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A Threads "Functional Diameter" Is Its Functional Characteristic

Since the fastener quality issue started heating up, threads, in particular, have come under closer and closer scrutiny. This closer evaluation of threads has brought to light several new terms that have caused some confusion along the way. One such term that is very frequently discussed now is the "functional diameter."

Most fastener people are accustomed to discussing a thread's "pitch diameter," but the discussion of the "functional diameter" is new and often confusing. ANSI/ASME B1.7-1984 defines these two terms as follows:

- Pitch Diameter: On a straight thread the pitch diameter is the diameter of the pitch cylinder. The pitch cylinder is an imaginary cylinder of such a diameter and location of its axis that its surface would pass through a straight thread in such a manner as to make the widths of the thread ridge and the thread groove equal. See Figure 1.

- Functional Diameter: The functional diameter is the pitch diameter of an enveloping thread with perfect pitch, lead, and flank angles and having a specified length of engagement. This diameter includes the cumulative effect of variations in lead (pitch), flank angle, taper, straightness, and roundness. See Figure 2.

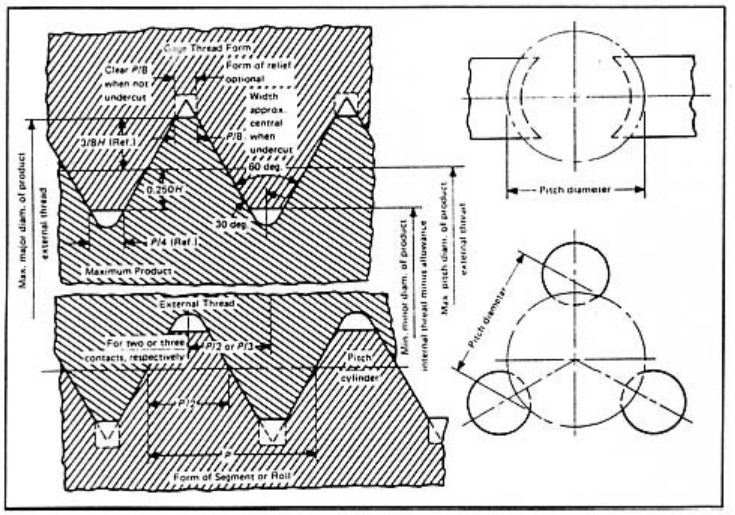


Figure 1.

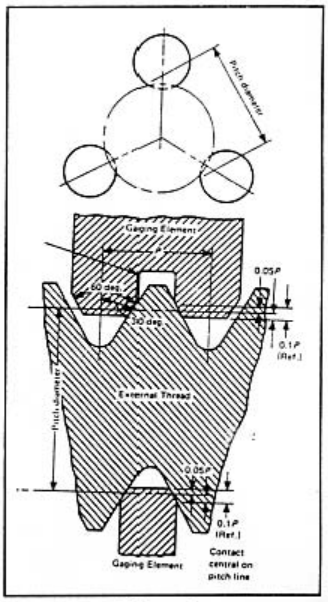


Figure 2.

It is generally thought that one is inspecting a fastener's "pitch diameter" when checking a screw or bolt with a ring gage. What is really being checked by this type of fixed limit gage is the fastener's "functional diameter."

This is so because one is checking the thread by determining if it will fit between the envelope boundaries established by the GO and NOGO gages. If the thread passes through the GO ring gage and does not enter the NOGO ring gage more than 3 turns then the thread is acceptable. If you will again look at the definitions, you will see that an envelope defines the "functional diameter." Once again, *a thread's "pitch diameter" is being evaluated when it is being measured at a single point: a thread's "functional diameter" is being evaluated when several consecutive threads are inspected or measured simultaneously.*

The functional diameter is the most important thread characteristic in determining if an external thread is going to fit with the corresponding internal thread. The "functional diameter" is really a thread's "functional characteristic." ANSI/ASME thread inspection Systems 21, 22, and 23, as well as Methods A, B, and C in MIL-5-7742 and MIL-5-8879, all require the inspection of this characteristic.

The "functional diameter" can be inspected in these systems by a variety of permissible gages. It can be inspected using fixed limit gages such as ring gages or variable gages such as segment or tri-roll gages equipped with multiple pitch gaging elements. All the gages designated in ANSI/ASME: B I.3M-1986 in columns A1, A2, B1, and B2 of Tables 1 and 2 are equally acceptable for inspecting the functional diameter.

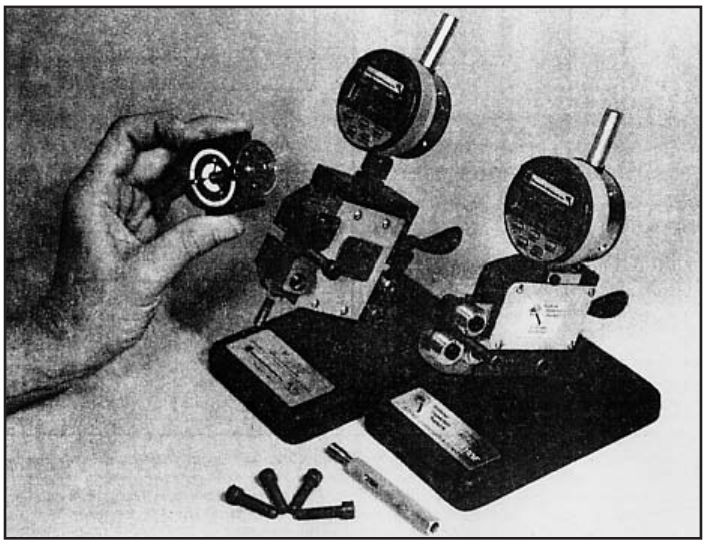
The ANSI/ASME B1 documents acknowledge that due to gage tolerances and the slightly different way that the different gages contact the product thread, some inspection discrepancies may occur from time to time. They state clearly in the two sections cited below that if one permissible, calibrated gage rejects a thread, but another permissible, calibrated gage accepts the same thread that thread is to be considered *acceptable*. The ANSI/ASME B1 documents state as follows:

> ANSI/ASME B1.2-1983, Section 2.2:
> "Product threads accepted by a gage of one type may be verified by other types. It is possible, however, that parts which are near limit may be accepted by one gage and rejected by another. *For these reasons, a product thread is considered acceptable when it passes a test by any of the permissible gages in ANSI/ASME B1.3* for the gaging system specified, provided the gages being used are within the tolerances specified in this standard."
>
> ANSI/ASME B1.3-1986, Section 6 (b): "Within each gaging system, a choice of gages is specified for each characteristic. *Acceptance by any one gage specified for a characteristic shall be the criterion for acceptance of that characteristic."*

The question frequently comes up, "If I use the pitch diameter chart to inspect the pitch diameter, what chart do I use to inspect the functional diameter?" Both thread characteristics are inspected to the dimensions shown on the same charts. The maximum and minimum limits for the pitch diameter and functional diameter come from the pitch diameter columns in ANSI/ASME B1.1-1989 for inch threads.

To add to the confusion on thread terminology the functional diameter is sometimes called the thread's "maximum material condition" and the pitch diameter is sometimes called the thread's "minimum material condition." These terms are interchangeable.

Remember, the thread's "functional diameter" is really its "functional characteristic." The thread obviously cannot function as an assembly component if it does not fit with its corresponding mating thread. The inspection and/or measurement of this crucial thread characteristic is essential for every fastener inspection program.



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