFACE DISCONTINUITY:AS PER IS:1367, PT.9 FINISH: ZINC PLATED IN ACCORDANCE WITH IS 1367 (PT.11) IN BRIGHT FINISH WITH YELLOW IRIDESCENT COLOUR (DESIG. L, TABLE D.3) HAVING MINIMUM COATING THICKNESS 5 MICRONS.' SIZE: M16X80	4500		

** **<u>The items are reserved for purchase from Micro & Small Enterprises (MSEs) only.</u>**

** Pre-qualification requirement attached.

** Specification attached.

** Techno-Commercial sheet attached.

** ITC Applicable.

** Reverse Auction (RA) is not applicable.

Please submit your lowest quotation / offer for the above requirement subject to our terms and conditions. Your offer should be submitted on or before the due date **by 1.45 PM**. BHEL will not be responsible for any type of delay / incomplete information from vendors etc.

- The Offers are invited through E-procurement System: https://eprocurebhel.co.in/nicgep/app
- Tender can be submitted digitally only (through E-Procurement system only), using Digital signature.

NOTE: The vendor should submit their best price at this stage itself and they will not be allowed to revise the price unless there is change in specification or terms and conditions or specifically asked by BHEL. In case of any uncalled revision / discount submitted by vendor subsequently will be ignored & the bid is likely to be rejected.

1. Intending vendors must remit the requisite EMD in the form of Demand draft / e-payment (in case of foreign bidders) only (**Cheque / Bank Guarantee are not acceptable**).

2. Documents submitted with the offer/bid by the bidder (Original Registered Supplier) shall be signed and stamped in each page by authorized representative of the bidder.

Tender has to be opened in TWO PARTS as described below, on or before the due date and time of tender opening:

a) Part-I : 1. EMD

2. Pre-Qualifying Requirement (PQR)

3. Techno-Commercial Bid.

b) Part-II : Price Bid.

After tender opening (Part –I), if it is found that:

- **The bidder has not submitted the requisite EMD (if applicable)**
- **The bidder has claimed to be an MSE vendor but no supporting documents have been submitted in this regard.**

In both the above cases the offer of the bidder shall be straightaway rejected and no correspondence from the bidder in this regard shall be entertained.

Micro and Small Enterprises (Udyog Aadhar Memorandum / Udyam Registration Certificate"/ documents as per GISTC will be exempted from the submission of EMD as per Govt. Guidelines. (For Indian Bidder)

Central / State – PSUs / Government departments are exempted from submission of EMD subject to approval by BHEL management.

BHEL-HEEP registered vendors (i.e. PMD vendors) are exempted from submission of EMD in case of open tender of related PMD items.

EMD shall not carry any interest.

In case of EMD, the envelope containing drafts for EMD and tender fee (if applicable) shall be sealed and super scribed as indicated, "DEMAND DRAFT FOR EMD/ TENDER FEE (IF APPLICABLE) FOR (ITEM NAME) AGAINST TENDER NO._____ DUE ON _____."

Vendor's full name and address should be clearly mentioned on the envelope and shall be addressed to:

Head of Materials Management,
Heavy Electrical Equipment Plant,
BHEL, Hardwar- 249403

Please note that EMD must reach tender room before due date and time of tender (i.e. 01:45 PM) otherwise your offer will be straightaway rejected and no correspondence from the bidder in this regard shall be entertained.

EMD by the Tenderer will be forfeited if, the successful bidder/vendor refuses to honor the Order after award of the same on him and/or withdraws his bid and /or unilaterally changes the offer and/or any of its terms & conditions within the validity period.

EMD given by all unsuccessful Tenderers shall be refunded on acceptance of award / LOI/PO by successful Tenderer. The EMD of successful bidder shall be returned after submission of Security Deposit.

BHEL will deal directly with the manufacturers / principal vendors and no correspondence with the agents will be entertained. The agents will not be permitted to visit / interact with BHEL on behalf of their principals. Subsequently also, no correspondence of any type will be made with any agent. (All individuals / companies - representing / Advisor /retainer ship basis or claimed to be part time employees for many OEMs / claiming to be channel or business partner for BHEL work / stockist not registered specifically etc are Agents). Communications with only those agents who have submitted agency agreement with their respective principal may be done.

Agents shall not be allowed to represent more than one manufacturer / supplier in the same tender. Moreover, either the agent could bid on behalf of the manufacturer / supplier or the manufacturer / supplier could bid directly but not both. In case bids are received from both, the manufacturer / supplier and the agent, bid received from the agent shall be ignored.

PART –II: PRICE SCHEDULE

For indigenous supply (Please attach un-priced copy of price schedule in techno-commercial bid)

Bidder to note that item wise evaluation will be done and hence should be complete in all respects for the full scope defined and considering all terms and conditions. Optional as indicated in specification will not be taken for evaluation. Any item not included in this price quoted above and shown separately will not be taken cognizance of and shall be ignored while evaluation.
Following details shall be provided in separate Annexure.
Unit prices for all items.
Prices for any other OPTIONAL items.
Transit insurance shall be arranged by BHEL.

Note:

The GST registration number of Bharat Heavy Electrical Ltd, Heavy Electricals Equipment Plant, Ranipur, Haridwar is "05AAACB4146P1ZL" with state Code as "05" and State Name as "Uttarakhand".

Transit insurance shall be arranged by BHEL.

The evaluation of tender shall be on the basis of "Total Landed cost at Destination" including Supply and Commissioning. For evaluation of foreign bids, exchange rate (TT selling rate of SBI) as on scheduled date of tender opening (Part-I bid opening) shall be considered. If the relevant day happens to be a bank holiday, then the Forex rate as on the previous bank (SBI) working day shall be taken.
Loading of TDS as applicable (TDS certificate shall be issued by BHEL) to calculate landed Cost at Destination for foreign bidders on price schedule submitted by bidder.
Also loading of custom duty (as applicable) in India will be done to calculate landed Cost at Destination for foreign bidders on price schedule submitted by bidder.
Indigenous suppliers: Vendors to quote rates on FOR destination (BHEL Haridwar) basis. However, the insurance will be arranged by BHEL.

The comparison between foreign and indigenous bids shall be done based on the Total Landed cost at Destination basis.

BHEL reserves the right to evaluate vendor's process capability / quality systems etc. by visiting vendor's works (if required).

BHEL reserves the rights to place order for tendered quantity on more than one vendor.

Currency for evaluation of the tender will be Indian rupees.

As per directives of CENTRAL VIGILANCE COMMISSION, GOVERNMENT OF INDIA, one agent can not represent two or more suppliers or quote on their behalf in a particular tender. If so found at any stage, BHEL Hardwar is likely to cancel Enquiries / POs to such suppliers. Further, such Indian Agent is likely to be de-listed (Black listed for business from BHEL)
The offers of the bidders who are on the banned list and also the offer of the bidders, who engage the services of the banned firm, shall be rejected. The list of banned firms is available on BHEL website www.bhel.com.
NOTE:

Make in India preference:

For this procurement, Public Procurement (Preference to Make in India), Order 2017 dated 15.06.2017, 28.05.2018, 29.05.2019 and 04.06.2020 subsequent Orders issued by the respective Nodal Ministry shall be applicable even if issued after issue of this NIT but before finalization of contract / PO / WP against this NIT.
In the event of any Nodal Ministry prescribing higher or lower percentage of purchase preference and/ or local content in respect of this procurement, same shall be applicable.

Default purchase preference under Make in India order shall be 20% to suppliers with default minimum local content of 50% for all items / works / services. For further details, please refer latest version of GISTC.

Procurements where the Estimated value to be procured is less than Rs. 5 lakhs shall be exempted from Public Procurement (Preference to Make in India), Order 2017 dated 15.06.2017, 28.05.2018, 29.05.2019 and 04.06.2020 & subsequent Orders issued by the respective Nodal Ministry.

The evaluation currency for this tender shall be INR.

Documents submitted with the offer / bid shall be signed and stamped in each page by authorized representative of the bidder.

Vendors operating from BHEL quarters, unauthorized colonies on BHEL land and Dharamshalas/ hotels shall not be considered, hence such vendors need not apply. Any vendor who is under hold (for the item)/delisted / banned with BHEL on date of opening of Part – 1 will not be allowed to quote for this tender. In case their offer is received, it may be out rightly rejected.

In the course of evaluation, if more than one bidder happens to occupy L-1 status, effective L-1 will be decided by soliciting discounts from the respective L-1 bidders. In case more than one bidder happens to occupy the L-1 status even after soliciting discounts, the L-1 bidder shall be decided by a toss/draw of lots, in the presence of the respective L-1 bidder (s) or their representative(s). Ranking will be done accordingly. BHEL's decision in such situations shall be final and binding.

QUOTATIONS NOT IN ACCORDANCE WITH THE ABOVE INSTRUCTIONS ARE LIABLE TO BE DISQUALIFIED AND IGNORED.

Please read general instructions and standard terms & conditions (GISTC) (latest revision) for tender enquiries. All the bidders / vendors must ensure compliance of the GISTC.

GISTC is available at https://hwr.bhel.com/bhelweb/Home.jsp

Thanking You,
Purchase Executive
For & on behalf of BHEL, Hardwar

Techno - Commercial Terms:

Sl. No.	Techno - Commercial Terms	Vendor's Compliance/ Remarks
1	**Payment Terms** 100% payment up to 45 days after receipt & acceptance of material at BHEL HEEP, Haridwar	**Accepted**
2	**Delivery basis:** FOR:- BHEL , HEEP, Store, Haridwar	**Accepted**
3	**Delivery Period**: Delivery period in no. of days from the date of purchase order.	**_____ days**
4	**Liquidated Damages (LD) For Late Delivery:** Liquidated Damages (LD) for Late Deliveries shall be applicable @0.5% per week or part thereof on the value of respective delayed supplies subject to a maximum of 10% of the value of respective delayed supplies.	**Accepted**
5	**Validity of offer -** 90 days from the tender opening date.	**Accepted**
6	**Rate of GST applicable**	**@ …… % Extra**
7	**Settlement of Disputes:** The venue of arbitration shall be Haridwar Courts, which will have exclusive jurisdiction.	**Accepted**
8	**Risk Purchase Clause** as per General Instructions and Standard Terms and Conditions (GISTC) mentioned in the tender documents.	**Accepted**
9	**Force Majeure Clause** as per General Instructions and Standard Terms and Conditions (GISTC) mentioned in the tender documents.	**Accepted**
10	**MSE status** along with documentary proof (i.e. UDYAM etc. must be attached)	**_____**
11	**Details of contact person, Email, contact no. etc.**	**_____**
12	**Test Certificate** Required	**Accepted**
13	**Guarantee certificate** required for 12 months from the date of material despatch.	**Accepted**

BIDDER MUST ENSURE TO SUBMIT THE FOLLOWING ALONG WITH THE OFFER: -

1. PLEASE PROVIDE SIGNED & STAMPED COPY OF ALL THE PAGES OF THIS BID DOCUMENT AS AN ACCEPTANCE TO ALL THE TERMS AND CONDITIONS OF BID.
2. PLEASE PROVIDE SUPPORTIVE DOCUMENTS AS PER PRE – QUALIFYING REQUIREMENTS (PQR).
3. PLEASE PROVIDE TECHNO – COMMERCIAL SHEET DULY FILLED AND SIGNED - STAMPED.

CERTIFICATE BY CHARTERED ACCOUNTANT ON LETTER HEAD

This is to Certify that M/s ……., (hereinafter referred to as 'company') having its registered office at……is registered under MSMED Act 2006, (Entrepreneur Memorandum No (Part-II) ……dtd:……., Category : …….. (Micro/Small). (copy enclosed).

Further verified form the Books of Accounts that the investment of the company as on date ……..as per MSMED Act 2006 is as follows:

1. **For Manufacturing Enterprises**: Investment in plant and machinery (i.e. original cost excluding land and building and the items specified by the Ministry of Small Scale Industries vide its notification No. S.O.1722(E) dated October 5, 2006: Rs……..Lacs.

2. **For Service Enterprises**: Investment in equipment (original cost excluding land and building and furniture, fittings and other items not directly related to the service rendered or as may be notified under the MSMED act, 2006: Rs……Lacs

(Strike off whichever is not applicable)

The above investment of Rs ……..Lacs is within permissible limit of Rs…….. Lacs for ……..micro / small (Strike off which is not applicable) Category under MSMED Act 2006.

Or

The company has been graduated from its original category (Micro / Small) (**Strike off whichever is not applicable)** and the date of graduation of such enterprises from its original category is …….. (dd/mm/yyyy) which is within the period of 3 years from the date of graduation of such enterprises from its original category as notified vide S.O. No. 3322(E) dated 01.11.2013 published in the gazette notification dated 04.11.2013 by Ministry of MSME.

Date:

(Signature)
Name-
Membership Number-
Seal of Chartered Accountant

Format for self-Certification under preference to make in India order (for Indian bidder) Certificate

In line with Government Public Procurement Order No. P-45021/2/2017-BE-II dt. 15.06.2017 & P-45021/2/2017-PP (BE-II) dated 28.05.2018, 29.05.2019, 04.06.2020 & subsequent Orders issued by the respective Nodal Ministry, we hereby certify that we M/s _____(supplier name) are local supplier meeting the requirement of minimum local content (50%) as defined in above orders for the material against Enquiry No. _____

Details of location at which local value addition will be made is as follows:

_____

We also understand, false declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law.

Seal and Signature of Supplier

Pre-Qualification Requirements for Bolts & Screw (Property Class: 8.8):

1. Vendor should be manufacturer of fasteners. ISO certificate for being fastener manufacturer to be submitted.
2. Vendor must have supplied minimum 2000 numbers high tensile fasteners (bolt & screw of property class 8.8/10.9/12.9) in last 5 years on enquiry issue date. Supply against single or multiple purchase order satisfying above quantity requirement is acceptable. Vendor to submit documentary evidence like unpriced order copy / dispatch notes with test certificate of material for quantity ≥ 2000.
3. Vendor to confirm that they have in house manufacturing facility for cold / hot forging, heat treatment & thread rolling for manufacturing bolts and screws as per enquiry specification and applicable Indian Standard. Thread rolled fasteners are only acceptable.
4. Fasteners of property class 8.8 are required to be supplied with zinc electroplating as per IS: 1367 Part 11 (refer details given in enquiry). Vendor to confirm that they have in-house zinc electroplating facility as per the requirement of IS:1367 Part 11. In case of outsourcing of zinc plating operation, vendor to inform details of their sub supplier with their credentials.
5. Vendor to confirm that they have in-house testing facility for Metallurgical Testing, Mechanical Testing, Chemical Analysis, Magnetic Particle Inspection (MPI) etc. as per the requirement of respective Indian Standard applicable for enquiry fasteners.
   In case of outsourcing of any test, vendor to confirm for testing at NABL accredited lab only.
6. Vendor to confirm bolts & screws shall be supplied meeting respective Indian Standard as given in enquiry.

Note: BHEL may ask additional clarification related to the above points. BHEL may also visit works of vendor to establish vendor's credentials.

Raju
05.08.2022
Raju Yadav
Manager/EME

Dinesh L Gond 05/08/22
Dinesh L Gond
DM/STE-TE

05/08/22
Ranjeet Kumar
DM/MTE

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BOLTS, HEXAGON HEAD, PRODUCT GRADE 'A' COARSE PITCH, STEEL PROPERTY CLASS 8.8 (M3 - M16)

1.0 DESIGNATION:

A product Gr.A, hexagon head, steel bolt of nominal diameter 10 mm, length 60 mm, coarse pitch and conforming to property class 8.8 shall be designated as:

1.1 On Drawings:

i) Material specification column : AA7111122

ii) Description Column : BOLT HEX A M10 X 60 – 8.8

1.2 On Indents:

Bolt Hex A M10 X 60 – 8.8: AA7111122

1.3 For issuing enquiries and on purchase orders:

While issuing enquiries and purchase orders delete BHEL standard number from above description and add the information given under clause 2.0

2.0 COMPLIANCE WITH STANDARDS:

2.1 Dimensions, Tolerance & General Requirements:

As per IS:1364, Part 1–2002

2.2 Mechanical Properties:

To conform to property class 8.8, as specified in Table–3 of IS:1367, Part 3

Permissible hardness 238-350 HB for sizes M6-M10

2.3 Threads:

Pitch-Coarse to IS:4218, Part 2

Tolerance quality – Medium

Tolerance class – 6g

2.4 Identification Marking:

As stated in Clause 9 of IS:1367, Part 3

2.5 Surface Discontinuity:

As per IS:1367, Part 9

2.6 Finish:

Planted as specified in BHEL order.

Revisions: Clause No. 31.4.0 of MOM of MRC-F			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(F)		
Rev No.08	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:02-07-2013	Dt:	Year:	HEEP, Haridwar	Corp.R&D	January 1977

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3.0 NOTE:

3.1 Length and diameter combination (refer Table-1 on page 3 of 3) between the bold lines should only be use

3.2 For screw threads, general (Metric) refer to BHEL standard AA0231800

3.3 For tolerance grade, position and class refer to BHEL standard AA0230201

3.4 Bolts to this standard would be un-plated, divisions wishing to have plated bolts would have to get them plated.

3.5 Weights given in this standard are for general reference only and are not meant for commercial transaction.

3.6 For product group Gr:A, hexagon head, steel bolts, property class 8.8 (M20 - M24) refer BHEL standard AA7111124

3.7 When fasteners are to be tested with in BHEL, the sampling and acceptance plan shall be as per IS:1367, part 17

4.0 REFERRED STANDARDS (Latest publications including amendment):

1) AA0231800 2) AA0230201 3) AA0231850

4) IS:1367, Part 3, 9 & 17 5) AA7111124 6) IS:4218, Part2

EXPLANATORY NOTE

- In Clause 2.2, Year of the IS:1367, Part 3 has been removed.
- In Table–1, the sizes, sub-codes and their weights have been corrected in line with CMCC of fasteners for mainly M12 and M16
- In Clause 4.0, the Standard No.AA0231850 has been added at Sl. No.7

CS-913 12/11/13

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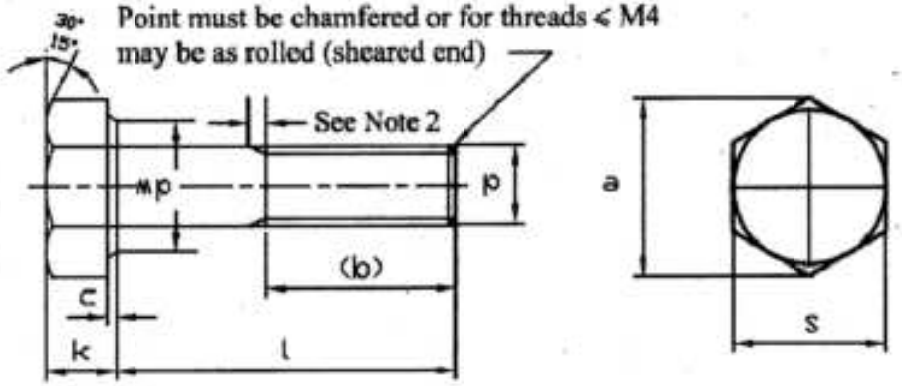

Note:
1) Corporate sub codes are shown in the table.
2) For thread runout refer AA0231850
3) Weights have been shown in kg per 1000Nos
4) Symbol Δ denotes the non-preferred size.

TABLE – 1

All dimensions are in 'mm'

Nom. Size d	Head			Washer		Thread Length b		Nominal Length (l)																				
	Flats s	Cms e	Thks k	Dia dw	Thks c	For Nom. Length ≤ 125	For Nom Length >125 & ≤ 200	20	25	30	35	40	45	50	55	60	65	70	80	90	100	110	120	130	140	150
	Max.	Min.	Max.	Min.	Max.												Sub Code											
	Min.		Min.		Min.												Weight											
M3	5.5	6.01	2.12	4.6	0.4	12	-																					
	5.32		1.88		0.15																							
M4	7.0	7.66	2.92	5.9	0.4	14	-																					
	6.78		2.68		0.15																							
M5	8.0	8.79	3.65	6.9	0.5	16	-			550			569															
	7.78		3.35		0.15					5.63			7.94															
M6	10.0	11.05	4.15	8.9	0.5	18	-		011 Δ	020*	038	542	356	046														
	9.78		3.85		0.15				7.36	8.47	9.58	10.2	11.8	12.9														
M8	13.0	14.38	5.45	11.6	0.6	22	28			364 Δ	372	054	429	062		380	445		453	577 Δ								
	12.73		5.15		0.15					16.3	18.27	20.3	22.2	24.2		28.15	30.1		34.0	40.0								
M10	16.0	17.77	6.58	14.6	0.6	26	32				070 Δ	089	585	097	593	100	119	399	127	402	135	143	151 Δ					
	15.73		6.22		0.15						32.0	35.1	38.2	41.3	44.4	47.4	50.5	53.6	56.7	59.8	65.9	72.0	78.2					
M12	18.0	20.03	7.68	16.6	0.6	30	36					160*	178	186	194	208	216	607	224	410	470*	488	232	496				
	17.73		7.32		0.15							49.9	54.3	58.7	63.2	67.7	72.1	76.5	74.32	85.4	94.3	103.2	112.0	121.0				
M16	24.0	26.75	10.18	22.5	0.8	38	44							240 Δ	259	267	275	283	291	305	313	321	500*	518	330*	348			
	23.67		9.82		0.2									108.0	115.9	123.7	131.6	139.5	147.4	155.3	171.0	187.0	203.0	218.5	233.0	249.0			

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DOC REV NO.: 1

SCREW THREADS – GENERAL (METRIC)

1.0 SCOPE:

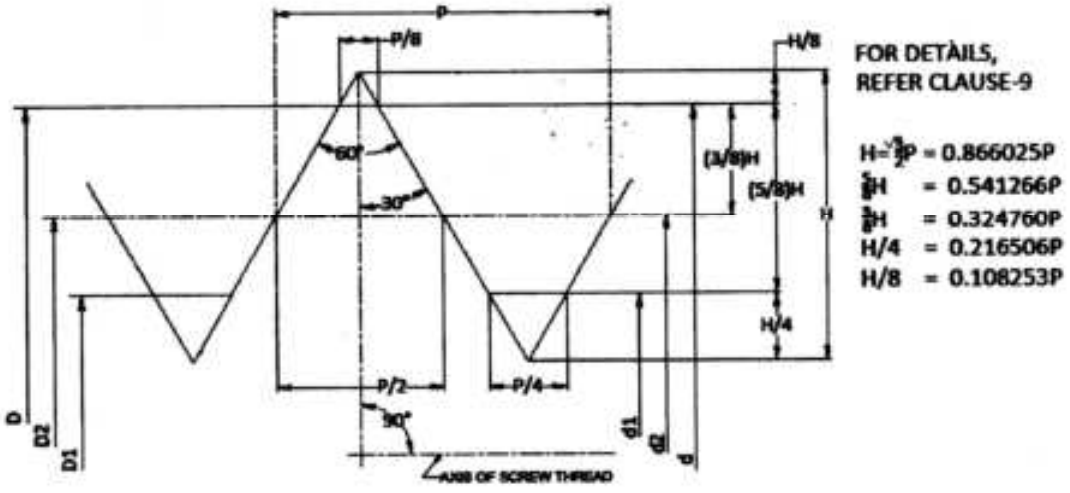
This standard gives information about metric screw threads with ISO (International Organization for Standardization) profile

2.0 COMPLIANCE WITH STANDARDS:

This standard is based on IS: 4218, Part 1-2001, IS: 4218, Part 2-2001, IS: 4218, Part 4-2001

3.0 BASIC PROFILE:

The basic profile of threads shall be as shown below



4.0 THREADED SERIES:

The following are the threaded series existing in the metric system.

4.1 Coarse Threaded Series

In coarse threaded series the pitch varies with the change in diameter and is coarser than fine threaded series (see also 6.2.1)

4.2 Fine thread series

In fine threaded series also the pitch varies with the change in diameter but is finer than the coarse series (see also 6.2.2)

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4.3 Constant Pitch Threaded Series

In constant pitch threaded series the pitch remains constant irrespective of change in diameter (see also 6.2.3)

5.0 DESIGNATION:

5.1 The complete designation of screw thread comprises a designation for the threaded system, size and a designation for the thread tolerance class.

5.2 Thread System and Sizes: The size of the screw thread shall be designated by the letter 'M' followed by the diameter and the pitch, the two being separated by sign 'X'

For example: M64 x 4

Where M signifies metric thread of ISO profile, 64 is the nominal diameter and 4 represents the pitch.

Where there is no indication of pitch, it shall mean that a coarse pitch is to be used.

5.2.1 Thread tolerance: The tolerance class designation includes a class designation for the pitch diameter tolerance.

Each class designation consists of:

a) A figure indicating the tolerance grade.

b) A letter indicating the tolerance position, capital letters for nut (internal) threads and small letters for bolt (external) threads.

EXAMPLES:

i) Nut (Internal) Threads: M64 - 6H

Which identifies as internal thread of 64 mm nominal diameter in the coarse thread series having 6H as the tolerance class

M24 x 2 – 6H

Which identifies s internal thread of 24 mm nominal diameter in the fine thread series having 2 mm as the pitch and 6H as the tolerance class

ii) Bolt (External) Threads: M64 - 6g

Which identifies external threads of 64 mm nominal diameter in the coarse thread having 6g as the tolerance class

M24 x 2 – 6g

Which identifies as external thread of 24 mm nominal diameter in the fine thread series having 2 mm as the pitch and 6g as the tolerance class

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6.0 SELECTION AND APPLICATION

6.1 Selection

6.1.1 In the interest of economy, designers should preferably select metric threads having either coarse or fine pitch series such that only these pitches are used for which tools and gauges stocked in various divisions.

6.1.2 Threads which are different from the standard graded pitch series e.g.: coarse or fine entail the design and manufacture of special threading tools and gauges with consequent increase in cost. Therefore first preference should always be given to the standard coarse or fine series before selecting one of the standard constant pitch series.

6.2 Application: The choice of coarse or fine thread series usually involves consideration of the following:

6.2.1 Coarse threads: The coarse thread gives a good resistance to stripping. It is suitable for threaded fasteners and for general use where the wall thickness can accommodate the thread dimensions.

It is particularly advantages for use with the lower tensile strength materials such as cast iron, mild steel and other softer materials (Brass, Aluminium, plastics etc.), it is also suitable for applications involving rapid assembly, removal or situation subjected to slight corrosion or damage i.e. for rough use.

6.2.2 Fine threads: The fine thread is recommended for all applications where a finer pitch is required. It is suitable for threaded fasteners where in static applications. It is necessary to provide extra care/strength. The series is less resistant to stripping and to the effect of repeated tightening than the coarse series. However, this gives sufficient resistances to stripping provided the length of engagement is adequate.

6.2.3 Constant pitch threads: Constant pitch threads may be used for parts which are repeatedly assembled or dismantled and where it may be necessary to rethread the part in service. The fine pitches, makes the series suitable for adjusting collars, retaining nuts, thin nuts etc. on compact design work (also refer clause 6.1.2).

6.3 Diameter/ Pitch Combination:

6.3.1 Combinations of diameter/pitch recommended for use are given in Table-1.

6.4 Unless otherwise specified, threads to this standard shall be right handed. Whenever L.H. threads are required to be used, it should be done only consultation with standard cell of respective division.

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7.0 COATED THREADS:

7.1 For coated threads, the tolerances apply to the parts before coating if not otherwise stated. After coating, the thread shall not transgress the maximum material limits for position 'H' or 'h' respectively.

8.0 CLASS OF FIT:

8.1 Three classes of fit for metric screw threads, generally designated as fine, medium and coarse have been provided for in the ISO metric screw thread system.

The general rule for the choice of thread class can be stated as follows:-

Fine: For precision threads, when little variation of fit is required.

Medium: For general use (tolerance class 6H/6g)

Coarse: For cases where manufacturing difficulties can arise e.g. when threading hot rolled bars and long blind holes and to meet the requirement of dirty and corrosive condition. (Tolerance class 7H/8g), also applicable in case of production Grade 'C' bolts, screws and nuts)

8.2 IT IS RECOMMENDED TO USE MEDIUM CLASS FIT i.e. "Tol. class 6H/6g in general, other tolerance class may be used after approval of appropriate authority at respective divisions.

8.3 Where no tolerances are specified, tolerance class 6H and 6g will be applicable for nuts/bolt threads respectively.

9.0 DETAILS OF BASIC PROFILE [Ref. Clause 3]

Where

D	is the basic major diameter of internal thread (nominal diameter)
d	is the basic major diameter of external thread (nominal diameter)
D_2	is the basic pitch diameter of internal thread
d_2	is the basic pitch diameter of external thread
D_1	is the basic minor diameter of internal thread
d_1	is the basic minor diameter of external thread
H	is the height of fundamental triangle
P	is the pitch

10.0 REFERRED STANDARDS (Latest publications including amendment)

Nil

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TABLE-1 RECOMMENDED PITCH DIAMETER COMBINATIONS

Nom dia (mm)	PITCHES												
	Coarse	Fine											
		6	4	3	2	1.5	1.25	1	0.75	0.5	0.35	0.25	0.2
1	0.25												0.2
1.2	0.25												0.2
1.6	0.35												0.2
2	0.4											0.25	
2.5	0.45										0.35		
3	0.5										0.35		
4	0.7									0.5			
5	0.8									0.5			
6	1								0.75				
8	1.25							1	0.75				
10	1.5						1.25	1	0.75				
12	1.75					1.5	1.25	1					
16	2					1.5		1					
20	2.5				2	1.5		1					
24	3				2	1.5		1					
30	3.5				2	1.5		1					
36	4			3	2	1.5							
42	4.5		4	3	2	1.5							
48	5		4	3	2	1.5							
56	5.5		4	3	2	1.5							
64	6		4	3	2	1.5							
72		6	4	3	2	1.5							
80		6	4	3	2	1.5							
90		6	4	3	2								
100		6	4	3	2								
110		6	4	3	2								
125		6	4	3	2								
140		6	4	3	2								
160		6	4	3									
180		6	4	3									
200		6	4	3									
220		6	4	3									
250		6	4	3									
280		6	4	3									

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ISO SYSTEM OF LIMITS AND FITS (BASES OF TOLERANCES, DEVIATIONS AND FITS)

1.0 SCOPE

This corporate standard gives the bases of the ISO system of limits and fits together with the calculated values of the standard tolerances and fundamental deviations. These values shall be taken as authoritative for the application of the system (see also clause A.1)

This corporate standard also gives terms and definitions together with associated symbols.

1.1 This corporate standard is based on IS: 919 Part 1-1993/Reaffirmed 2008 (ISO 286-1)

1.2 The hole basis system shall only be used in BHEL.

2.0 FIELD OF APPLICATION

The ISO system of limits and fits provides a system of tolerances and deviations suitable for plain work pieces.

For simplicity and also because of the importance of cylindrical work pieces of circular section, only these are referred to explicitly. It should be clearly understood, however, that the tolerances and deviations given in this standard equally apply to work pieces of other than circular section.

In particular, the general term "hole" or "shaft" can be taken as referring to the space contained by (or containing) the two parallel faces (or tangent planes) of any work piece, such as the width of a slot or the thickness of a key.

The system also provides for fits between mating cylindrical features or fits between work pieces having features with parallel faces, such as the fit between a key and keyway, etc.

NOTE – It should be noted that the system is not intended to provide fits for work piece with features having other than simple geometric forms.

For the purposes of this Corporate Standard, a simple geometric form consists of a cylindrical surface area or two parallel planes.

3.0 REFERRED STANDARDS

Note – See also clause 10.

ISO 1 Standard reference temperature for industrial length measurements.

AA0230206 (ISO 286) ISO system of limits and fits - part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.

ISO/R 1938, ISO system of limits and fits - Inspection of plain work pieces[1)]

ISO 8015 IS: 12160 Technical drawings - Fundamental tolerancing principle.

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4.0 TERMS AND DEFINITIONS

For the purposes for this Standard, the following terms and definitions apply. It should be noted, however, that some of the terms are defined in a more restricted sense than in common usage.

4.1 Shaft

A term used, according to convention, to describe an external feature of a work piece, including features which are not cylindrical (see also clause 2).

4.1.1 Basic shaft

Shaft chosen as a basis for a shaft-basis system of fits (see also 4.11.1)

For the purposes of the ISO system of limits and fits, a shaft the upper deviation of which is zero.

4.2 Hole

A term used, according to convention, to describe an internal feature of a work piece, including features which are not cylindrical (see also clause 2)

4.2.1 Basic hole

Hole chosen as a basis for a hole-basis system of fits (see also 4.11.2)

For the purposes of the ISO system of limits and fits, a hole the lower deviation of which is zero.

4.3 Size

A number expressing, in a particular unit, the numerical value of a linear dimension.

4.3.1 Basic Size; nominal size

The size from which the limits of size are derived by the application of the upper and lower deviations (see figure 1).

NOTE – The basic size can be a whole number or a decimal number, e.g 32; 15; 8,75; 0,5; etc.

4.3.2 Actual size

The size of a feature, obtained by measurement.

4.3.2.1 Actual local size

Any individual distance at any cross section of a feature, i.e. any size measured between any two opposite points.

4.3.3 Limits of size

The two extreme permissible sizes of a feature, between which the actual size should lie, the limits of size being included.

4.3.3.1 Maximum limit of size

The greatest permissible size of a feature (see figure 1)

4.3.3.2 Minimum limit of size

The smallest permissible size of a feature (see figure 1)

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4.4 Limit System

A system of standardized tolerances and deviations.

4.5 Zero line

In a graphical representation of limits and fits, the straight line, representing the basic size, to which the deviations and tolerances are referred (see figure 1),

According to convention, the zero line is drawn horizontally, with positive deviations shown above and negative Deviations below (see figure 2).

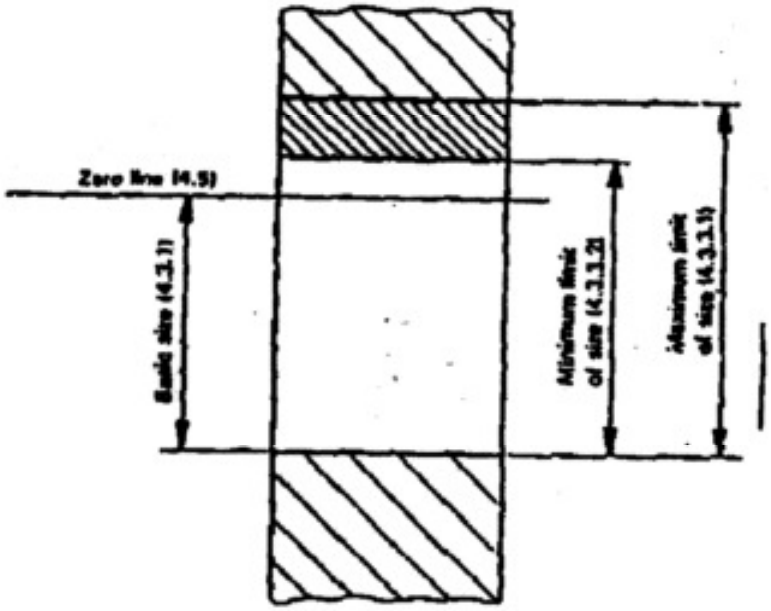

Figure 1 – Basic size, and maximum and minimum limits of size

4.6 Deviation

The algebraic difference between a size (actual size, limit of size, etc) and the corresponding basic size.

Note:- Symbols for shaft deviations are lower case letters (*es*, *ei*) and symbols for hole deviations are upper case Letters (*ES*, *EI*) (see figure 2).

4.6.1 Limit deviations

Upper deviation and lower deviation.

4.6.1.1 Upper deviation (ES, es)

The algebraic difference between the maximum limit of size and the corresponding basic size (see figure 2).

4.6.1.2 Lower deviation (ES, es)

The algebraic difference between the minimum limit of size and the corresponding basic size (see figure 2).

4.6.2 Fundamental deviation

For the purpose of the ISO system of limits and fits, that deviation which defines the position of the tolerance zone, in relation to the zero line (see figure 2).

NOTE: This may be either the upper or lower deviation, but, according to convention, the fundamental deviation is the one nearest the zero line.

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4.7 Size tolerance

The difference between the maximum limit of size and the minimum limit of size i.e. the difference between the upper deviation and the lower deviation.

NOTE: The tolerance is an absolute value without sign.

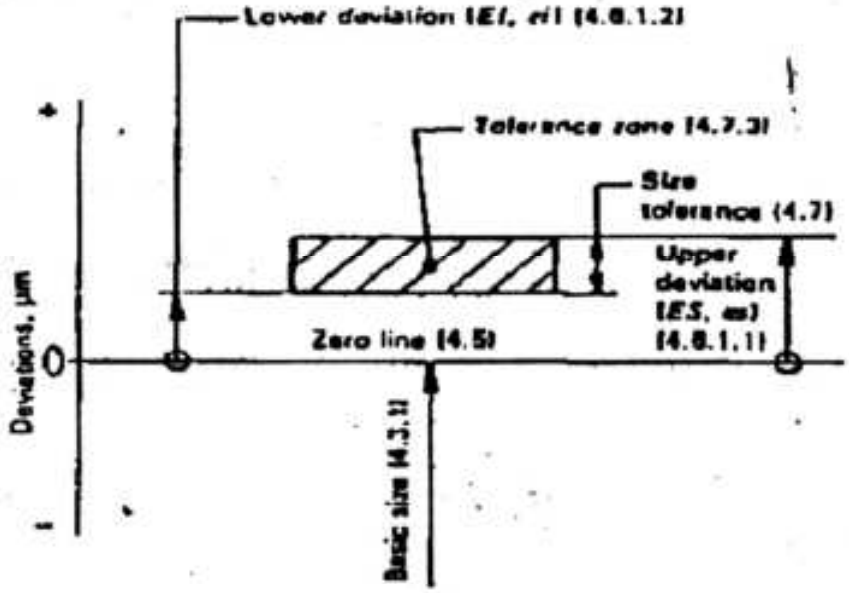

Figure 2 – Conventional representation of a tolerance zone

4.7.1 Standard tolerance (IT)

For the purpose of the ISO system of limits and fits, any tolerance belonging to this system.

NOTE: The letters of the symbol IT stand for "International Tolerance" grade.

4.7.2 Standard tolerance grades

For the purpose of the ISO system of limits and fits, a group of tolerances (e.g. IT7), considered as corresponding to the same level of accuracy for all basic sizes.

4.7.3 Tolerance class

In a graphical representation of tolerances, the zone, contained between two lines representing the maximum and minimum limits of size, defined by the magnitude of the tolerance and its position relative to the zero line (see figure 2).

4.7.4 Tolerance class

The term used for a combination of fundamental deviation and a tolerance grade, e.g. h9, D13 etc.

4.7.5 Standard tolerance factor (*i*, *I*)

For the purposes of the ISO system of limits and fits, a factor which is a function of the basic size, and which is used as a basis for the determination of the standard tolerances of the system.

Notes

A.1 The standard tolerance factor *i* is applied to basic sizes less than or equal to 500 mm.

A.2 The standard tolerance factor *I* is applied to basic sizes greater than 500 mm.

4.8 Clearance

The positive difference between the sizes of the hole and the shaft, before assembly, when the diameter of the shaft is smaller than the diameter of the hole (see figure 3).

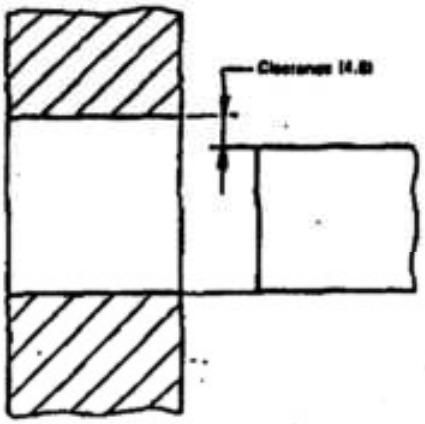

Figure 3 - Clearance

4.8.1 Minimum Clearance

In a clearance fit, the positive difference between the minimum limit of size of the hole and the maximum limit of size of the shaft (see figure 4).

4.8.2 Maximum Clearance

In a clearance or transition fit, the positive difference between the maximum limit of size of the hole and the minimum limit of size of the shaft (see figures 4 and 5).

4.9 Interference

The negative difference between the sizes of the hole and the shaft, before assembly, when the diameter of the shaft is larger than the diameter of the hole (see figure 6).

4.9.1 Minimum Interference

In an interference fit, the negative difference, before assembly, between the maximum limit of size of the hole and the minimum limit of size of the shaft (see figure 7).

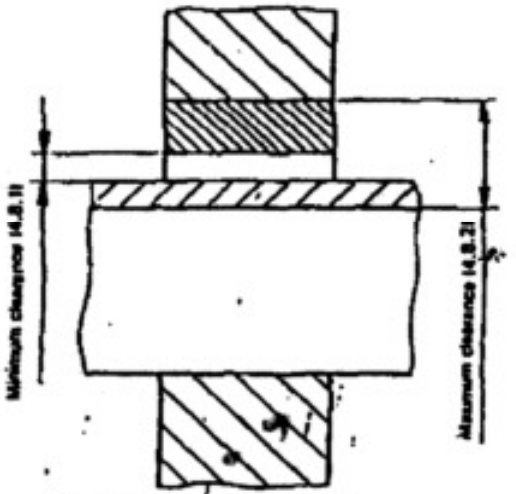

Figure 4 - Clearance fit

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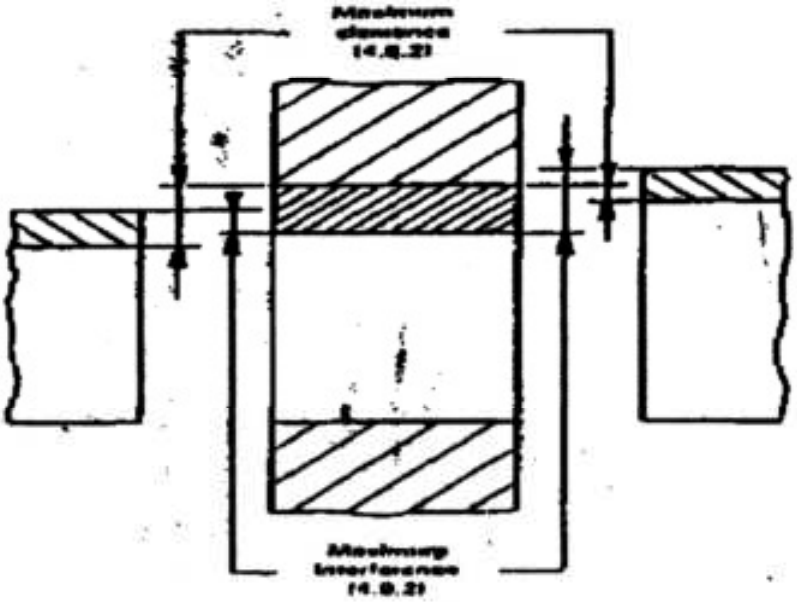

Figure5 – Transition fit

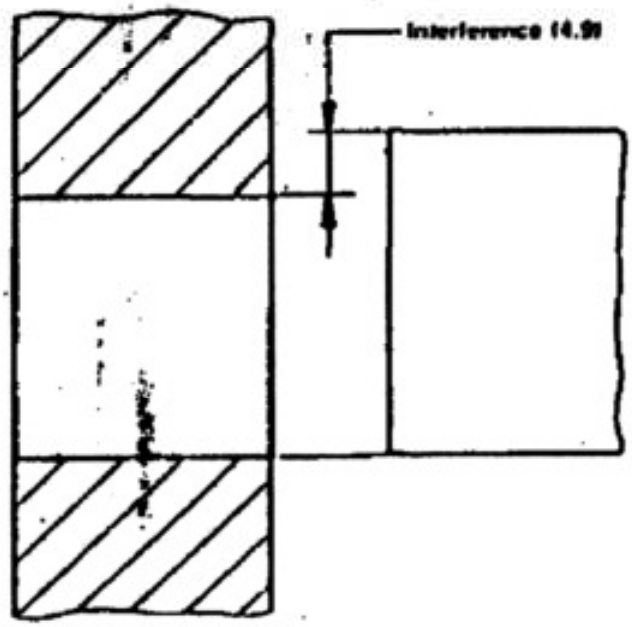

Figure 6 – Interference

4.9.2 Maximum Interference

In an interference or transition fit, the negative difference, before assembly, between the minimum limit of size of the hole and the maximum limit of size of the shaft (see figures 5 and 7).

4.10 Fit

The relationship resulting from the difference, before assembly, between the sizes of the two features (the hole and the shaft) which are to be assembled.

NOTE: The two mating parts of a fit have a common basic size.

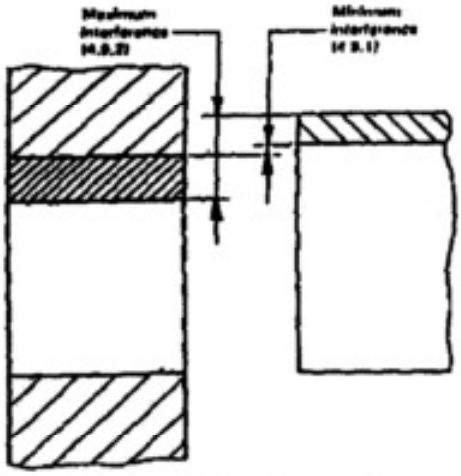

Figure 7 – Interference fit

4.10.1 Clearance fit

A fit that always provides a clearance between the hole and shaft when assembled, i.e., the minimum size of the hole is either greater than or, in the extreme case, equal to the maximum size of the shaft (see Figure 8).

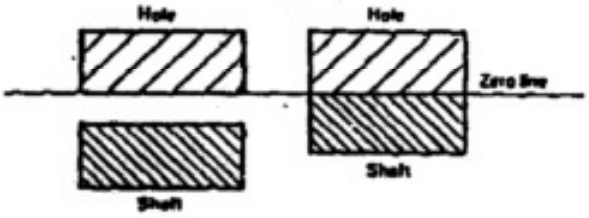

Figure 8 – Schematic representation of clearance fit

4.10.2 Interference fit

A fit which everywhere provides an interference between the hole and shaft when assembled, i.e. the maximum size of the hole is either smaller than or, in the extreme case, equal to the minimum size of the shaft (see figure 9).

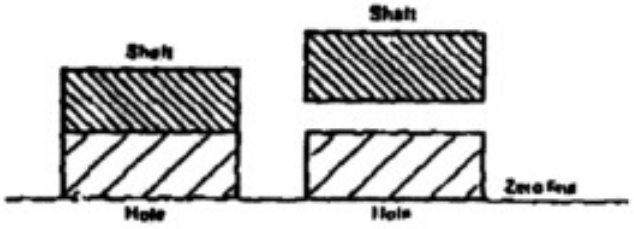

Figure 9 – Schematic representation of interference fits

4.10.3 Transition fit

A fit which may provide either a tolerance or an interference between the hole and shaft when assembled, depending on the actual sizes of the hole and shaft, i.e. the tolerance zones of the hole and the shaft overlap completely or in part (see figure 10).

