



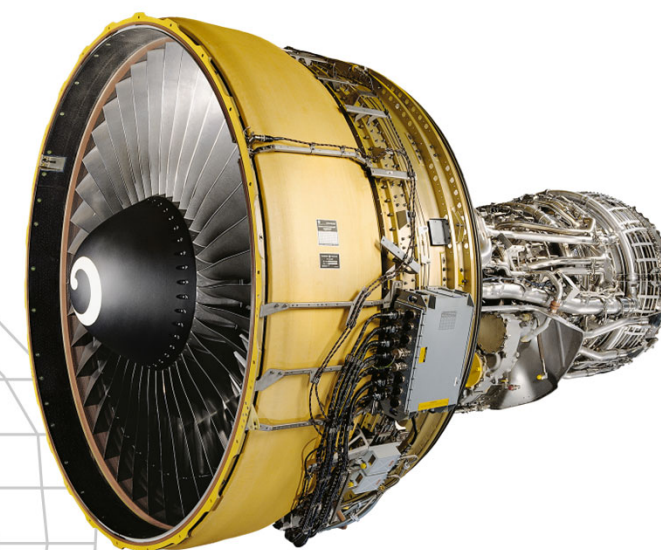
Metallurgical Investigation Report

DRB: AvEng-561264.A

**EVALUATION OF A CF6-80C2 ESN 707-605 HMU IDLER
ADAPTER FROM ESN 707-605 OPERATED BY FEDEX
INVOLVED IN AN IN-FLIGHT SHUT-DOWN AND
UNDERCOWL FIRE EVENT**

Part Number: 9395M78G10
Part Serial Number: FIA217EE
Part TSN / CSN: 1,421 hrs / 728 cycles

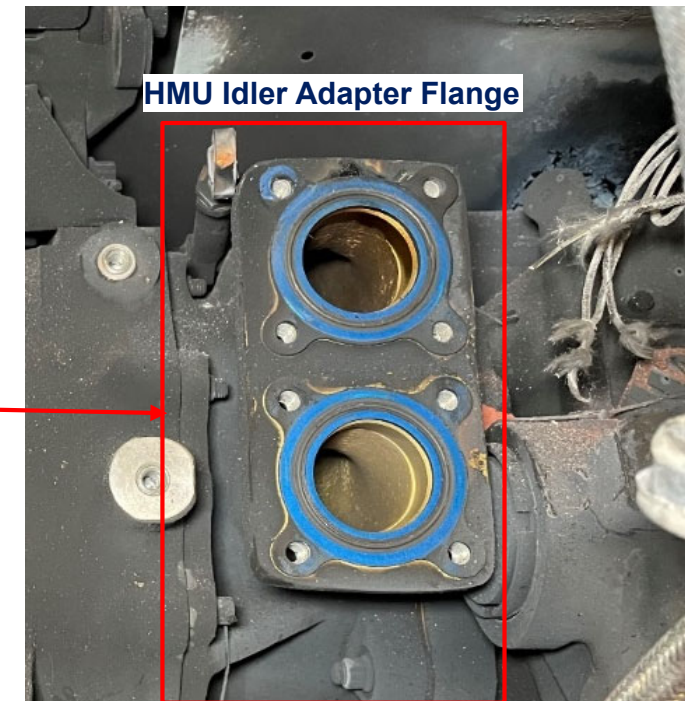
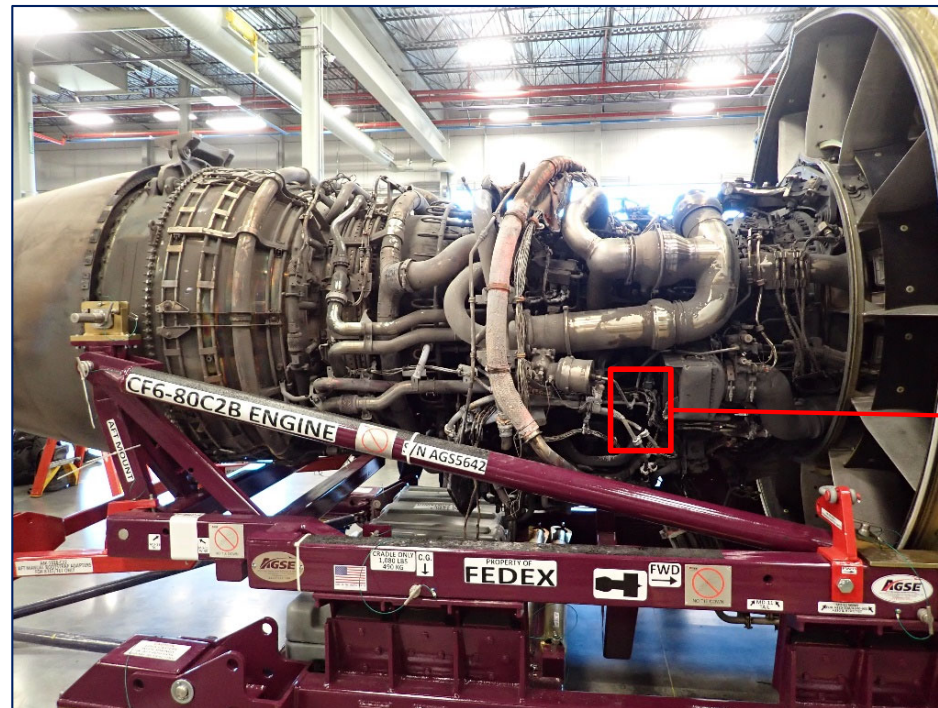
Date: 10/4/2024



Export Classification: NLR, 9E991.A

Background

- On 10/18/2023, a CF6-80C (ESN707-605) with 1,421 hours and 728 cycles operated by FedEx experienced an In-Flight Shutdown (IFSD). The pilots reportedly heard a loud bang followed by the engine fire light and warning bell from an under-cowl fire. Initial post-flight inspection performed in Memphis, TN found severe fire damage on the engine externals and a fractured main fuel pump. Follow-on engine tear down and inspection at GE Celma found a blown gasket seal on the HMU idler adapter. Views of the HMU Idler Adapter and the flange of interest are shown in Figures 1-3. The main fuel pump was sent to Collins Aerospace for metallurgical evaluation. The HMU idler adapter, tubes, and gasket seals were sent to the GE Evendale failure analysis lab for metallurgical evaluation (descriptions in Figure 4).



Background: Images from the post-flight on-site investigation

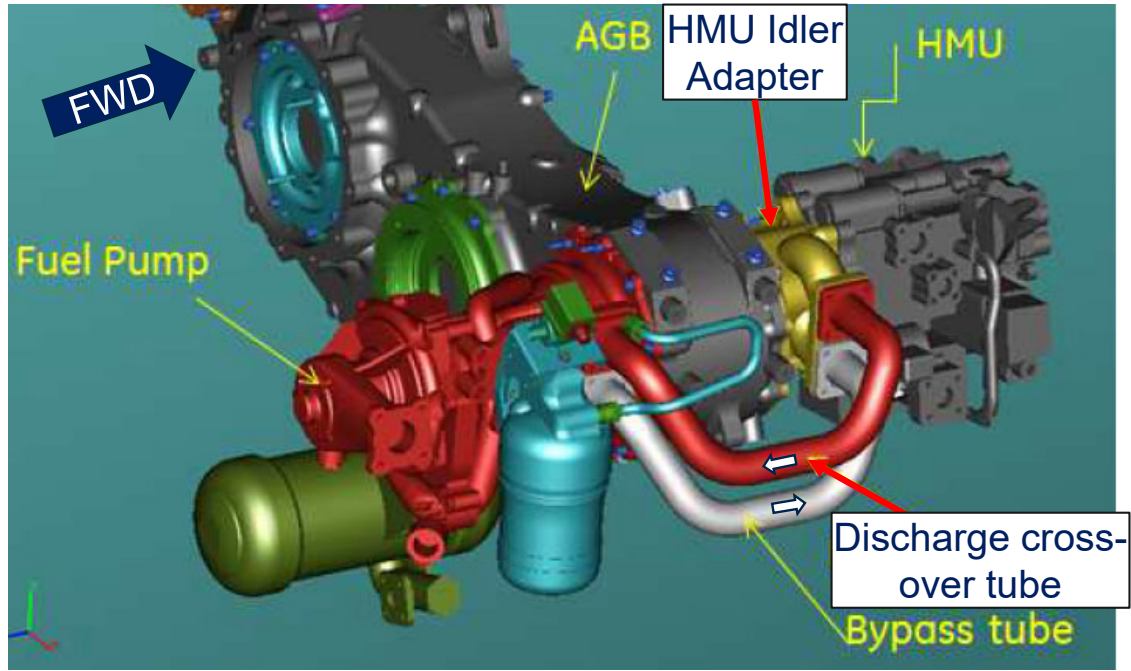
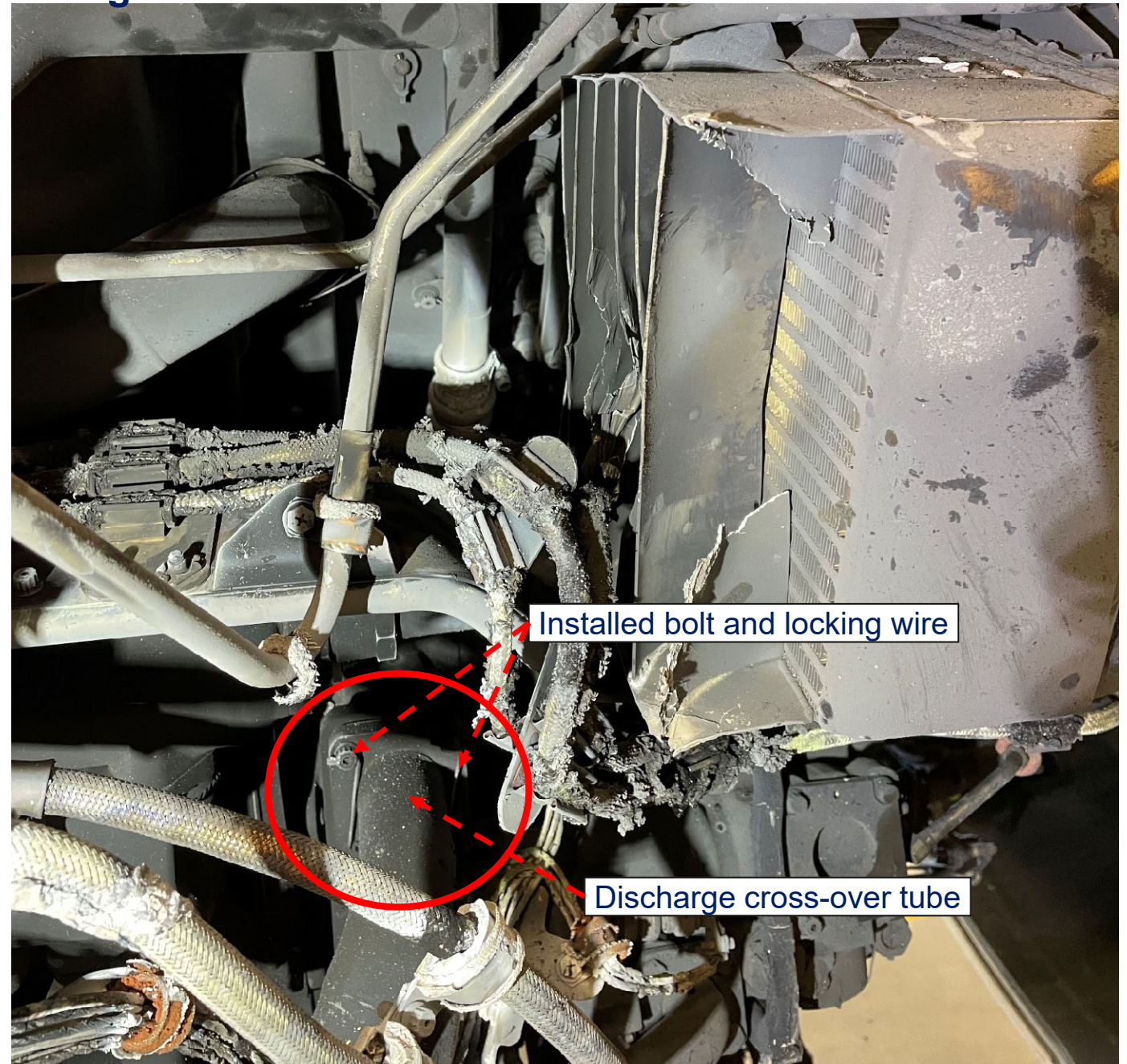
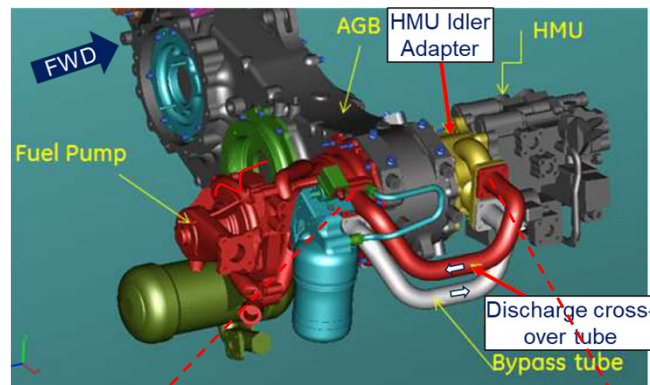


Figure 1: Left: A 3D model shows the assembly of the fuel pump (red) and HMU idler adapter (gold). The fuel pump sits aft of the Accessory Gearbox (AGB) and the HMU idler adapter sits forward of the AGB. A discharge cross-over tube (red) is attached by 4-bolt flanges to the fuel pump and HMU idler adapter. **Right:** an image captured during the on-site investigation shows the HMU idler adapter discharge cross-over tube flange. The top-left bolt and both locking wires are shown present. No bolts were found missing during disassembly.



Background: Images from the post-flight on-site investigation



No soot

HMU Idler adapter discharge cross-over tube flange



Gasket seal retainer flange deformed

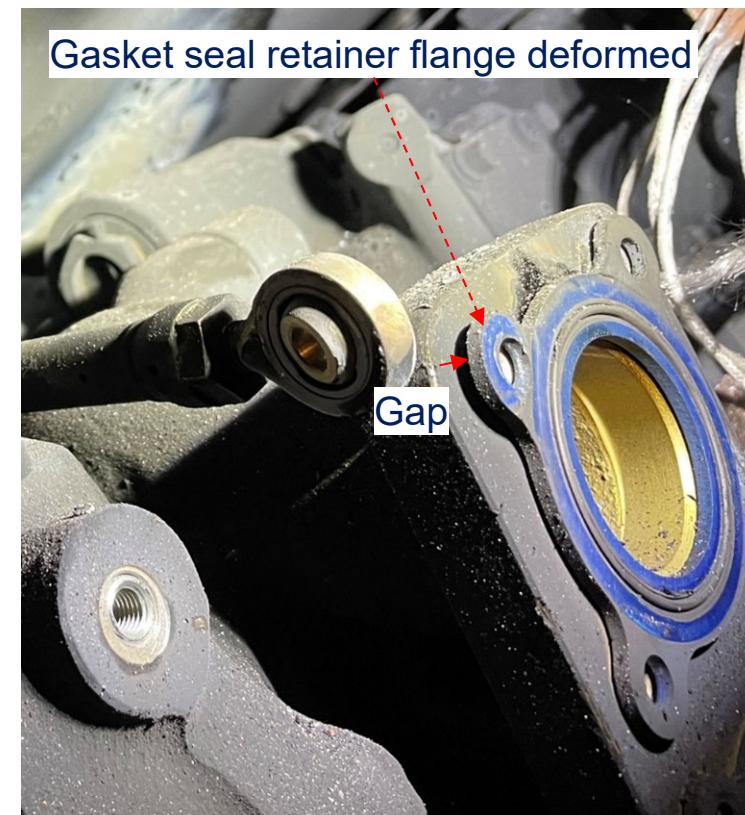


Figure 2: Images taken after the discharge and bypass tubes were removed, revealing the gasket seals (P/N 1453M60P04) that are assembled between the cross-over tube flange and HMU idler adapter flange surfaces . Most of the area is covered in black soot from the engine fire. Some areas of the gasket seal retainers are not covered in soot and are visually blue, consistent with these areas contacting the cross-over tube flanges during the fire. The top left tab of the aluminum gasket seal retainer is deformed outboard relative to the idler adapter flange surface.



Background: Images from the engine teardown performed at GE Celma

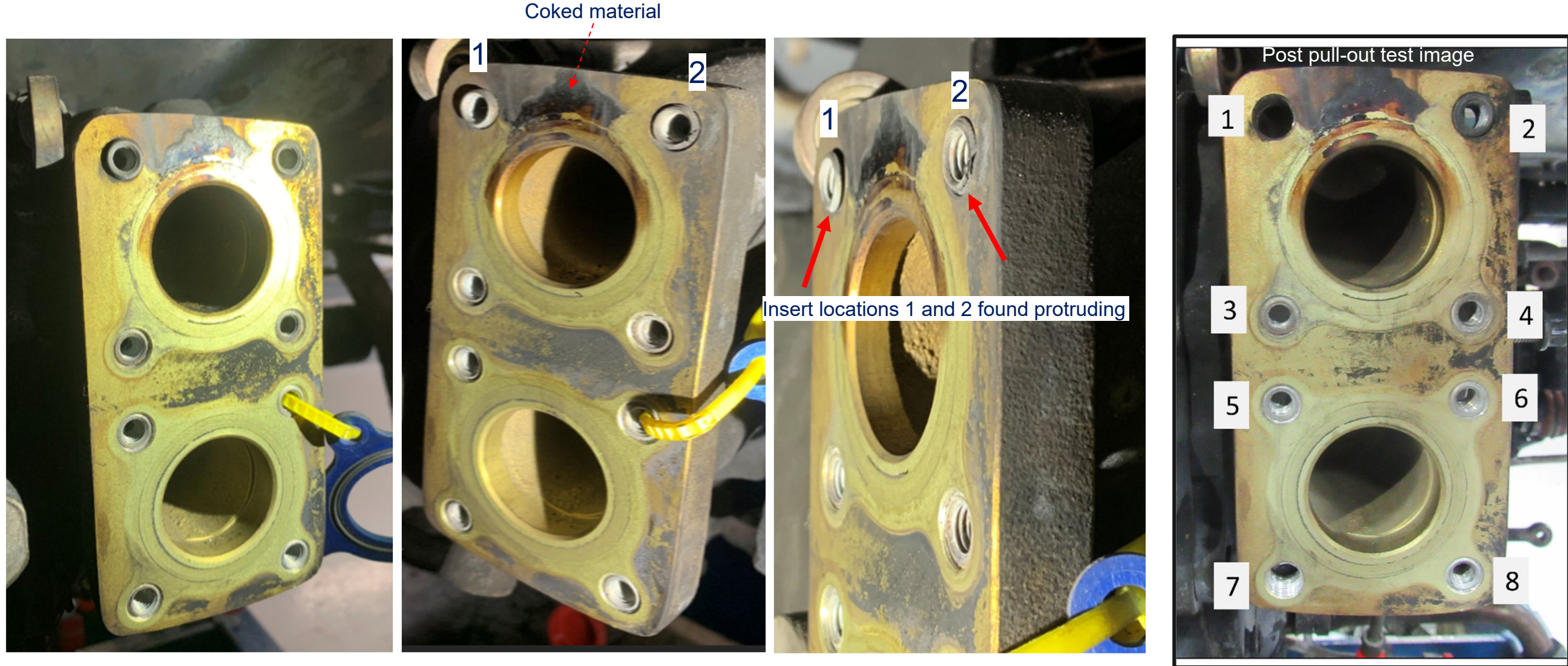


Figure 3: Images of the HMU idler adapter taken at GE Celma prior to the thread insert pull-out tests. The black soot has been removed from the flange surface. Coked fuel is observed on the top portion of the flange, consistent with fuel leaking in this area. The position 1 and 2 thread inserts were found protruding above the flange surface. No other thread inserts were found protruding.

Part	PN	Material Spec	Material
HMU Idler Adapter	9395M78G10	AMS 4219 (Be .00-.07%)	A357-T6 Aluminum Casting
Self-tapping Thread Insert	1518M34P02	AISI 11L17 or SAE1117	Case Hardened Carbon steel (Zn plated)
Gasket Seal	1453M60P04	Retainer: AMS4027 Seal: AMS7276	Retainer: 6061-T6 Al alloy Seal: Fluorocarbon rubber
Top Tube, Pump-Fuel to Main	1872M82G01	AMS 5581 Type 1	Ni alloy (tubes)
Top Tube Flange, Swivel	1508M96P01	AMS 5666	Ni alloy (rings)

Figure 5: Table describing the parts received by the Evendale failure analysis lab.



Summary



Summary

- Metallurgical evaluation of the event engine HMU idler adapter (S/N FIA217EE) found the steel self-tapping **thread inserts** in three locations (labeled in this report as insert locations 1, 2, and 3) **did not have parent metal thread engagement** in approximately 70% of the hole depth, reducing the pull-out capability and allowing insert locations 1 and 2 to pull out above the flange surface. The adjacent aluminum **gasket seal retainer tab at location 1 was mechanically deformed outboard** by approximately 0.064-inches and has contact marks matching the size and shape of the thread insert, consistent with being pushed outboard by the protruding insert. Evaluation of the gasket seal found an approximately 70-degree section of the **rubber seal was ruptured** at the 12:00 o'clock location. Coked fuel is observed on the flange surface outside the sealed area at the same 70-degree location, consistent with **fuel leaking** in this area. Due to the protruding inserts not being found until after the discharge cross-tube disassembly, the leak gap was not measured.
- During the investigation it was found that the holes were manufactured with a non-conforming pre-tapped hole operation vs. a through-hole (Figure 5). Additional evaluations were performed on four Return To Vendor (RTV) HMU idler adapters that were manufactured using the same non-conforming pre-tapping operation at the same manufacturer – Avio (Figure 6). Table 1 below shows the insert locations that were found without thread engagement in CT scans for each returned part. Destructive analysis showed the areas with missing threads had **angled cut lines out of phase with the original pre-tapped threads and were missing the anodized layer, consistent with the self-tapping steel thread inserts cross-threading and cutting out the aluminum pre-tapped threads during installation**. The inserts were held in place by approximately two threads at the bottom of the hole where the pre-tap operation did not reach, and the self-cutting inserts were able to cut threads. No retained material was found in the areas with missing threads, consistent with the material exiting the three debris holes that are a design feature in the self-tapping inserts. Comparison of the RTV with the event engine holes 1 and 2 showed similar findings (Figure 7).

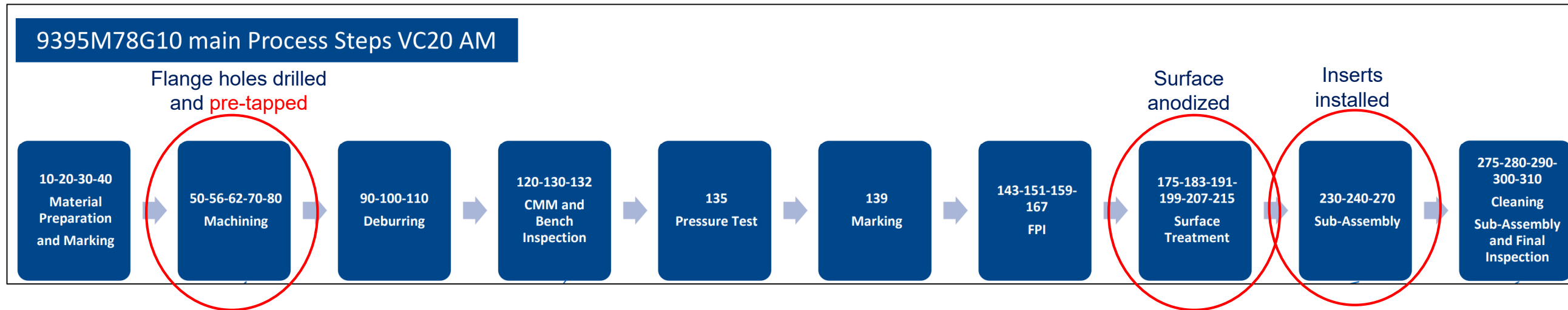
Table 1: RTV CT Scan Summary

	SN FIA217EE (Event Part)	<u>SN FIA217C9</u>	<u>SN FIA231MR</u>	<u>SN FIA23K9F</u>	<u>SN FIA1YN6T</u>
Insert #	CT Scan Thread Engagement				
1	No	Yes	No	Yes	Yes
2	No	Yes	No	Yes	Yes
3	No	No	No	Yes	Yes
4	Yes	Yes	No	Yes	Yes
5	Yes	Yes	No	Yes	Yes
6	Yes	Yes	No	Yes	No
7	Yes	Yes	No	Yes	No
8	Yes	Yes	No	Yes	No



Summary: Non-conforming pre-tap operation

Figure 5: HMU Idler adapter main process steps taken from the Avio Gemba walk report. The event HMU idler adapter (S/N FIA217EE) is part of a population that received a non-conforming thread pre-tap during the machining step to assist in insert alignment. Approximately 60-70% of the hole depths were tapped. A surface anodize step occurs after the holes are drilled and tapped. The image below shows an example of a conforming, drilled thru-hole required by the part drawing, and an example of the non-conforming pre-tapped hole that was used for all insert locations on the event HMU idler adapter flange.



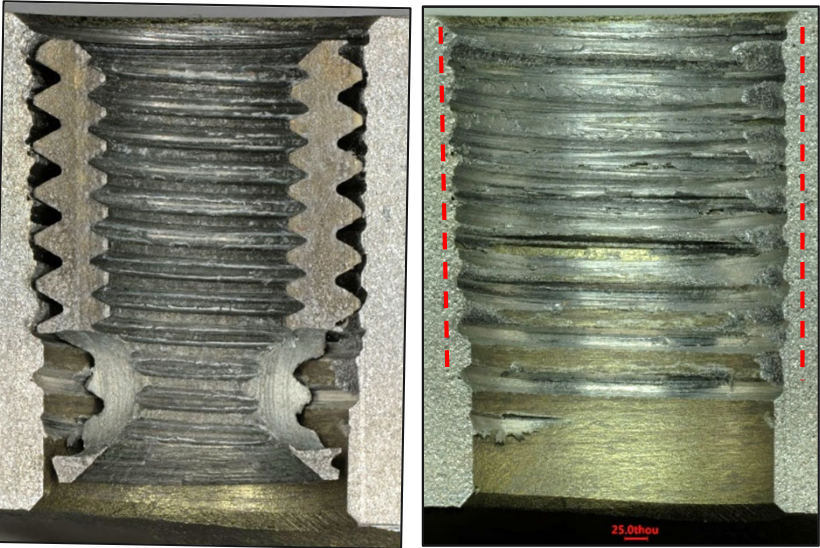
Example of a **non-conforming pre-tapped hole** with internal threads

Example of a **conforming drilled thru-hole** without internal threads

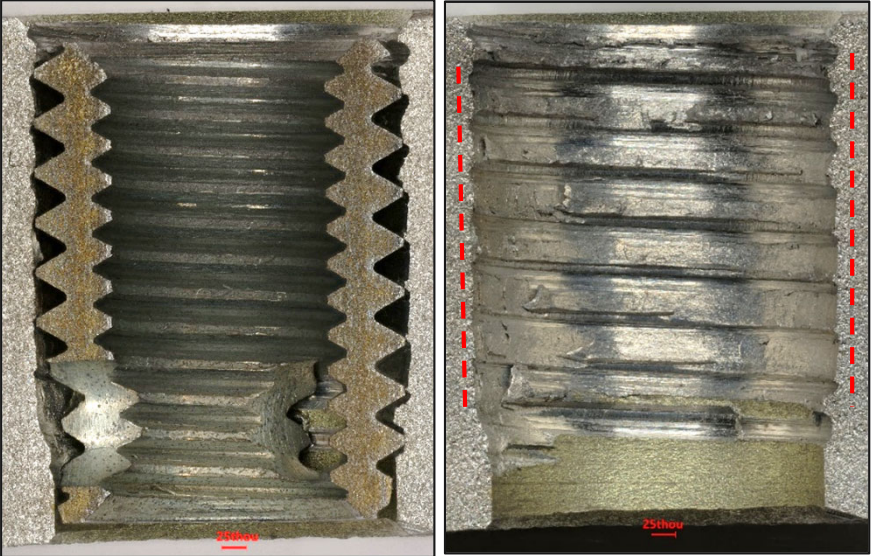


Return To Vendor (RTV) Idler Adapter Evaluation Summary

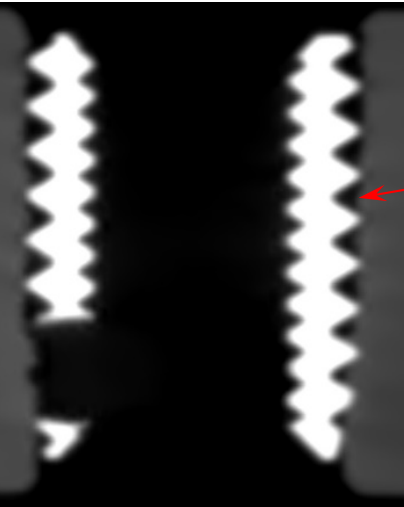
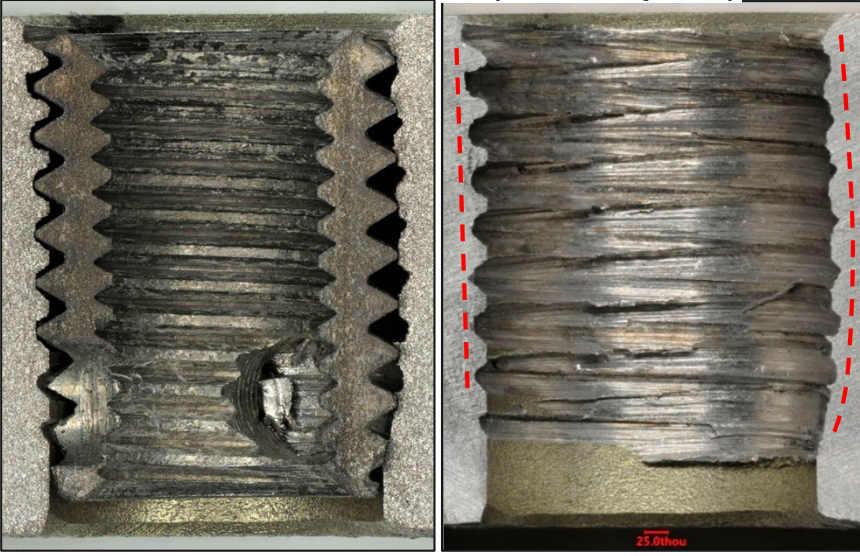
RTV S/N FIA231MR Hole 5 (Insert in place)



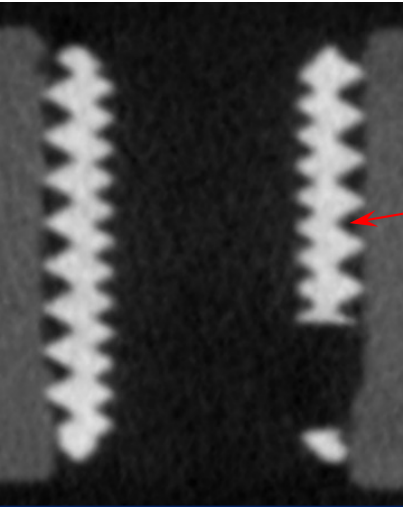
RTV S/N F1A1YN6T Hole 7 (Insert in place)



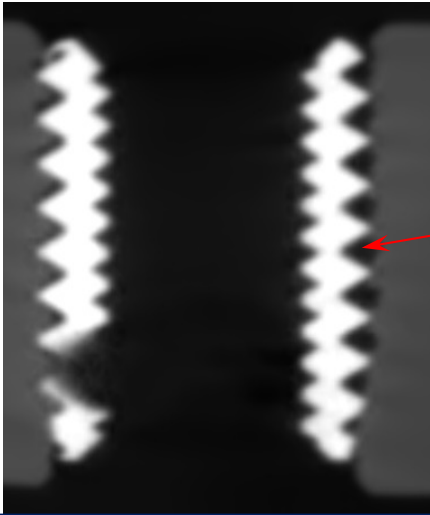
RTV S/N FIA217C9 Hole 3 (Insert in place)



Lack of threads



Lack of threads

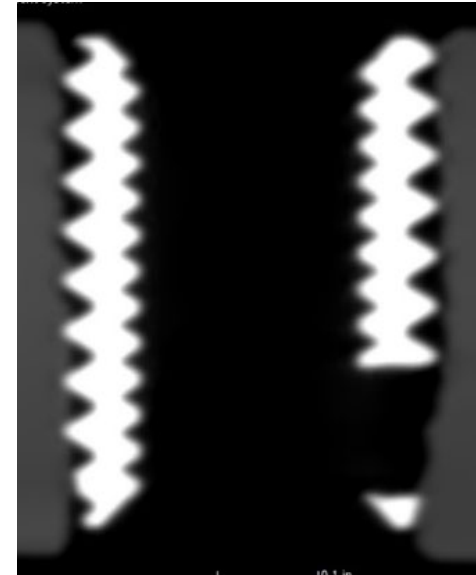
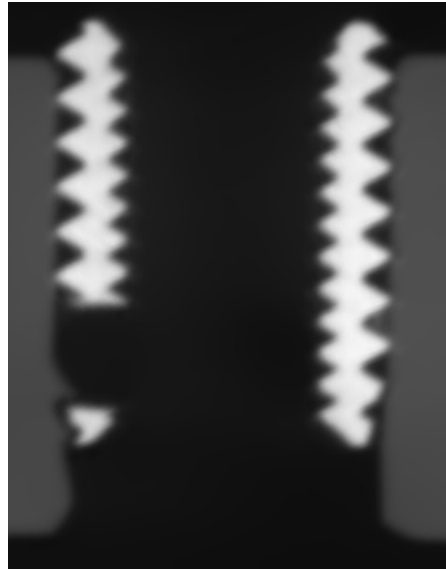


Lack of threads

Figure 6: Side-by-side comparison of the insert holes of three Return To Vendor (RTV) parts (SNs FIA231MR, FIA1YN6T, and FIA217C9) that showed a lack of thread engagement in the CT scans. These inserts did not have a pull-out test performed so the inserts are in the undisturbed manufactured positions. All three insert locations have similar findings of no remaining thread debris, crossed cut lines, and missing anodized layer. Detailed analysis for each S/N can be found in the appendices.



Event Engine FIA217EE
Hole 2 (Insert pulled out)



RTV FIA231MR
Hole 7 (Post Pull Out Test)



Figure 7: Comparison images of the RTV SN FIA231MR insert 7 hole to the event engine SN FIA217EE insert 2 hole. Both holes show similar lack of thread engagement in the CT scans. FIA217EE insert 2 was found protruding during disassembly and did not go through a pull-out test. FIA231MR insert 7 was pulled out during the lab pull-out test and shows similar surface condition to FIA217EE insert 2 (missing thread material, vertical scoring lines from the insert being pulled out, small areas with CCW smear).

Metallurgical Evaluation



Observations

- Optical view of the HMU in the as-received condition is shown in Figure 8, along with the gasket seal in Figure 9. The images show that 2 of the inserts were proud of the flange surface (locations 1 and 2) and the gasket had a corresponding 70-degree region of blow-out seal, with corresponding coking on the flange (Figures 8 and 9).
- A table describing the results of the running torque measurements and pull-out tests performed at GE Celma during the engine tear-down is provided in Figure 10.
- CT scans of the event HMU idler adapter (Figures 11-18) found insert location 1, 2, and 3 were missing the pre-tapped threads and did **not have thread engagement** into the parent metal. The remaining inserts did show parent metal engagement.
- Sectioning of insert location 2 revealed the pre-tapped threads were missing 360-degrees around the hole to a depth of approximately 0.34-inches (Figure 20). High magnification views of the microstructure at the hole surface revealed no compressed grains that would indicate severe smearing, consistent with the material being cut out by the self-tapping inserts (Figures 23). Vertical scoring lines are observed in the areas with missing internal threads consistent with the insert contacting the surface while pulling out. Smeared material in the CCW direction is observed in multiple areas (Figures 21-22). Two areas with the intact threads are observed at the bottom of the hole with the same spacing as the insert installation holes 120-degrees around (Figure 24). The missing threads between them were found trapped in the insert threads, consistent with the aluminum parent metal thread shearing when the steel insert was pulled out.
- Evaluation of a hole that showed thread engagement in the CT scan (insert 5) revealed the gold-colored anodized pre-tapped threads were still present (Figure 26). However, insert location 3 has similar vertical scoring lines and remaining lower two threads similar to findings observed in insert 2 (Figure 27). The insert 3 damaged location also showed insert cut lines that were angled and out of phase with the original pre-tapped threads, consistent with cross-threading during installation of the inserts (Figure 28).
- Dimensional analysis of inserts 3 and 5 showed the lengths and diameters were conforming to the drawing (1518M34P02) (Figure 29).
- Cross-section images reveal a similar microstructure at the top of the flange near holes 2 and the bottom of the flange near hole 8. Hardness was measured to be 86 HRE near the bottom of the flange and decreases to 76 HRE at the top of the flange, consistent with softening due to overaging due to heat exposure from the fire (Figure 31).



Observations

- Evaluation of the gasket seal found 70-degrees of the rubber seal at the 12:00 position was ruptured and approximately 150-degrees of the rubber seal was damaged (Figures 32-33). Impressions were found in the gasket seal retainer matched the shape and size of the protruding thread inserts (Figure 34). Blue light scans show the location 1 gasket seal retainer tab was deformed outboard approximately 0.062 – 0.069 inches and the location 2 tab was deformed approximately 0.012-inches (Figures 36-37). Two areas of the gasket seal retainer do not have black surface deposits, consistent with contacting the tube flange at these areas during the fire. The retainer surface that mates with the tube ferrule is relatively flat and has a circular impression, consistent with being clamped between the idler adapter flange and tube ferrule surfaces when the insert 1 gasket tab location deformed (Figure 35). The tube ferrule/flange average measured distance (gap) was 0.044-inches. Subtracting the measured 0.044-inch gap from the max 0.069-inches of gasket seal retainer deformation gives 0.025-inches of gap that would reduce the compression of the rubber seal. This is an approximate value; the actual leak gap was not measured prior to disassembly (Figure 38).
- **Appendix E:** Figure 104 provides the running torque and pull-out test performed at GE Celma during engine tear down. Figure 105 provides the stack up analysis performed to determine the minimum insert parent metal engagement depth for a max hole/min insert diameter condition.



