DIESEL MECHANIC

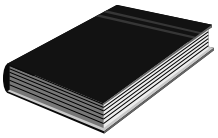
MINING QUALIFICATIONS AUTHORITY

CODE: ATF

ALLOWANCES AND TOLERANCES FOR FITS

INDEX

The following elements are contained in this learning guide:



SOURCE REFERENCES

Demonstration by a competent person, e.g. Training Officer.

OBJECTIVE

You will be learning towards the outcome “Allowances and tolerances for fits”. Whilst learning towards the outcome you will be required to achieve the following:

- Calculate the bore sizes for a bush to fit onto a shaft according to the different classes of fits.

On completion of this module, the learner must be able to:

- Explain the five different types of fits used in the manufacturing of Engineering parts.
- Measure the diameter if a shaft, using the appropriate tables, calculates the bore size of a bush to fit onto the shaft according to a specified fit.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A theoretical assessment will be set at the end of the module and must be completed without using reference other than tables for allowances and tolerances.
- The learner will be given a number of shafts, the diameter of which he / she must first measure and then calculate the bore of a bush to fit each according to a specified fit.
- Shaft diameters must be measured correctly and each fit must be calculated correctly.

1. ALLOWANCES FOR FITS

ITEM / TASK: Introduction.

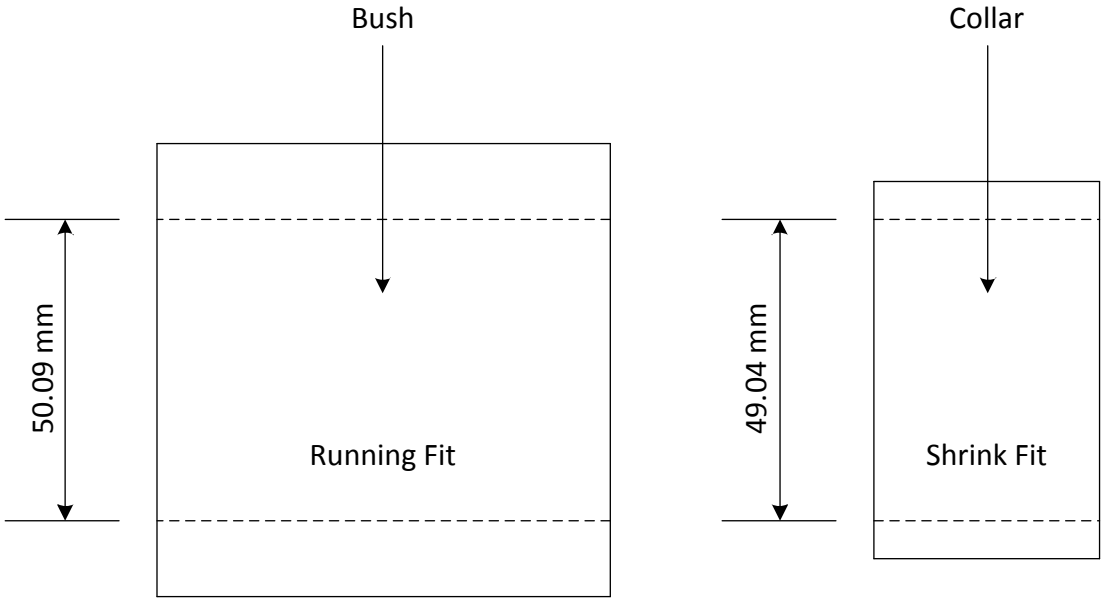
DESCRIPTION:

The nominal size is the size, which is commonly used when referring to dimensions. It is usually rounded to the nearest whole number. Thus we may say that the diameter of a shaft is 50mm, although the true size of the shaft might be 50,01mm or 49,98mm.

ITEM / TASK: Allowances.

DESCRIPTION:

A. Allowance is the amount of **difference in size** between two mating components, one of which has to fit inside the other to allow for a certain type of fit. For example, in case of a shaft, which has to fit into a hole, it refers to the difference between the shaft size and hole size, which can range from a running fit to a shrink fit.
B. Fig 1 shows a bush that must have a running fit on a shaft with a nominal diameter of 50mm, and a collar that must be a shrink fit on the same shaft (see Table 1 for running fits and Table 5 for shrink fits).



Measurement in millimeters

FIG 1.

2. TOLERANCES FOR FITS

ITEM / TASK: Tolerances.