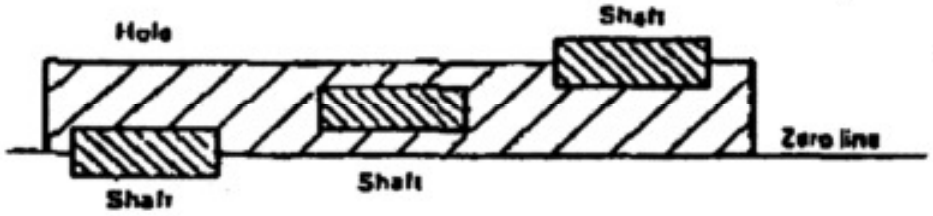

Figure 10 – Schematic representation of transition fits

4.10.4 Variation of a fit

The arithmetic sum of the tolerances of the two features comprising the fit.

Note: The variation of a fit is an absolute value without sign.

4.11 Fit system

A system of fits comprising shafts and holes belonging to a limit system.

4.11.1 Shaft basis system of fits

A system of fits in which the required clearances or interferences are obtained by associating holes of various tolerance classes with shafts of a single tolerance class.

For the purposes of the ISO system of limits and fits, a system of fits in which the maximum limit of size of the shaft is identical to the basic size i.e. the upper deviation is zero (see figure 11)

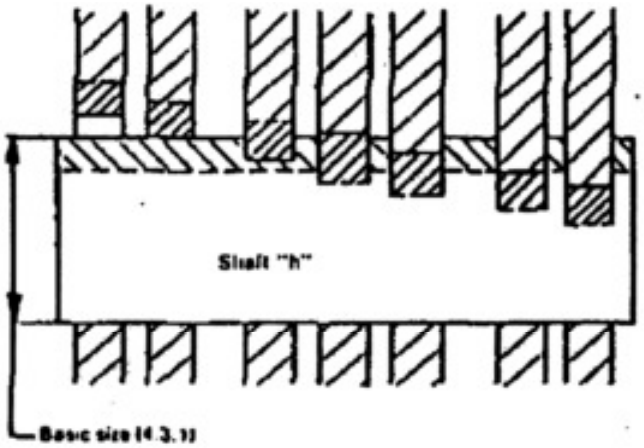

Figure 11 - Shaft-basis system of fits

NOTES:

1) The horizontal continuous line represent the fundamental deviations for holes or shafts.

2) The dashed lines represent the other limits and show the possibility of different combinations between holes and shafts, related to their grade of tolerance (e.g G7/ h4, H6/h4, M5/h4).

4.11.2 Hole – basis system of fits

A system of fits in which the required clearances or interferences are obtained by associating shaft of various tolerance classes with holes of a single tolerance class.

For the purposes of the ISO system of limits and fits, a system of fits in which the minimum limit of size of the hole is identical to the basic size. i.e. the lower deviation is zero (see figure 12).

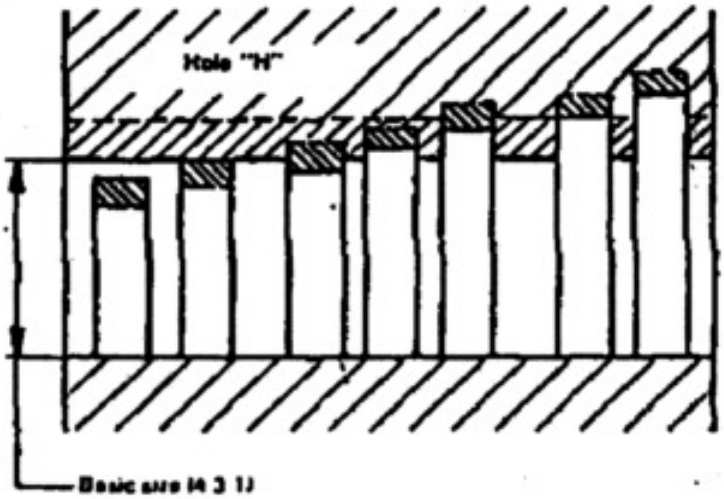

Figure 12 - Hole-basis system of fits

NOTES:

1) The horizontal continuous lines represent the fundamental deviations for holes or shafts.

2) The dashed lines represent the other limits and show the possibility of different combinations between holes and shafts, related to their grade of tolerance (e.g. H6/h6, H6/js5, H6/p4).

4.12 Maximum material limit (MML)

The designation applied to that of the two limits of size which corresponds to the maximum material size for the feature i.e.

A.1 The maximum (upper) limit of size for and external feature (shaft)

A.2 The minimum (lower) limit of size for an internal feature (hole)

Note – Previously called "GO limit"

4.13 Least material limit (LML)

The designation applied to that of the two limits of size which corresponds to the minimum material size for the feature, i.e.

1) The minimum (Lower) limit of size for an external feature (shaft)

2) The maximum (Upper) limit of size for an internal feature (hole)

Note – Previously called "NOT GO limit"

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5.0 SYMBOLS, DESIGNATION AND INTERPRETATION OF TOLERANCES, DEVIATIONS AND FITS

5.1 Symbols

5.1.1 Standard tolerance grades

The standard tolerance grades are designated by the letters IT followed by a number, e.g. IT7. When tolerance grade is associated with (a) letter(s) representing a fundamental deviation to form a tolerance class, the letters IT are omitted e.g.h7.

NOTE – The ISO system provides for a total of 20 standard tolerance grades of which grades IT1 to IT18 are in general use and given in the main body of the standard. Grades IT0 and IT01, which are not in general use, are given in annex A for information purposes.

5.1.2 Deviations

5.1.2.1 Position of tolerance Zone

The position of the tolerance zone with respect to the zero line, which is a function of the basic size, is designated by (an) upper case letter(s) for holes (A....ZC) or (a) lower case letter(s) for shafts (a....zc) (see figures 13 and 14).

NOTE – To avoid confusion, the following letters are not used:

I. i; L, l; O, o; Q, q; W, w

5.1.2.2 Upper deviations

The upper deviations are designated by the letters "ES" for holes and the letters "es" for shafts.

5.1.2.3 Lower Deviations

The lower deviations are designated by the letters "EI" for holes and the letters "ei" shafts.

5.2 Designation

5.2.1 Tolerance class

A tolerance class shall be designated by the letter(s) representing the fundamental deviation followed by the number representing the standard tolerance grade.

Examples:

H7 (holes)

h7 (shafts)

5.2.2 Toleranced size

A tolerance size shall be designated by the basic size followed by the designation of the required tolerance class, or the explicit deviations.

Example:

32H7

80js15

100g6

$100^{-0.012}_{-0.034}$

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ATTENTION – In order to distinguish between holes and shafts when transmitting information on equipment with limited character sets, such as telex, the designation shall be prefixed by the following letters:

1) H or h holes;

2) S or s for shafts

Examples:

50H5 becomes H50H5 or h50h5

50h6 becomes S50H6 or s50h6

This method of designation shall not be used on drawings.

5.2.3 Fit

A fit requirement between mating features shall be designated by

1) The common basic size;

2) The tolerance class symbol for the hole;

3) The tolerance class symbol for the shaft.

Examples:

52H7/g6 or $52\frac{H7}{g6}$

ATTENTION: In order to distinguish between the hole and the shaft when transmitting information on equipment with limited character sets, such as telex, the designation shall be prefixed by the following letters:

a) H or h for holes;

b) S or s for shafts;

c) and the basic size repeated

Examples:

52H7/g6 becomes H52H7/S52G6 or h52h7/s52g6

This method of designation shall not be used on drawings.

5.3 Interpretation of a tolerance size

5.3.1 Tolerance indication in accordance with ISO 8015

The tolerances for work pieces manufactured to drawings marked with the notation, Tolerancing ISO 8015, shall be interpreted as indicated in 5.3.1.1 and 5.3.1.2

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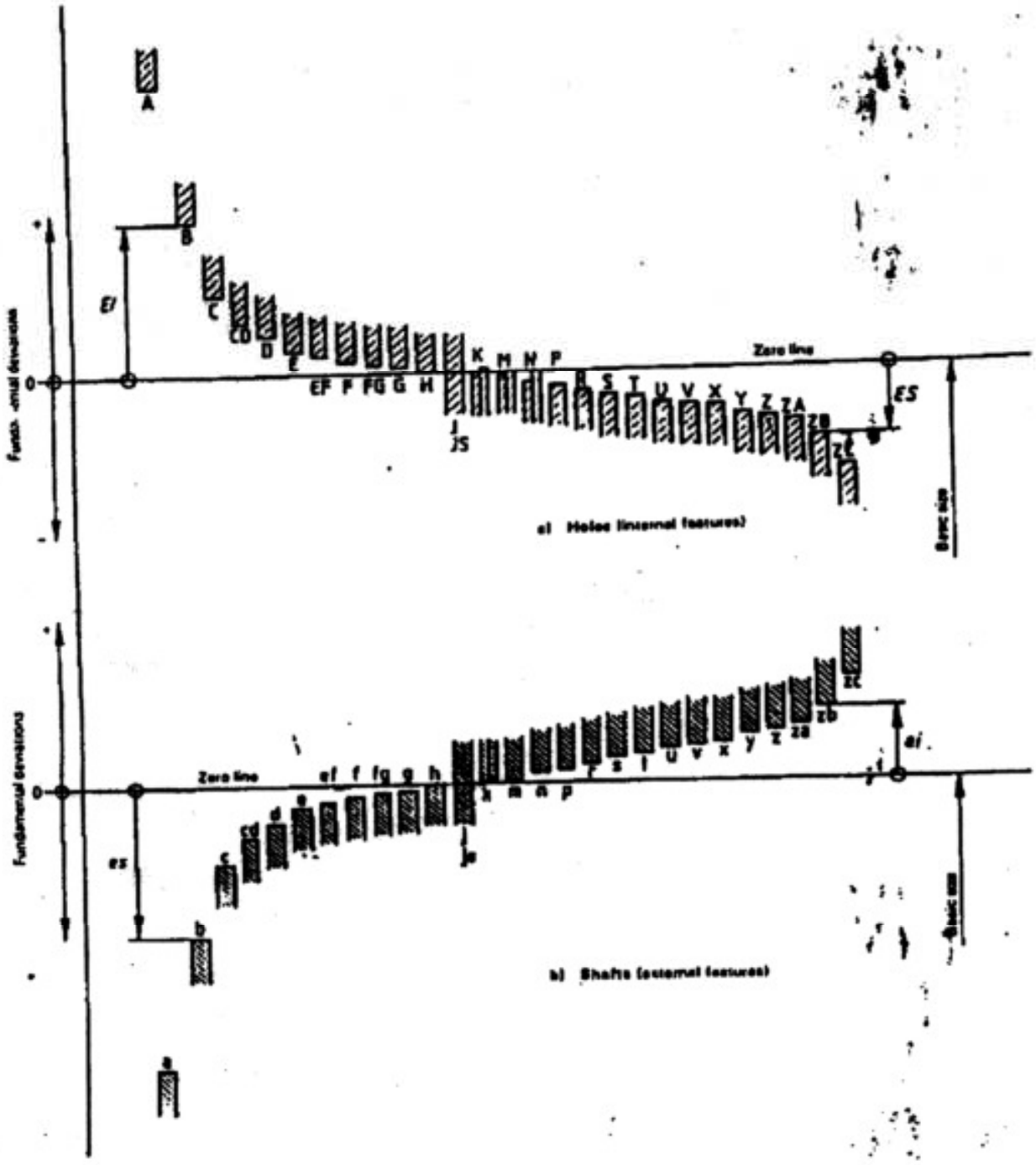

NOTES:

1) According to convention, the fundamental deviation is the one defining the nearest limit to the zero line.

2) For details concerning fundamental deviations for J/j, K/k, M/m and N/n, see figure 14.

Figure 13 - Schematic representation of the position of fundamental deviations

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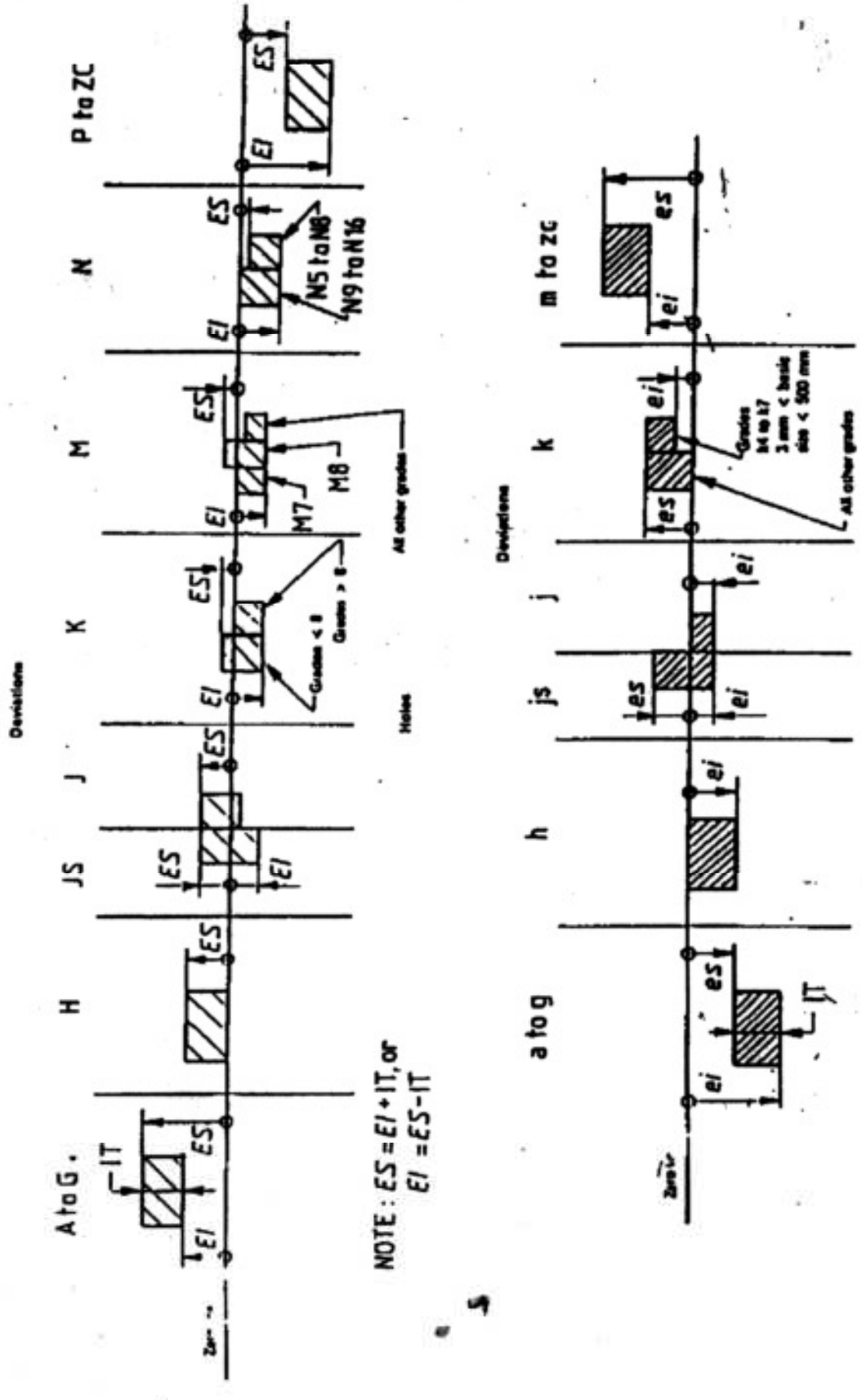

Figure 14 – Deviations for shafts and holes

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5.3.1.1 Linear size tolerances

A linear size tolerance controls only the actual local sizes (two point measurements) of a feature, but not its form deviations (for example circularity and straightness deviations of a cylindrical feature or flatness deviations of parallel surfaces). There is no control of the geometrical interrelationship of individual features by the size tolerances. (For further information, see ISO/R 1938 and ISO 8015).

5.3.1.2 Envelope requirement

Single features, whether a cylinder, or established by two parallel planes, having the function of a fit between mating parts, are indicated on the drawing by the symbol Ⓔ in addition to the dimension and tolerance. This indicates a mutual dependence of size and form which requires that the envelope of perfect form for the feature at maximum material size shall not be violated. (For further information, see ISO/R 1938 and ISO 8015).

NOTE – Some national standards (which should be referred to on the drawing) specify that the envelope requirement for single features is the norm and therefore this is not indicated separately on the drawing.

5.3.2 Tolerance indication not in accordance with ISO 8015

The tolerances for work pieces manufactured to drawings which do not have the notation, Tolerancing ISO 8015, shall be interpreted in the following ways within the stipulated length.

B.1 For holes

The diameter of the largest perfect imaginary cylinder, which can be inscribed within the hole so that it just contacts the highest points of the surface, should not be smaller than the maximum material limit of size. The maximum diameter at any position in the hole shall not exceed the least material limit of size.

B.2 For shafts

The diameter of the smallest perfect imaginary cylinder, which can be circumscribed about the shaft so that it just contacts the highest points of the surface, should not be larger than the maximum material limit of size. The minimum diameter at any position on the shaft shall be not less than the least material limit of size.

The interpretations given in a) and b) mean that if a work piece is everywhere at its maximum material limit, that work piece should be perfectly round and straight, i.e. a perfect cylinder.

Unless otherwise specified, and subject to the above requirements, departures from a perfect cylinder may reach the full value of the diameter tolerance specified. For further information, see ISO/R 1938.

NOTE – In special cases, the maximum form deviations permitted by the interpretations given in a) and b) may be too large to allow satisfactory functioning of the assembled parts: in such cases, separate tolerances should be given for the form, e.g. separate tolerances on circularity and / or straightness (see AA0230415)

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6.0 Graphical Representation:

The major terms and definitions given in clause 4 are illustrated in figure 15.

In practice, a schematic diagram such as that shown in figure 16 is used for simplicity. In this diagram, the axis of the work pieces, which is not shown in the figure, according to convention always lies below the diagram.

In the example illustrated, the two deviations of the hole are positive and those of the shaft are negative.

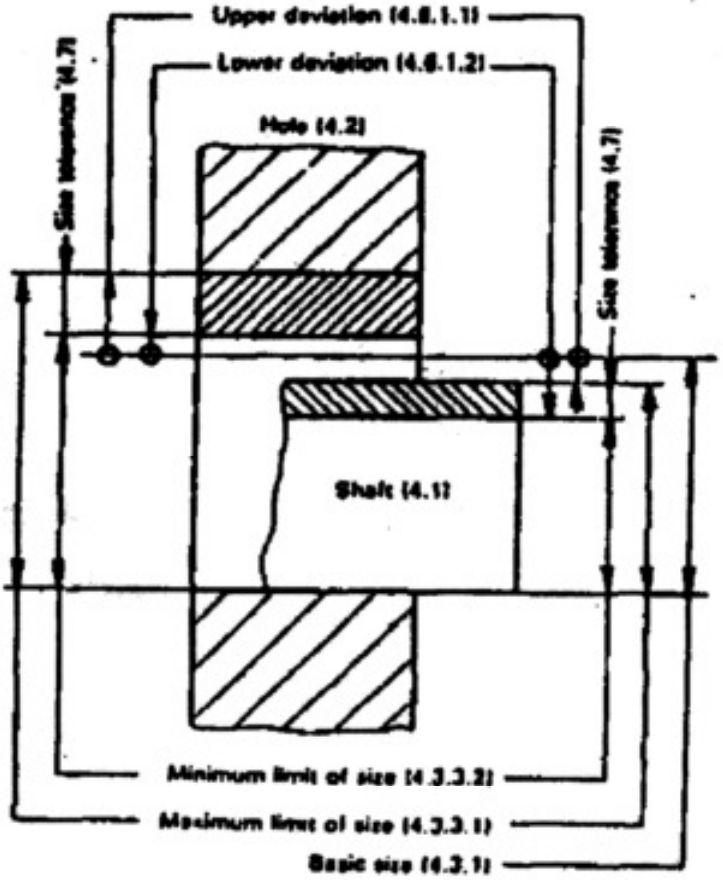

Figure 15 – Graphical Representation

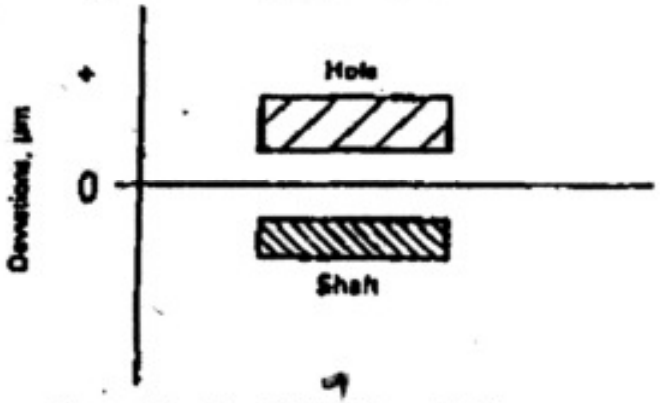

Figure 16 – Simplified schematic diagram

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7.0 REFERENCE TEMPERATURE

The temperature at which the dimensions of the ISO system of limits and fits are specified is 20° C (see ISO 1)

8.0 STANDARD TOLERANCES FOR BASIC SIZES UP TO 3150 mm

8.1 Basis of the system

The bases for calculating the standard tolerances are given in annex A.

8.2 Values of standard tolerance grades (IT)

Values of standard tolerance grades IT1 to IT18 inclusive are given in table 1. These values are to be taken as authoritative for the application of the system.

NOTE – Values for standard tolerance grades IT0 and IT01 are given in annex A.

9.0 FUNDAMENTAL DEVIATIONS FOR BASIC SIZES UP TO 3150 mm

9.1 Fundamental deviations for shafts [except deviation is (see 9.3)]

The fundamental deviations for shafts and their respective sign (+ or -) are shown in figure 17. Values for the fundamental deviations are given in table 2.

The Upper deviation (es) and lower deviation (ei) are established from the fundamental deviation and the standard tolerance grade (IT) as shown in figure 17.

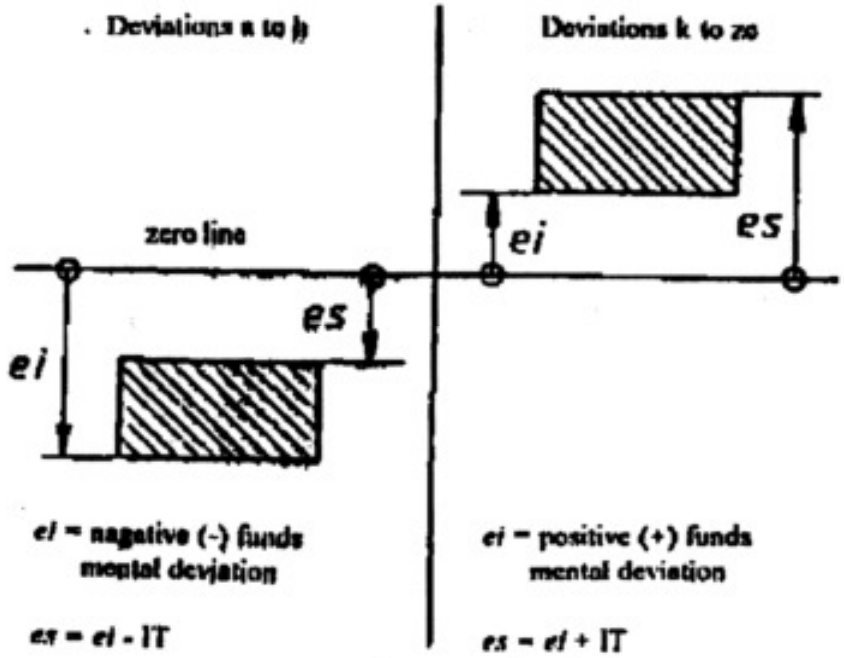

Figure 17 – Deviations for shafts

9.2 Fundamental deviation for holes [except deviation JS (see 9.3)]

The fundamental deviations for holes and their respective sign (+ or -) are shown in figure 18. Values for the fundamental deviations are given in table 3.

The upper deviation (ES) and lower deviation (EI) are established from the fundamental deviation and the standard tolerance grade (IT) as shown in figure 18.

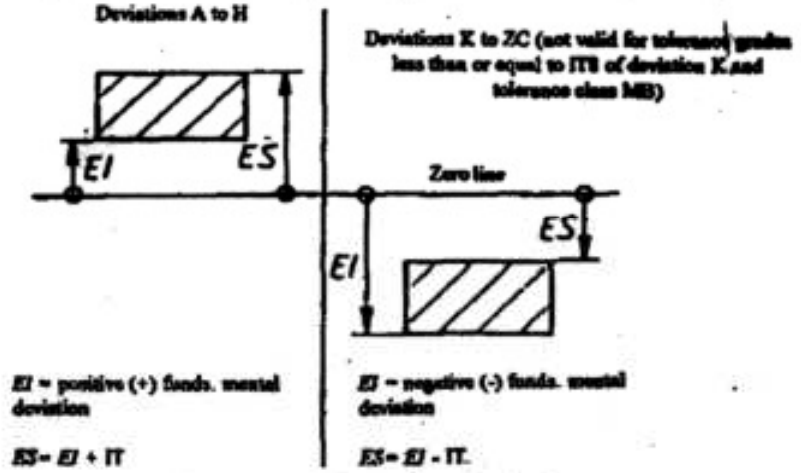

Figure 18 – Deviations for holes

9.3 Fundamental deviation js and JS (see figure 19)

The information given in 9.1 and 9.2 does not apply to fundamental deviations js and JS which are a symmetrical distribution of the standard tolerance grade about the zero line, i.e. for js:

$$es = ei = \frac{IT}{2}$$

and for JS:

$$ES = EI = \frac{IT}{2}$$

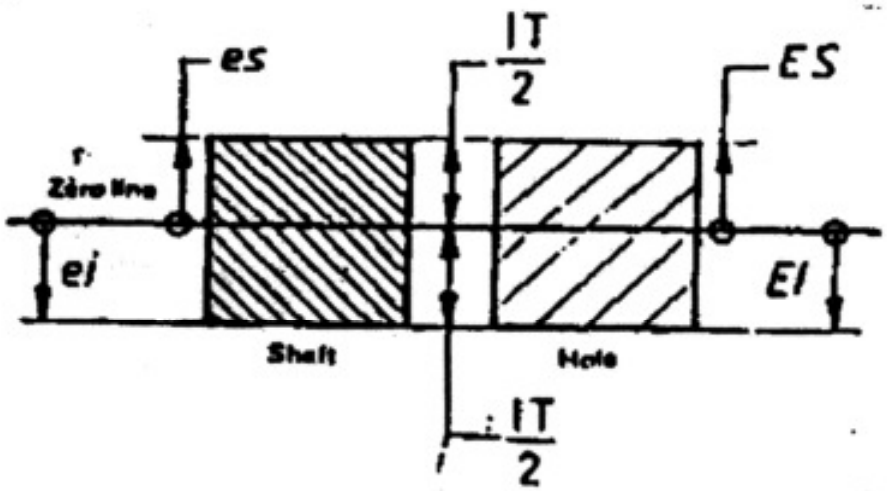

Figure 19 – Deviations js and JS

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9.4 Fundamental deviations j and J

The information given in 9.1 to 9.3 does not apply to fundamental deviations j and J, which are, for the most part, asymmetrical distributions of the standard tolerance grade about the zero line (see AA0230206 tables 8 and 24).

Table 1 – Numerical values of standard tolerance grades IT for basic sizes up to 3150 mm[1)]

Basic Size mm		Standard tolerance grades																	
		IT1[2)]	IT2[2)]	IT3[2)]	IT4[2)]	IT5[2)]	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14[2)]	IT15[2)]	IT16[2)]	IT17[2)]	IT18[2)]
Above	Upto and including	Tolerances																	
		µm											mm						
-	3[2)]	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
50	80	2	3	5	8	13	19	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
180	250	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
500	630[2)]	9	11	16	22	32	44	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11
630	800[2)]	10	13	18	25	36	50	80	125	200	320	500	0.8	1.25	2	3.2	5	8	12.5
800	1000[2)]	11	15	21	28	40	56	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
1000	1250[2)]	13	18	24	33	47	66	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	10.5	16.5
1250	1600[2)]	15	21	29	39	55	78	125	195	310	500	780	1.25	1.95	3.1	5	7.8	12.5	19.5
1600	2000[2)]	18	25	35	46	65	92	150	230	370	600	920	1.5	2.3	3.7	6	9.2	15	23
2000	2500[2)]	22	30	41	55	78	110	175	280	440	700	1100	1.75	2.8	4.4	7	11	17.5	28
2500	3150[2)]	26	36	50	68	96	135	210	330	540	860	1350	2.1	3.3	5.4	8.6	13.5	21	33

B.3 Values for standard tolerance grades IT01 and IT0 for basic sizes less than or equal to 500 mm are given in annex A, table 5.

B.4 Values for standard tolerance grades ITI to IT5 (incl.) for basic sizes over 500 mm are included for experimental use.

B.5 Standard tolerance grades IT14 to IT18 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

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Table 2 – Numerical values of the fundamental deviations of shafts

Basic size mm		Upper deviation es											Fundamental deviation values					Lower deviations ei																
Above	Up to and including	All standard tolerance grades											IT5 and IT6	IT7	IT8	IT4 to IT7	Upto IT3 (incl.) and above IT7	All standard tolerance grades																
		js*	j*	k	m	n	p	r	s	t	u	v	j			k		m	n	p	r	s	t	u	v	x	y	z	za	zb	zc
-	3	±3	-2	-4	-6	-4	-10	-14		-18		-20	-2	-4	-6	0	0	+2	+4	+6	+10	+14		+18		+20		+26	+32	+40	+60
3	6	±4	-2	-4		+1	0			-19		-28	-4	-8		+1	0	+4	+8	+12	+15	+19		+23		+28		+35	+42	+50	+80
6	10	±4,5	-2	-5		+1	0			-22		-34	-5	-10		+1	0	+6	+10	+15	+19	+23		+28		+34		+42	+52	+67	+97
10	14	±5,5	-3	-6		+1	0			-26		-40	-7	-12		+2	0	+7	+12	+18	+23	+28		+33	+39	+40		+50	+64	+90	+130
14	18									-33		-50													+45	+60		+77	+108	+150	
18	24	±6,5	-4	-8		+2	0			-41		-61	-8	-15		+2	0	+8	+15	+22	+28	+35		+41	+47	+54	+63	+73	+98	+136	+188
24	30									-48		-75											+41	+48	+55	+64	+75	+88	+118	+160	+218
30	40	±8	-5	-10		+2	0			-60		-92	-9	-17		+3	0	+9	+17	+26	+34	+43	+48	+60	+68	+80	+94	+112	+148	+200	+274
40	50									-70		-112											+54	+70	+81	+97	+114	+136	+180	+242	+325
50	65	±9,5	-7	-12		+2	0			-87		-134	-11	-20		+4	0	+11	+20	+32	+41	+53	+66	+87	+102	+122	+144	+172	+226	+300	+405
65	80									-102		-159											+43	+59	+75	+102	+120	+146	+210	+274	+360	+480
80	100	±11	-9	-15		+3	0			-124		-193	-13	-23		+4	0	+13	+23	+37	+51	+71	+91	+124	+146	+178	+214	+258	+335	+445	+585
100	120									-144		-225											+54	+79	+104	+144	+172	+210	+274	+365	+480	+640
120	140									-170		-266											+63	+92	+122	+170	+202	+248	+300	+396	+525	+690
140	160	±12,5	-11	-18		+3	0			-190		-298	-15	-27		+4	0	+15	+27	+43	+65	+100	+134	+190	+228	+280	+340	+415	+535	+700	+900
160	180									-210		-328											+68	+108	+146	+210	+252	+310	+390	+500	+660	+860
180	200									-236		-370											+77	+122	+166	+236	+284	+350	+425	+560	+740	+960
200	225	±14,5	-13	-21		+4	0			-258		-405	-18	-31		+5	0	+17	+31	+50	+80	+130	+180	+258	+310	+385	+470	+575	+740	+960	+1250
225	250									-284		-445											+84	+140	+196	+284	+340	+425	+520	+675	+880	+1150
250	280	±16	-16	-26		+4	0			-315		-498	-20	-34		+5	0	+20	+34	+56	+94	+158	+218	+315	+385	+475	+580	+710	+920	+1200	+1550
280	315									-350		-548											+98	+170	+240	+350	+425	+525	+650	+840	+1100	+1450
315	355	±18	-18	-28		+4	0			-390		-615	-22	-37		+7	0	+21	+37	+62	+108	+190	+268	+390	+475	+590	+730	+900	+1150	+1500	+1900
355	400									-435		-685											+114	+208	+294	+435	+530	+660	+820	+1050	+1400	+1850
400	450	±20	-20	-32		+5	0			-490		-767	-25	-43		+7	0	+23	+40	+68	+126	+232	+330	+490	+595	+740	+920	+1100	+1450	+1850	+2400
450	500									-540		-847											+132	+252	+360	+540	+660	+820	+1000	+1300	+1650	+2100
500	560																				+150	+280	+400	+600								
560	630																				+155	+310	+450	+660								
630	710																				+175	+340	+500	+740								
710	800																				+185	+380	+560	+840								
800	900																				+210	+430	+620	+940								
900	1000																				+220	+470	+680	+1050								
1000	1120																				+250	+520	+780	+1150								
1120	1250																				+260	+580	+840	+1300								
1250	1400																				+300	+640	+960	+1450								
1400	1600																				+330	+720	+1050	+1600								
1600	1800																				+370	+820	+1200	+1850								
1800	2000																				+400	+920	+1350	+2000								
2000	2240																				+440	+1000	+1500	+2300								
2240	2500																				+460	+1100	+1650	+2500								
2500	2800																				+550	+1250	+1900	+2900								
2800	3150																				+580	+1400	+2100	+3200								

1) Fundamental deviations a and b shall not be used for basic sizes less than or equal to 1 mm.

2) For tolerance classes js7 to js11, if the IT value number, n, is an odd number, this may be rounded to the even number immediately below, so that the resulting deviations i.e. $\pm\frac{ITn}{2}$ can be expressed in whole micrometres.

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Table-3 Numerical values of the fundamental deviations of holes

Fundamental deviation values in micrometres

Basic size mm		Lower deviation EI											Fundamental deviation values									Upper deviation ES													Values for Δ					
		All standard tolerance grades											IT6	IT7	IT8	Up to IT8 (incl.)	Above IT8	Up to IT8 (incl.)	Above IT8	Upto IT8 (incl.)	Above IT8	Upto IT7 (incl.)	Standard tolerance grades above IT7													Standard tolerance grades					
Above	Up to and including	A	B	C	CD	D	E	EF	F	FG	G	H	JS	J			K		M		N		P to ZC	P	R	S	T	U	V	X	Y	Z	ZA	ZB	ZC	IT3	IT4	IT5	IT6	IT7	IT8
-	3	+270	+140	+60	+34	+20	+14	+10	+6	+4	+2	0		+2	+4	+6	0	0	-2	-2	-4	-4		-6	-10	-14		-18		-20		-26	-32	-40	-60	0	0	0	0	0	0
3	6	+270	+140	+70	+46	+30	+20	+14	+10	+6	+4	0		+5	+6	+10	-1+Δ		-4+Δ	-4	0+Δ	0		-12	-15	-19		-23		-28		-35	-42	-50	-80	1	1.5	1	3	4	6
6	10	+280	+150	+80	+56	+40	+25	+18	+13	+8	+5	0		+5	+8	+12	-1+Δ		-4+Δ	-6	-10+Δ	0		-15	-19	-23		-28		-34		-42	-52	-67	-97	1	1.5	2	3	6	7
10	14	+290	+150	+95		+50	+32		+16		+6	0		+6	+10	+15	-1+Δ		-7+Δ	-7	-12+Δ	0		-18	-23	-28		-33		-40		-50	-64	-90	-130	1	2	3	3	7	9
14	18																													-39	-45	-60	-77	-108	-150						
18	24	+300	+160	+110		+65	+40		+20		+7	0		+8	+12	+20	-2+Δ		-8+Δ	-8	-15+Δ	0		-22	-28	-35		-41	-47	-54	-63	-73	-98	-136	-188	1.5	2	3	4	8	12
24	30																										-41	-48	-55	-64	-75	-88	-118	-160	-218						
30	40	+310	+170	+120		+80	+50		+25		+9	0		+10	+14	+24	-2+Δ		-9+Δ	-9	-17+Δ	0		-26	-34	-43	-48	-60	-68	-80	-94	-112	-148	-200	-274	1.5	3	4	5	9	14
40	50	+320	+180	+130																							-54	-70	-81	-97	-114	-136	-180	-242	-325						
50	65	+340	+190	+140		+100	+60		+30		+10	0		+13	+18	+28	-2+Δ		-11+Δ	-11	-20+Δ	0		-32	-41	-53	-66	-87	-102	-122	-144	-172	-226	-300	-405	2	3	5	6	11	16
65	80	+360	+200	+150																							-43	-59	-75	-102	-120	-146	-174	-236	-274	-360	-480						
80	100	+380	+220	+170		+120	+72		+36		+12	0		+16	+22	+34	-3+Δ		-13+Δ	-13	-23+Δ	0		-37	-51	-71	-91	-124	-146	-178	-214	-258	-335	-445	-585	2	4	5	7	13	19
100	120	+410	+240	+180																				-54	-79	-104	-144	-172	-210	-254	-310	-400	-525	-690						
120	140	+460	+260	+200																				-63	-92	-122	-170	-202	-248	-300	-365	-470	-620	-800						
140	160	+520	+280	+210		+145	+85		+43		+14	0		+18	+26	+41	-3+Δ		-15+Δ	-15	-27+Δ	0		-43	-65	-100	-134	-190	-228	-280	-340	-415	-535	-700	-900	3	4	6	7	15	23
160	180	+580	+310	+230																				-68	-108	-146	-210	-252	-310	-380	-465	-600	-780	-1000						
180	200	+660	+340	+240																				-77	-122	-166	-236	-284	-350	-425	-520	-670	-880	-1150						
200	225	+740	+380	+260		+170	+100		+50		+15	0		+22	+30	+47	-4+Δ		-17+Δ	-17	-31+Δ	0		-50	-80	-130	-180	-258	-310	-385	-470	-575	-740	-960	-1250	3	4	6	9	17	26
225	250	+820	+420	+280																				-84	-140	-196	-284	-340	-425	-520	-640	-820	-1050	-1350						
250	280	+920	+480	+300		+190	+110		+56		+17	0		+25	+36	+55	-4+Δ		-20+Δ	-20	-34+Δ	0		-56	-94	-158	-218	-315	-385	-475	-580	-710	-920	-1200	-1550	4	4	7	9	20	29
280	315	+1050	+540	+330																				-98	-170	-240	-350	-425	-525	-650	-790	-1000	-1300	-1700						
315	355	+1200	+600	+360		+210	+125		+62		+18	0		+29	+39	+60	-4+Δ		-21+Δ	-21	-37+Δ	0		-62	-108	-190	-268	-390	-475	-590	-730	-900	-1150	-1500	-1900	4	5	7	11	21	32
355	400	+1350	+680	+400																				-114	-208	-294	-435	-530	-660	-820	-1000	-1300	-1650	-2100						
400	450	+1500	+760	+440		+230	+135		+68		+20	0		+33	+43	+66	-5+Δ		-23+Δ	-23	-40+Δ	0		-68	-126	-232	-330	-490	-595	-740	-920	-1150	-1450	-1850	-2400	5	5	7	13	23	34
450	500	+1650	+840	+480																				-132	-252	-360	-540	-660	-820	-1000	-1250	-1600	-2100	-2600						
500	560					+260	+145		+76		+22	0					0		-26		-44			-78	-150	-280	-400	-600													
560	630																								-155	-310	-450	-660													
630	710					+290	+160		+80		+24	0					0		-30		-50			-88	-175	-340	-500	-740													
710	800																								-185	-380	-560	-840													
800	900					+320	+170		+86		+26	0					0		-34		-56			-100	-210	-430	-620	-940													
900	1000																								-220	-470	-680	-1050													
1000	1120					+350	+195		+98		+28	0					0		-40		-66			-120	-250	-520	-780	-1150													
1120	1250																								-260	-580	-840	-1300													
1250	1400					+390	+220		+110		+30	0					0		-48		-78			-140	-300	-640	-960	-1450													
1400	1600																								-330	-720	-1050	-1600													
1600	1800					+430	+240		+120		+32	0					0		-58		-92			-170	-370	-820	-1200	-1850													
1800	2000																								-400	-920	-1350	-2000													
2000	2240					+480	+260		+130		+34	0					0		-68		-110			-195	-440	-1000	-1500	-2300													
2240	2500																								-460	-1100	-1650	-2500													
2500	2800					+520	+290		+145		+38	0					0		-76		-135			-240	-550	-1250	-1900	-2900													
2800	3150																								-580	-1400	-2100	-3200													

Deviations = ± IT/2, where n is the IT value number

Values on the standard tolerance grades above IT7 increased by Δ

- Fundamental deviations A and B shall not be used for basic sizes less than or equal to 1 mm.
- For tolerance classes JS7 to JS11, if the IT value number, n, is an odd number, this may be rounded to the even number immediately below.
  So that the resulting deviations, i.e. $\pm \frac{IT_n}{2}$ can be expressed in whole micrometres
- For determining the values K, M and N for standard tolerance grades up to IT8 (incl.) and deviations P to ZC for standard tolerance grades up to IT7 (incl.) take the values from the columns on the right

(concl.) Examples:
K7 in the range 18 to 30 mm: Δ = 8µm, therefore ES = -2 + 8 = +6 µm
S6 in the range 18 to 30 mm: Δ = 4µm, therefore ES= -35 + 4 = -31µm

- Special cases for tolerance class M6 in the range from 250 to 315 mm. ES = -9 µm (instead of -11µm)
- Fundamental deviation N for standard tolerance grades above IT8 shall not be used for basic sizes less than or equal to 1mm.

10.0 BIBLOGRAPHY

The following standards on tolerancing and tolerance systems will be useful with regard to the application of this part of ISO 286:

AA0423103 (ISO 406) Technical drawings - Linear and angular tolerances - Indications on drawings.

AA0230415 (ISO 1101) Technical drawings - Geometrical tolerancing - Tolerancing of form, orientation, location and run out - Generalities, definitions, symbols, indications on drawings.

ISO 1829, Selection of tolerance zones for general purposes.

ISO 1947, System of cone tolerances for conical work pieces from C = 1:3 to 1:500 and lengths from 6 to 630 mm.

AA0230416 (ISO 2692) Technical drawings – Geometrical tolerancing Maximum material principle.

AA0230208 (ISO 2768-1) General tolerances for dimensions without tolerance indications - Part 1: Tolerances for linear and angular dimensions.[1)]

ISO 5166, System of cone fits for cones from C = 1:3 to 1 : 500 lengths from 6 to 630 mm and diameters up to 500 mm.

11.0 REFERRED STANDARDS (Latest publications including amendment)

1) AA0230206
2) AA0230415
3) AA0423103
4) AA0230416
5) AA0230208
6) ISO 8015 IS: 12160
7) ISO 1
8) ISO/R 1938
9) ISO 406
10) ISO 1101
11) ISO 1829
12) ISO 1947
13) ISO 2692
14) ISO 2768-1
15) ISO 5166

At present at the stage of draft. (Revision, in part of ISO 2768-1973)

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Annex A

Bases of the ISO System of limits and fits

A.3 General

This annex gives the bases of the ISO system of limits and fits. The data are given primarily so that values can be calculated for fundamental deviations, which may be required in very special circumstances and which are not given in the tables, and also so that a more complete understanding of the system is provided.

It is once more emphasized that the tabulated values in either this corporate standard or AA0230206 standard tolerances and fundamental deviations, are definitive, and shall be used when applying the system.

A.4 Basic size steps

For convenience, the standard tolerances and fundamental deviations are not calculated individually for each separate basic size, but for steps of the basic size as given in table 4. These steps are grouped into main steps and intermediate steps. The intermediate steps are only used in certain cases for calculating standard tolerances and fundamental deviations a to c and r to zc for shafts, and A to C and R to ZC for holes.

The values of the standard tolerances and fundamental deviations for each basic size step are calculated from the geometrical mean (D) of the extreme sizes (D_1 and D_2) of that step as follows:

$$D = \sqrt{D1 \times D2}$$

For the first basic size step (less than or equal to 3 mm) the geometrical mean, D according to convention, is taken between the sizes 1 and 3 mm, therefore D = 1.732 mm.

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Table 4 – Basic size steps

Values in millimetres

– Basic sizes up to 500 mm (incl.)			
Main steps		Intermediate steps [1]	
Above	Up to and including	Above	Up to and including
-	3	No subdivision	
3	6		
6	10		
10	18	10 14	14 18
18	30	18 24	24 30
30	50	30 40	40 50
50	80	50 65	65 80
80	120	80 100	100 120
120	180	120 140 160	140 160 180
180	250	180 200 225	200 225 250
250	315	250 280	280 315
315	400	315 355	355 400
400	500	400 450	450 500

– Basic sizes above 500 mm up to 3150 mm (incl.)			
Main steps		Intermediate steps [2]	
Above	Up to and including	Above	Up to and including
500	630	500 560	560 630
630	800	630 710	710 800
800	1000	800 900	900 1000
1000	1250	1000 1120	1120 1250
1250	1600	1250 1400	1400 1600
1600	2000	1600 1800	1800 2000
2000	2500	2000 2240	2240 2500
2500	3150	2500 2800	2800 3150

A.5 Standard tolerance grades

A.5.1 General

ISO system of limits and fits provides for 20 standard tolerance grades designated IT01, IT0, IT1....IT18 in the size range from 0 up to 500 mm (incl.) and 18 standard tolerance grades in the size range from 500 mm up to 3150 mm (incl.) designated IT1 to IT18.

As stated in the "Foreword" the ISO system is derived from ISA Bulletin 25, which only covered basic sizes up to 500 mm, and was mainly based on practical experience in industry. The system was not developed from a coherent mathematical base, and hence there are discontinuity in the system and differing formulae for the deviation of IT grades up to 500 mm.

The values for standard tolerances for basic sizes from 500 mm up to 3150 mm (incl.) were subsequently developed for experimental purposes, and since they have proved acceptable to industry they are now given as a part of the ISO system.

It should be noted that values for standard tolerances in grades IT0 and IT01 are not given in the main body of the standard because they have little use in practice; however, values for these are given in table 5.

[1] – These are used in certain cases for deviations a to b and r to zc or A to C and R to ZC (see tables 2 and 3).

[2] – These are used for the deviations r to u and R to U (see tables 2 and 3).

Table 5 – Numerical values for standard tolerances in grades IT01 and IT0

Basic size mm		Standard tolerance grades	
		IT01	IT0
Above	Up to and including	Tolerances µm	
-	3	0.3	0.5
3	6	0.4	0.6
6	10	0.4	0.6
10	18	0.5	0.8
18	30	0.6	1
30	50	0.6	1
50	80	0.8	1.2
80	120	1	1.5
120	180	1.2	2
180	250	2	3
250	315	2.5	4
315	400	3	5
400	500	4	6

A.5.2 Derivation of standard tolerances (IT) for basic sizes up to and including 500 mm

A.5.2.1 Standard tolerance grades IT01 to IT4

The values of standard tolerances in grades IT01, IT0 and IT1 are calculated from the formulae given in table 6. It should be noted that no formulae are given for grades IT2, IT3 and IT4. The values for tolerances in these grades have been approximately scaled in geometrical progression between the values for IT1 and IT5.