Observations

- **Four additional parts were evaluated for comparison to the event part and are described below.**
- **RTV S/N FIA217C9 (Appendix A)**
 - CT scans showed insert 3 was missing the internal threads on approximately half of the hole. The other 7 inserts showed thread engagement. Destructive analysis of insert 3 revealed angled cut lines through the flange female threads, consistent with the thread insert cross-threading and cutting through the flange threads. The side with missing threads and a concave cut shape, consistent with the insert being pulled to one side then straightening out as it was installed (Figures 40-52).
- **RTV S/N FIA231MR (Appendix B)**
 - CT scans showed all eight insert locations did not have thread engagement. Destructive analysis showed inserts 3 and 5 were missing the threads 360-degrees around the hole and had angled cut lines through the flange female threads, consistent with the thread insert cross-threading and cutting through the flange threads. Inserts 1, 2, and 6 had the inserts pulled out prior to arrival at the lab and had vertical scoring lines in the damaged areas consistent with being pulled out (Figures 53-77).
 - A SB 72-1577 pull-out test was performed on SN FIA231MR insert number 7 which showed no thread engagement in the CT scan. The insert pulled-out at 150 in-lbs (indicated by large torque drop) and was found protruding 0.014-inches above the flange surface (0.023-inches of total travel). Destructive analysis found the insert hole surface had vertical scoring lines and two remaining threads in the insert debris hole locations, similar to the event engine observations (Figures 78-79).
- **RTV S/N FIA23K9F (Appendix C)**
 - CT scans showed all eight insert locations had thread engagement. Destructive analysis of inserts 3 and 5 revealed a gold-colored anodized layer, consistent with the insert “screwing” into the pre-tapped thread path (Figures 80-92).
- **RTV S/N FIA23K9F (Appendix D)**
 - CT scans showed inserts 6, 7, and 8 did not have thread engagement. The remaining inserts did show thread engagement. Destructive analysis of insert 7 showed the threads had been removed 360-degrees around the hole and the insert was observed out of phase with the original pre-tapped threads, consistent with cross-threading. CCW smear is also observe in the damaged area. Insert 8 had been pulled out prior to arriving at the lab and showed the vertical scoring lines similar to other holes with insert pull-out. (Figures 93-103)



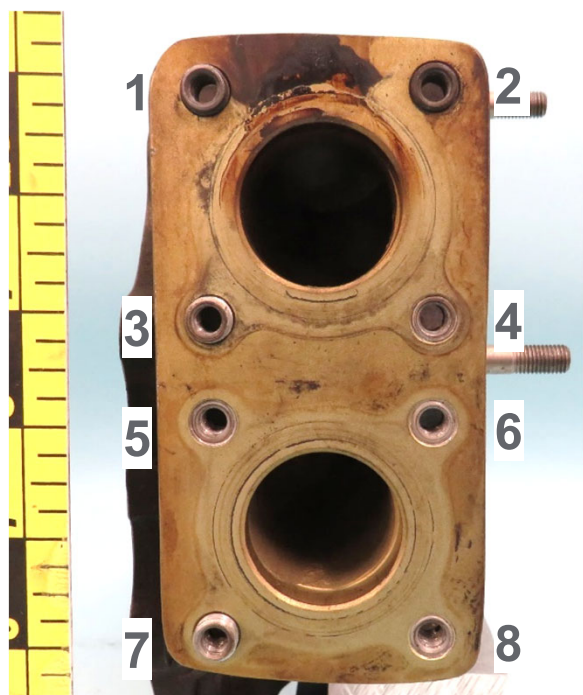


Figure 8: Images of the HMU idler adapter as-received by the failure analysis lab. The part number (9395M78G10) and serial number (FIA217EE) markings are shown.

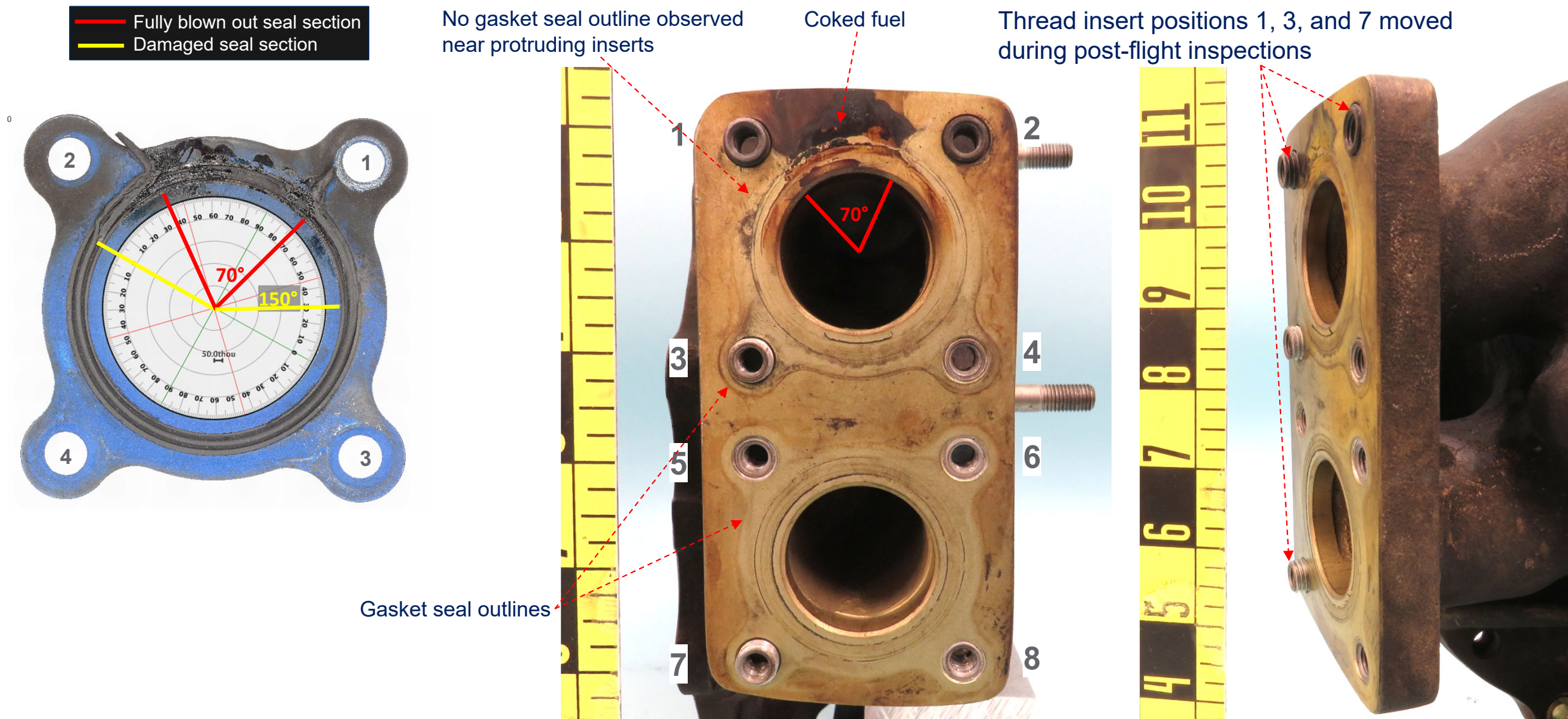
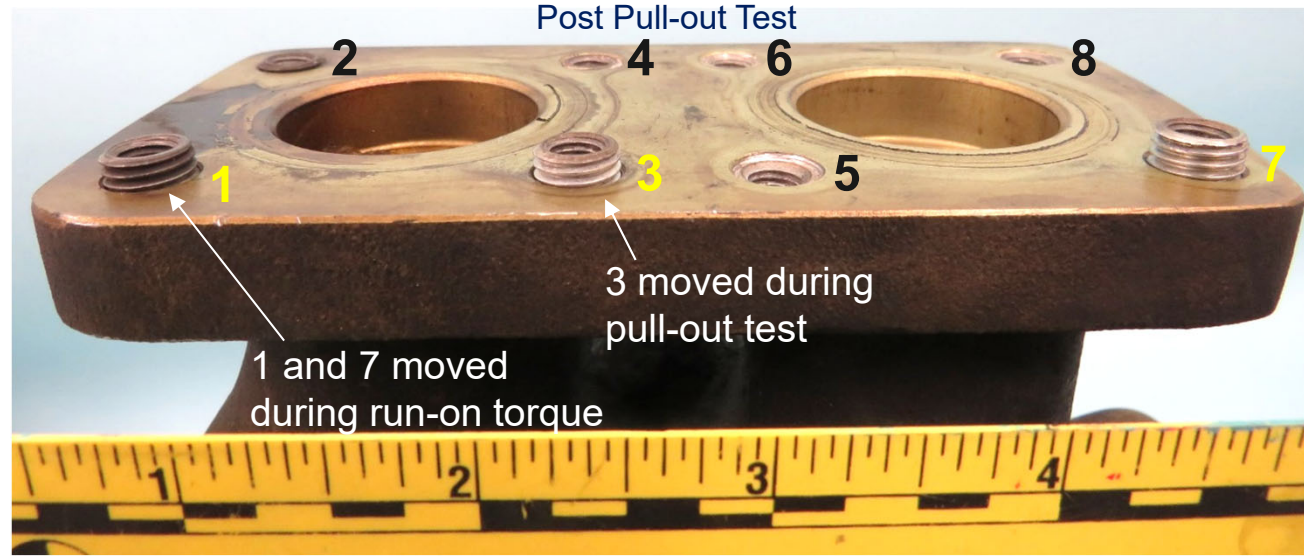
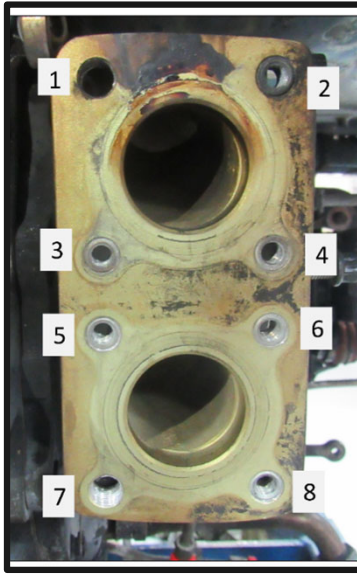


Figure 9: Images of the HMU idler adapter flange in the as-received condition, after the GE Celma thread insert pull out tests. Images of the gasket seal reveals an approximately 70-degree section at the 12:00 o'clock location with the seal fully blown out. Coked fuel is observed on the flange surface at the same 70-degree location, consistent with fuel leaking in this area. Approximately 150-degrees of the seal appears damaged.

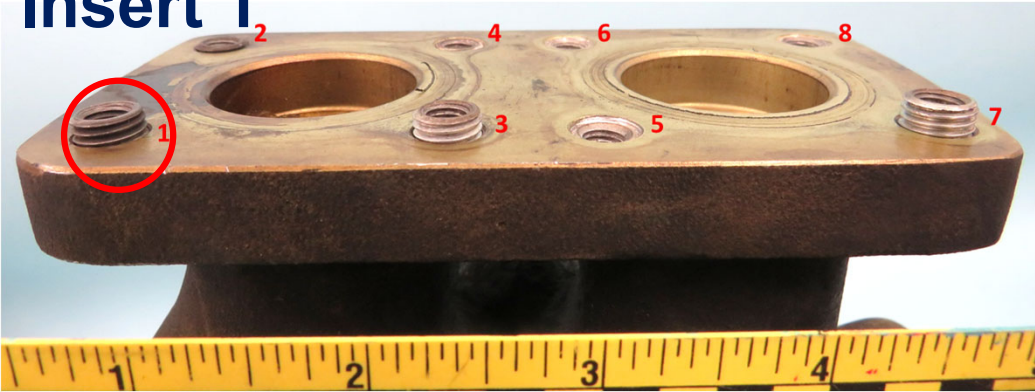


Insert #	Measured Run-on Torque (lb-in)	SB 72-1577 Pull Out Test Performed?	CT Scan Thread Engagement	Notes
1	8	No	No	Came loose during running torque. Insert was fully removed during running torque bolt removal, then partially reinstalled by hand. Flange base metal was reportedly observed coming out with the insert during removal.
2	5	No	No	Found protruding. No pull-out test performed.
3	5	Yes	No	Failed pull-out test (moved during test)
4	7	Yes	Yes	Passed pull-out test
5	5	Yes	Yes	Passed pull-out test
6	12	Yes	Yes	Passed pull-out test
7	37	No	Yes	Came loose during running torque. Insert was fully removed during running torque bolt removal, then partially reinstalled by hand. Flange base metal was reportedly observed coming out with the insert during removal.
8	15	Yes	Yes	Passed pull-out test

Figure 10: Prior to arriving at the failure analysis lab, a SB 72-1577 pull out test was performed on the HMU idler adapter flange thread inserts. Side views of the idler adapter flange shows the position of each thread insert after the pull-out tests. A summary table with the reported pull-out test torque values and observed thread engagement based on CT images is provided.

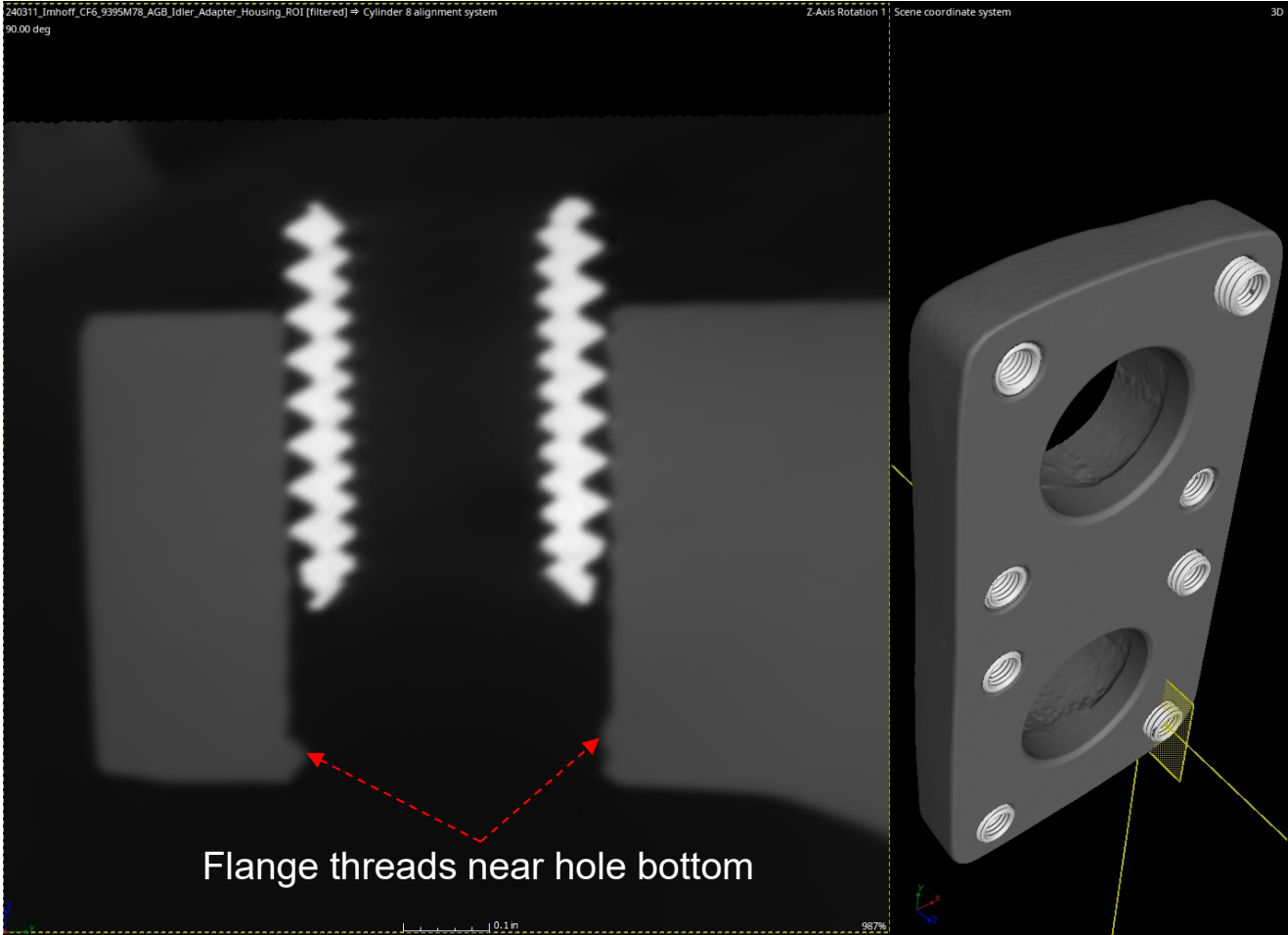
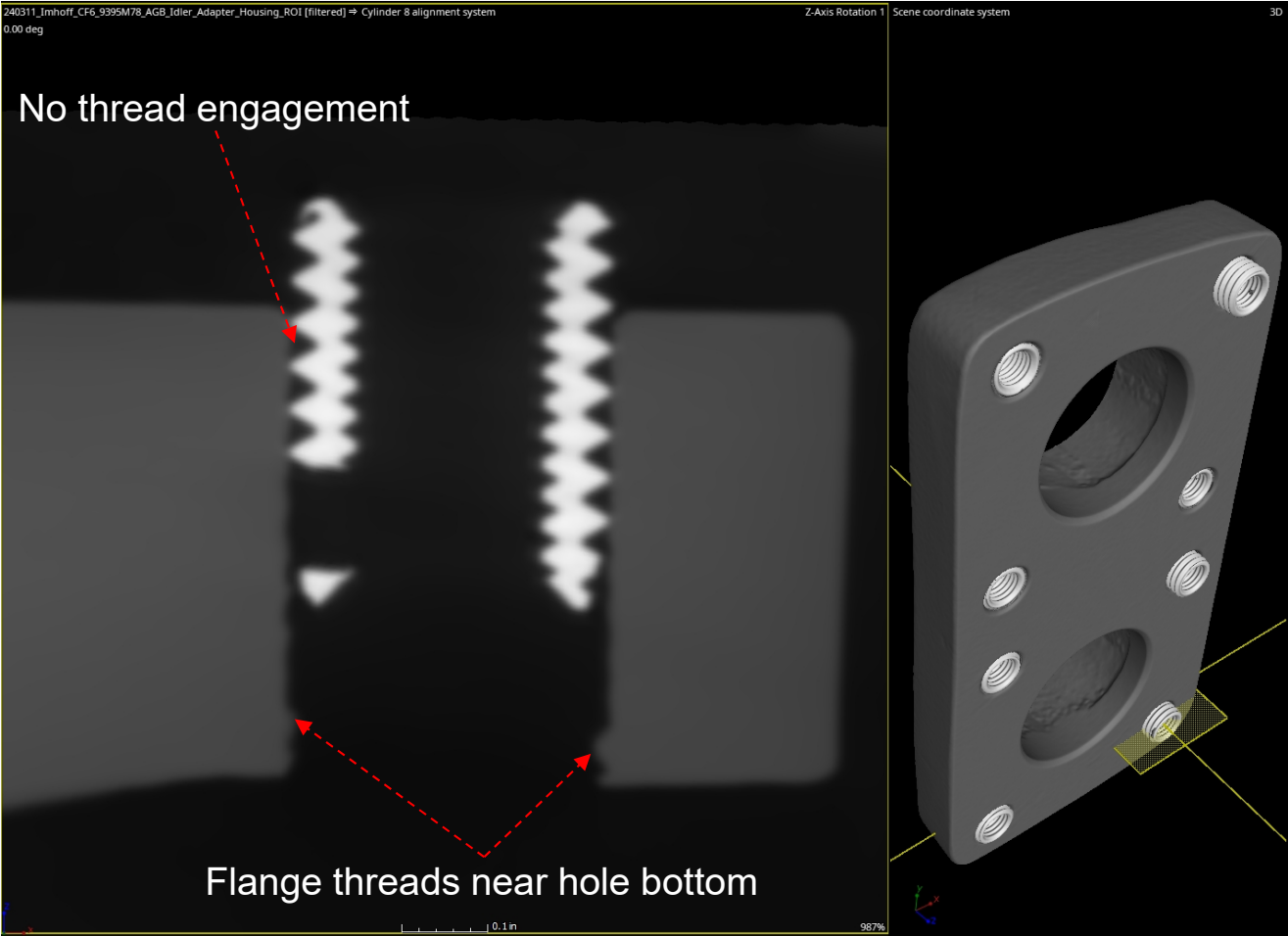


Insert 1

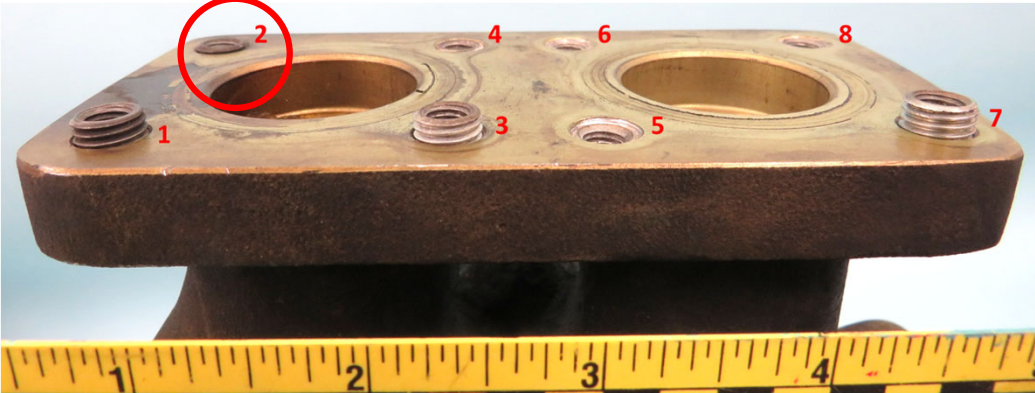


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 11: CT scan cross-section of thread insert position 1. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

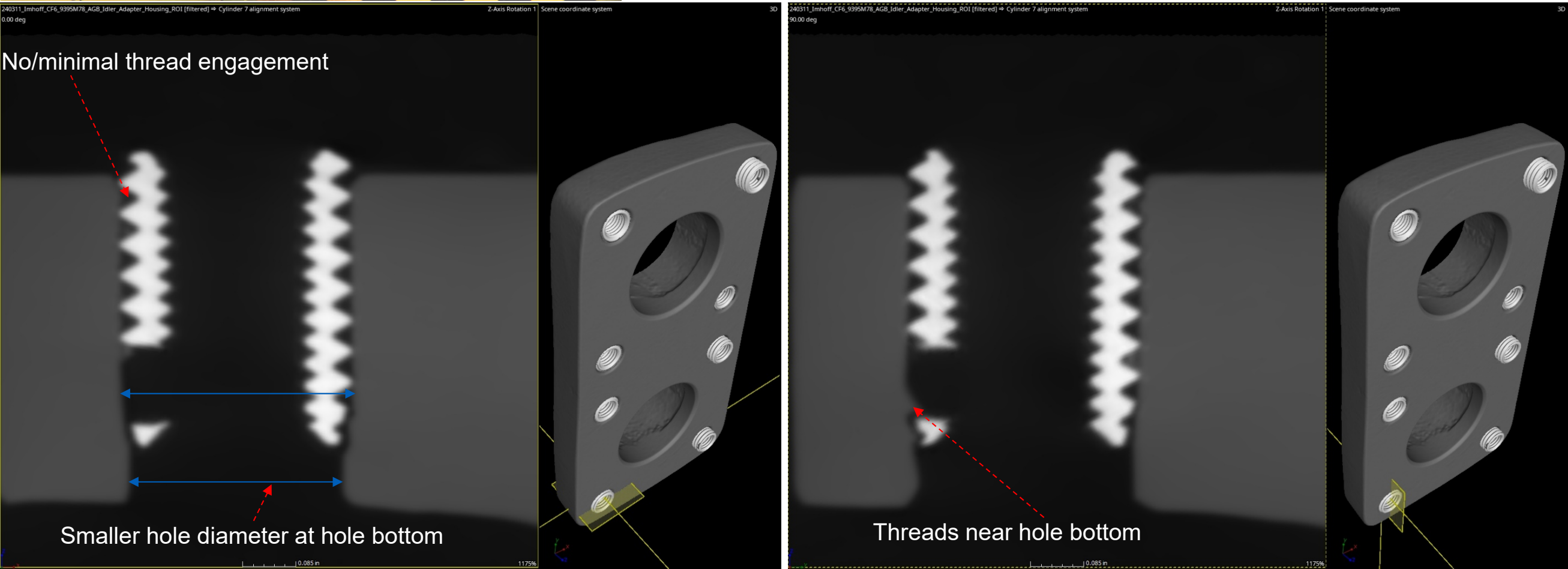


Insert 2

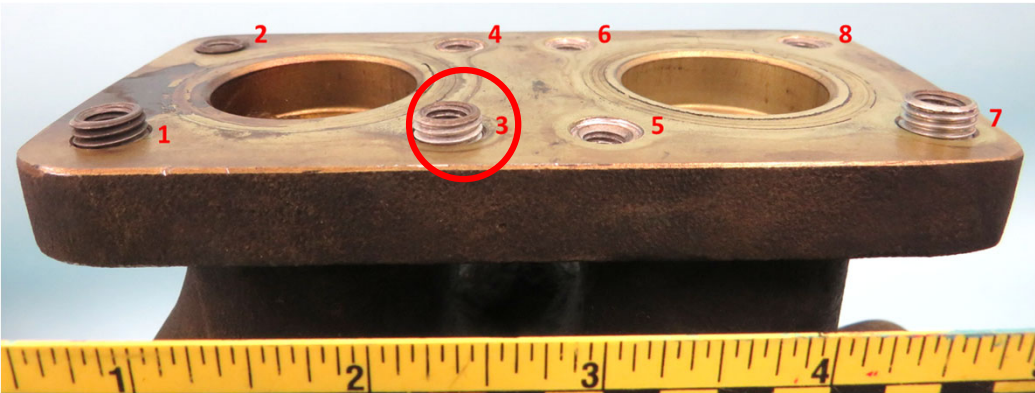


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 12: CT scan cross-section of thread insert position 2. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

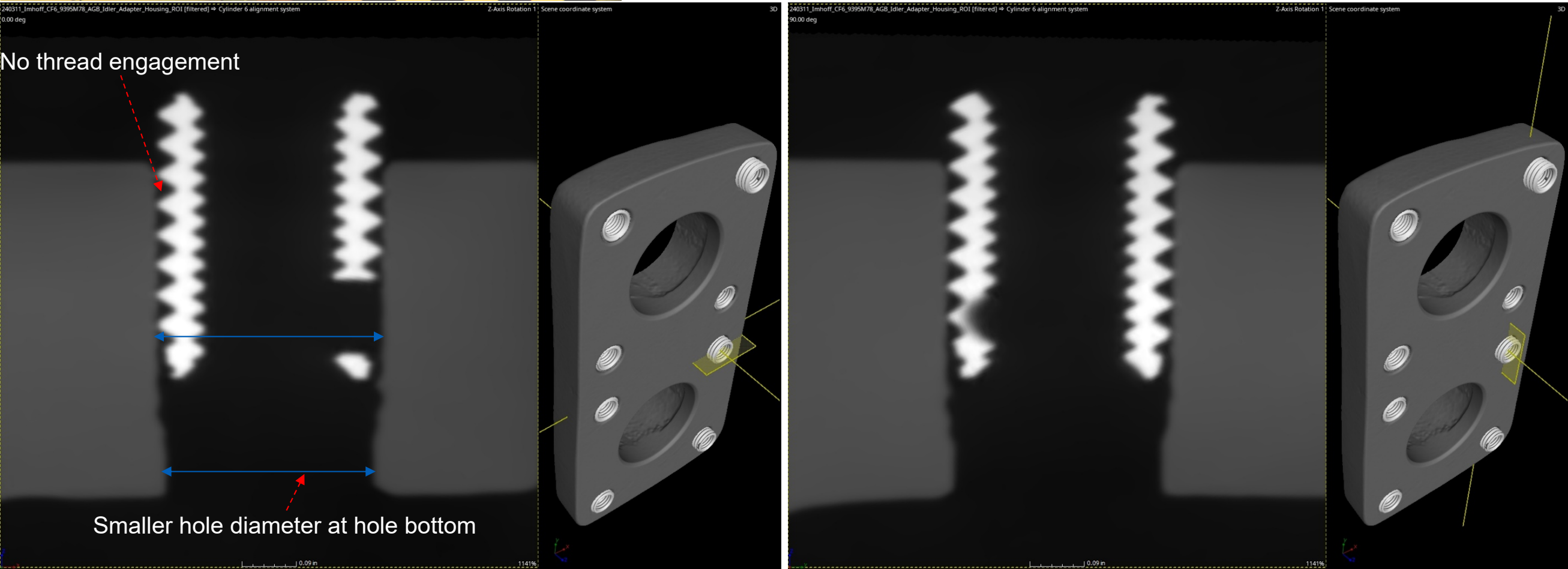


Insert 3



Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 13: CT scan cross-section of thread insert position 3. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

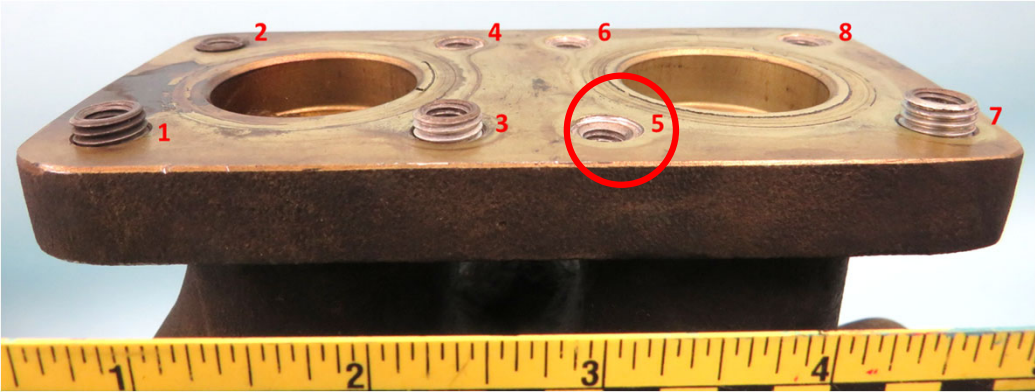


A close-up photograph of the top surface of a brass component. The component has a rectangular shape with rounded corners and two large circular openings. Eight threaded holes are visible, labeled with red numbers 1 through 8. Hole 4 is circled in red. A yellow ruler is placed at the bottom of the image for scale.

Figure 14: CT scan cross-section of thread insert position 4. Thread engagement is observed into the flange material.

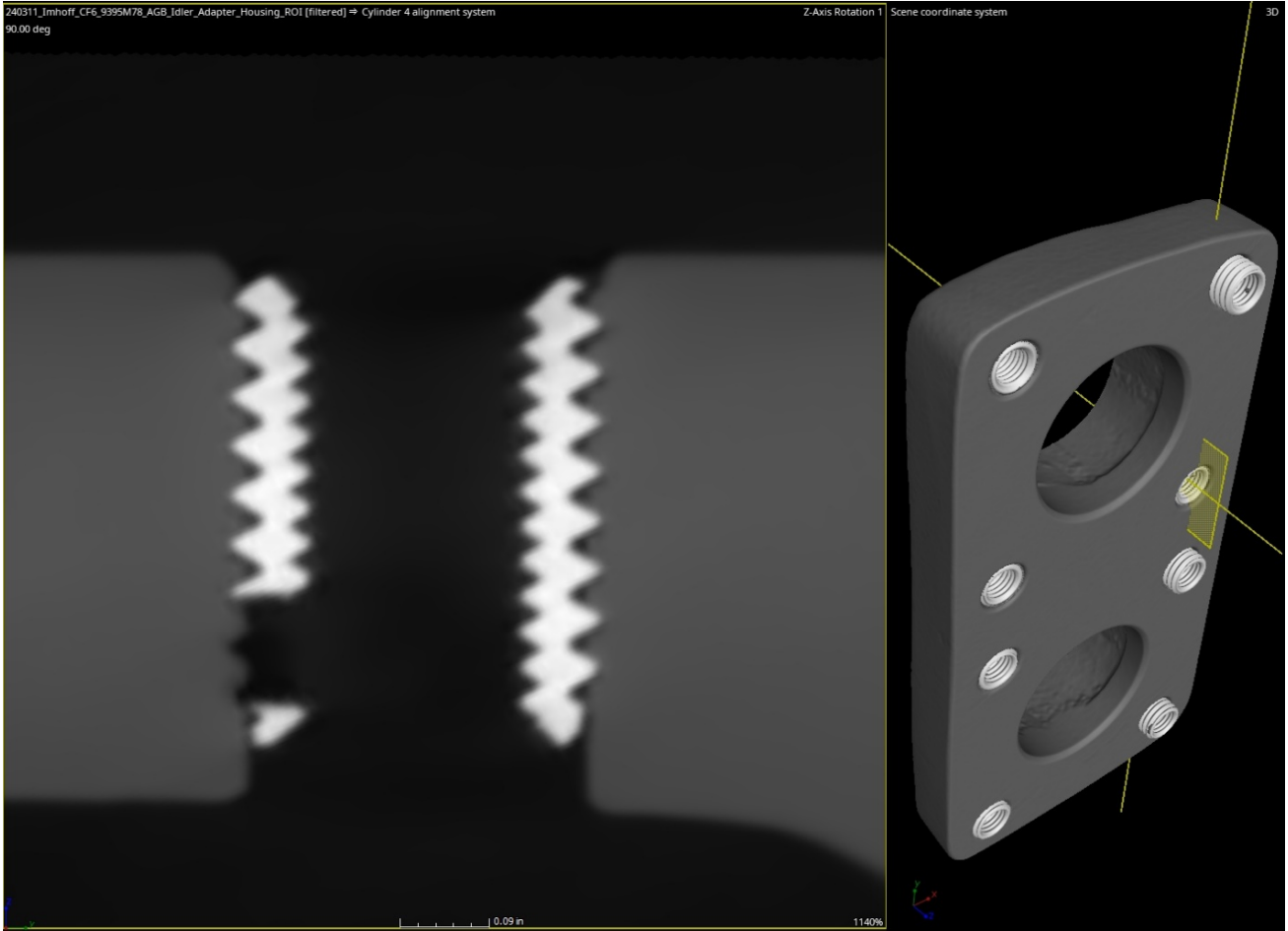
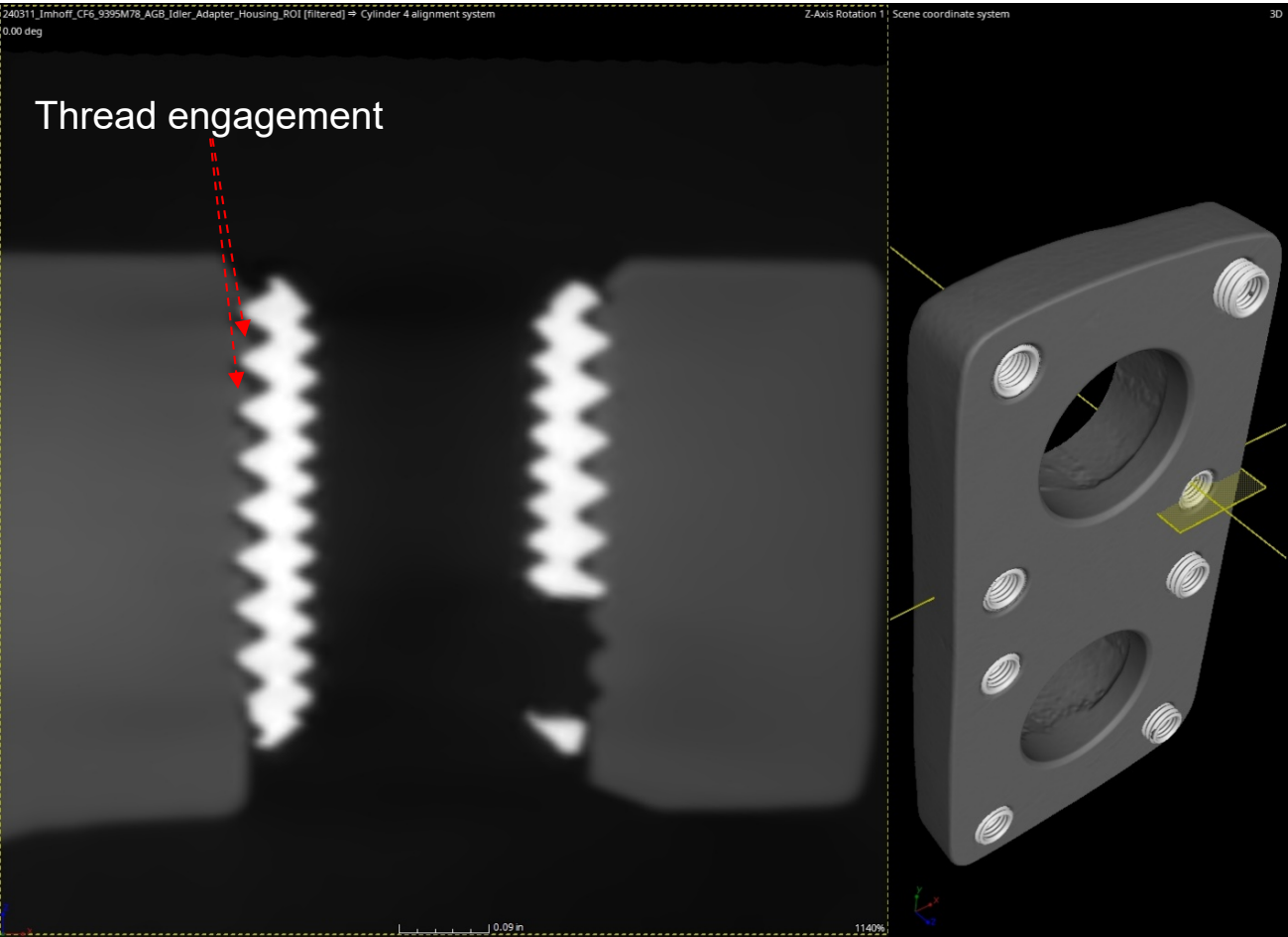


Insert 5

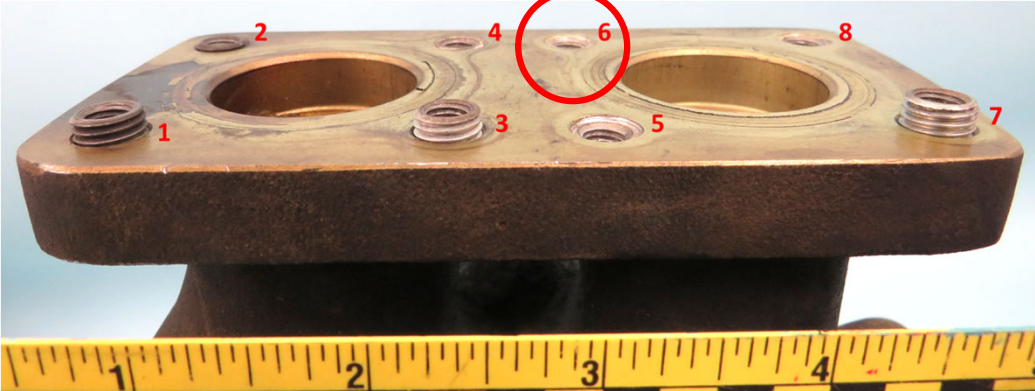


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 15: CT scan cross-section of thread insert position 5. Thread engagement is observed into the flange material.

