Dr. Fastener

Questions about Thread Gaging

Dr. Fastener: Thread gaging is one of those subjects that is often misunderstood and misapplied. Following are some common questions and answers related to this subject.

Q: I was reviewing the Socket Cap Screw standard ASME B18.3 and came across the note, "For plated or unplated screws, acceptability shall be based upon System 22, ASME B1.3"- what does it mean that we should accept the threads to System 22?

A: Hopefully this does not get too complicated. ASME B1.1 and 1.13M define and describe the dimensions and form of inch and metric screw threads. Essentially, both internal and external threads can be completely defined by 10 different characteristics. ASME B1.2 provides guidance regarding the appropriate gages to verify those characteristics. Finally, ASME B1.3 is the ASME standard that describes the gaging systems that can be used to accept inch and metric threads types UN, UNR,UNJ,M, and MJ. All these standards work together to provide a cohesive set of instructions on what one must do to properly make and then gage (or verify) the threads they just made.

Understanding that these documents work together, let's go back to the question, "what is System 22"? ASME B1.3 defines different approaches that one can take to verify thread quality. Now remember, there are ten different characteristics we could check. Doing so is possible but usually not feasible, as it takes a lot of time and access to some special, often quite costly, gages. Additionally, not every characteristic is usually necessary to be evaluated, but only those characteristics that are most important to the end use. So, the authors of ASME B1.3 developed three (3) different approaches that can be taken to verify a thread depending on how critical the thread quality is to the application and how deeply one wants to look at it. The three different approaches are identified as "systems": System 21, System 22, and System 23.

System 21 is easily the most common thread gaging practice employed worldwide. It is simple and quick, which makes it particularly attractive to high volume fastener manufacturing. System 21 is defined as "providing interchangeable assembly with functional size inspection/evaluation at the maximum material limit within the length of standard gauging elements, and also inspection/evaluation of characteristics identified as NOT GO functional diameters…" That is a mouthful and probably confusing to some readers, so let's unpack it… As the standard says the selection of the gaging is a function of the characteristics important to end use. In this case, it describes a method that evaluates whether the thread should assemble when applied in the field. For this, the method essentially defines the use of attribute gages. These are commonly referred to as GO/NOT GO gages and simply verify that the characteristic falls within the acceptable specified zone. So, **for System 21, external threads are evaluated with a GO gage for maximum material, NOT GO gage for Functional Diameter, and a caliper or micrometer for Major Diameter. Internal threads are evaluated with a GO gage for maximum material, NOT GO gage for Functional Diameter, and usually a GO/NOT GO unthreaded pin gage for the Minor Diameter.**

System 22 is generally employed when more precision is desired in evaluating the thread. It adds a variable evaluation of the Pitch Diameter. Therefore, to evaluate an external thread, one checks the Pitch Diameter, Functional Diameter, and Major Diameter. This would typically be accomplished with some combination of Indicating gage for Pitch Diameter, indicating gage or NOT GO ring gage for the Functional Diameter, and caliper or micrometer for the Major Diameter. Internal threads are a similar story with evaluation by an indicating gage for the Pitch Diameter, indicating or NOT GO gage for the Functional Diameter, and usually a GO/NOT GO unthreaded pin gage for the Minor Diameter.

System 23 requires evaluation of all characteristics. Since this is such a monumental task, this system is intended to only be employed for experimentation or, perhaps, validation.

Q: If I don't have an indicating gage can I just use an attribute gage to validate the Pitch Diameter for System 22?

A: No, as explained above, System 22 requires a variable measurement for the Pitch Diameter over the length of one full thread. This is not possible with either a threaded ring gage or threaded plug gage. If you did not have an indicating gage you could investigate ASME B1.2 for other acceptable gage methods such as measuring over pins. However, other methods may be much more time consuming to execute.

Q: What are the proper gages to use for evaluating a plated Class 2A externally threaded part?