Table 6 – Formulae for standard tolerances in grades IT01, IT0 and IT1 for basic sizes up to and including 500 mm

Values in micrometers

Standard tolerance grade	Formula for calculation where D is geometric mean of the basic size in millimetres
IT01[1)]	0.3+0.008D
IT0[1)]	0.5+0.012D
IT1	0.8+0.020D

– See the "Foreword" and A.3.1

A.5.2.2 Standard tolerance grades IT5 to IT18

The values for standard tolerances in grades IT5 to IT18 for basic sizes up to and including 500 mm are determined as a function of the standard tolerance factor, i.

The standard tolerance factor, i, in micrometres, is calculated from the following formula:

$i = 0.45 \sqrt[3]{D} + 0.001\ D$

Where D is the geometric mean of the basic size step in millimetres (see clause A.2).

This formula was empirically derived, being based on various national practices and on the premise that, for the same manufacturing process, the relationship between the magnitude of the manufacturing errors and the basic size approximates a parabolic function.

The values of the standard tolerances are calculated in terms of the standard tolerance factor, i, as shown in table 7.

It should be noted that from IT6 upwards, the standard tolerances are multiplied by a factor of 10 at each fifth step. This rule applies to all standard tolerances and may be used to extrapolate values for IT grades above IT18.

Example:

IT20 = IT15 x 10 = 640i x 10 = 6400 i

Note – The above rule applies except for IT6 in the basic size range from 3 to 6 mm (incl.)

Table 7 – Formulae for standard tolerances in grades IT1 to IT18

Basic size mm		Standard tolerance grades																	
		IT1[1)]	IT2[1)]	IT3[1)]	IT4[1)]	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
Above	Up to and including	Formulae for standard tolerances (Results in micrometres)																	
-	500	-	-	-	-	7*i*	10*i*	16*i*	25*i*	40*i*	64*i*	100*i*	160*i*	250*i*	400*i*	640*i*	1000*i*	1600*i*	2500*i*
500	3150	2*i*	2.7*i*	3.7*i*	5*i*	7*i*	10*i*	16*i*	25*i*	40*i*	64*i*	100*i*	160*i*	250*i*	400*i*	640*i*	1000*i*	1600*i*	2500*i*

– See A.3.2.1

A.5.3 Derivation of standard tolerances (IT) for basic sizes from 500 mm up to and including 3150 mm

The values for standard tolerances I grades IT1 to IT18 are determined as a function of the standard tolerance factor, I.

Standard tolerance factor, I, in micrometres, is calculated from the following formula:

I = 0.004D + 2.1

Where D is the geometric mean of the basic size step in millimetres (see clause A.2).

The values of the standard tolerances are calculated in terms of the standard tolerance factor, *i*, as shown in table 7.

It should be noted that from IT6 upwards, the standard tolerances are multiplied by a factor of 10 at each fifth step. This rule applies to all standard tolerances and may be used to extrapolate values for IT grades above IT18.

Examples:

IT20 = IT15 x 10 = 640*i* x 10 = 6400*i*

NOTES

– The formulae for standard tolerance in grades IT1 to IT5 are given on a provisional basis only. (These did not appear in ISO/R 286-1962)

– Although the formulae for i and I vary, continuity of progression is assured for the transition range.

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A.5.4 Rounding of values for standard tolerances

For each basic size step, the values obtained from the formulae given in A.3.2 and A.3.3 for standard tolerances in grades up to and including IT11, are rounded off in accordance with the rules given in table 8.

The calculated values of standard tolerances in grades above IT11 do not require rounding off because they are derived from values of tolerance grade IT7 to IT11, which have already been rounded off.

Table 8 – Rounding for IT values up to and including standard tolerance grade IT11

Rounding values in micrometres

Calculated values obtained from the formulae given in A.3.2 and A.3.3		Basic size	
		Up to 500 mm (incl.)	Above 500 mm up to 3150 mm (incl.)
Above	Up to and including	Rounding in multiples of	
0	60	1	1
60	100	1	2
100	200	5	5
200	500	10	10
500	1000	-	20
1000	2000	-	50
2000	5000	-	100
5000	10000	-	200
10000	20000	-	500
20000	50000	-	1000

NOTES

- For the small values in particular, it has sometimes been necessary to depart from these rules, and, in some instances, even from the application of the formulae given in A.3.2 and A.3.3 in order to ensure better scaling. Therefore the values given for the standard tolerances in tables 1 to 5 as appropriate, shall be used in preference to calculated values when applying the ISO system.
- Values for standard tolerances in grades IT1 to IT18 are given in table 1 and for IT0 and IT01 in table 5.

A.6 Derivation of fundamental deviations

A.6.1 Fundamental deviations for shafts

The fundamental deviations for shafts are calculated from the formulae given in table 9.

The fundamental deviation given by the formulae in table 9 is, in principle, that corresponding to the limits closest to the zero line i.e. the upper deviation for shafts a to h and the lower deviation for shafts k to zc.

Except for shafts j and js, for which, strictly speaking, there is no fundamental deviation, the value of the deviation is independent of the selected grade of tolerance (even if the formula includes a term involving ITn).

A.6.2 Fundamental deviations for holes

The fundamental deviations for holes are calculated from the formulae given in table 9 and, therefore, the limit corresponding to the fundamental deviation for a hole is exactly symmetrical in relation to the zero line, to the limit corresponding to the fundamental deviation for a shaft with the same letter.

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This rule applies to all fundamental deviations except for the following.

- Deviation N, for standard tolerance grades IT9 to IT16 in basic sizes above 3 mm up to 500 mm (incl.) for which the fundamental deviation is zero.
- Shaft of hole basis fits, for basic sizes above 3 up to 500 mm (incl.) in which a hole of a given standard tolerance grade is associated with a shaft of the next finer grade (e.g) H7/P6 and P7/h6) and which are required to have exactly the same clearance or interferences, see figure 20.

In the cases, the fundamental deviation, as calculated, is adjusted by algebraically adding the value of Δ as follows:

ES = ES (as calculated) + Δ

Where Δ is the difference ITn- IT(n-1) between the standard tolerance, for the basic size step in the given grade, and that in the next finer grade.

Example:

For P7 in the basic size range from 18 to 30 mm:

Δ = IT7 – IT6 = 21 – 13 = 8 μm

NOTE – The rule given in b) above is only applicable for basic sizes over 3 mm for fundamental deviations K, M and N in standard tolerance grades up to and including IT8 and deviations P to ZC in standard tolerance grades up to and including IT7.

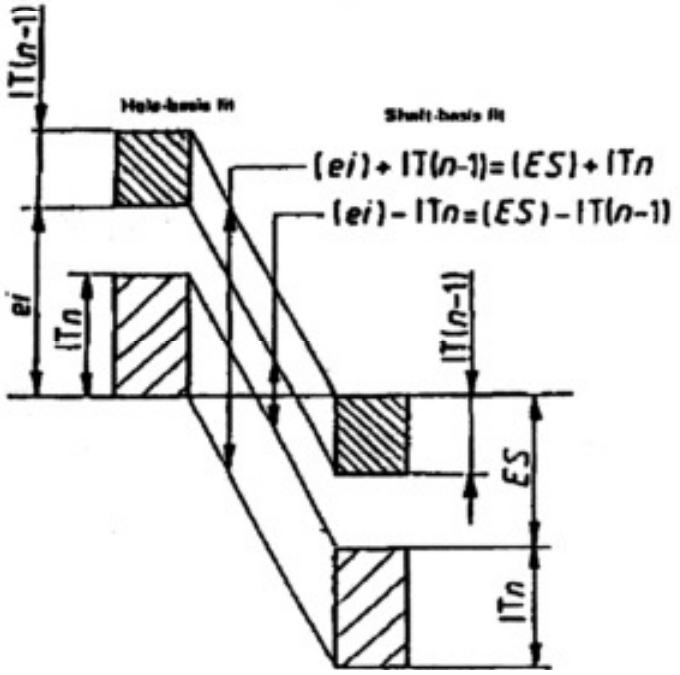

Figure 20 – Diagrammatic representation of the rule given A 4.2b)

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The fundamental deviation given by the formulae in table 9 is, in principle, that corresponding to the limits closest to the limits closest to the zero line, i.e. the lower deviation for holes A to H and the upper deviation for holes K to ZC.

Except for holes J and JS, for which, strictly speaking, there is no fundamental deviation, the value of the deviation is independent of the selected grade of tolerance (even if the formula includes a term involving ITn).

A.6.3 Rounding of values for fundamental deviations

For each basic size step, the values obtained from the formulae given in table 9 are rounded off in accordance with the rules given in table 10.

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Table 9 - Formulae for fundamental deviations for shafts and holes

Basic size mm		Shafts				Holes			Basic size mm	
Above	Up to and including	Fundamental deviation	Sign (negative or positive)	Designation	Formulae[1] where D is the geometric mean of the basic size in millimetres	Designation	Sign (negative or positive)	Fundamental deviation	Above	Up to and including
1	120	A	-	es	265 + 1.3D	EI	+	A	1	120
120	500				3.5D				120	500
1	160	B	-	es	≈140 + 0.85D	EI	+	B	1	160
160	500				≈ 1.8D				160	500
0	40	C	-	es	$52D^{0.2}$	EI	+	C	0	40
40	500				95 + 0.8D				40	500
0	10	cd	-	es	Geometric mean of the values for C.c and D.d	EI	+	CD	0	10
0	3150	d	-	es	$16D^{0.44}$	EI	+	D	0	3150
0	3150	e	-	es	$11D^{0.41}$	EI	+	E	0	3150
0	10	ef	-	es	Geometric mean of the values for E.e and F.f	EI	+	EF	0	10
0	3150	f	-	es	$5.5D^{0.41}$	EI	+	F	0	3150
0	10	fg	-	es	Geometric mean of the values for F.f and G.g	EI	+	FG	0	10
0	3150	g	-	es	$2.5D^{0.34}$	EI	+	G	0	3150
0	3150	h	No sign	es	Deviation=0	EI	No sign	H	0	3150
0	500	j			No formula[2]			J	0	500
0	3150	js	+ or -	es ei	0.5IT*n*	EI ES	+ -	JS	0	3150
0	500[3]	k	+	ei	$0.6\sqrt[3]{D}$	ES	-	K[4]	0	500[5]
500	3150		No sign		Deviation=0		No sign		500	3150
0	500	m	+	ei	IT7-IT6	ES	-	M[4]	0	500
500	3150				0.024D+12.6				500	3150
0	500	n	+	ei	$5D^{0.34}$	ES	-	N[4]	0	500
500	3150				0.04D + 21				500	3150
0	500	p	+	ei	IT7+ 0 to 5	ES	-	P[4]	0	500
500	3150				0.072D+37.8				500	3150
0	3150	r	+	ei	Geometric mean of the values for P,p and S,s	ES	-	R[4]	0	3150
0	50	s	+	ei	IT8 + 1 to 4	ES	-	S[4]	0	50
50	3150				IT7 + 0.4D				50	3150
24	3150	t	+	ei	IT7+0.63D	ES	-	T[4]	24	3150
0	3150	u	+	ei	IT7+D	ES	-	U[4]	0	3150
14	500	v	+	ei	IT7+1.25D	ES	-	V[4]	14	500
0	500	x	+	ei	IT7+1.6D	ES	-	X[4]	0	500
18	500	y	+	ei	IT7+2D	ES	-	Y[4]	18	500
0	500	z	+	ei	IT7+2.5D	ES	-	Z[4]	0	500
0	500	za	+	ei	IT8+3.15D	ES	-	ZA[4]	0	500
0	500	zb	+	ei	IT9+4D	ES	-	ZB[4]	0	500
0	500	zc	+	ei	IT10+5D	ES	-	ZC[4]	0	500

- Fundamental deviations (i.e. results from formula) in micrometres.
- Values only given in tables 2 and 3
- Formula only applies to grades IT4 to IT7 inclusively; fundamental deviation k for all other basic sizes and all other IT grades = 0
- Special rule applies (see A.4.2.b)
- Formula only applies to grades up to IT8 inclusively; fundamental deviation K for all other basic sizes and all other IT grades = 0

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Table 10 – Rounding for fundamental deviations

Rounding values in micrometres

Calculated vales obtained from the formulae given in table 9 µm		Basic size		
		Up to 500 mm (incl.)		Above 500 mm up to 3150 mm (incl.)
		Fundamental deviations		
Above	Up to and including	a to g A to G	k to zc K to ZC	d to u D to U
		Rounding in multiples of		
5	45	1	1	1
45	60	2	1	1
60	100	5	1	2
100	200	5	2	5
200	300	10	2	10
300	500	10	5	10
500	560	10	5	20
560	600	20	5	20
600	800	20	10	20
800	1000	20	20	20
1000	2000	50	50	50
2000	5000		100	100
...	...			...
20×10^n	50×10^n			1×10^n
50×10^n	100×10^n			2×10^n
100×10^n	200×10^n			5×10^n

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Annex B
Examples of the use of ISO 286-1

B.6 General

This annex gives examples in the use of the ISO system of limits and fits, in determining the limits for shafts and holes.

The numerical values of the upper and lower deviations for the more generally used basic size steps, fundamental deviations and tolerance grades have been calculated and are tabulated in AA0230206.

In special cases, not covered by AA0230206 the appropriate upper and lower deviations, and hence the limits of size, can be calculated from the data given in tables 1 to 3, and tables 4 to 6 in annex A in this Corporate Standard.

B.7 Review of special features

A summary of the features and factors which shall be taken into consideration when using this part of ISO 286 to derive upper and lower deviations for special cases is given below:

- Shafts and holes a, A, b, B are provided only for basic sizes greater than 1 mm;
- Shafts j8 are provided only for basic sizes less than or equal to 3 mm;
- Holes K in tolerance grades above IT8 are provided only for basic sizes less than or equal to 3 mm;
- Shafts and holes t, T, v, V and y, Y are only provided for basic sizes greater than 24 mm, 14 mm and 18 mm, respectively (for smaller basic sizes, the deviations are practically the same as those of the adjacent tolerance grades);
- Tolerance grades IT14 to IT8 are only provided for basic sizes greater than 1 mm;
- Holes N of tolerance grades above IT8 are only provided for basic sizes greater than 1 mm.

B.8 Examples

B.8.1 Determining the limits of size for a shaft Φ 40g11

Basic size step: 30 to 15 mm (from table 4)
Standard tolerance = 160 µm (from table 1)
Fundamental deviation = - 9 µm (from table 2)
Upper deviation = fundamental deviation = - 9 µm
Lower deviation = fundamental deviation - tolerance = -9 - 160 µm = -169 µm
Limits of size:
Maximum = 40-0.009 = 39.991 mm
Minimum = 40-0.169 = 39.831 mm

B.8.2 Determining the limits of size for hole Φ 130N4

Basic size step: 120 to 180 mm (from table 4)
Standard tolerance = 12 µm (from table 1)
Fundamental deviation = -27 + Δ µm (from table 3)
Value of Δ = 4 µm (from table 3)
Upper deviation = fundamental deviation
= -27 + 4 = -23 µm
Lower deviation = fundamental deviation – tolerance
= -23 -12 µm = -35 µm
Limits of size:
Maximum = 130-0.023 = 129.977 mm
Minimum = 130-0.035 = 129.965 mm

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DIMENSIONS FOR SCREW THREAD RUNOUTS AND UNDERCUTS

1.0 SCOPE

This standard covers the dimensions for runouts and undercuts for external and internal metric screw threads with pitches 0.2 to 6 mm.

2.0 COMPLANCE WITH STANDARDS

This standard is technically identical to IS: 1369-1993/ Reaffirmed 2008

3.0 RUNOUTS

3.1 **Runouts**, whenever it occurs, shall include the washout threads and clearance, where a clearance is required.

3.2 **Runouts for External Threads** - The width of runout 'X' shall be measured from the point at which the thread root ceases to be fully formed. The dimensions for runout for external threads shall be as given in Table-1.

3.3 **Runouts for Internal Threads** - The width of runout shall be measured from the point at which the thread root ceases to be fully formed. The runout dimension shall be given in Table-2. The figure in Table-2 showing runout illustrates a blind tapped hole. The dimension 'e' indicates the additional length needed for taping and swarf clearance.

4.0 UNDERCUTS

4.1 **Undercuts for External Threads** - The form of undercut illustrated in Table-1. Two values of width of undercuts f_1 and f_2 are provided. Width f_1 is the clear width and f_2 is the width upto the latest full form thread. These values are given in Table-1. The diameter of undercut 'g' shall be as given in Table-1.

4.2 **Undercuts for Internal Threads** - The form of undercut illustrated in Table-2. Two values of width of undercuts f_1 and f_2 are provided. Width f_1 is the clear width and f_2 is from the starting of the transition angle. These values are given in Table-2. The diameter of undercut 'g' shall be as given in Table-2

5.0 GUIDE FOR APPLICATION

Guidelines for application of thread runout and undercut values are given in Notes Table 1 and 2.

6.0 REFERRED STANDARDS (Latest publications including Amendments)

1) Nil

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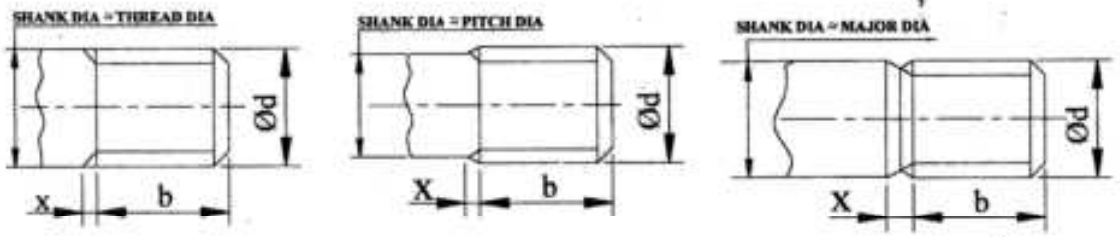
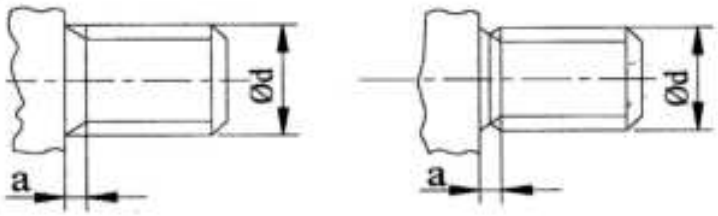
TABLE-1 DIMENSIONS FOR BLIND HOLE PROJECTION AND UNDERCUTS FOR INTERNAL THREADS

(Clauses 3.2 and 4.1)

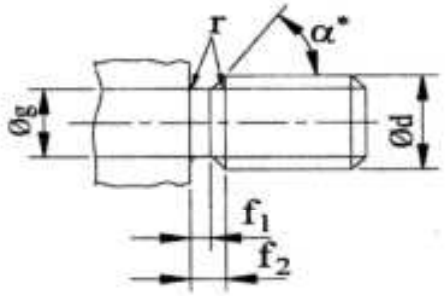
All dimension in millimetres



MACHINED THREAD **ROLLER THREADS**



PARTS THREADED UPTO HEAD



THREADED UNDERCUT

a = distance from last full thread to contact face

b = length of full thread

x = thread runout

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Pitch P	Thread Runout x Max.		Runout Distance a Max.			Thread Undercut g	f_1 Min.		f_2 Max.		r ≈
	Normal (see Note1)	Short (see Note 2)	Normal (see Note 3)	Short (see Note 4)	Long (see Note 5)	h13 (see Note 6)	Normal	Short (see Note 7)	Normal	Short (see Note 7)	
0.2	0.5	0.25	0.6	0.4	0.8	d-0.3	0.45	0.25	0.7	0.5	0.1
0.25	0.6	0.3	0.75	0.5	1	d-0.4	0.55	0.25	0.9	0.6	0.12
0.3	0.75	0.4	0.9	0.6	1.2	d-0.5	0.6	0.3	1.05	0.75	0.15
0.35	0.9	0.45	1.05	0.7	1.4	d-0.6	0.7	0.4	1.2	0.9	0.17
0.4	1	0.5	1.2	0.8	1.6	d-0.7	0.8	0.5	1.4	1	0.2
0.45	1.1	0.6	1.35	0.9	1.8	d-0.7	1	0.5	1.6	1.1	0.22
0.5	1.25	0.7	1.5	1	2	d-0.8	1.1	0.5	1.75	1.25	0.25
0.6	1.5	0.75	1.8	1.2	2.4	d-1	1.2	0.6	2.1	1.5	0.3
0.7	1.75	0.9	2.1	1.4	2.8	d-1.1	1.5	0.8	2.45	1.75	0.35
0.75	1.9	1	2.25	1.5	3	d-1.2	1.6	0.9	2.6	1.9	0.4
0.8	2	1	2.4	1.6	3.2	d-1.3	1.7	0.9	2.8	2	0.4
1	2.5	1.25	3	2	4	d-1.6	2.1	1.1	3.5	2.5	0.5
1.25	3.2	1.6	4	2.5	5	d-2	2.7	1.5	4.4	3.2	0.6
1.5	3.8	1.9	4.5	3	6	d-2.3	3.2	1.8	5.2	3.8	0.75
1.75	4.3	2.2	5.3	3.5	7	d-2.6	3.9	2.1	6.1	4.3	0.9
2	5	2.5	6	4	8	d-3	4.5	2.6	7	5	1
2.5	6.3	3.2	7.5	5	10	d-3.6	5.6	3.2	8.7	6.3	1.25
3	7.5	3.8	9	6	12	d-4.4	6.7	3.7	10.5	7.5	1.5
3.5	9	4.5	10.5	7	14	d-5	7.7	4.7	12	9	1.75
4	10	5	12	8	16	d-5.7	9	5	14	10	2
4.5	11	5.5	13.5	9	18	d-6.4	10.5	5.5	16	11	2.25
5	12.5	6.3	15	10	20	d-7	11.5	6.5	17.5	12.5	2.5
5.5	14	7	16.5	11	22	d-7.7	12.5	7.5	19	14	2.75
6	15	7.5	18	12	24	d-8.3	14	8	21	15	3
Indicated dimensions approximately correspond to	2.5P	1.25P	3P	2P	4P	-	-	-	3.5P	2.5 P	0.5P

Note 1- Runout x normal for all types of screws in product Grades A, B and C [see IS: 1367 (Part 2)-1979 Technical supply conditions for threaded steel fasteners: Part II Product graders and tolerances (second revision)].

Note 2- Runout x short only in cases where a short runout is required for technical reasons.

Note 3- Distance *a* normal for all types of screws in product Grade A.

Note 4- Distance *a* short for special cases in which for technical reasons a short distance is necessary.

Note 5- Distance *a* long for all types of screws in product Grades B and C.

Note 6- Tolerance zone h12 for *g* for threads up to 3 mm nominal diameter.

Note 7- Undercut short is for special cases. This short undercut requires special tools for thread manufacture.

*The value of transition angle α for the range between f_1 and f_2 shall be 30° to 60° depending on the method of thread manufacture.

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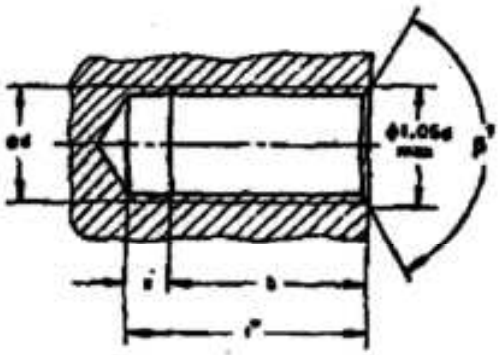
CORPORATE STANDARD

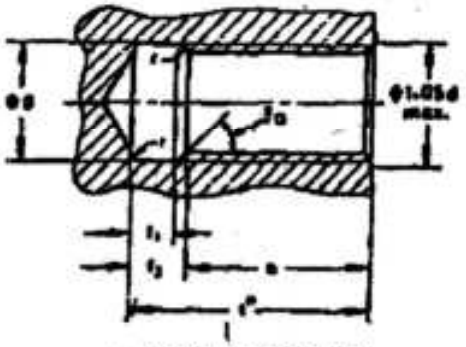
TABLE 2 DIMENSIONS FOR THREAD RUNOUTS AND UNDERCUTS FOR EXTERNAL THREADS

(Clauses 3.3 and 4.2)

All dimension in millimetres



BLIND HOLE PROJECTION



THREAD UNDERCUT

b = length of full thread

Pitch P	Blind Hole Projection e			Thread Undercut					r ≈
	Normal	Short	Long	g H13	f_1 Min.		f_2 Max.		
					Normal	Short (see Note)	Normal	Short (see Note)	
0.2	1.3	0.8	2	d+0.1	0.8	0.5	1.2	0.9	0.1
0.25	1.5	1	2.4	d+0.1	1	0.6	1.4	1	0.12
0.3	1.8	1.2	2.9	d+0.1	1.2	0.75	1.6	1.25	0.15
0.35	2.1	1.3	3.3	d+0.2	1.4	0.9	1.9	1.4	0.17
0.4	2.3	1.5	3.7	d+0.2	1.6	1	2.2	1.6	0.2
0.45	2.6	1.6	4.1	d+0.2	1.8	1.1	2.4	1.7	0.22
0.5	2.8	1.8	4.5	d+0.3	2	1.25	2.7	2	0.25
0.6	3.4	2.1	5.4	d+0.3	2.4	1.5	3.3	2.4	0.3
0.7	3.8	2.4	6.1	d+0.3	2.8	1.75	3.8	2.75	0.35
0.75	4	2.5	6.4	d+0.3	3	1.9	4	2.9	0.4
0.8	4.2	2.7	6.8	d+0.3	3.2	2	4.2	3	0.4
1	5.1	3.2	8.2	d+0.5	4	2.5	5.2	3.7	0.5
1.25	6.2	3.9	10	d+0.5	5	3.2	6.7	4.9	0.6
1.5	7.3	4.6	11.6	d+0.5	6	3.8	7.8	5.6	0.75
1.75	8.3	5.2	13.3	d+0.5	7	4.3	9.1	6.4	0.9
2	9.3	5.8	14.8	d+0.5	8	5	10.3	7.3	1
2.5	11.2	7	17.9	d+0.5	10	6.3	13	9.3	1.25
3	13.1	8.2	21	d+0.5	12	7.5	15.2	10.7	1.5
3.5	15.2	9.5	24.3	d+0.5	14	9	17.7	12.7	1.75
4	16.8	10.5	26.9	d+0.5	16	10	20	14	2
4.5	18.4	11.5	29.4	d+0.5	18	11	23	16	2.25
5	20.8	13	33.3	d+0.5	20	12.5	26	18.5	2.5
5.5	22.4	14	35.8	d+0.5	22	14	28	20	2.75
6	24	15	38.4	d+0.5	24	15	30	21	3
Indicated dimensions approximately correspond to	6.3P To 4P	4P To 2.5P	10P To 6.3P	-	4P	2.5P	-	-	0.5P

Note- The undercut short is for special cases.

*Recommended permissible tolerance for calculated distance t: $^{+0.5P}_{0}$

† The countersunk angle ß will normally be $120°^{0}_{-10°}$ in special cases it may be 90°. For studs with runout and for centre holes an angle of 60° is recommended, while for studs in light metal a counter bore it recommended.

‡ The value of transition angle α for the range between f_1 and f_2 shall be 30° to 60° depending on the method of thread manufacture.

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	CORPORATE STANDARD	AA7111124
		Rev No.07
		PAGE 1 of 3

BOLTS, HEXAGON HEAD, PRODUCT Gr: 'A' COARSE PITCH, STEEL, PROPERTY CLASS 8.8 (M20 – M24)

1.0 DISIGNATION:

A product Gr.A, hexagon head, steel bolt to M20, length 80 mm, coarse pitch and conforming to property class 8.8 shall be designated as:

1.1 On drawings:

i). Material specification column : AA7111124

ii). Description column : BOLT HEX A M20 X 80 – 8.8

1.2 On indents: Bolt Hex A M20 X 80 – 8.8: AA7111124

1.3 For issuing enquiries and on purchase orders:

While issuing enquiries and purchase orders, delete BHEL standard number from above description and add the information given under clause 2.0

2.0 COMPLIANCE WITH STANDARDS:

2.1 Dimensions, Tolerances & General Requirements:

As per IS:1364, Part 1–2002, Reaffirmed 2007

2.2 Mechanical Properties:

To conform to property class 8.8, as specified in Table-3 of IS:1367, Part 3

2.3 Threads:

Pitch – Coarse to IS:4218, Part 2

Tolerance quality – Medium

Tolerance class – 6g

2.4 Identification Marking: As stated in clause 9 of IS:1367, Part 3

2.5 Surface Discontinuity: As per IS:1367, Part 9

2.6 Finish: Plated as specified in BHEL order.

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c S-920

Revisions: Clause No. 31.4.0 of MOM of MRC-F			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC(F)		
Rev No.07	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:02-07-2013	Dt:	Year:	HEEP, Haridwar	Corp.R&D	December1976

CORPORATE STANDARD

3.0 NOTE:

3.1 Length and diameter combination (refer Table 1 on page 3 of 3) between the bold lines should only be used.

3.2 For screw threads, general (Metric) refer to BHEL standard AA0231800

3.3 For tolerance grade, position and class refer to BHEL standard AA0230201

3.4 Bolts to this standard would be un-plated, divisions wishing to have plated bolts would have to get them plated.

3.5 Weights given in this standard are for general reference only and are not meant for commercial transactions.

3.6 When fasteners are to be tested with in BHEL, the sampling and acceptance plan shall be as per IS:1367, part 17

4.0 REFERRED STANDARDS (Latest publications including amendment):

1) AA0231850 2) IS:1367, Pt.3, 9 & 17 3) IS:4218, Pt.2
4) AA0231800 5) AA0230201

EXPLANATORY NOTE

The following changes have been made in this revision:

- Clause 2.1 "Dimensions, Tolerances & General Requirements", has been modified as "As per IS:1364, Part 1-2002, Reaffirmed 2007"
- Clause 2.2 "Mechanical properties" year "2002" of IS:1367, Part 3 has been removed.
- Clause 4.0 has been modified accordingly.
- Figure and Table -1 on page 3 of 3 have been updated.

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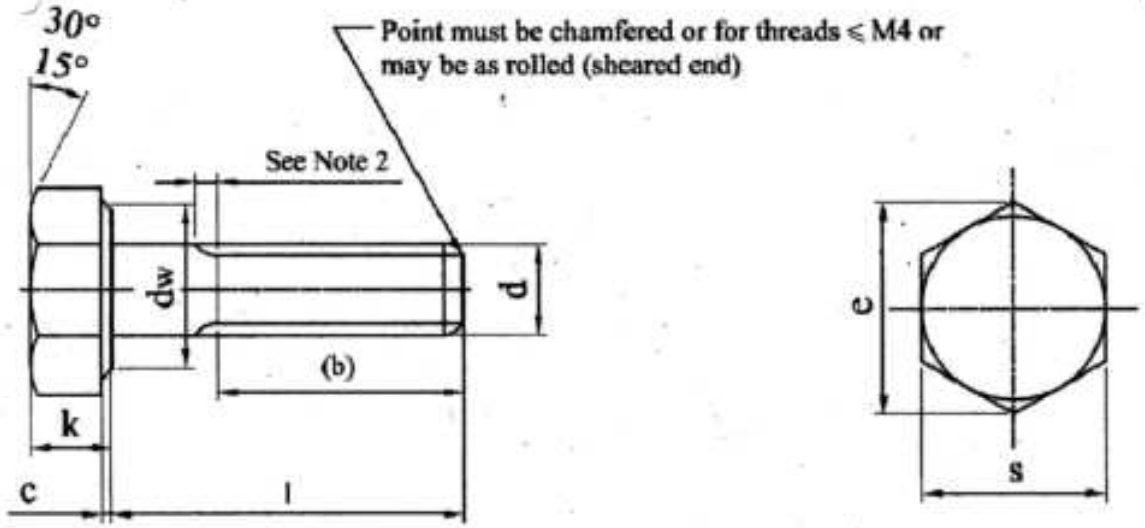

Note:

1) Corporate code numbers are shown below.
2) For thread runout refer AA0231850
3) Weights have been shown in kg per 1000Nos
4) Symbol Δ denotes non-preferred size.

TABLE–1 (All dimensions are in 'mm')

Thread Size d	Head			Washer		Thread Length b			Nominal Length (l)										
	Flats s Max. / Min	Cms e Min.	Thks k Max. / Min.	Dia. dw Min.	Thks c Max. / Min.	For Nom. Length ≤125	For Nom. Length >125 & ≤200		65	70	75	80	90	100	110	120	130	140	150
M 20	30.0 / 29.67	33.53	12.72 / 12.28	28.2	0.8 / 0.2	46	52	Sub Code	014 Δ	235 Δ	049 Δ	057	065	022	073	081		090	103
								Weight	220	232	243	255	282	307	331	356		392	428
M24	36.0 / 35.38	39.98	15.22 / 14.78	33.6	0.8 / 0.2	54	60	Sub Code	111 Δ			120 Δ	138	030	146	154	162		170
								Weight	330			384	419	455	490	526	560		629

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ES- 920

ISO SYSTEM OF LIMITS AND FITS

TABLES OF STANDARD TOLERANCE GRADES AND LIMIT DEVIATIONS FOR HOLES AND SHAFTS

1.0 SCOPE

This corporate standard gives values of the limit deviations for commonly used tolerance classes (zone) for holes and shafts calculated from the information given in AA0230201. This corporate standard covers values for the upper deviations ES (for holes) and es (for shafts), and the lower deviations EI (for holes) and ei (for shafts) (see figure 1).

NOTE – In the tables of limit deviations, the values for the upper deviations ES or es are shown above the values for the lower deviation EI or ei except for tolerance class JS and js which is symmetrical about the zero line.

1.1 This Corporate Standard is based on IS: 919 (Part-2) – 1993, Reaffirmed 2008/ ISO 286-2.

2.0 FIELD OF APPLICATION

The ISO system of limits and fits provides a system of tolerances and deviations suitable for plain work pieces.

It should be noted that the general term "hole" or "shaft" used in this Corporate Standard can be taken as referring to the space contained by (or containing) two parallel faces (or tangent planes) of any work piece, such as the width of a slot or the thickness of a key (see also AA0230201). Similarly, the term "commonly used holes and shafts" shall be interpreted as providing a very wide choice of limit deviations suitable for a wide variety of requirements.

For further information on terminology, symbols, bases of the system, etc., see AA0230201.

Notes on the presentation of tables 2 to 32 are given on page 7.

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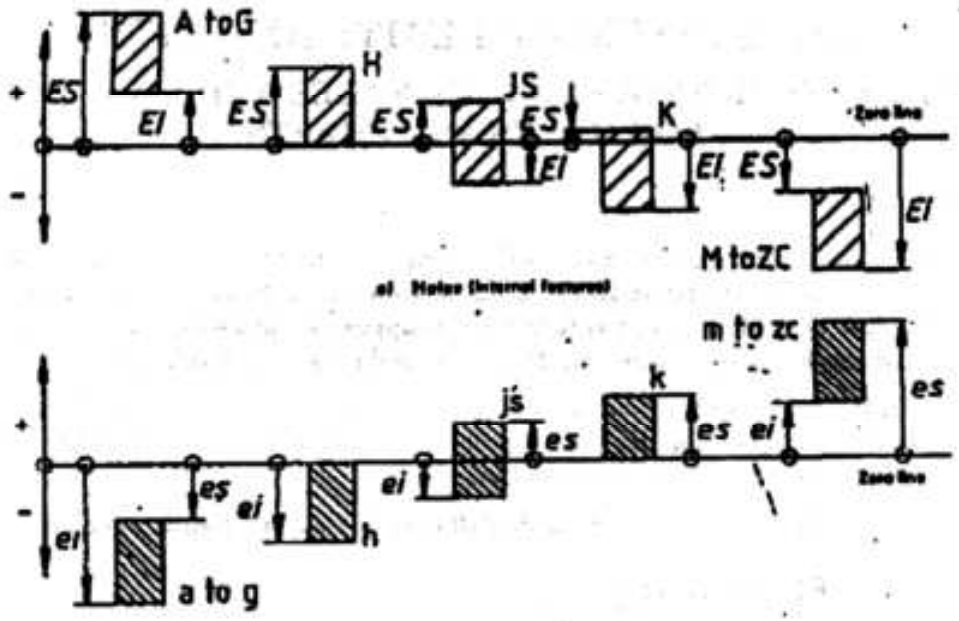
CORPORATE STANDARD



a) Holes (internal features)

b) Shafts (external features)

Figure 1 – Upper and Lower deviation

3.0 REFERENCES

Note – See also clause 7.

AA0230201 (ISO 286-1): ISO system of limits and fits: Bases of tolerances, deviations and fits.

ISO 1829, Selecting of tolerance zones for general purposes.

4.0 STANDARD TOLERANCES

The values of standard tolerance grades IT1 to IT18 inclusive are given in table 1.

For information on the bases of the system and its application, see AA0230201: for values of standard tolerances IT0 and IT01, See AA0230201, annex A, table 5.

5.0 LIMIT DEVIATIONS FOR HOLES

A synoptic representation of the tolerance classes for holes, given in AA0230206, is shown in figures 2 and 3. Attention is drawn to the fact that the tolerance classes shown in figures 2 and 3, and their limit deviation, given in tables 2 to 16, are not intended to give detailed directives on the selection of tolerance classes for any purpose. Recommendations for the selection of tolerance classes are given in ISO 1829.

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NOTE – Some tolerance classes are only provided for a restricted range of basic size steps. For further information, see note 1 on page 7.

6.0 LIMIT DEVIATIONS FOR SHAFTS

A synoptic representation of the tolerance classes for shafts, given in AA0230206, is shown in figures 4 and 5.

Attention is drawn to the fact that the tolerance classes shown in figures 4 and 5, and their limit deviations, given in table 17 to 32, are not intended to give detailed directives on the selection of tolerance classes for any purpose, Recommendations for the selection of tolerance classes are given in ISO 1829.

NOTE – Some tolerance classes are only provided for a restricted range of basic size steps. For further information, see note 1 on page 7.

7.0 BIBILOGRAPHY

The following Corporate Standards on tolerancing and tolerance systems will be useful with regard to the application of this Corporate Standard AA0230206.

AA0423103 (ISO 406): Technical drawings – Linear and angular tolerancing indications on drawings.

AA0230415 (ISO 1101): Technical drawings – Geometrical tolerancing – Tolerancing of form, orientation, location and run-out-Generalities, definitions, symbols, indications on drawings.

ISO/R 1938, ISO system of limits and fits – Inspection of plain work pieces[1)]

AA0230416 (ISO 2692): Technical drawings – Geometrical tolerancing – Maximum material principle.

AA0230208 (ISO 2768-1): General tolerances for dimensions without tolerance indications – Part 1: Tolerances for linear and angular dimensions.[2)]

ISO 5166, System of cone fits for cones from C = 1:3 to 1: 500, lengths from 6 to 630 mm and diameters up to 500 mm.

AA0230401 (ISO 8015): Technical drawings – Fundamental tolerancing principle.

ISO 8062, Castings – System of dimensional tolerances.

1) At present under revision.
2) At present at the stage of draft. (Revision, in part of ISO 2768: 1973)

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CORPORATE STANDARD

Table 1 Numerical values of standard tolerance grade IT for basic sizes up to 3150 mm

Note – This table, taken from AA0230201 (ISO 286-1), has been included in AA0230206 to facilitate understanding and use of the system.

Basic size mm		Standard tolerance grades																	
		IT1[2]	IT2[2]	IT3[2]	IT4[2]	IT5[2]	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14[3]	IT15[3]	IT16[3]	IT17[3]	IT18[3]
Above	Upto and including	Tolerances																	
		μm											mm						
-	3[3]	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
50	80	2	3	5	8	13	19	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
180	250	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
500	630[2]	9	11	16	22	32	44	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11
630	800[2]	10	13	18	25	36	50	80	125	200	320	500	0.8	1.25	2	3.2	5	8	12.5
800	1000[2]	11	15	21	28	40	56	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
1000	1250[2]	13	18	24	33	47	66	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	10.5	16.5
1250	1600[2]	15	21	29	39	55	78	125	195	310	500	780	1.25	1.95	3.1	5	7.8	12.5	19.5
1600	2000[2]	18	25	35	46	65	92	150	230	370	600	920	1.5	2.3	3.7	6	9.2	15	23
2000	2500[2]	22	30	41	55	78	110	175	280	440	700	1100	1.75	2.8	4.4	7	11	17.5	28
2500	3150[2]	26	36	50	68	96	135	210	330	540	860	1350	2.1	3.3	5.4	8.6	13.5	21	33

1) Values for standard tolerance grades IT01 and IT0 for basic sizes less than or equal to 500 mm are given in ISO 286-1, annex A. Table 5.
2) Values for standard tolerance grades IT1 and IT5 (incl.) for basic sizes over 500 mm are included for experimental use.
3) Standard tolerance grades IT14 and IT18 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

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2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B8 C8 A9 B9 C9 A10 B10 C10 A11 B11 C11 A12 B12 C12 A13 B13 C13	CD6 D6 E6 CD7 D7 E7 CD8 D8 E8 CD9 D9 E9 CD10 D10 E10 D11 D12 D13	EF3 F3 EF4 F4 E5 EF5 F5 EF6 F6 EF7 F7 EF8 F8 EF9 F9 EF10 F10	FG3 G3 FG4 G4 FG5 G5 FG6 G6 FG7 G7 FG8 G8 FG9 G9 FG10 G10	H1 H2 H3 H4 H5 H6 H7 H8 H9 H10 H11 H12 H13 H14 H15 H16 H17 H18	JS1 JS2 JS3 JS4 JS5 JS6 JS7 JS8 JS9 JS10 JS11 JS12 JS13 JS14 JS15 JS16 JS17 JS18	J6 K6 J7 K7 J8 K8 K3 K4 K5 K9 K10	M3 N3 M4 N4 M5 N5 M6 N6 M7 N7 M8 N8 M9 N9 M10 N10 N11	P3 P4 P5 P6 P7 P8 P9 P10	R3 R4 R5 R6 R7 R8 R9 R10	S3 S4 S5 S6 S7 S8 S9 S10	T5 U5 T6 U6 T7 U7 T8 U8 U9 U10	V5 X5 V6 X6 Y6 V7 X7 Y7 V8 X8 Y8 X9 Y9 X10 Y10	Z6 ZA6 Z7 ZA7 Z8 ZA8 Z9 ZA9 Z10 ZA10 Z11 ZA11	ZB6 ZC6 ZB7 ZC7 ZB8 ZC8 ZB9 ZC9 ZB10 ZC10 ZB11 ZC11

Tables

Figure 2 – Synoptic representation of tolerance classes for holes for basic sizes less than or equal to 500 mm

3	4	5	6	7	8	9	10	11	12	13
D6 E6 D7 E7 D8 E8 D9 E9 D10 E10 D11 D12 D13	F6 F7 F8 F9	G6 G7 G8	H1 H2 H3 H4 H5 H6 H7 H8 H9 H10 H11 H12 H13 H14 H15 H16 H17 H18	JS1 JS2 JS3 JS4 JS5 JS6 JS7 JS8 JS9 JS10 JS11 JS12 JS13 JS14 JS15 JS16 JS17 JS18	K6 K7 K8	M6 N6 M7 N7 M8 N8 N9	P6 P7 P8 P9	R6 R7 R8	S6 S7 S8	T6 U6 T7 U7 T8 U8

Tables

Note – The tolerance classes in the frame are given for experimental use.

Figure 3 – Synoptic representation of tolerance classes for holes for basic sizes greater than 500 mm and less than or equal to 3150 mm

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CORPORATE STANDARD

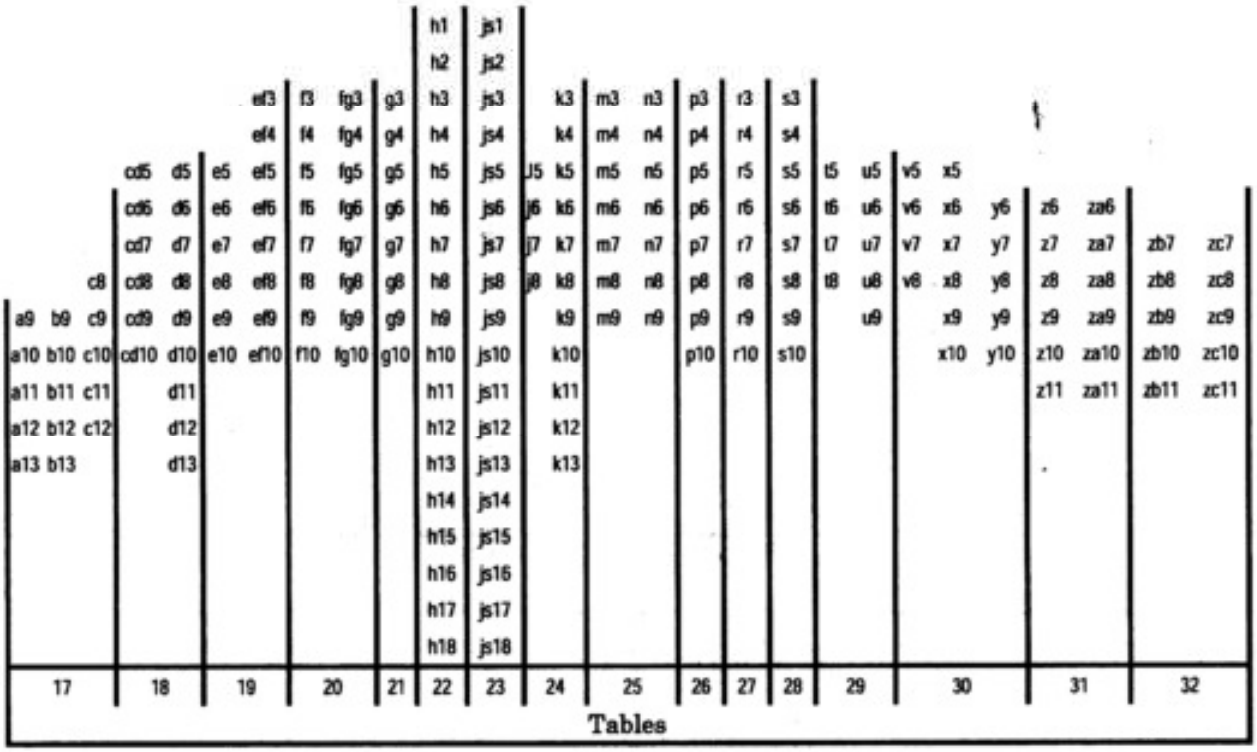
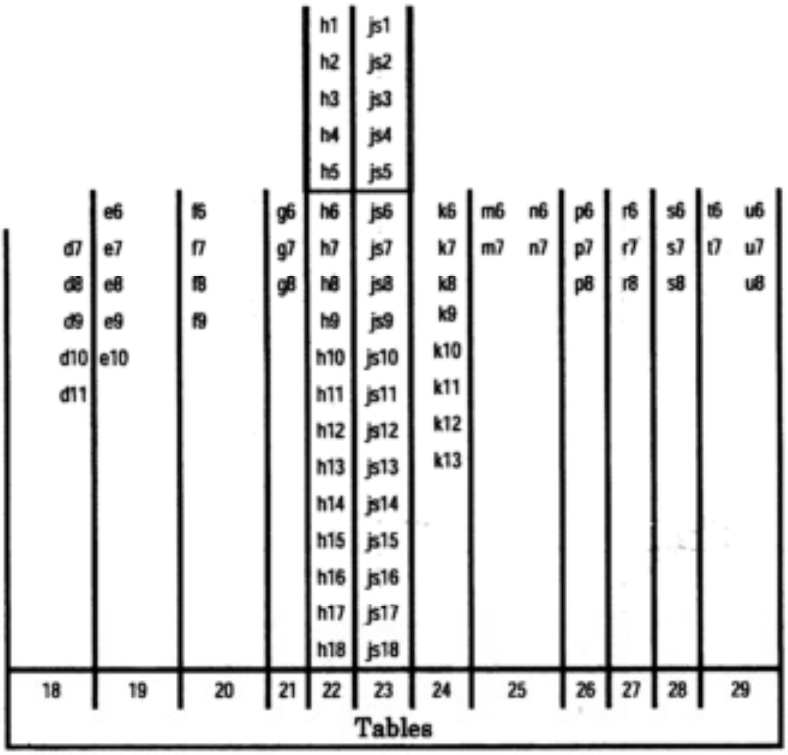


Figure 4 – Synoptic representation of tolerance classes for shafts for basic sizes less than or equal to 500 mm



NOTE – The tolerance classes in the frame are given for experimental use.