DESCRIPTION:

A. Tolerance is the amount of variation allowed to compensate for inaccuracy in workmanship and is not the same as allowance.

B. The tolerance is equal to the difference between the maximum and minimum limits of any specified dimension. It is obtained by subtracting the smallest size allowed from the largest size allowed.

Practical example:

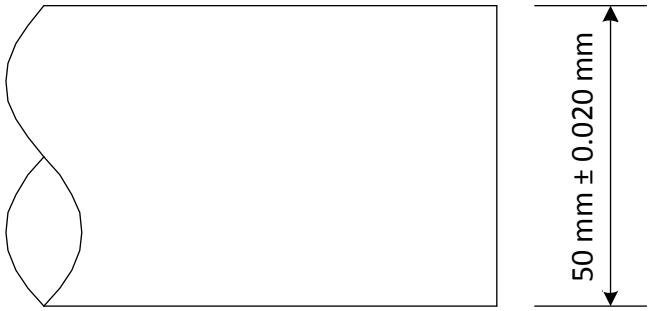


FIG 2.

The dimensions of the shaft in Fig 2 are given as 50mm ± 0,020.

Maximum dimension allowed = 50 mm + 0,020 mm
= 50,020 mm.

Minimum dimension allowed = 50 mm – 0.020 mm
= 49,98mm

∴Tolerance = 0,040 mm.

ITEM / TASK: Bilateral tolerances.

DESCRIPTION:

Fig 3 shows bilateral tolerance on the dimensions of a shaft.

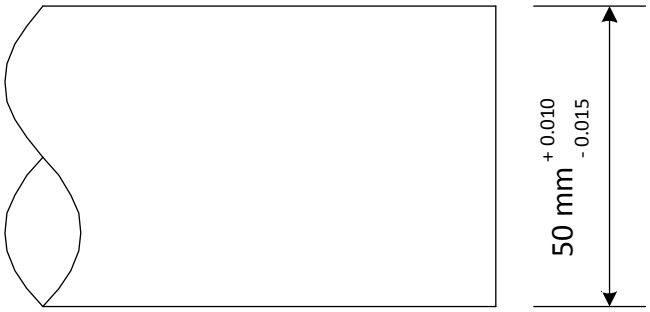


FIG 3.

The dimension of the shaft in Fig 3 may therefore be:

- Maximum of: 50mm + 0.01, i.e. 50.010 mm, and
- Minimum of : 50mm – 0.015, i.e. 49.985 mm

Note: It is not necessary that the limits be the same.

ITEM / TASK: Unilateral tolerances.

DESCRIPTION:

Fig 4 shows unilateral tolerance on the dimensions of a shaft.

Unilateral tolerance is when the dimension of the shaft may only vary on one side of the basic size:

- In Fig. 4 the **maximum thickness** of the shaft may not be bigger than 50 mm. i.e. 50 mm + 0.000 mm.

- The **minimum dimension** may, however be as small as 49,975 mm, i.e. 50 mm – 0.015 mm.

The tolerance may also be specified the other way round, i.e. it may be specified that the shaft has a fixed minimum diameter, but allow a variance in the maximum diameter.

e.g. The dimensions may be 75mm $^{+0.05}_{-0.00}$

3. FITS

ITEM / TASK: Classes of fits.

DESCRIPTION:

A. Fits show the amount of play, which is present when two mating parts (e.g. a shaft and a bush) are assembled.
B. There are five classes of fits commonly used in ordinary machine construction, namely -
    - running fit,
    - push fit,
    - drive fit,
    - force fit, and
    - shrink fit.

ITEM / TASK: Running fit.

DESCRIPTION:

A. A running fit is used when the shaft must rotate in the bush. With this fit the bore of the bush is always larger than the shaft diameter.
B. Table 1 **on the next page** shows the allowances and tolerances for running fits with speeds of 600 RPM or greater.
C. To determine the diameter of a bush for a running fit, the following should be done:
    - Measure the outside diameter of the shaft with a micrometer. If the outside diameter of the shaft is 25,03mm then the nominal size is 25mm.
    - Determine the allowance and tolerance from Table 1.

We know that for a running fit the bore of the bush must be larger than the diameter of the shaft. For a shaft with a nominal size of 25 mm, the allowance **is 0.07mm**.
(Table 1, fifth row, column b), and the **tolerance is ±0.01 mm**. (Column c).

