Force Calibration Safety: Three Threads Was Not Enough

A case study in verified thread engagement and tension calibration safety

Setting up a tension calibration is often treated as a simple bolt-together step: connect the unit under test to the machine, thread the connection, and begin applying force. The working assumption is that if the threads engage at all, the connection is ready to load. A recent field incident shows why that assumption fails, and what a documented, verified installation actually requires.

A customer's tension calibration in a 200 000 lbf (890 kN) machine separated when a threaded connection let go under load. Only three complete threads were engaged where the adapter's design required full engagement. The internal threads stripped and the connection released, sending everything above the failure point apart at once. Nobody was hurt. The customer shared photos of the failure with equipment identifiers removed, because the failure was preventable and the lesson generalizes to any tension load path.

Reviewing the setup with the customer surfaced the same pain points that show up on nearly every under-engaged tension connection:

- The connection looked normal from the outside right up to the point of failure — three engaged turns look much like thirty, so appearance alone cannot confirm engagement.
- No documented installation check — turn count, witness mark, or depth gauge — existed to catch the partial engagement before force was applied.
- A rule of thumb (engagement near one nominal thread diameter) was available for reference, but it is not a universal minimum and is not a substitute for the adapter's documented design requirement.
- The rated capacity applies to the complete adapter installed as specified; it cannot be scaled down by the fraction of threads engaged, so the actual safe capacity of the partially engaged connection was unknown.

Morehouse examined the failed hardware and the setup with the customer to establish exactly what went wrong and to quantify what verified engagement requires on a connection of this type.

PARTIAL ENGAGEMENT, NOT OVERLOAD, CAUSED THE FAILURE

The adapter drawing for this class of connection calls for 2.500 in (63.5 mm) of engagement on a 2.500-12 UN thread. At 12 threads per inch, that is thirty full turns (2.500 in × 12 = 30 turns). Three full turns provide only 0.250 in (6.35 mm) of engagement — 10 % of the specified depth. That 10 % figure describes engagement depth only; it is not a 10 % capacity rating. The safe capacity of a partially engaged connection is unknown, because load distribution, material properties, thread condition, and alignment all factor into the actual strength of the joint. The stripped internal threads recovered after this failure are consistent with a connection carrying load well outside its designed engagement.

WHY A TENSION FAILURE RELEASES WITHOUT WARNING

A tension setup under load behaves like a coiled spring. The machine frame, tension members, adapters, and unit under test are stiff, but they still stretch elastically as force increases, storing energy throughout the load path. A tensile failure is more explosive than a compressive one because pulling a material apart lets existing micro-cracks widen and release accumulated strain energy at once; a compressive failure instead closes internal flaws and forces the material to slowly yield, crumble, or deform before breaking. When a threaded connection strips or disengages under tension, components can separate along the load line with little warning, and adapters or fixtures can become projectiles. That is why engagement must be verified before loading rather than judged by appearance: is the setup appropriate for the instrument and force range, is every threaded connection installed to the required depth or seating condition, and have the threads, adapters, and alignment features been inspected? In this incident, the answer to at least one of those questions was no.

AN ENGAGEMENT ERROR ALSO COSTS ACCURACY

Thread engagement is a safety issue first, but it is also a measurement issue. Engagement depth and seating condition change the load path and strain distribution inside many force instruments. Morehouse testing has shown output changes ranging from hundredths of a percent to more than 0.5 %, depending on the load-cell design, adapter, and installation condition. On an instrument with a 0.1 % of full-scale specification, an engagement change can consume or exceed the entire tolerance. Calibration data only transfers to the field if the laboratory installs the adapter the way the end user does — replicating and documenting the engagement or seating condition keeps that link intact between the calibration certificate and the instrument in service.

THE MOREHOUSE IMPACT

The review gave the customer a documented cause for the failure and a repeatable way to prevent a recurrence. Four actions carry the most weight for any tension setup:

1. **Verify engagement before loading, every time.** Convert the required depth to full turns (threads per inch × required engagement) and confirm it with a witness mark, depth gauge, or fixed installation stop — never judge engagement by appearance.
2. **Treat rated adapters as complete assemblies.** The rated capacity applies to the adapter installed exactly as designed. Do not infer a reduced capacity from partial engagement, and do not substitute unqualified bolts or shop-bin hardware for calibration adapters.
3. **Inspect the threads before every setup.** Reject galling, flattened crests, cross-threading, corrosion, or debris, and confirm that fully formed threads — not just the lead-in threads — are engaged.
4. **Follow the documented procedure for the machine itself.** Morehouse's own tension-setup instructions carry the same requirement for its Universal Calibrating Machines: any fasteners used with tension members must be fully engaged before loading. See the Universal Calibrating Machine (UCM) Manual (PM-5201, Rev. 4/2025), §4.3 Tension Setup.

SAFETY CONSIDERATIONS

The customer in this story was fortunate: damaged hardware, a stopped lab, and a set of photographs. A sudden tension release at even a fraction of machine capacity can cause severe injury or death, so the controls below apply beyond this one incident:

- **Keep people out of the load line.** Establish an exclusion zone and use guards or shields where practical. A purpose-built safety cage, like the Morehouse safety cages designed for calibration machines, contains the hardware if a connection lets go under load. Nobody should stand above, below, or directly in line with a loaded tension connection.
- **Keep the force axial.** Use self-aligning tension members, clevises, and proper adapters so bending and torsion stay out of the connection.
- **Do not improvise with reducers.** A purpose-designed, rated reducer may be acceptable; an unqualified stack of bushings and adapters adds interfaces, reduces control of engagement, and can worsen alignment.
- **Replicate and document.** Record the adapter, engagement depth or turn count, seating condition, and any locking method so the setup can be reproduced at the next calibration.

FORCE CALIBRATION SAFETY SOLUTIONS BY MOREHOUSE

Force calibration safety starts before the first force is applied. Walk out to your machine this week and inspect every tension connection: verify the adapters, count the turns or check the witness marks, and confirm that each connection is installed as designed. If you are unsure which adapters your machine and instruments need, or whether your machine should have a safety cage, contact Morehouse at (717) 843-0081 or sales@mhforce.com. We will help match the adapter, thread, engagement, alignment method, and guarding to the application.