Figure 5 – Synoptic representation of tolerance classes for shafts for basic sizes greater than 500 mm and less than or equal to 3150 mm

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Notes on the presentation of tables 2 to 32

1) Values may be calculated, from the bases given in AA0230201, for fundamental deviations used for tolerance classes, for which there is no entry in the tables, but for which the space has been left blank.

2) A small horizontal separation has been inserted in the tables, where appropriate, to distinguish between values for basic sizes less than or equal to 500 mm and those greater than 500 mm, which have been derived from different bases.

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Table 2 Limit deviations for holes A, B and C[1)]

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic Size mm		A[2]					B[2]						C					
Above	Upto and including	9	10	11	12	13	8	9	10	11	12	13	8	9	10	11	12	13
-	3[2]	+295 +270	+310 +270	+330 +270	+370 +270	+410 +270	+154 +140	+165 +140	+180 +140	+200 +140	+240 +140	+280 +140	+74 +60	+85 +60	+100 +60	+120 +60	+160 +60	+200 +60
3	6	+300 +270	+318 +270	+345 +270	+390 +270	+450 +270	+158 +140	+170 +140	+188 +140	+215 +140	+260 +140	+320 +140	+88 +70	+100 +70	+118 +70	+145 +70	+190 +70	+250 +70
6	10	+316 +280	+338 +280	+370 +280	+430 +280	+500 +280	+172 +150	+186 +150	+208 +150	+240 +150	+300 +150	+370 +150	+102 +80	+116 +80	+138 +80	+170 +80	+230 +80	+300 +80
10	18	+333 +290	+360 +290	+400 +290	+470 +290	+560 +290	+177 +150	+193 +150	+220 +150	+260 +150	+330 +150	+420 +150	+122 +95	+138 +95	+165 +95	+205 +95	+275 +95	+365 +95
18	30	+352 +300	+384 +300	+430 +300	+510 +300	+630 +300	+193 +160	+212 +160	+244 +160	+290 +160	+370 +160	+490 +160	+143 +110	+162 +110	+194 +110	+240 +110	+320 +110	+440 +110
30	40	+372 +310	+410 +310	+470 +310	+560 +310	+700 +310	+209 +170	+232 +170	+270 +170	+330 +170	+420 +170	+560 +170	+159 +120	+182 +120	+220 +120	+280 +120	+370 +120	+510 +120
40	50	+382 +320	+420 +320	+480 +320	+570 +320	+710 +320	+219 +180	+242 +180	+280 +180	+340 +180	+430 +180	+570 +180	+169 +130	+192 +130	+230 +130	+290 +130	+380 +130	+520 +130
50	65	+414 +340	+460 +340	+530 +340	+640 +340	+800 +340	+236 +190	+264 +190	+310 +190	+380 +190	+490 +190	+650 +190	+186 +140	+214 +140	+260 +140	+330 +140	+440 +140	+600 +140
65	80	+434 +360	+480 +360	+550 +360	+660 +360	+820 +360	+246 +200	+274 +200	+320 +200	+390 +200	+500 +200	+660 +200	+196 +150	+224 +150	+270 +150	+340 +150	+450 +150	+610 +150
80	100	+467 +380	+520 +380	+600 +380	+730 +380	+920 +380	+274 +220	+307 +220	+360 +220	+440 +220	+570 +220	+760 +220	+224 +170	+257 +170	+310 +170	+390 +170	+520 +170	+710 +170
100	120	+497 +410	+550 +410	+630 +410	+760 +410	+950 +410	+294 +240	+327 +240	+380 +240	+460 +240	+590 +240	+780 +240	+234 +180	+267 +180	+320 +180	+400 +180	+530 +180	+720 +180
120	140	+560 +460	+620 +460	+710 +460	+860 +460	+1090 +460	+323 +260	+360 +260	+420 +260	+510 +260	+660 +260	+890 +260	+263 +200	+300 +200	+360 +200	+450 +200	+600 +200	+830 +200
140	160	+620 +520	+680 +520	+770 +520	+920 +520	+1150 +520	+343 +280	+380 +280	+440 +280	+530 +280	+680 +280	+910 +280	+273 +210	+310 +210	+370 +210	+460 +210	+610 +210	+840 +210
160	180	+680 +580	+740 +580	+830 +580	+980 +580	+1210 +580	+373 +310	+410 +310	+470 +310	+560 +310	+710 +310	+940 +310	+293 +230	+330 +230	+390 +230	+480 +230	+630 +230	+860 +230
180	200	+775 +660	+845 +660	+950 +660	+1120 +660	+1380 +660	+412 +340	+455 +340	+525 +340	+630 +340	+800 +340	+1060 +340	+312 +240	+355 +240	+425 +240	+530 +240	+700 +240	+960 +240
200	225	+855 +740	+925 +740	+1030 +740	+1200 +740	+1460 +740	+452 +380	+495 +380	+565 +380	+670 +380	+840 +380	+1100 +380	+332 +260	+375 +260	+445 +260	+550 +260	+720 +260	+980 +260
225	250	+935 +820	+1005 +820	+1110 +820	+1280 +820	+1540 +820	+492 +420	+535 +420	+605 +420	+710 +420	+880 +420	+1140 +420	+352 +280	+395 +280	+465 +280	+570 +280	+740 +280	+1000 +280
250	280	+1050 +920	+1130 +920	+1240 +920	+1440 +920	+1730 +920	+561 +480	+610 +480	+690 +480	+800 +480	+1000 +480	+1290 +480	+381 +300	+430 +300	+510 +300	+620 +300	+820 +300	+1110 +300
280	315	+1180 +1050	+1260 +1050	+1370 +1050	+1570 +1050	+1860 +1050	+621 +540	+670 +540	+750 +540	+860 +540	+1060 +540	+1350 +540	+411 +330	+460 +330	+540 +330	+650 +330	+850 +330	+1140 +330
315	355	+1340 +1200	+1430 +1200	+1560 +1200	+1770 +1200	+2000 +1200	+689 +600	+740 +600	+830 +600	+960 +600	+1170 +600	+1490 +600	+449 +360	+500 +360	+590 +360	+720 +360	+930 +360	+1250 +360
355	400	+1490 +1350	+1580 +1350	+1710 +1350	+1920 +1350	+2240 +1350	+769 +680	+820 +680	+910 +680	+1040 +680	+1250 +680	+1570 +680	+489 +400	+540 +400	+630 +400	+760 +400	+970 +400	+1290 +400
400	450	+1655 +1500	+1750 +1500	+1900 +1500	+2130 +1500	+2470 +1500	+857 +760	+915 +760	+1010 +760	+1160 +760	+1390 +760	+1730 +760	+537 +440	+595 +440	+690 +440	+840 +440	+1070 +440	+1410 +440
450	500	+1805 +1650	+1900 +1650	+2050 +1650	+2280 +1650	+2620 +1650	+937 +840	+995 +840	+1090 +840	+1240 +840	+1470 +840	+1810 +840	+577 +480	+635 +480	+730 +480	+880 +480	+1110 +480	+1450 +480

1) Fundamental deviations A, B and C are not provided for basic sizes greater than 500 mm.

2) Fundamental deviations A and B shall not be used for any standard tolerance in basic sizes less than or equal to 1 mm.

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Table 3 – Limit deviations for holes CD, D and E

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		CD[1]					D								E					
Above	Upto and including	6	7	8	9	10	6	7	8	9	10	11	12	13	5	6	7	8	9	10
-	3	+40 +34	+44 +34	+48 +34	+59 +34	+74 +34	+26 +20	+30 +20	+34 +20	+45 +20	+60 +20	+80 +20	+120 +20	+160 +20	+18 +14	+20 +14	+24 +14	+28 +14	+39 +14	+54 +14
3	6	+54 +46	+58 +46	+64 +46	+76 +46	+94 +46	+38 +30	+42 +30	+48 +30	+60 +30	+78 +30	+105 +30	+150 +30	+210 +30	+25 +20	+28 +20	+32 +20	+38 +20	+50 +20	+68 +20
6	10	+65 +56	+71 +56	+78 +56	+92 +56	+114 +56	+49 +40	+55 +40	+62 +40	+76 +40	+98 +40	+130 +40	+190 +40	+260 +40	+31 +25	+34 +25	+40 +25	+47 +25	+61 +25	+83 +25
10	18						+61 +50	+68 +50	+77 +50	+93 +50	+120 +50	+160 +50	+230 +50	+320 +50	+40 +32	+43 +32	+50 +32	+59 +32	+75 +32	+102 +32
18	30						+78 +65	+86 +65	+98 +65	+117 +65	+149 +65	+195 +65	+275 +65	+395 +65	+49 +40	+53 +40	+61 +40	+73 +40	+92 +40	+124 +40
30	50						+96 +80	+105 +80	+119 +80	+142 +80	+180 +80	+240 +80	+330 +80	+470 +80	+61 +50	+66 +50	+75 +50	+89 +50	+112 +50	+150 +50
50	80						+119 +100	+130 +100	+146 +100	+174 +100	+220 +100	+290 +100	+400 +100	+560 +100	+73 +60	+79 +60	+90 +60	+106 +60	+134 +60	+180 +60
80	120						+142 +120	+155 +120	+174 +120	+207 +120	+260 +120	+340 +120	+470 +120	+660 +120	+87 +72	+94 +72	+107 +72	+125 +72	+159 +72	+212 +72
120	180						+170 +145	+185 +145	+208 +145	+245 +145	+305 +145	+395 +145	+545 +145	+775 +145	+103 +85	+110 +85	+125 +85	+148 +85	+185 +85	+245 +85
180	250						+199 +170	+216 +170	+242 +170	+285 +170	+355 +170	+460 +170	+630 +170	+890 +170	+120 +100	+129 +100	+146 +100	+172 +100	+215 +100	+285 +100
250	315						+222 +190	+242 +190	+271 +190	+320 +190	+400 +190	+510 +190	+710 +190	+1000 +190	+133 +110	+142 +110	+162 +110	+191 +110	+240 +110	+320 +110
315	400						+246 +210	+267 +210	+299 +210	+350 +210	+440 +210	+570 +210	+780 +210	+1100 +210	+150 +125	+161 +125	+182 +125	+214 +125	+265 +125	+355 +125
400	500						+270 +230	+293 +230	+327 +230	+385 +230	+480 +230	+630 +230	+860 +230	+1200 +230	+162 +135	+175 +135	+198 +135	+232 +135	+290 +135	+385 +135
500	630						+304 +260	+330 +260	+370 +260	+435 +260	+540 +260	+700 +260	+960 +260	+1360 +260		+189 +145	+215 +145	+255 +145	+320 +145	+425 +145
630	800						+340 +290	+370 +290	+415 +290	+490 +290	+610 +290	+790 +290	+1090 +290	+1540 +290		+210 +160	+240 +160	+285 +160	+360 +160	+480 +160
800	1000						+376 +320	+410 +320	+460 +320	+550 +320	+680 +320	+880 +320	+1220 +320	+1720 +320		+226 +170	+260 +170	+310 +170	+400 +170	+530 +170
1000	1250						+416 +350	+455 +350	+515 +350	+610 +350	+770 +350	+1010 +350	+1400 +350	+2000 +350		+261 +195	+300 +195	+360 +195	+455 +195	+615 +195
1250	1600						+468 +390	+515 +390	+585 +390	+700 +390	+890 +390	+1170 +390	+1640 +390	+2340 390		+298 +220	+345 +220	+415 +220	+530 +220	+720 +220
1600	2000						+522 +430	+580 +430	+660 +430	+800 +430	+1030 +430	+1350 +430	+1930 +430	+2730 +430		+332 +240	+390 +240	+470 +240	+610 +240	+840 +240
2000	2500						+590 +480	+655 +480	+760 +480	+920 +480	+1180 +480	+1580 +480	+2230 +480	+3280 +480		+370 +260	+435 +260	+540 +260	+700 +260	+960 +260
2500	3150						+655 +520	+730 +520	+850 +520	+1060 +520	+1380 +520	+1870 +520	+2620 +520	+3820 +520		+425 +290	+500 +290	+620 +290	+830 +290	+1150 +290

1) The intermediate fundamental deviation CD is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with AA0230201.

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Table 4 – Limit deviations for holes EF and F

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		EF[1]								F							
Above	Up to and including	3	4	5	6	7	8	9	10	3	4	5	6	7	8	9	10
-	3	+12 +10	+13 +10	+14 +10	+16 +10	+20 +10	+24 +10	+35 +10	+50 +10	+8 +6	+9 +6	+10 +6	+12 +6	+16 +6	+20 +6	+31 +6	+46 +6
3	6	+16.5 +14	+18 +14	+19 +14	+22 +14	+26 +14	+32 +14	+44 +14	+62 +14	+12.5 +10	+14 +10	+15 +10	+18 +10	+22 +10	+28 +10	+40 +10	+58 +10
6	10	+20.5 +18	+22 +18	+24 +18	+27 +18	+33 +18	+40 +18	+54 +18	+76 +18	+15.5 +13	+17 +13	+19 +13	+22 +13	+28 +13	+35 +13	+49 +13	+71 +13
10	18									+19 +16	+21 +16	+24 +16	+27 +16	+34 +16	+43 +16	+59 +16	+86 +16
18	30									+24 +20	+26 +20	+29 +20	+33 +20	+41 +20	+53 +20	+72 +20	+104 +20
30	50									+29 +25	+32 +25	+36 +25	+41 +25	+50 +25	+64 +25	+87 +25	+125 +25
50	80											+43 +30	+49 +30	+60 +30	+76 +30	+104 +30	
80	120											+51 +36	+58 +36	+71 +36	+90 +36	+123 +36	
120	180											+61 +43	+68 +43	+83 +43	+106 +43	+143 +43	
180	250											+70 +50	+79 +50	+96 +50	+122 +50	+165 +50	
250	315											+79 +56	+88 +56	+108 +56	+137 +56	+186 +56	
315	400											+87 +62	+98 +62	+119 +62	+151 +62	+202 +62	
400	500											+95 +68	+108 +68	+131 +68	+165 +68	+223 +68	
500	630												+120 +76	+146 +76	+186 +76	+251 +76	
630	800												+130 +80	+160 +80	+205 +80	+280 +80	
800	1000												+142 +86	+176 +86	+226 +86	+316 +86	
1000	1250												+164 +98	+203 +98	+263 +98	+358 +98	
1250	1600												+188 +110	+235 +110	+305 +110	+420 +110	
1600	2000												+212 +120	+270 +120	+350 +120	+490 +120	
2000	2500												+240 +130	+305 +130	+410 +130	+570 +130	
2500	3150												+280 +145	+355 +145	+475 +145	+685 +145	

1) The intermediate fundamental deviation EF is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with AA0230201.

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Table 5 – Limit deviations for holes FG and G

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		FG[1]								G							
Above	Up to and including	3	4	5	6	7	8	9	10	3	4	5	6	7	8	9	10
-	3	+6 +4	+7 +4	+8 +4	+10 +4	+14 +4	+18 +4	+29 +4	+44 +4	+4 +2	+5 +2	+6 +2	+8 +2	+12 +2	+16 +2	+27 +2	+42 +2
3	6	+8.5 +6	+10 +6	+11 +6	+14 +6	+18 +6	+24 +6	+36 +6	+54 +6	+6.5 +4	+8 +4	+9 +4	+12 +4	+16 +4	+22 +4	+34 +4	+52 +4
6	10	+10.5 +8	+12 +8	+14 +8	+17 +8	+23 +8	+30 +8	+44 +8	+66 +8	+7.5 +5	+9 +5	+11 +5	+14 +5	+20 +5	+27 +5	+41 +5	+63 +5
10	18									+9 +6	+11 +6	+14 +6	+17 +6	+24 +6	+33 +6	+49 +6	+76 +6
18	30									+11 +7	+13 +7	+16 +7	+20 +7	+28 +7	+40 +7	+59 +7	+91 +7
30	50									+13 +9	+16 +9	+20 +9	+25 +9	+34 +9	+48 +9	+71 +9	+109 +9
50	80											+23 +10	+29 +10	+40 +10	+56 +10		
80	120											+27 +12	+34 +12	+47 +12	+66 +12		
120	180											+32 +14	+39 +14	+54 +14	+77 +14		
180	250											+35 +15	+44 +15	+61 +15	+87 +15		
250	315											+40 +17	+49 +17	+69 +17	+98 +17		
315	400											+43 +18	+54 +18	+75 +18	+107 +18		
400	500											+47 +20	+60 +20	+83 +20	+117 +20		
500	630												+66 +22	+92 +22	+132 +22		
630	800												+74 +24	+104 +24	+149 +24		
800	1000												+82 +26	+116 +26	+166 +26		
1000	1250												+94 +28	+133 +28	+193 +28		
1250	1600												+108 +30	+155 +30	+225 +30		
1600	2000												+124 +32	+182 +32	+262 +32		
2000	2500												+144 +34	+209 +34	+314 +34		
2500	3150												+173 +38	+248 +38	+368 +38		

1) The intermediate fundamental deviation FG is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with AA0230201.

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Table 6 – Limit deviations for holes H

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Basic size mm		H																	
Above	Up to and including	1	2	3	4	5	6	7	8	9	10	11	12	13	14[1]	15[1]	16[1]	17[1]	18[1]
		Deviations																	
		μm											mm						
-	3[1]	+0.8 0	+1.2 0	+2 0	+3 0	+4 0	+6 +0	+10 0	+14 0	+25 0	+40 0	+60 0	+0.1 0	+0.14 0	+0.25 0	+0.4 0	+0.6 0		
3	6	+1 0	+1.5 0	+2.5 0	+4 0	+5 0	+8 0	+12 0	+18 0	+30 0	+48 0	+75 0	+0.12 0	+0.18 0	+0.3 0	+0.48 0	+0.75 0	+1.2 0	+1.8 0
6	10	+1 0	+1.5 0	+2.5 0	+4 0	+6 0	+9 0	+15 0	+22 0	+36 0	+58 0	+90 0	+0.15 0	+0.22 0	+0.36 0	+0.58 0	+0.9 0	+1.5 0	+2.2 0
10	18	+1.2 0	+2 0	+3 0	+5 0	+8 0	+11 0	+18 0	+27 0	+43 0	+70 0	+110 0	+0.18 0	+0.27 0	+0.43 0	+0.7 0	+1.1 0	+1.8 0	+2.7 0
18	30	+1.5 0	+2.5 0	+4 0	+6 0	+9 0	+13 0	+21 0	+33 0	+52 0	+84 0	+130 0	+0.21 0	+0.33 0	+0.52 0	+0.84 0	+1.3 0	+2.1 0	+3.3 0
30	50	+1.5 0	+2.5 0	+4 0	+7 0	+11 0	+16 0	+25 0	+39 0	+62 0	+100 0	160 0	+0.25 0	+0.39 0	+0.62 0	+1 0	+1.6 0	+2.5 0	+3.9 0
50	80	+2 0	+3 0	+5 0	+8 0	+13 0	+19 0	+30 0	+46 0	+74 0	+120 0	+190 0	+0.3 0	+0.46 0	+0.74 0	+1.2 0	+1.9 0	+3 0	+4.6 0
80	120	+2.5 0	+4 0	+6 0	+10 0	+15 0	+22 0	+35 0	+54 0	+87 0	+140 0	+220 0	+0.35 0	+0.54 0	+0.87 0	+1.4 0	+2.2 0	+3.5 0	+5.4 0
120	180	+3.5 0	+5 0	+8 0	+12 0	+18 0	+25 0	+40 0	+63 0	+100 0	+160 0	+250 0	+0.4 0	+0.63 0	+1 0	+1.6 0	+2.5 0	+4 0	+6.3 0
180	250	+4.5 0	+7 0	+10 0	+14 0	+20 0	+29 0	+46 0	+72 0	+115 0	+185 0	+290 0	+0.46 0	+0.72 0	+1.15 0	+1.85 0	+2.9 0	+4.6 0	+7.2 0
250	315	+6 0	+8 0	+12 0	+16 0	+23 0	+32 0	+52 0	+81 0	+130 0	+210 0	+320 0	+0.52 0	+0.81 0	+1.3 0	+2.1 0	+3.2 0	+5.2 0	+8.1 0
315	400	+7 0	+9 0	+13 0	+18 0	+25 0	+36 0	+57 0	+89 0	+140 0	+230 0	+360 0	+0.57 0	+0.89 0	+1.4 0	+2.3 0	+3.6 0	+5.7 0	+8.9 0
400	500	+8 0	+10 0	+15 0	+20 0	+27 0	+40 0	+63 0	+97 0	+155 0	+250 0	+400 0	+0.63 0	+0.97 0	+1.55 0	+2.5 0	+4 0	+6.3 0	+9.7 0
		2)																	
500	630	+9 0	+11 0	+16 0	+22 0	+32 0	+44 0	+70 0	+110 0	+175 0	+280 0	+440 0	+0.7 0	+1.1 0	+1.75 0	+2.8 0	+4.4 0	+7 0	+11 0
630	800	+10 0	+13 0	+18 0	+25 0	+36 0	+50 0	+80 0	+125 0	+200 0	+320 0	+500 0	+0.8 0	+1.25 0	+2 0	+3.2 0	+5 0	+8 0	+12.5 0
800	1000	+11 0	+15 0	+21 0	+28 0	+40 0	+56 0	+90 0	+140 0	+230 0	+360 0	+560 0	+0.9 0	+1.4 0	+2.3 0	+3.6 0	+5.6 0	+9 0	+14 0
1000	1250	+13 0	+18 0	+24 0	+33 0	+47 0	+66 0	+105 0	+165 0	+260 0	+420 0	+660 0	+1.05 0	+1.65 0	+2.6 0	+4.2 0	+6.6 0	+10.5 0	+16.5 0
1250	1600	+15 0	+21 0	+29 0	+39 0	+55 0	+78 0	+125 0	+195 0	+310 0	+500 0	+780 0	+1.25 0	+1.95 0	+3.1 0	+5 0	+7.8 0	+12.5 0	+19.5 0
1600	2000	+18 0	+25 0	+35 0	+46 0	+65 0	+92 0	+150 0	+230 0	+370 0	+600 0	+920 0	+1.5 0	+2.3 0	+3.7 0	+6 0	+9.2 0	+15 0	+23 0
2000	2500	+22 0	+30 0	+41 0	+55 0	+78 0	+110 0	+175 0	+280 0	+440 0	+700 0	+1100 0	+1.75 0	+2.8 0	+4.4 0	+7 0	+11 0	+17.5 0	+28 0
2500	3150	+26 0	+36 0	+50 0	+68 0	+96 0	+135 0	+210 0	+330 0	+540 0	+860 0	+1350 0	+2.1 0	+3.3 0	+5.4 0	+8.6 0	+13.5 0	+21 0	+33 0

1) Tolerance grades IT14 to IT18 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

2) The values given in the frame, for tolerance grades IT1 to IT5 (incl.) for basic sizes greater than 500 mm less than or equal to 3150 mm, are included for experimental use.

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Table 7 - Limit deviations[1)] for holes JS

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Basic Size mm		JS																	
Above	Up to and including	1	2	3	4	5	6	7	8	9	10	11	12	13	14[2)]	15[2)]	16[2)]	17	18
		Deviations																	
		µm											mm						
-	3[2)]	±0.4	±0.6	±1	±1.5	±2	±3	±5	±7	±12.5	±20	±30	±0.05	±0.07	±0.125	±0.2	±0.3		
3	6	±0.5	±0.75	±1.25	±2	±2.5	±4	±6	±9	±15	±24	±37.5	±0.06	±0.09	±0.15	±0.24	±0.375	±0.6	±0.9
6	10	±0.5	±0.75	±1.25	±2	±3	±4.5	±7.5	±11	±18	±29	±45	±0.075	±0.11	±0.18	±0.29	±0.45	±0.75	±1.1
10	18	±0.6	±1	±1.5	±2.5	±4	±5.5	±9	±13.5	±21.5	±35	±55	±0.09	±0.135	±0.215	±0.35	±0.55	±0.9	±1.35
18	30	±0.75	±1.25	±2	±3	±4.5	±6.5	±10.5	±16.5	±26	±42	±65	±0.105	±0.165	±0.26	±0.42	±0.65	±1.05	±1.65
30	50	±0.75	±1.25	±2	±3.5	±5.5	±8	±12.5	±19.5	±31	±50	±80	±0.125	±0.195	±0.31	±0.5	±0.8	±1.25	±1.95
50	80	±1	±1.5	±2.5	±4	±6.5	±9.5	±15	±23	±37	±60	±95	±0.15	±0.23	±0.37	±0.6	±0.95	±1.5	±2.3
80	120	±1.25	±2	±3	±5	±7.5	±11	±17.5	±27	±43.5	±70	±110	±0.175	±0.27	±0.435	±0.7	±1.1	±1.75	±2.7
120	180	±1.75	±2.5	±4	±6	±9	±12.5	±20	±31.5	±50	±80	±125	±0.2	±0.315	±0.5	±0.8	±1.25	±2	±3.15
180	250	±2.25	±3.5	±5	±7	±10	±14.5	±23	±36	±57.5	±92.5	±145	±0.23	±0.36	±0.575	±0.925	±1.45	±2.3	±3.6
250	315	±3	±4	±6	±8	±11.5	±16	±26	±40.5	±65	±105	±160	±0.26	±0.405	±0.65	±1.05	±1.6	±2.6	±4.05
315	400	±3.5	±4.5	±6.5	±9	±12.5	±18	±28.5	±44.5	±70	±115	±180	±0.285	±0.445	±0.7	±1.15	±1.8	±2.85	±4.45
400	500	±4	±5	±7.5	±10	±13.5	±20	±31.5	±48.5	±77.5	±125	±200	±0.315	±0.485	±0.775	±1.25	±2	±3.15	±4.85
						3)													
500	630	±4.5	±5.5	±8	±11	±16	±22	±35	±55	±87.5	±140	±220	±0.35	±0.55	±0.875	±1.4	±2.2	±3.5	±5.5
630	800	±5	±6.5	±9	±12.5	±18	±25	±40	±62.5	±100	±160	±250	±0.4	±0.625	±1	±1.6	±2.5	±4	±6.25
800	1000	±5.5	±7.5	±10.5	±14	±20	±28	±45	±70	±115	±180	±280	±0.45	±0.7	±1.15	±1.8	±2.8	±4.5	±7
1000	1250	±6.5	±9	±12	±16.5	±23.5	±33	±52.5	±82.5	±130	±210	±330	±0.525	±0.825	±1.3	±2.1	±3.3	±5.25	±8.25
1250	1600	±7.5	±10.5	±14.5	±19.5	±27.5	±39	±62.5	±97.5	±155	±250	±390	±0.625	±0.975	±1.55	±2.5	±3.9	±6.25	±9.75
1600	2000	±9	±12.5	±17.5	±23	±32.5	±46	±75	±115	±185	±300	±460	±0.75	±1.15	±1.85	±3	±4.6	±7.5	±11.5
2000	2500	±11	±15	±20.5	±27.5	±39	±55	±87.5	±140	±220	±350	±550	±0.875	±1.4	±2.2	±3.5	±5.5	±8.75	±14
2500	3150	±13	±18	±25	±34	±48	±67.5	±105	±165	±270	±430	±675	±1.05	±1.65	±2.7	±4.3	±6.75	±10.5	±16.5

1) In order to avoid repetition of equal values, the table lists the values as "± x"; this is to be interpreted as ES = + x and EI = - x, e.g. $^{+0.23}_{-0.23}$ µm.

2) Tolerance grades IT14 to IT16 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

3) The values in the frame, for tolerance grades IT1 to IT5 (incl.), for basic sizes greater than 500 mm and less than or equal to 3150 mm, are included for experimental use.

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Table 8 – Limit deviations for holes J and K

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviation in micrometres

Basic size mm		J				K							
Above	Up to and including	6	7	8	9[1]	3	4	5	6	7	8	9[1]	10[1]
-	3	+2 -4	+4 -6	+6 -8		0 -2	0 -3	0 -4	0 -6	0 -10	0 -14	0 -25	0 -40
3	6	+5 -3	±6[3]	+10 -8		0 -2.5	+0.5 -3.5	0 -5	+2 -6	+3 -9	+5 -13		
6	10	+5 -4	+8 -7	+12 -10		0 -2.5	+0.5 -3.5	+1 -5	+2 -7	+5 -10	+6 -16		
10	18	+6 -5	+10 -8	+15 -12		0 -3	+1 -4	+2 -6	+2 -9	+6 -12	+8 -19		
18	30	+8 -5	+12 -9	+20 -13		-0.5 -4.5	0 -6	+1 -8	+2 -11	+6 -15	+10 -23		
30	50	+10 -6	+14 -11	+24 -15		-0.5 -4.5	+1 -6	+2 -9	+3 -13	+7 -18	+12 -27		
50	80	+13 -6	+18 -12	+28 -18				+3 -10	+4 -15	+9 -21	+14 -32		
80	120	+16 -6	+22 -13	+34 -20				+2 -13	+4 -18	+10 -25	+16 -38		
120	180	+18 -7	+26 -14	+41 -22				+3 -15	+4 -21	+12 -28	+20 -43		
180	250	+22 -7	+30 -16	+47 -25				+2 -18	+5 -24	+13 -33	+22 -50		
250	315	+25 -7	+36 -16	+55 -26				+3 -20	+5 -27	+16 -36	+25 -56		
315	400	+29 -7	+39 -18	+60 -29				+3 -22	+7 -29	+17 -40	+28 -61		
400	500	+33 -7	+43 -20	+66 -31				+2 -25	+8 -32	+18 -45	+29 -68		
500	630								0 -44	0 -70	0 -110		
630	800								0 -50	0 -80	0 -125		
800	1000								0 -56	0 -90	0 -140		
1000	1250								0 -66	0 -105	0 -165		
1250	1600								0 -78	0 -125	0 -195		
1600	2000								0 -92	0 -150	0 -230		
2000	2500								0 -110	0 -175	0 -280		
2500	3150								0 -135	0 -210	0 -330		

1) Tolerance classes J9, J10, etc. are symmetrical about the zero line. For these values, see JS9, JS10, etc.

2) Deviations for K in tolerance grades above IT8 are not defined for basic sizes greater than 3 mm.

3) Identical with JS7.

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Table 9 – Limit deviations for holes M and N

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		M								N								
Above	Up to and including	3	4	5	6	7	8	9	10	3	4	5	6	7	8	9[1]	10[1]	11[1]
-	3[1]	-2 -4	-2 -5	-2 -6	-2 -8	-2 -12	-2 -16	-2 -27	-2 -42	-4 -6	-4 -7	-4 -8	-4 -10	-4 -14	-4 -18	-4 -29	-4 -44	-4 -64
3	6	-3 -5.5	-2.5 -6.5	-3 -8	-1 -9	0 -12	+2 -16	-4 -34	-4 -52	-7 -9.5	-6.5 -10.5	-7 -12	-5 -13	-4 -16	-2 -20	0 -30	0 -48	0 -75
6	10	-5 -7.5	-4.5 -8.5	-4 -10	-3 -12	0 -15	+1 -21	-6 -42	-6 -64	-9 -11.5	-8.5 -12.5	-8 -14	-7 -16	-4 -19	-3 -25	0 -36	0 -58	0 -90
10	18	-6 -9	-5 -10	-4 -12	-4 -15	0 -18	+2 -25	-7 -50	-7 -77	-11 -14	-10 -15	-9 -17	-9 -20	-5 -23	-3 -30	0 -43	0 -70	0 -110
18	30	-6.5 -10.5	-6 -12	-5 -14	-4 -17	0 -21	+4 -29	-8 -60	-8 -92	-13.5 -17.5	-13 -19	-12 -21	-11 -24	-7 -28	-3 -36	0 -52	0 -84	0 -130
30	50	-7.5 -11.5	-6 -13	-5 -16	-4 -20	0 -25	+5 -34	-9 -71	-9 -109	-15.5 -19.5	-14 -21	-13 -24	-12 -28	-8 -33	-3 -42	0 -62	0 -100	0 -160
50	80			-6 -19	-5 -24	0 -30	+5 -41					-15 -28	-14 -33	-9 -39	-4 -50	0 -74	0 -120	0 -190
80	120			-8 -23	-6 -28	0 -35	+6 -48					-18 -33	-16 38	-10 -45	-4 -58	0 -87	0 -140	0 -220
120	180			-9 -27	-8 -33	0 -40	+8 -55					-21 -39	-20 -45	-12 -52	-4 -67	0 -100	0 -160	0 -250
180	250			-11 -31	-8 -37	0 -46	+9 -63					-25 -45	-22 -51	-14 -60	-5 -77	0 -115	0 -185	0 -290
250	315			-13 -36	-9 -41	0 -52	+9 -72					-27 -50	-25 -57	-14 -66	-5 -86	0 -130	0 -210	0 -320
315	400			-14 -39	-10 -46	0 -57	+11 -78					-30 -55	-26 -62	-16 -73	-5 -94	0 -140	0 -230	0 -360
400	500			-16 -43	-10 -50	0 -63	+11 -86					-33 -60	-27 -67	-17 -80	-6 -103	0 -155	0 -250	0 -400
500	630				-26 -70	-26 -96	-26 -136						-44 -88	-44 -114	-44 -154	-44 -219		
630	800				-30 -80	-30 -110	-30 -155						-50 -100	-50 -130	-50 -175	-50 -250		
800	1000				-34 -90	-34 -124	-34 -174						-56 -112	-56 -146	-56 -196	-56 -286		
1000	1250				-40 -106	-40 -145	-40 -205						-66 -132	-66 -171	-66 -231	-66 -326		
1250	1600				-48 -126	-48 -173	-48 -243						-78 -156	-78 -203	-78 -273	-78 -388		
1600	2000				-58 -150	-58 -208	-58 -288						-92 -184	-92 -242	-92 -322	-92 -462		
2000	2500				-68 -178	-68 -243	-68 -348						-110 -220	-110 -285	-110 -390	-110 -550		
2500	3150				-76 -211	-76 -286	-76 -406						-135 -270	-135 -345	-135 -465	-135 -675		

1) Tolerance classes N9, N10 and N11 shall not be used for basic sizes less than or equal to 1 mm.

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Table 10 – Limit deviations for holes P

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		P							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	-6 -8	-6 -9	-6 -10	-6 -12	-6 -16	-6 -20	-6 -31	-6 -46
3	6	-11 -13.5	-10.5 -14.5	-11 -16	-9 -17	-8 -20	-12 -30	-12 -42	-12 -60
6	10	-14 -16.5	-13.5 -17.5	-13 -19	-12 -21	-9 -24	-15 -37	-15 -51	-15 73
10	18	-17 -20	-16 -21	-15 -23	-15 -26	-11 -29	-18 -45	-18 -61	-18 -88
18	30	-20.5 -24.5	-20 -26	-19 -28	-18 -31	-14 -35	-22 -55	-22 -74	-22 -106
30	50	-24.5 -28.5	-23 -30	-22 -33	-21 -37	-17 -42	-26 -65	-26 -88	-26 -126
50	80			-27 -40	-26 -45	-21 -51	-32 -78	-32 -106	
80	120			-32 -47	-30 -52	-24 -59	-37 -91	-37 -124	
120	180			-37 -55	-36 -61	-28 -68	-43 -106	-43 -143	
180	250			-44 -64	-41 -70	-33 -79	-50 -122	-50 -165	
250	315			-49 -72	-47 -79	-36 -88	-56 -137	-56 -186	
315	400			-55 -80	-51 -87	-41 -98	-62 -151	-62 -202	
400	500			-61 -88	-55 -95	-45 -108	-68 -165	-68 -223	
500	630				-78 -122	-78 -148	-78 -188	-78 -253	
630	800				-88 -138	-88 -168	-88 -213	-88 -288	
800	1000				-100 -156	-100 -190	-100 -240	-100 -330	
1000	1250				-120 -186	-120 -225	-120 -285	-120 -380	
1250	1600				-140 -218	-140 -265	-140 -335	-140 -450	
1600	2000				-170 -262	-170 -320	-170 -400	-170 -540	
2000	2500				-195 -305	-195 -370	-195 -475	-195 -635	
2500	3150				-240 -375	-240 -450	-240 -570	-240 -780	

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Table 11– Limit deviations for holes R

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		R							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	-10 -12	-10 -13	-10 -14	-10 -16	-10 -20	-10 -24	-10 -35	-10 -50
3	6	-14 -16.5	-13.5 -17.5	-14 -19	-12 -20	-11 -23	-15 -33	-15 -45	-15 -63
6	10	-18 -20.5	-17.5 -21.5	-17 -23	-16 -25	-13 -28	-19 -41	-19 -55	-19 -77
10	18	-22 -25	-21 -26	-20 -28	-20 -31	-16 -34	-23 -50	-23 -66	-23 -93
18	30	-26.5 -30.5	-26 -32	-25 -34	-24 -37	-20 -41	-28 -61	-28 -80	-10 -112
30	50	-32.5 -36.5	-31 -38	-30 -41	-29 -45	-25 -50	-34 -73	-34 -96	-34 -134
50	65			-36 -49	-35 -54	-30 -60	-41 -87		
65	80			-38 -51	-37 -56	-32 -62	-43 -89		
80	100			-46 -61	-44 -66	-38 -73	-51 -105		
100	120			-49 -64	-47 -69	-41 -76	-54 -108		
120	140			-57 -75	-56 -81	-48 -88	-63 -126		
140	160			-59 -77	-58 -83	-50 -90	-65 -128		
160	180			-62 -80	-61 -86	-53 -93	-68 -131		
180	200			-71 -91	-68 -97	-60 -106	-77 -149		
200	225			-74 -94	-71 -100	-63 -109	-80 -152		
225	250			-78 -98	-75 -104	-67 -113	-84 -156		
250	280			-87 -110	-85 -117	-74 -126	-94 -175		
280	315			-91 -114	-89 -121	-78 -130	-98 -179		
315	355			-101 -126	-97 -133	-87 -144	-108 -197		
355	400			-107 -132	-103 -139	-93 -150	-114 -203		
400	450			-119 -146	-113 -153	-103 -166	-126 -223		
450	500			-125 -152	-119 -159	-109 -172	-132 -229		

Basic size mm		R		
Above	Up to and including	6	7	8
500	560	-150 -194	-150 -220	-150 -260
560	630	-155 -199	-155 -225	-155 -265
630	710	-175 -225	-175 -255	-175 -300
710	800	-185 -235	-185 -265	-185 -310
800	900	-210 -266	-210 -300	-210 -350
900	1000	-220 -276	-220 -310	-220 -380
1000	1120	-250 -316	-250 -355	-250 -415
1120	1250	-260 -326	-260 -365	-260 -425
1250	1400	-300 -378	-300 -425	-300 -495
1400	1600	-330 -408	-330 -455	-330 -525
1600	1800	-370 -462	-370 -520	-370 -600
1800	2000	-400 -492	-400 -550	-400 -630
2000	2240	-440 -550	-440 -615	-440 -720
2240	2500	-460 -570	-460 -635	-460 -740
2500	2800	-550 -685	-550 -760	-550 -880
2800	3150	-580 -715	-580 -790	-580 -910

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Table 12 – Limit deviations for holes S

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		S							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	-14 -16	-14 -17	-14 -18	-14 -20	-14 -24	-14 -28	-14 -39	-14 -54
3	6	-18 -20.5	-17.5 -21.5	-18 -23	-16 -24	-15 -27	-19 -37	-19 -49	-19 67
6	10	-22 -24.5	-21.5 -25.5	-21 -27	-20 -29	-17 -32	-23 -45	-23 -59	-23 -81
10	18	-27 -30	-26 -31	-25 -33	-25 -36	-21 -39	-28 -55	-28 -71	-28 -98
18	30	-33.5 -37.5	-33 -39	-32 -41	-31 -44	-27 -48	-35 -68	-35 -87	-35 -119
30	50	-41.5 -45.5	-40 -47	-39 -50	-38 -54	-34 -59	-43 -82	-43 -105	-43 -143
50	65			-48 -61	-47 -66	-42 -72	-53 -99	-53 -127	
65	80			-54 -67	-53 -72	-48 -78	-59 -105	-59 -133	
80	100			-66 -81	-64 -86	-58 -93	-71 -125	-71 -158	
100	120			-74 -89	-72 -94	-66 -101	-79 -133	-79 -166	
120	140			-86 -104	-85 -110	-77 -117	-92 -155	-92 -192	
140	160			-94 -112	-93 -118	-85 -125	-100 -163	-100 -200	
160	180			-102 -120	-101 -126	-93 -133	-108 -171	-108 -208	
180	200			-116 -136	-113 -142	-105 -151	-122 -194	-122 -237	
200	225			-124 -144	-121 -150	-113 -159	-130 -202	-130 -245	
225	250			-134 -154	-131 -160	-123 -169	-140 -212	-140 -255	
250	280			-151 -174	-149 -181	-138 -190	-158 -239	-158 -288	
280	315			-163 -186	-161 -193	-150 -202	-170 -251	-170 -300	
315	355			-183 -208	-179 -215	-169 -226	-190 -279	-190 -330	
355	400			-201 -226	-197 -233	-187 -244	-208 -297	-208 -348	
400	450			-225 -252	-219 -259	-209 -272	-232 -329	-232 -387	
450	500			-245 -272	-239 -279	-229 -292	-252 -349	-252 -407	

Basic size mm		S		
Above	Up to and including	6	7	8
500	560	-280 -324	-280 -350	-280 -390
560	630	-310 -354	-310 -380	-310 -420
630	710	-340 -390	-340 -420	-340 -465
710	800	-380 -430	-380 -460	-380 -505
800	900	-430 -486	-430 -520	-430 -570
900	1000	-470 -526	-470 -560	-470 -610
1000	1120	-520 -586	-520 -625	-520 -685
1120	1250	-580 -646	-580 -685	-580 -745
1250	1400	-640 -718	-640 -765	-640 -835
1400	1600	-720 -798	-720 -845	-720 -915
1600	1800	-820 -912	-820 -970	-820 -1050
1800	2000	-920 -1012	-920 -1070	-920 -1150
2000	2240	-1000 -1110	-1000 -1175	-1000 -1280
2240	2500	-1100 -1210	-1100 -1275	-1100 -1380
2500	2800	-1250 -1385	-1250 -1460	-1250 -1580
2800	3150	-1400 -1535	-1400 -1610	-1400 -1730

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Table 13 – Limit deviations for holes T and U

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		T[1]							U		
Above	Up to and including	5	6	7	8	5	6	7	8	9	10
-	3					-18 -22	-18 -24	-18 -28	-18 -32	-18 -43	-18 -58
3	6					-22 -27	-20 -28	-19 -31	-23 -41	-23 -53	-23 -71
6	10					-26 -32	-25 -34	-22 -37	-28 -50	-28 -64	-28 -86
10	18					-30 -38	-30 -41	-26 -44	-33 -60	-33 -76	-33 -103
18	24					-38 -47	-37 -50	-33 -54	-41 -74	-41 -93	-41 -125
24	30	-38 -47	-37 -50	-33 -54	-41 -74	-45 -54	-44 -57	-40 -61	-48 -81	-48 -100	-48 -132
30	40	-44 -55	-43 -59	-39 -64	-48 -87	-56 -67	-55 -71	-51 -76	-60 -99	-60 -122	-60 -160
40	50	-50 -61	-49 -65	-45 -70	-54 -93	-66 -77	-65 -81	-61 -86	-70 -109	-70 -132	-70 -170
50	65		-60 -79	-55 -85	-66 -112		-81 -100	-76 -106	-87 -133	-87 -161	-87 -207
65	80		-69 -88	-64 -94	-75 -121		-96 -115	-91 -121	-102 -148	-102 -176	-102 -222
80	100		-84 -106	-78 -113	-91 -145		-117 -139	-111 -146	-124 -178	-124 -211	-124 -264
100	120		-97 -119	-91 -126	-104 -158		-137 -159	-131 -166	-144 -198	-144 -231	-144 -284
120	140		-115 -140	-107 -147	-122 -185		-163 -188	-155 -195	-170 -233	-170 -270	-170 -330
140	160		-127 -152	-119 -159	-134 -197		-183 -208	-175 -215	-190 -253	-190 -290	-190 -350
160	180		-139 -164	-131 -171	-146 -209		-203 -228	-195 -235	-210 -273	-210 -310	-210 -370
180	200		-157 -186	-149 -195	-166 -238		-227 -256	-219 -265	-236 -308	-236 -351	-236 -421
200	225		-171 -200	-163 -209	-180 -252		-249 -278	-241 -287	-258 -330	-258 -373	-258 -443
225	250		-187 -216	-179 -225	-196 -268		-275 -304	-267 -313	-284 -356	-284 -399	-284 -469
250	280		-209 -241	-198 -250	-218 -299		-306 -338	-295 -347	-315 -396	-315 -445	-315 -525
280	315		-231 -263	-220 -272	-240 -321		-341 -373	-330 -382	-350 -431	-350 -480	-350 -560
315	355		-257 -293	-247 -304	-268 -357		-379 -415	-369 -426	-390 -479	-390 -530	-390 -620
355	400		-283 -319	-273 -330	-294 -383		-424 -460	-414 -471	-435 -524	-435 -575	-435 -665
400	450		-317 -357	-307 -370	-330 -427		-477 -517	-467 -530	-490 -587	-490 -645	-490 -740
450	500		-347 -387	-337 -400	-360 -457		-527 -567	-517 -580	-540 -637	-540 -695	-540 -790

Basic size mm		T[1]			U		
Above	Up to and including	6	7	8	6	7	8
500	560	-400 -444	-400 -470	-400 -510	-600 -644	-600 -670	-600 -710
560	630	-450 -494	-450 -520	-450 -560	-660 -704	-660 -730	-660 -770
630	710	-500 -550	-500 -580	-500 -625	-740 -790	-740 -820	-740 -865
710	800	-560 -610	-560 -640	-560 -685	-840 -890	-840 -920	-840 -965
800	900	-620 -676	-620 -710	-620 -760	-940 -996	-940 -1030	-940 -1080
900	1000	-680 -736	-680 -770	-680 -820	-1050 -1106	-1050 -1140	-1050 -1190
1000	1120	-780 -846	-780 -885	-780 -945	-1150 -1216	-1150 -1255	-1150 -1315
1120	1250	-840 -906	-840 -945	-840 -1005	-1300 -1366	-1300 -1405	-1300 -1465
1250	1400	-960 -1038	-960 -1085	-960 -1155	-1450 -1528	-1450 -1575	-1450 -1645
1400	1600	-1050 -1128	-1050 -1175	-1050 -1245	-1600 -1678	-1600 -1725	-1600 -1795
1600	1800	-1200 -1292	-1200 -1350	-1200 -1430	-1850 -1942	-1850 -2000	-1850 -2080
1800	2000	-1350 -1442	-1350 -1500	-1350 -1580	-2000 -2092	-2000 -2150	-2000 -2230
2000	2240	-1500 -1610	-1500 -1675	-1500 -1780	-2300 -2410	-2300 -2475	-2300 -2580
2240	2500	-1650 -1760	-1650 -1825	-1650 -1930	-2500 -2610	-2500 -2675	-2500 -2780
2500	2800	-1900 -2035	-1900 -2110	-1900 -2230	-2900 -3035	-2900 -3110	-2900 -3230
2800	3150	-2100 -2235	-2100 -2310	-2100 -2430	-3200 -3335	-3200 -3410	-3200 -3530

1) Tolerance classes T5 to T8 (incl.) have not been tabulated for basic sizes less than or equal to 24 mm. It is recommended that tolerance classes u5 to u8 (incl.) be used instead. However, if tolerance classes T5 to T8 (incl.) are especially required, they may be calculated from the bases given in AA0230201.