Therefore, the bore of the bush can be -

$$(25.03 + 0.07) \pm 0.01 = 25.10 \pm 0.01 \text{ mm}$$

- Maximum bore: 25.10 + 0.01= 25.11mm
- Minimum bore: 25.10 – 0.01 = 25.09 mm

TABLE 1.

ALLOWANCES AND TOLERANCES FOR RUNNING FITS

a	b	c
4 – 6 mm	+ 0.03	± 0.01
7 – 12 mm	+ 0.04	± 0.01
13 – 19 mm	+ 0.06	± 0.01
20 – 25 mm	+ 0.07	± 0.01
26 – 32 mm	+ 0.08	± 0.01
33 – 38mm	+ 0.08	± 0.02
39 – 50 mm	+ 0.09	± 0.02
51 – 63 mm	+ 0.10	± 0.02
64 – 76 mm	+ 0.12	± 0.02
77 – 100 mm	+ 0.14	± 0.02
NOTE : a = Diameter of shaft b = Average allowance c = Permissible tolerance		

DO SELF TEST 1 ON THE NEXT PAGE BEFORE CONTINUEING WITH THE MODULE.

SELF TEST 1

Determine the diameters of the bushes for a running fit for the following shafts:

a. Outside diameter of the shaft is 38.03 mm

b. Outside diameter of the shaft is 19.03 mm

c. Outside diameter of the shaft is 75.03 mm

d. Outside diameter of the shaft is 100.04 mm

e. Outside diameter of the shaft is 50.04 mm

f. Outside diameter of the shaft is 6.01 mm

Check your answers against those given below.

ANSWERS		
a.	Max - 38.13 mm	Min - 38.09 mm
b.	Max - 19.10 mm	Min - 19.08 mm
c.	Max - 75.17 mm	Min - 75.13mm
d.	Max - 100.20 mm	Min - 100.16 mm
e.	Max - 50.15 mm	Min - 50.11mm
f.	Max - 6.05 mm	Min - 6.03 mm

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Push fit.

DESCRIPTION:

A. In a push fit the allowance is smaller than that of a running fit and a moderate pressure is required to assemble the parts.
B. The pin or the shaft will turn slowly without seizing.
C. An example of this type of fit is a gudgeon pin when in a motorcar engine.
D. Table 2 below shows the tolerances and allowances to be used for **push fits**.
E. To determine the diameter of the bush for a push fit, the same procedure described above for a running fit should be followed.

TABLE 2.

ALLOWANCES AND TOLERANCES FOR PUSH FITS

a	b	c
4 – 6 mm	+ 0.01	+ 0.01 - 0.00
7 – 12 mm	+ 0.01	+ 0.01 - 0.00
13 – 19 mm	+ 0.01	+ 0.01 - 0.00
20 – 25 mm	+ 0.01	+ 0.01 - 0.00
26 – 32 mm	+ 0.02	± 0.01
33 – 38mm	+ 0.02	± 0.01
39 – 50 mm	+ 0.02	± 0.01
51 – 63 mm	+ 0.02	± 0.01
64 – 76 mm	+ 0.03	± 0.01
77 – 100 mm	+ 0.03	± 0.01
NOTE : a = Diameter of shaft b = Average allowance c = Permissible tolerance		

DO SELF TEST 2 ON THE NEXT PAGE BEFORE

CONTINUEING WITH THE MODULE.

SELF TEST 2

Use table 2 to determine the diameters of the bushes for the following shafts if it has to have a push fit:

a. Outside diameter of the shaft is 25.01 mm

b. Outside diameter of the shaft is 38.01 mm

c. Outside diameter of the shaft is 19.00 mm

d. Outside diameter of the shaft is 100.02 mm

e. Outside diameter of the shaft is 63.02 mm

Check your answers against those given below.

ANSWERS		
a.	Max - 25.03 mm	Min - 25.02 mm
b.	Max - 38.04 mm	Min - 38.02 mm
c.	Max - 19.02 mm	Min - 19.01 mm
d.	Max - 100.06 mm	Min - 100.04 mm
e.	Max - 63.05 mm	Min - 63.03 mm

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

ITEM / TASK: Drive fit.

DESCRIPTION:

A. A drive fit is a semi-permanent fit and is assembled by means of light hammer blows or medium pressure, e.g.
   - a roller bearings on a shaft, or
   - inserting a small bush in a pulley.

