

## Gaging Systems Part 1: System 21

Oftentimes we get phone calls or E-mails asking for help determining how to measure fastener characteristics. Many times the print specifies a “Gaging System” that further confuses the customer because they are unfamiliar with that terminology and what it means. Others are familiar with the terminology, but are still unsure about the requirements and differences between the Gaging Systems. I’d like to help clarify what a “Gaging System” is as defined by the ASME B1.3 – 2007 standard, as well as explain the different Gaging Systems as it applies to product threads. These systems apply to both internal and external threads.

ASME B1.3 – 2007 is the foundation of “Gaging Systems”. Both the FED-STD-H28, as well as the SAE AS8879 standards, refer back to the ASME B1.3 standard for definition on gaging systems. Not only does it define the various systems, but also includes detailed charts on what gages are acceptable for each thread element to be measured. In this Article we will deal with the simplest of the them, System 21, and future articles will cover System 22, and System 23 in the same manner.

ASME B1.3 – 2007, Section 1 defines a gaging system as; “*a list of screw thread characteristics that must be inspected/evaluated to establish the acceptability of the screw threads on a threaded product and the gage(s) which shall be used when inspecting/evaluating those characteristics.*” In other words, what needs to be checked and what gage we need to use. The standard also states that a gaging system **SHALL** be defined, and if it is not the supplier and customer **MUST** agree on one. We all know that this does not always happen, but it is a good practice for a customer to be aware of these gaging systems and demand some kind of formal inspection procedure for the product they are purchasing.

When no system is defined, and no inspection is performed, you get folks after the fact asking whether there is a default procedure. Just to make it clear, there is no “default” procedure for an undefined inspection plan or Gaging System. ASME B1.3 – 2007, section 5(b) specifically states; “*There is no implied default gaging system*”. This is why it is important to work that out upfront, rather than assuming it will just get done.

There are various “standard” methods of defining a gaging system on prints, procurement documents, or purchase orders. Some examples are:

- A general note somewhere on the documentation. For example “Acceptability of screw threads shown on this drawing shall be determined based on System 21, ASME B1.3”
- The designation can be part of the thread description. For example, “ $\frac{1}{4}$ -20 UNC-2A(21)”, where the “(21)” indicates System 21 inspection.
- There are also cases where you may want a standard System 21 inspection, but you also want additional features like flank angle. In this case, you would use an “S” after the gaging system number and go onto define the extra features. For example, “ $\frac{1}{4}$ -20 UNC-2A(21S): Flank Angle.”

According to ASME B1.3 – 2007, section 4(1); “*System 21 provides for interchangeable assembly with functional size inspection/evaluation at the maximum material limit within the length of the standard gaging elements, and also inspection/evaluation of characteristics identified as NOTGO functional diameter or as HI (internal) and LO (external) functional diameters*”. The easy way to remember this is that System 21 only requires the use of fixed limit gaging, i.e. Pass/Fail or Go/NoGo gages.

The nice thing about the gaging systems is that acceptability is backward qualifying. By this I mean that if a product thread is acceptable using higher level inspections like System 22 or System 23 methods, then it automatically qualifies the product to meet System 21 requirements even though you did not use Go/NoGo gaging. For example if you are inspecting a nut per System 21 and you have the Go/NoGo work plug, but you don't have the Go/NoGo minor diameter plug. If you have an ID mic, you can use the ID mic to qualify the minor diameter to System 21. Let's get into the particulars now, and discuss the characteristics and appropriate gaging to be used.

**External Threads, ASME B1.3 – 2007, Table 3.** In this table you will find that System 21 requires the following features to be checked.

- GO Maximum material
- NOT GO Functional Diameter
- Major Diameter
- Minor Diameter (rounded root – UNJ, MJ only)

Next to each of the above characteristics you will find several gage numbers for Attribute/Fixed Limit and Variable/Indicating gages that are acceptable for inspection of the characteristic listed. To figure out what these gages are, you have to reference Table 1. In doing so, you will find that the acceptable gages for checking Go Maximum Material are:

- Go Threaded ring gage, split or solid.
- Go segments for a Thread Snap Gage
- Go rolls for a Thread Snap Gage
- Go segments for an indicating gage with 120 degree contacts
- Go segments for an indicating gage with 180 degree contacts
- Go rolls for an indicating gage with 120 degree contacts
- Go rolls for an indicating gage with 180 degree contacts

Note: Essentially you are evaluating the Maximum Functional Diameter using either a Go ring gage or variable type gage that will actually provide you with a Functional Pitch Diameter reading. Functional diameter meaning that you are evaluating a group of threads all at the same time including individual elements such as flank angle, lead, taper, etc.