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Table 14 – Limit deviations for holes V, X and Y[1)]

Upper limit deviation = *ES* Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		V[2)]				X						Y[3)]				
Above	Up to and including	5	6	7	8	5	6	7	8	9	10	6	7	8	9	10
-	3					-20 -24	-20 -26	-20 -30	-20 -34	-20 -45	-20 -60					
3	6					-27 -32	-25 -33	-24 -36	-28 -46	-28 -58	-28 -76					
6	10					-32 -38	-31 -40	-28 -43	-34 -56	-34 -70	-34 -92					
10	14					-37 -45	-37 -48	-33 -51	-40 -67	-40 -83	-40 -110					
14	18	-36 -44	-36 -47	-32 -50	-39 -66	-42 -50	-42 -53	-38 -56	-45 -72	-45 -88	-45 -115					
18	24	-44 -53	-43 -56	-39 -60	-47 -80	-51 -60	-50 -63	-46 -67	-54 -87	-54 -106	-54 -138	-59 -72	-55 -76	-63 -96	-63 -115	-63 -147
24	30	-52 -61	-51 -64	-47 -68	-55 -88	-61 -70	-60 -73	-56 -77	-64 -97	-64 -116	-64 -148	-71 -84	-67 -88	-75 -108	-75 -127	-75 -159
30	40	-64 -75	-63 -79	-59 -84	-68 -107	-76 -87	-75 -91	-71 -96	-80 -119	-80 -142	-80 -180	-89 -105	-85 -110	-94 -133	-94 -156	-94 -194
40	50	-77 -88	-76 -92	-72 -97	-81 -120	-93 -104	-92 -108	-88 -113	-97 -136	-97 -159	-97 -197	-109 -125	-105 -130	-114 -153	-114 -176	-114 -214
50	65		-96 -115	-91 -121	-102 -148		-116 -135	-111 -141	-122 -168	-122 -196		-138 -157	-133 -163	-144 -190		
65	80		-114 -133	-109 -139	-120 -166		-140 -159	-135 -165	-146 -192	-146 -220		-168 -187	-163 -193	-174 -220		
80	100		-139 -161	-133 -168	-146 -200		-171 -193	-165 -200	-178 -232	-178 -265		-207 -229	-201 -236	-214 -268		
100	120		-165 -187	-159 -194	-172 -226		-203 -225	-197 -232	-210 -264	-210 -297		-247 -269	-241 -276	-254 -308		
120	140		-195 -220	-187 -227	-202 -265		-241 -266	-233 -273	-248 -311	-248 -348		-293 -318	-285 -325	-300 -363		
140	160		-221 -246	-213 -253	-228 -291		-273 -298	-265 -305	-280 -343	-280 -380		-333 -358	-325 -365	-340 -403		
160	180		-245 -270	-237 -277	-252 -315		-303 -328	-295 -335	-310 -373	-310 -410		-373 -398	-365 -405	-380 -443		
180	200		-275 -304	-267 -313	-284 -356		-341 -370	-333 -379	-350 -422	-350 -465		-416 -445	-408 -454	-425 -497		
200	225		-301 -330	-293 -339	-310 -382		-376 -405	-368 -414	-385 -457	-385 -500		-461 -490	-453 -499	-470 -542		
225	250		-331 -360	-323 -369	-340 -412		-416 -445	-408 -454	-425 -497	-425 -540		-511 -540	-503 -549	-520 -592		
250	280		-376 -408	-365 -417	-385 -466		-466 -498	-455 -507	-475 -556	-475 -605		-571 -603	-560 -612	-580 -661		
280	315		-416 -448	-405 -457	-425 -506		-516 -548	-505 -557	-525 -606	-525 -655		-641 -673	-630 -682	-650 -731		
315	355		-464 -500	-454 -511	-475 -564		-579 -615	-569 -626	-590 -679	-590 -730		-719 -755	-709 -766	-730 -819		
355	400		-519 -555	-509 -566	-530 -619		-649 -685	-639 -696	-660 -749	-660 -800		-809 -845	-799 -856	-820 -909		
400	450		-582 -622	-572 -635	-595 -692		-727 -767	-717 -780	-740 -837	-740 -895		-907 -947	-897 -960	-920 -1017		
450	500		-647 -687	-637 -700	-660 -757		-807 -847	-797 -860	-820 -917	-820 -975		-987 -1027	-977 -1040	-1000 -1097		

1) Fundamental deviations V, X and Y are not provided for basic sizes greater than 500 mm.
2) Tolerance classes V5 to V8 (incl.) have not been tabulated for sizes less than or equal to 14 mm. It is recommended that tolerance classes X5 to X8 (incl.) be used instead. However, if tolerance V5 to V8 (inc l.) are especially required, they may be calculated from the bases given in ISO 286-1.
3) Tolerance classes Y6 to Y 10 (incl.) have not been tabulated for basic sizes less than or equal to 18 mm. It is recommended that tolerance classes Z6 to Z10 (incl.) be used instead. However, if tolerance classes Y6 to Y10 (incl.) are especially required they may be calculated from the bases given in ISO 286-1.

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Table 15 – Limit deviations for holes Z and ZA[1)]

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviations in micrometres

Basic size mm		Z						ZA					
Above	Up to and including	6	7	8	9	10	11	6	7	8	9	10	11
-	3	-26 -32	-26 -36	-26 -40	-26 -51	-26 -66	-26 -86	-32 -38	-32 -42	-32 -46	-32 -57	-32 -72	-32 -92
3	6	-32 -40	-31 -43	-35 -53	-35 -65	-35 -83	-35 -110	-39 -47	-38 -50	-42 -60	-42 -72	-42 -90	-42 -117
6	10	-39 -48	-36 -51	-42 -64	-42 -78	-42 -100	-42 -132	-49 -58	-46 -61	-52 -74	-52 -88	-52 -110	-52 -142
10	14	-47 -58	-43 -61	-50 -77	-50 -93	-50 -120	-50 -160	-61 -72	-57 -75	-64 -91	-64 -107	-64 -134	-64 -174
14	18	-57 68	-53 -71	-60 -87	-60 -103	-60 -130	-60 -170	-74 -85	-70 -88	-77 -104	-77 -120	-77 -147	-77 -187
18	24	-69 82	-65 -86	-73 -106	-73 -125	73 -157	-73 -203	-94 -107	-90 -111	-98 -131	-98 -150	-98 -182	-98 -228
24	30	-84 -97	-80 -101	-88 -121	-88 -140	-88 -172	-88 -218	-114 -127	-110 -131	-118 -151	-118 -170	-118 -202	-118 -248
30	40	-107 -123	-103 -128	-112 -151	-112 -174	-112 -212	-112 -272	-143 -159	-139 -164	-148 -187	-148 -210	-148 -248	-148 -308
40	50	-131 -147	-127 -152	-136 -175	-136 -198	-136 -236	-136 -296	-175 -191	-171 -196	-180 -219	-180 -242	-180 -280	-180 -340
50	65		-161 -191	-172 -218	-172 -246	-172 -292	-172 -362		-215 -245	-226 -272	-226 -300	-226 -345	-226 -416
65	80		-199 -229	-210 -256	-210 -284	-210 -330	-210 -400		-263 -293	-274 -320	-274 -348	-274 -394	-274 -464
80	100		-245 -280	-258 -312	-258 -345	-258 -398	-258 -478		-322 -357	-335 -389	-335 -422	-335 -475	-335 -555
100	120		-297 -332	-310 -364	-310 -397	-310 -450	-310 -530		-387 -422	-400 -454	-400 -487	-400 -540	-400 -620
120	140		-350 -390	-365 -428	-365 -465	-365 -525	-365 -615		-455 -495	-470 -533	-470 -570	-470 -630	-470 -720
140	160		-400 -440	-415 -478	-415 -515	-415 -575	-415 -665		-520 -560	-535 -598	-535 -635	-535 -695	-535 -785
160	180		-450 -490	-465 -528	-465 -565	-465 -625	-465 -715		-585 -625	-600 -663	-600 -700	-600 -760	-600 -850
180	200		-503 -549	-520 -592	-520 -635	-520 -705	-520 -810		-653 -699	-670 -742	-670 -785	-670 -855	-670 -960
200	225		-558 -604	-575 -647	-575 -690	-575 -760	-575 -865		-723 -769	-740 -812	-740 -855	-740 -925	-740 -1030
225	250		-623 -669	-640 -712	-640 -755	-640 -825	-640 -930		-803 -849	-820 -892	-820 -935	-820 -1005	-820 -1110
250	280		-690 -742	-710 -791	-710 -840	-710 -920	-710 -1030		-900 -952	-920 -1001	-920 -1050	-920 -1130	-920 -1240
280	315		-770 -822	-790 -871	-790 -920	-790 -1000	-790 -1110		-980 -1032	-1000 -1081	-1000 -1130	-1000 -1210	-1000 -1320
315	355		-879 -936	-900 -989	-900 -1040	-900 -1130	-900 -1260		-1129 -1186	-1150 -1239	-1150 -1290	-1150 -1380	-1150 -1510
355	400		-979 -1036	-1000 -1089	-1000 -1140	-1000 -1230	-1000 -1360		-1279 -1336	-1300 -1389	-1300 -1440	-1300 -1530	-1300 -1660
400	450		-1077 -1140	-1100 -1197	-1100 -1255	-1100 -1350	-1100 -1500		-1427 -1490	-1450 -1547	-1450 -1605	-1450 -1700	-1450 -1850
450	500		-1227 -1290	-1250 -1347	-1250 -1405	-1250 -1500	-1250 -1650		-1577 -1640	-1600 -1697	-1600 -1755	-1600 -1850	-1600 -2000

1) Fundamental deviations Z and ZA are not provided for basic sizes greater than 500 mm.

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CORPORATE STANDARD

Table 16 – Limit deviations for holes ZB and ZC[1)]

Upper limit deviation = *ES*
Lower limit deviation = *EI*

Deviation in micrometres

Basic size mm		ZB					ZC				
Above	Up to and including	7	8	9	10	11	7	8	9	10	11
-	3	-40 -50	-40 -54	-40 -65	-40 -80	-40 -100	-60 -70	-60 -74	-60 -85	-60 -100	-60 -120
3	6	-46 -58	-50 -68	-50 -80	-50 -98	-50 -125	-76 -88	-80 -98	-80 -110	-80 -128	-80 -155
6	10	-61 -76	-67 -89	-67 -103	-67 -125	-67 -157	-91 -106	-97 -119	-97 -133	-97 -155	-97 -187
10	14	-83 -101	-90 -117	-90 -133	-90 -160	-90 -200	-123 -141	-130 -157	-130 -173	-130 -200	-130 -240
14	18	-101 -119	-108 -135	-108 -151	-108 -178	-108 -218	-143 -161	-150 -177	-150 -193	-150 -220	-150 -260
18	24	-128 -149	-136 -169	-136 -188	-136 -220	-136 -266	-180 -201	-188 -221	-188 -240	-188 -272	-188 -318
24	30	-152 -173	-160 -193	-160 -212	-160 -244	-160 -290	-210 -231	-218 -251	-218 -270	-218 -302	-218 -348
30	40	-191 -216	-200 -239	-200 -262	-200 -300	-200 -360	-265 -290	-274 -313	-274 -336	-274 -374	-274 -434
40	50	-233 -258	-242 -281	-242 -304	-242 -342	-242 -402	-316 -341	-325 -364	-325 -387	-325 -425	-325 -485
50	65	-289 -319	-300 -346	-300 -374	-300 -420	-300 -490	-394 -424	-405 -451	-405 -479	-405 -525	-405 -595
65	80	-349 -379	-360 -406	-360 -434	-360 -480	-360 -550	-469 -499	-480 -526	-480 -554	-480 -600	-480 -670
80	100	-432 -467	-445 -499	-445 -532	-445 -585	-445 -665	-572 -607	-585 -639	-585 -672	-585 -725	-585 -805
100	120	-512 -547	-525 -579	-525 -612	-525 -665	-525 -745	-677 -712	-690 -744	-690 -777	-690 -830	-690 -910
120	140	-605 -645	-620 -683	-620 -720	-620 -780	-620 -870	-785 -825	-800 -863	-800 -900	-800 -960	-800 -1050
140	160	-685 -725	-700 -763	-700 -800	-700 -860	-700 -950	-885 -925	-900 -963	-900 -1000	-900 -1060	-900 -1150
160	180	-765 -805	-780 -843	-780 -880	-780 -940	-780 -1030	-985 -1025	-1000 -1063	-1000 -1100	-1000 -1160	-1000 -1250
180	200	-863 -909	-880 -952	-880 -995	-880 -1065	-880 -1170	-1133 -1179	-1150 -1222	-1150 -1265	-1150 -1335	-1150 -1440
200	225	-943 -989	-960 -1032	-960 -1075	-960 -1145	-960 -1250	-1233 -1279	-1250 -1322	-1250 -1365	-1250 -1435	-1250 -1540
225	250	-1033 -1079	-1050 -1122	-1050 -1165	-1050 -1235	-1050 -1340	-1333 -1379	-1350 -1422	-1350 -1465	-1350 -1535	-1350 -1640
250	280	-1180 -1232	-1200 -1281	-1200 -1330	-1200 -1410	-1200 -1520	-1530 -1582	-1550 -1631	-1550 -1680	-1550 -1760	-1550 -1870
280	315	-1280 -1332	-1300 -1381	-1300 -1430	-1300 -1510	-1300 -1620	-1680 -1732	-1700 -1781	-1700 -1830	-1700 -1910	-1700 -2020
315	355	-1479 -1536	-1500 -1589	-1500 -1640	-1500 -1730	-1500 -1860	-1879 -1936	-1900 -1989	-1900 -2040	-1900 -2130	-1900 -2260
355	400	-1629 -1686	-1650 -1739	-1650 -1790	-1650 -1880	-1650 -2010	-2079 -2136	-2100 -2189	-2100 -2240	-2100 -2330	-2100 -2460
400	450	-1827 -1890	-1850 -1947	-1850 -2005	-1850 -2100	-1850 -2250	-2377 -2440	-2400 -2497	-2400 -2555	-2400 -2650	-2400 -2800
450	500	-2077 -2140	-2100 -2197	-2100 -2255	-2100 -2350	-2100 -2500	-2577 -2640	-2600 -2697	-2600 -2755	-2600 -2850	-2600 -3000

1) Fundamental deviations ZB and ZC are not provided for basic sizes greater than 500 mm.

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Table 17– Limit deviations for shafts a, b and c[1)]

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		a[2)]					b[2)]						c				
Above	Up to and including	9	10	11	12	13	8	9	10	11	12	13	8	9	10	11	12
-	3[2)]	-270 -295	-270 -310	-270 -330	-270 -370	-270 -410	-140 -154	-140 -165	140 -180	-140 -200	-140 -240	-140 -280	-60 -74	-60 -85	-60 -100	-60 -120	-60 -160
3	6	-270 -300	-270 -318	-270 -345	-270 -390	-270 -450	-140 -158	-140 -170	-140 -188	-140 -215	-140 -260	-140 -320	-70 -88	-70 -100	-70 -118	-70 -145	-70 -190
6	10	-280 -316	-280 -338	-280 -370	-280 -430	-280 -500	-150 -172	-150 -186	-150 -208	-150 -240	-150 -300	-150 -370	-80 -102	-80 -116	-80 -138	-80 -170	-80 -230
10	18	-290 -333	-290 -360	-290 -400	-290 -470	-290 -560	-150 -177	-150 -193	-150 -220	-150 -260	-150 -330	-150 -420	-95 -122	-95 -138	-95 -165	-95 -205	-95 -275
18	30	-300 -352	-300 -384	-300 -430	-300 -510	-300 -630	-160 -193	-160 -212	-160 -244	-160 -290	-160 -370	-160 -490	-110 -143	-110 -162	-110 -194	-110 -240	-110 -320
30	40	-310 -372	-310 -410	-310 -470	-310 -560	-310 -700	-170 -209	-170 -232	-170 -270	-170 -330	-170 -420	-170 -560	-120 -159	-120 -182	-120 -220	-120 -280	-120 370
40	50	-320 -382	-320 -420	-320 -480	-320 -570	-320 -710	-180 -219	-180 -242	-180 -280	-180 -340	-180 -430	-180 -570	-130 -169	-130 -192	-130 -230	-130 -290	-130 -380
50	65	-340 -414	-340 -460	-340 -530	-340 -640	-340 -800	-190 -236	-190 -264	-190 -310	-190 -380	-190 -490	-190 -650	-140 -186	-140 -214	-140 -260	-140 -330	-140 -440
65	80	-360 -434	-360 -480	-360 -550	-360 -660	-360 -820	-200 -246	-200 -274	-200 -320	-200 -390	-200 -500	-200 -680	-150 -196	-150 -224	-150 -270	-150 -340	-150 -450
80	100	-380 -467	-380 -520	-380 -600	-380 -730	-380 -920	-220 -274	-220 -307	-220 -360	-220 -440	-220 -570	-220 -760	-170 -224	-170 -257	-170 -310	-170 -390	-170 -520
100	120	-410 -497	-410 -550	-410 -630	-410 -760	-410 -950	-240 -294	-240 -327	-240 -380	-240 -460	-240 -590	-240 -780	-180 -234	-180 -267	-180 -320	-180 -400	-180 -530
120	140	-460 -560	-460 -620	-460 -710	-460 -860	-460 -1090	-260 -323	-260 -360	-260 -420	-260 -510	-260 -660	-260 -890	-200 -263	-200 -300	-200 -360	-200 -450	-200 -600
140	160	-520 -620	-520 -680	-520 -770	-520 -920	-520 -1150	-280 -343	-280 -380	-280 -440	-280 -530	-280 -680	-280 -910	-210 -273	-210 -310	-210 -370	-210 -460	-210 -610
160	180	-580 -680	-580 -740	-580 -830	-580 -980	-580 -1210	-310 -373	-310 -410	-310 -470	-310 -560	-310 -710	-310 -940	-230 -293	-230 -330	-230 -390	-230 -480	-230 -630
180	200	-660 -775	-660 -845	-660 -950	-660 -1120	-660 -1380	-340 -412	-340 -455	-340 -525	-340 -630	-340 -800	-340 -1060	-240 -312	-240 -355	-240 -425	-240 -530	-240 -700
200	225	-740 -855	-740 -925	-740 -1030	-740 -1200	-740 -1460	-380 -452	-380 -495	-380 -565	-380 -670	-380 -840	-380 -1100	-260 -332	-260 -375	-260 -445	-260 -550	-260 -720
225	250	-820 -935	-820 -1005	-820 -1110	-820 -1280	-820 -1540	-420 -492	-420 -535	-420 -605	-420 -710	-420 -880	-420 -1140	-280 -352	-280 -395	-280 -465	-280 -570	-280 -740
250	280	-920 -1050	-920 -1130	-920 -1240	-920 -1440	-920 -1730	-480 -561	-480 -610	-480 -690	-480 -800	-480 -1000	-480 -1290	-300 -381	-300 -430	-300 -510	-300 -620	-300 -820
280	315	-1050 -1180	-1050 -1260	-1050 -1370	-1050 -1570	-1050 -1860	-540 -621	-540 -670	-540 -750	-540 -860	-540 -1060	-540 -1350	-330 -411	-330 -460	-330 -540	-330 -650	-330 -850
315	355	-1200 -1340	-1200 -1430	-1200 -1560	-1200 -1770	-1200 -2090	-600 -689	-600 -740	-600 -830	-600 -960	-600 -1170	-600 -1490	-360 -449	-360 -500	-360 -590	-360 -720	-360 -930
355	400	-1350 -1490	-1350 -1580	-1350 -1710	-1350 -1920	-1350 -2240	-680 -769	-680 -820	-680 -910	-680 -1040	-680 -1250	-680 -1570	-400 -489	-400 -540	-400 -630	-400 -760	-400 -970
400	450	-1500 -1655	-1500 -1750	-1500 -1900	-1500 -2130	-1500 -2470	-760 -857	-760 -915	-760 -1010	-760 -1160	-760 -1390	-760 -1730	-440 -537	-440 -595	-440 -690	-440 -840	-440 -1070
450	500	-1650 -1805	-1650 -1900	-1650 -2050	-1650 -2280	-1650 -2620	-840 -937	-840 -995	-840 -1090	-840 -1240	-840 -1470	-840 -1810	-480 -577	-480 -635	-480 -730	-480 -880	-480 -1110

1) Fundamental deviations a, b and c are not provided for basic sizes greater than 500 mm.

2) Fundamental deviations a and b shall not be used for any standard tolerance grades in basic sizes less than or equal to 1 mm.

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Table 18 – Limit deviations for holes cd and d

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviation in micrometres

Basic size mm		cd[1]						d								
Above	Up to and including	5	6	7	8	9	10	5	6	7	8	9	10	11	12	13
-	3	-34 -38	-34 -40	-34 -44	-34 -48	-34 -59	-34 -74	-20 -24	-20 -26	-20 -30	-20 -34	-20 -45	-20 -60	-20 -80	-20 -120	-20 -160
3	6	-46 -51	-46 -54	-46 -58	-46 -64	-46 -76	-46 -94	-30 -35	-30 -38	-30 -42	-30 -48	-30 -60	-30 -78	-30 -105	-30 -150	-30 -210
6	10	-56 -62	-56 -65	-56 -71	-56 -78	-56 -92	-56 -114	-40 -46	-40 -49	-40 -55	-40 -62	-40 -76	-40 -98	-40 -130	-40 -190	-40 -260
10	18							-50 -58	-50 -61	-50 -68	-50 -77	-50 -93	-50 -120	-50 -160	-50 -230	-50 -320
18	30							-65 -74	-65 -78	-65 -86	-65 -98	-65 -117	-65 -149	-65 -195	-65 -275	-65 -395
30	50							-80 -91	-80 -96	-80 -105	-80 -119	-80 -142	-80 -180	-80 -240	-80 -330	-80 -470
50	80							-100 -113	-100 -119	-100 -130	-100 -146	-100 -174	-100 -220	-100 -290	-100 -400	-100 -560
80	120							-120 -135	-120 -142	-120 -156	-120 -174	-120 -207	-120 -260	-120 -340	-120 -470	-120 -660
120	180							-145 -163	-145 -170	-145 -185	-145 -208	-145 -245	-145 -305	-145 -395	-145 -545	-145 -775
180	250							-170 -190	-170 -199	-170 -216	-170 -242	-170 -285	-170 -355	-170 -460	-170 -630	-170 -890
250	315							-190 -213	-190 -222	-190 -242	-190 -271	-190 -320	-190 -400	-190 -510	-190 -710	-190 -1000
315	400							-210 -235	-210 -246	-210 -267	-210 -299	-210 -350	-210 -440	-210 -570	-210 -780	-210 -1100
400	500							-230 -257	-230 -270	-230 -293	-230 -327	-230 385	-230 -480	-230 -630	-230 -860	-230 -1200
500	630									-260 -330	-260 -370	-260 -435	-260 -540	-260 -700		
630	800									-290 -370	-290 -415	-290 -490	-290 -610	-290 -790		
800	1000									-320 -410	-320 -460	-320 -550	-320 -680	-320 -880		
1000	1250									-350 -455	-350 -515	-350 -610	-350 -770	-350 -1010		
1250	1600									-390 -515	-390 -585	-390 -700	-390 -890	-390 -1170		
1600	2000									-430 -580	-430 -660	-430 -800	-430 -1030	-430 -1350		
2000	2500									-480 -655	-480 -760	-480 -920	-480 -1180	-480 -1580		
2500	3150									-520 -730	-520 -850	-520 -1060	-520 -1380	-520 -1870		

1) The intermediate fundamental deviation cd is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with ISO 286-1.

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Table 19 – Limit deviations for shafts e and ef

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		e						ef[1]							
Above	Up to and including	5	6	7	8	9	10	3	4	5	6	7	8	9	10
-	3	-14 -18	-14 -20	-14 -24	-14 -28	-14 -39	-14 -54	-10 -12	-10 -13	-10 -14	-10 -16	-10 -20	-10 -24	-10 -35	-10 -50
3	6	-20 -25	-20 -28	-20 -32	-20 -38	-20 -50	-20 -68	-14 -16.5	-14 -18	-14 -19	-14 -22	-14 -26	-14 -32	-14 -44	-14 -62
6	10	-25 -31	-25 -34	-25 -40	-25 -47	-25 -61	-25 -83	-18 -20.5	-18 -22	-18 -24	-18 -27	-18 -33	-18 -40	-18 -54	-18 -76
10	18	-32 -40	-32 -43	-32 -50	-32 -59	-32 -75	-32 -102								
18	30	-40 -49	-40 -53	-40 -61	-40 -73	-40 -92	-40 -124								
30	50	-50 -61	-50 -66	-50 -75	-50 -89	-50 -112	-50 -150								
50	80	-60 -73	-60 -79	-60 -90	-60 -106	-60 -134	-60 -180								
80	120	-72 -87	-72 -94	-72 -107	-72 -126	-72 -159	-72 -212								
120	180	-85 -103	-85 -110	-85 -125	-85 -148	-185 -185	-85 -245								
180	250	-100 -120	-100 -129	-100 -146	-100 -172	-100 -215	-100 -285								
250	315	-110 -133	-110 -142	-110 -162	-110 -191	-110 -240	-110 -320								
315	400	-125 -150	-125 -161	-125 -182	-125 -214	-125 -265	-125 -355								
400	500	-135 -162	-135 -175	-135 -198	-135 -232	-135 -290	-135 -385								
500	630		-145 -189	-145 -215	-145 -255	-145 -320	-145 -425								
630	800		-160 -210	-160 -240	-160 -285	-160 -360	-160 -480								
800	1000		-170 -226	-170 -260	-170 -310	-170 -400	-170 -530								
1000	1250		-195 -261	-195 -300	-195 -360	-195 -455	-195 -615								
1250	1600		-220 -298	-220 -345	-220 -415	-220 -530	-220 -720								
1600	2000		-240 -332	-240 -390	-240 -470	-240 -610	-240 -840								
2000	2500		-260 -370	-260 -435	-260 -540	-260 -700	-260 -960								
2500	3150		-290 -425	-290 -500	-290 -620	-290 -830	-290 -1150								

1) The intermediate fundamental deviation ef is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with ISO 286-1.

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Table 20 – Limit deviations for shafts f and fg

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviation in micrometres

Basic size mm		f								fg[1]							
Above	Up to and including	3	4	5	6	7	8	9	10	3	4	5	6	7	8	9	10
-	3	-6 -8	-6 -9	-6 -10	-6 -12	-6 -16	-6 -20	-6 -31	-6 -46	-4 -6	-4 -7	-4 -8	-4 -10	-4 -14	-4 -18	-4 -29	-4 -44
3	6	-10 -12.5	-10 -14	-10 -15	-10 -18	-10 -22	-10 -28	-10 -40	-10 -58	-6 -8.5	-6 -10	-6 -11	-6 -14	-6 -18	-6 -24	-6 -36	-6 -54
6	10	-13 -15.5	-13 -17	-13 -19	-13 -22	-13 -28	-13 -35	-13 -49	-13 -71	-8 10.5	-8 -12	-8 -14	-8 -17	-8 -23	-8 -30	-8 -44	-8 -66
10	18	-16 -19	-16 -21	-16 -24	-16 -27	-16 -34	-16 -43	-16 -59	-16 -86								
18	30	-20 -24	-20 -26	-20 -29	-20 -33	-20 -41	-20 -53	-20 -72	-20 -104								
30	50	-25 -29	-25 -32	-25 -36	-25 -41	-25 -50	-25 -64	-25 -87	-25 -125								
50	80		-30 -38	-30 -43	-30 -39	-30 -60	-30 -76	-30 -104									
80	120		-36 -46	-36 -51	-36 -58	-36 -71	-36 -90	-36 -123									
120	180		-43 -55	-43 -61	-43 -68	-43 -83	-43 -106	-43 -143									
180	250		-50 -64	-50 -70	-50 -79	-50 -96	-50 -122	-50 -165									
250	315		-56 -72	-56 -79	-56 -88	-56 -108	-56 -137	-56 -185									
315	400		-62 -80	-62 -87	-62 -98	-62 -119	-62 -151	-62 -202									
400	500		-68 -88	-68 -95	-68 -108	-68 -131	-68 -165	-68 -223									
500	630				-76 -120	-76 -146	-76 -186	-76 -251									
630	800				-80 -130	-80 -160	-80 -205	-80 -280									
800	1000				-86 -142	-86 -176	-86 -226	-86 -316									
1000	1250				-98 -164	-98 -203	-98 -263	-98 -358									
1250	1600				-110 -188	-110 -235	-110 -305	-110 -420									
1600	2000				-120 -212	-120 -270	-120 -350	-120 -490									
2000	2500				-130 -240	-130 -305	-130 -410	-130 -570									
2500	3150				-145 -280	-145 -355	-145 -475	-145 -685									

1) This intermediate fundamental deviation fg is provided primarily for fine mechanisms and horology. If tolerance classes involving this fundamental deviation in other basic sizes are required, they may be calculated in accordance with ISO 286-1.

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Table 21 – Limit deviations for shafts g

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		g							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	-2 -4	-2 -5	-2 -6	-2 -8	-2 -12	-2 -16	-2 -27	-2 -42
3	6	-4 -6.5	-4 -8	-4 -9	-4 -12	-4 -16	-4 -22	-4 -34	-4 -52
6	10	-5 -7.5	-5 -9	-5 -11	-5 -14	-5 -20	-5 -27	-5 -41	-5 -63
10	18	-6 -9	-6 -11	-6 -14	-6 -17	-6 -24	-6 -33	-6 -49	-6 -76
18	30	-7 -11	-7 -13	-7 -16	-7 -20	-7 -28	-7 -40	-7 -59	-7 -91
30	50	-9 -13	-9 16	-9 -20	-9 -25	-9 -34	-9 -48	-9 -71	-9 -109
50	80		-10 -18	-10 -23	-10 -29	-10 -40	-10 -56		
80	120		-12 -22	-12 -27	-12 -34	-12 -47	-12 -66		
120	180		-14 -26	-14 -32	-14 -39	-14 -54	-14 -77		
180	250		-15 -29	-15 -35	-15 -44	-15 -61	-15 -87		
250	315		-17 -33	-17 -40	-17 -49	-17 -69	-17 -98		
315	400		-18 -36	-18 -43	-18 -54	-18 -75	-18 -107		
400	500		-20 -40	-20 -47	-20 -60	-20 -83	-20 -117		
500	630				-22 -66	-22 -92	-22 -132		
630	800				-24 -74	-24 -104	-24 -149		
800	1000				-26 -82	-26 -116	-26 -166		
1000	1250				-28 -94	-28 -133	-28 -193		
1250	1600				-30 -108	-30 -155	-30 -225		
1600	2000				-32 -124	-32 -182	-32 -262		
2000	2500				-34 -144	-34 -209	-34 -314		
2500	3150				-38 -173	-38 -248	-38 -368		

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Table 22 – Limit deviations for shafts h

Upper limit deviation = *es*
Lower limit deviation = *ei*

Basic size mm		h																	
Above	Up to and including	1	2	3	4	5	6	7	8	9	10	11	12	13	14[1]	15[1]	16[1]	17	18
		Deviations																	
		μm											mm						
-	3[1]	0 -0.8	0 -1.2	0 -2	0 -3	0 -4	0 -6	0 -10	0 -14	0 -25	0 -40	0 -60	0 -0.1	0 -0.14	0 -0.25	0 -0.4	0 -0.6		
3	6	0 -1	0 -1.5	0 -2.5	0 -4	0 -5	0 -8	0 -12	0 -18	0 -30	0 -48	0 -75	0 -0.12	0 -0.18	0 -0.3	0 -0.48	0 -0.75	0 -1.2	0 1.8
6	10	0 -1	0 -1.5	0 -2.5	0 -4	0 -6	0 -9	0 -15	0 -22	0 -36	0 -58	0 -90	0 -0.15	0 -0.22	0 -0.36	0 -0.58	0 -0.9	0 -1.5	0 -2.2
10	18	0 -1.2	0 -2	0 -3	0 -5	0 -8	0 -11	0 -18	0 -27	0 -43	0 -70	0 -110	0 -0.18	0 -0.27	0 -0.43	0 -0.7	0 -1.1	0 -1.8	0 -2.7
18	30	0 -1.5	0 -2.5	0 -4	0 -6	0 -9	0 -13	0 -21	0 -33	0 -52	0 -84	0 -130	0 -0.21	0 -0.33	0 -0.52	0 -0.84	0 -1.3	0 -2.1	0 -3.3
30	50	0 -1.5	0 2.5	0 -4	0 -7	0 -11	0 -16	0 -25	0 -39	0 -62	0 -100	0 -160	0 -0.25	0 -0.39	0 -0.62	0 -1	0 -1.6	0 -2.5	0 -3.9
50	80	0 -2	0 -3	0 -5	0 -8	0 -13	0 -19	0 -30	0 -46	0 -74	0 -120	0 -190	0 -0.3	0 -0.46	0 -0.74	0 -1.2	0 -1.9	0 -3	0 -4.6
80	120	0 -2.5	0 -4	0 -6	0 -10	0 -15	0 -22	0 -35	0 -54	0 -87	0 -140	0 -220	0 -0.35	0 -0.54	0 -0.87	0 -1.4	0 -2.2	0 -3.5	0 -5.4
120	180	0 -3.5	0 -5	0 -8	0 -12	0 -18	0 -25	0 -40	0 -63	0 -100	0 -160	0 -250	0 -0.4	0 -0.63	0 -1	0 -1.6	0 -2.5	0 -4	0 -6.3
180	250	0 -4.5	0 -7	0 -10	0 -14	0 -20	0 -29	0 -46	0 -72	0 -115	0 -185	0 -290	0 -0.46	0 -0.72	0 -1.15	0 -1.85	0 -2.9	0 -4.5	0 -7.2
250	315	0 -6	0 -8	0 -12	0 -16	0 -23	0 -32	0 -52	0 -81	0 -130	0 -210	0 -320	0 -0.52	0 -0.81	0 -1.3	0 -2.1	0 -3.2	0 -5.2	0 -8.1
315	400	0 -7	0 -9	0 -13	0 18	0 -25	0 -36	0 -57	0 -89	0 -140	0 -230	0 -360	0 -0.57	0 -0.89	0 -1.4	0 -2.3	0 -3.6	0 -5.7	0 -8.9
400	500	0 -8	0 -10	0 -15	0 -20	0 -27	0 -40	0 -63	0 -97	0 -155	0 -250	0 -400	0 -0.63	0 -0.97	0 -1.55	0 -2.5	0 -4	0 -6.3	0 -9.7
		2)																	
500	630	0 -9	0 -11	0 -16	0 -22	0 -32	0 -44	0 -70	0 -110	0 -175	0 -280	0 -440	0 -0.7	0 -1.1	0 -1.75	0 -28	0 -4.4	0 -7	0 -11
630	800	0 -10	0 -13	0 -18	0 -25	0 -36	0 -50	0 -80	0 -125	0 -200	0 -320	0 -500	0 -0.8	0 -1.25	0 -2	0 -3.2	0 -5	0 -8	0 -12.5
800	1000	0 -11	0 -15	0 -21	0 -28	0 -40	0 -56	0 -90	0 -140	0 -230	0 -360	0 -560	0 -0.9	0 -1.4	0 -2.3	0 -3.6	0 -5.6	0 -9	0 -14
1000	1250	0 -13	0 -18	0 -24	0 -33	0 -47	0 -66	0 -105	0 -165	0 -260	0 -420	0 -660	0 -1.05	0 -1.65	0 -2.6	0 -4.2	0 -6.6	0 -10.5	0 -16.5
1250	1600	0 -15	0 -21	0 -29	0 -39	0 -55	0 -78	0 -125	0 -195	0 -310	0 -500	0 -780	0 -1.25	0 -1.95	0 -3.1	0 -5	0 -7.8	0 -12.5	0 -19.5
1600	2000	0 -18	0 -25	0 -35	0 -46	0 -65	0 -92	0 -150	0 -230	0 -370	0 -600	0 -920	0 -1.5	0 -2.3	0 -3.7	0 -6	0 -9.2	0 -15	0 -23
2000	2500	0 -22	0 -30	0 -41	0 -55	0 -78	0 -110	0 -175	0 -280	0 -440	0 -700	0 -1100	0 -1.75	0 -2.8	0 -4.4	0 -7	0 -11	0 -17.5	0 -28
2500	3150	0 -26	0 -36	0 -50	0 -68	0 -96	0 -135	0 -210	0 -330	0 -540	0 -860	0 -1350	0 -2.1	0 -3.3	0 -5.4	0 -8.6	0 13.5	0 -21	0 -33

1) Tolerance grades IT14 to IT16 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

2) The values given in the frame, for tolerance grades IT1 to IT5 (incl.), for basic sizes greater than 500 mm and less than or equal to 3150 mm, are included for experimental use.

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Table 23 - Limit deviation[1] for shafts js

Upper limit deviation = *es*
Lower limit deviation = *ei*

Basic size mm		js[3]																	
Above	Up to and including	1	2	3	4	5	6	7	8	9	10	11	12	13	14[2]	15[2]	16[2]	17	18
		Deviations µm											Deviations mm						
-	3[3]	±0.4	±0.6	±1	±1.5	±2	±3	±5	±7	±12.5	±20	±30	±0.05	±0.07	±0.125	±0.2	±0.3		
3	6	±0.5	±0.75	±1.25	±2	±2.5	±4	±6	±9	±15	±24	±37.5	±0.06	±0.09	±0.15	±0.24	±0.375	±0.6	±0.9
6	10	±0.5	±0.75	±1.25	±2	±3	±4.5	±7.5	±11	±18	±29	±45	±0.075	±0.11	±0.18	±0.29	±0.45	±0.75	±1.1
10	18	±0.6	±1	±1.5	±2.5	±4	±5.5	±9	±13.5	±21.5	±35	±55	±0.09	±0.135	±0.215	±0.35	±0.55	±0.9	±1.35
18	30	±0.75	±1.25	±2	±3	±4.5	±6.5	±10.5	±16.5	±26	±42	±65	±0.105	±0.165	±0.26	±0.42	±0.65	±1.05	±1.65
30	50	±0.75	±1.25	±2	±3.5	±5.5	±8	±12.5	±19.5	±31	±50	±80	±0.125	±0.195	±0.31	±0.5	±0.8	±1.25	±1.95
50	80	±1	±1.5	±2.5	±4	±6.5	±9.5	±15	±23	±37	±60	±95	±0.15	±0.23	±0.37	±0.6	±0.95	±1.5	±2.3
80	120	±1.25	±2	±3	±5	±7.5	±11	±17.5	±27	±43.5	±70	±110	±0.175	±0.27	±0.435	±0.7	±1.1	±1.75	±2.7
120	180	±1.75	±2.5	±4	±6	±9	±12.5	±20	±31.5	±50	±80	±125	±0.2	±0.315	±0.5	±0.8	±1.25	±2	±3.15
180	250	±2.25	±3.5	±5	±7	±10	±14.5	±23	±36	±57.5	±92.5	±145	±0.23	±0.36	±0.575	±0.925	±1.45	±2.3	±3.6
250	315	±3	±4	±6	±8	±11.5	±16	±26	±40.5	±65	±105	±160	±0.26	±0.405	±0.65	±1.05	±1.6	±2.6	±4.05
315	400	±3.5	±4.5	±6.5	±9	±12.5	±18	±28.5	±44.5	±70	±115	±180	±0.285	±0.445	±0.7	±1.15	±1.8	±2.85	±4.45
400	500	±4	±5	±7.5	±10	±13.5	±20	±31.5	±48.5	±77.5	±125	±200	±0.315	±0.485	±0.775	±1.25	±2	±3.15	±4.85
500	630	±4.5	±5.5	±8	±11	±16	±22	±35	±55	±87.5	±140	±220	±0.35	±0.55	±0.875	±1.4	±2.2	±3.5	±5.5
630	800	±5	±6.5	±9	±12.5	±18	±25	±40	±62.5	±100	±160	±250	±0.4	±0.625	±1	±1.6	±2.5	±4	±6.25
800	1000	±5.5	±7.5	±10.5	±14	±20	±28	±45	±70	±115	±180	±280	±0.45	±0.7	±1.15	±1.8	±2.8	±4.5	±7
1000	1250	±6.5	±9	±12	±16.5	±23.5	±33	±52.5	±82.5	±130	±210	±330	±0.525	±0.825	±1.3	±2.1	±3.3	±5.25	±8.25
1250	1600	±7.5	±10.5	±14.5	±19.5	±27.5	±39	±62.5	±97.5	±155	±250	±390	±0.625	±0.975	±1.55	±2.5	±3.9	±6.25	±9.75
1600	2000	±9	±12.5	±17.5	±23	±32.5	±46	±75	±115	±185	±300	±460	±0.75	±1.15	±1.85	±3	±4.6	±7.5	±11.5
2000	2500	±11	±15	±20.5	±27.5	±39	±55	±87.5	±140	±220	±350	±550	±0.875	±1.4	±2.2	±3.5	±5.5	±8.75	±14
2500	3150	±13	±18	±25	±34	±48	±67.5	±105	±165	±270	±430	±675	±1.05	±1.65	±2.7	±4.3	±6.75	±10.5	±16.5

A.1. In order to avoid repetition of equal values, the table lists the values as "± x"; this is to be interpreted as es = + x and ei = - x, e.g. $^{+0.23}_{-0.23}$ µm.

A.2. The table gives the exact values derived from $\pm \frac{IT}{2}$, either in micrometres or millimetres. For tolerance classes js7 to js11 (incl.), the values with decimal fractions of 0.5 µm may possibly be rounded in national standards by replacing the exact value by the integer immediately below, e.g. ± 19.5 µm may be rounded to ± 19 µm.

A.3. Tolerance grades IT14 to IT16 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

A.4. The values in the frame, for tolerance grades IT1 to IT5 (incl.), for basic sizes greater than 500 mm and less than or equal to 3150 mm, are included for experimental use.

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Table 24 – Limit deviations for shafts j and k

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		j				k										
Above	Up to and including	5[1]	6[1]	7[1]	8	3	4	5	6	7	8	9	10	11	12	13
-	3	±2	+4 -2	+6 -4	+8 -6	+2 0	+3 0	+4 0	+6 0	+10 0	+14 0	+25 0	+40 0	+60 0	+100 0	+140 0
3	6	+3 -2	+6 -2	+8 -4		+2.5 0	+5 +1	+6 +1	+9 +1	+13 +1	+18 0	+30 0	+48 0	+75 0	+120 0	+180 0
6	10	+4 -2	+7 -2	+10 -5		+2.5 0	+5 +1	+7 +1	+10 +1	+16 +1	+22 0	+36 0	+58 0	+90 0	+150 0	+220 0
10	18	+5 -3	+8 -3	+12 -6		+3 0	+6 +1	+9 +1	+12 +1	+19 +1	+27 0	+43 0	+70 0	+110 0	+180 0	+270 0
18	30	+5 -4	+9 -4	+13 -8		+4 0	+8 +2	+11 +2	+15 +2	+23 +2	+33 0	+52 0	+84 0	+130 0	+210 0	+330 0
30	50	+6 -5	+11 -5	+15 -10		+4 0	+9 +2	+13 +2	+18 +2	+27 +2	+39 0	+62 0	+100 0	+160 0	+250 0	+390 0
50	80	+6 -7	+12 -7	+18 -12			+10 +2	+15 +2	+21 +2	+32 +2	+46 0	+74 0	+120 0	+190 0	+300 0	+460 0
80	120	+6 -9	+13 -9	+20 -15			+13 +3	+18 +3	+25 +3	+38 +3	+54 0	+87 0	+140 0	+220 0	+350 0	+540 0
120	180	+7 -11	+14 -11	+22 -18			+15 +3	+21 +3	+28 +3	+43 +3	+63 0	+100 0	+160 0	+250 0	+400 0	+630 0
180	250	+7 -13	+16 -13	+25 -21			+18 +4	+24 +4	+33 +4	+50 +4	+72 0	+115 0	+185 0	+290 0	+460 0	+720 0
250	315	+7 -16	±16	±26			+20 +4	+27 +4	+36 +4	+56 +4	+81 0	+130 0	+210 0	+320 0	+520 0	+810 0
315	400	+7 -18	±18	+29 -28			+22 +4	+29 +4	+40 +4	+61 +4	+89 0	+140 0	+230 0	+360 0	+570 0	+890 0
400	500	+7 -20	±20	+31 -32			+25 +5	+32 +5	+45 +5	+68 +5	+97 0	+156 0	+250 0	+400 0	+630 0	+970 0
500	630								+44 0	+70 0	+110 0	+175 0	+280 0	+440 0	+700 0	+1100 0
630	800								+50 0	+80 0	+125 0	+200 0	+320 0	+500 0	+800 0	+1250 0
800	1000								+56 0	+90 0	+140 0	+230 0	+360 0	+560 0	+900 0	+1400 0
1000	1250								+66 0	+105 0	+165 0	+260 0	+420 0	+660 0	+1050 0	+1650 0
1250	1600								+78 0	+125 0	+195 0	+310 0	+500 0	+780 0	+1250 0	+1950 0
1600	2000								+92 0	+150 0	+230 0	+370 0	+600 0	+920 0	+1500 0	+2300 0
2000	2500								+110 0	+175 0	+280 0	+440 0	+700 0	+1100 0	+1750 0	+2800 0
2500	3150								+135 0	+210 0	+330 0	+540 0	+860 0	+1350 0	+2100 0	+3300 0

• Where values for j5, j6 and j7 are shown as "± x", they are identical with the tolerance class js5, js6 and js7 for that basic size step.

