

Gaging Systems Part 2: System 22

Last issue, we covered System 21 Gaging Systems, and this time we are going to go a little deeper and cover System 22 requirements. I just wanted to recap on the definition of a gaging system according to the standards.

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.

According to ASME B1.3 – 2007, section 4(2): *System 22 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 the minimum material size pitch diameter or thread groove diameter over the length of the full thread. The cumulative effects of all other thread characteristics such as lead, flank angle, taper, and roundness variations are confined within product tolerance limits with no specific inspection/evaluation of their magnitudes.* The easy way to remember this is that System 22 involves variable gaging, or in other terms involves obtaining an actual number.

The most common products that require system 22 measurements are Socket Head Cap Screws defined in ASME B18.3, and Aerospace threads defined in SAE AS8879. A quick outline of what is required for external and internal threads are:

External threads:

- Pitch Diameter
- Functional Diameter
- Major Diameter
- Minor Diameter (UNJ only)
- Root Radius (UNJ only)

Internal Threads:

- Pitch Diameter
- Functional Diameter
- Minor Diameter

Let's look at each characteristic a little closer.

External Threads, ASME B1.3 – 2007, Table 3. In this table you will find that System 22 requires the following features to be checked. Under each feature the acceptable gages are summarized. These acceptable gages are detailed in table 1 of the standard.

- **GO Maximum material**

- Go threaded ring gage, split or solid.
- Go Rolls or Segments for Thread Snap Gages.
- Rolls or Segments for indicating gages with either 120 or 180 degree contact points.

Note: 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 incorporating individual elements such as flank angle, lead, taper, etc. Go Maximum material is one of the features in system 22 inspection/evaluation that can be done using a fixed limit gage.

- **Minimum Material (Pitch Diameter, Groove Diameter)**

- **Note: Not Go functional diameter is another option (i.e. nogo plug gage), but control of lead (including helix) and Flank Angle (over the length of the full thread) must also be demonstrated. This option is only acceptable by agreement between purchaser and supplier.**
- Thread Snap gages, minimum material, pitch diameter type (cone and vee), or groove diameter type (cone only).
- Thread indicating gages, minimum material, pitch diameter type (cone and vee) with either 120 or 180 degree contact points.
- Thread indicating gages, minimum material, thread groove diameter type (cone or best wire size radius profile) with either 120 or 180 degree contact points.
- Pitch Micrometer with Modified Contacts (approximately pitch diameter contact) Cone and Vee.
- Thread Measuring wires with suitable fixturing
- Optical Comparator and Toolmaker's microscope with suitable fixturing
- Linear Measuring Machine with required accessories
- Coordinate Measuring Machine with required accessories.

Note: You are evaluating the Minimum Pitch Diameter by isolating a single thread at a time and using either cone and vee contacts or a radiused contact that simulates "best wire". Simple Pitch Diameter has also been used to describe this feature. An actual value is required for this characteristic.

- **Major Diameter**

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

Note: You are evaluating the Major Diameter either using Go/NoGo styles of gages, or just measuring it directly using optical or hard contact means. Major Diameter is another feature in system 22 inspection/evaluation, that can be done using a fixed limit gage.

- **Minor Diameter (rounded root – UNJ, MJ only)**

- Minor Diameter Snap Gage
- Maximum and Minimum minor diameter Snap gage
- Minor Diameter Indicating Gage
- Optical Comparator and tool makers microscope with suitable fixturing
- Linear Measuring Machine with required accessories
- Coordinate Measuring Machine with required accessories.

Note: 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.

- **Root Profile (UNJ, MJ only)**

- Optical Comparator and tool makers microscope with suitable fixturing
- Profile Tracing equipment with suitable fixturing
- Coordinate Measuring Machine with required accessories.



Typical External Variable Thread Gage – “Tri-roll” gage

Internal Threads, ASME B1.3 – 2007, Table 4. In this table you will find that System 22 requires the following features to be checked. Under each feature the acceptable gages are summarized. These acceptable gages are detailed in table 2 of the standard.

Note: An internal thread smaller than a #10 or M5 is not required to be evaluated/inspected by system 22 gaging. SAE AS8879, Table 8 states; *For internal threads of nominal size less than .1900 inch, only the functional diameter limit and minor diameter limit inspections are to be performed.* ASME B1.2 states; *Internal product threads less than 3/16 in. in diameter are not practical to check with snap gages or indicating gages.*

- **GO Maximum material**

- Go Threaded Plug Gage (Full form Go plug gage for MJ only).
- Go Rolls or Segments for an indicating gage with 120 or 180 degree contact points.

Note: 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 plug gage.

- **Minimum Material (Pitch Diameter, Groove Diameter)**

- **Note: Not Go functional diameter is another option, but control of lead (including helix) and Flank Angle (over the length of the full thread) must also be demonstrated. This option is only acceptable by agreement between purchaser and supplier.**
- Thread indicating gages, minimum material, pitch diameter type (cone and vee) with either 120 or 180 degree contact points.
- Thread indicating gages, minimum material, thread groove diameter type (cone or best wire size radius profile) with either 120 or 180 degree contact points.
- Pitch Micrometer with Modified Contacts (approximately pitch diameter contact) Cone and Vee
- Thread Measuring balls with suitable measuring means
- Linear Measuring Machine with required accessories
- Coordinate Measuring Machine with required accessories.

Note: You are checking the Pitch Diameter, by isolating a single thread at a time and using some type of direct measurement gage. An actual value is required.

- **Minor Diameter**

- Full Form Go Thread Plug (MJ only)
- 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.



Typical Internal Variable Thread Gauge – “Bi-Point” gage

System 22 measurements require more than just pass/fail results, some characteristics require a numerical value. Remember that the lists of gages above are all the acceptable forms of gaging that can be used to check a characteristic. Acceptance by any one gage in current calibration specified for a characteristic shall be the criterion for acceptance of that characteristic.