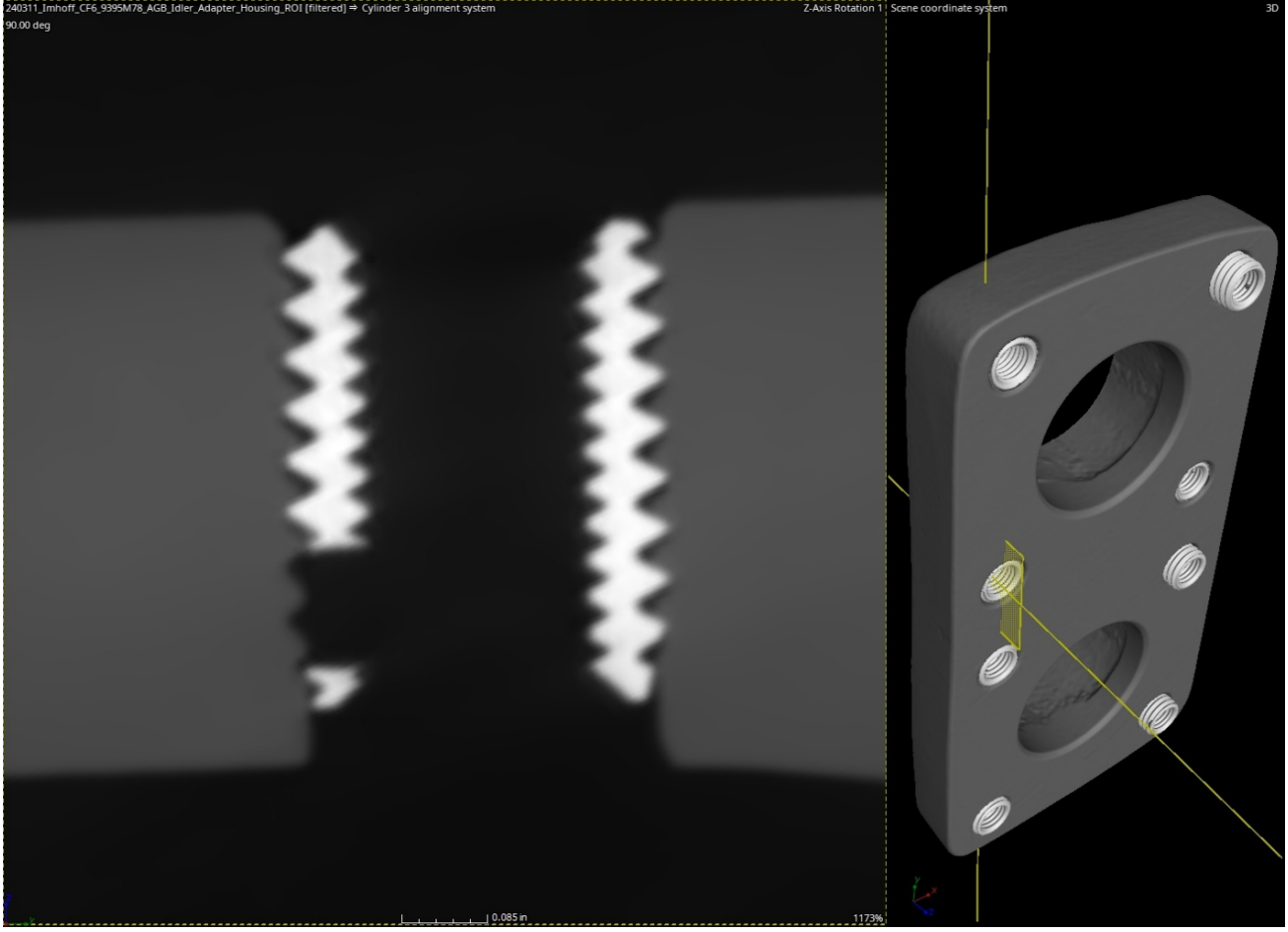
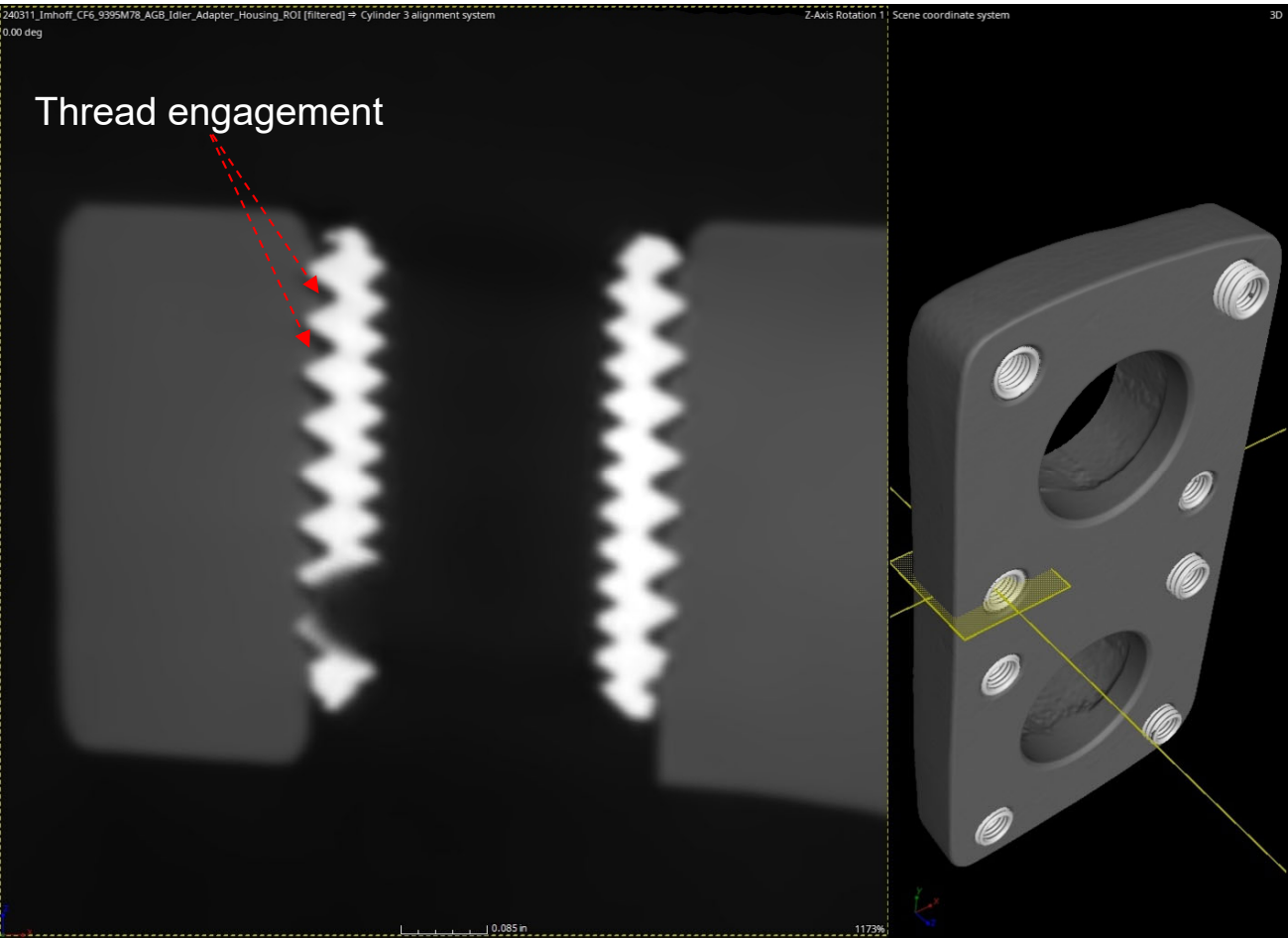


Insert 6

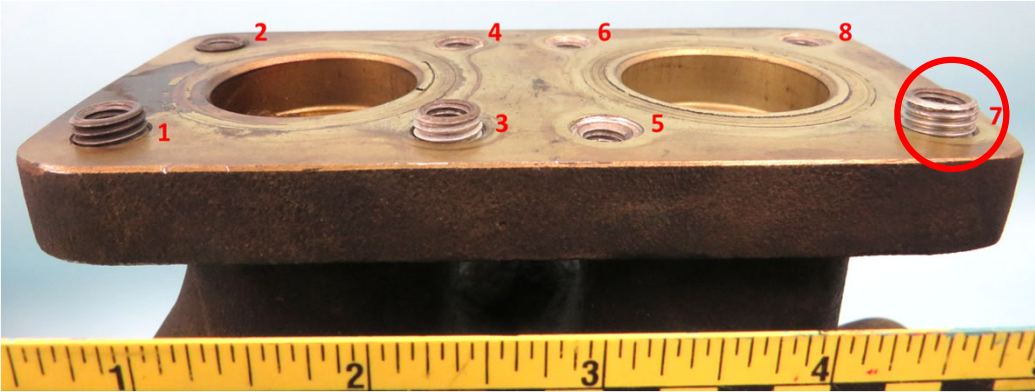


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 16: CT scan cross-section of thread insert position 6. Thread engagement is observed into the flange material.

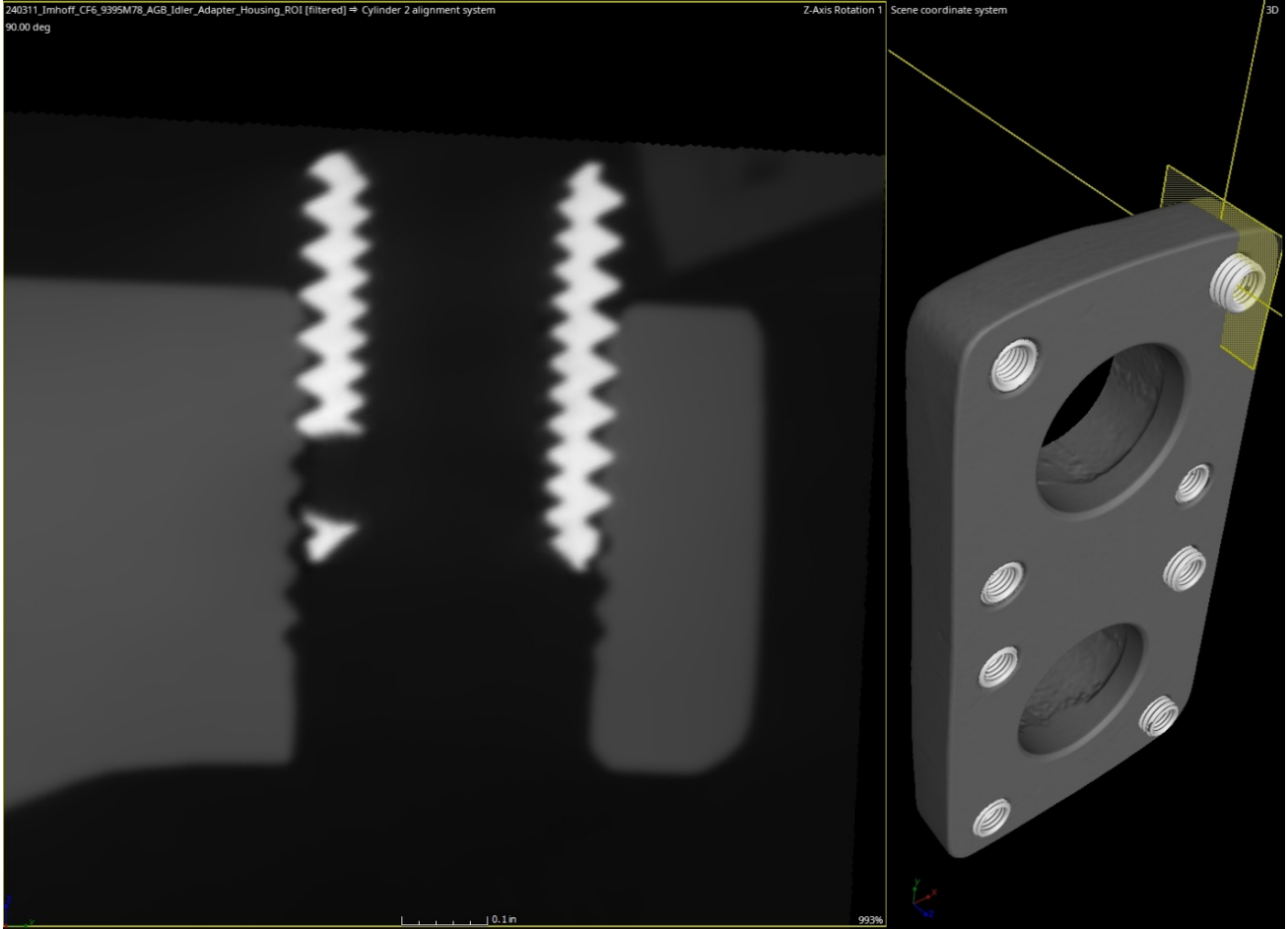
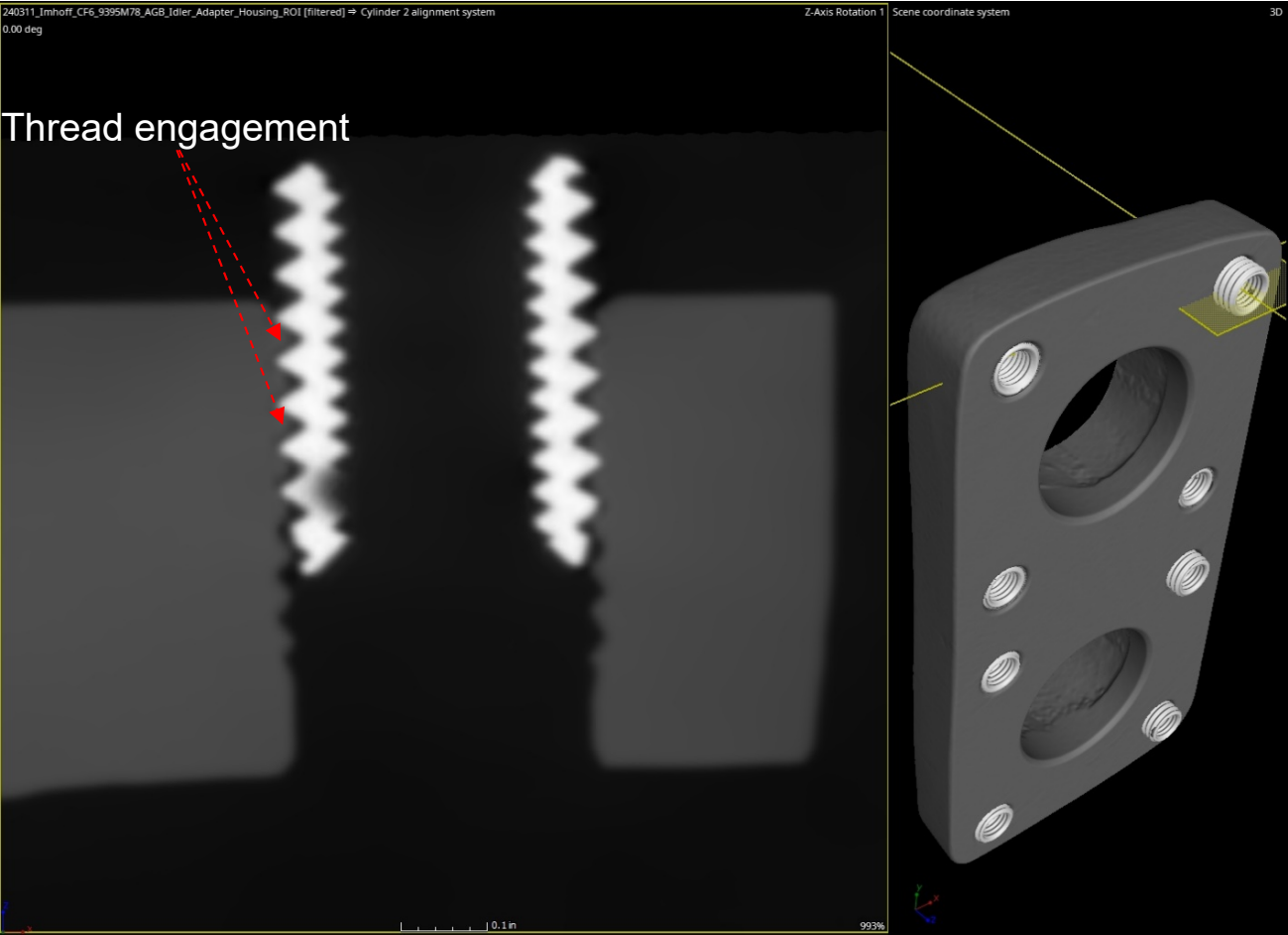


Insert 7

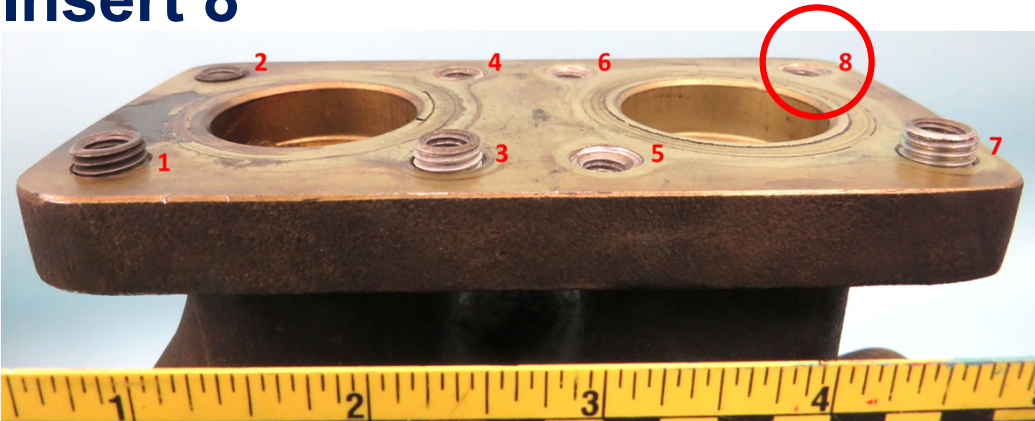


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 17: CT scan cross-section of thread insert position 7. Thread engagement is observed into the flange material.

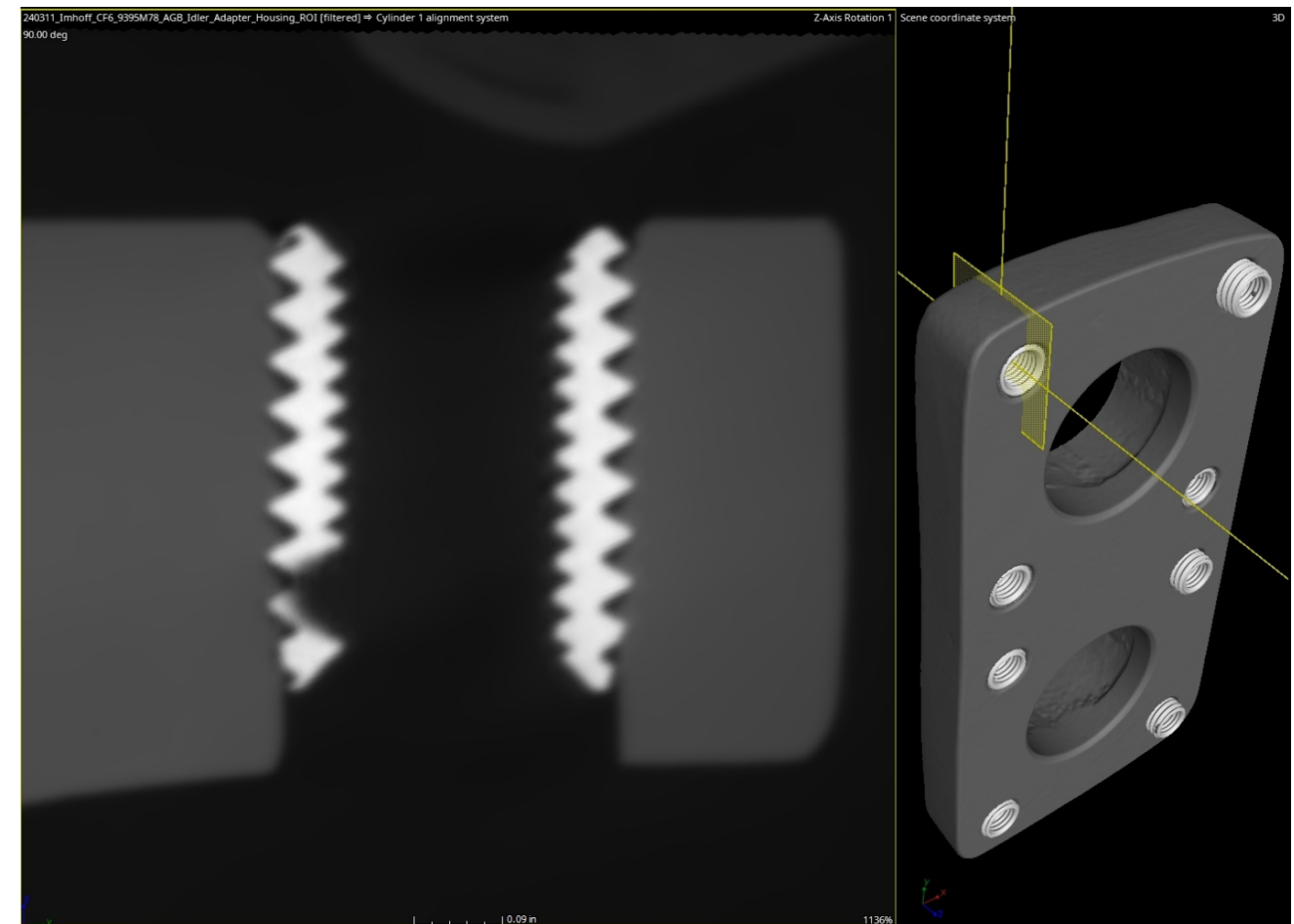
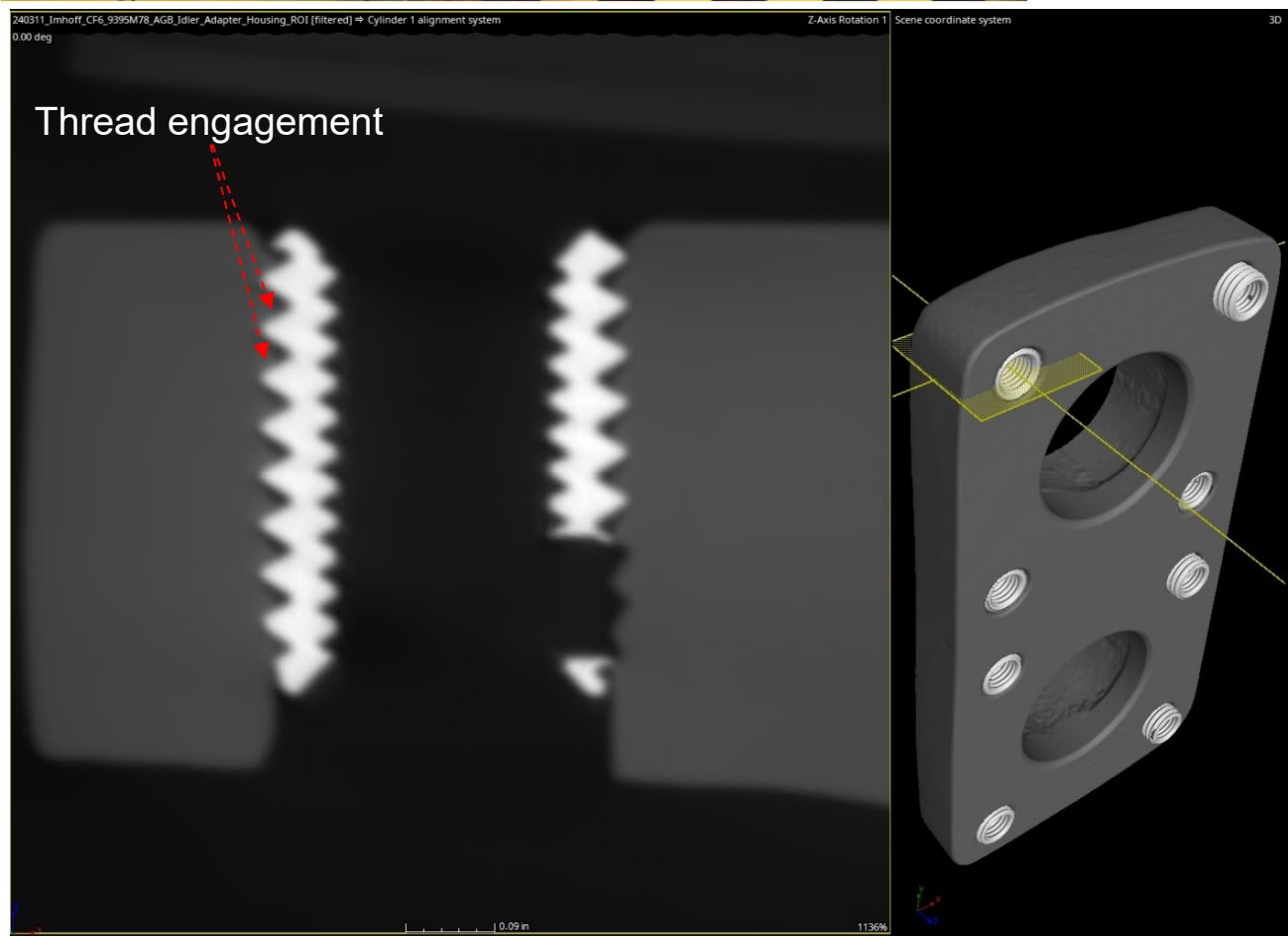


Insert 8



Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 18: CT scan cross-section of thread insert position 8. Thread engagement is observed into the flange material.



Insert 2

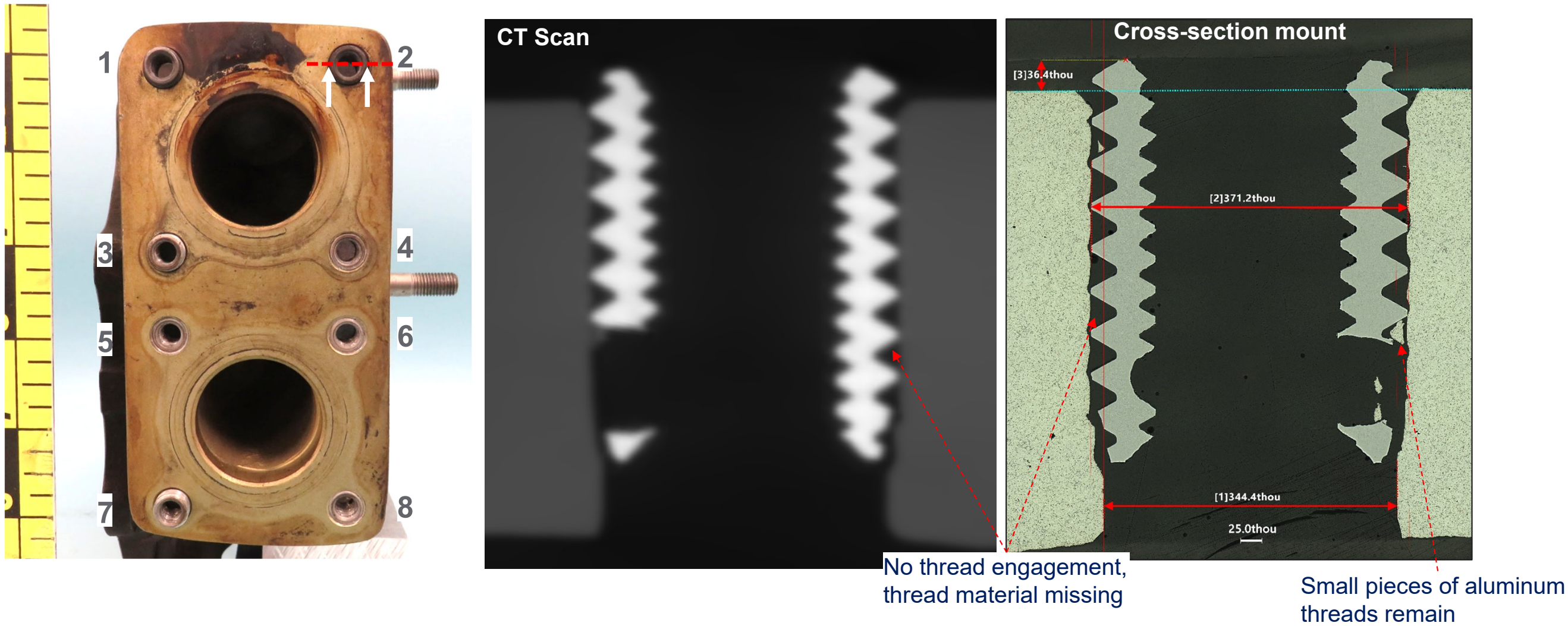
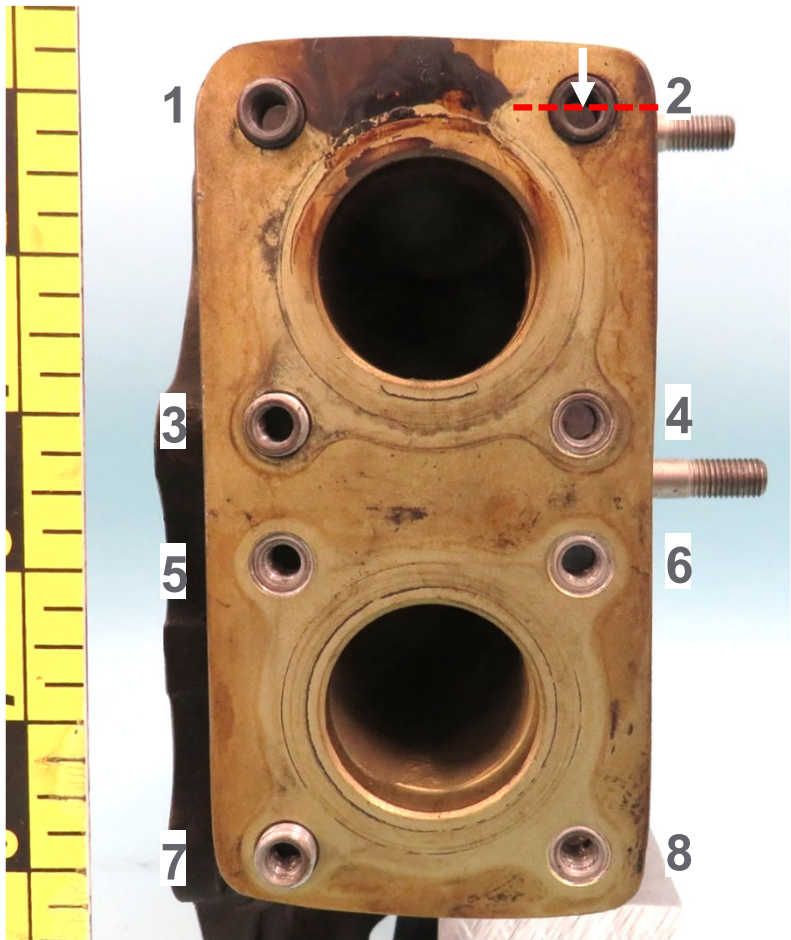


Figure 19: Insert 2 is the only thread insert found protruding that was not disturbed by a pull-out test. Cross-section views confirms the lack of thread engagement observed in the CT scan. Small pieces of loose aluminum are observed trapped between the insert threads, however **most of the aluminum thread material is missing**. This insert has reportedly never been removed since new make.



Insert 2



CCW circumferential smear

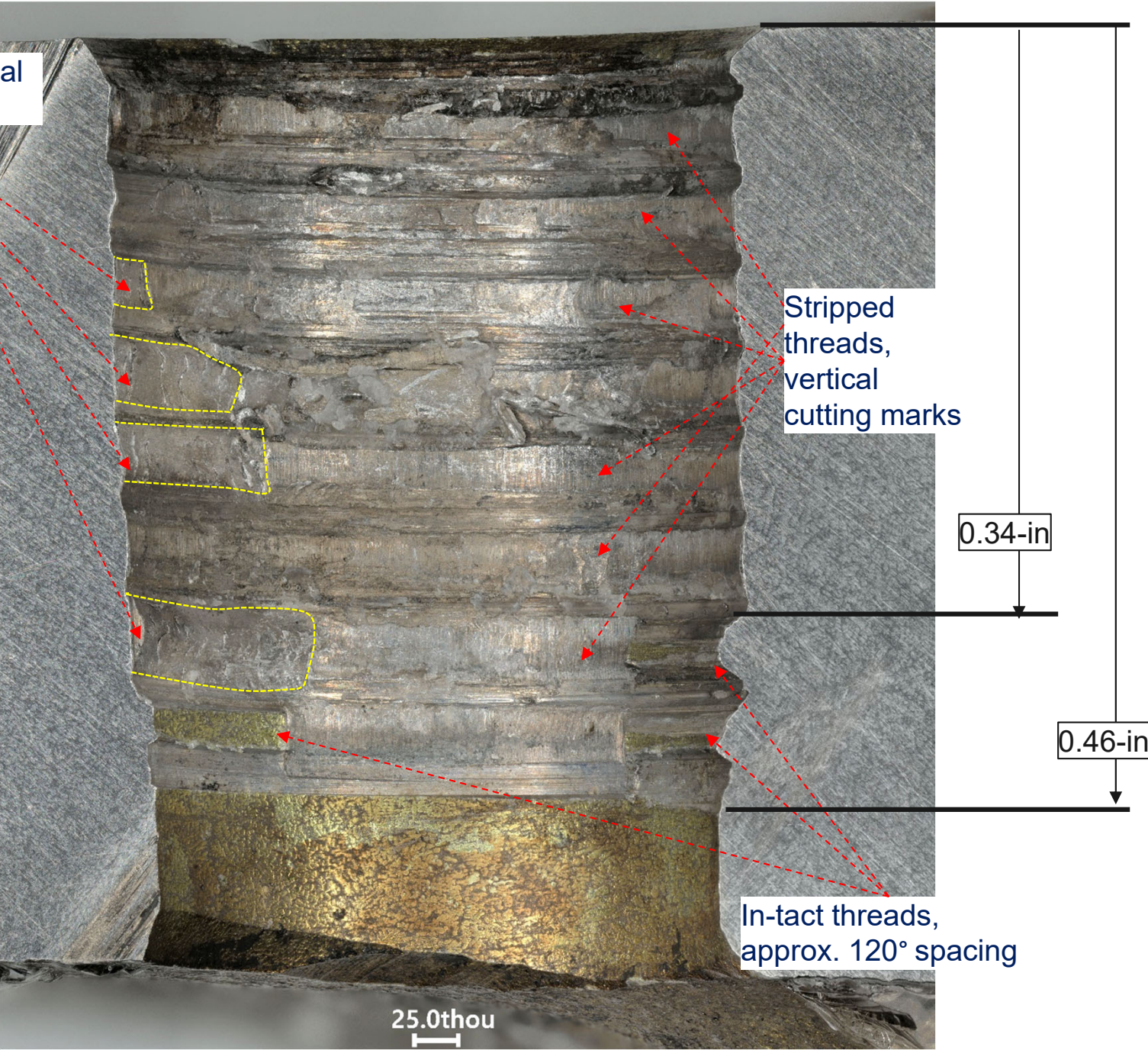


Figure 20: Optical views of the lower half of the insert 2 hole with the inset removed. Most of the threads are stripped and the thread material is missing. Two areas with the intact threads are observed with the same spacing as the insert installation holes (120°). The threads are completely missing through approximately 0.34-inches of the hole depth.



Insert 2

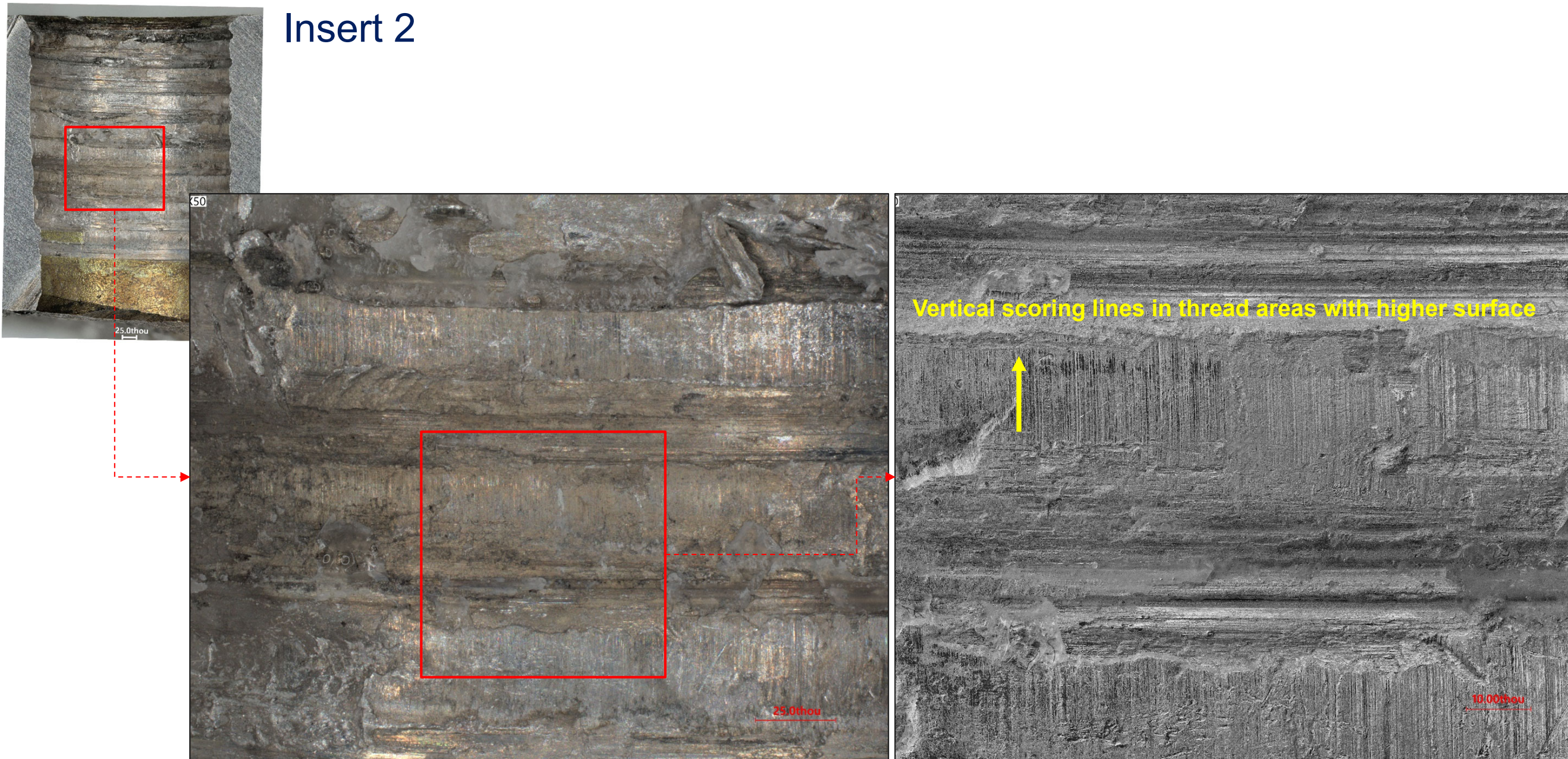


Figure 21: High magnification views reveal vertical scoring lines consistent with contact damage from the steel thread insert pulling out.

Insert 2

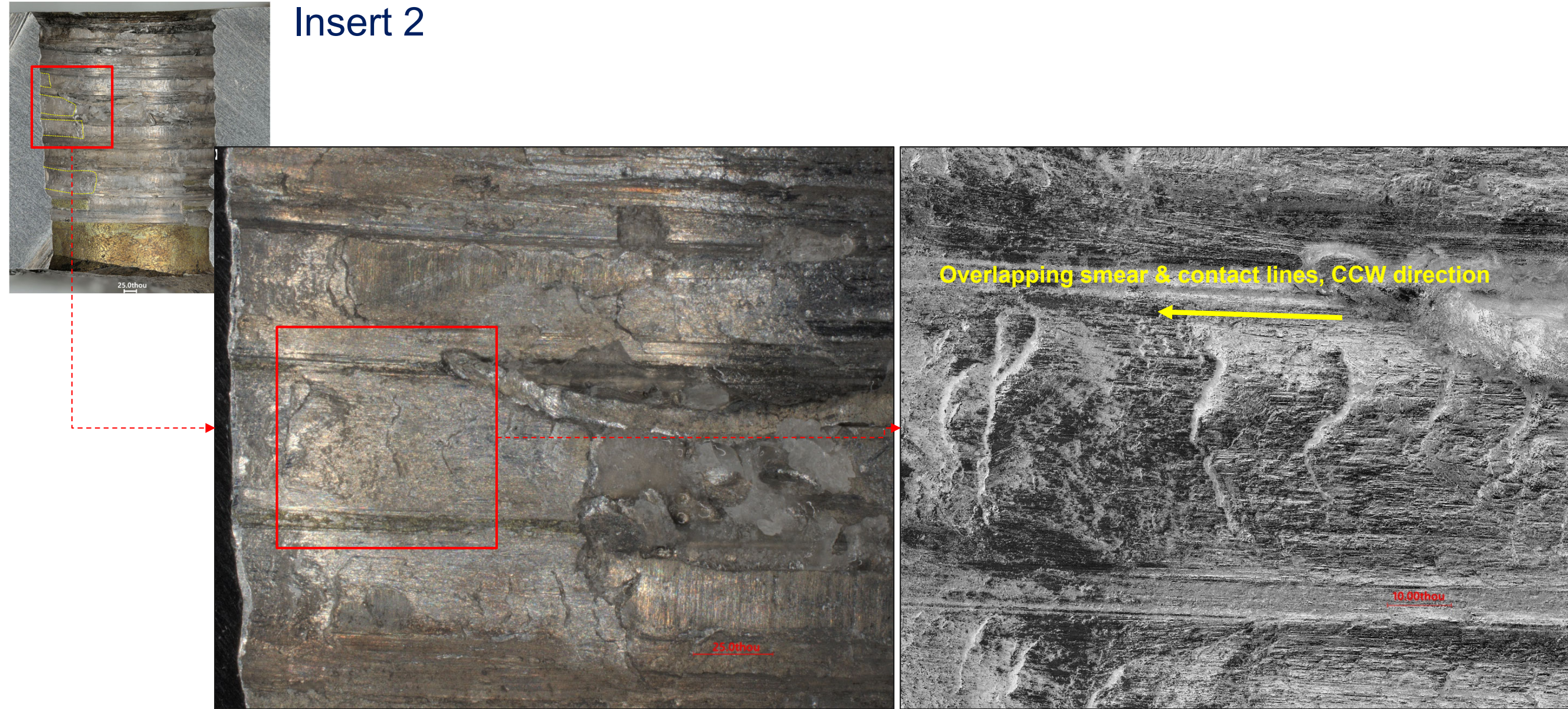
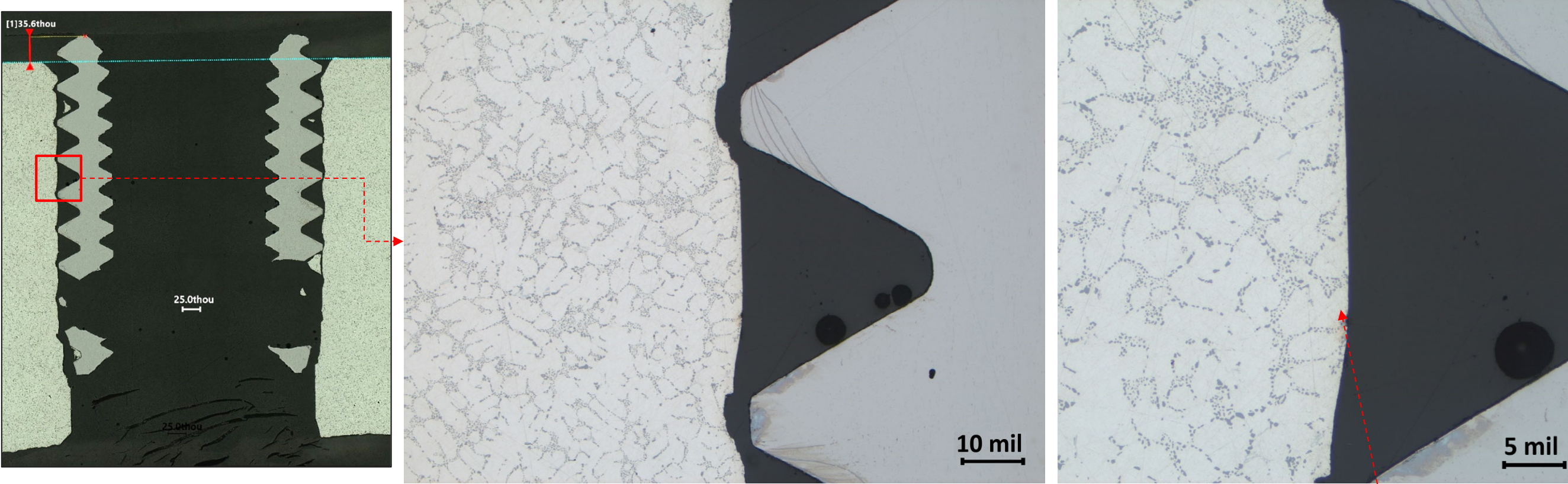


Figure 22: High magnification views of the circumferential damage reveal overlapping smear consistent with counter-clockwise rotation. Per the part processing plan, the steel inserts should not experience a counter-clockwise rotation during installation.