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Table 25 – Limit deviations for shafts m and n

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		m							n						
Above	Up to and including	3	4	5	6	7	8	9	3	4	5	6	7	8	9
-	3	+4 +2	+5 +2	+6 +2	+8 +2	+12 +2	+16 +2	+27 +2	+6 +4	+7 +4	+8 +4	+10 +4	+14 +4	+18 +4	+29 +4
3	6	+6.5 +4	+8 +4	+9 +4	+12 +4	+16 +4	+22 +4	+34 +4	+10.5 +8	+12 +8	+13 +8	+16 +8	+20 +8	+26 +8	+38 +8
6	10	+8.5 +6	+10 +6	+12 +6	+15 +6	+21 +6	+28 +6	+42 +6	+12.5 +10	+14 +10	+16 +10	+19 +10	+25 +10	+32 +10	+46 +10
10	18	+10 +7	+12 +7	+15 +7	+18 +7	+25 +7	+34 +7	+50 +7	+15 +12	+17 +12	+20 +12	+23 +12	+30 +12	+39 +12	+55 +12
18	30	+12 +8	+14 +8	+17 +8	+21 +8	+29 +8	+41 +8	+60 +8	+19 +15	+21 +15	+24 +15	+28 +15	+36 +15	+48 +15	+67 +15
30	50	+13 +9	+16 +9	+20 +9	+25 +9	+34 +9	+48 +9	+71 +9	+21 +17	+24 +17	+28 +17	+33 +17	+42 +17	+56 +17	+79 +17
50	80		+19 +11	+24 +11	+30 +11	+41 +11				+28 +20	+33 +20	+39 +20	+50 +20		
80	120		+23 +13	+28 +13	+35 +13	+48 +13				+33 +23	+38 +23	+45 +23	+58 +23		
120	180		+27 +15	+33 +15	+40 +15	+55 +15				+39 +27	+45 +27	+52 +27	+67 +27		
180	250		+31 +17	+37 +17	+46 +17	+63 +17				+45 +31	+51 +31	+60 +31	+77 +31		
250	315		+36 +20	+43 +20	+52 +20	+72 +20				+50 +34	+57 +34	+66 +34	+86 +34		
315	400		+39 +21	+46 +21	+57 +21	+78 +21				+55 +37	+62 +37	+73 +37	+94 +37		
400	500		+43 +23	+50 +23	+63 +23	+86 +23				+60 +40	+67 +40	+80 +40	+103 +40		
500	630				+70 +26	+96 +26						+88 +44	+114 +44		
630	800				+80 +30	+110 +30						+100 +50	+130 +50		
800	1000				+90 +34	+124 +34						+112 +56	+146 +56		
1000	1250				+106 +40	+145 +40						+132 +66	+171 +66		
1250	1600				+126 +48	+173 +48						+156 +78	+203 +78		
1600	2000				+150 +58	+208 +58						+184 +92	+242 +92		
2000	2500				+178 +68	+243 +68						+220 +110	+285 +110		
2500	3150				+211 +76	+286 +76						+270 +135	+345 +135		

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Table 26 – Limit deviations for shafts p

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		p							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	+8 +6	+9 +6	+10 +6	+12 +6	+16 +6	+20 +6	+31 +6	+46 +6
3	6	+14.5 +12	+16 +12	+17 +12	+20 +12	+24 +12	+30 +12	+42 +12	+60 +12
6	10	+17.5 +15	+19 +15	+21 +15	+24 +15	+30 +15	+37 +15	+51 +15	+73 +15
10	18	+21 +18	+23 +18	+26 +18	+29 +18	+36 +18	+45 +18	+61 +18	+88 +18
18	30	+26 +22	+28 +22	+31 +22	+35 +22	+43 +22	+55 +22	+74 +22	+106 +22
30	50	+30 +26	+33 +26	+37 +26	+42 +26	+51 +26	+65 +26	+86 +26	+126 +26
50	80		+40 +32	+45 +32	+51 +32	+62 +32	+78 +32		
80	120		+47 +37	+52 +37	+59 +37	+72 +37	+91 +37		
120	180		+55 +43	+61 +43	+68 +43	+83 +43	+106 +43		
180	250		+64 +50	+70 +50	+79 +50	+96 +50	+122 +50		
250	315		+72 +56	+79 +56	+88 +56	+108 +56	+137 +56		
315	400		+80 +62	+87 +62	+98 +62	+119 +62	+151 +62		
400	500		+88 +68	+95 +68	+108 +68	+131 +68	+165 +68		
500	630				+122 +78	+148 +78	+188 +78		
630	800				+138 +88	+168 +88	+213 +88		
800	1000				+156 +100	+190 +100	+240 +100		
1000	1250				+186 +120	+225 +120	+285 +120		
1250	1600				+218 +140	265 +140	+335 +140		
1600	2000				+262 +170	+320 +170	+400 +170		
2000	2500				+305 +195	+370 +195	+475 +195		
2500	3150				+375 +240	+450 +240	+570 +240		

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Table 27 – Limit deviations for shafts r

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		r							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	+12 +10	+13 +10	+14 +10	+16 +10	+20 +10	+24 +10	+35 +10	+50 +10
3	6	+17.5 +15	+19 +15	+20 +15	+23 +15	+27 +15	+33 +15	+45 +15	+63 +15
6	10	+21.5 +19	+23 +19	+25 +19	+28 +19	+34 +19	+41 +19	+55 +19	+77 +19
10	18	+26 +23	+28 +23	+31 +23	+34 +23	+41 +23	+50 +23	+66 +23	+93 +23
18	30	+32 +28	+34 +28	+37 +28	+41 +28	+49 +28	+61 +28	+80 +28	+112 +28
30	50	+38 +34	+41 +34	+45 +34	+50 +34	+59 +34	+73 +34	+96 +34	+134 +34
50	65		+49 +41	+54 +41	+60 +41	+71 +41	+87 +41		
65	80		+51 +43	+56 +43	+62 +43	+73 +43	+89 +43		
80	100		+61 +51	+66 +51	+73 +51	+86 +51	+105 +51		
100	120		+64 +54	+69 +54	+76 +54	+89 +54	+108 +54		
120	140		+75 +63	+81 +63	+88 +63	+103 +63	+126 +63		
140	160		+77 +65	+83 +65	+90 +65	+105 +65	+128 +65		
160	180		+80 +68	+86 +68	+93 +68	+108 +68	+131 +68		
180	200		+91 +77	+97 +77	+106 +77	+123 +77	+149 +77		
200	225		+94 +80	+100 80	+109 +80	+126 +80	+152 +80		
225	250		+98 +84	+104 +84	+113 +84	+130 +84	+156 +84		
250	280		+110 +94	+117 +94	+126 +94	+146 +94	+175 +94		
280	315		+114 +98	+121 +98	+130 +98	+150 +98	+179 +98		
315	355		+126 +108	+133 +108	+144 +108	+165 -108	+197 +108		
355	400		+132 +114	+139 +114	+150 +114	+171 +114	+203 +114		
400	450		+146 +126	+153 +126	+166 +126	+189 +126	+223 +126		
450	500		+152 +132	+159 +132	+172 +132	+195 +132	+229 +132		

Basic size mm		r		
Above	Up to and including	6	7	8
500	560	+194 +150	+220 +150	+260 +150
560	630	+199 +155	+225 +155	+265 +155
630	710	+225 +175	+255 +175	+300 +175
710	800	+235 +185	+265 +185	+310 +185
800	900	+266 +210	+300 +210	+350 +210
900	1000	+276 +220	+310 +220	+360 +220
1000	1120	+316 +250	+355 +250	+415 +250
1120	1250	+326 +260	+365 +260	+425 +260
1250	1400	+378 +300	+425 +300	+495 +300
1400	1600	+408 +330	+455 +330	+525 +330
1600	1800	+462 +370	+520 +370	+600 +370
1800	2000	+492 +400	+550 +400	+630 +400
2000	2240	+550 +440	+615 +440	+720 +440
2240	2500	+570 +460	+635 +460	+740 +460
2500	2800	+685 +550	+760 +550	+880 +550
2800	3150	+715 +580	+790 +580	+910 +580

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Table 28 – Limit deviations for shafts s

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		s							
Above	Up to and including	3	4	5	6	7	8	9	10
-	3	+16 +14	+17 +14	+18 +14	+20 +14	+24 +14	+28 +14	+39 +14	+54 +14
3	6	+21.5 +19	+23 +19	+24 +19	+27 +19	+31 +19	+37 +19	+49 +19	+67 +19
6	10	+25.5 +23	+27 +23	+29 +23	+32 +23	+38 +23	+45 +23	+59 +23	+81 +23
10	18	+31 +28	+33 +28	+36 +28	+39 +28	+46 +28	+55 +28	+71 +28	+98 +28
18	30	+39 +35	+41 +35	+44 +35	+48 +35	+56 +35	+68 +35	+87 +35	+119 +35
30	50	+47 +43	+50 +43	+54 +43	+59 +43	+68 +43	+82 +43	+105 +43	+143 +43
50	65		+61 +53	+66 +53	+72 +53	+83 +53	+99 +53	+127 +53	
65	80		+67 +59	+72 +59	+78 +59	+89 +59	+105 +59	+133 +59	
80	100		+81 +71	+86 +71	+93 +71	+106 +71	+125 +71	+158 +71	
100	120		+89 +79	+94 +79	+101 +79	+114 +79	+133 +79	+166 +79	
120	140		+104 +92	+110 +92	+117 +92	+132 +92	+155 +92	+192 +92	
140	160		+112 +100	+118 +100	+125 +100	+140 +100	+163 +100	+200 +100	
160	180		+120 +108	+126 +108	+133 +108	+148 +108	+171 +108	+208 +108	
180	200		+136 +122	+142 +122	+151 +122	+168 +122	+194 +122	+237 +122	
200	225		+144 +130	+150 +130	+159 +130	+176 +130	+202 +130	+245 +130	
225	250		+154 +140	+160 +140	+169 +140	+186 +140	+212 +140	+255 +140	
250	280		+174 +158	+181 +158	+190 +158	+210 +158	+239 +158	+288 +158	
280	315		+186 +170	+193 +170	+202 +170	+222 +170	+251 +170	+300 +170	
315	355		+208 +190	+215 +190	+226 +190	+247 +190	+279 +190	+330 +190	
355	400		+226 +208	+233 +208	+244 +208	+265 +208	+297 +208	+348 +208	
400	450		+252 +232	+259 +232	+272 +232	+295 +232	+329 +232	+387 +232	
450	500		+272 +252	+279 +252	+292 +252	+315 +252	+349 +252	+407 +252	

Basic size mm		s		
Above	Up to and including	6	7	8
500	560	+324 +280	+350 +280	+390 +280
560	630	+354 +310	+380 +310	+420 +310
630	710	+390 +340	+420 +340	+465 +340
710	800	+430 +380	+460 +380	+505 +380
800	900	+486 +430	+520 +430	+570 +430
900	1000	+526 +470	+560 +470	+610 +470
1000	1120	+586 +520	+625 +520	+685 +520
1120	1250	+646 +580	+685 +580	+745 +580
1250	1400	+718 +640	+765 +640	+835 +640
1400	1600	+798 +720	+845 +720	+915 +720
1600	1800	+912 +820	+970 +820	+1050 +820
1800	2000	+1012 +920	+1070 +920	+1150 +920
2000	2240	+1110 +1000	+1175 +1000	+1280 +1000
2240	2500	+1210 +1100	+1275 +1100	+1380 +1100
2500	2800	+1385 +1250	+1460 +1250	+1580 +1250
2800	3150	+1535 +1400	+1610 +1400	+1730 +1400

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Table 29 – Limit deviations for shafts t and u

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		t[1]				u				
Above	Up to and including	5	6	7	8	5	6	7	8	9
-	3					+22 +18	+24 +18	+28 +18	+32 +18	+43 +18
3	6					+28 +23	+31 +23	+35 +23	+41 +23	+53 +23
6	10					+34 +28	+37 +28	+43 +28	+50 +28	+64 +28
10	18					+41 +33	+44 +33	+51 +33	+60 +33	+76 +33
18	24					+50 +41	+54 +41	+62 +41	+74 +41	+93 +41
24	30	+50 +41	+54 +41	+62 +41	+74 +41	+57 +48	+61 +48	+69 +48	+81 +48	+100 +48
30	40	+59 +48	+64 +48	+73 +48	+87 +48	+71 +60	+76 +60	+85 +60	+99 +60	+122 +60
40	50	+65 +54	+70 +54	+79 +54	+93 +54	+81 +70	+86 +70	+95 +70	+109 +70	+132 +70
50	65	+79 +66	+85 +66	+96 +66	+112 +66	+100 +87	+106 +87	+117 +87	+133 +87	+161 +87
65	80	+88 +75	+94 +75	+105 +75	+121 +75	+115 +102	+121 +102	+132 +102	+148 +102	+176 +102
80	100	+106 +91	+113 +91	+126 +91	+145 +91	+139 +124	+146 +124	+159 +124	+178 +124	+211 +124
100	120	+119 +104	+126 +104	+139 +104	+158 +104	+159 +144	+166 +144	+179 +144	+198 +144	+231 +144
120	140	+140 +122	+147 +122	+162 +122	+185 +122	+188 +170	+195 +170	+210 +170	+233 +170	+270 +170
140	160	+152 +134	+159 +134	+174 +134	+197 +134	+208 +190	+215 +190	+230 +190	+253 +190	+290 +190
160	180	+164 +146	+171 +146	+186 +146	+209 +146	+228 +210	+235 +210	+250 +210	+273 +210	+310 +210
180	200	+186 +166	+195 +166	+212 +166	+238 +166	+256 +236	+265 +236	+282 +236	+308 +236	+351 +236
200	225	+200 +180	+209 +180	+226 +180	+252 +180	+278 +258	+287 +258	+304 +258	+330 +258	+373 +258
225	250	+216 +196	+225 +196	+242 +196	+268 +196	+304 +284	+313 +284	+330 +284	+356 +284	+399 +284
250	280	+241 +218	+250 +218	+270 +218	+299 +218	+338 +315	+347 +315	+367 +315	+396 +315	+445 +315
280	315	+263 +240	+272 +240	+292 +240	+321 +240	+373 +350	+382 +350	+402 +350	+431 +350	+480 +350
315	355	+293 +268	+304 +268	+325 +268	+357 +268	+415 +390	+426 +390	+447 +390	+479 +390	+530 +390
355	400	+319 +294	+330 +294	+351 +294	+383 +294	+460 +435	+471 +435	+492 +435	+524 +435	+575 +435
400	450	+357 +330	+370 +330	+393 +330	+427 +330	+517 +490	+530 +490	+553 +490	+587 +490	+645 +490
450	500	+387 +360	+400 +360	+423 +360	+457 +360	+567 +540	+580 +540	+603 +540	+637 +540	+695 +540

Basic size mm		t[1]		u		
Above	Up to and including	6	7	6	7	8
500	560	+444 +400	+470 +400	+644 +600	+670 +600	+710 +600
560	630	+494 +450	+520 +450	+704 +660	+730 +660	+770 +660
630	710	+550 +500	+580 +500	+790 +740	+820 +740	+865 +740
710	800	+610 +560	+640 +560	+890 +840	+920 +840	+965 +840
800	900	+676 +620	+710 +620	+996 +940	+1030 +940	+1080 +940
900	1000	+736 +680	+770 +680	+1106 +1050	+1140 +1050	+1190 +1050
1000	1120	+846 +780	+885 +780	+1216 +1150	+1255 +1150	+1315 +1150
1120	1250	+906 +840	+945 +840	+1366 +1300	+1405 +1300	+1465 +1300
1250	1400	+1038 +960	+1085 +960	+1528 +1450	+1575 +1450	+1645 +1450
1400	1600	+1128 +1050	+1175 +1050	+1678 +1600	+1725 +1600	+1795 +1600
1600	1800	+1292 +1200	+1350 +1200	+1942 +1850	+2000 +1850	+2080 +1850
1800	2000	+1442 +1350	+1500 +1350	+2092 +2000	+2150 +2000	+2230 +2000
2000	2240	+1610 +1500	+1675 +1500	+2410 +2300	+2475 +2300	+2580 +2300
2240	2500	+1760 +1650	+1825 +1650	+2610 +2500	+2675 +2500	+2780 +2500
2500	2800	+2035 +1900	+2110 +1900	+3035 +2900	+3110 +2900	+3230 +2900
2800	3150	+2235 +2100	+2310 +2100	+3335 +3200	+3410 +3200	+3530 +3200

1. Tolerance classes t5 to t8 (incl.) have not been tabulated for basic sizes less than or equal to 24 mm. It is recommended that tolerance classes u5 to u6 (incl.) be used instead. However, if tolerance classes t5 to t8 (incl) are especially required, they may be calculated from the bases given in AA0230201.

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Table 30 – Limit deviations for shafts v, x and y[1)]

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		v[2]				x						y[3]				
Above	Up to and including	5	6	7	8	5	6	7	8	9	10	6	7	8	9	10
-	3					+24 +20	+26 +20	+30 +20	+34 +20	+45 +20	+60 +20					
3	6					+33 +28	+36 +28	+40 +28	+46 +28	+58 +28	+76 +28					
6	10					+40 +34	+43 +34	+49 +34	+56 +34	+70 +34	+92 +34					
10	14					+48 +40	+51 +40	+58 +40	+67 +40	+83 +40	+110 +40					
14	18	+47 +39	+50 +39	+57 +39	+66 +39	+53 +45	+56 +45	+63 +45	+72 +45	+88 +45	+115 +45					
18	24	+56 +47	+60 +47	+68 +47	+80 +47	+63 +54	+67 +54	+75 +54	+87 +54	+106 +54	+138 +54	+76 +63	+84 +63	+96 +63	+115 +63	+147 +63
24	30	+64 +55	+68 +55	+76 +55	+88 +55	+73 +64	+77 +64	+85 +64	+97 +64	+116 +64	+148 +64	+88 +75	+96 +75	+108 +75	+127 +75	+159 +75
30	40	+79 +68	+84 +68	+93 +68	+107 +68	+91 +80	+96 +80	+105 +80	+119 +80	+142 +80	+180 +80	+110 +94	+119 +94	+133 +94	+156 +94	+194 +94
40	50	+92 +81	+97 +81	+106 +81	+120 +81	+108 +97	+113 +97	+122 +97	+136 +97	+159 +97	+197 +97	+130 +114	+139 +114	+153 +114	+176 +114	+214 +114
50	65	+115 +102	+121 +102	+132 +102	+148 +102	+135 +122	+141 +122	+152 +122	+168 +122	+196 +122	+242 +122	+163 +144	+174 +144	+190 +144		
65	80	+133 +120	+139 +120	+150 +120	+166 +120	+159 +146	+165 +146	+176 +146	+192 +146	+220 +146	+266 +146	+193 +174	+204 +174	+220 +174		
80	100	+161 +146	+168 +146	+181 +146	+200 +146	+193 +178	+200 +178	+213 +178	+232 +178	+265 +178	+318 +178	+236 +214	+249 +214	+268 +214		
100	120	+187 +172	+194 +172	+207 +172	+226 +172	+225 +210	+232 +210	+245 +210	+264 +210	+297 +210	+350 +210	+276 +254	+289 +254	+308 +254		
120	140	+220 +202	+227 +202	+242 +202	+265 +202	+266 +248	+273 +248	+288 +248	+311 +248	+348 +248	+408 +248	+325 +300	+340 +300	+363 +300		
140	160	+246 +228	+253 +228	+268 +228	+291 +228	+298 +280	+305 +280	+320 +280	+343 +280	+380 +280	+440 +280	+365 +340	+380 +340	+403 +340		
160	180	+270 +252	+277 +252	+292 +252	+315 +252	+328 +310	+335 +310	+350 +310	+373 +310	+410 +310	+470 +310	+405 +380	+420 +380	+443 +380		
180	200	+304 +284	+313 +284	+330 +284	+356 +284	+370 +350	+379 +350	+396 +350	+422 +350	+465 +350	+535 +350	+454 +425	+471 +425	+497 +425		
200	225	+330 +310	+339 +310	+356 +310	+382 +310	+405 +385	+414 +385	+431 +385	+457 +385	+500 +385	+570 +385	+499 +470	+516 +470	+542 +470		
225	250	+360 +340	+369 +340	+386 +340	+412 +340	+445 +425	+454 +425	+471 +425	+497 +425	+540 +425	+610 +425	+549 +520	+566 +520	+592 +520		
250	280	+408 +385	+417 +385	+437 +385	+466 +385	+498 +475	+507 +475	+527 +475	+556 +475	+605 +475	+685 +475	+612 +580	+632 +580	+661 +580		
280	315	+448 +425	+457 +425	+477 +425	+506 +425	+548 +525	+557 +525	+577 +525	+606 +525	+655 +525	+735 +525	+682 +650	+702 +650	+731 +650		
315	355	+500 +475	+511 +475	+532 +475	+564 +475	+615 +590	+626 +590	+647 +590	+679 +590	+730 +590	+820 +590	+766 +730	+787 +730	+819 +730		
355	400	+555 +530	+566 +530	+587 +530	+619 +530	+685 +660	+696 +660	+717 +660	+749 +660	+800 +660	+890 +660	+856 +820	+877 +820	+909 +820		
400	450	+622 +595	+635 +595	+658 +595	+692 +595	+767 +740	+780 +740	+803 +740	+837 +740	+895 +740	+990 +740	+960 +920	+983 +920	+1017 +920		
450	500	+687 +660	+700 +660	+723 +660	+757 +660	+847 +820	+860 +820	+883 +820	+917 +820	+975 +820	+1070 +820	+1040 +1000	+1063 +1000	+1097 +1000		

1. Fundamental deviations v, x and y are not provided for basic sizes greater than 500 mm.
2. Tolerance classes v5 to v8 (incl.) have not been tabulated for basic sizes less than or equal to 14 mm. it is recommended that tolerance classes x5 to x8 (incl.) be used instead. However, if tolerance classes v5 to v8 (incl.) are especially required, they may be calculated from the bases given in ISO 286-1.
3. Tolerance classes y6 to y10 (incl.) have not been tabulated for basic sizes less than or equal to 18 mm. it is recommended that tolerance classes z6 to z10 (incl.) be used instead. However, if tolerance classes y6 to y10 (incl.) are especially required, they may be calculated from the bases given in ISO 286-1.

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Table 31– Limit deviations for shafts z and za[1)]

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		z						za					
Above	Up to and including	6	7	8	9	10	11	6	7	8	9	10	11
-	3	+32 +26	+36 +26	+40 +26	+51 +26	+66 +26	+86 +26	+38 +32	+42 +32	+46 +32	+57 +32	+72 +32	+92 +32
3	6	+43 +35	+47 +35	+53 +35	+65 +35	+83 +35	+110 +35	+50 +42	+54 +42	+60 +42	+72 +42	+90 +42	+117 +42
6	10	+51 +42	+57 +42	+64 +42	+78 +42	+100 +42	+132 +42	+61 +52	+67 +52	+74 +52	+88 +52	+110 +52	+142 +52
10	14	+61 +50	+68 +50	+77 +50	+93 +50	+120 +50	+160 +50	+75 +64	+82 +64	+91 +64	+107 +64	+134 +64	+174 +64
14	18	+71 +60	+78 +60	+87 +60	+103 +60	+130 +60	+170 +60	+88 +77	+95 +77	+104 +77	+120 +77	+147 +77	+187 +77
18	24	+86 +73	+94 +73	+106 +73	+125 +73	+157 +73	+203 +73	+111 +98	+119 +98	+131 +98	+150 +98	+182 +98	+228 +98
24	30	+101 +88	+109 +88	+121 +88	+140 +88	+172 +88	+218 +88	+131 +118	+139 +118	+151 +118	+170 +118	+202 +118	+248 +118
30	40	+128 +112	+137 +112	+151 +112	+174 +112	+212 +112	+272 +112	+164 +148	+173 +148	+187 +148	+210 +148	+248 +148	+308 +148
40	50	+152 +136	+161 +136	+175 +136	+198 +136	+236 +136	+296 +136	+196 +180	+205 +180	+219 +180	+242 +180	+280 +180	+340 +180
50	65	+191 +172	+202 +172	+218 +172	+246 +172	+292 +172	+362 +172	+245 +226	+256 +226	+272 +226	+300 +226	+346 +226	+416 +226
65	80	+229 +210	+240 +210	+256 +210	+284 +210	+330 +210	+400 +210	+293 +274	+304 +274	+320 +274	+348 +274	+394 +274	+464 +274
80	100	+280 +258	+293 +258	+312 +258	+345 +258	+398 +258	+478 +258	+357 +335	+370 +335	+389 +335	+422 +335	+475 +335	+555 +335
100	120	+332 +310	+345 +310	+364 +310	+397 +310	+450 +310	+530 +310	+422 +400	+435 +400	+454 +400	+487 +400	+540 +400	+620 +400
120	140	+390 +365	+405 +365	+428 +365	+465 +365	+525 +365	+615 +365	+495 +470	+510 +470	+533 +470	+570 +470	+630 +470	+720 +470
140	160	+440 +415	+455 +415	+478 +415	+515 +415	+575 +415	+665 +415	+560 +535	+575 +535	+588 +535	+635 +535	+695 +535	+785 +535
160	180	+490 +465	+505 +465	+528 +465	+565 +465	+625 +465	+715 +465	+625 +600	+640 +600	+663 +600	+700 +600	+760 +600	+850 +600
180	200	+549 +520	+566 +520	+592 +520	+635 +520	+705 +520	+810 +520	+699 +670	+716 +670	+742 +670	+785 +670	+855 +670	+960 +670
200	225	+604 +575	+621 +575	+647 +575	+690 +575	+760 +575	+865 +575	+769 +740	+786 +740	+812 +740	+855 +740	+925 +740	+1030 +740
225	250	+669 +640	+686 +640	+712 +640	+755 +640	+825 +640	+930 +640	+849 +820	+866 +820	+892 +820	+935 +820	+1005 +820	+1110 +820
250	280	+742 +710	+762 +710	+791 +710	+840 +710	+920 +710	+1030 +710	+952 +920	+972 +920	+1001 +920	+1050 +920	+1130 +920	+1240 +920
280	315	+822 +790	+842 +790	+871 +790	+920 +790	+1000 +790	+1110 +790	+1032 +1000	+1052 +1000	+1081 +1000	+1130 +1000	+1210 +1000	+1320 +1000
315	355	+936 +900	+957 +900	+989 +900	+1040 +900	+1130 +900	+1260 +900	+1186 +1150	+1207 +1150	+1239 +1150	+1290 +1150	+1380 +1150	+1510 +1150
355	400	+1036 +1000	+1057 +1000	+1089 +1000	+1140 +1000	+1230 +1000	+1360 +1000	+1336 +1300	+1357 +1300	+1389 +1300	+1440 +1300	+1530 +1300	+1600 +1300
400	450	+1140 +1100	+1163 +1100	+1197 +1100	+1255 +1100	+1350 +1100	+1500 +1100	+1490 +1450	+1513 +1450	+1547 +1450	+1605 +1450	+1700 +1450	+1850 +1450
450	500	+1290 +1250	+1313 +1250	+1347 +1250	+1405 +1250	+1500 +1250	+1650 +1250	+1640 +1600	+1663 +1600	+1697 +1600	+1755 +1600	+1850 +1600	+2000 +1600

1. Fundamental deviations z and za are not provided for basic sizes greater than 500 mm.

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Table 32 – Limit deviations for shafts zb and zc[1)]

Upper limit deviation = *es*
Lower limit deviation = *ei*

Deviations in micrometres

Basic size mm		zb					zc				
Above	Up to and including	7	8	9	10	11	7	8	9	10	11
-	3	+50 +40	+54 +40	+65 +40	+80 +40	+100 +40	+70 +60	+74 +60	+85 +60	+100 +60	+120 +60
3	6	+62 +50	+68 +50	+80 +50	+96 +50	+125 +50	+92 +80	+98 +80	+110 +80	+128 +80	+155 +80
6	10	+82 +67	+89 +67	+103 +67	+125 +67	+157 +67	+112 +97	+119 +97	+133 +97	+155 +97	+187 +97
10	14	+108 +90	+117 +90	+133 +90	+160 +90	+200 +90	+148 +130	+157 +130	+173 +130	+200 +130	+240 +130
14	18	+126 +108	+135 +108	+151 +108	+178 +108	+218 +108	+168 +150	+177 +150	+193 +150	+220 +150	+260 +150
18	24	+157 +136	+169 +136	+188 +136	+220 +136	+266 +136	+209 +188	+221 +188	+240 +188	+272 +188	+318 +188
24	30	+181 +160	+193 +160	+212 +160	+244 +160	+290 +160	+239 +218	+251 +218	+270 +218	+302 +218	+348 +218
30	40	+225 +200	+239 +200	+262 +200	+300 +200	+360 +200	+299 +274	+313 +274	+336 +274	+374 +274	+434 +274
40	50	+267 +242	+281 +242	+304 +242	+342 +242	+402 +242	+350 +325	+364 +325	+387 +325	+425 +325	+485 +325
50	65	+330 +300	+346 +300	+374 +300	+420 +300	+490 +300	+435 +405	+451 +405	+479 +405	+525 +405	+595 +405
65	80	+390 +360	+406 +360	+434 +360	+480 +360	+550 +360	+510 +480	+526 +480	+554 +480	+600 +480	+670 +480
80	100	+480 +445	+499 +445	+532 +445	+585 +445	+665 +445	+620 +585	+639 +585	+672 +585	+725 +585	+805 +585
100	120	+560 +525	+579 +525	+612 +525	+665 +525	+745 +525	+725 +690	+744 +690	+777 +690	+830 +690	+910 +690
120	140	+660 +620	+683 +620	+720 +620	+780 +620	+870 +620	+840 +800	+863 +800	+900 +800	+960 +800	+1050 +800
140	160	+740 +700	+763 +700	+800 +700	+860 +700	+950 +700	+940 +900	+963 +900	+1000 +900	+1060 +900	+1150 +900
160	180	+820 +780	+843 +780	+880 +780	+940 +780	+1030 +780	+1040 +1000	+1063 +1000	+1100 +1000	+1160 +1000	+1250 +1000
180	200	+926 +880	+952 +880	+995 +880	+1065 +880	+1170 +880	+1196 +1150	+1222 +1150	+1265 +1150	+1335 +1150	+1440 +1150
200	225	+1006 +960	+1032 +960	+1075 +960	+1145 +960	+1250 +960	+1296 +1250	+1322 +1250	+1365 +1250	+1435 +1250	+1540 +1250
225	250	+1096 +1050	+1122 +1050	+1165 +1050	+1235 +1050	+1340 +1050	+1396 +1350	+1422 +1350	+1465 +1350	+1535 +1350	+1640 +1350
250	280	1252 +1200	+1281 +1200	+1330 +1200	+1410 +1200	+1520 +1200	+1602 +1550	+1631 +1550	+1680 +1550	+1760 +1550	+1870 +1550
280	315	+1352 +1300	+1381 +1300	+1430 +1300	+1510 +1300	+1620 +1300	+1752 +1700	+1781 +1700	+1830 +1700	+1910 +1700	+2020 +1700
315	355	+1557 +1500	+1589 +1500	+1640 +1500	+1730 +1500	+1860 +1500	+1957 +1900	+1989 +1900	+2040 +1900	+2130 +1900	+2260 +1900
355	400	+1707 +1650	+1739 +1650	+1790 +1650	+1880 +1650	+2010 +1650	+2157 +2100	+2189 +2100	+2240 +2100	+2330 +2100	+2460 +2100
400	450	+1913 +1850	+1947 +1850	+2005 +1850	+2100 +1850	+2250 +1850	+2463 +2400	+2497 +2400	+2555 +2400	+2650 +2400	+2800 +2400
450	500	+2163 +2100	+2197 +2100	+2255 +2100	+2350 +2100	+2500 +2100	+2663 +2600	+2697 +2600	+2755 +2600	+2850 +2600	+3000 +2600

1. Fundamental deviations zb and zc are not provided for basic sizes greater than 500 mm.

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Annex

Graphical review of tolerance zones of holes and shafts

A.5. Representation of tolerance zones for holes

A graphical review of a broad selection of tolerance classes for holes is given in figures 6 and 7. Figure 6 shows the tolerance classes in terms of the fundamental deviation (A to ZC), whereas figure 7 gives the same information in terms of the standard tolerance grade (IT5 to IT11), Figure 6 and 7 do not include all the tolerance classes given in AA0230206 and reference should be made to the tables for specific details.

For comparative purposes, the tolerance classes given in figures 6 and 7 illustrate the values for ES, EI and IT given for the basic size step from 6 to 10 mm. Where there are no tabulated values for this basic size step, i.e. those tolerance classes involving fundamental deviations T, V and Y, the values have been given, again for comparative purposes, for the basic size step from 24 to 30 mm.

A.6. Representation of tolerance zones for shafts

A graphical review of a broad selection of tolerance classes for shafts is given in figures 8 and 9. Figure 8 shows the tolerance classes in terms of the fundamental deviation (a to zc), whereas figure 9 gives the same information in terms for the standard tolerance grade IT5 to IT11), Figures 8 and 9 do not include all the tolerance classes given in AA0230206 and references should be made to the tables for specific details.

For comparative purposes, the tolerance classes given in figures 8 and 9 illustrate the values for es, ei and IT given for the basic size step from 6 to 10 mm. Where there are no tabulated values for this basic size step, i.e., those tolerance classes involving fundamental deviations t, v and y, the values have been given, again for comparative purposes, for the basic size step from 24 to 30 mm.

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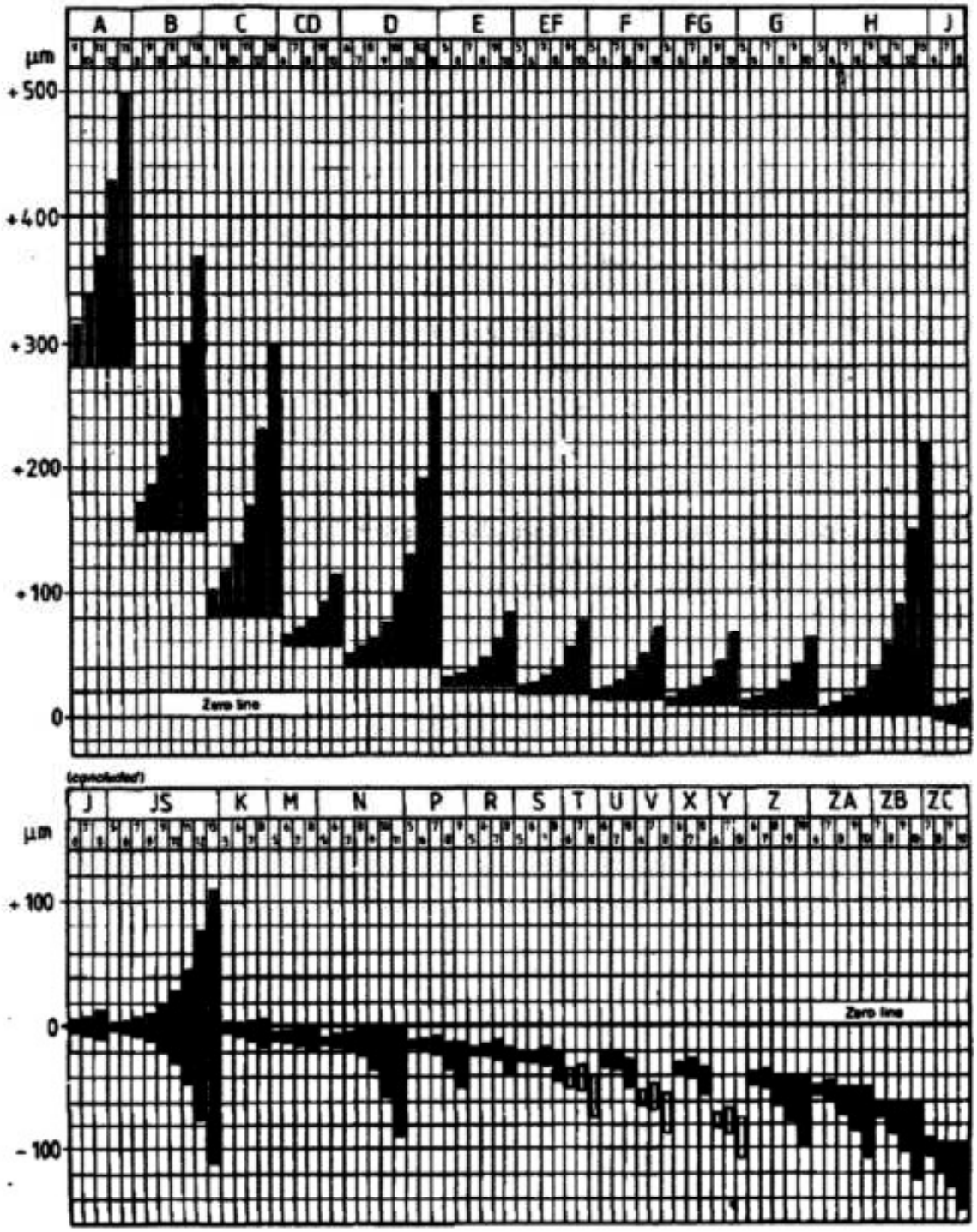

Figure 6 – Graphical review of tolerance classes for holes in terms of fundamental deviations

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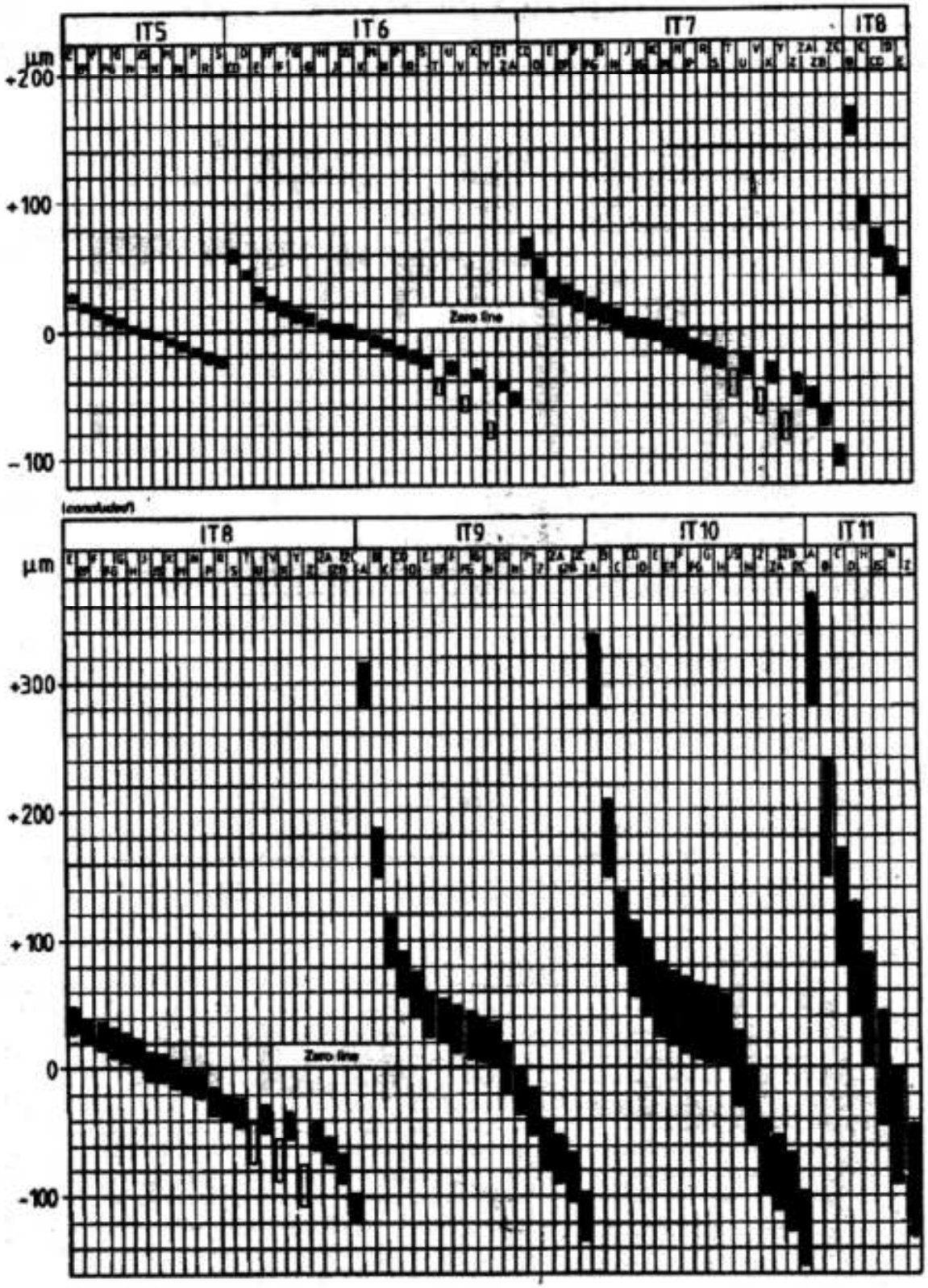

Figure 7 – Graphical review of tolerance classes for holes in terms of standard tolerance grades

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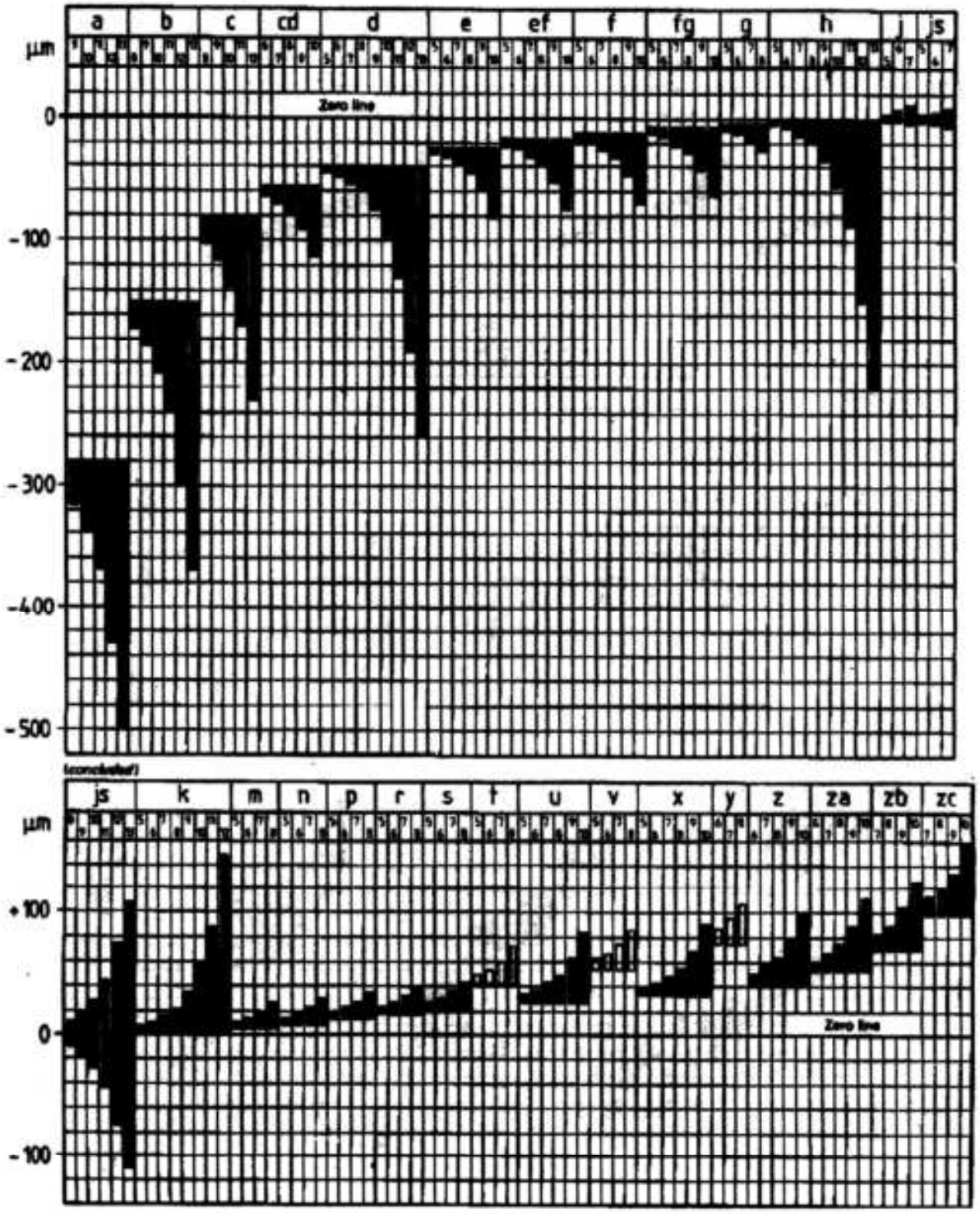

Figure 8 – Graphical review of tolerance classes for shafts in terms of fundamental deviations

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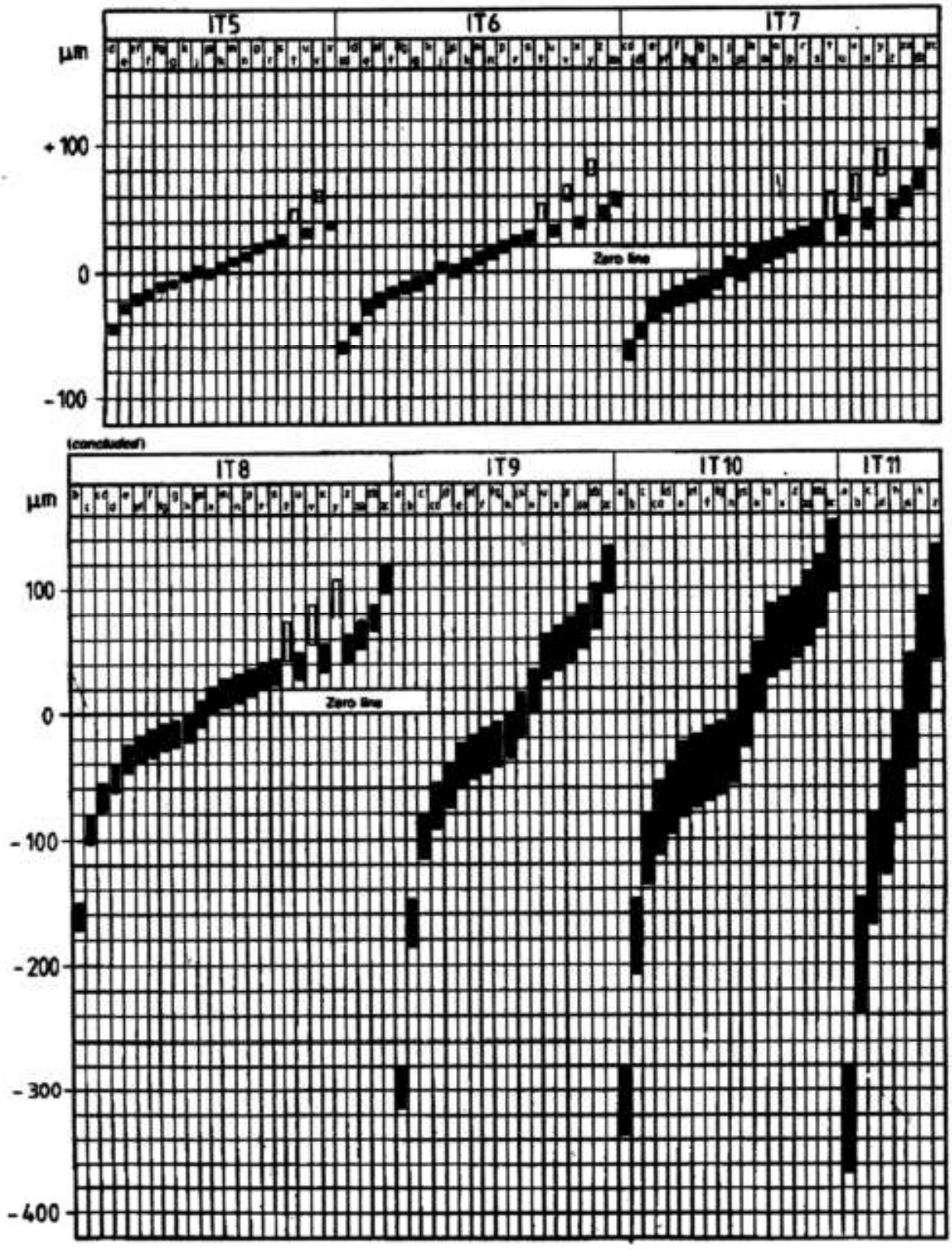

Figure 9 – Graphical review of tolerance classes for shafts in terms of standard tolerance grades

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GENERAL TOLERANCES – TOLERANCES FOR LINEAR AND ANGULAR DIMENSIONS WITHOUT INDIVIDUAL TOLERANCE INDICATIONS

0.0 GENERAL

When selecting the tolerance class, the respective customary workshop accuracy has to be taken into consideration. If smaller tolerances are required or larger tolerances are permissible and more economical for any individual feature, such tolerances should be indicated to the relevant nominal dimension(s).