A: Without going into great detail, "Class 2" tells us the intended fit for the part. Class 2 is the most common fit class for inch externally threaded

fasteners and contains what is known as the "Accommodation". This means that before plating the maximum Pitch Diameter tolerance does not come all the way to the Basic Pitch Diameter for whatever size part is being evaluated. This is intentional and, if properly executed, allows the manufacturer to lay down a layer of plating or coating without exceeding the Basic Pitch Diameter. However, the plating or coating does increase the Pitch Diameter so that the GO gage for before plating is no longer valid after plating. As such, **when evaluating Class 2A parts to System 21, the proper gaging method is to evaluate using a GO and NOT GO 2A ring gage for before plated parts and a 3A GO ring gage and 2A NOT GO ring gage for after plated parts.** Interestingly, several years ago, the former Technical Director of the IFI and fastener expert, Joe Greenslade, shared with me that misunderstanding of this transition between proper gages was the most frequently asked technical question that he had to routinely field.

Q: How far do you have to engage the threaded GO gage?

A: ASME B1.2 instructs that for externally threaded product the GO ring gage must pass over the "entire length of the threaded portion" and that for internally threaded product the GO threaded plug gage must "pass through the full threaded length of the product."

Q: The standard says that the gages must "freely" pass over or through the length of the part. What does "freely" mean?

A: This is one of those areas that the standards sort of let us down, for how does one really interpret "freely"? In other words, one person might accept some degree of resistance in the gage as "freely" as long as it is still turning while another person might interpret any resistance as not "freely" turning. I believe this is one of those instances where you must use some common sense. On one hand, the standard does not say "free spinning" which suggests no resistance, while on the other hand, clearly if you have to use all of your might and your face is turning red trying to get the gage to advance, it is not freely turning. But there is probably some middle ground where feeling a little resistance while the gage is still freely advancing is acceptable. If in doubt, perhaps engaging a third party or simply having the conversation with your customer will resolve the issue.

Q: What if I have nicks on the external threads that are preventing the GO Ring Gage from freely advancing?

A: This is a common problem and one recognized throughout the industry. As a result the standards organizations have either issued standards specific to this problem or included this in a section of a quality standard allowing the evaluator to apply a low level of torque to the gage. There are specified torque values that follow a defined equation for each diameter size. If the obstruction is a nick, the torque will be enough to advance the gage past it but not enough to compromise the subsequent installation behavior of the screw. **Standards that address this issue include ISO 6157-3, Din 276 Part 19, IFI 166/566, and ASTM F788/788M.**

Q: What is the rule for using the NOT GO gage?

A: As the name suggests a NOT GO gage is not supposed to advance through a part. **ASME B1.2 instructs that the NOT GO ring gage or threaded plug gage is supposed to advance no more than three full rotations. Anything past that is considered a failure.**

Q: What is the difference between W and X tolerances?

A: W tolerances represent the highest grade of accuracy and workmanship and are intended for setting gages. X tolerances are larger than W tolerances and are intended for product inspection gages. **Unless the specification or customer specifies things differently, all thread gages that directly check parts use the X tolerance scheme.**

Q: How often should we be calibrating Ring Gages?

A: There is no single definitive answer to this question. Calibration frequency is usually a function of a number of variables including how much a gage is used, the environment it is used in, and how prone it is to "wander" from calibration. Some gages are calibrated as frequently as every day while others may go every year or two. If the ring gage is used a lot, a prudent calibration period may be every six months while gages used less frequently can probably be on an annual cycle.

Remember that regardless of the specified calibration frequency there are times that warrant immediate attention. Any time a gage is dropped or damaged it should be evaluated to determine if it needs recalibration. Likewise, if there is any question about whether it is working properly, it should be evaluated and recalibrated if necessary.

Q: Is it difficult to calibrate a ring gage?

A: Many organizations choose to send their gages out for calibration to a third-party expert that specializes in gage calibration. Their rational is often that it is simpler to let the experts do it and to not have to stock all the setting plugs. However, other organizations choose to do this in-house and train individuals to become specialists. IFI-301 goes through the procedure for calibrating threaded ring gages.

Q: If my acceptable gage method passes a part and my customer's accepted gage method fails the part- should the parts be rejected?

A: **According to ASME B1.2 if one party uses a gage and method that are acceptable under ASME B1.2 and ASME B1.3 and finds the part acceptable and a second party, also using an acceptable gage and method, find the part unacceptable- the parts are to be accepted.**

Dr Fastener: In conclusion, thread gaging is one of those areas that is often confusing to individuals. Individuals tasked with executing and defending evaluations should become familiar with the thread gaging standards, such as ASME B1.2 and 1.3. These standards are a wealth of information and address the issues covered in the questions above and more. ■

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