Insert 2



Minimally deformed microstructure at the missing thread location, no evidence of compressed material

Figure 23: High magnification views of the aluminum hole wall reveals a minimally deformed microstructure near the edge, consistent with sheared material due to cutting (self-tapping inserts). No evidence of smeared/compacted material into the hole wall is observed.



Insert 2

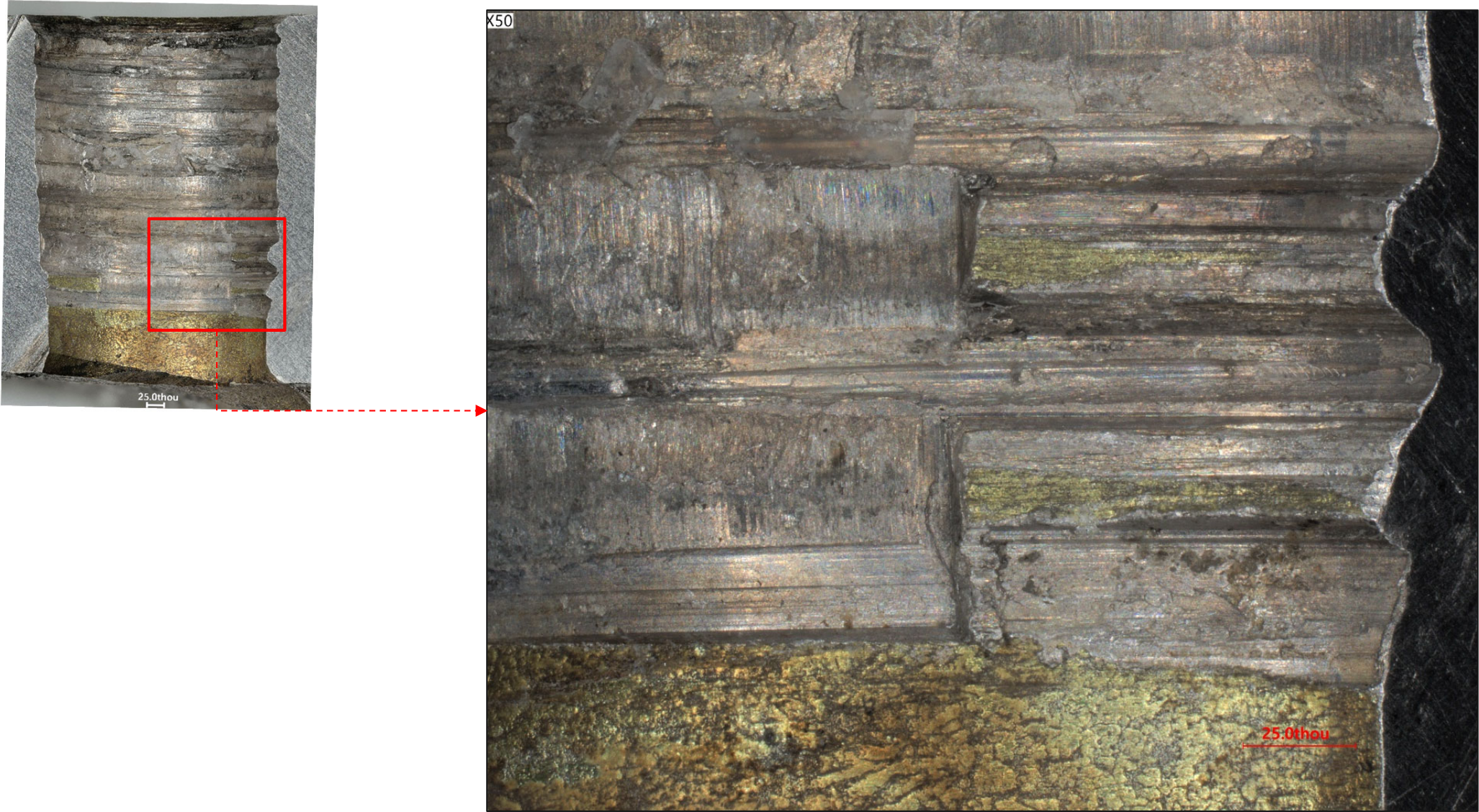


Figure 24: High magnification view of the remaining threads that align with the insert installation hole positions. The gold-like color observed on threads is from the anodized surface treatment which occurs after hole drilling and pre-tap.



Insert 1

Flange Back-side View

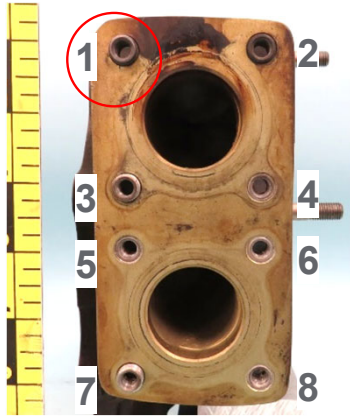


Image looking into the back side of the hole

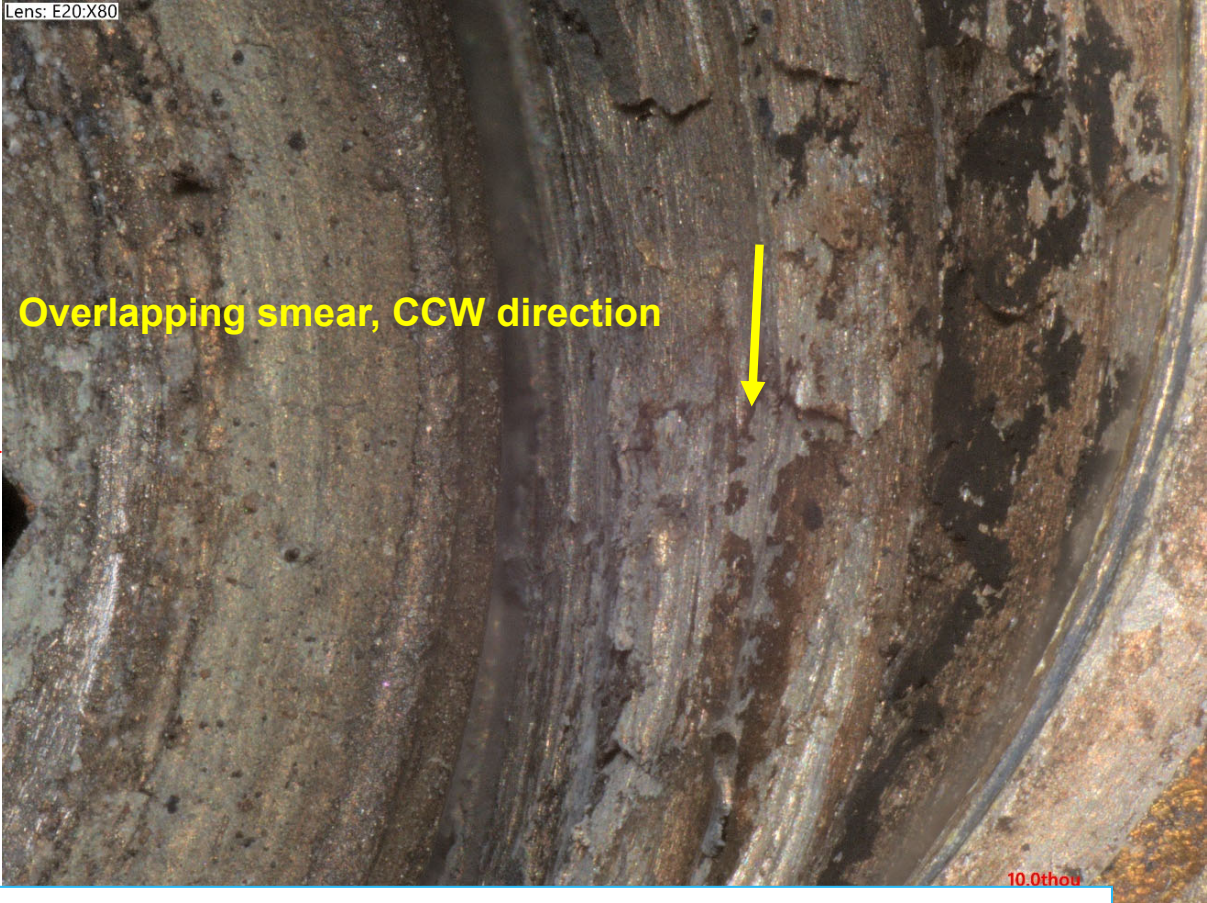


Figure 25: High magnification views of the Insert 1 hole circumferential damage reveal overlapping smear consistent with counter-clockwise rotation. Black soot-like material is observed on the smeared material, consistent with the smeared material existing during the fire.



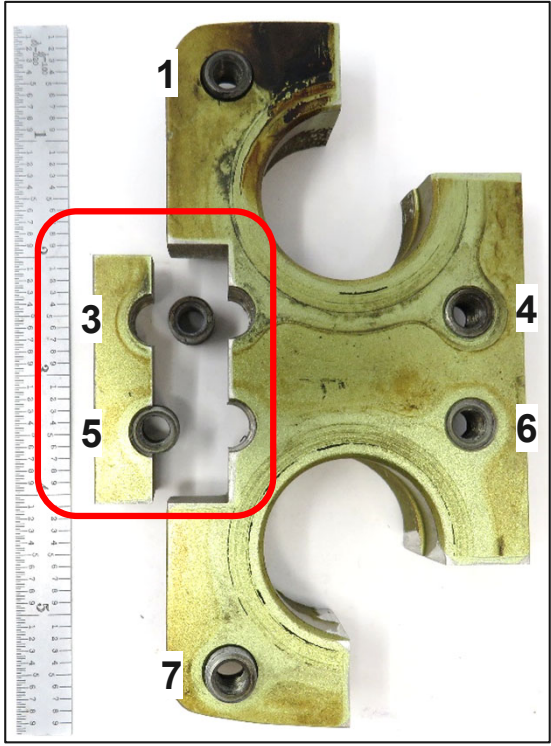
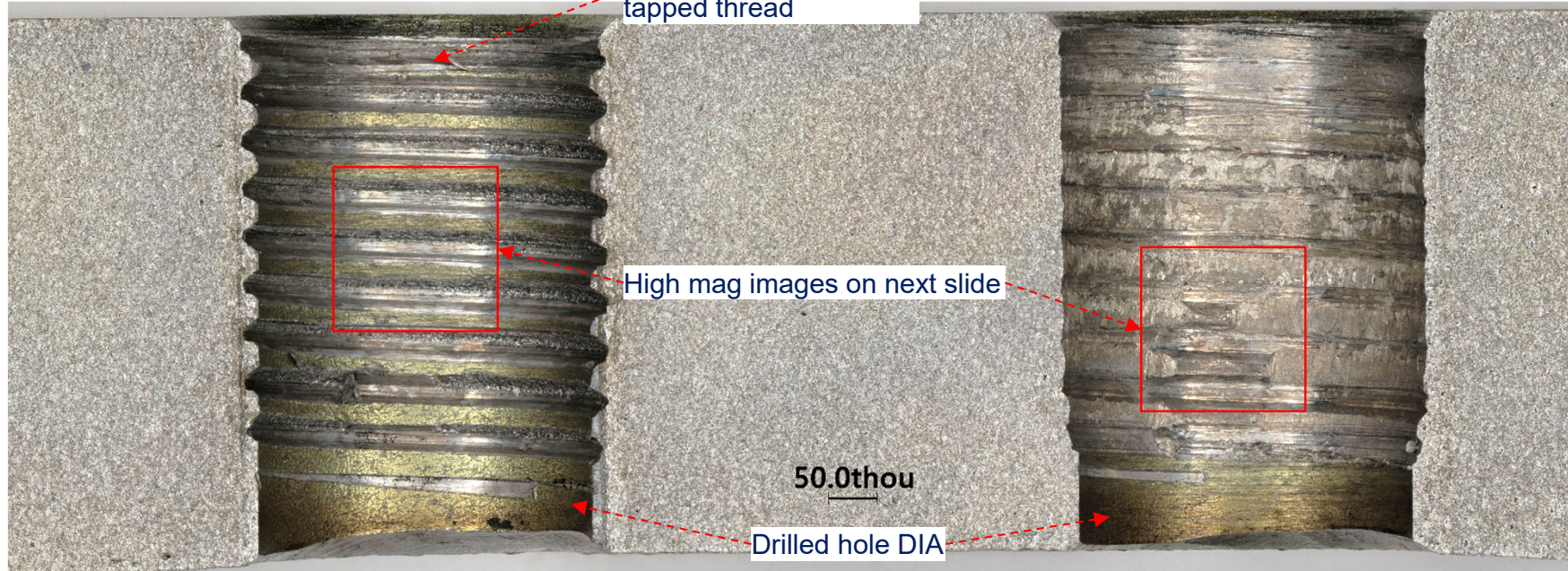
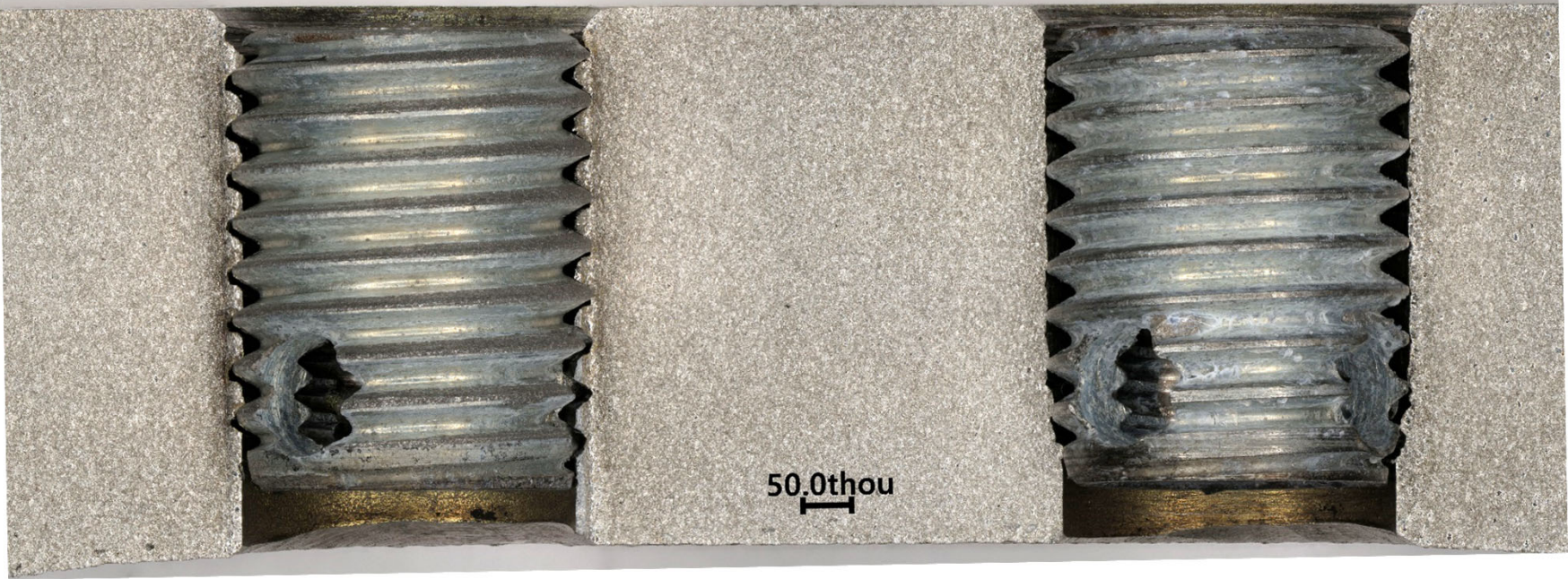


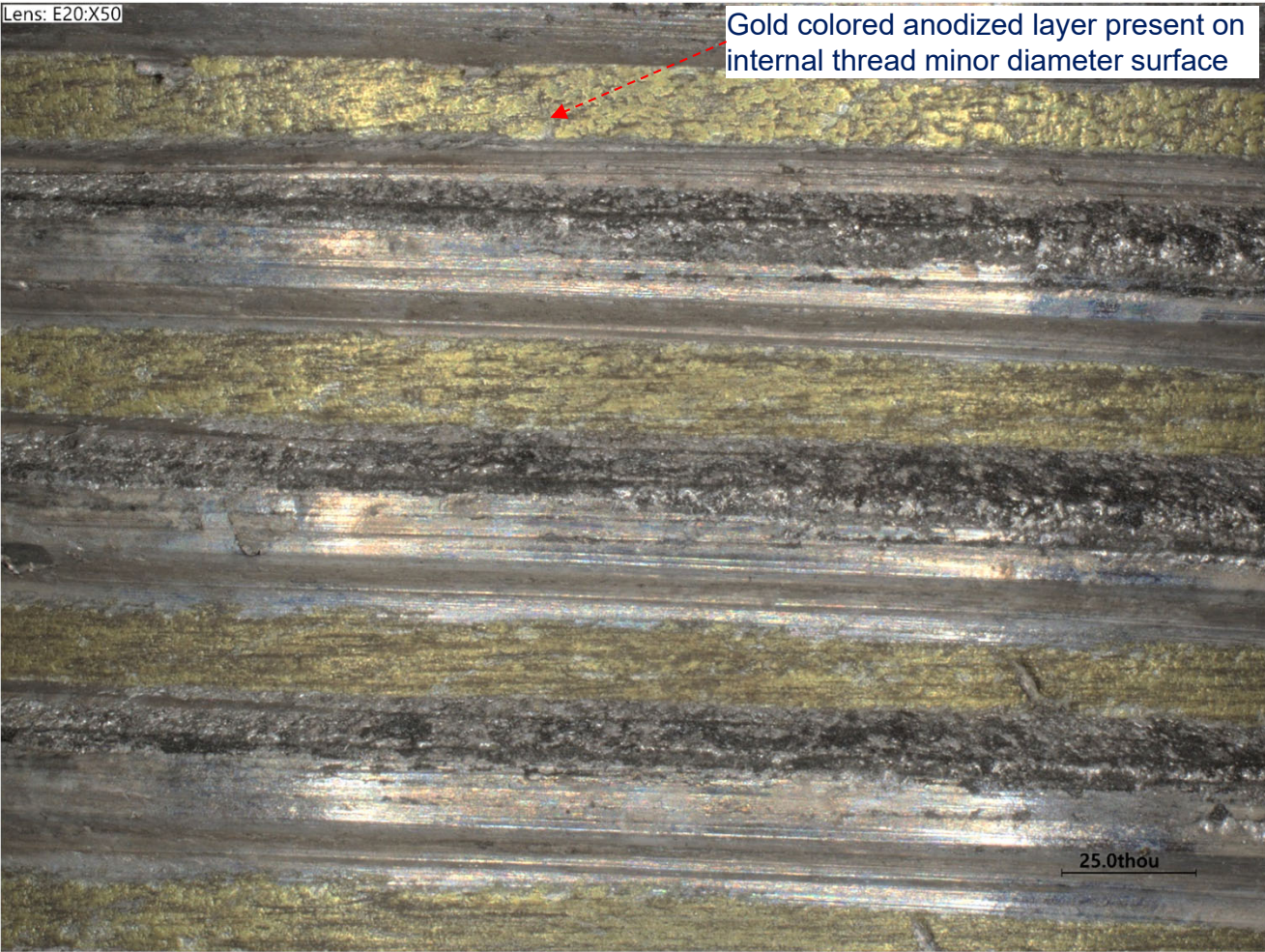
Figure 26: Optical views of insert hole numbers 3 and 5 after wire EDM sectioning. Insert 3 was loose and fell out due to normal handling prior to cutting. The wire EDM cutting was stopped on both sides of Insert 5 so it could be removed and inspected. The top image shows the sectioned holes with the inserts in place, and the bottom image shows the holes with the inserts removed. The gold-like color observed on the Insert 5 hole threads is from the anodized surface treatment which occurs after hole drilling and pre-tap. The fresh, silver metal observed in Insert 5 hole is from the insert tapping threads. The insert 3 hole shows all of the threads are missing, except for three areas that align with the three insert hole locations.

Insert 5 (Passed pull-out test)

Insert 3 (Failed pull-out test)



Insert 5 Hole Threads (Passed pull-out test)



Insert 3 Hole Threads (Failed pull-out test)



Figure 27: 50X optical images of insert 5 and 3 hole thread surfaces. The gold, anodized surface is observed on the tips of the insert 5 hole threads. The stripped threads in insert 3 hole have vertical scoring lines on the surface, consistent with contact damage from the steel insert during the pull-out test. No loose material was observed in the CT scan or collected inside the insert 3 hole after sectioning.

Intact threads in three equally spaced locations, matching the insert installation hole locations



Insert 3 (Failed pull-out test) Side Lighting

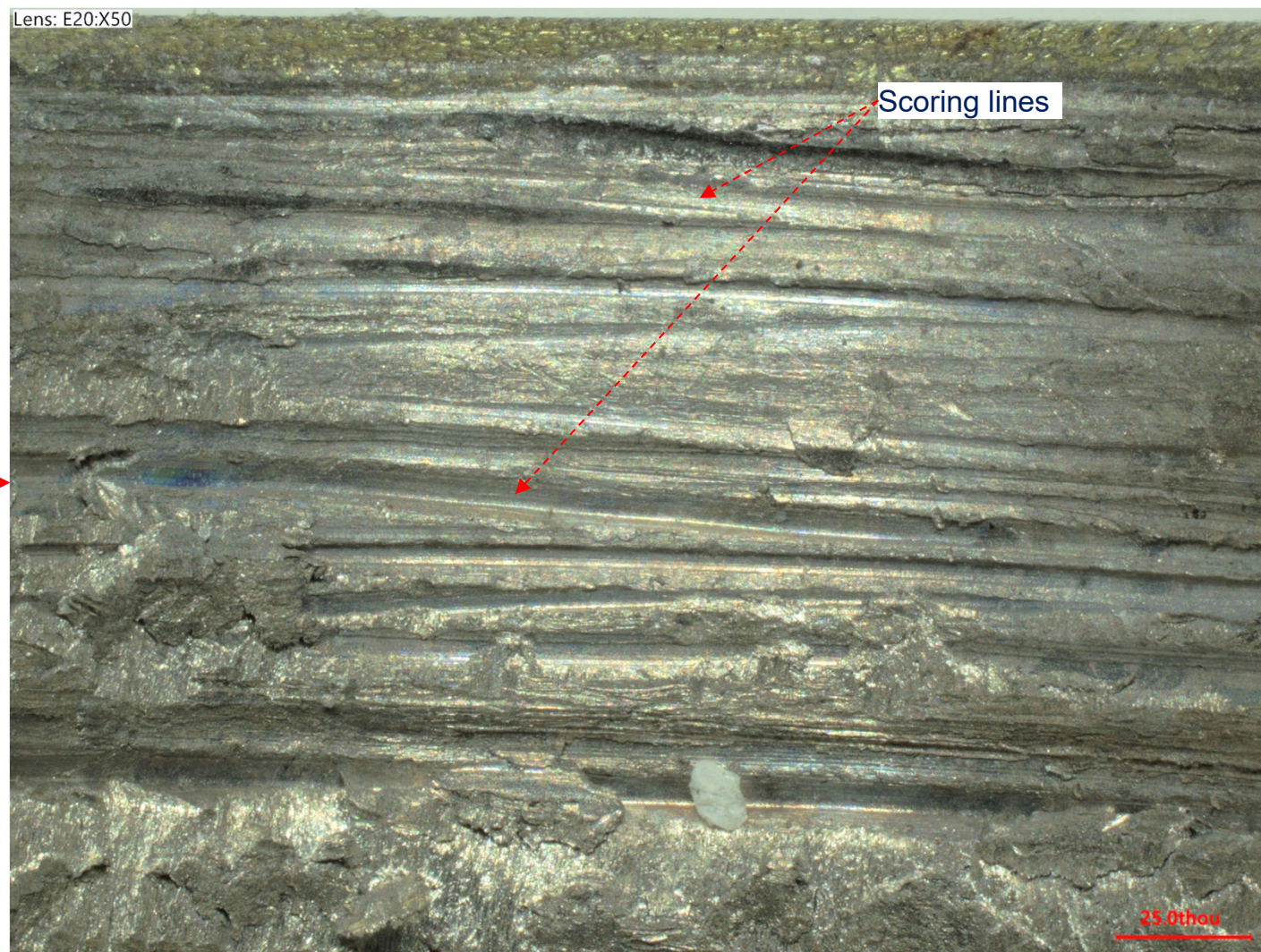
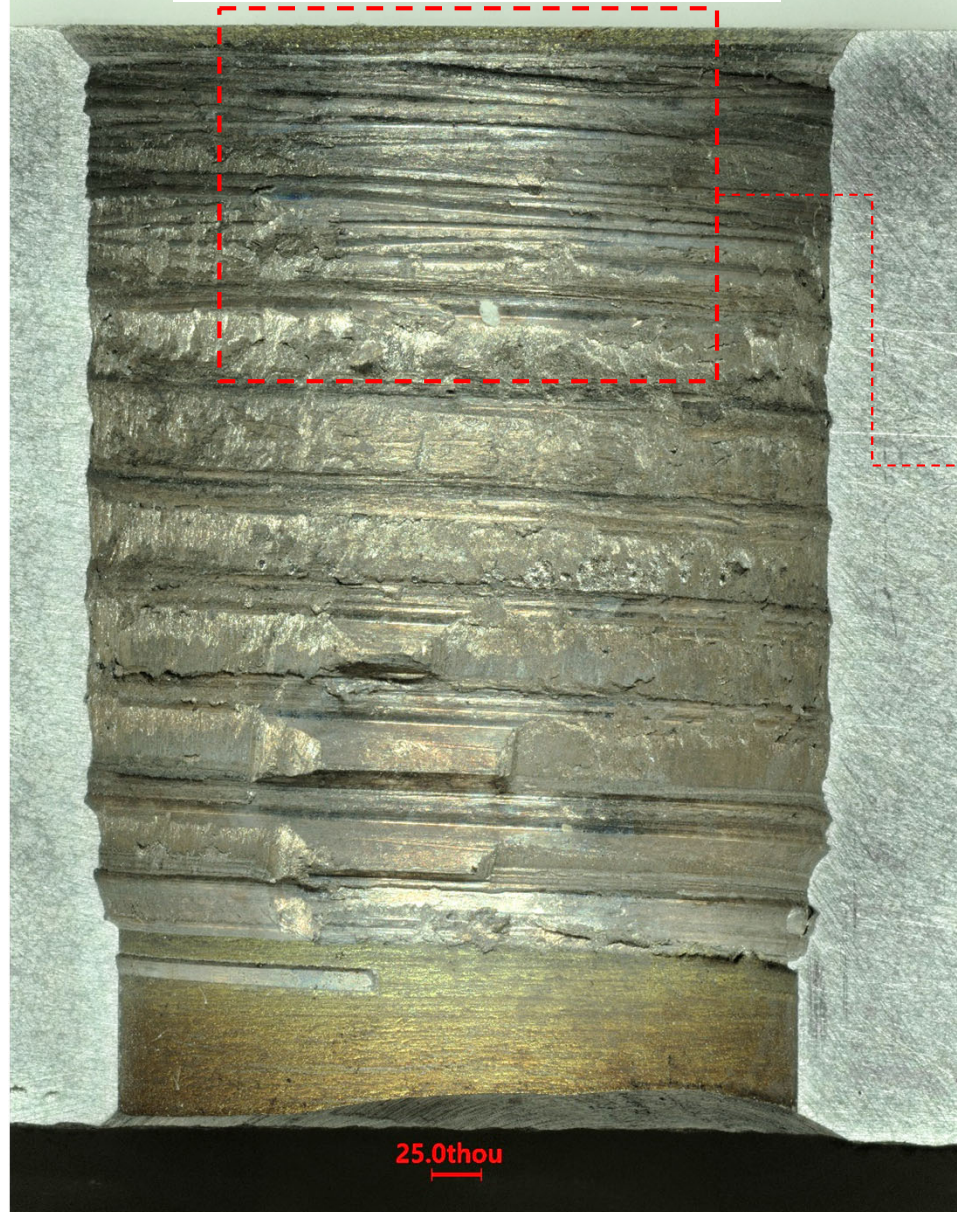


Figure 28: Image of the Insert 3 hole location with side lighting. Scoring lines near the top of the hole are consistent with the steel insert cross-threading and cutting through the pre-tapped internal threads.

	Drawing Requirement	Insert 1 Measurement	Insert 2 Measurement	Insert 3 Measurement	Insert 5 Measurement	Insert 8 Measurement
Insert Major DIA, J (in)	0.3700 - 0.3750	0.374	0.371	0.374	0.374	0.372
Insert Length, C (in)	0.474 - 0.494	--	--	0.480	0.480	--
Drilled Hole Diameter	0.344 - 0.351	--	0.344	--	--	0.344

Insert 5 (Passed pull-out test)



Insert 3 (Failed pull-out test)

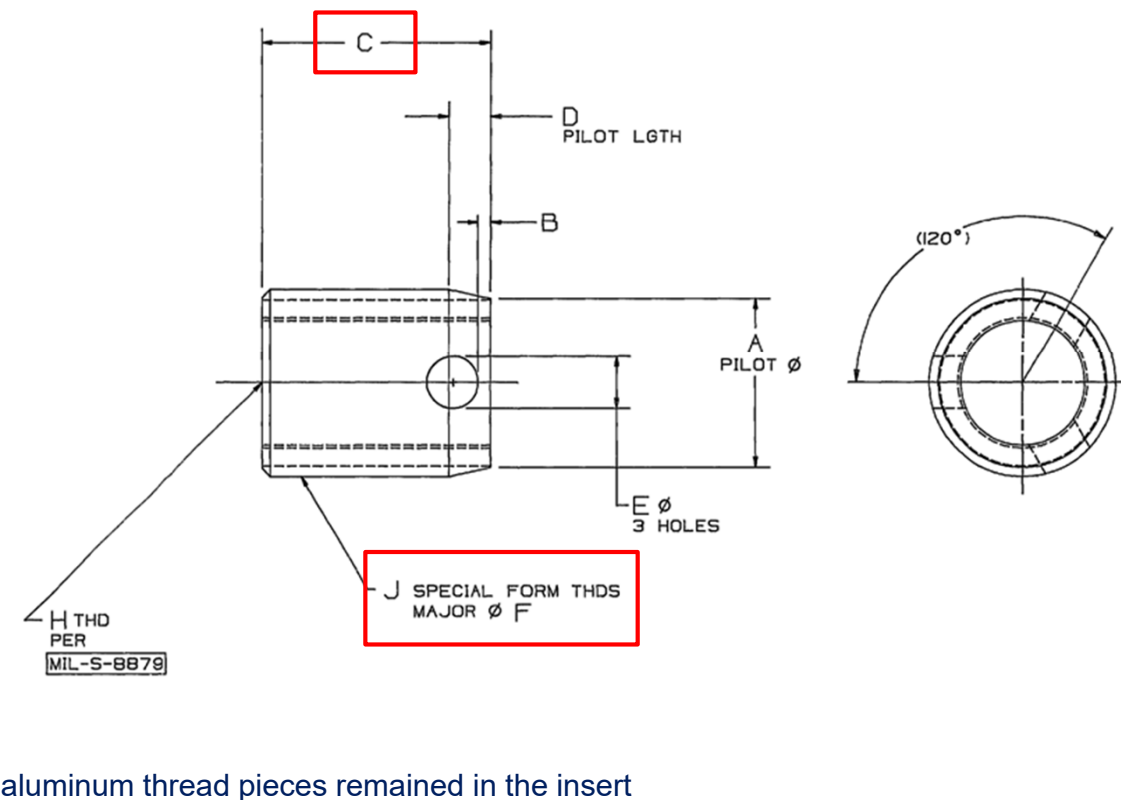
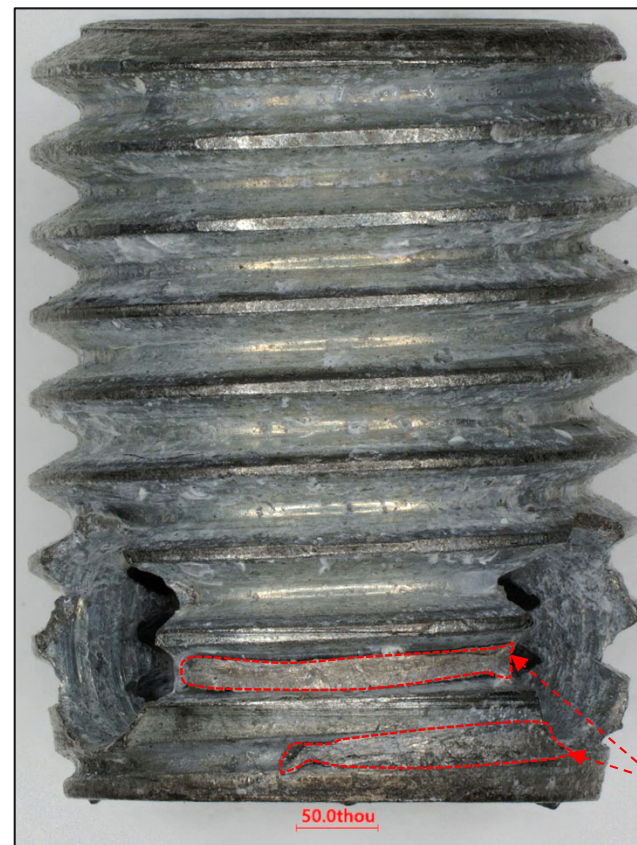


Figure 29: Images of insert 3 and 5 after removal from the flange. The major diameter of inserts 1, 3, 5, and 8 were measured and are conforming to the drawing requirement. The drilled hole diameters for holes 2 and 8 were measured at the bottom of the holes in the untapped section and both are conforming.