General tolerance for linear and angular dimensions apply when drawings or associated specifications refer to this standard in accordance with clauses 3 and 4. If there are general tolerances for other International standards, reference shall be made to them on the drawings or associated specifications. For a dimension between an unfinished and a finished surface, e.g. of cast or forged parts, for which no individual tolerance is directly indicated, the larger of the two general tolerances in question applies, e.g. for castings, see ISO 8062, Castings - system of Dimensional Tolerances.

1.0 SCOPE

The standard is intended to simplify drawing indications and it specifies general tolerances for linear and angular dimensions without individual tolerance indications in four tolerance classes.

It applies to the dimensions of parts that are produced by metal removal or parts that are formed from sheet metal.

NOTE:

1) The concepts behind the general tolerancing of linear and angular dimensions are described in Annex-A.

2) These tolerances may be suitable for use with materials other than metals.

This standard only applies for the following dimensions which do not have an individual tolerance indication:

a) Linear dimensions (e.g. external sizes, internal sizes, step sizes, diameters, radii, distances, external radii and chamfer heights for broken edges).

b) Angular dimensions, including angular dimensions usually not indicated, e.g. right angles (90°), unless reference to IS: 2102 (Part 2) is made, or angles of uniform polygons.

c) Linear and angular dimensions produced by machining assembled parts.

It does not apply for the following dimensions:

a) Linear and angular dimensions which are covered by reference to other standards on general tolerances.

b) Auxiliary dimensions indicated in brackets.

c) Theoretically exact dimensions indicated in rectangular frames.

2.0 COMPLIANCE WITH STANDARDS

This standard is based on IS: 2102 (Part 1)-1993 (ISO 2768-1).

3.0 GENERAL TOLERANCES

3.1 Linear dimensions are given in Table 1 and 2.

3.2 Angular dimensions: General tolerance specified in angular units control only the general orientation of lines or line elements of surfaces, but not their form deviations.

The general orientation of the line derived from the actual surface is the orientation of the contracting line of ideal geometrical form. The maximum distance between the contacting line and the actual line shall be the least possible value (see IS: 12160).

The permissible deviations of angular dimensions are given in Table 3.

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4.0 INDICATIONS ON DRAWINGS:

If general tolerances in accordance with this standard shall apply, the following information shall be indicated.

Example: AA0230208 m

5.0 REJECTION

Unless otherwise stated, work pieces exceeding the general tolerance shall not lead to automatic rejection provided that the ability of the work piece to function is not impaired (see clause A4).

6.0 NOTE:

6.1 For "permissible deviations for Un-toleranced dimensions of castings" refer AA0230402.

6.2 For "Tolerances and machining allowances for flame cutting" refer AA0621101.

6.3 For "General tolerances for welding construction for length and angles" refer AA0621104.

6.4 For "General tolerances for welded structures form and position" refer AA0621105.

Table 1 – Permissible deviations for linear dimensions except for broken edges (external radii and chamfer heights, see table 2)

Values in millimetres

Tolerance class		Permissible deviations for basic size range							
Designation	Description	0.5[1] Up to 3	Over 3 Up to 6	Over 6 Up to 30	Over 30 Up to 120	Over 120 Up to 400	Over 400 Up to 1000	Over 1000 Up to 2000	Over 2000 Up to 4000
f	Fine	±0.05	±0.05	±0.1	±0.15	±0.2	±0.3	±0.5	-
m	Medium	±0.1	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2
c	Coarse	±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	±4
v	Very coarse	-	±0.5	±1	±1.5	±2.5	±4	±6	±8
1) For nominal sizes below 0.5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s).									

Table 2 – Permissible deviations for broken edges (external radii and chamfer heights)

Values in millimetres

Tolerance class		Permissible deviations for basic size range		
Designation	Description	0.5[1] up to 3	Over 3 up to 6	Over 6
f	fine	±0.2	±0.5	±1
m	medium			
c	coarse	±0.4	±1	±2
v	very coarse			
1) For nominal sizes below 0.5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s)				

Table 3 – Permissible deviations of angular dimensions

Tolerance class		Permissible deviations for ranges of lengths, in millimetres, of the shorter side of the angle concerned				
Designation	Description	Up to 10	Over 10 Up to 50	Over 50 Up to 120	Over 120 Up to 400	Over 400
f	fine	±1°	±0°30′	±0°20′	±0°10′	±0.5′
m	medium					
c	coarse	±1°30′	±1°	±0°30′	±0°15′	±0°10′
v	very coarse	±3°	±2°	±1°	±0°30′	±0°20′

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Annex A
(informative)

Concepts behind general tolerancing of linear and angular dimensions

A.1 General tolerances should be indicated on the drawing by reference to this standard in accordance with clause 4.

The values of general tolerances correspond to tolerance classes of customary workshop accuracy, the appropriate tolerance class being selected and indicated on the drawing according to the requirement of the components.

A.2 Above certain tolerance values, there is usually no gain in manufacturing economy by enlarging the tolerance. For example, a feature having a 35 mm diameter could be manufactured to a high level of conformance in a workshop with "customary medium accuracy". Specifying a tolerance of ± 1 mm would be of not benefit in this particular workshop, as the general tolerance values of ± 0.3 mm would be quite adequate.

However, if, for functional reasons, a feature requires a smaller tolerance value than the general tolerance values, these should not be indicated adjacent to the dimension but should be stated on the drawing as described in clause 4. This type of tolerance allows full use of the concept of general tolerancing.

There will be "exceptions to the rule" where the function of the feature allows a larger tolerance than the general tolerances, and the larger tolerance will provide manufacturing economy. In these special cases, the larger tolerance should be indicated individually adjacent to the dimension for the particular feature, e.g. the depth of blind holes drilled at assembly.

A.3 Using general tolerances leads to the following advantages:

a) drawings are easier to read and thus communication is made more effective to the user of the drawing;

b) The design draughtsman saves time by avoiding detailed tolerance calculations as it is sufficient to know that the function allows a tolerance greater than or equal to the general tolerance;

c) The drawing readily indicates which feature can be produced by normal process capability, which also assists quality engineering by reducing inspection levels;

d) Those dimensions remaining, which have individually indicated tolerances, will, for the most part, be those controlling features for which the function requires relatively small tolerances and which therefore may require special effort in the production – this will be helpful for production planning and will assist quality control services in their analysis of inspection requirements;

e) Purchase and sub-contract supply engineers can negotiate orders more readily since the "customary workshop accuracy" is known before the contract is placed; this also avoids arguments on delivery between the buyer and supplier, since in this respect the drawing is complete.

These advantages are fully obtained only when there is sufficient reliability that the general tolerances will not be exceeded, i.e. when the customary workshop accuracy of the particular workshop is equal to or fine than the general tolerances indicated in the drawing.

The workshop should therefore

- Find out by measurements what is customary workshop accuracy is;
- Accept only those drawings having general tolerances equal to or greater than its customary workshop accuracy;
- Check by sampling that its customary workshop accuracy does not deteriorate.

Relying on underlined "good workmanship" with all its uncertainties and misunderstandings is no longer necessary with the concept of general geometrical tolerances. The general geometrical tolerances defines the required accuracy of "good workmanship".

A.4 The tolerance the function allows is often greater than the general tolerances. The function of the part is, therefore, not always impaired when the general tolerance is (occasionally) exceeded at any feature of the work piece. Exceeding the general tolerance should lead to a rejection of the work piece only if the function is impaired.

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EC-28

GEOMETRICAL TOLERANCING ON TECHNICAL DRAWINGS – TOLERANCING OF FORM, ORIENTATION, LOCATION AND RUN – OUT –AND APPROPRIATE GEOMETRICAL DEFINITIONS

1.0 Introduction:

For uniformity all figures in this corporate standard are in first angle projection.

For the definitive presentation (proportions and dimensions) of symbols for geometrical tolerancing, see ISO 7083.

1.1 Scope:

1.2 This corporate standard gives the principles of symbolization and indication on technical drawings of tolerances of form, orientation, location and run out , and establishes the appropriate geometrical definitions. Hence the term "geometrical tolerances" will be used in this document as synonyms with these groups of tolerances.

1.3 Geometrical tolerances shall be specified only where they are essential, that is, in the light of functional requirements, interchange ability and probable manufacturing circumstances.

1.4 Indicating geometrical tolerances does not necessarily imply the use of any particular method of production, measurement or gauging.

2.0 COMPLIANCE WITH STANDARDS:

This corporate standard is based on IS: 8000(Part. 1) – 1985/Reaffirmed 2005 (ISO:1101-1983).

2.1 Referred standards (Latest Publications including amendments):

AA 042 21 01 – IS: 10714 (ISO: 128) General Principles of presentation on technical drawings.
AA 042 31 01 – IS: 11669 (ISO: 129) General Principles of dimensioning on technical drawings.
AA 023 04 17 – IS: 8000 (ISO: 1660) Geometrical tolerancing on technical drawings: part 3 (Part. 3) Dimensioning and tolerancing of profiles.
AA 023 24 16 – IS: 8000(ISO: 2692) Geometrical toelrancing on technical drawings: part 2 (Part.2) Maximum material principles.
AA 042 32 02 – IS: 10721 (ISO: 5458) Datum and datum systems for geometrical tolerancing on technical drawings.

Revisions:			APPROVED: PROCEDURAL GUIDELINES COMMITTEE – PGC(DOP+BES)		
Rev. No.02	Amd. No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:22-06-2013	Dt:	Year:2013	Corp. R&D	Corp. R&D	June 1986

3.0 GENERAL:

3.1 A geometrical tolerance applied to a feature defines the tolerance zone within which the feature (surface, axis, or medium plane) is to be contained {see 3.7 and 3.8}.

3.2 According to the characteristic which is to be tolerance and the manner in which it is dimensioned, the tolerances zone is one of the following:

- the area within a circle;
- the area between two concentric circles;
- the area between two equidistant lines or two parallel straight lines;
- the space within a cylinder;
- the space between two coaxial cylinders;
- the space between two equidistant planes or two parallel planes;
- the space within a parallapiped.

3.3 A tolerance feature may be of any form or orientation within this tolerance zone, unless a more restrictive indication is given, for example by an explanatory note (see figures 8 and 9).

3.4 Unless otherwise specified as in clause 9 and 11, the tolerance applies to the whole length or surface of the considered feature.

3.5 The datum feature is a real feature of a part, which is used to establish the location of a datum (see ISO 5459).

3.6 Geometrical tolerances which are assigned to features related to a datum do not limit the form deviations of the datum feature itself. The form of a datum feature shall be sufficiently accurate for its purpose and it may therefore be necessary to specify tolerances of form for the datum features.

3.7 The straightness or flatness of a single tolerance feature is deemed to be correct when the distanced its individual points from a superimposed surface of ideal geometrical form is equal to or less than the value of the specified tolerance. The orientation of the ideal line or surface shall be chosen so that the maximum distance between it and the actual surface of the feature concerned is the least possible value.

Example:

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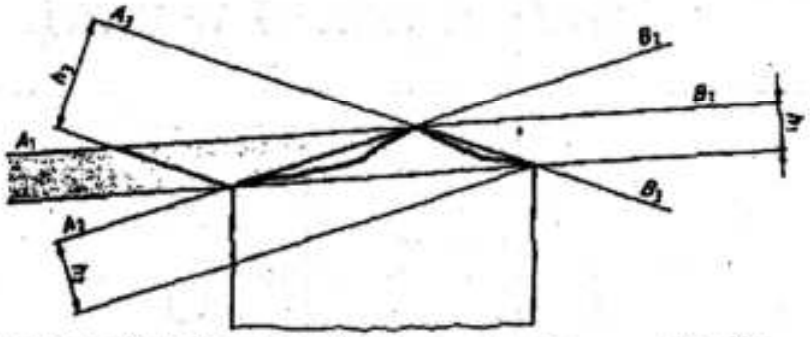


Possible orientations of the line or surface:	$A_1 - B_1$		$A_2 - B_2$		$A_3 - B_3$
Corresponding distances:	h1		h2		h3
In the case of figure 1:	h1	<	h2	<	h3

Therefore the correct orientation of the ideal line or surface is A1 – B1. The distance h1 is to be equal to or less than the specified tolerance.

3.8 For the definition of circularity and cylindricity, the location of the two concentric circles or coaxial cylinders shall be chosen so that the radial distance between them is the minimum.

Example:

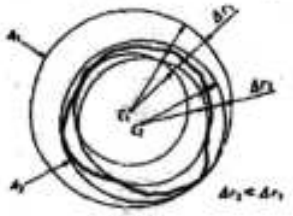


Figure 2

Possible location of the centers of the two concentric circles or the axes of the two coaxial cylinders and their minimal radial distances.

Centre (C_1) of A1 locates two concentric circles or two coaxial cylinders.

Centre (C_2) of A2 locates two concentric circles or two coaxial cylinders with minimal radial distance.

Corresponding radial distances:	Δr1		Δr2
In the case of figure2:	Δr2	<	Δr1

Therefore the correct location of the two concentric circles or the two coaxial cylinders is the one designated A_2. The radial distance Δr_2 should than be equal to or less than the specified tolerance.

4.0 Symbols:

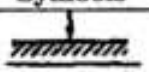
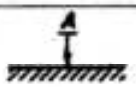
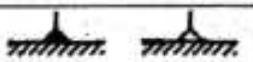
Table 1 – Symbols for tolerance characteristic.

Features and tolerances	Toleranced characteristics	Symbols	Sub clauses

CORPORATE STANDARD

Single feature	Form tolerances	Straightness		14.1
		Flatness		14.2
		Circularity		14.3
		Cylindricity		14.4
Single or related features		Profile of any line		14.5
		Profile of any surface		14.6
Related features	Orientation tolerance	Parallelism		14.7
		Perpendicularity		14.8
		Angularity		14.9
	Location tolerances	Position		14.10
		Concentricity and coaxiality		14.11
		Symmetry		14.12
	Run-out tolerances	Circular run – out		14.13
		Total run - out		14.14

Table – 2 Additional Symbols

Descriptions		Symbols	Clauses
Toleranced feature indications	direct		6
	By letter		7.4
Datum indications	direct		8
	by letter		

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Datum target		ISO 5459
Theoretically exact dimension		10
Projected tolerance zone		11
Maximum material condition		12

5.0 Tolerance frame:

5.1 The tolerance requirements are shown in a rectangular frame which is divided into two or more compartments. These compartments contain, from left to right, in the following order (see figure 3,4 and 5);

- The symbol for the characteristic to be tolerances.
- The tolerance value in the unit used for linear dimensions. This value is preceded by the sign if the tolerance zone is circular or cylindrical;
- If appropriate, the letter or letters identifying the datum feature of features (see figures 4 and 5).

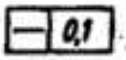

Figure 3

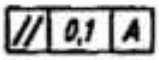

Figure 4

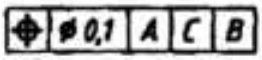

Figure 5

5.2 Remarks related to the tolerance, for example :6holes", "4 surfaces" or "6x" shall be written above the frame (see figures 6 and 7).

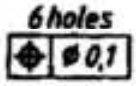

Figure 6

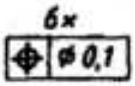

Figure 7

5.3 Indications qualifying the form of the feature within the tolerance zone shall be written near the tolerance frame and may be connected by a leader line (see figures 8 and 9).

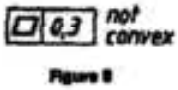

Figure 8

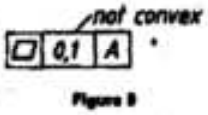

Figure 9

5.4 If it is necessary to specify more than one tolerance characteristic for a feature, the tolerance specifications are given in tolerance frames one under the other (see figure 10).

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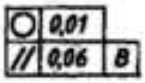

Figure 10

6.0 Tolerance features

The tolerance frame is connected to the tolerance feature by a leader line terminating with an arrow in the following way:

- On the outline of the feature or an extension of the outline (but clearly separated from the dimension line) when the tolerance refers to the line or surface itself (see figures 11 and 12).

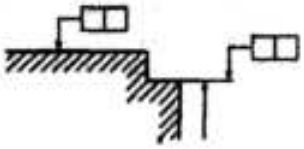

Figure 11

Figure 12

- As an extension of a dimension line when the tolerance refers to the axis or medium plane defined by the feature so dimensioned (see figures 13 to 15).

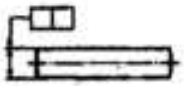

Figure 13

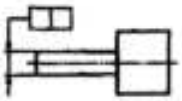

Figure 14

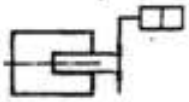

Figure 15

- On the axis when the tolerance refers to the axis or median plane of all features common to that axis or median plane (see figures 16,17 and 18).

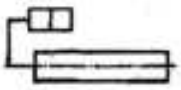

Figure 16

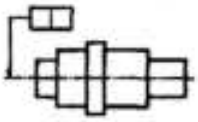

Figure 17

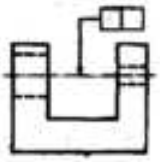

Figure 18

NOTE – Whether a tolerance shtould be applied to the contour of cylindrical or symmetrical features or to its axis or median plane respectively depends on the functional requirements.

7.0 Tolerance Zones:

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7.1 The width of the tolerance zone is in the direction of the arrow of the leader line joining the tolerance frame to the feature which is tolerance, unless the tolerance value is preceded by the sign ø (see figures 19 and 20).

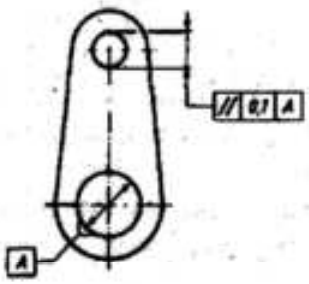

Figure 19

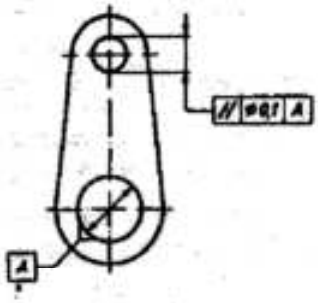

Figure 20

7.2 In general, the direction of the width of the tolerance zone is normal to the specified geometry of the part (see figures 21 and 22).

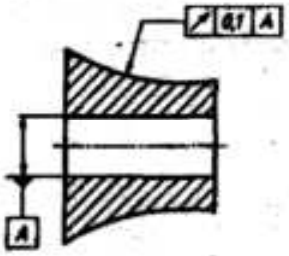

Figure 21

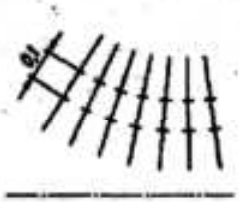

Figure 22

7.3 The direction of the width of the tolerance zone shall be indicated when desired not normal to the specified geometry of the part (see figures 23 and 24).

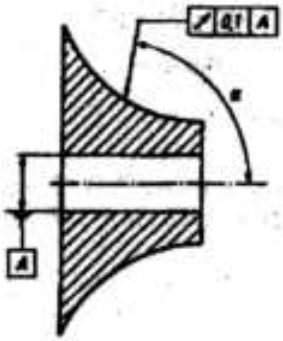

Figure 23

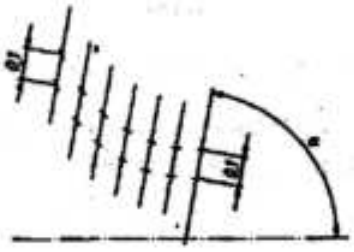

Figure 24

7.4 Individual tolerance zones of the same value applied to several separate features can be specified as shown in figures 25 and 28.

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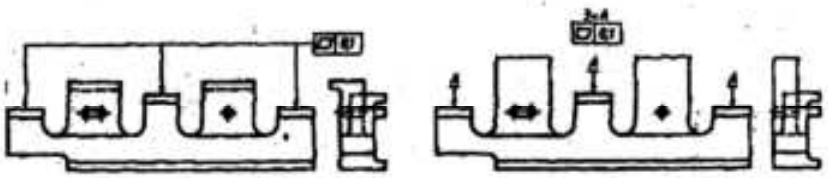
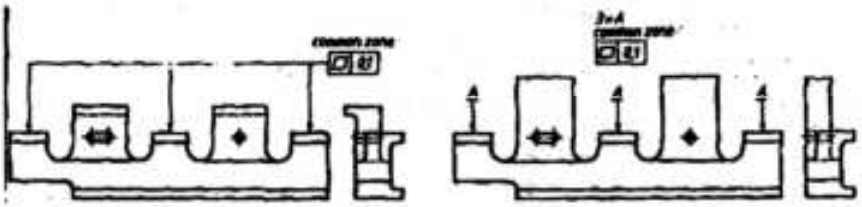


7.5 Where a common tolerance zone is applied to several separate features, the requirements is indicated by the words "common zone" above the tolerances frame (see figures 27 and 28).



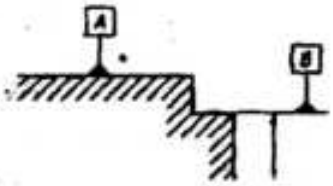
8.0 Datum's:

8.1 When a tolerance featured is related to a datum, this is generally shown by datum letters. The same letter which defines the datum is repeated in the tolerance frame.

To identify the datum, a capital letter enclosed in a frame is concerned to a solid or blank datum triangle (see figures 29 and 30).

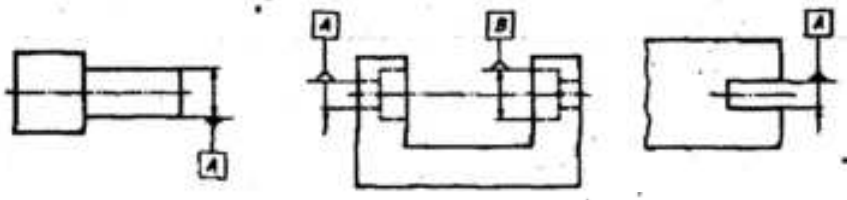
8.2 The datum triangle with the datum letter is placed:

- on the outline of the features or an extension of the outline (but clearly separated from the dimension line), when the datum feature is the line or surface itself (see figure 3.1).



- As on extension of the dimension line when the datum feature is the axis or median plane (see figures 32 to 34).

NOTE – If there is insufficient space for two arrows, one of them may be replaced by the datum triangle (see figures 33 and 34).



- on the axis or median plane when the datum is :

  a) the axis or median plane of a single feature (for example a cylinder);
  b) the common axis or plane formed by two features (see figure 35).

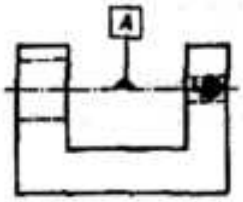


Figure 35

8.3 If the tolerance frame can be directly connected with the datum feature by a leader line, the datum letter may be omitted (see figures 36 and 37).

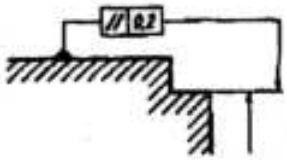


Figure 36

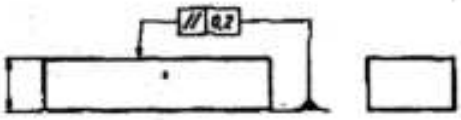


Figure 37

8.4 A single datum is identified by a capital letter (see figure 38).

A common datum formed by two datum features is identified by two datum letters separated by a hyphen (see figure 39).

If the sequence of two or more datum features Is important the datum letters are placed in different compartments (see figure 40), where the sequence from left to right shows the order of priority.

If the sequence of two or more datum features is not important the datum letters are indicated in the same compartment (see figure 41).

Figure 38

Figure 39

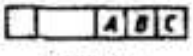


Figure 40

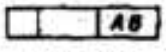


Figure 41

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9.0 Restrictive specifications

9.1 If the tolerance is applied to a restricted length, lying anywhere, the value of this length shall be added after the tolerance value and separated from it by an oblique stroke.

In the case of a surface, the same indication is used. This means that the tolerance applies to all lines of the restricted length in any position and any direction (see figure 42).

Figure 42

9.2 If a smaller tolerance of the same type is added to the tolerance on the whole feature, but restricted over a limited length, the restrictive tolerance shall be indicated in the lower compartment (see figure 43).

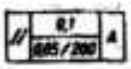


Figure 43

9.3 If the tolerance is applied to a restricted part of the feature only, this shall be dimensioned as shown in figure 44.

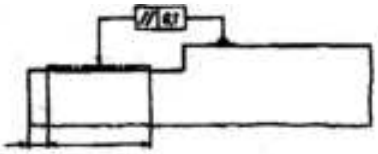


Figure 44

9.4 If the datum is applied to a restricted part of the datum feature only, this shall be dimensioned as shown in figure 45.

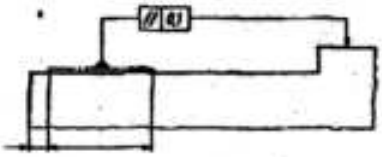


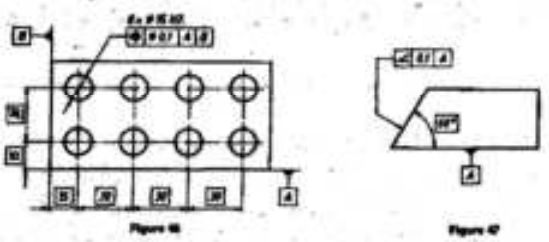
Figure 45

9.5 Restrictions to the form of the feature within the tolerance zone are shown in 5.3.

10.0 Theoretically exact dimensions:

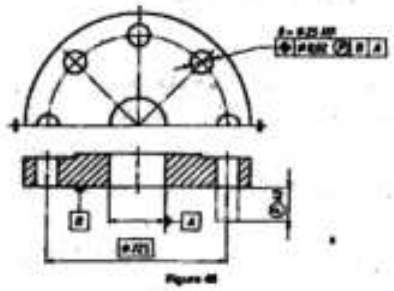
If tolerances of position or of profile or of angularity are prescribed for feature, the dimensions determining the theoretically exact position, profiles or angle respectively, shall not be tolerance.

These dimensions are enclosed, for example [30] . The corresponding actual dimensions of the part are subject only to the position tolerance, profile tolerance or angularity tolerance specified within the tolerance frame (see figures 46 and 47).



11.0 Projected tolerance zone:

In some cases the tolerances of orientation and location shall apply not to the feature itself but to the external projection of It. Such projected tolerance zones are to be indicated by the symbol P (see figure 48).



12.0 Maximum material condition:

The indication that the tolerance value applies at the maximum material condition is shown by the symbol
Ⓜ Placed after:

- the tolerance value (see figure 49);
- the datum letter (see figure 50);
- or both (see figure 51);

According to whether the maximum material principle is to be applied respectively to the tolerance feature, the datum feature or both.

Figure 49

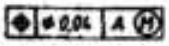


Figure 50

Figure 51

13.0 Definition of tolerances:

13.1 The various geometrical tolerances are defined with their tolerance zones in the following pages. In all the illustrations of the definitions only those deviations are shown with which the definitions deal.

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13.2 Where required for functional reasons, one or more characteristics will be toleranced to define the geometrical accuracy of a feature. When the geometrical accuracy of a feature is defined by a certain type of tolerance, other deviations of this feature in some cases will be controlled by this tolerance (for example, straightness deviation is limited by parallelism tolerance). Thus it would rarely be necessary to symbolize all of these characteristics, since the other deviations are included on the zone of tolerance defined by the symbol specified.

However, certain other types of tolerances do not control other deviations (for example, straightness tolerance does not control deviation of parallelism).

For some tolerance zones (for example, for straightness of a line or axis in one direction only) there are two possible methods of graphical representation :

- By two parallel planes a distance / apart (see figure 52);
- By two parallel straight lines a distance / apart (see figure 53).

Figure 52 shows a three – dimensional representation, figure 53 its projection in a plane.

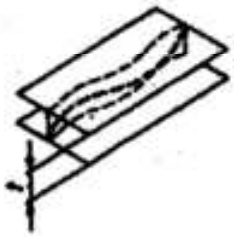

Figure 52

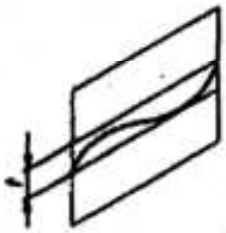

Figure 53

There is no difference in the meaning of the two representations (such a tolerance does not restrict the deviation in any direction perpendicular to the arrow). The simpler method as shown in figure 53 is normally used in this international standard.

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TECHNICAL DRAWINGS-LINEAR AND ANGULAR TOLERANCING INDICATION ON DRAWINGS

1.0 SCOPE

1.1 This corporate standard specifies the indication of tolerances for linear and angular dimensions on technical drawings. Indicating such tolerances does not necessarily imply the use of any particular method of production, measurement or gauging.

1.2 For the purpose of this corporate standard, all dimensions and tolerances on the drawings have been stencilled in upright lettering. It should be understood that these indications could just as well be written in free-hand or inclined (italic) lettering without altering the meaning of the indications.

2.0 COMPLIANCE WITH STANDARDS

This corporate standard is based on IS: 11667-1991 and reaffirmed in 2008 (ISO 406-1987)

3.0 UNITS

Deviations shall be expressed in the same unit as the basic size.

If two deviations relating to the same dimensions have to be shown, both shall be expressed to the same number of decimal places (see fig. 2), except if one of the deviations is zero (see fig. 5).

4.0 INDICATION OF THE COMPONENTS OF A LINEAR DIMENSION

4.1 ISO SYMBOLS

The component of the tolerance dimension shall be indicated in the following order:

a) The basic size

b) The tolerance symbol

If, in addition to the symbol (see fig.1), it is necessary to express the values of the deviations (see fig.2) or the limits of size (see fig.3), the additional information shall be shown in parentheses.

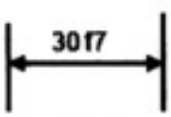

Fig. 1

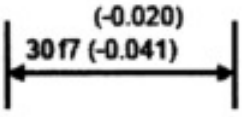

Fig. 2

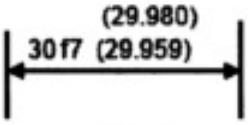

Fig. 3

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4.2 PERMISSIBLE DEVIATIONS

The components of the toleranced dimensions shall be indicated in the following order (see figs. 4 to 6)

a) the basic size

b) the values of the deviations

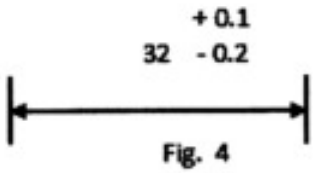

Fig. 4

If one of the two deviations is zero, this should be expressed by the digit zero (see fig 5).

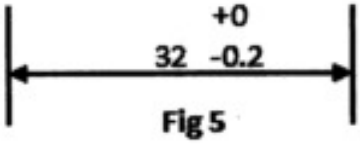

Fig 5

If the tolerance is symmetrical in relation to the basic size, the value of the deviations should be indicated once only, preceded by the sign ± (see fig. 6).

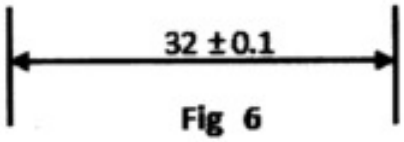

Fig 6

4.3 LIMITS OF SIZE

The limits of size may be indicated by an upper & lower dimension (see figure 7).

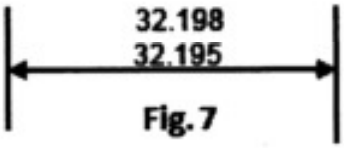

Fig. 7

4.4 LIMITS OF SIZE IN ONE DIRECTION

If a dimension needs to be limited in one direction only, this should be indicated by adding "min." or "max." to the dimension (see fig 8)

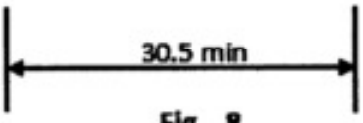

Fig. 8

5.0 ORDER OF INDICATION OF DEVIATIONS AND LIMITS OF SIZE

The upper deviation or the upper limit of size shall be written in the upper position and the lower deviation or the lower limit of size in the lower position, irrespective of whether a hole or a shaft is toleranced.

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6.0 RELATED STANDARDS

6.1 For "Technical drawings English lettering part 1 currently used characters" refer AA0421401.

6.2 For "Technical drawings- dimensioning-general principles, definitions, methods of executions and special indications" refer AA0423101.

7.0 REFERRED STANDARDS (Latest publications including Amendments)

1) AA0421401
2) AA0423101

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TECHNICAL DRAWINGS – GEOMETRICAL TOLERANCING MAXIMUM MATERIAL PRINCIPLES

0.0 INTRODUCTION

0.1 The assembly of parts depends on the relationship between the actual size and actual geometrical deviation of the features being fitted together, such as the bolt holes in two flanges and the bolts securing them.

The minimum assembly clearance occurs when each of the mating features is at its maximum material size (e.g. largest bolt and smallest hole) and when their geometrical deviations (e.g. positional deviation) are also at their maximum.

Assembly clearance increase to a maximum when the actual sizes of the assembled features are furthest from their maximum material sizes (e.g. smallest shaft and largest hole) and when the geometrical deviations (e.g. positional deviations) are zero.

From the above, it follows that if the actual sizes of a mating part do not reach their maximum material size, the indicated geometrical tolerance may be increased without endangering the assembly of the other part.

This is called the "maximum material principle" and is indicated on drawings by thesymbol Ⓜ.

The figures in this standard are intended only as illustrations to aid the user in understanding the maximum material principle. In some instances, figures show added details for emphasis; in other instances, figures have deliberately been left incomplete. Numerical values of dimensions and tolerances have been given for illustrative purpose only.

For simplicity, the examples are limited to cylinders and planes.

0.2 For uniformity all figures in this standard are in first angle projection.

For the definitive presentation (proportions and dimensions) of symbols for geometrical tolerancing, see AA0423104 (IS:11158).

1.0 SCOPE AND FIELD OF APPLICATION

This standard defines and describes the maximum material principle and specifies its application.

The use of the maximum material principle facilitates manufacture without disturbing the free assembly of parts where there is a mutual dependence of size and geometry.

NOTE – The envelope requirement (see 5.2.2) for a single feature may be indicated by the symbol Ⓔ (see AA0230401 (IS:12160) or by reference to an appropriate national standard invoking this requirement.

2.0 COMPLIANCE WITH STANDARDS

This standard is based on IS: 8000 Part 2-1992 / ISO 2692.

3.0 DEFINITIONS

3.1 Actual local size

Any individual distance at any cross section of a feature. i.e. any size measured between any two opposite points [examples: see figures 1, 12 b) and 13b)].

3.2 Mating size

3.2.1 Mating size for an external feature

The dimension of the smallest perfect feature which can be circumscribed about the feature so that it just contacts the surface at the highest points.

NOTE – For example, the size of the smallest cylinder of perfect form or the smaller distance between two parallel planes form which just contacts the highest point(s) of the actual surface(s) (see figure 1).

3.2.2 Mating size for an internal feature

The dimension of the largest perfect feature which can be inscribed within the feature so that it just contacts the surface at the highest points.

NOTE – For example, the size of the largest cylinder of perfect form or the largest distance between two parallel planes of perfect form which just contact the highest point(s) of the actual surface (s).

3.3 Maximum material condition (MMC)

The state of the considered feature in which the feature is everywhere at that limit of sizewhere the material of the feature is at its maximum. e.g. minimum hole diameter and maximum shaft diameter (see figure 1)

NOTE – The axis of the feature need not be straight.

3.4 Maximum material size (MMS)

The dimension defining the maximum material condition of a feature (see figure 1).

3.5 Least material condition (LMC)

The state of the considered feature in which the feature is everywhere at that limit of size where the material of the feature is at its minimum, e.g. maximum hole diameter and minimum shaft diameter.

3.6 Least material size (LMS)

The dimensions defining the least material condition of a feature (see figure 1).

3.7 Virtual condition

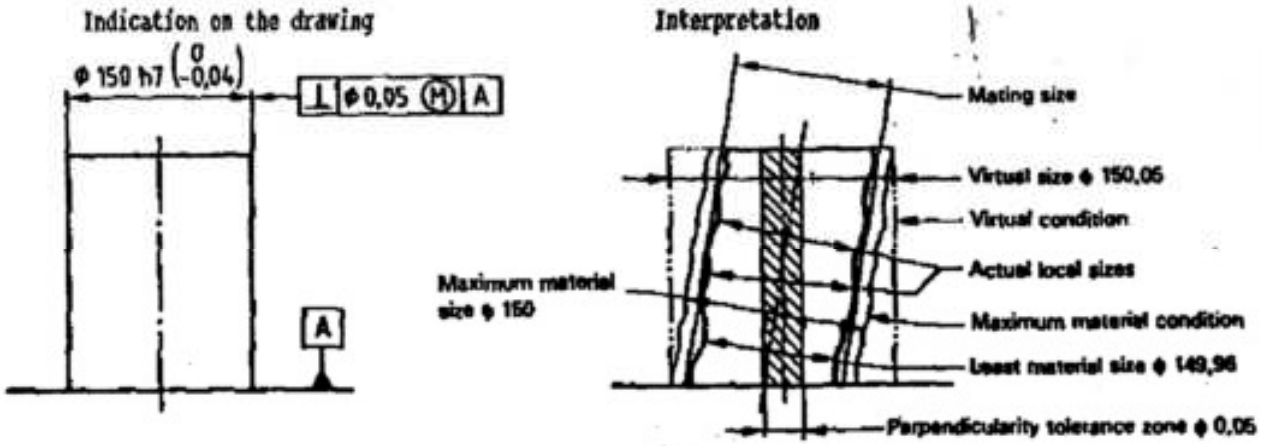
The limiting boundary of perfect form permitted by the drawing data for the feature; the condition is generated by the collective effect of the maximum material size and the geometrical tolerances.

When the maximum material principle is applied, only those geometrical tolerances followed by the symbol Ⓜshall be taken into account when determining the virtual condition (see figure 1).

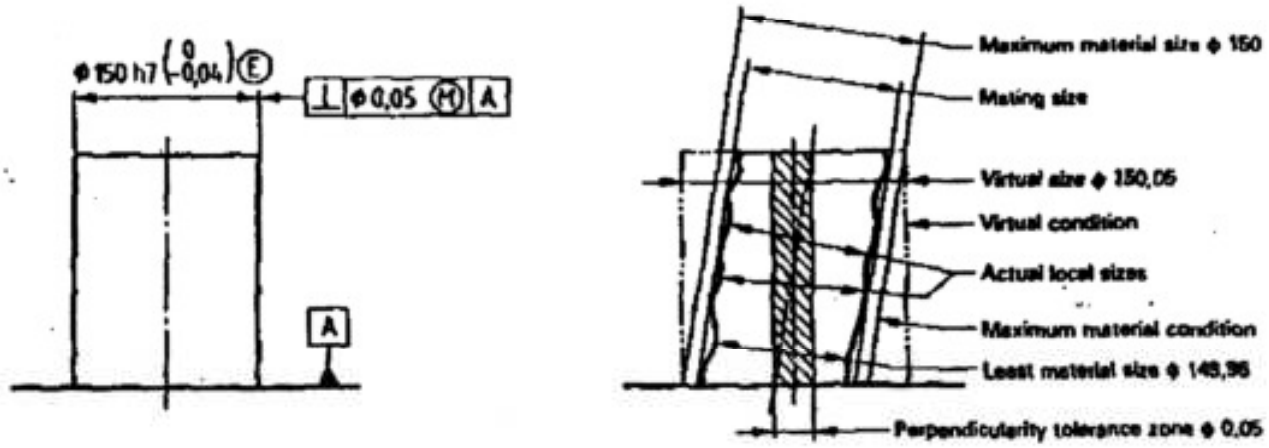
NOTE – The virtual condition represents the design dimension of the functional gauge.

3.8 Virtual size

The dimension defining the virtual condition of a feature.



a) Dimensioning in accordance with the independance principle



b) Dimensioning in accordance with the envelope principle

Figure 1

4.0 MAXIMUM MATERIAL PRINCIPLE

4.1 General

The maximum material principle is a tolerancing principle which requires that the virtual condition for the toleranced feature(s) and, if indicated, the maximum material condition of perfect form for datum feature(s), shall not be violated.

This principle applies to axes or median planes and takes into account the mutual relationship of size and the geometrical tolerance concerned. The application of this principle shall be indicated by the symbol Ⓜ.

4.2 Maximum material principle applied to the toleranced feature(s)

When applied to the toleranced feature(s), the maximum material principle permits an increase in the stated geometrical tolerance when the toelranced feature concerned departs from its maximum material condition provided that the feature does not violate the virtual condition.

4.3 Maximum material principle applied to the datum feature(s)

When the maximum material principle is applied to the datum feature(s), the datum axis or median plane may float in relation to the toleranced feature if there is a departure from the maximum material condition of the datum feature. The value of the float is equal to the departure of the mating size of the datum feature from its maximum material size (see figures 27 b)and 27 c)).

NOTE – The departure of the datum feature from its maximum material size does not increase the tolerance of the toleranced features in relation to each other.

5.0 APPLICATION OF THE MAXIMUM MATERIAL PRINCIPLE

In all cases, the designer has to decide whether the application of the maximum material principle may be permitted on the tolerances concerned.

NOTE – The maximum material principle should not be used in such applications as kinematic linkages, gear centres, threaded holes, interference fit holes, etc., where the function may be endangered by an increase in the tolerance.

5.1 Position tolerance for a group of holes

The maximum material principle is most commonly used with positional tolerances, and therefore positional tolerancing has been used for the illustrations in this sub-clause.

NOTE – In the calculations of virtual size, it has been assumed that the pins and holes are at their maximum material size and are of perfect form.

5.1.1 The indication on the drawing of the positional tolerance for a group of four holes is shown in figure 2.

The indication on the drawing of the positional tolerance for a group of four fixed pins which fit into the group of holes is shown in figure 4.

The minimum size of the holes is ø 8.1 – this is the maximum material size.

The maximum size of the pins is ø 7.9 – this is the maximum material size.

5.1.2 The difference between the maximum material size of the holes and the pins is

$$8.1 - 7.9 = 0.2$$

The sum of the positional tolerances for the holes and pins shall not exceed this difference (0.2). In this example, this tolerance is equally distributed between holes and pins, i.e. the positional tolerance for the holes is ø 0.1 (see figure 2) and the positional tolerance for the pins is also ø 0.1 (see figure 4).

The tolerance zones of ø 0.1 are located at their theoretically exact positions (see figures 3 and 5).

Depending on the actual size of each feature, the increase in the positional tolerance may be different for each feature.

Indication on the drawing

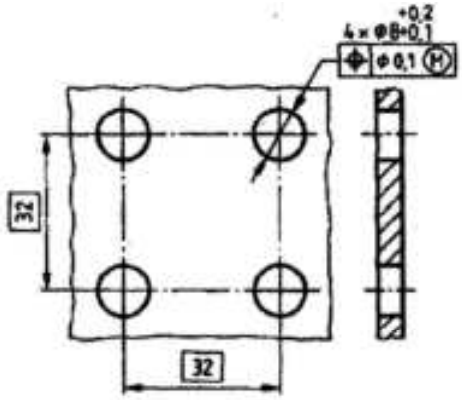


Figure 2

Interpretation

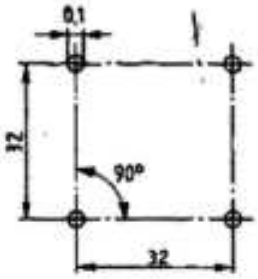


Figure 3

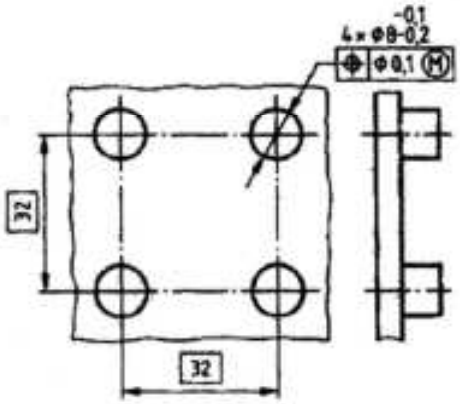


Figure 4

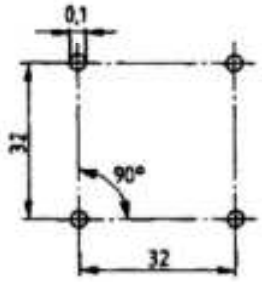


Figure 5

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5.1.3 Figure 6 shows four cylindrical surfaces for each of the four holes all being at their maximum material size and of perfect form. The axes are located at extreme positions within the tolerance zone.

Figure 8 shows the corresponding pins at their maximum material size. It can be seen from figures 6 to 9 that assembly of the parts is still possible under the most unfavorable conditions.

5.1.3.1 One of the holes in figure 6 is shown to a larger scale in figure 7. The tolerance zone for the axis is ø 0.1. The maximum size of the hole is ø 8.1. All ø 8.1 circles, the axes of which are located at the extreme limit of the ø 0.1 tolerance zone, form an inscribed enveloping cylinder of ø8. This ø 8 enveloping cylinder is located at the theoretically exact position and forms the functional boundary for the surface of the hole.

