Hob accuracy tolerances

The DIN 3968 normative indicates dimensional errors on single-start hobs.
This normalization is universally recognized as correct for hobs that cut cylindrical gears.
Still today, however, hobs are divided into 4 different classes of accuracy even though in reality only the first two classes are actually commercialized as well as the class AAA type for which there is at present non normative table.

Class AA: these have a very high precision ground profile: They are recommended when it is necessary to obtain a gear with very limited errors that does not require any subsequent finishing operation. Pre-shave hobs should also be whitin class AA as this operation is not able to completely eliminate errors that appear on the roughed workpiece.

Class A: these have an accurate ground profile. This type of hob is more than sufficient for those gears that will be subsequently finished with a grinding operation where the stock removed is around 0,10 mm.

Class B: these are also know as hobs with a normal ground profile. The acceptable errors are significantly higher than the previous two classes but this type of hob could in any case be utilized without problems to prepare gears that must be ground. In some cases they have an unground finished profile but the savings made on the profile grinding operation are outweighed by the problems that arise from heat treatment distortion. Furthermore the performance of these hobs is poor since during heat treatment the surface of the tool tends to decarbonise, therefore compromising its hardness and wear resistance properties. Lastly it is not possible to TiN coat these tools.

Class C: these have an unground finished profile and their level of accuracy is poor. They serve to perform low precision hobbing mostly for gear that are used in mechanisms which do not involve rotation. It is rare to see these tools commercialized today.

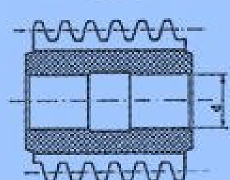
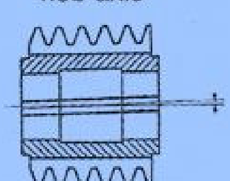
Class D: these are hobs which have an unground finished profile. The limitations in tolerance for these tools are very generous and they are not generally commercialized. The tables that are shown in the next pages do not take this class of hob into consideration.

How hobs are finished and to what class of accuracy is a choice which is usually left to the manufacturer.
Some years ago there was a significant difference in price between class AA, class A and class B hobs since all grinding machines were old-style and manual.
Nowadays standard manufacturing with modern numeric control grinding machines is to class AA accuracy and therefore there are no longer particular differences in price between these three classes of accuracy.
Normally the slightly higher cost of class AA hobs compared to class A tools (about 5%) is due to the need for greater care in bore, face and collar grinding as well as much stricter inspection of all manufacturing parameters.
The DIN 3968 table, as stated above, refers to single-start hobs and it does not consider the tolerances for special profiles such as those with protuberance or with semi-topping and so on. It therefore only covers standard hobs.
Generally, however, multi-start hobs are considered in the same manner as single-start hobs for the purpose of manufacturing tolerances.

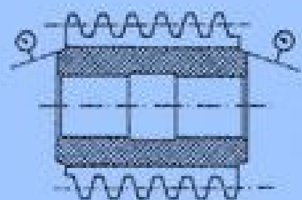
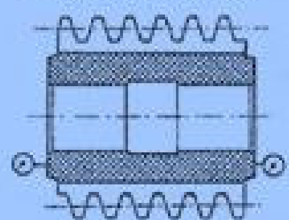
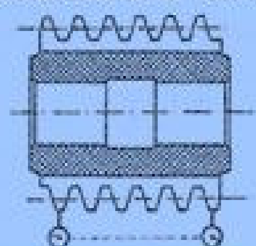
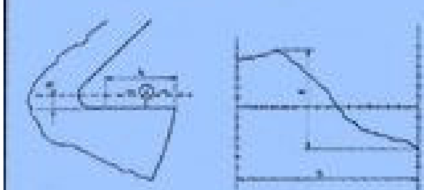
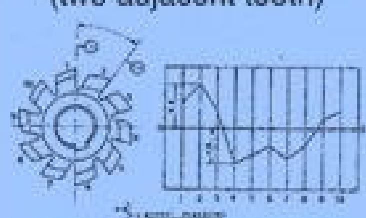
At times, as mentioned above, class AAA hobs are required even though these are not covered by the DIN normative.
Samputensili S.p.A. considers 67% of class AA tolerances for this class of accuracy. Others manufacturers, however, reduce the tolerances to 75% of the class AA values.
The accuracy that is possible to achieve on gear that are hobbed with different accuracy class hobs depends on various factors especially on the type and state of the hobbing machine, the care used in setting un the machine and on the working conditions.
Furthermore, not all of the various errors are of the same quality level. The helix and the pitch, for example, may be of higher class of accuracy than the profile if a good NC machine is used.
If the DIN 3962 and AGMA 390.03 norms are considered, it is generally possible to say that the accuracy levels attainable are the following and they may increased by one class if certain conditions are available during usage.