Insert 8

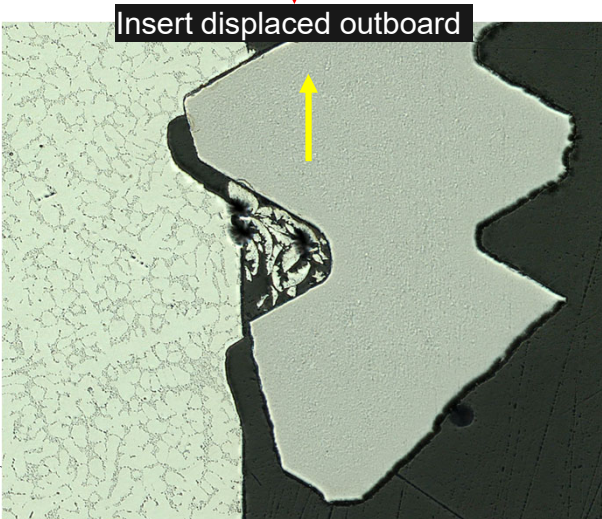
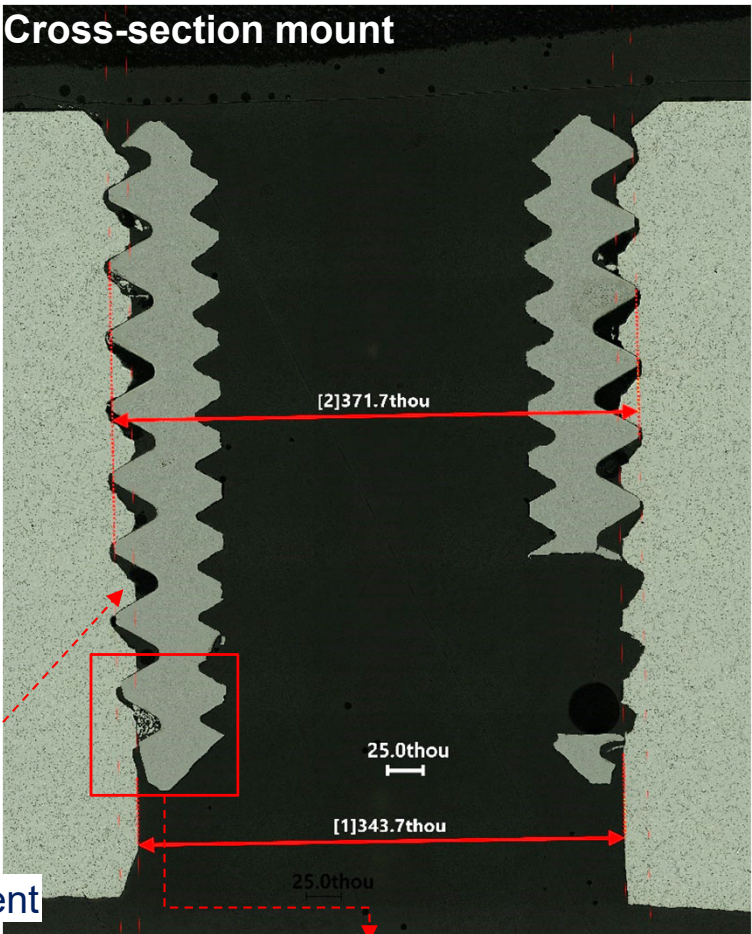
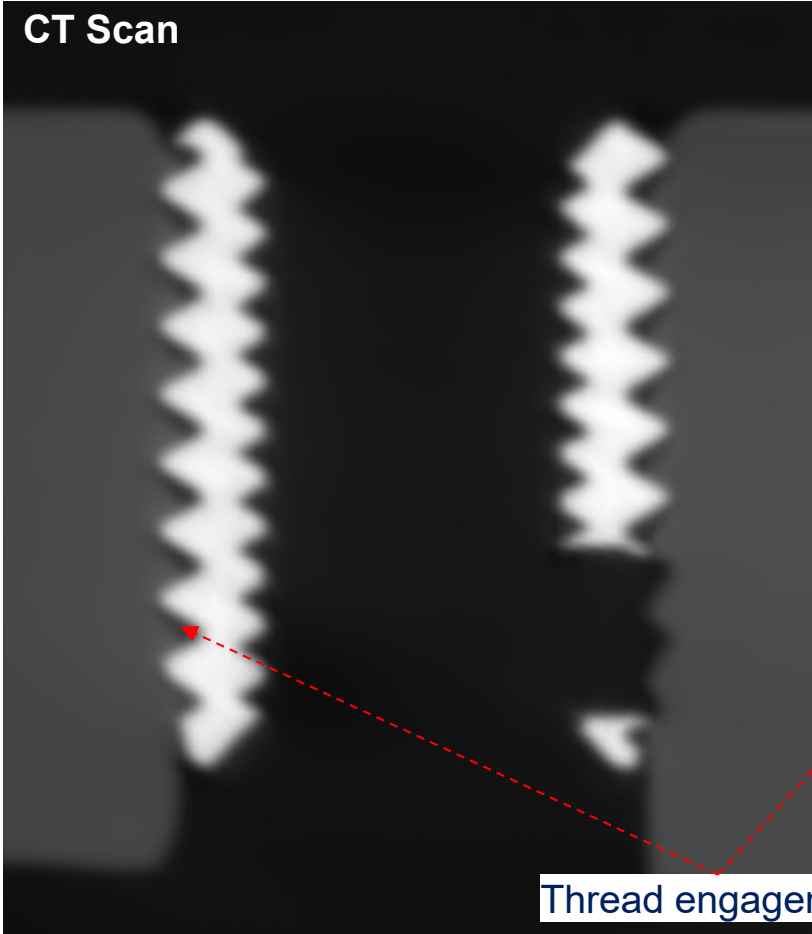
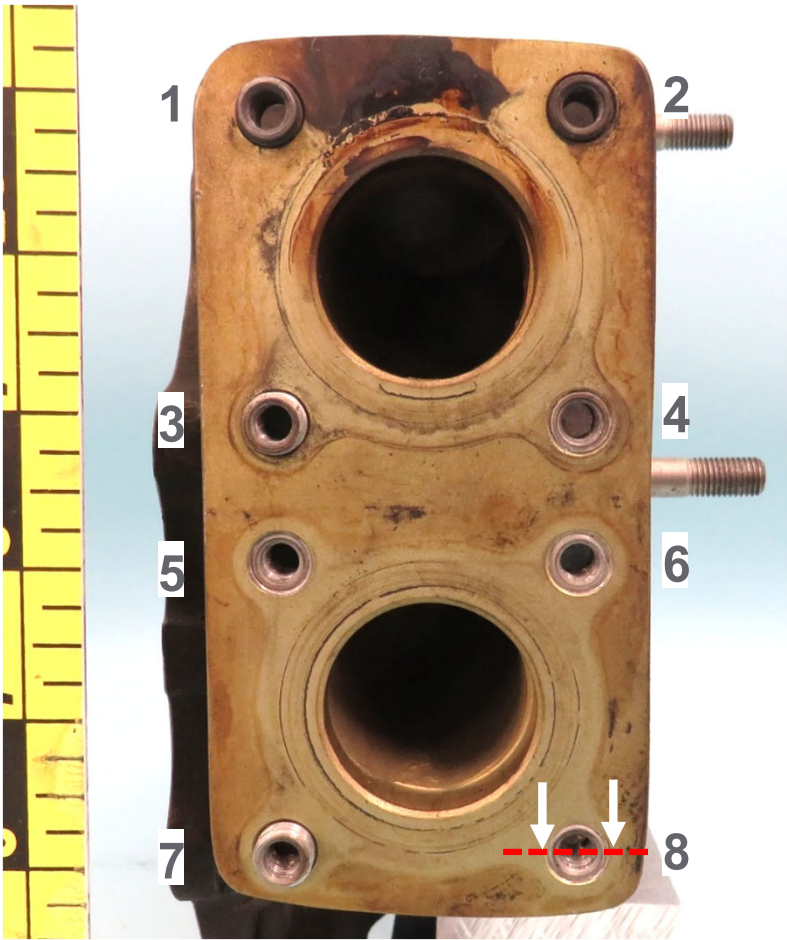


Figure 30: Insert 8 cross-section mount views confirms the thread engagement observed in the CT scan. This insert passed the pull-out test. The cut threads in the aluminum flange are larger than the steel insert thread, however, evidence of a sheared lower thread and displacement of an insert thread into the adjacent aluminum thread (lower right image) is consistent with the insert moving outboard from the original cut position. It is unknown whether the outboard movement occurred at installation or during the post-flight pull-out test.



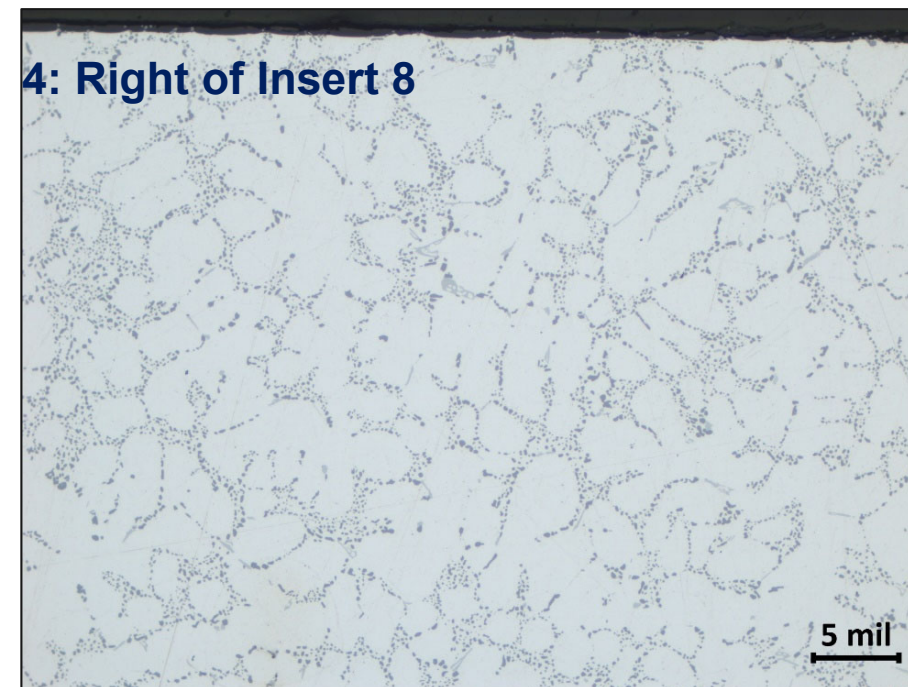
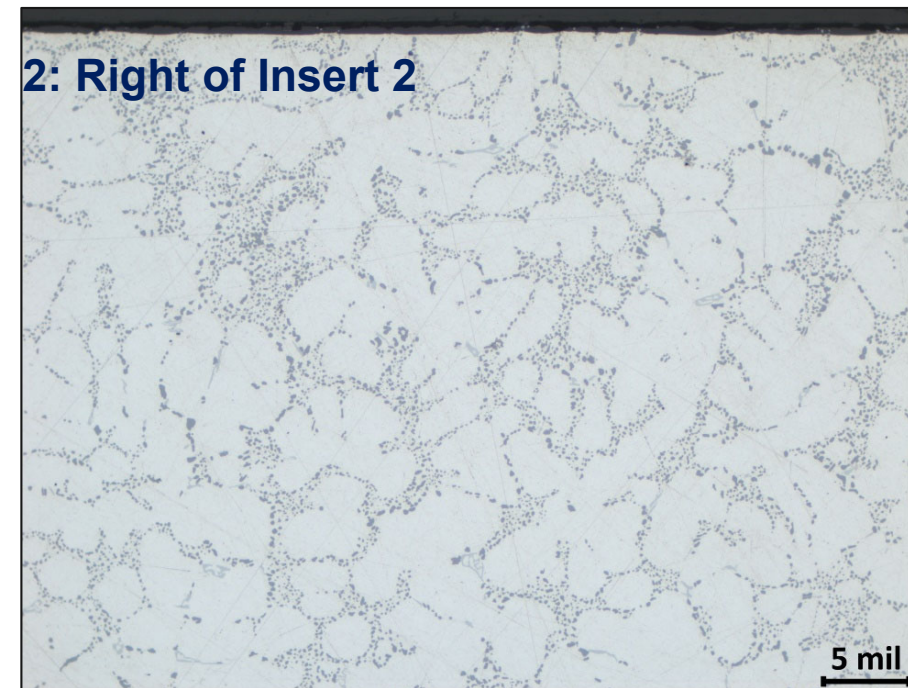
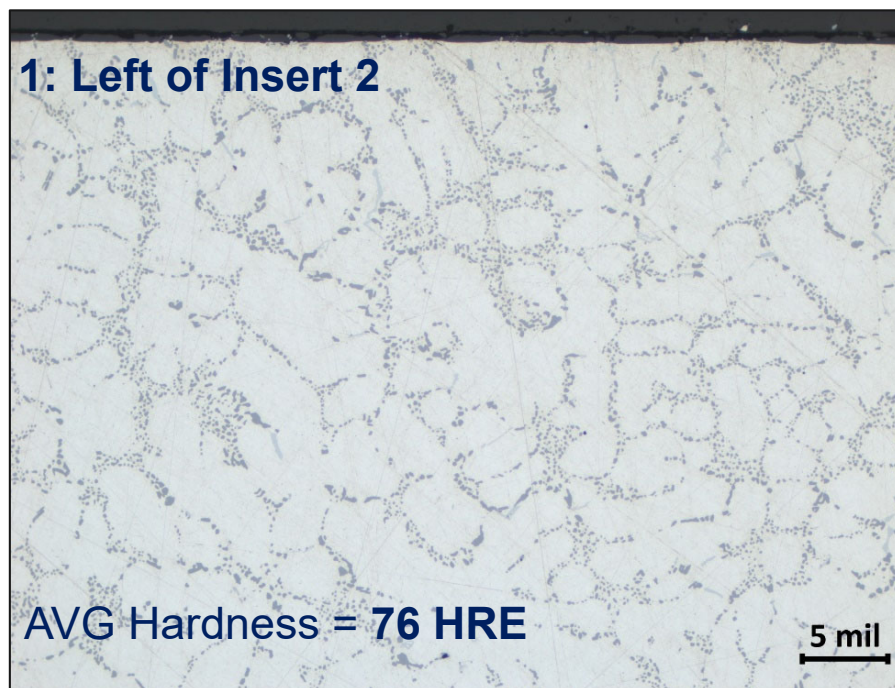
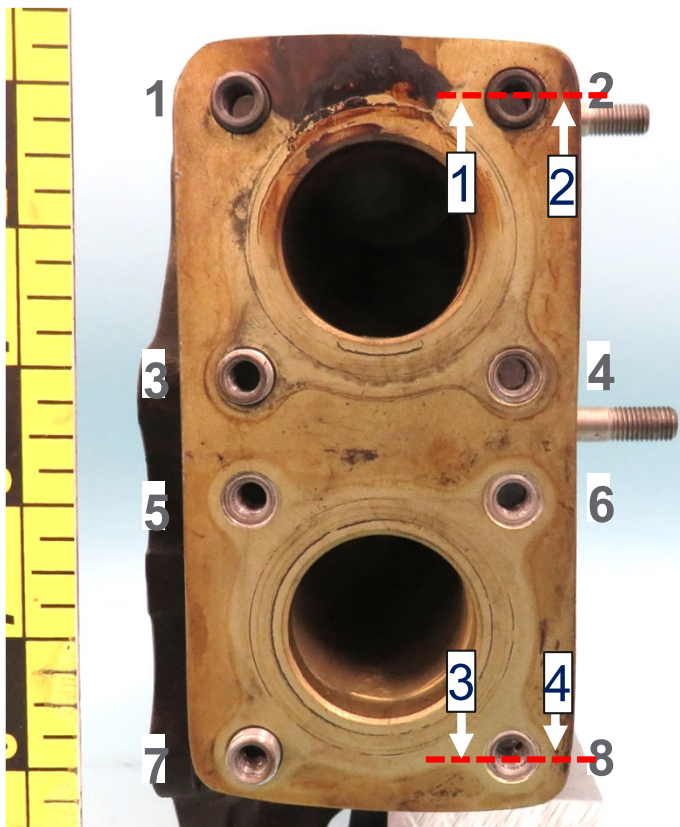


Figure 31: Cross-section images reveal a similar microstructure near holes 2 and 8. Hardness is 76 HRE near the top of the flange and increases towards the bottom, consistent with aging due to heat exposure from the fire.

Hole 2 AVG Hardness: 76 HRE

Hole 3 AVG Hardness: 82 HRE

Hole 8 AVG Hardness: 85 HRE



Gasket Seal

P/N: 1453M60P04



Top gasket (discharge cross-over tube):



Bottom gasket (bypass cross-over tube):



Figure 32: Optical views of the gasket seals as-received by the FA lab.

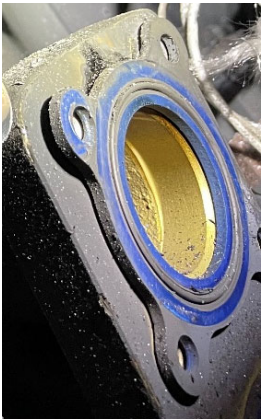
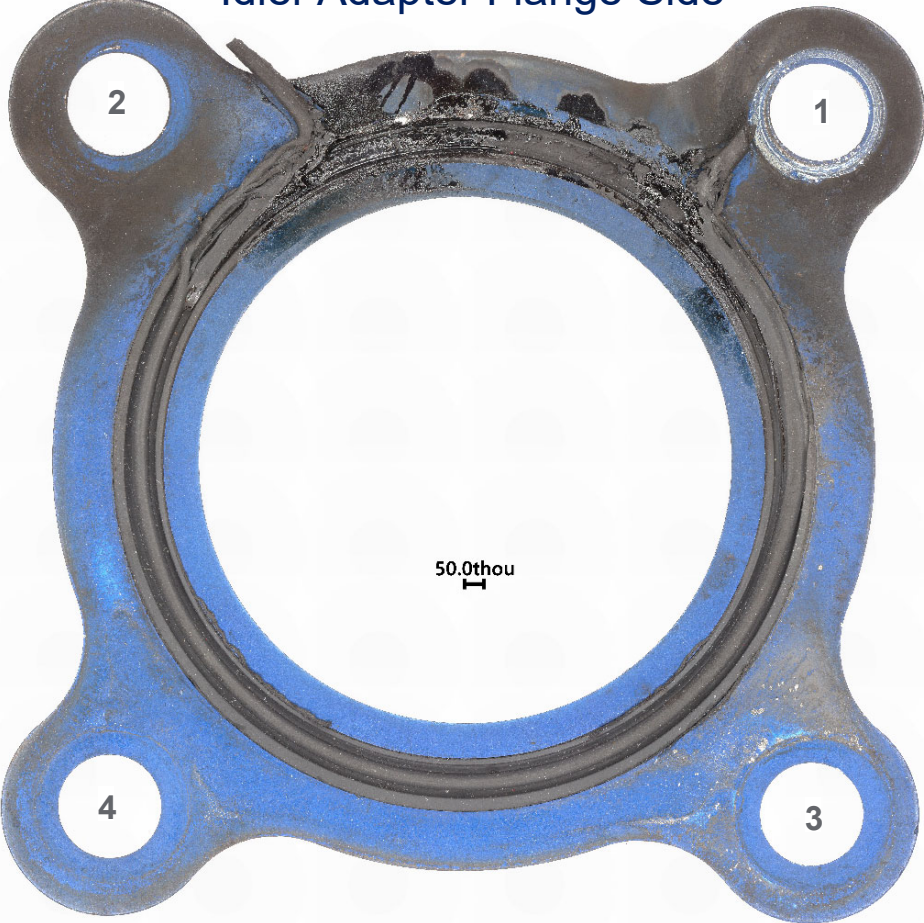
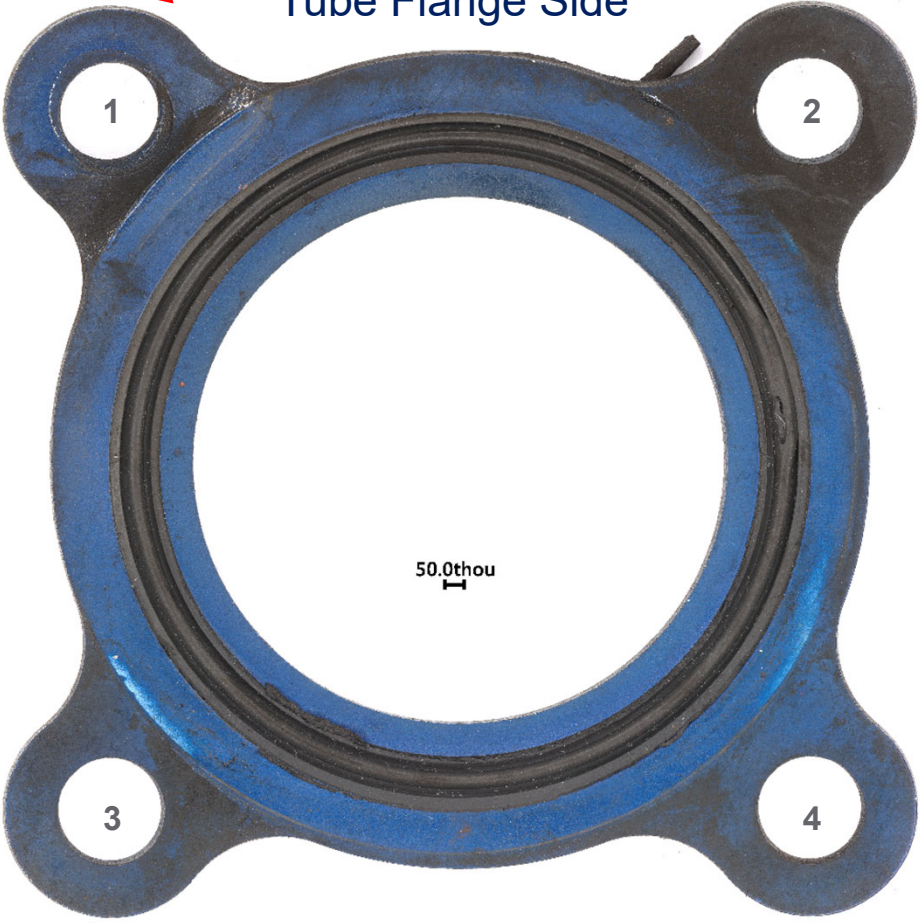


Figure 33: Images of the top gasket seal as-received by the FA lab. The retainer at the thread insert location1 is deformed outboard relative to the idler adapter flange surface. The thread insert was found protruding from the flange at this surface.

Idler Adapter Flange Side

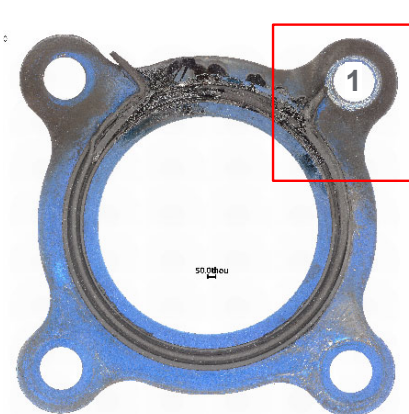


Tube Flange Side

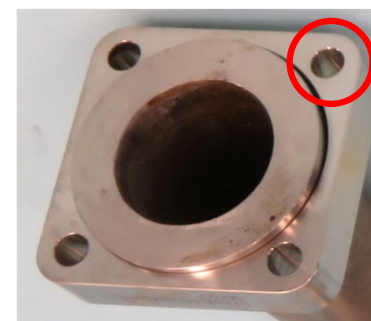


Deformed retainer flange





Idler Adapter Flange (thread insert) Side



Tube Flange Side

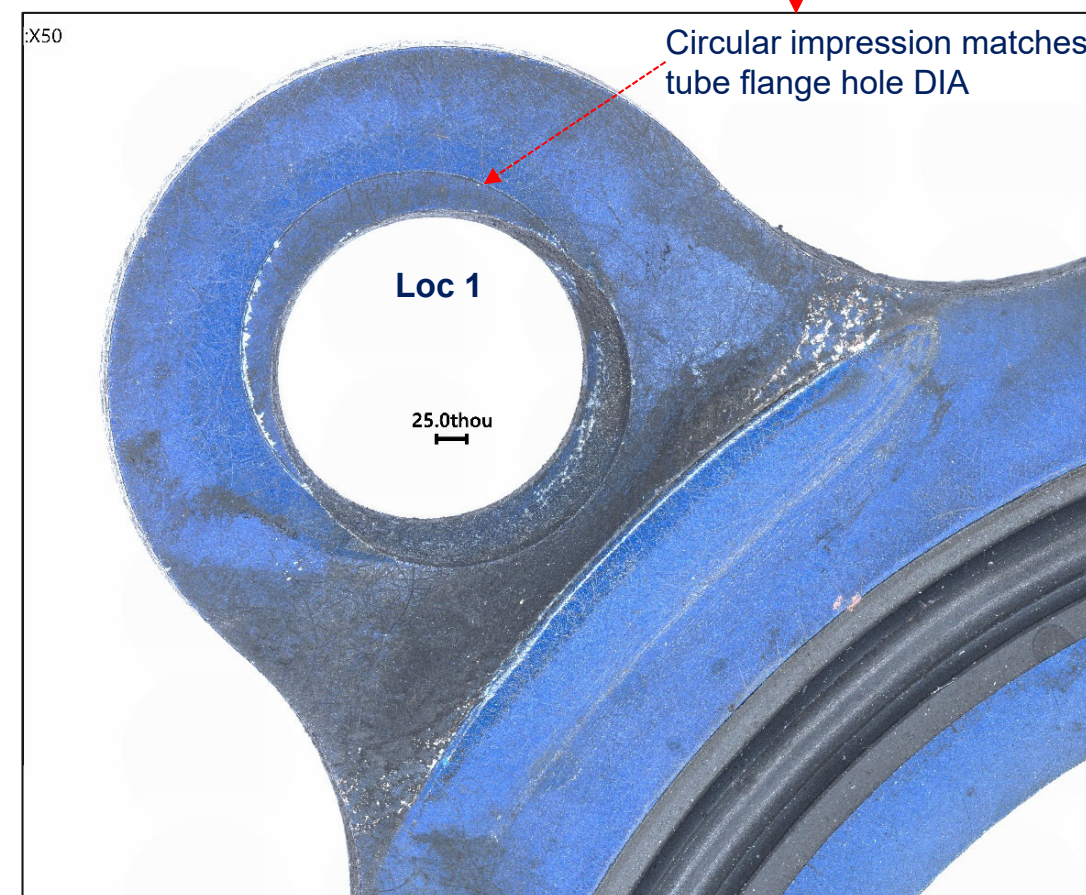
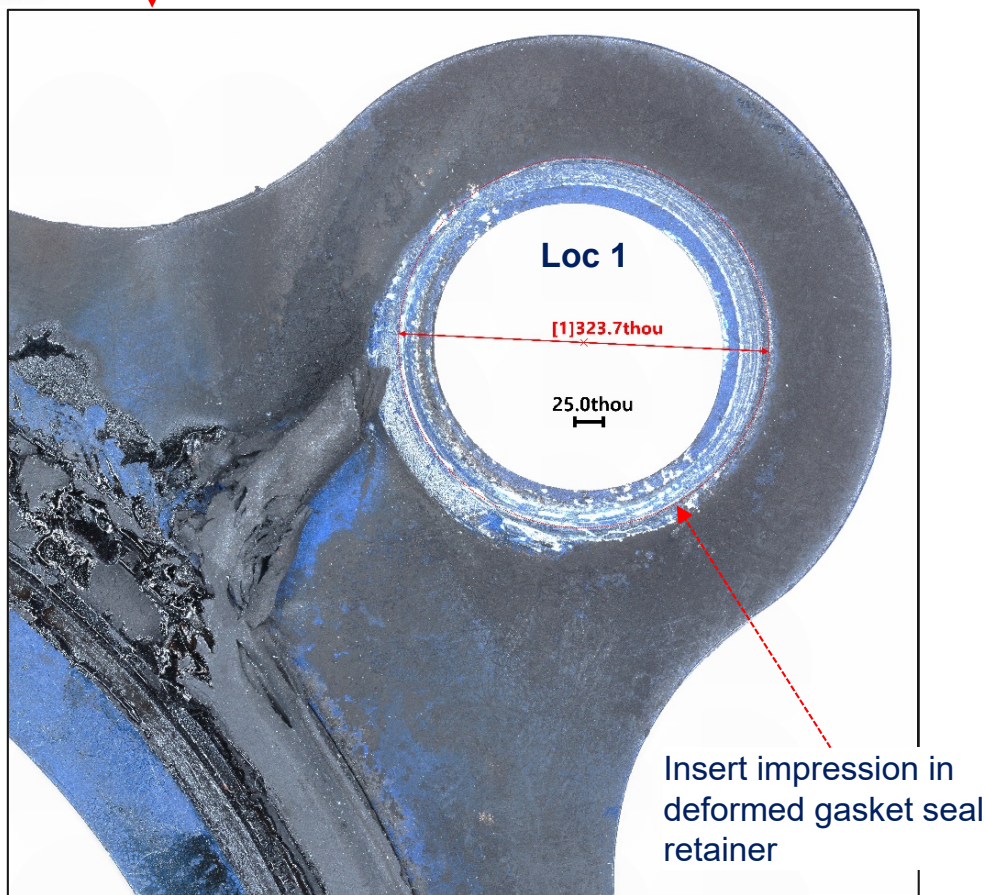
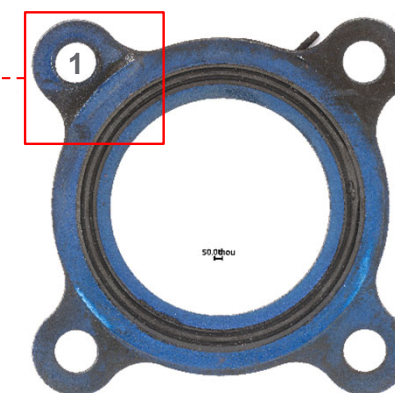


Figure 34: Images of the top gasket seal reveals an impression matching the shape and size of the thread insert at location 1, where the insert was found protruding from the flange (left). A circular impression observed on the tube flange side of the gasket is consistent with the tab contacting the tube flange after deforming outboard (right).



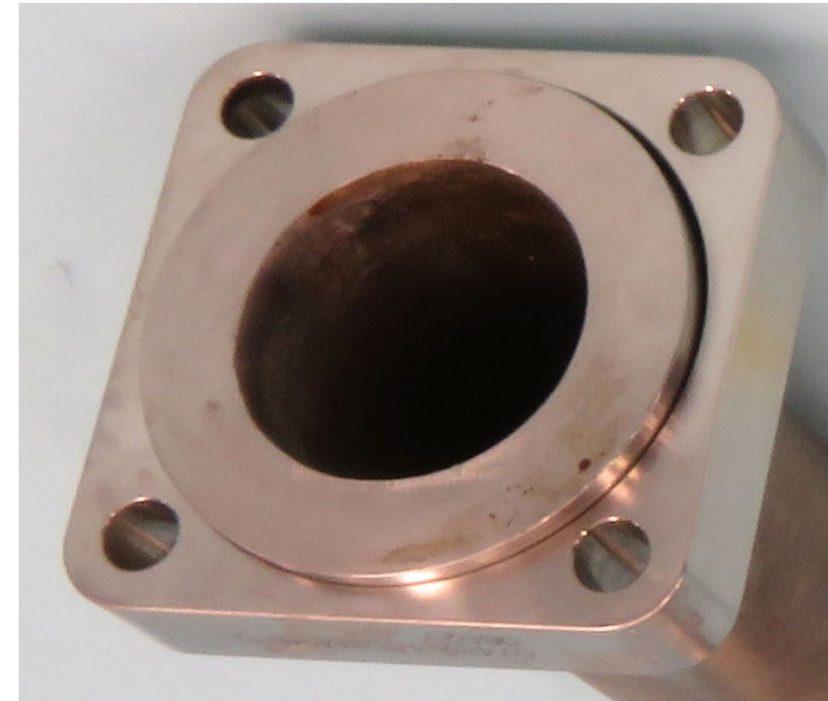
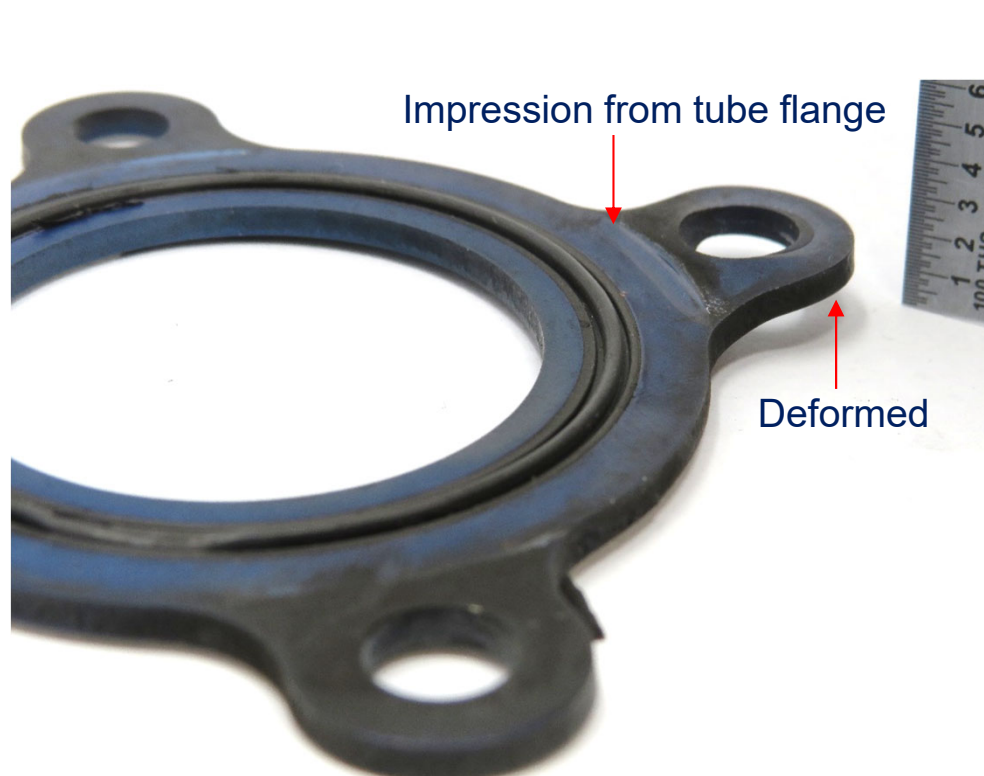


Figure 35: Two areas of the gasket seal retainer do not have black surface deposits, consistent with contacting the tube flange at these areas during the fire. The retainer surface that mates with the tube ferrule is relatively flat and has a circular impression, consistent with being clamped between the idler adapter flange and tube ferrule surfaces when the insert 1 gasket tab location deformed.



Figure 36: Blue light scan measurements of the top gasket seal reveals a 0.062 – 0.069 inches of deformation in the location 1 retainer flange.

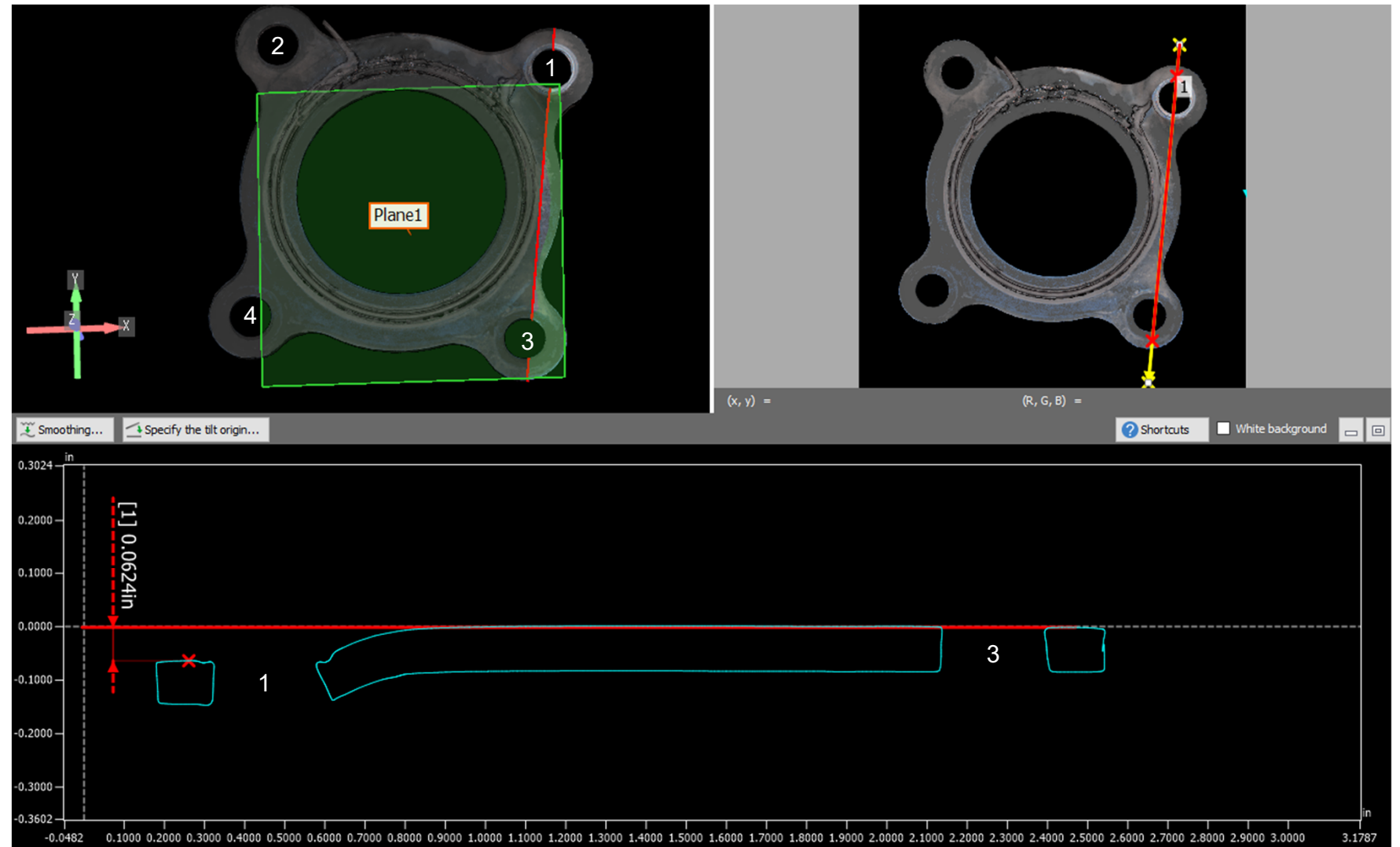
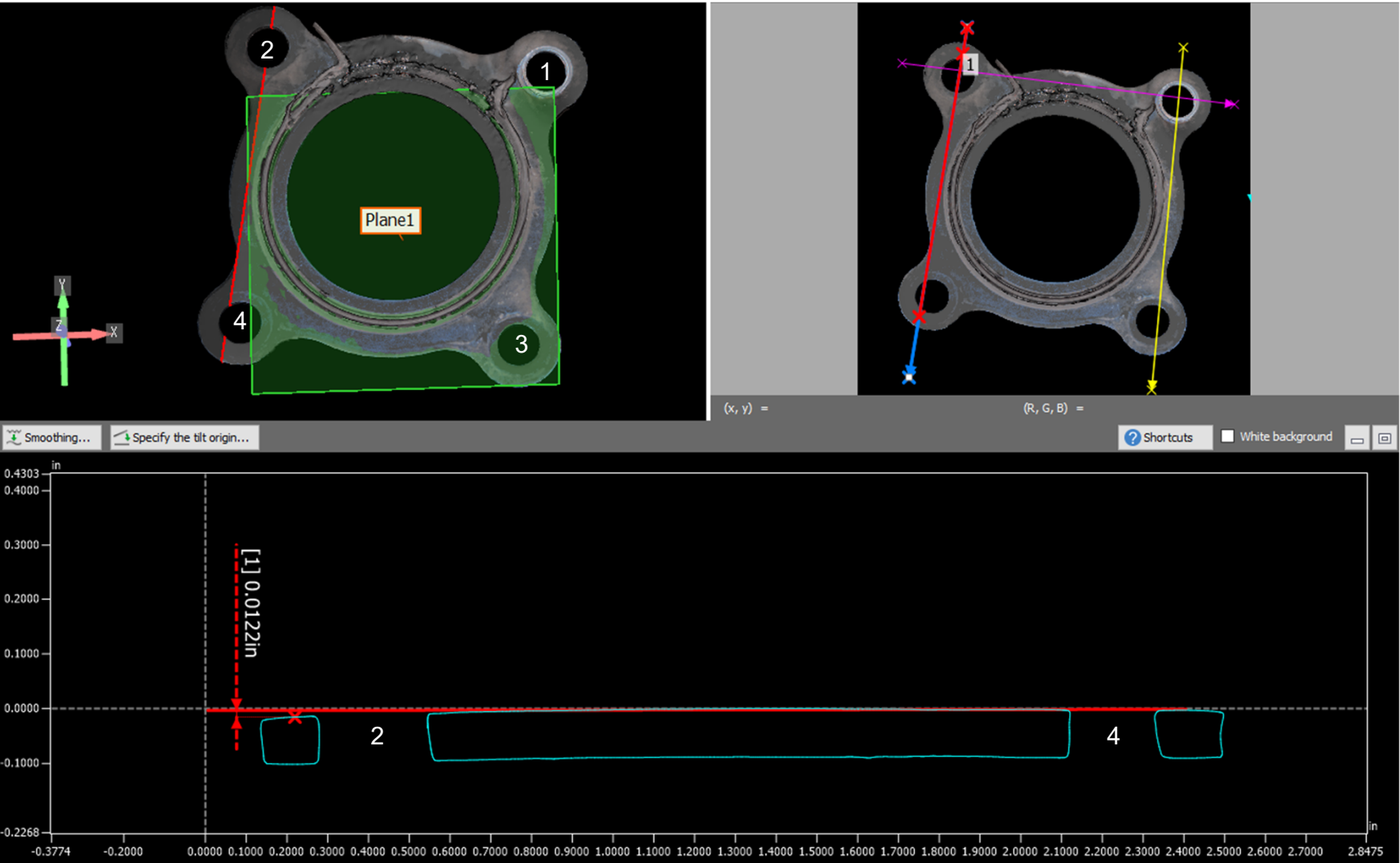


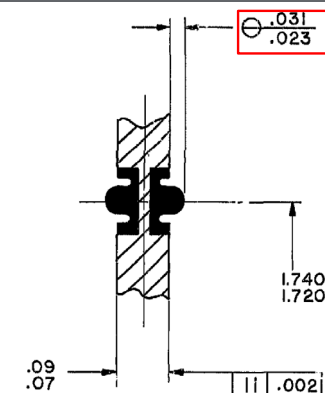
Figure 37: Blue light scan measurements of the top gasket seal reveals a 0.012 inches of deformation in the location 2 retainer flange.