For NOT GO Functional Diameter there are:

- Not Go Threaded ring gage, split or solid.
- Not Go segments for a Thread Snap Gage

- Not Go rolls for a Thread Snap Gage
- Go segments for an indicating gage with 120 degree contacts
- Go segments for an indicating gage with 180 degree contacts
- Go rolls for an indicating gage with 120 degree contacts
- Go rolls for an indicating gage with 180 degree contacts
- Pitch Micrometer with Modified Contacts (approximately pitch diameter contact) Cone and Vee.

Note: Essentially you are evaluating the Minimum Functional Diameter using either a NoGo ring gage or variable type gage that will actually provide you with a Functional Pitch Diameter reading. There are no “NoGo” segments or rolls which is why they are also listed as “Go”.

For Major Diameter there are:

- Maximum (Go) and Minimum (Not Go) Plain Cylindrical ring gages for Major Diameter.
- Major Diameter Snap Gage
- Indicating Plain diameter gages, major diameter type
- Optical Comparator and tool makers microscope with suitable fixturing
- Plain Micrometer and Calipers

Note: Essentially you are evaluating your Major Diameter either using Go/NoGo styles of gages, or just measuring it directly using optical or hard contact means.

For Minor Diameters (UNJ or MJ only) there are:

- Minor Diameter Snap Gage
- Minor Diameter Indicating Gage
- Optical Comparator and tool makers microscope with suitable fixturing

Note: Essentially you are using either optical means or some other type of hard gaging that will pick up on the minor diameter and not interfere with the helix angle of the fastener. The maximum minor diameter limit is acceptable when product passes Go gage on UN, UNR, UNJ, M, and MJ threads.

**Internal Threads, ASME B1.3 – 2007, Table 4.** In this table you will find that System 21 requires the following features to be checked.

- GO Maximum material
- NOT GO Functional Diameter
- Minor Diameter

The same concept applies here, there are gage numbers listed next to each feature, and these can be found in Table 2.

For Go Maximum Material there are:

- Go Threaded Plug Gage
- Go segments for an indicating gage with 120 degree contacts
- Go segments for an indicating gage with 180 degree contacts
- Go rolls for an indicating gage with 120 degree contacts

- Go rolls for an indicating gage with 180 degree contacts

Note: Essentially, you are checking the Functional Diameter using either a Go plug or some type of direct measurement gage that will evaluate multiple threads at the same time. The minimum Major diameter limit is acceptable when the product passes the Go gage.

For Not Go Functional Diameter there are:

- Not Go Threaded Plug Gage
- Go segments for an indicating gage with 120 degree contacts
- Go segments for an indicating gage with 180 degree contacts
- Go rolls for an indicating gage with 120 degree contacts
- Go rolls for an indicating gage with 180 degree contacts

Note: Essentially, you are checking the Functional Diameter using either a NoGo plug or some type of direct measurement gage that will evaluate multiple threads at the same time. There are no “NoGo” segments or rolls which is why they are also listed as “Go”.

For Minor Diameter there are:

- Minimum (Go) and Maximum (Not Go) Plain Cylindrical plug gage for minor diameter.
- Minor diameter type indicating gage
- Optical comparator and toolmakers microscope with suitable fixturing and cast replica.
- Linear measuring machine with required accessories
- Coordinate measuring machine with required accessories

Note: You are checking the minor diameter using either a go/nogo cylindrical plug gage, or some type of direct measurement gage.

System 21 measurements are the simplest and most commonly used Gaging System. A quick way to remember system 21 is to say that it requires pass/fail evaluation only, with no actual data. Should you not have pass/fail (Go/NoGo) gages for a particular feature then a direct measure style of gage is also acceptable.

System 21: External Threads



System 21: Internal Threads