B. Table 3 below shows the tolerances and allowances to be used for **drive fits**.

C. To determine the diameters of the bush for a drive fit, the same procedure described for the previous fits should be used.

TABLE 3.

ALLOWANCES AND TOLERANCES FOR DRIVE FITS

a	b	c
4 – 6 mm	0.00	+ 0.00 - 0.01
7 – 12 mm	0.00	+ 0.00 - 0.01
13 – 19 mm	- 0.01	+ 0.00 - 0.01
20 – 25 mm	- 0.01	+ 0.00 - 0.01
26 – 32 mm	- 0.01	+ 0.00 - 0.01
33 – 38mm	- 0.01	+ 0.01 - 0.01
39 – 50 mm	- 0.01	+ 0.01 - 0.01
51 – 63 mm	- 0.01	+ 0.01 - 0.01
64 – 76 mm	- 0.02	+ 0.01 - 0.01
77 – 100 mm	- 0.02	+ 0.01 - 0.01
NOTE : a = Diameter of shaft b = Average allowance c = Permissible tolerance		

ITEM / TASK: Force fit.

DESCRIPTION:

A. A force fit is a permanent fit and requires high pressures, e.g. the hydraulic pressure of a press, to assemble the parts. The high pressure is needed because of the "negative allowance". An example of this type of fit is an axle through the hub of a locomotive wheel.

B. Table 4 shows the tolerances and allowances to be used for **force fits**.

C. To determine the diameter of a bush for a force fit, the same method as for determining the previous fits is again used, i.e. by referring to the nominal size and the appropriate table. (Table 4)

TABLE 4.

ALLOWANCES AND TOLERANCES FOR FORCE FITS

a	b	c
4 – 6 mm	0.00	+ 0.00 - 0.01
7 – 12 mm	- 0.01	+ 0.00 - 0.01
13 – 19 mm	- 0.01	+ 0.00 - 0.01
20 – 25 mm	- 0.02	+ 0.00 - 0.01
26 – 32 mm	- 0.02	+ 0.00 - 0.01
33 – 38mm	- 0.03	± 0.01
39 – 50 mm	- 0.03	± 0.01
51 – 63 mm	- 0.04	± 0.01
64 – 76 mm	- 0.05	± 0.01
77 – 100 mm	- 0.06	± 0.01
NOTE : a = Diameter of shaft b = Average allowance c = Permissible tolerance		

ITEM / TASK: Shrink fit.

DESCRIPTION:

A. A shrink fit is a permanent fit.

B. The outer component is heated until it slips easily over the shaft. It is then allowed to cool, e.g. the tyre of a locomotive wheel.

C. Table 5 shows the tolerances and allowances to be used for shrink **fits**.

D. The same procedure as described above should be used to determine the fit.

TABLE 5.

ALLOWANCES AND TOLERANCES FOR SHRINK FITS

a	b	c
4 – 6 mm	- 0.01	+ 0.00 - 0.01
7 – 12 mm	- 0.02	+ 0.00 - 0.01
13 – 19 mm	- 0.02	+ 0.00 - 0.01
20 – 25 mm	- 0.03	± 0.01
26 – 32 mm	- 0.04	± 0.01
33 – 38mm	- 0.05	± 0.01
39 – 50 mm	- 0.06	± 0.01
51 – 63 mm	- 0.07	± 0.01
64 – 76 mm	- 0.08	± 0.01
77 – 100 mm	- 0.09	± 0.01
NOTE : a = Diameter of shaft b = Average allowance c = Permissible tolerance		

DO SELF TEST 3 ON THE NEXT PAGE.

SELF TEST 3

Use table 1 - 5 to determine the diameter of the bushes for each of the following specified fits For a shaft with an outside diameter of 50.05mm:

a. Shrink fit

b. Force fit

c. Drive fit

d. Push fit

e. Running fit

Check your answers against those given below.

ANSWERS		
a. Shrink fit	Max - 50.00 mm	Min - 49.98 mm
b. Force fit	Max - 50.03 mm	Min - 50.01 mm
c. Drive fit	Max - 50.05 mm	Min - 50.03 mm
d. Push fit	Max - 50.08 mm	Min - 50.06 mm
e. Running fit	Max - 50.16 mm	Min - 50.12 mm

Note :

Note how the diameter of the bush varies for the different fits.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

REMEMBER ALWAYS WORK SAFE

Once you have passed all the Self Tests, you are now at liberty to request a Formative Assessment from your Assessor.