Seal retainer deformation = 0.069 in

Tube ferrule/flare AVG measured distance (gap) = 0.044 in

1453M60P04 Gasket Seal



Approximate Idler Adapter Flange/Gasket Seal Retainer Separation = 0.069 in - 0.044 in = 0.025 in

Approximately 0.025-in of separation reduces compression of gasket rubber seal

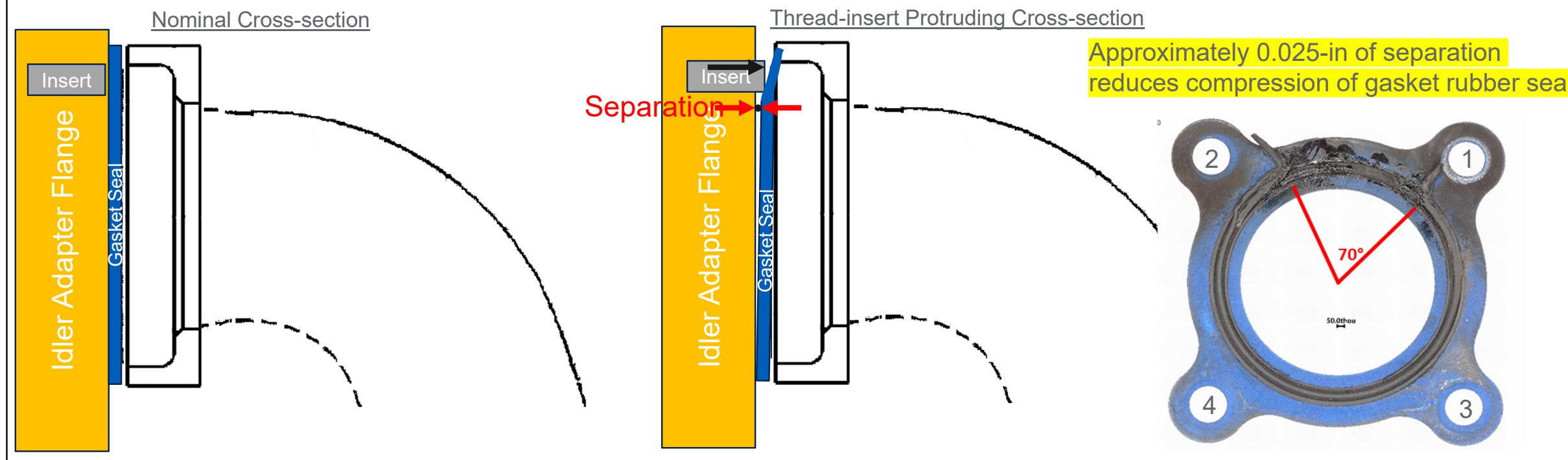


Figure 38: Approximate flange separation calculation based on the average measured 0.044in tube ferrule-to-flange distance and the measured gasket seal retainer deformation.





Figure 39: Image of the discharge cross-over tube in the as-received condition by the FA lab. No unusually findings were observed.

Appendices: Return To Vendor (RTV) HMU Idler Adapter Evaluations



Appendix A: RTV Part

P/N: 9395M78G10

S/N: FIA217C9

[Click here to return to summary table](#)



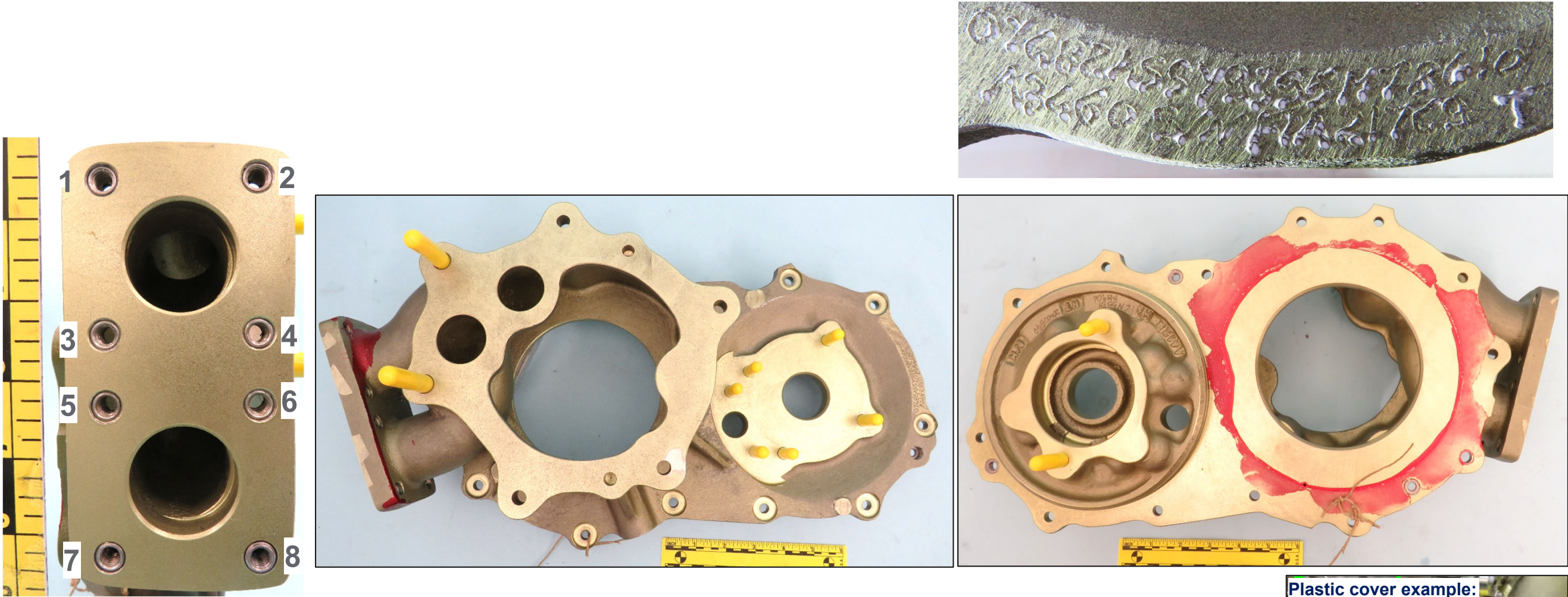
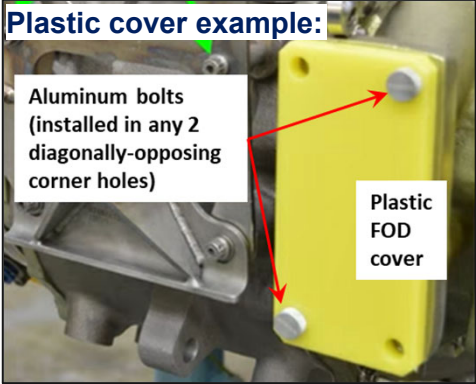


Figure 40: Images of a HMU idler adapter (P/N 9395M78G10, S/N FIA217C9) which was manufactured at Avio the same day as the ESN 707-605 event idler adapter (S/N F1A217EE). S/N FIA217C9 was returned to the manufacturer (Avio) from the Durham engine assembly facility. A protective plastic cover is attached to the flange at new make using two aluminum bolts which can be placed in insert locations 1, 2, 7, or 8 and removed during engine assembly (example image shown on the right). Reportedly, the thread insert labeled number 8 backed out while removing the plastic cover bolts during engine assembly at the Durham facility.



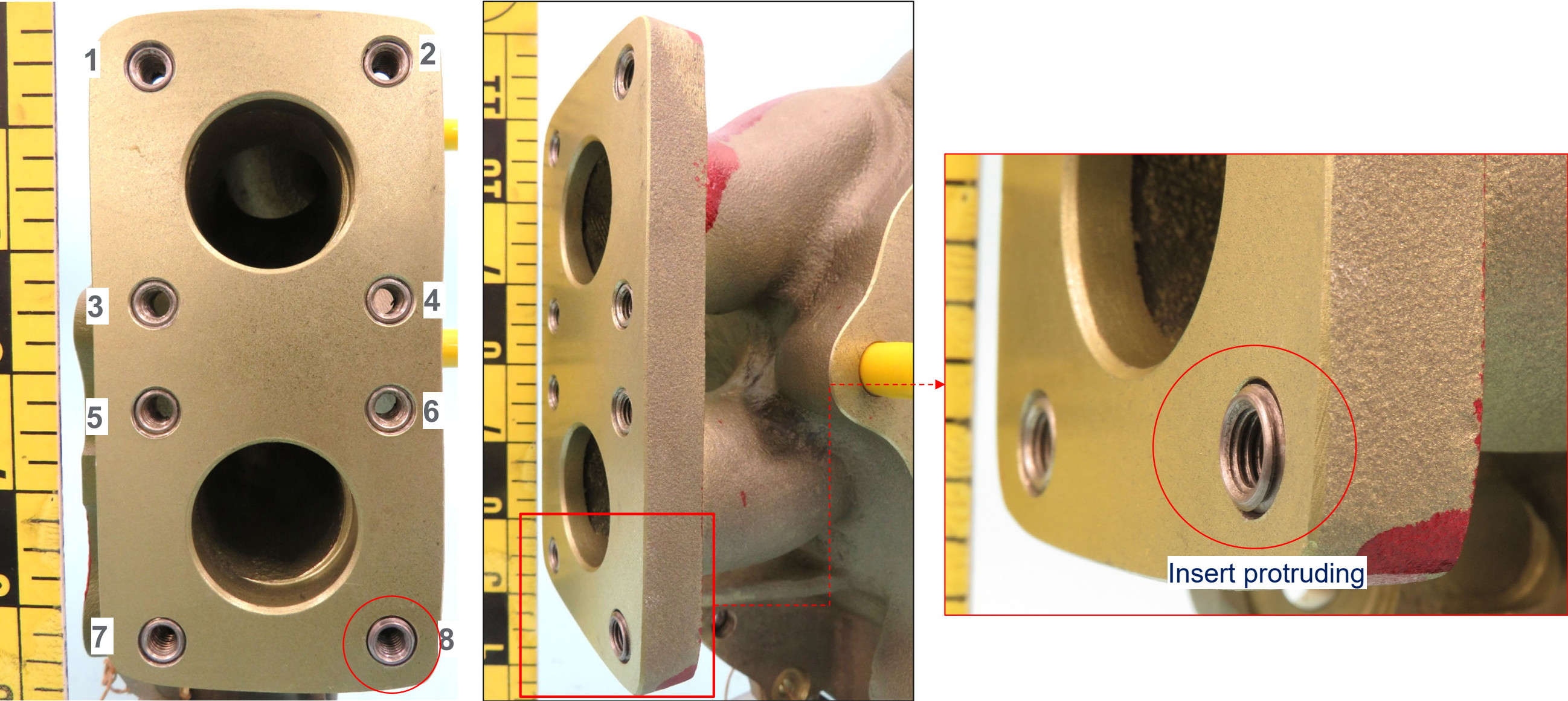
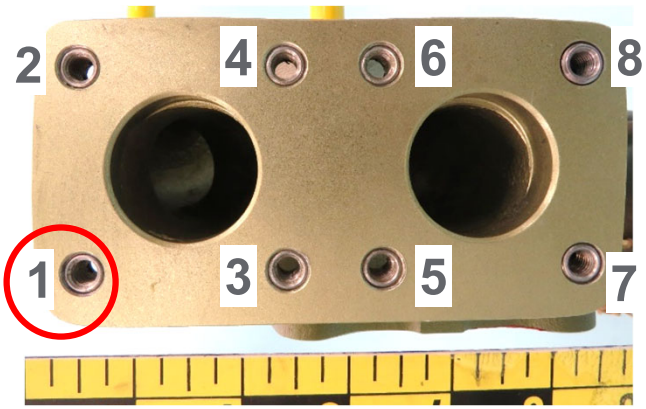


Figure 41: Insert location number 8 which backed out during the removal of the plastic cover is protruding approximately 0.020-inches from the flange surface. The protruding insert was found loose and easy to move by hand.

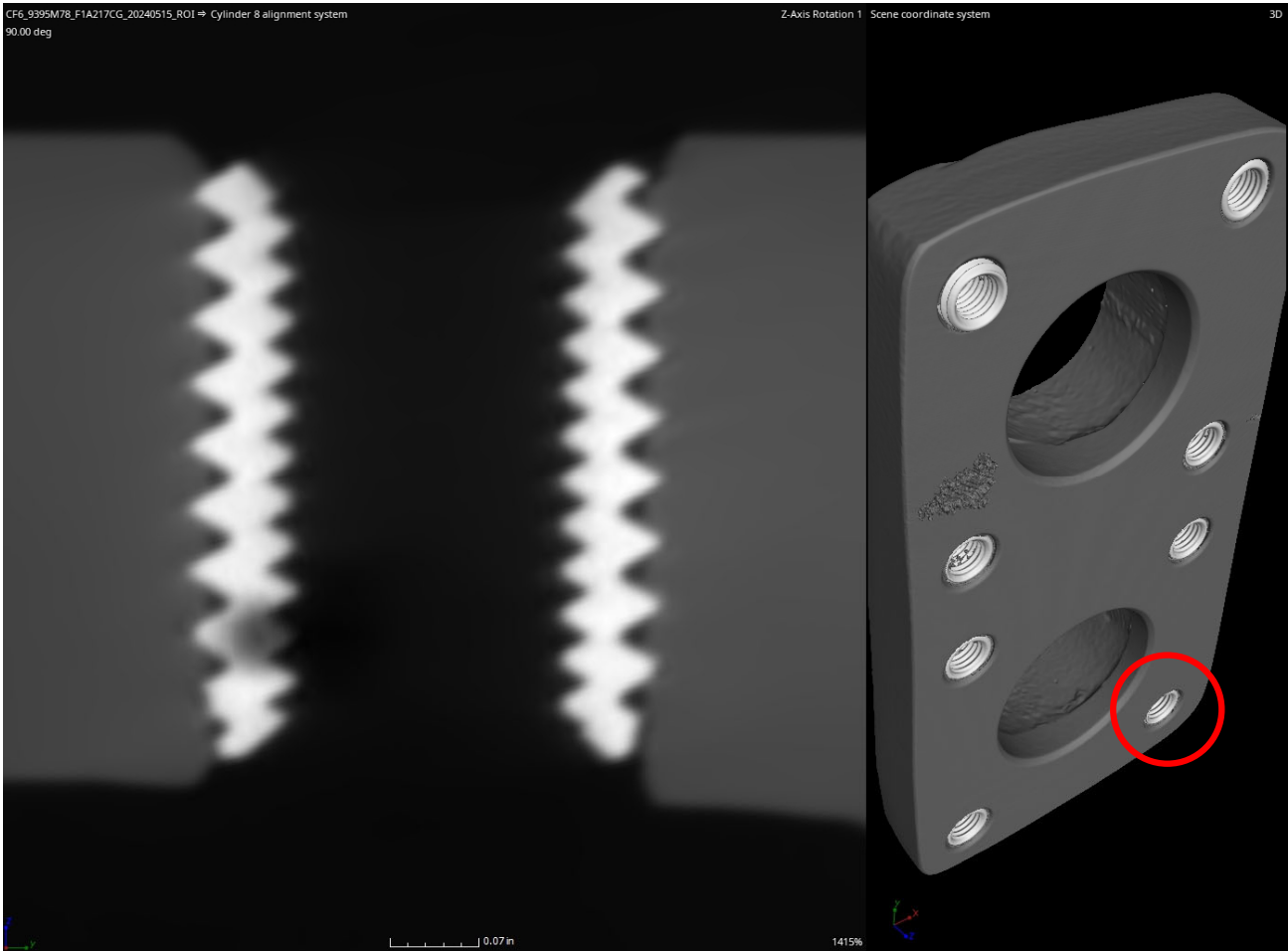
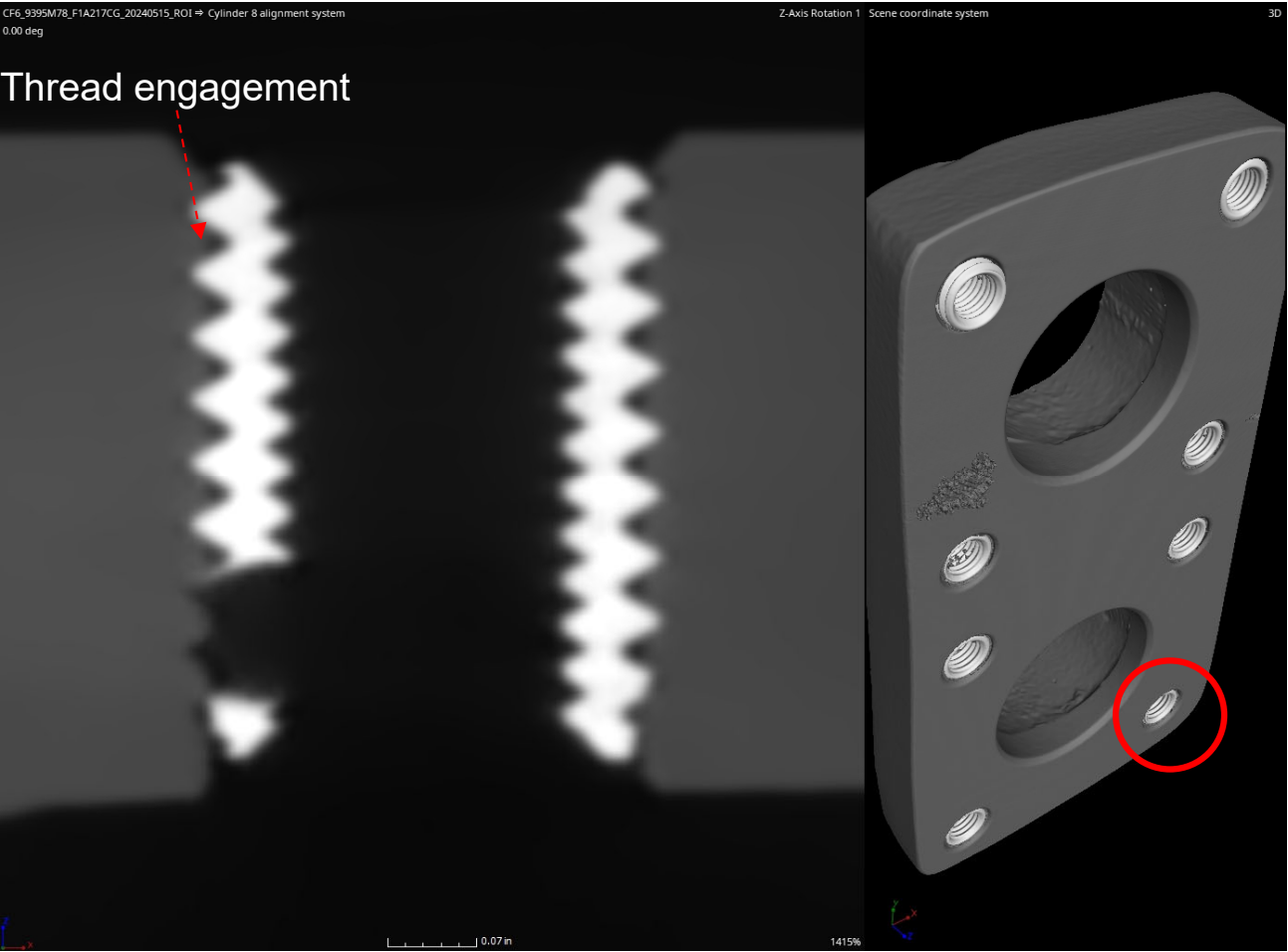


Insert 1

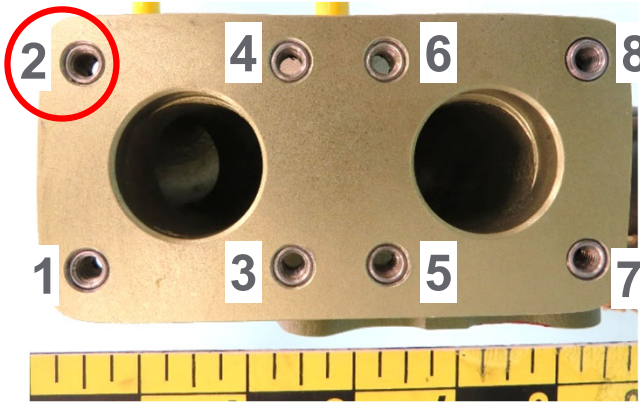


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 42: CT scan cross-section of thread insert position 1. Thread engagement is observed into the flange material.

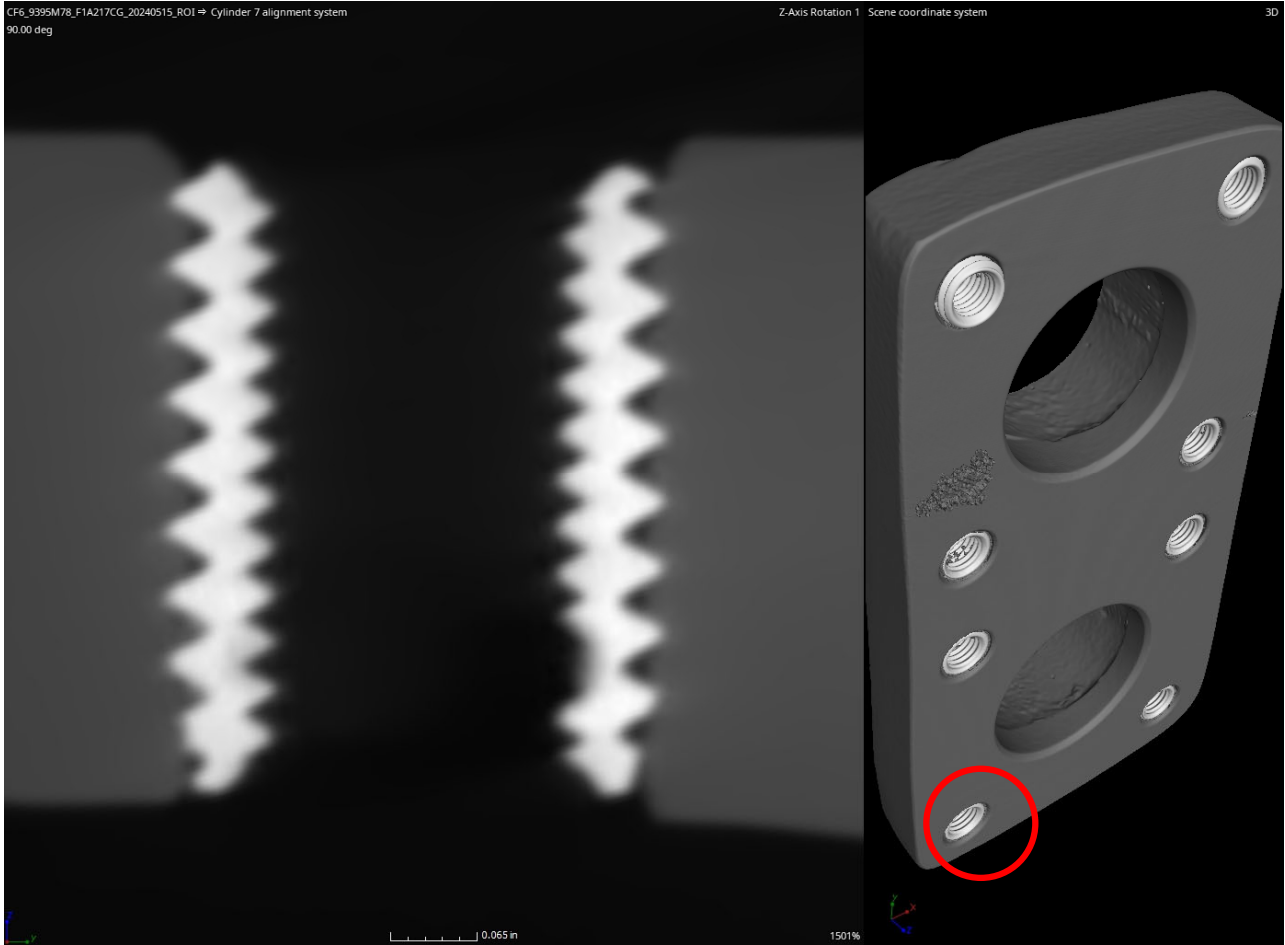
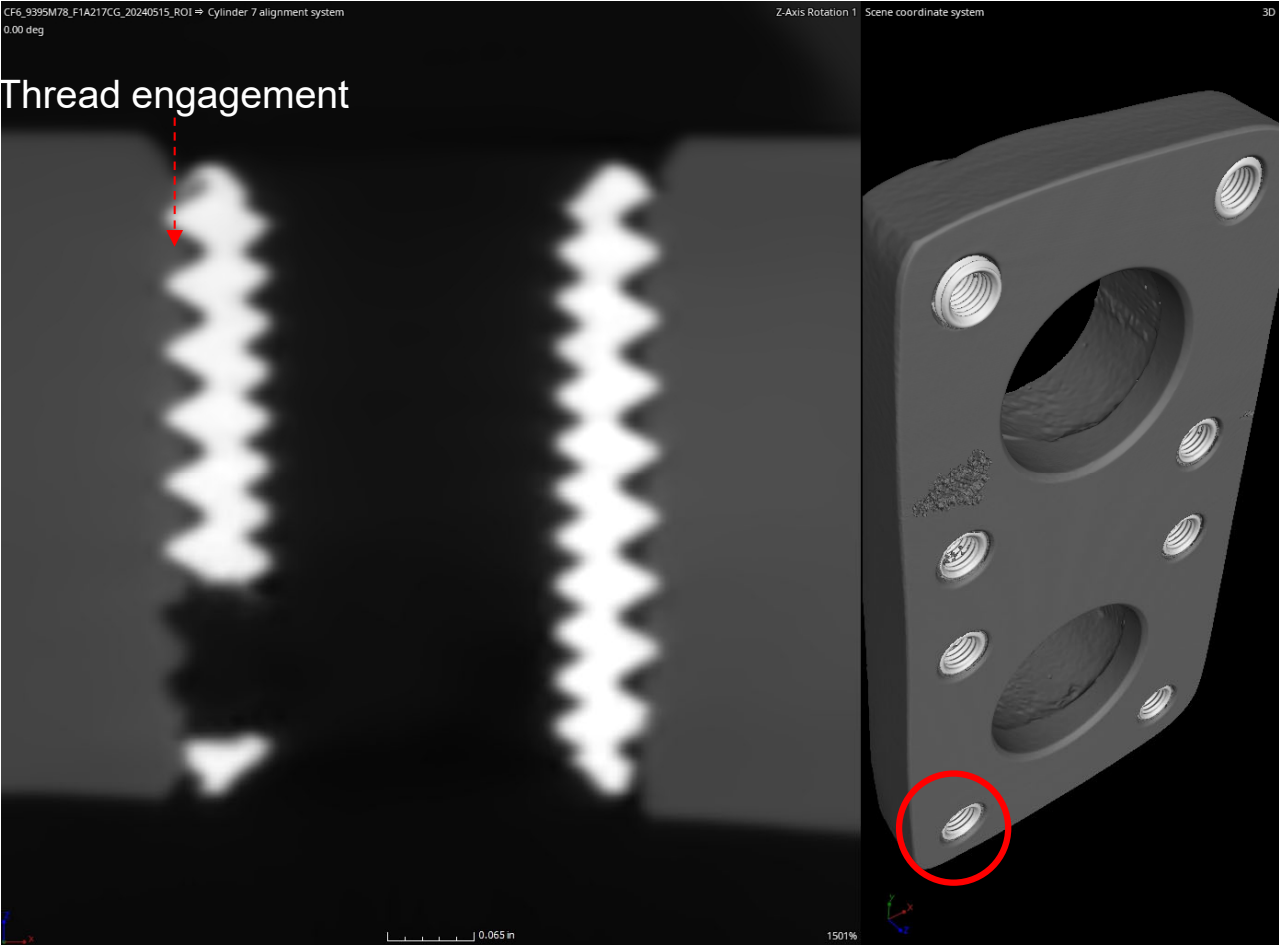


Insert 2

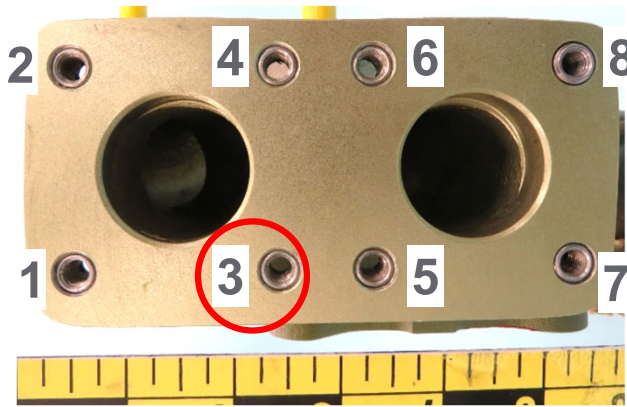


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 43: CT scan cross-section of thread insert position 2. Thread engagement is observed into the flange material.

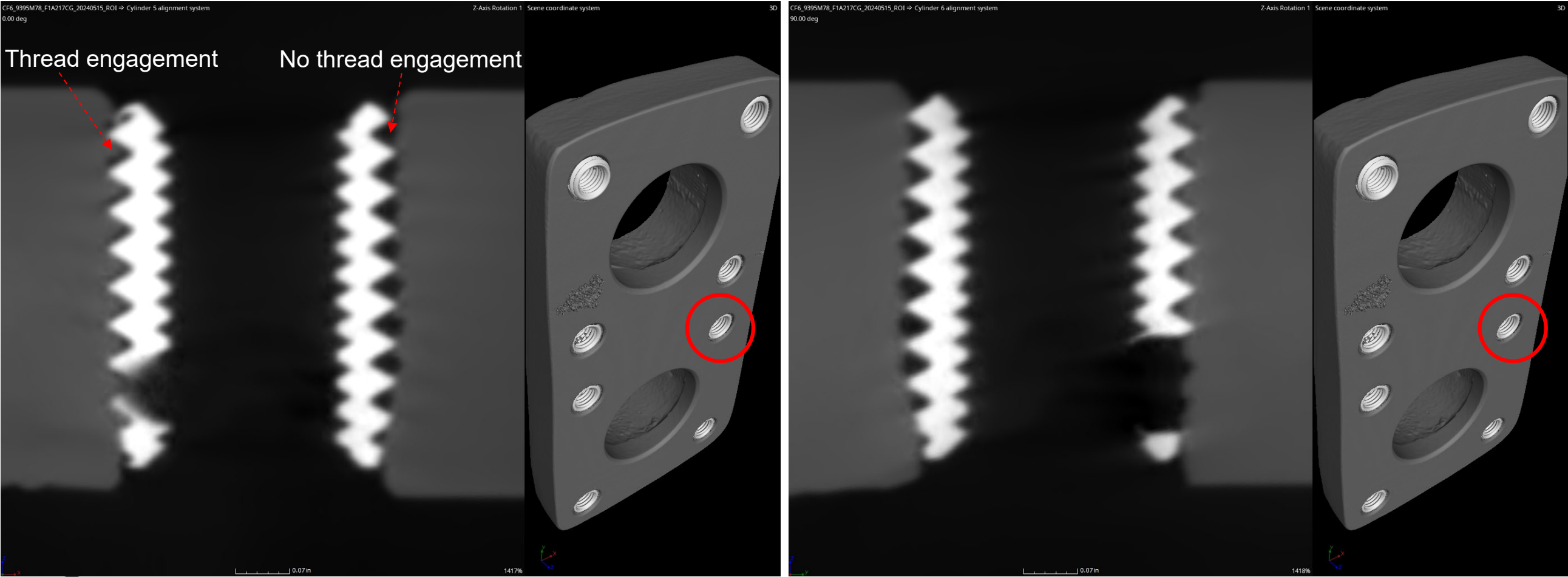


Insert 3

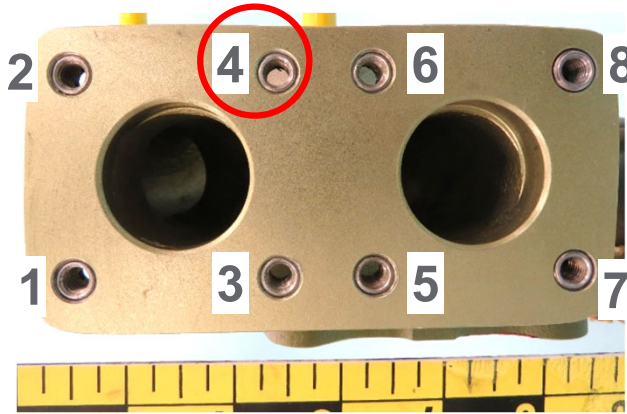


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 44: CT scan cross-section of thread insert position 3. No engagement is observed into the flange material on one side of the hole.

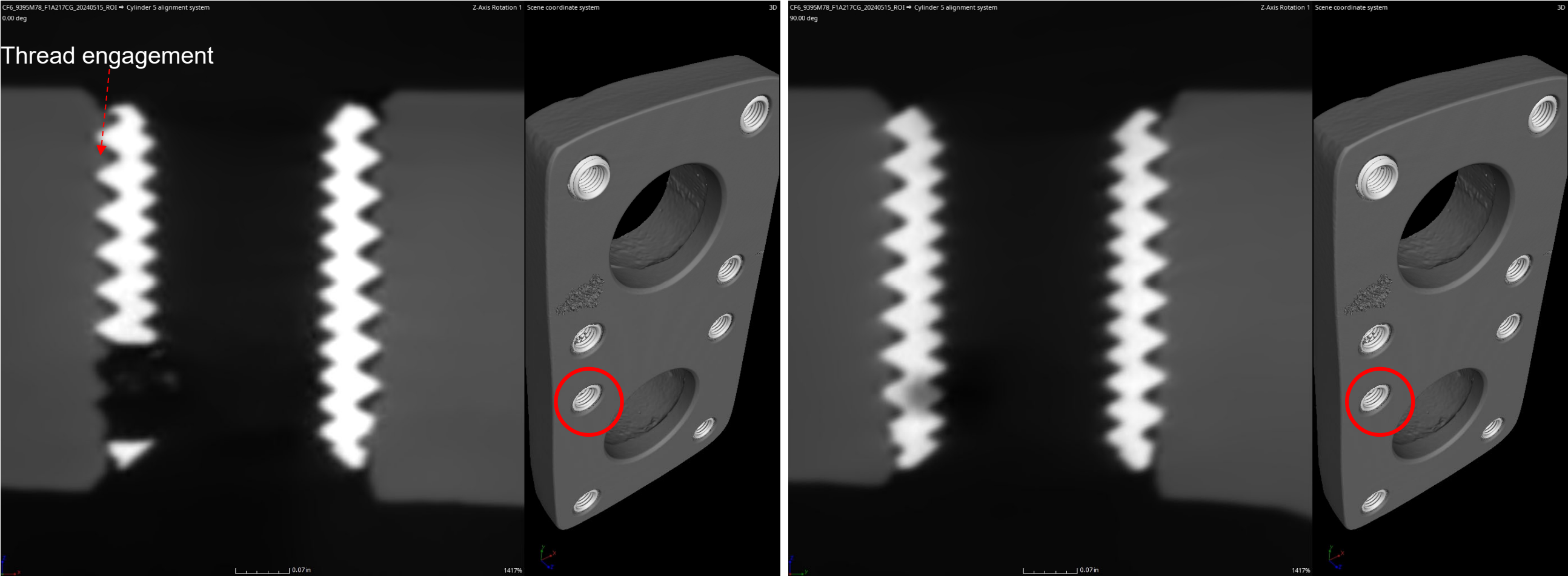


Insert 4

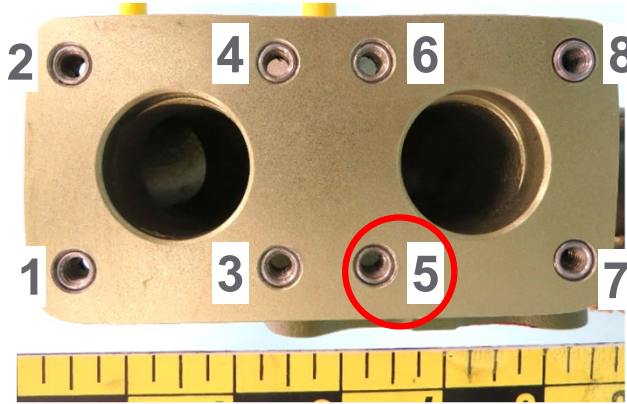


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 45: CT scan cross-section of thread insert position 4. Thread engagement is observed into the flange material.

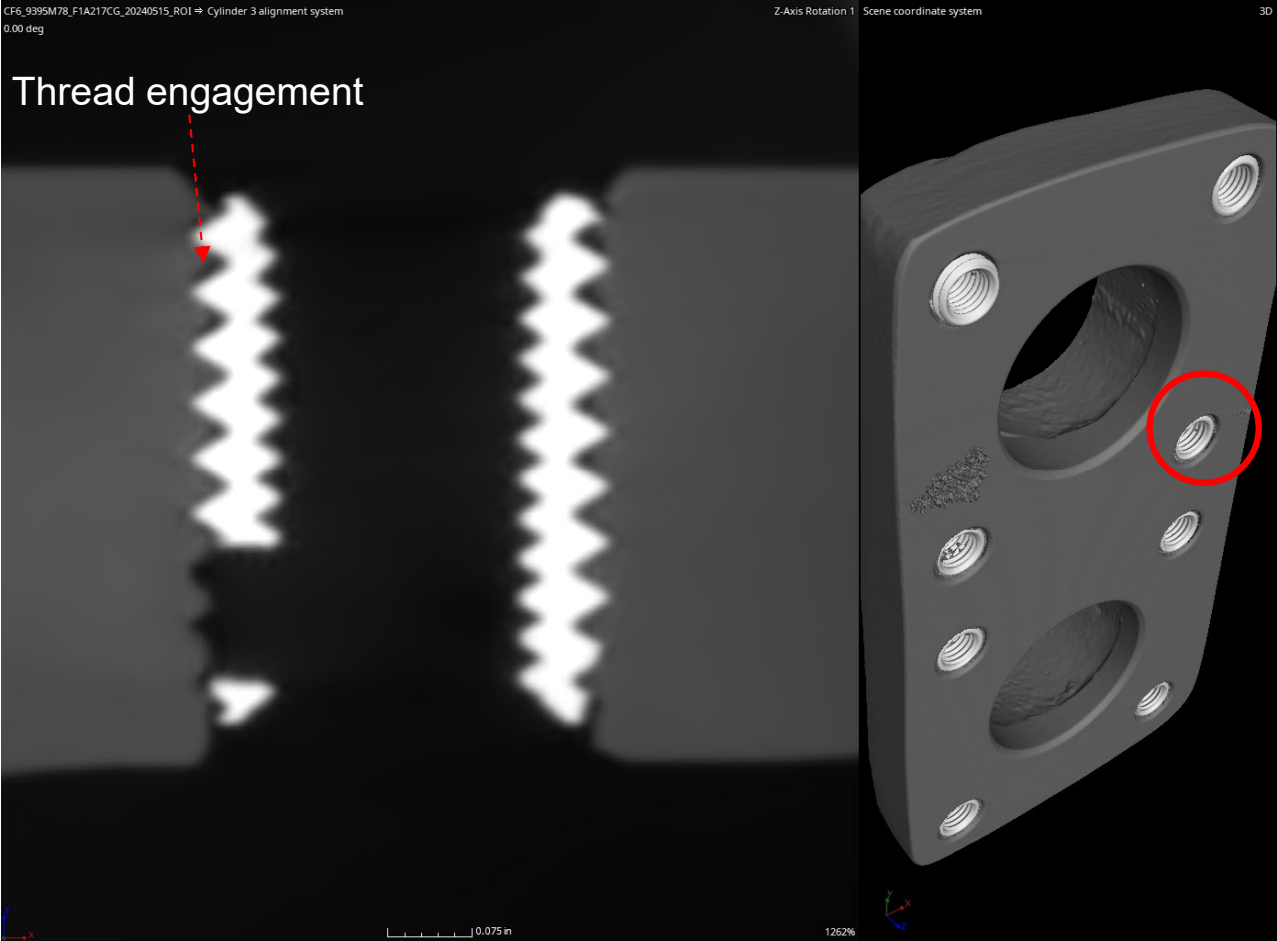


Insert 5

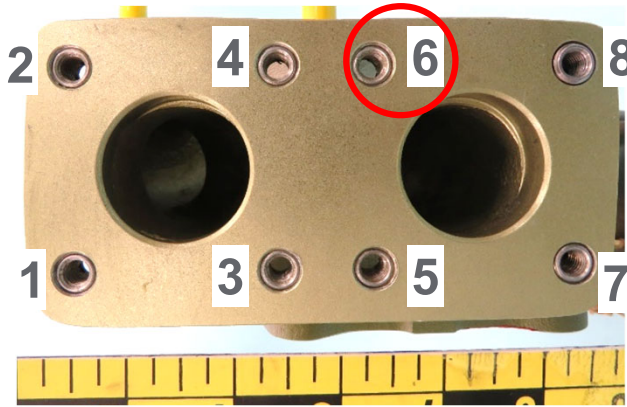


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 46: CT scan cross-section of thread insert position 5. Thread engagement is observed into the flange material.

