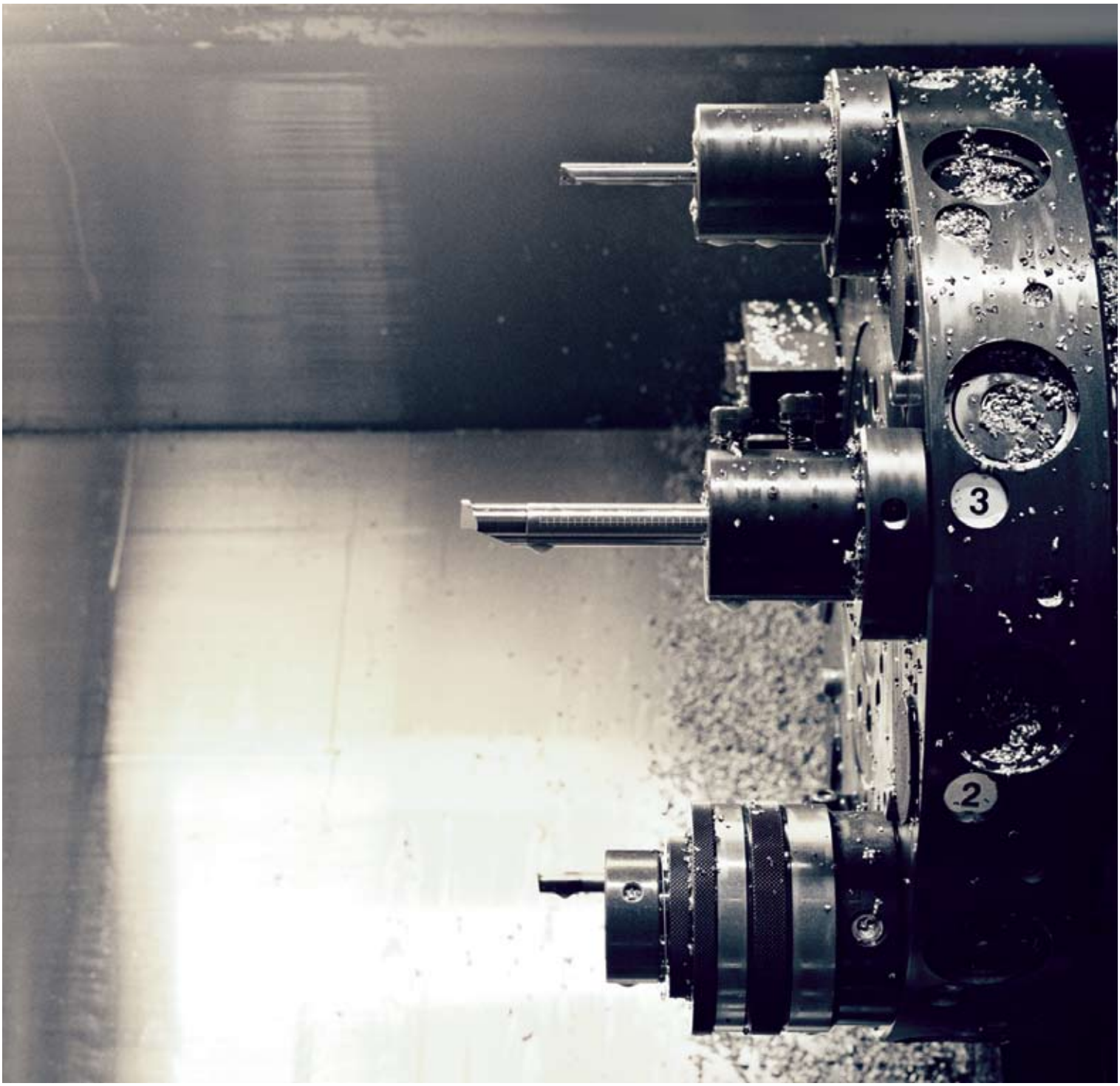


DIMENSIONAL DEVIATION OF HOLES AND SHAFTS

MULTI-WING
DON'T COMPROMISE

Scope

The need to use a relatively tight bore on standard bosses for electrical motors is frequently discussed with customers and distributors. This paper attempts to explain this as well as give guidance on how problems related to this issue can be overcome.