- *Class AA hobs: they hob DIN 8 quality gears (AGMA 8)*
- *Class A hobs: they hob DIN 9 quality gear (AGMA 7)*
- *Class B hobs: they hob DIN 10 quality gears (AGMA 6)*

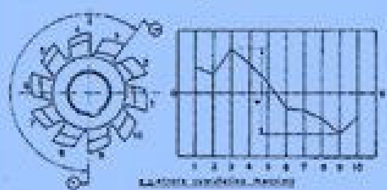
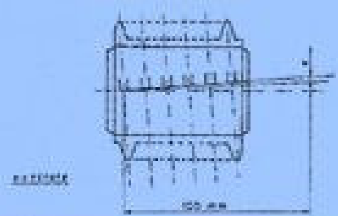
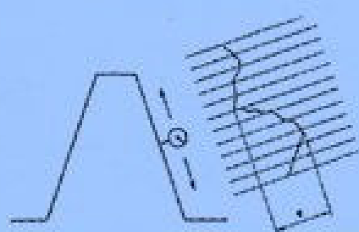
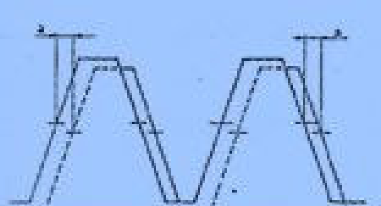
In the following tables, the tolerances accepted by DIN 3968 normative are given for classes AA, A and B. class C and D have been excluded since they are basically no longer in use. Furthermore, in those cases where the DIN normative do not specify a tolerance, the tolerances that are in use by Samputensili S.p.A are indicated.

Hob tollerance (DIN 3968) (microns)								
Elements measured	Class	Modules						
		0,6-1	1-1,6	1,6-2,5	2,5-4	4-6,3	6,3-10	10,1-16
Bore 	AA	H5						
	AA	H5						
	B	H6						
Keyway off centre 	AA	IT10						
	AA	IT10						
	B							
Parallelism of keyway to hob axis 	AA	IT10						
	AA	IT10						
	B							

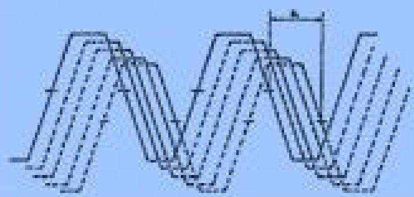
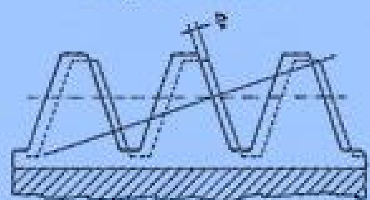
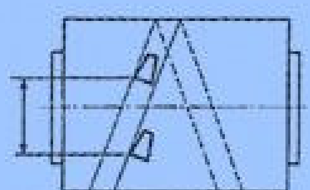
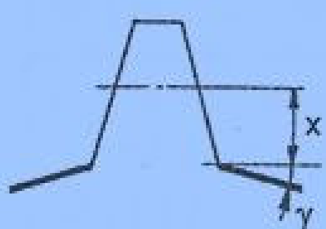
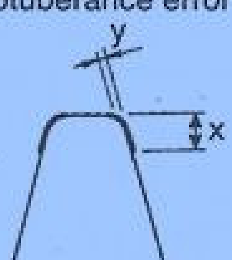
(segue)

Collar run out 	AA	5	5	5	5	5	5	
	AA	5	5	5	6	8	10	12
	B	6	6	6	8	10	12	16
Side face run out 	AA	3	3	3	3	3	4	
	AA	3	3	3	5	5	8	8
	B	4	4	4	6	6	10	10
Outside diameter run out 	AA	10	10	12	16	20	25	
	AA	12	16	20	25	32	40	50
	B	25	32	40	50	63	80	100
Gash radial alignment 	AA	10	10	12	16	20	25	
	AA	12	16	20	25	32	40	50
	B	25	32	40	50	63	80	100
Indexing between gashes (two adjacent teeth) 	AA	10	10	12	16	20	25	
	AA	12	16	20	25	32	40	50
	B	25	32	40	50	63	80	100

(segue)

Maximum indexing error between any two teeth 	AA	20	20	25	32	40	50	
	AA	25	32	40	50	63	80	100
	B	50	63	80	100	125	160	200
Accuracy of gashes over 100mm 	AA	50						
	AA	70						
	B	100						
Profile error 	AA	4	5	5	7	8	10	
	AA	6	8	8	11	13	16	20
	B	12	13	16	20	24	30	36
Tooth thickness on pitch line (Minus only) 	AA	16	16	16	20	25	32	
	AA	25	28	32	36	40	50	63
	B	50	56	63	71	80	100	125
Tooth to tooth lead variation 	AA	4	4	4	5	6	8	
	AA	6	7	8	9	10	12	16
	B	12	14	16	18	20	25	32

(segue)

Total variation along helix in one revolution 	AA	6	6	6	8	10	12	
	AA	10	11	12	14	16	20	25
	B	20	22	25	28	32	40	50
Pitch line error between two adjacent teeth 	AA	4	4	4	5	6	8	
	AA	6	7	8	9	10	12	16
	B	12	14	16	18	20	25	32
Indexing error between starts (only for hobs that have more than one start) 	AA	5	5	6	8	10	12	
	AA	8	8	9	13	17	21	26
	B	13	13	14	20	24	29	33
Chamfer error 	theoretical amount x	30		50		80		120
	theoretical amount y	3°		3°		3°		3°
Protuberance error 	theoretical amount y	12		18		24		30
	theoretical amount x	100		200		300		400

(fine)