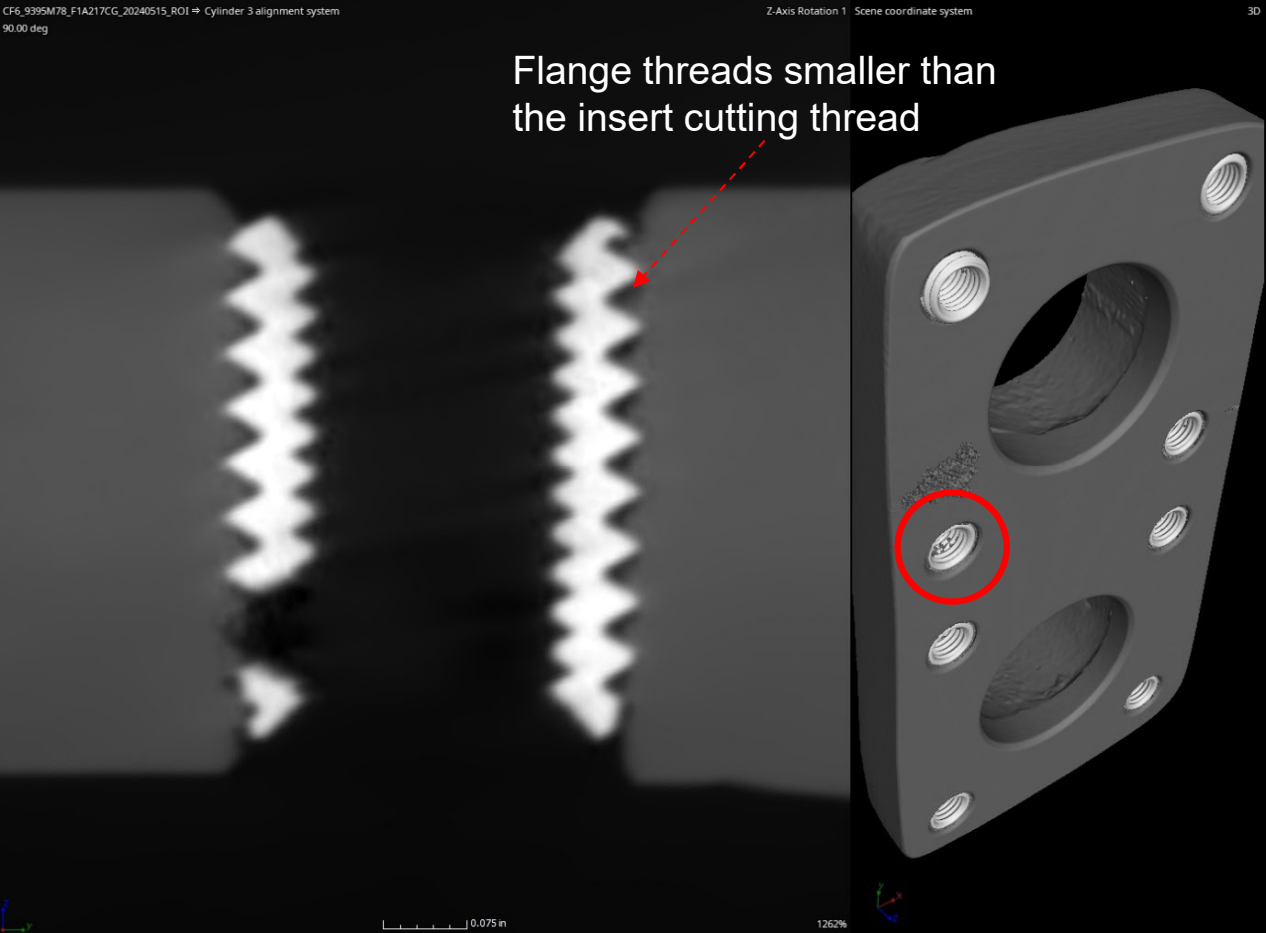
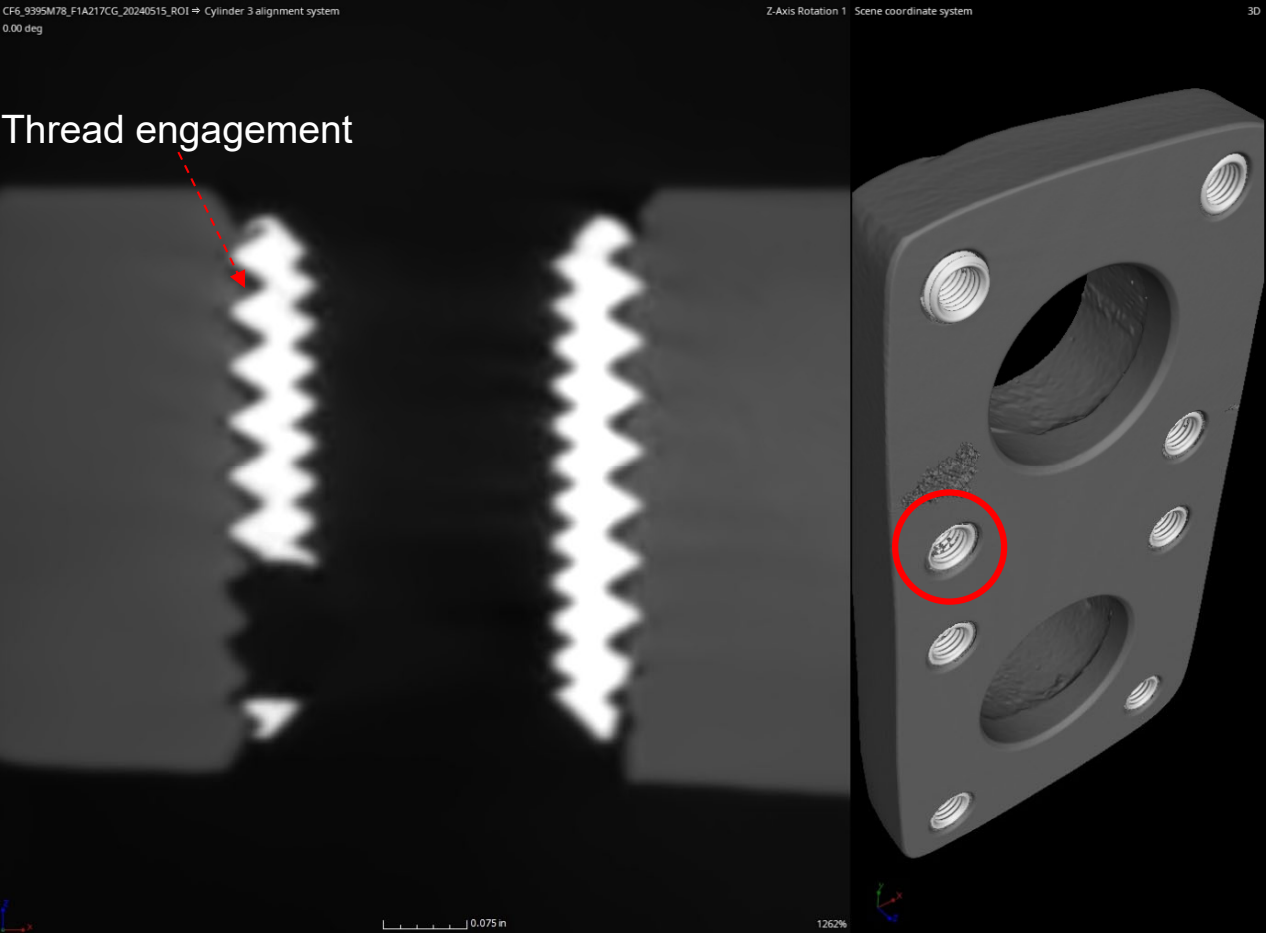


Insert 6

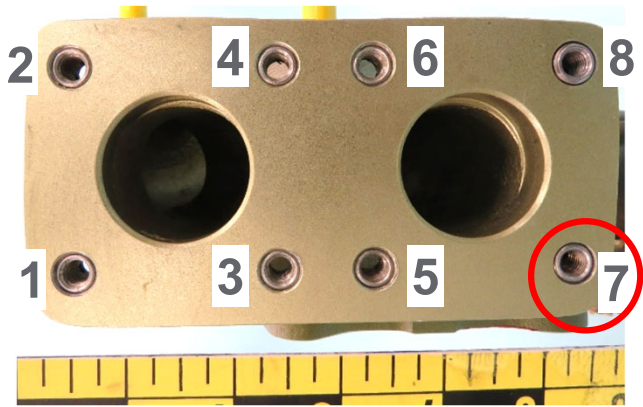


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 47: CT scan cross-section of thread insert position 6. Thread engagement is observed into the flange material.

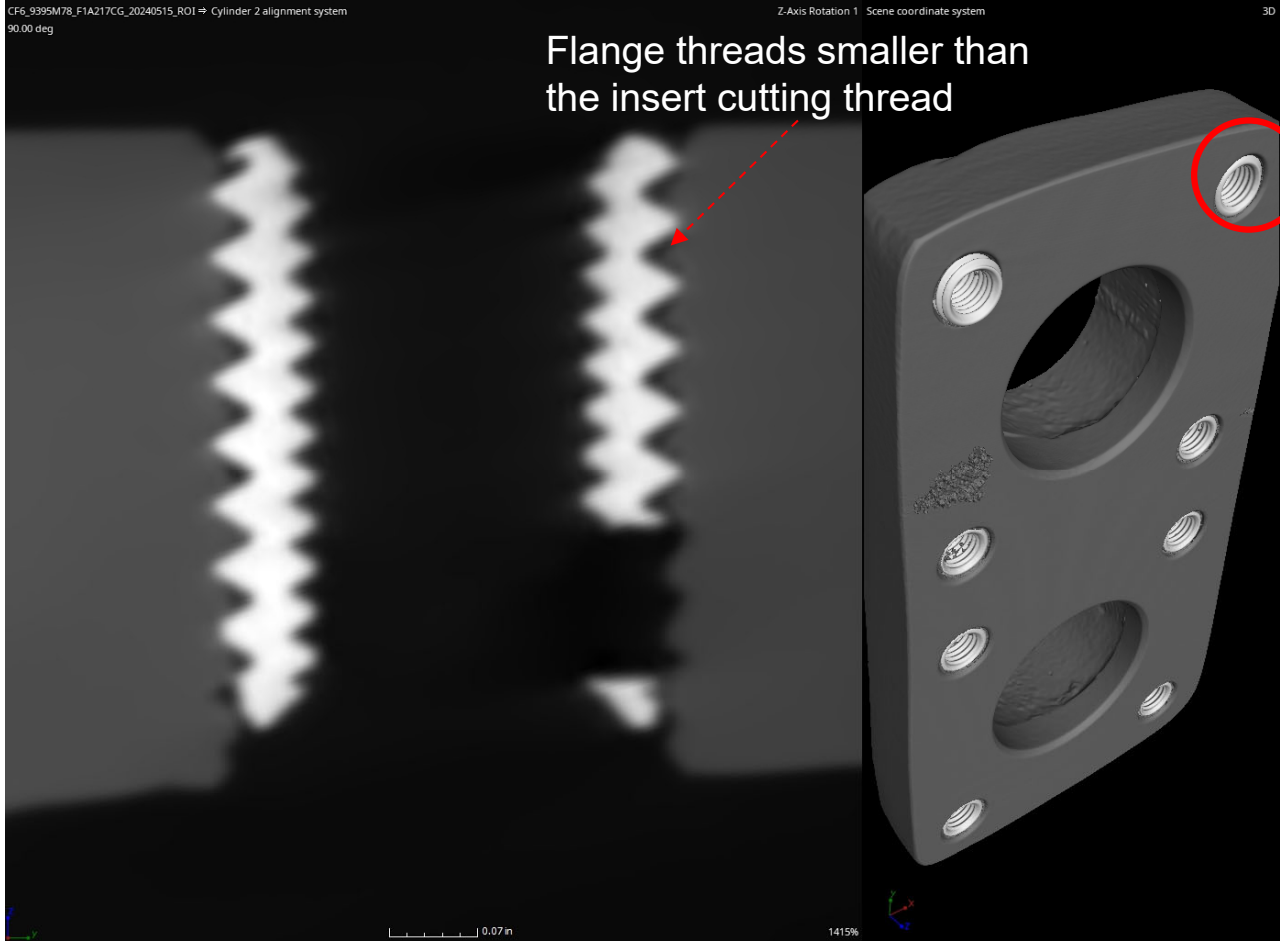
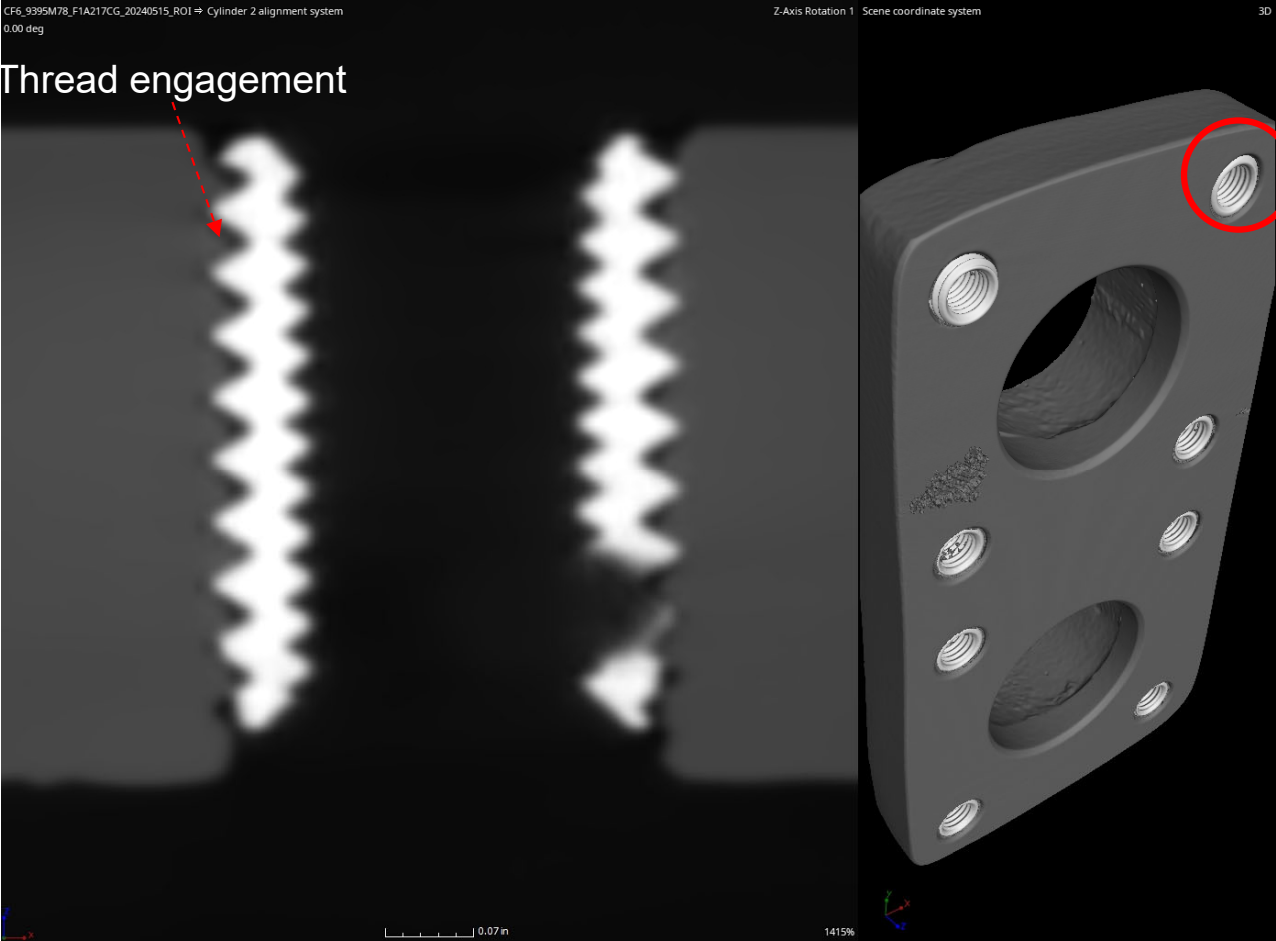


Insert 7

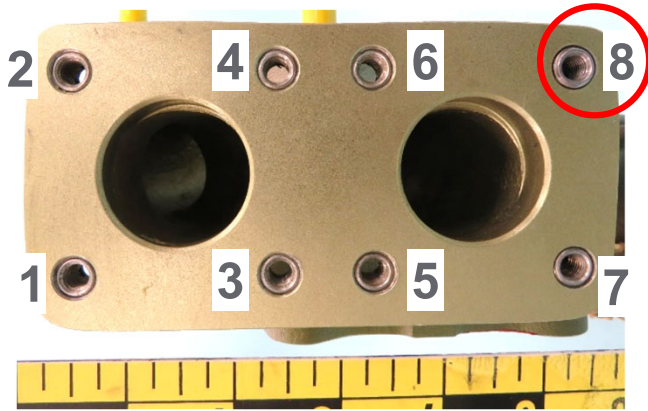


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 48: CT scan cross-section of thread insert position 7. Thread engagement is observed into the flange material.

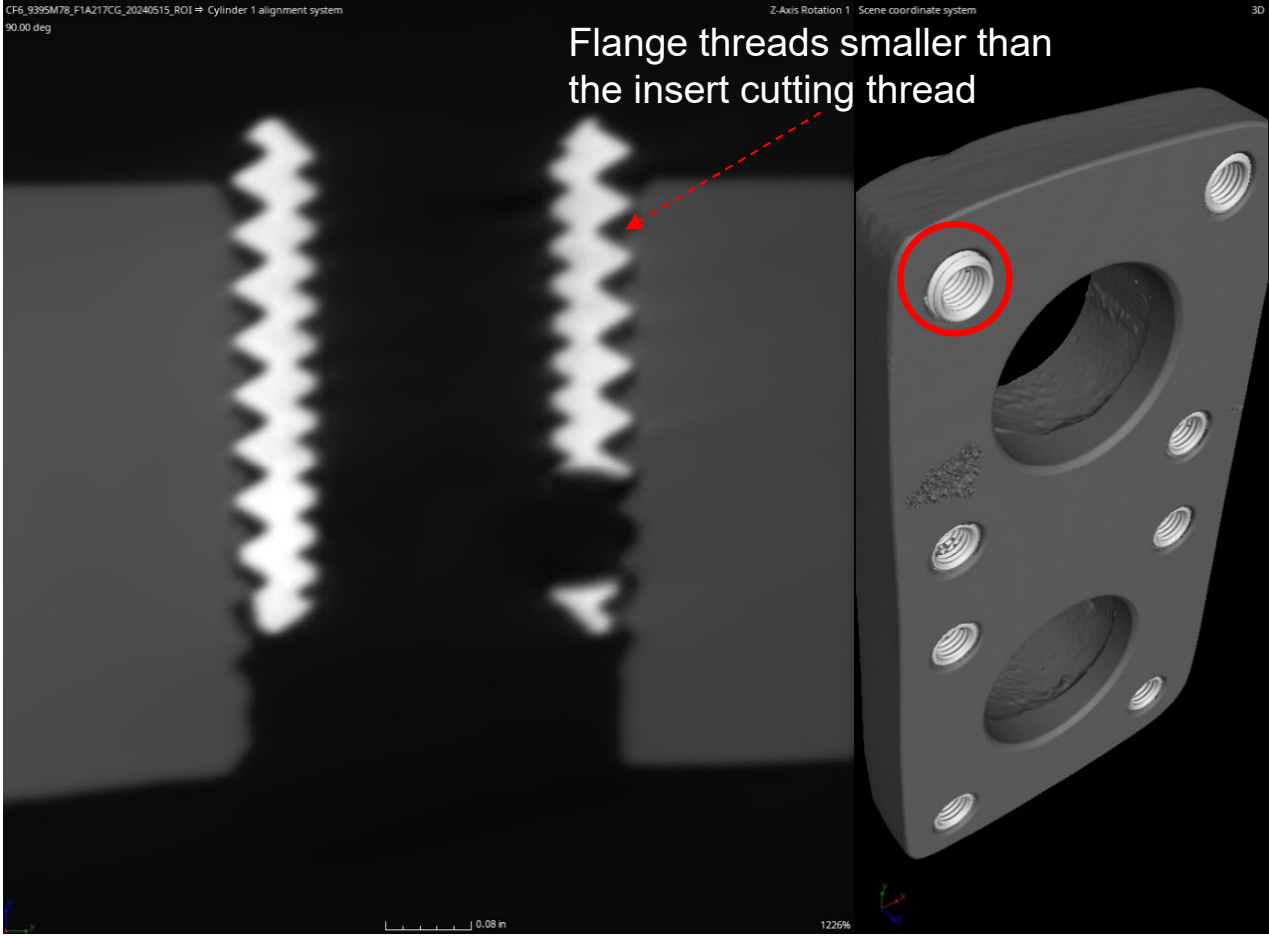
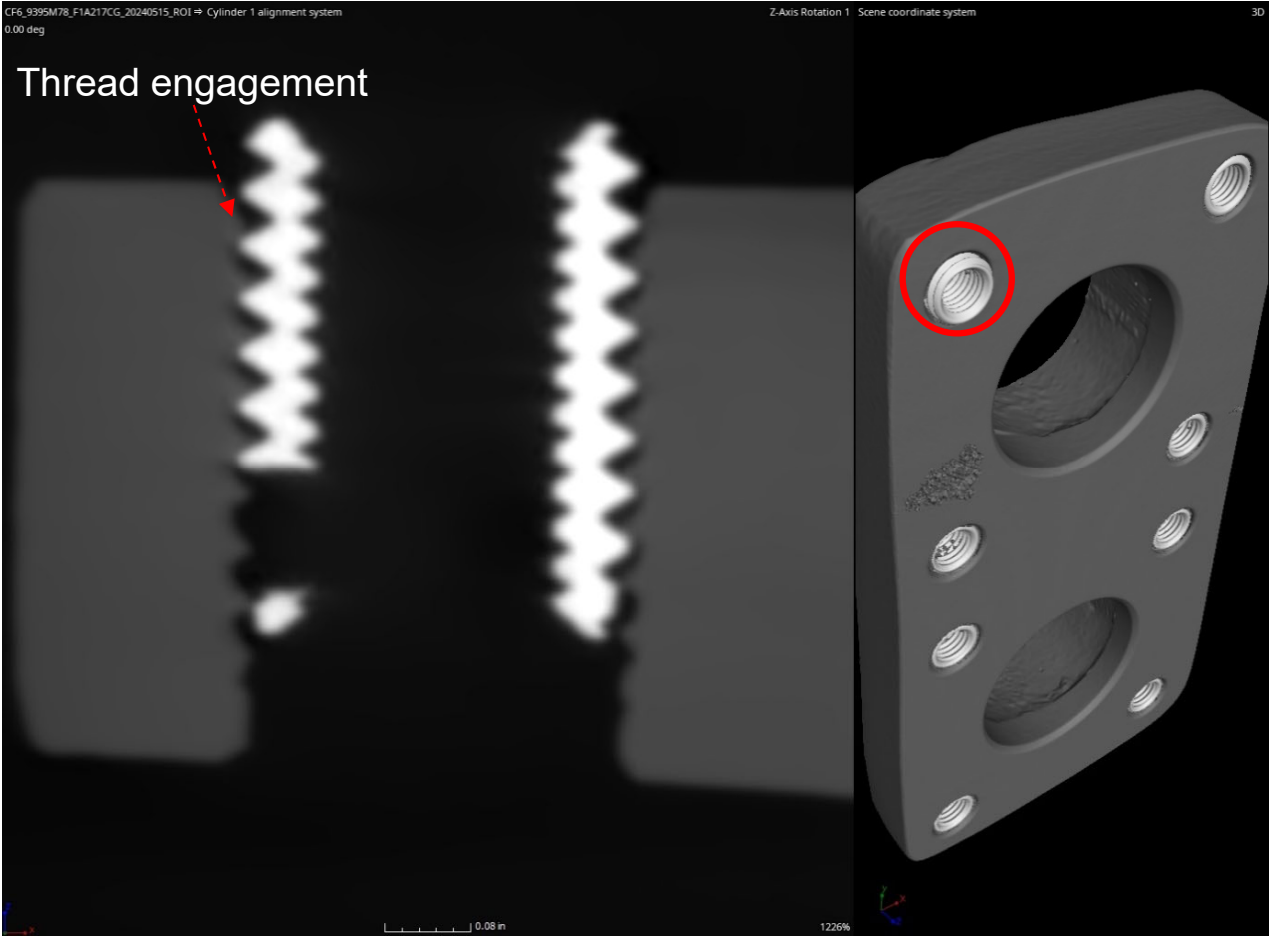


Insert 8

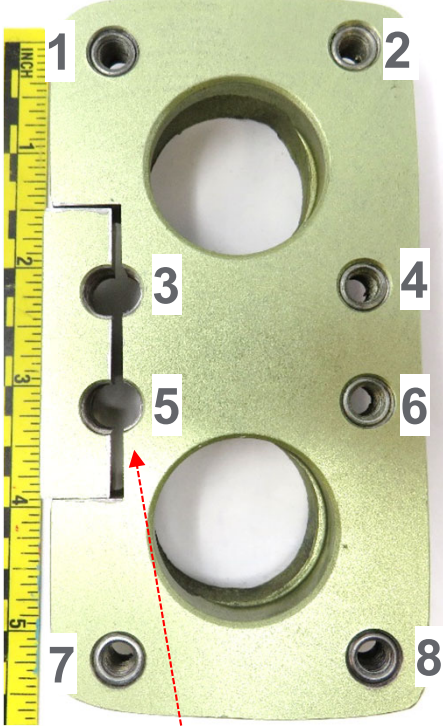


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	No
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 49: CT scan cross-section of thread insert position 8. Thread engagement is observed into the flange material.

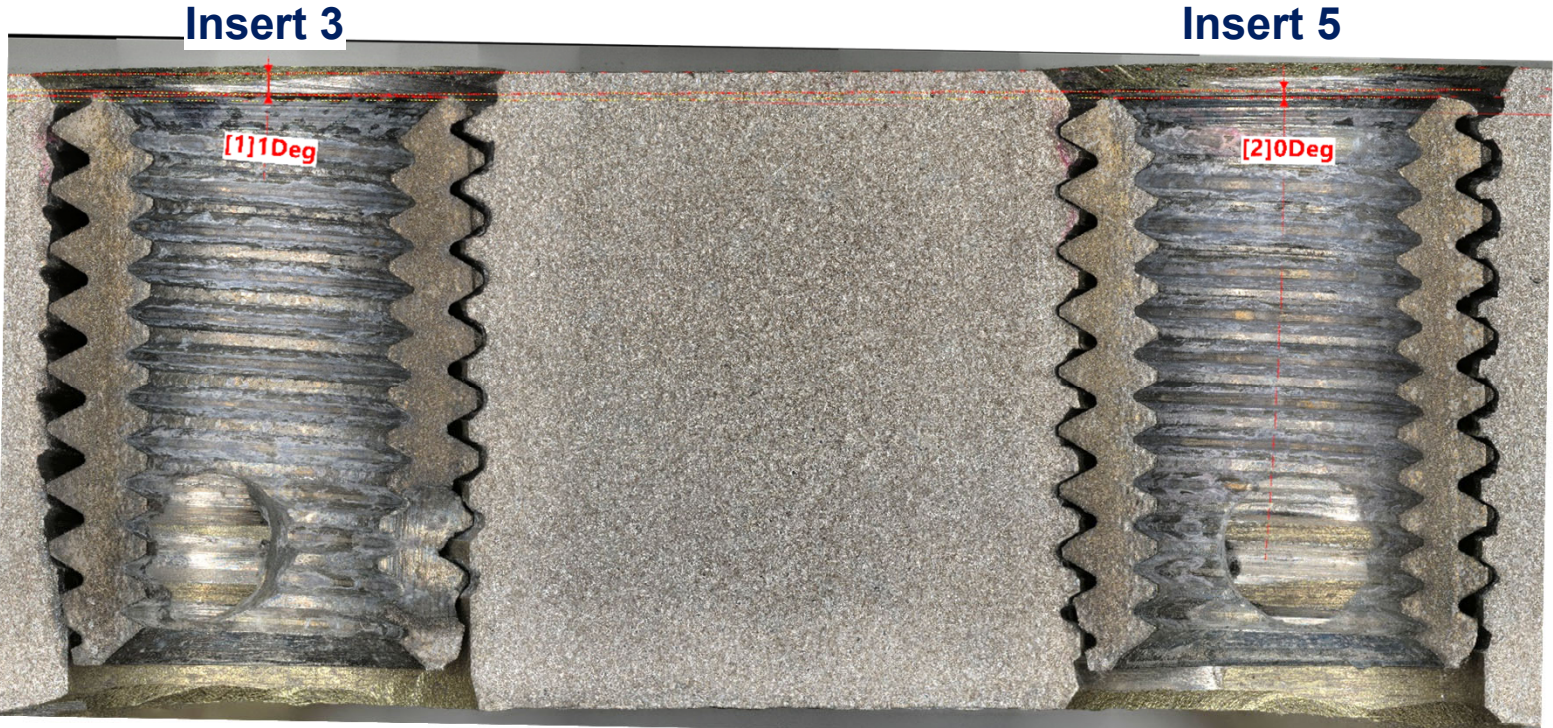


SN FIA217C9



Inserts 3 and 5 cut in half with wire EDM

Inserts in place:



Inserts removed:

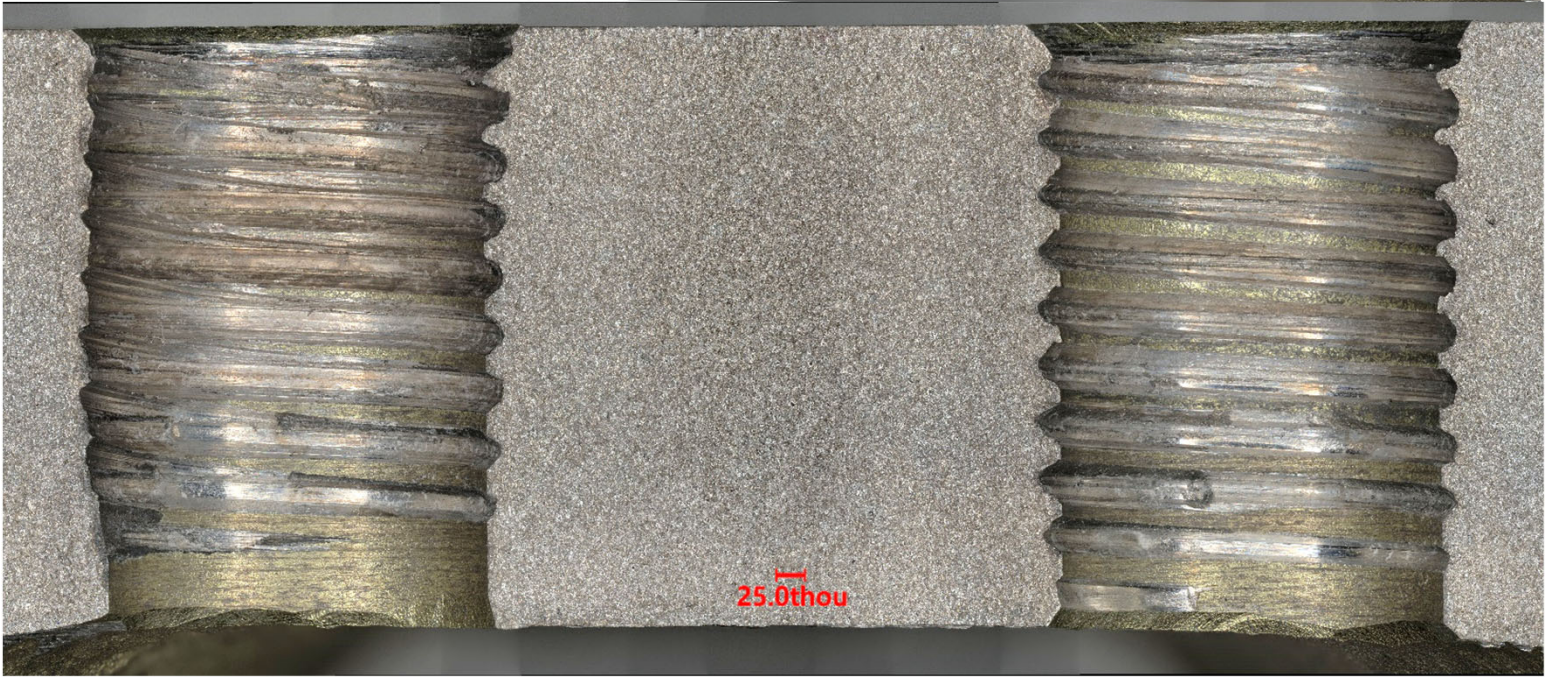


Figure 50: Optical views of insert locations 3 and 5 with the inserts in place (top) and removed (bottom). Insert 3 is rotated approximately 1-degrees from the flange surface, consistent with being installed at an angle. Insert 5 is perpendicular to the flange surface.



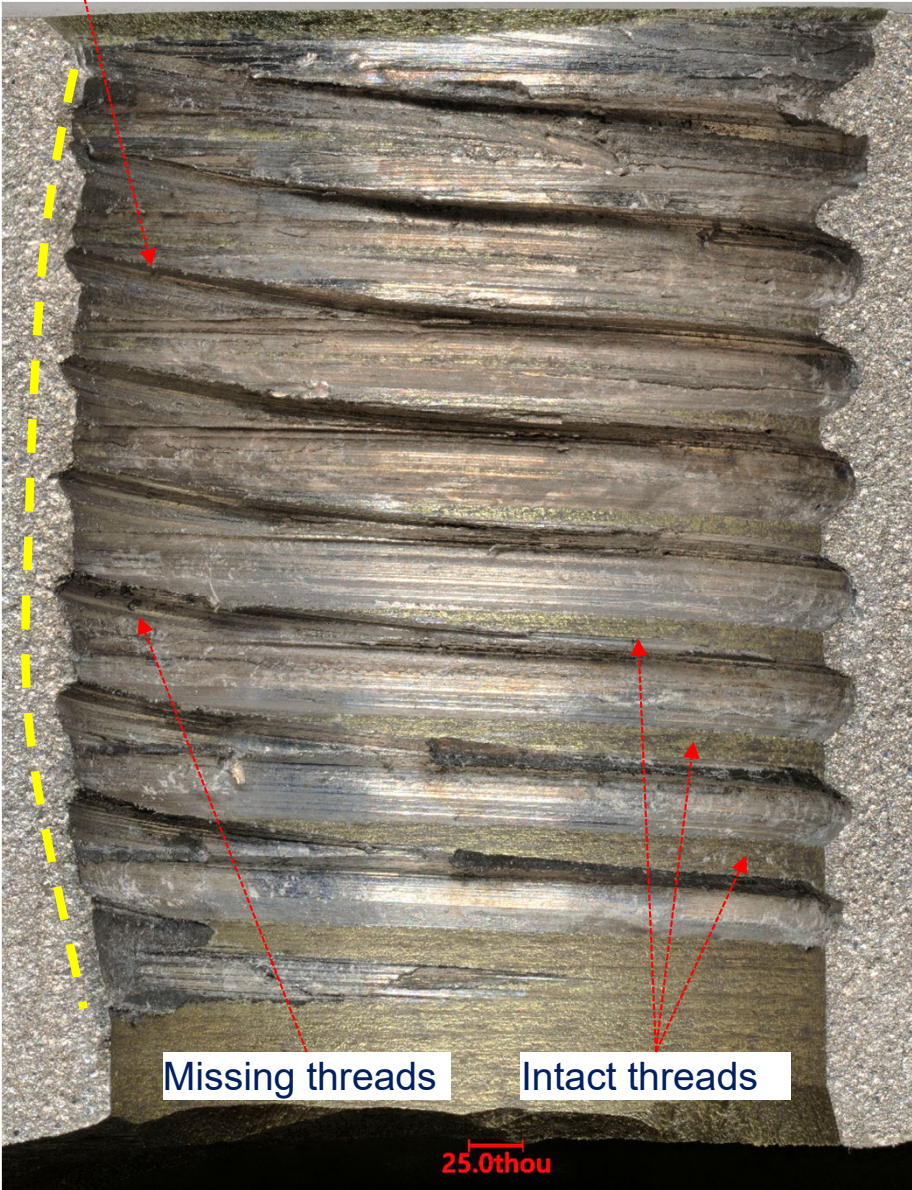
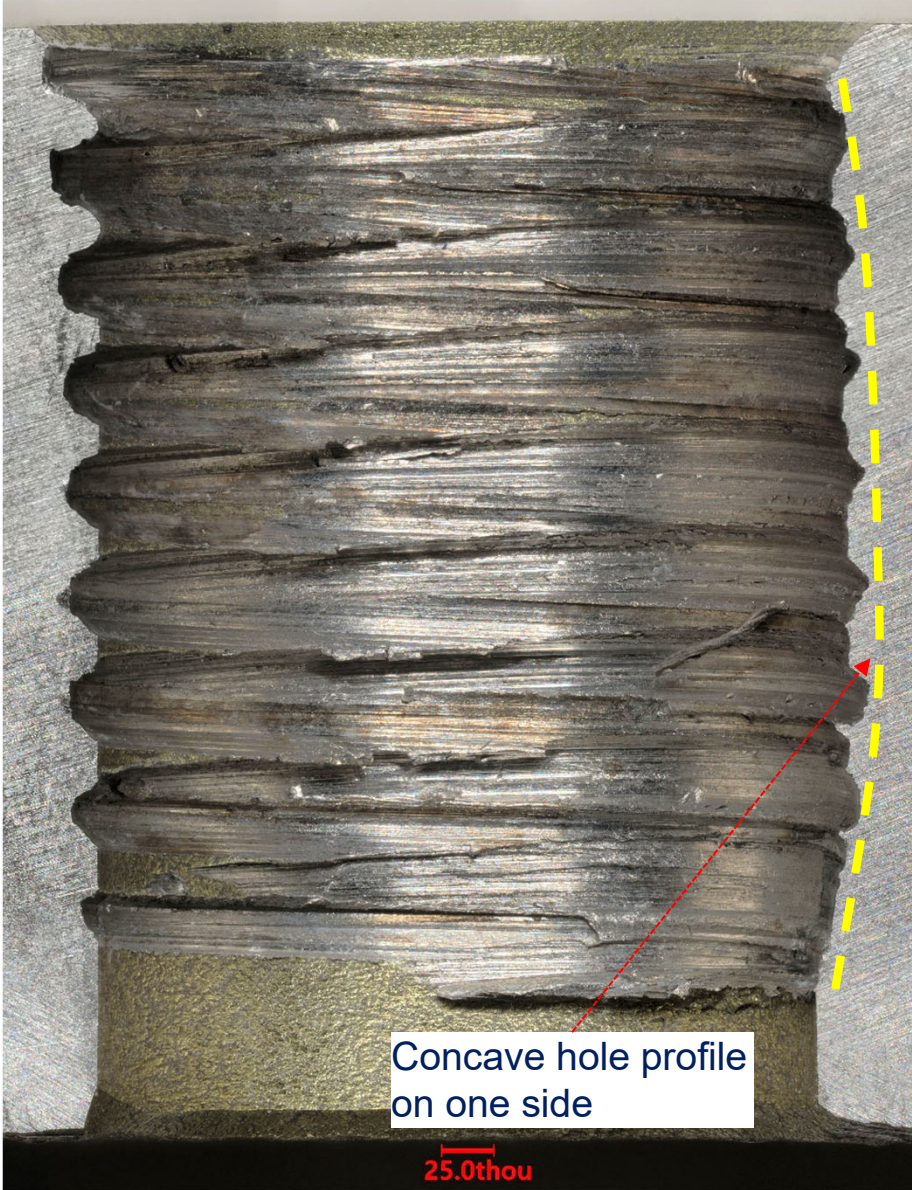
Insert cut threads at an angle
relative to the pre-tapped threads

Insert 3 Side 1

Insert 3 Side 2



Figure 51: Optical views of insert location 3 reveals angled cut threads consistent with cross-threading. One side of the hole has a concave profile and is missing threads, while the opposite side of the hole is straight with some threads intact, consistent with the insert being installed at an angle and cutting through the pre-tapped threads.