The bore - shaft connection

The impellers in the Multi-Wing range are used in a wide variety of applications. In this perspective, drying applications that have relatively heavy aluminium impellers with reversible operation and other applications with frequent start/stop are the most critical. In general, however, the mounting of axial impellers is critical to any clearance between the shaft and the hub since the appearance of even a diminutive rotational slip will build up and lead to severe stress on the key and keyway.

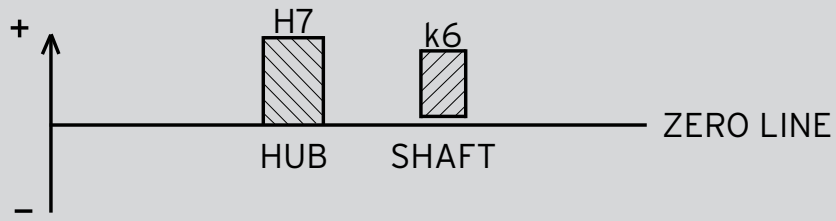
A rough bore also causes displacement of the rotating mass from the axis of rotation and thus eccentricity and possible unbalance.

The conclusion is that a close fitting connection between the impeller hub and the shaft is necessary and that a uniform tight fit of the hub is a significant part of the overall quality of the impeller.

Tolerance grades

The ISO standard 286-2 describes a system of tolerances limiting the deviations for shafts and holes. The commonly used tolerance for electrical motors manufactured according to the IEC norm is k6 for bores up to ø48mm. Using a H7 in the hub, which is the commonly used hole tolerance for engineering component, the fitting is adequate.

According to the figure below, any H tolerance is defined by being a plus tolerance in the sense that the bore is bigger than, or equivalent to, the nominal dimension where the number 7 is indicating how rough the deviation limit is. The shaft tolerance k6 is also a plus tolerance, but with deviation limit slight narrower than the H7.



Upper and lower deviation limits

Mounting the impellers

The figure shows, that where there is a small H7 and a big k6, the connection will be very tight since there's simply too much material when fitting the hub to the shaft. Trying to mount the impeller in such a situation requires force and the result is an increasing burr as the hub slices on the shaft.

The problem is accentuated by the relatively high temperature expansion coefficient of aluminium. If the temperature of the hub was slightly higher when machined or if the hub is taken directly from a colder storage facility or a truck the mounting will be problematical.

However, aluminium's expansion coefficient makes it relatively easy to solve the mounting problem. If the hub is heated to room temperature, or a little more, most problems are overcome. It is important that no force is used when mounting the impeller. As long as the hub is kept perfectly straight, it should slide on the shaft using a minimum of force. If that's not the case the hub should be heated up more or be checked for burrs at the keyway.

Example – an estimate of the diameter alteration at changing temperatures.

Hub size	ø28	mm	This example shows that a temperature change of just 20°C results in a diameter alteration of 13µm. This roughly compensates for the worst-case scenario of the bore / shaft deviation limits.
Hole tolerance H7	+21/0	µm	
Shaft tolerance k6	+15/+2	µm	
Linier expansion coefficient	23,5 x 10^{-6}	m/m°C	
Temperature change	20	°C	
Diameter alteration	13	µm	

The machining process

The machining procedure for standard bosses utilises the most modern CNC based equipment. Furthermore, reaming the drilled hole gives the surface of the bore a smooth finish. By using the reamer it is also possible to obtain the most uniform tolerance of the bore.

It should also be mentioned that the manufacturing of the standard bosses is based on large-scale production placed on stock, without direct reference to the order flow.

Conclusion

It is a poor solution to use a bigger bore tolerance due to both technical and logistical reasons.

Mounting problems can, however, be fundamentally solved by applying a very simple procedure that takes into consideration the temperatures of the impellers hub.

Following guidelines should be used when mounting impeller:

- The temperature of the hub should as a minimum be at room temperature
- Check the bore for burrs
- No force should be used when mounting the impeller