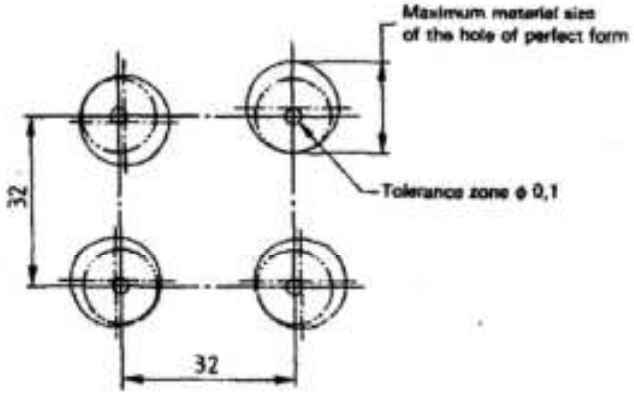

Figure 6

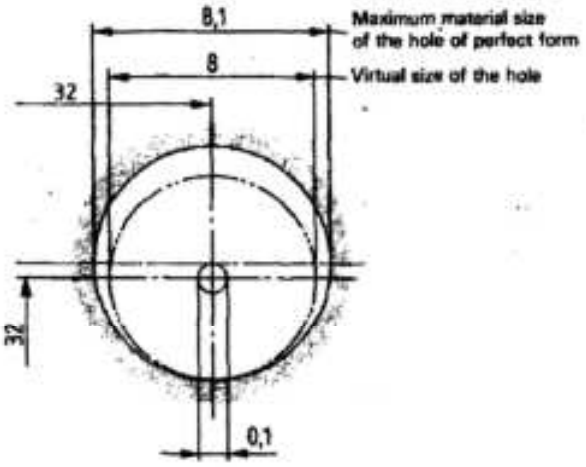

Figure 7

5.1.3.2 One of the pins in figure 8 is shown to a larger scale in figure 9. The tolerance zone for the axis is ø 0.1. The maximum size of the pins is ø7.9. All ø 7.9 circles, the axes of which are located at the extreme limit of the ø 0.1 tolerance zone, form a circumscribed enveloping cylinder of ø 8, which is the virtual condition of the pin.

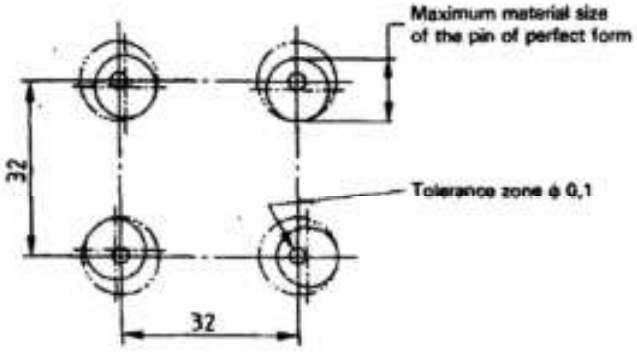

Figure 8

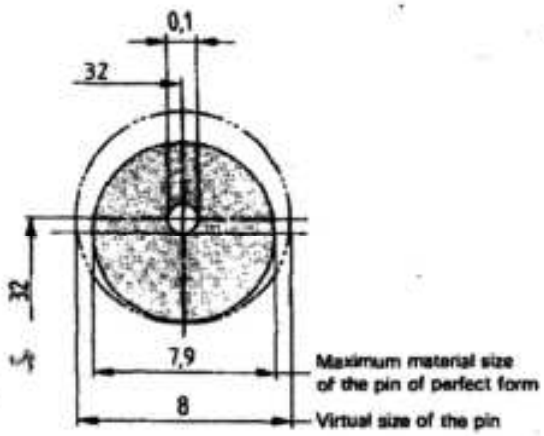

Figure 9

5.1.4 When the size of the hole is larger than its maximum material size and/or when the size of the pin is smaller than its maximum material size, there is an increased clearance between the pin and hole which can be used to increase the positional tolerances of the pin and/or the hole. Depending on the actual size of each feature, the increase in the positional tolerance may be different for each feature.

The extreme case is when the hole is at the least material size, i.e. ϕ 8.2 figure 10 shows that the axis of the hole may lie anywhere within a tolerance zone of ø 0.2 without the surface of the hole violating the cylinder of virtual size.

Figure 11 shows a similar situation with regard to the pins. When the pin is at the least material size, i.e. ø 7, 8, the diameter of the tolerance zone for position is ø 0.2.

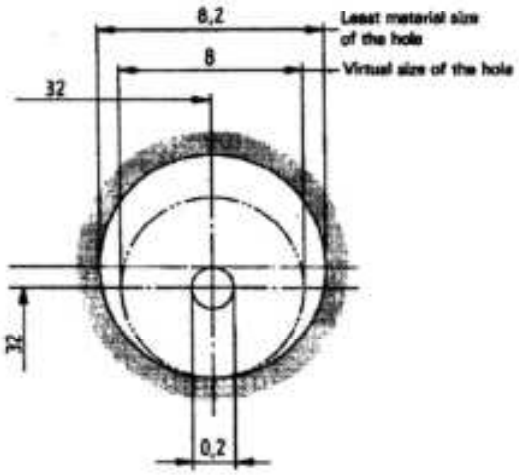

Figure 10

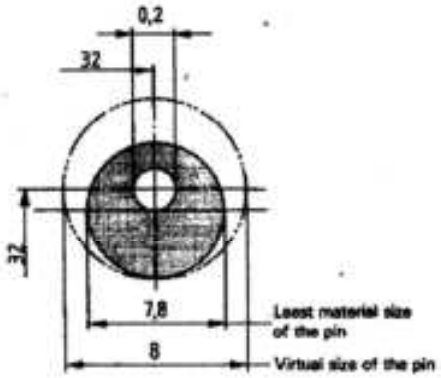

Figure 11

5.1.5 The increase in geometrical tolerance is applied to one part of the assembly without reference to the mating part. Assembly will always be possible even when the mating part is manufactured on the extreme limits of the tolerance in the direction most unfavourable for the assembly, because the combined deviation of size and geometry on neither part is exceeded, i.e. their virtual conditions are not violated.

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CORPORATE STANDARD

5.2 Perpendicularity tolerance of a shaft related to a datum plane:

5.2.1 The toleranced feature in figure 12 a) has to meet the conditions shown in figure 12 b), i.e. the feature shall not violate the visual condition, i.e. ø 20.2 (ø 20 + 0.2), and as all actual local sizes shall remain between ø 19.9 and ø 20, the straightness deviations of the generator lines or of the axis cannot exceed 0.2.....0.3 depending on the actual local sizes, e.g. 0.2 if all actual local sizes are ø 20 [see figure 12 c)] and 0.3 if all actual sizes are ø 19.9 [see figure 12 d)].

Indication on the drawing

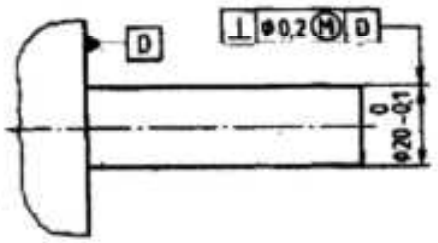
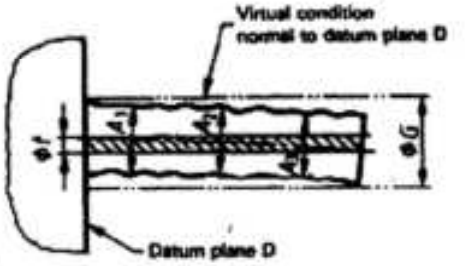


Figure 12 a)

Interpretation



A_1 to A_3 = actual local sizes = 19,9 ... 20
(maximum material size = ø 20)

G = virtual size = ø 20,2

ø t = orientational tolerance zone = 0,2 ... 0,3

Figure 12 b)

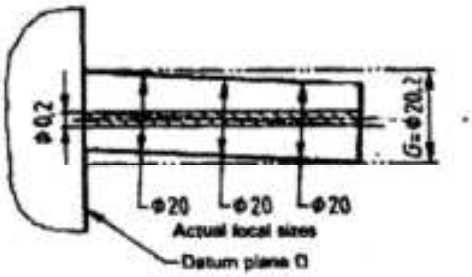


Figure 12 c)

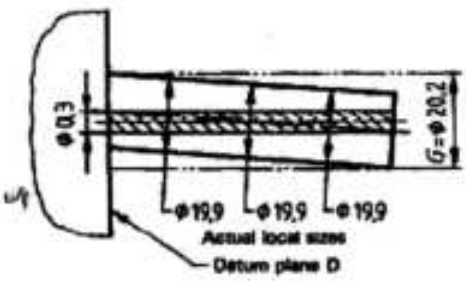


Figure 12 d)

5.2.2 In figure 13 a) the additional requirement Ⓔ (see AA0230401 [IS: 12160]) together with Ⓜ further restricts the feature to lie within the envelope of perfect form at maximum material size ø 20 [see figure 13 b)]. In this example, the actual local sizes shall remain within ø 19.9 and ø 20 and the combined effect of the straightness and roundness deviations shall not cause the feature to violate the envelope requirement. For example, the straightness deviation of the generator lines or of the axis cannot exceed 0.....0.1 depending on the actual local sizes; however, the perpendicularity deviation, because of the Ⓜ indication, may be increased to 0.3 (virtual size = ø 20.2) when the actual local sizes of the feature are ø 19.9 [see figure 13 b)].

Indication on the drawing

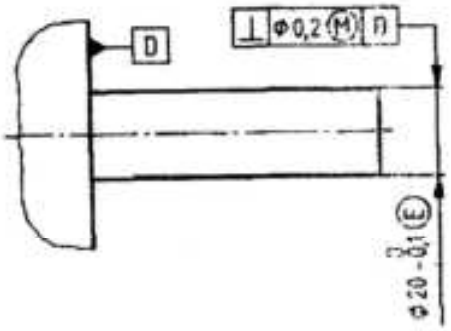
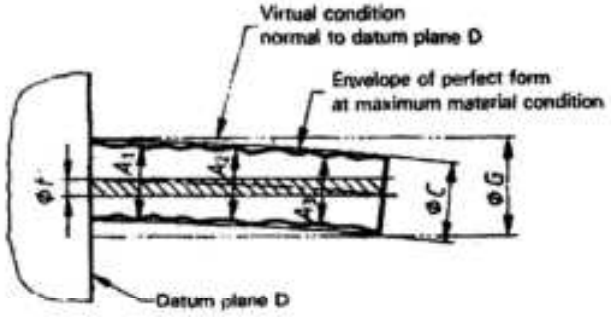


Figure 13 a)

Interpretation



A_1 to A_2 = actual local sizes = 19,9 ... 20
C = maximum material size = ø 20
G = virtual size = ø 20,2
f = orientational tolerance zone = 0,2 ... 0,3

Figure 13 b)

CORPORATE STANDARD

6.0 EXAMPLE OF APPLICATION WEERE Ⓜ APPLIES TO THE TOLERANCED FEATURE(S)

6.1 Straightness tolerance of an axis:

a) Indication on the drawing

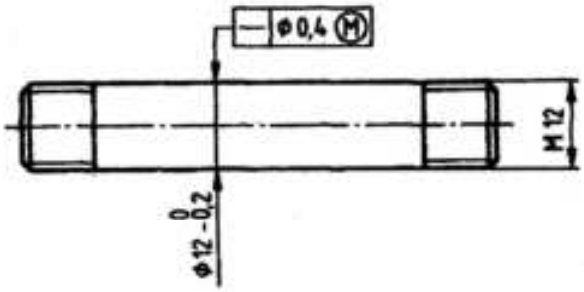


Figure 14 a)

b) Functional requirements

The toleranced feature shall meet the following requirements:

- each actual local size of the feature shall remain within the size tolerance of 0.2 and therefore may vary between ø 12 and ø 11.8;
- the tolerance feature shall comply with the virtual condition, i.e. the enveloping cylinder of perfect form of ø 12.4 (= ø 12 + 0.4) [see figures 14 b) and 14 c)].

The axis shall, therefore, remain within the straightness tolerance zone of ø 0.4 when all diameters of the feature are at their maximum material size of ø 12 [see figure 14 b)] and may vary within a tolerance zone of up to ø 0.6 when all diameters of the feature are at their least material size of ø 11.8 [see figure 14 c)].

NOTES

1) The two figures 14 b) and 14 c) illustrate the extreme cases of the size of the feature. In practice, the feature would be somewhere between the extreme conditions with different actual sizes.
2) This indication [see figure 14 a)] may be appropriate when the indication of a greater diameter tolerance associated with the envelope requirement cannot be applied, e.g. in the case of a threaded bolt.

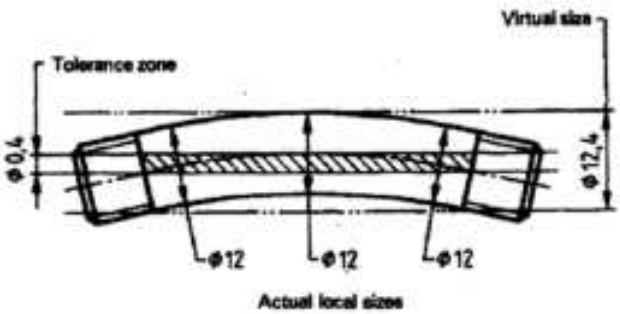


Figure 14 b)

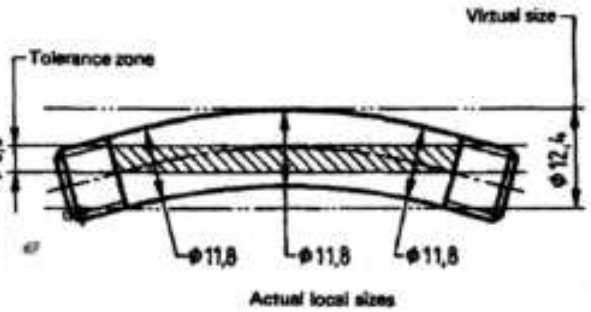


Figure 14 c)

6.2 Parallelism tolerance of a shaft related to a datum plane:

a) Indication on the drawing

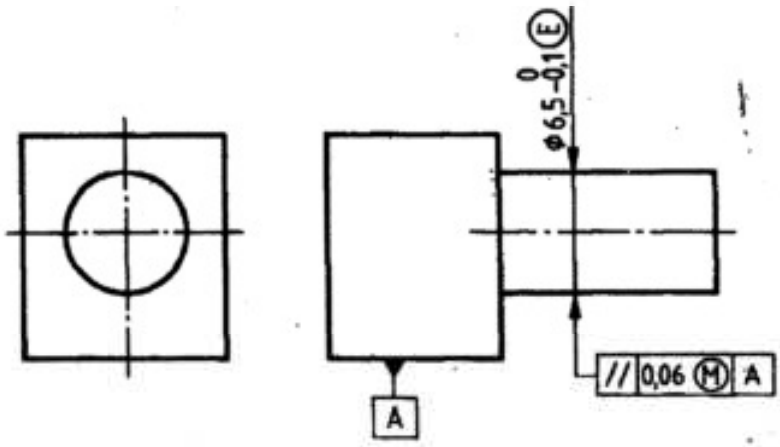


Figure 15 a)

b) Functional requirements

The tolerance feature shall meet the following requirements:

- each actual local size of the feature shall remain within the size tolerance of 0.1 and therefore may vary between ø 6.5 and ø 6.4;
- the entire feature shall remain within the boundary of the enveloping cylinder of perfect form of ø 6.5;
- the toleranced feature shall comply with the virtual condition established by two parallel planes 6.56 (=6.5 + 0.06) apart and parallel to the datum plane A [see figures 15 b) and 15 c)].

The axis shall, therefore, remain between two parallel planes 0.06 apart and parallel to the datum plane A when all diameters of the feature are at their maximum material size of ø 6.5 [see figure 15 b] and may vary within a tolerance zone (distance between two parallel planes)of up to 0.16when all diameters of the feature are at their least material size of ø 6.4 [see figure 15 c)].

NOTES

a) In the case of a parallelism tolerance of an axis to a datum plane, the tolerance zone has to be a zone between two parallel planes and cannot be a cylindrical tolerance zone.

b) As the parallelism tolerance zone is a zone between parallel planes, the virtual condition is a zone, between two parallel planes, the distance between them is the maximum material size 6.5 plus the parallelism tolerance of 0.06, i.e. 6.56.

The condition of the perfect cylinder at maximum material size, as indicated by Ⓔ, has to be checked separately.

c) The two figures 15 b) and 15 c) illustrate the extreme cases where the feature is of theoretically exact form. In practice, the feature would be somewhere between the extreme conditions with different actual local sizes.

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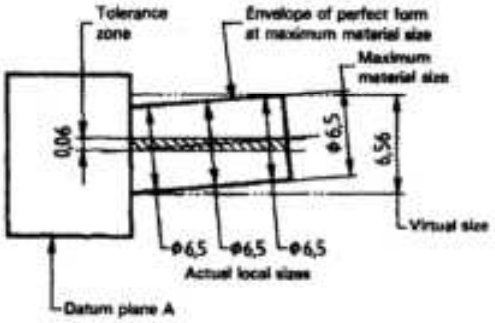


Figure 15 b)

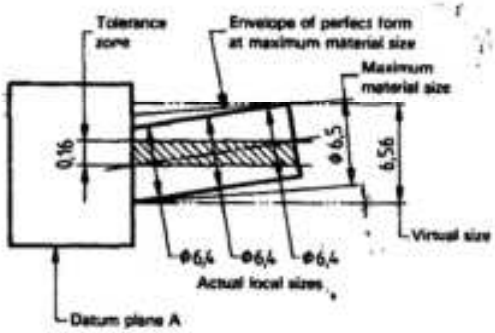


Figure 15 c)

6.3 Perpendicularity tolerance of a hole related to a datum plane:

a) indication on the drawing

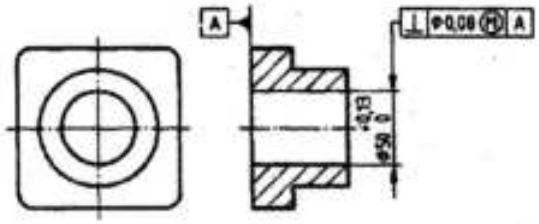


Figure 16 a)

b) Functional requirements

The toleranced feature shall meet the following requirements:

- each actual local size of the feature shall remain within the size tolerance of 0.13 and therefore may vary between ø 50 and ø 50.13;
- the tolerance feature shall comply with the virtual condition boundary, i.e. the inscribed cylinder of perfect form of ø 49.92 (= ø 50-0.08) and perpendicular to the datum plane A [see figures 16 b) and 16 c)].

The axis shall, therefore, remain within the tolerance zone of ø 0.08 perpendicular to the datum plane A when all diameters of the feature are at their maximum material size of ø 50 [see figure 16 b)] and may vary within a tolerance zone of up to ø 0.21 when all diameters of the feature are at their least material size of ø 50.13 [see figure 16 c)].

NOTE – The two figures 16 b) and 16 c) illustrate the extreme cases where the feature is of theoretically exact form. In practice, the feature would be somewhere between the extreme conditions with different actual local sizes.

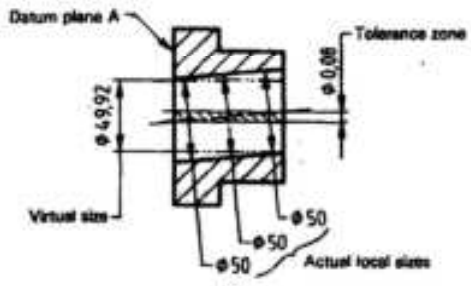


Figure 16 b)

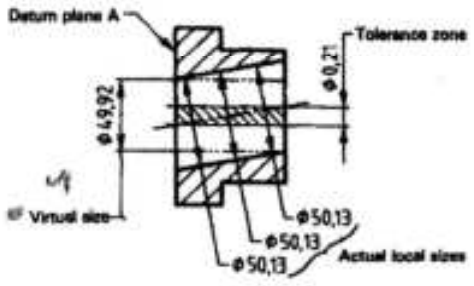


Figure 16 c)

6.4 Angularity tolerance of a slot related to a datum plane:

a) Indication on the drawing

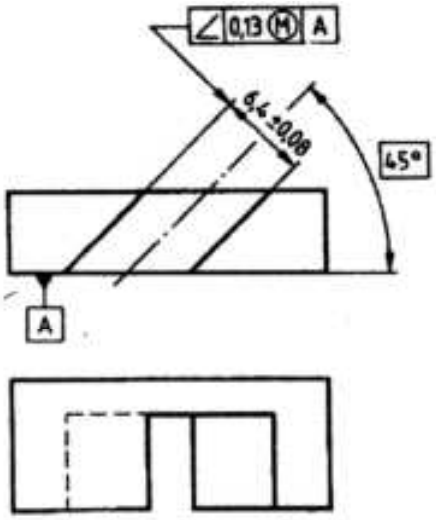


Figure 17 a)

b) Functional requirements

The tolerance feature shall meet the following requirements:

- each actual local size of the feature shall remain within the size tolerance of 0.16 and therefore may vary between 6.32 and 6.48;
- the toleranced feature shall comply with the virtual condition boundary established by two parallel planes **6.19 (=6.32 – 0.13)**apart and at the specified angle of 45° to the datum plane A (see figure 17 a)).

The median plane of the feature shall, therefore, remain between two parallel planes 0.13 apart, inclined at the specified angle of 45° to the datum plane A, when all widths of the feature are at their maximum material size of 6.32 [see figure 17 b)]. The median plane of the feature may vary within a tolerance zone of up to 0.29 when all widths of the feature are at their least material size of 6.48 [see figure 17 c)].

NOTE – The two figures 17 b) and 17 c) illustrate the extreme cases where the feature is of theoretically exact form. In practice, the feature would be somewhere between the extreme conditions with different actual local sizes.

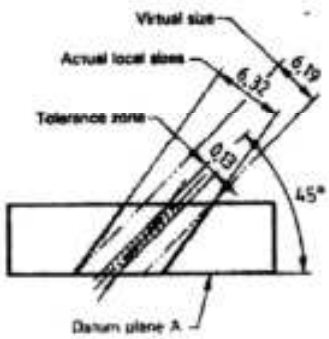


Figure 17 b)

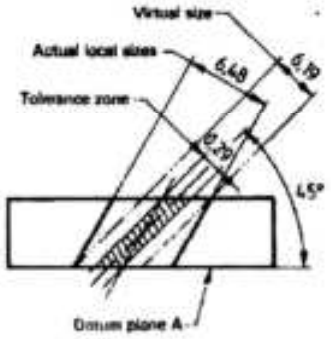


Figure 17 c)

6.5 Positional tolerance of four holes related to each other:

a) Indication on the drawing

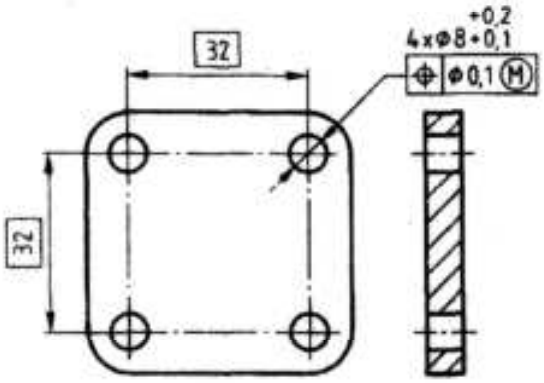


Figure 18 a)

b) Functional requirements

The toleranced features shall meet the following requirements:

- each actual local size of each feature shall remain within the size tolerance of 0.1and each may vary between ø 8.1 and ø 8.2;
- all toleranced features shall comply with the virtual condition boundary, i.e. the inscribed cylinder of perfect form of ø 8 (ø 8.1-0.1), where each of these cylinders is located in its theoretically exact position in relation to the other cylinders (dimension 32 in an exact 90° pattern) [see figure 18 a)].

The axis of each feature shall, therefore, remain within the positional tolerance zone of ø 0.1 when each diameter of the feature is at its maximum size of ø 8.1 [see figure 18 b)] and may vary within a tolerance zone of ø 0.2 when each diameter of the feature is at its least material size of ø 8.2 [see figure 18 c)].

NOTE – The two figures 18 b) and 18 c) illustrate the extreme cases where the features are of theoretically exact form. In practice, the features would be somewhere between the extreme conditions with different actual local sizes.

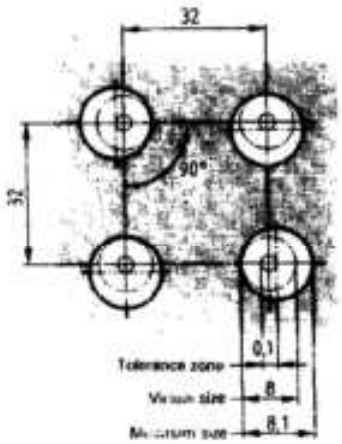


Figure 18 b)

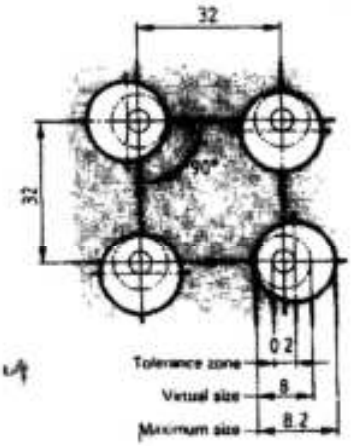
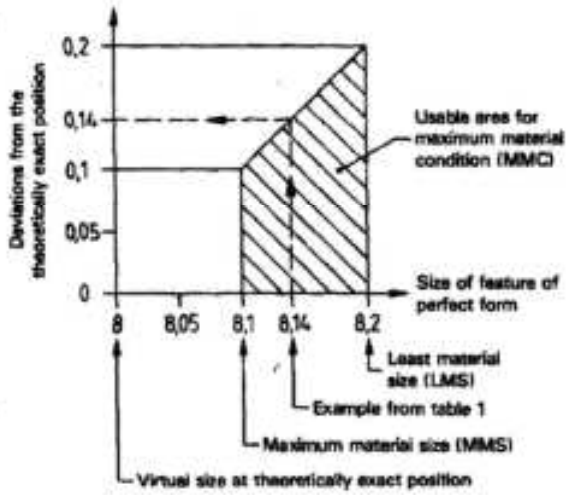


Figure 18 c)

The dynamic tolerance diagram (see figure 19) illustrate the interrelation between the feature, size and the permissible deviation from theoretically exact position according to table 1.

The functional gauge (see figure 20) represents the virtual condition



Diameter of hole of perfect form	Positional Tolerance
8.1 MMS	0.1
8.12	0.12
8.14	0.14
8.16	0.16
8.18	0.18
8.2 LMS	.0.2

Figure 19

The functional gauge (see figure 20) represents the virtual condition.

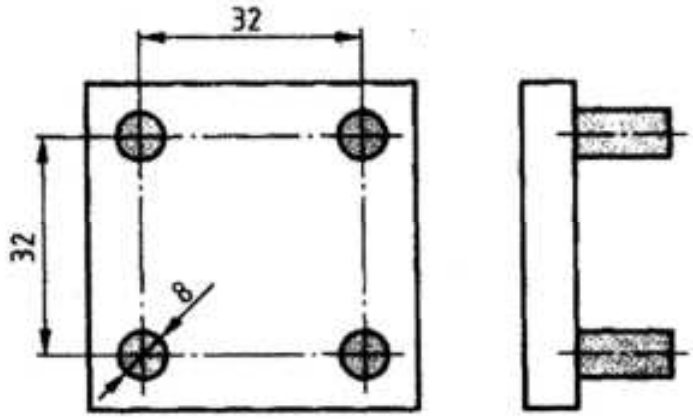


Figure 20

7.0 ZERO GEOMETRICAL TOLERANCING

7.1 General

In the examples given in 5.1 and 6.5, the tolerance is distributed between size and position. The extreme case is to allocate the total tolerance to the size and to indicate a zero positional tolerance. In this case, the size tolerance is increased and becomes the sum of the size and positional tolerance indicated previously.

The indication on the drawing for the holes in figure 2, therefore, becomes as illustrated in figure 21 a) and the indication on the drawing for the pins in figure 4 therefore becomes as illustrated in figure 21 b).

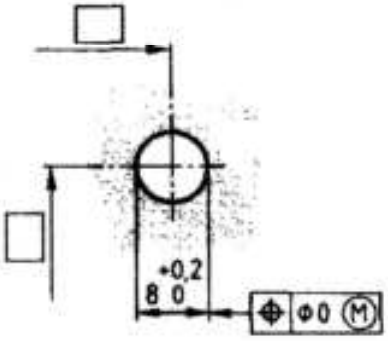


Figure 21 a)

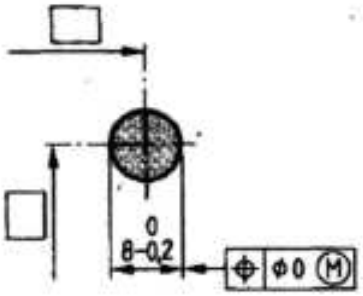


Figure 21 b)

According to the indications on the drawings in figures 21 a) and 21 b), the positional tolerances may vary between ø 0 and ø 0.2 as the actual sizes vary between maximum and minimum.

The indication "0Ⓜ" may also be used with other geometrical characteristics.

7.2 Examples

7.2.1 Four hole related to each other:

a) Indication on the drawing

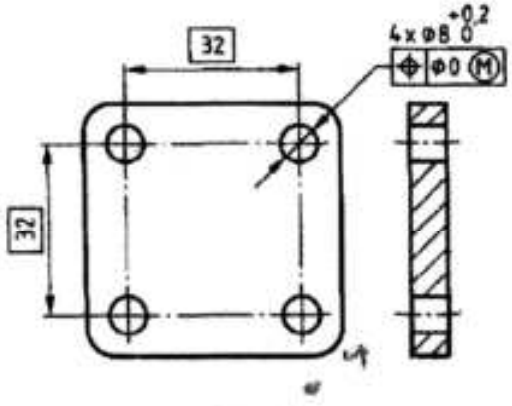


Figure 22

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b) Interpretation

According to the indication on the drawing in figure 22, the virtual size is the maximum material size (minimum hole diameter) minus thegiven positional tolerance, i.e. ø 8 – ø 0 = ø 8.

The dynamic tolerance diagram (see figure 23) illustrates the interrelation between the feature size and the permissible deviation from the theoretically exact position according to table 2.

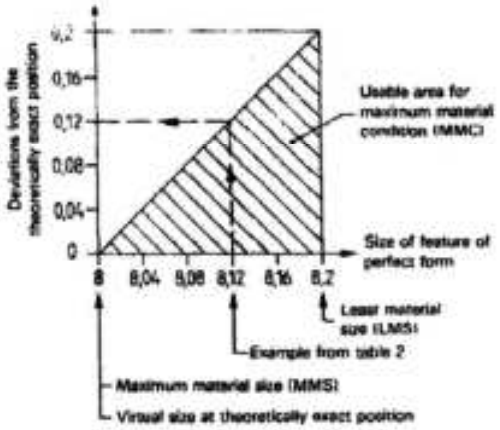


Figure 22

Diameter of Hole of perfect form	Positional tolerance
8 MMS	0
8.04	0.04
8.08	0.08
8.12	0.12
8.16	0.16
8.2	0.2

The functional gauge in accordance with figure 20 also represents the virtual condition of the part illustrated in figure 22. In both cases, the feature diameters shall be checked separately according to their different size tolerances.

7.2.2 Four pins related to each other:

a) Indication on the drawing

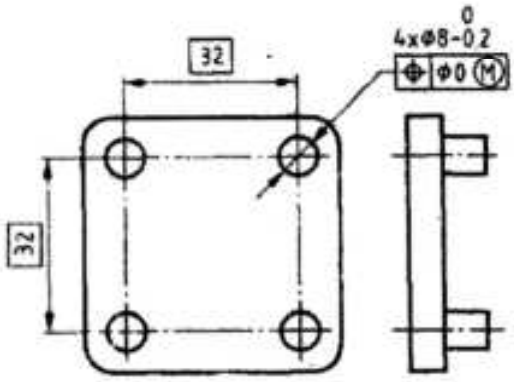


Figure 24

b) Interpretation

According to the indication on the drawing in figure 24, the virtual size is the maximum material size (maximum pin diameter) plus the given positional tolerance, i.e. ø 8 + ø 0 = ø 8.

The dynamic tolerance diagram (see figure 25) illustrates the interrelation between the feature size and the permissible deviation from the theoretically exact position according to table 3.

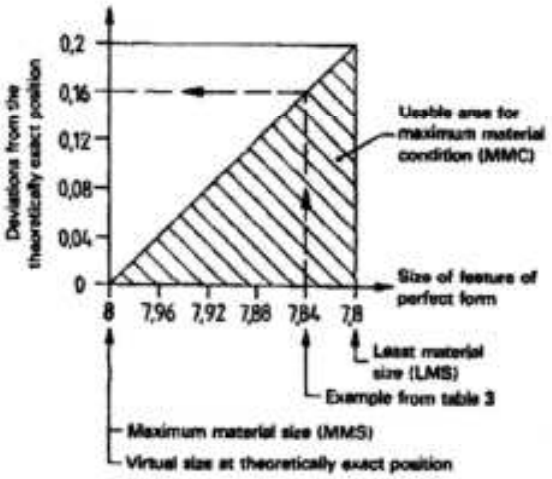


Figure 25

Diameter of pin of perfect form	Positional tolerance
8 MMS	0
7.96	0.04
7.92	0.08
7.88	0.12
7.84	0.16
7.8	0.2

The functional gauge (see figure 26) represents the virtual condition.

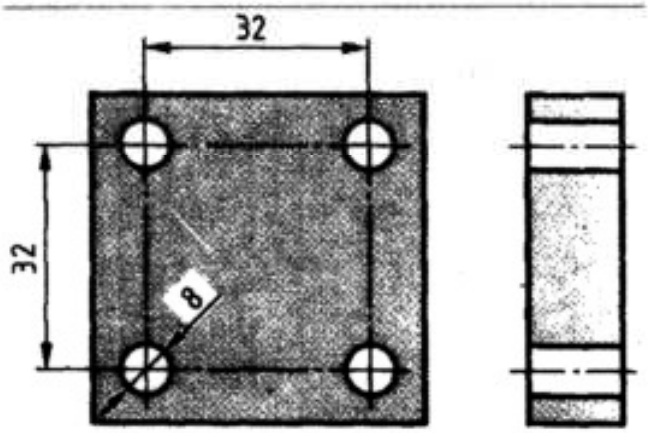


Figure 26

8.0 EXAMPLES OF APPLICATION WHERE Ⓜ APPLIES TO THE TOLERANCED FEATURE(S) AND THE DATUM FEATURE:

8.1 Positional tolerance of four holes related to a datum hole:

a) Indication on the drawing

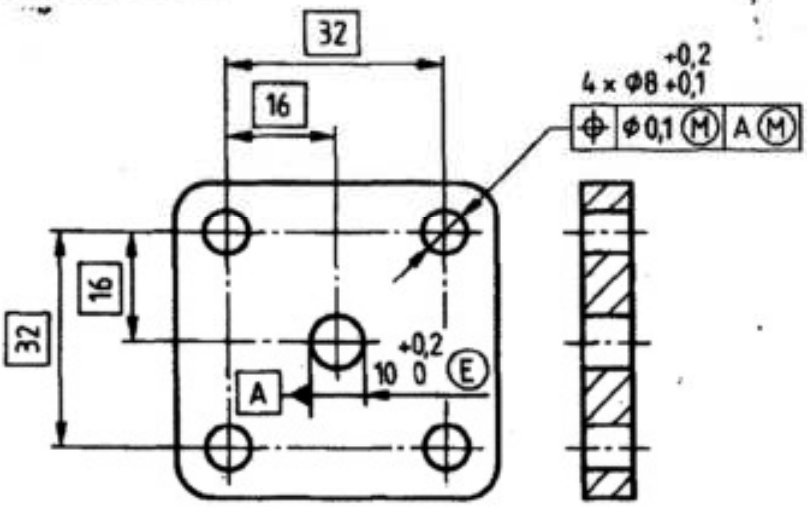


Figure 27 a)

b) Functional requirements

The toelranced feature shall meet the following requirements:

- each actual local size of each feature shall remain within the size tolerance of 0.1 and therefore may vary between ø8.1 and 8.2 [see 27 b) and 27 c)]
- all toleranced features shall comply with the virtual condition boundary, i.e. the inscribed cylinder of perfect form of ø 8 (=ø8.1-0.1), where each of these cylinders is located in its theoretically exact position in relation to the other cylinders [dimension 32 in an exact 90° pattern, see figures 27 b) and 27 c)] and also in its theoretically exact position in relation to the datum axis when the mating size of the datum feature A is at the maximum material size of ø 10 [see figure 27 b)].

  In the extreme case, the axis of each feature shall, therefore, remain within the positional tolerance zone of ø0.1 when each feature diameter is at its maximum material size of ø 8.1 [see figure 27 b] and may vary within a tolerance zone of ø 0.2 when each feature diameter is at its least material size of ø 8.2 [see figure 27 c)].
- The actual axis of the datum feature A may float in relation to the virtual conditions of the position of the four features if there is a departure from the maximum material size of the datum feature. The value of the float is equal to the departure of the mating size of the datum feature from its maximum material size [see figures 27 b) and 27 c)].

In the extreme case, the actual axis of the datum feature A may, therefore float within a zone of ø 0.2 when the datum feature A is of perfect form and of least material size ø 10.2 [see figure 27 c)].

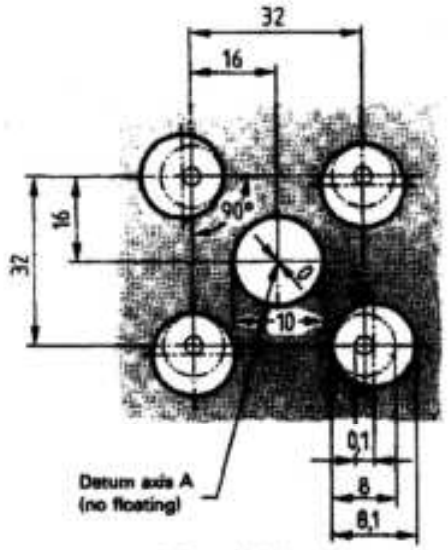


Figure 27 b)

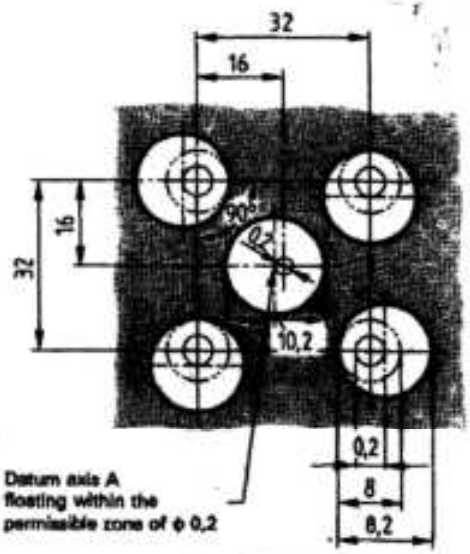


Figure 27 c)

The positional tolerance applies to the four toleranced feature in relation to each other as well as in relation to the datum feature. The given value is increased by an amount equal to the departure given in table 4 (second column).

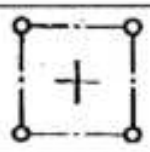
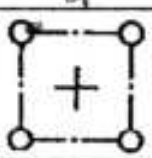
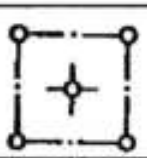
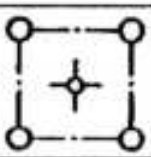
The additional positional tolerance which depends on the size of the datum feature (due to the maximum material condition on the datum) applies only to the toelranced features as a group tolerance in relation to the datum feature, but does not apply to the toleranced features in relation to each other, i.e. the datum may float in relation to the toleranced feature (for the values, see Table 4).

Table 4

Toleranced Hole diameter	Positional tolerance of each toleranced feature	Datum hole diameter	Floating zone for datum feature
8.1 MMS	0.1	10 MMS	0
8.12	0.12	10.05	0.05
8.14	0.14	10.1	0.1
8.16	0.16	10.15	0.15
8.18	0.18	10.2 LMS	0.2
8.2 LMS	0.2		

Any combination of the values in the second and fourth columns of table 4 may occur. The values in the second and fourth columns cannot simply be added because they have different interpretations. Some examples of extreme combinations are given in Table 5.

Table 5

Tolerance zone for toleranced feature	0.1	0.2	0.1	0.2
Tolerance zone for datum feature	0	0	0.2	0.2
Tolerance diagram				

The functional gauge (see figure 28) represents the virtual condition.

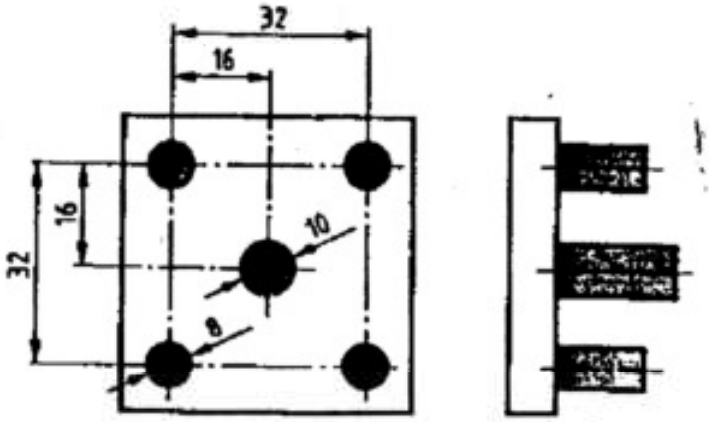


Figure 28

8.2 Coaxiality tolerances

a) Indication on the drawing

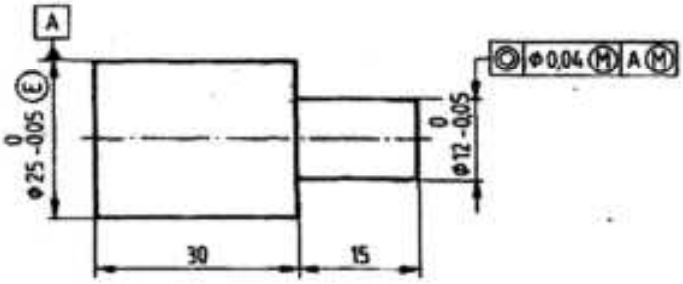


Figure 29 a)

b) Functional requirements

The actual toleranced feature shall meet the following requirements:

- Each actual local size of the features shall remain within the size tolerance of 0.05 and therefore may vary between ø 12 and ø 11.95 [see figures 29 b) and 29 c)].
- The whole feature shall remain within the virtual condition boundary, i.e. the enveloping cylinder of perfect form of ø 12.04 (=ø 12+0.04) and coaxial to the datum axis A when the mating size of the datum feature A is at its maximum material size [see figures 29 b) and 29 c)].
- The actual axis of the datum feature A may float in relation to the virtual condition if there is a departure from the maximum material size of the datum feature. The value of the float is equal to the departure of the mating size of the datum feature from its maximum material size. [See figure 29 d)].

The axis of the feature shall, therefore, remain within the coaxiality tolerance zone of ø0.04 when all diameters of the feature are at their maximum material size of ø 12 [see figure 29 b)] and may vary within a tolerance zone of up to ø 0.09 when all diameters of the toleranced feature are at their least material size of ø 11.95 and the mating size of the datum feature is at the maximum material size of ø 25 [see figure 29 c)]. The actual axis of the datum feature A may float within a zone of ø0.05 when the mating size of datum

feature A is at the least material size of ø24.95 [see figure 29 d)]. As in this case only one feature is related to the datum, the float of the datum has the effect of an increase in the coaxiality tolerances as illustrated in figure 29 e).

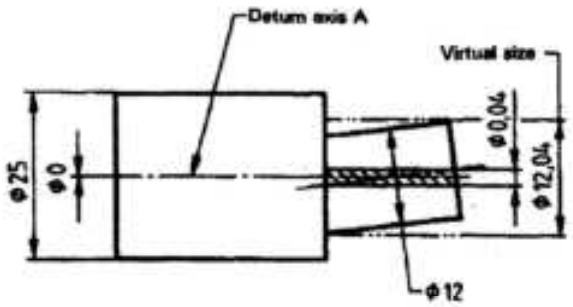


Figure 29 b)

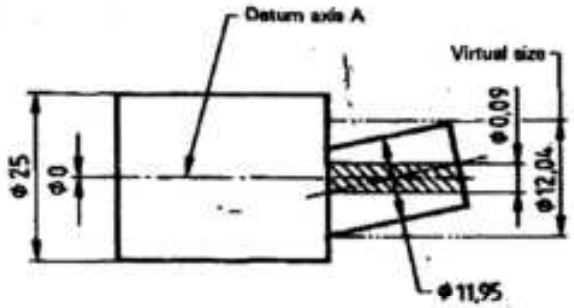


Figure 29 c)

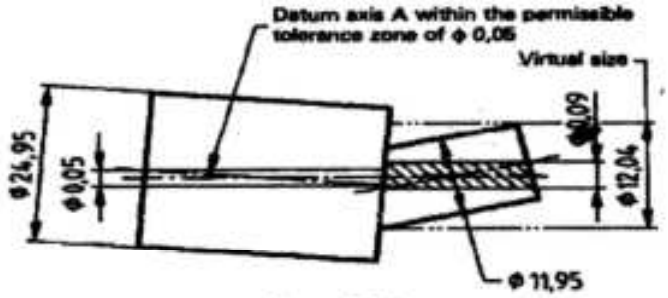
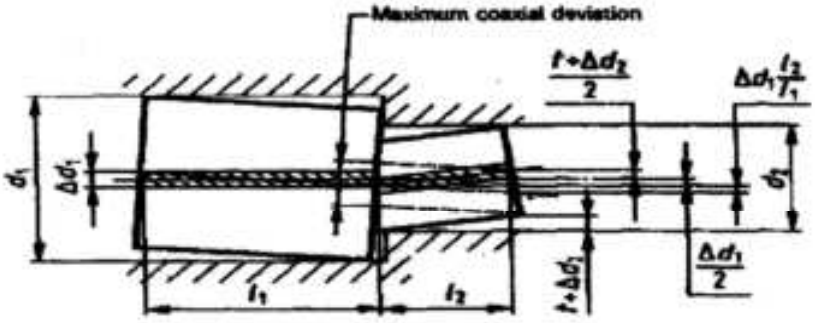


Figure 29 d)



where

d_1 is the maximum material size MMS of the datum feature

d_2 is the virtual size of the toleranced feature

t is the geometrical tolerance

Δd_1 = d_1 minus the mating size of the datum feature

$t + \Delta d_2$ = d_2 minus the mating size of the toleranced feature

Maximum coaxial deviation: $= 2 \left(\frac{t + \Delta d_2}{2} + \frac{\Delta d_1}{2} + \Delta d_1 \frac{l_2}{l_1} \right)$

$= 2 \left(\frac{0,04 + 0,05}{2} + 0,025 + 0,05 \frac{15}{30} \right)$

$= 0,19$

Figure 29 e)

The functional gauge (see figure 30) represents the virtual condition.

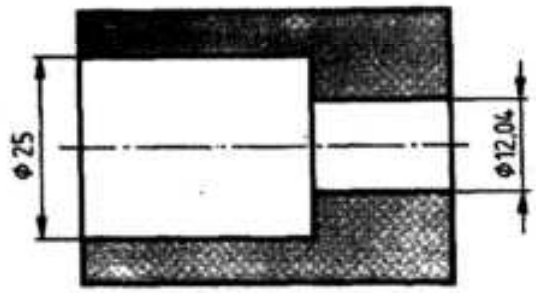


Figure 30

9.0 REFERRED STANDARDS (Latest publications including Amendments)

1) AA0423104
2) AA0230401