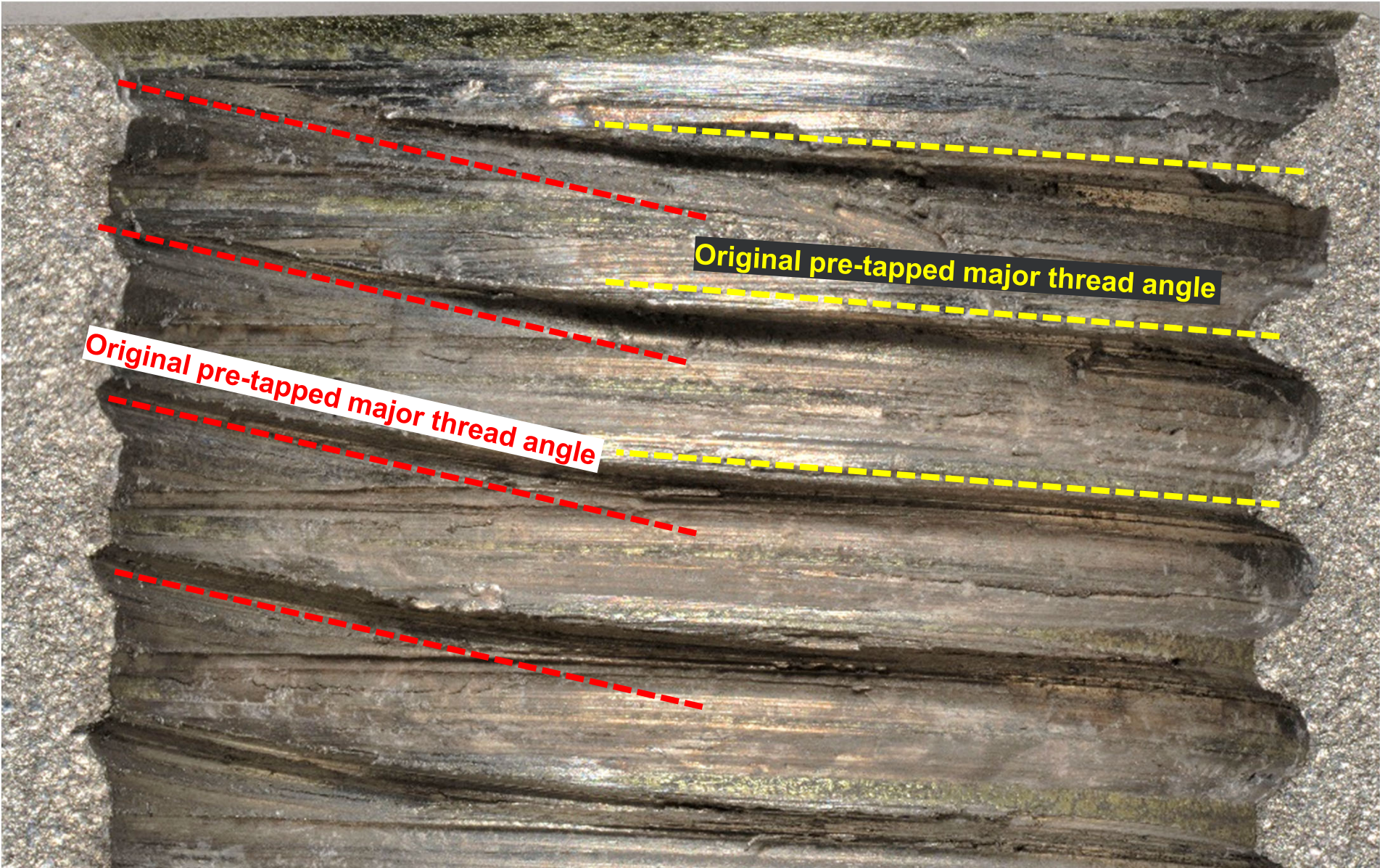


Figure 52: High magnification views show the angled cut lines through the flange female threads, consistent with the thread insert cross-threading and cutting through the flange threads.



Appendix B: RTV Part

P/N: 9395M78G10

S/N: FIA231MR

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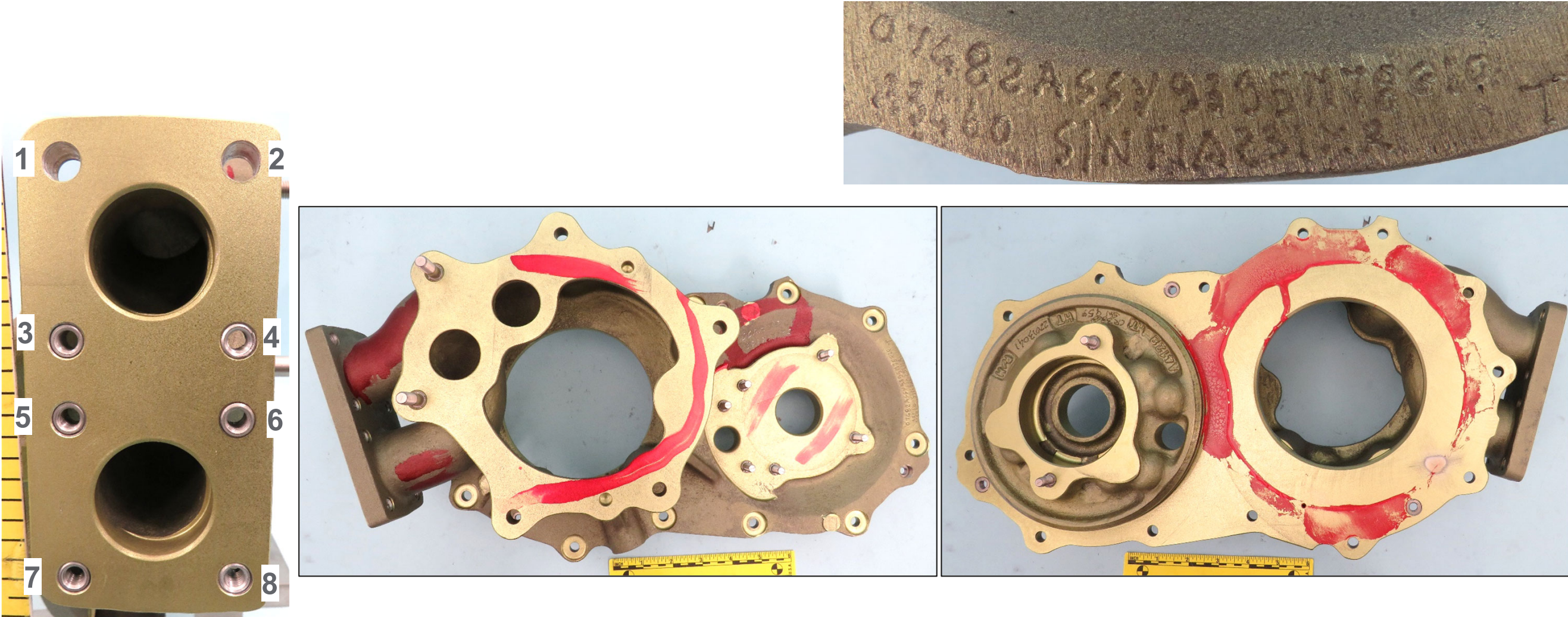


Figure 53: Images of a HMU idler adapter (P/N 9395M78G10, S/N FIA231MR) which was manufactured at Avio. The part was returned to the manufacturer (Avio) from the Durham engine assembly facility.

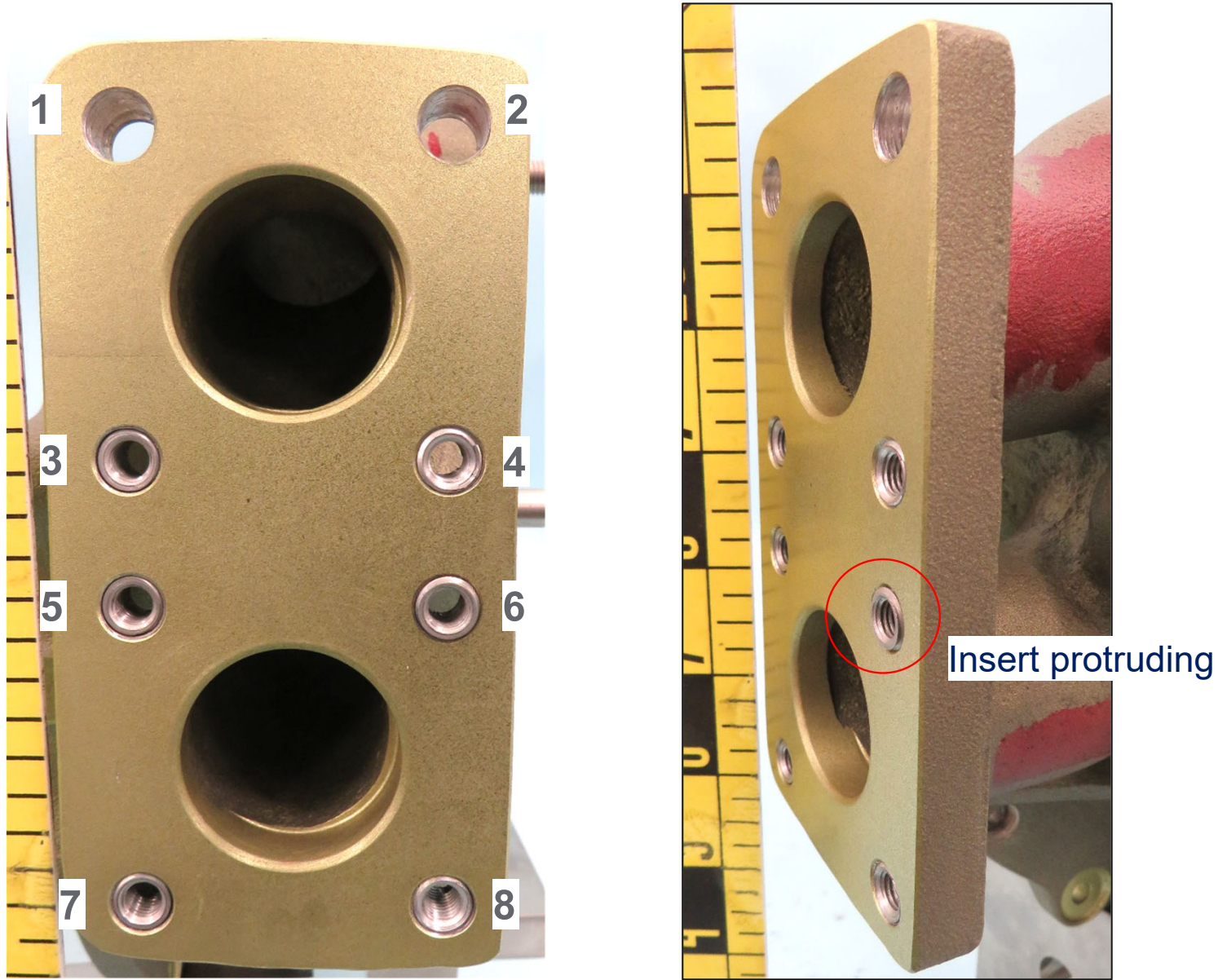


Figure 54: Insert locations 1 and 2 were removed prior to arriving to the FA lab. Insert number 6 was found protruding from the flange surface.

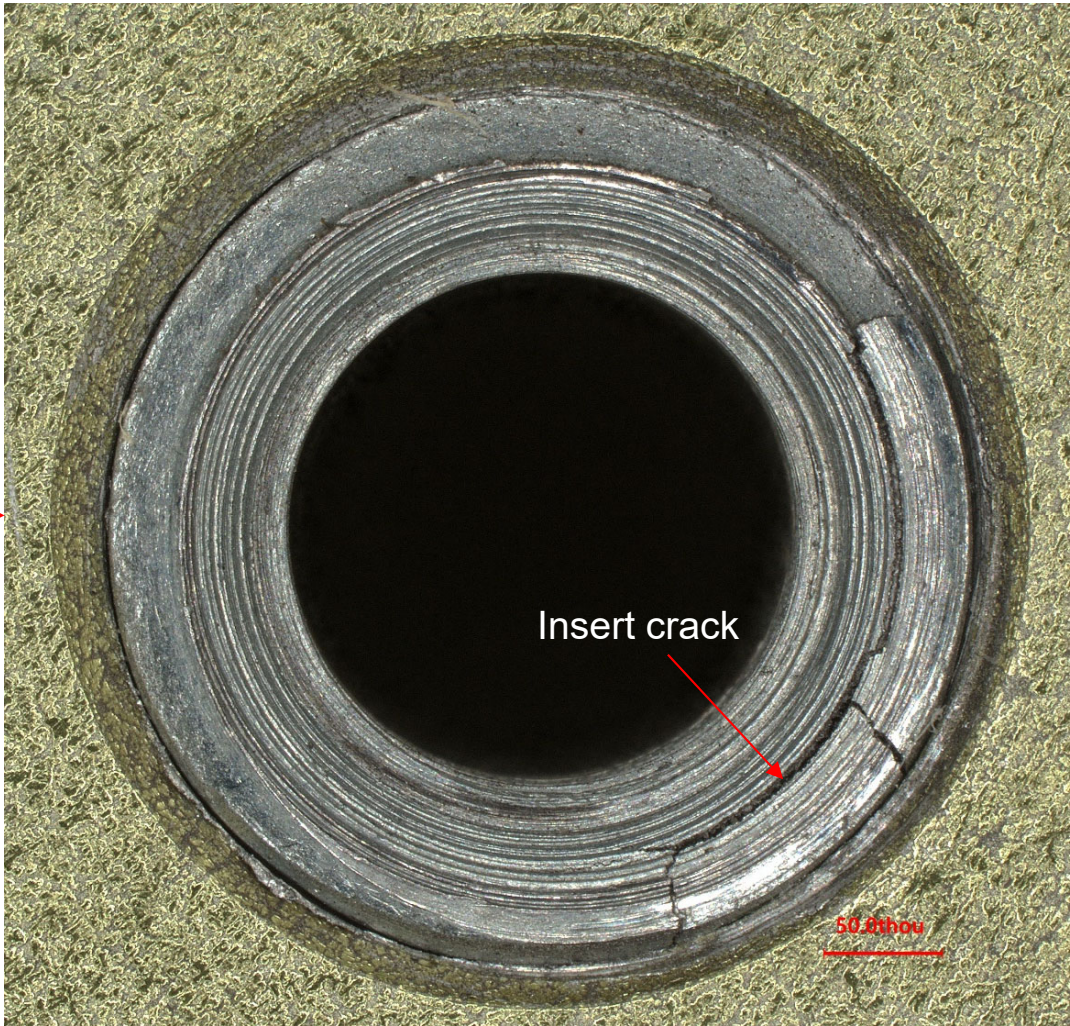
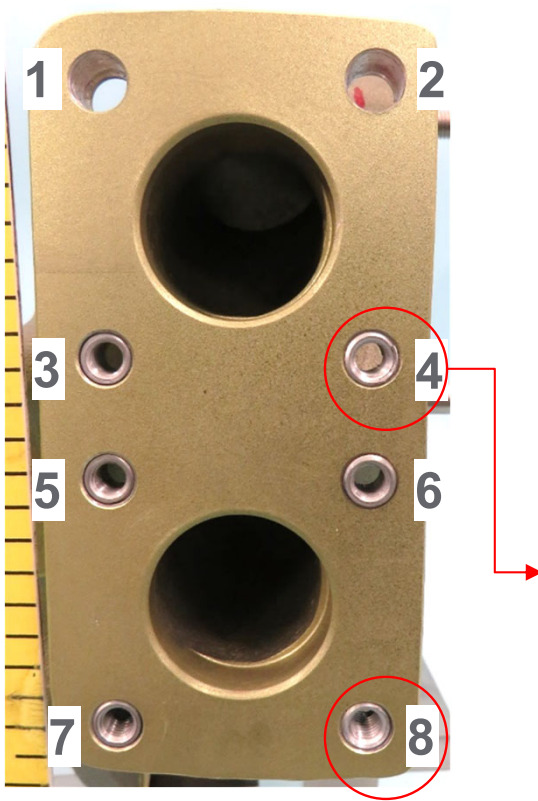
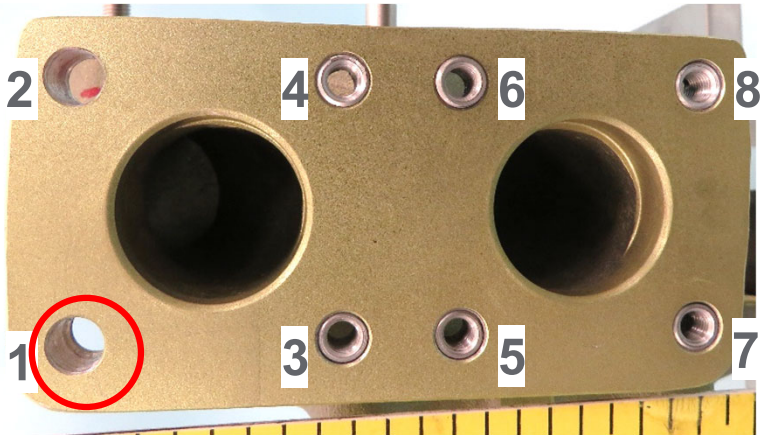


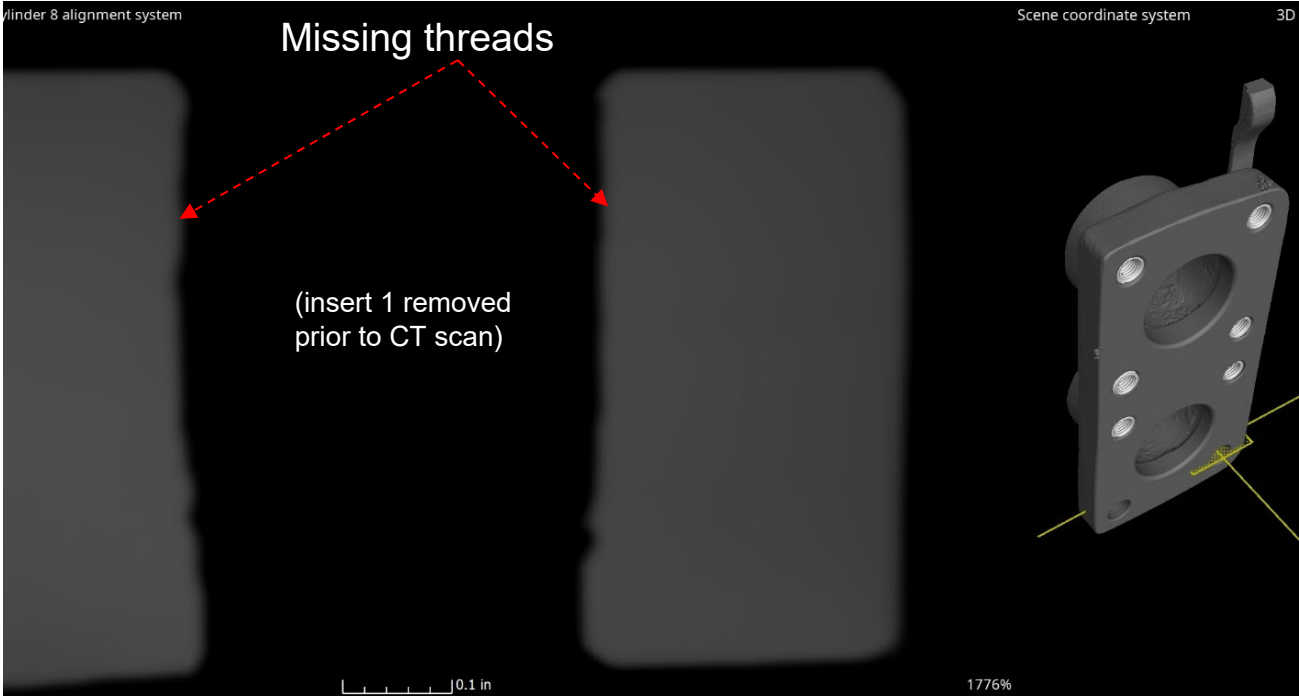
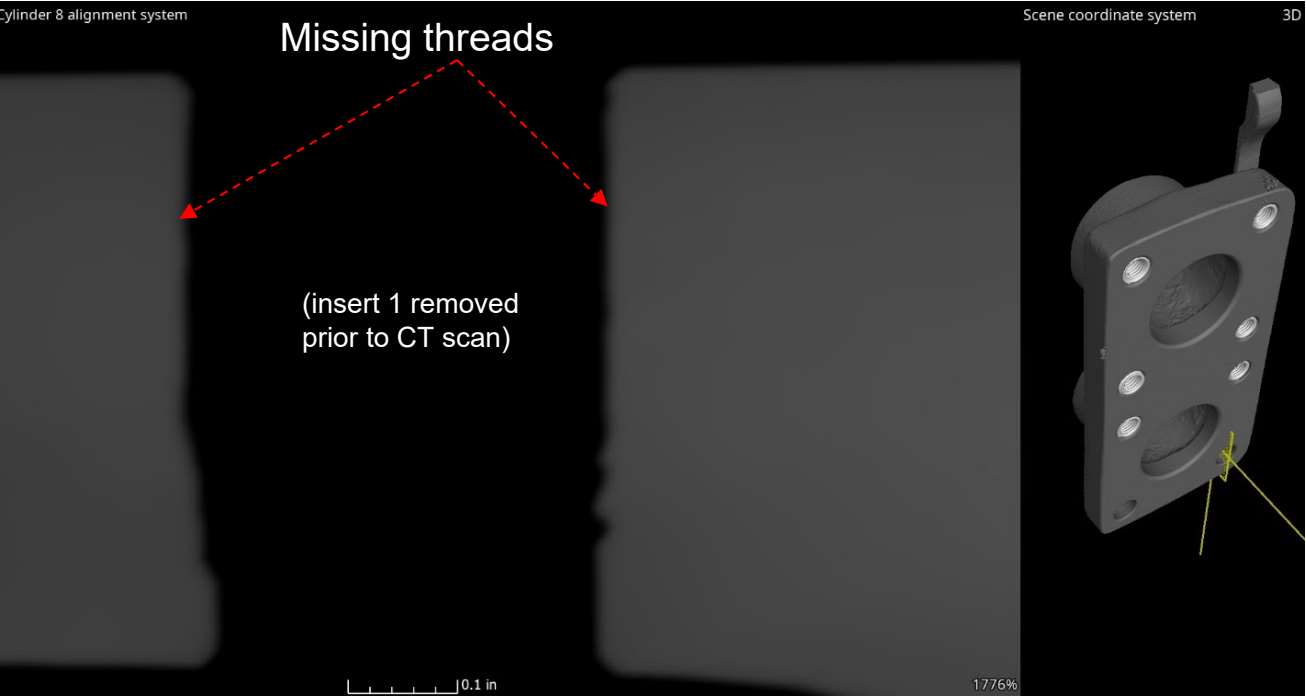
Figure 55: Insert locations 4 and 8 have cracked top threads as shown above.

Insert 1

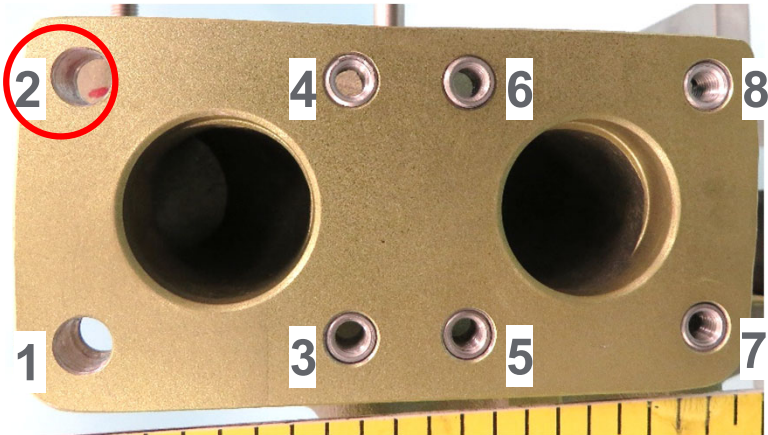


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 56: CT scan cross-section of thread insert position 1. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

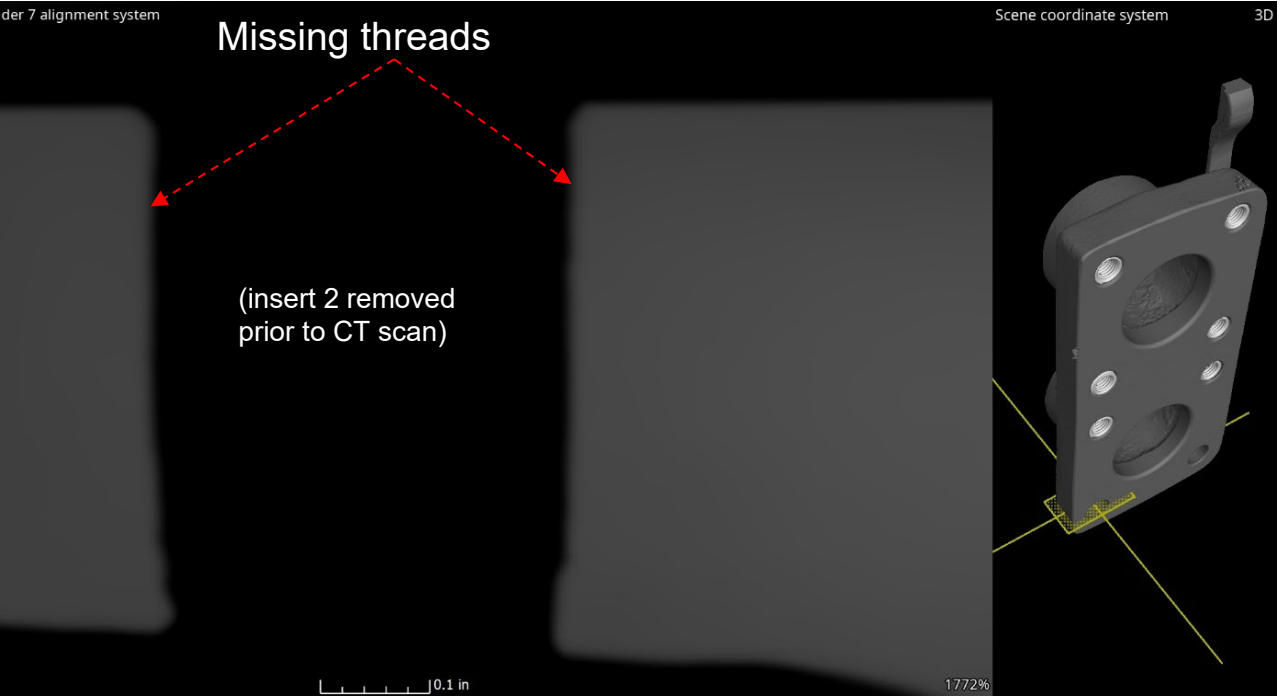
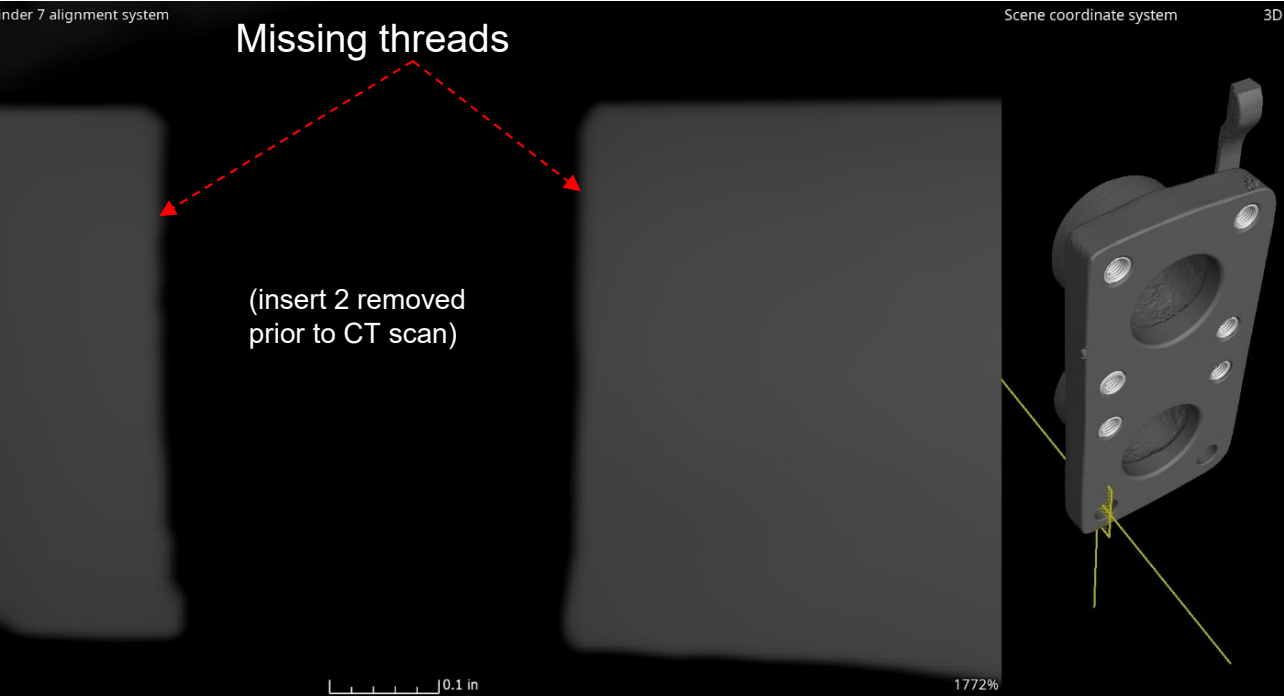


Insert 2

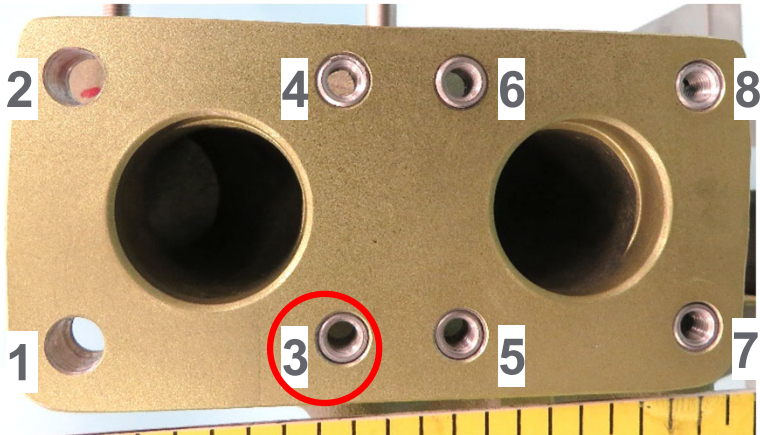


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 57: CT scan cross-section of thread insert position 2. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

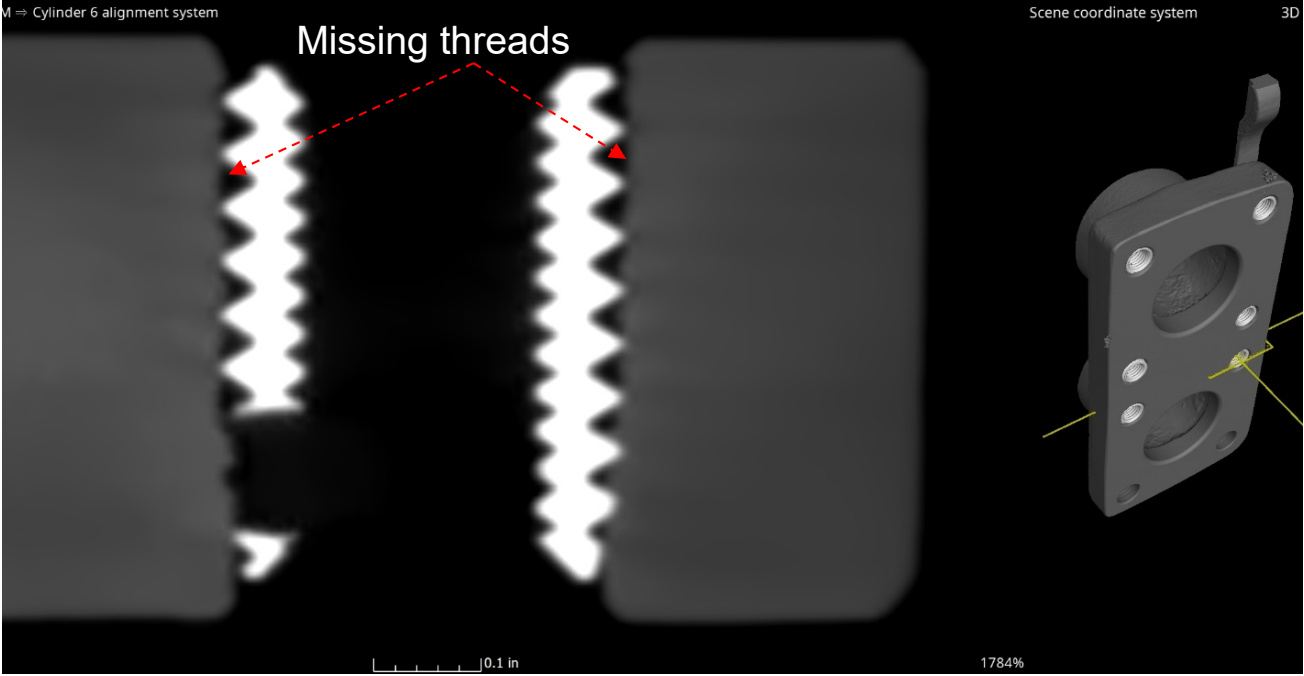
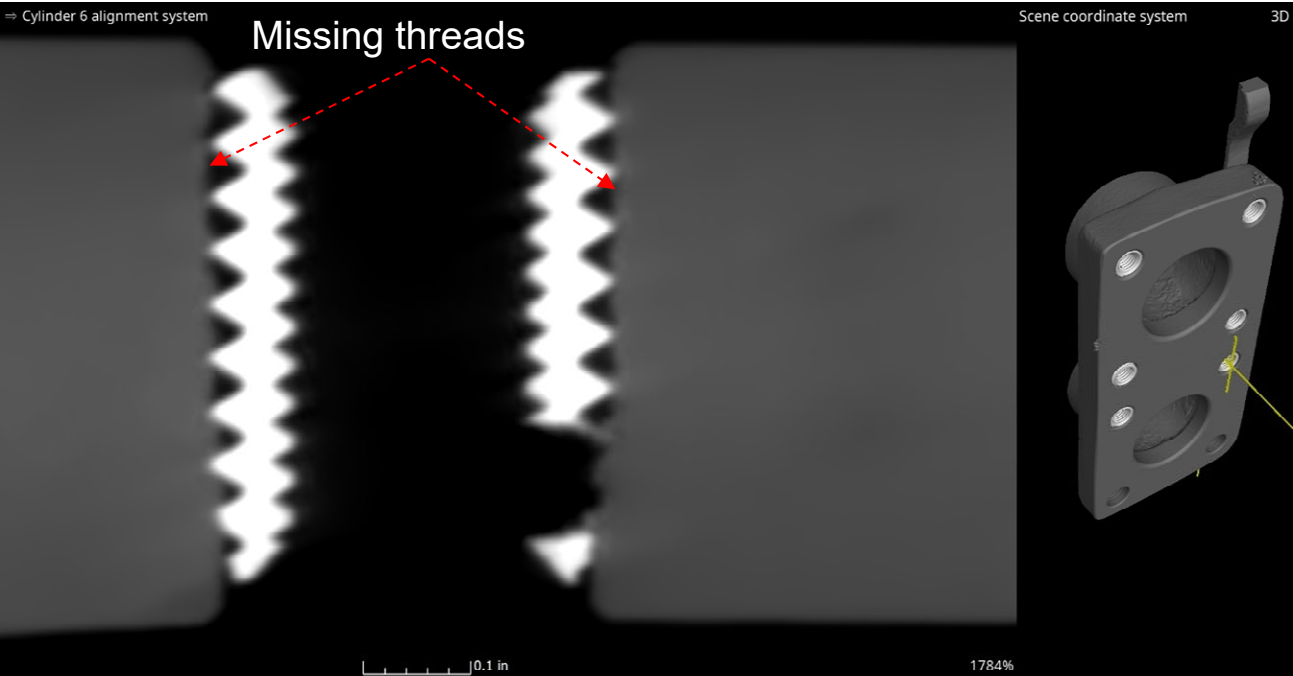


Insert 3

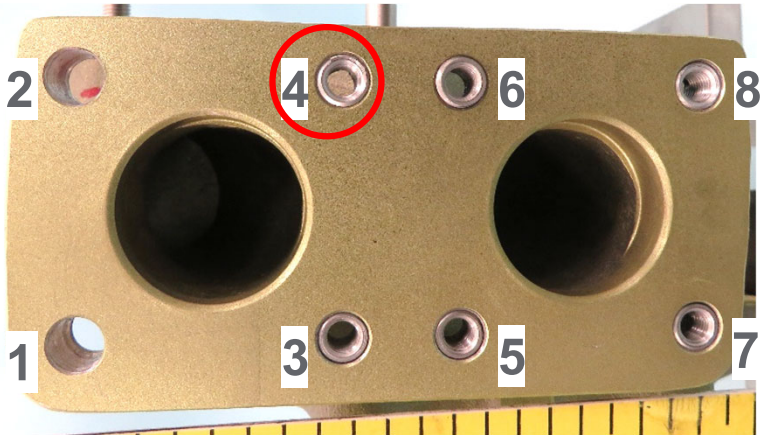


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 58: CT scan cross-section of thread insert position 3. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

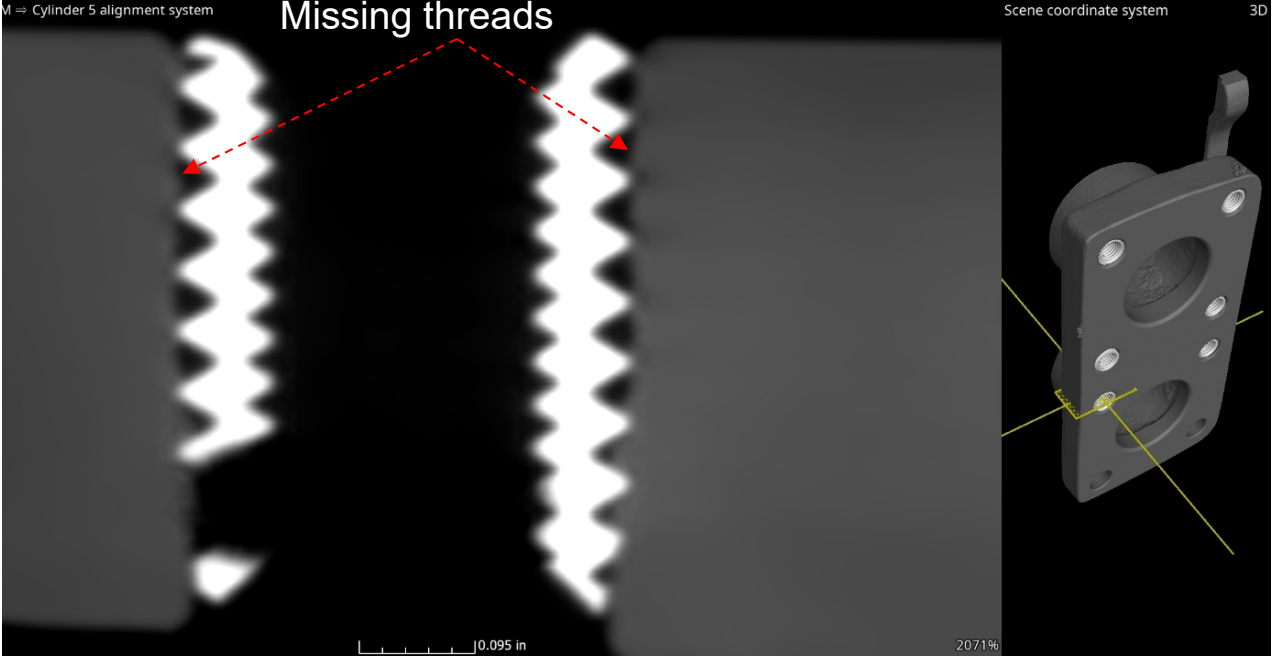
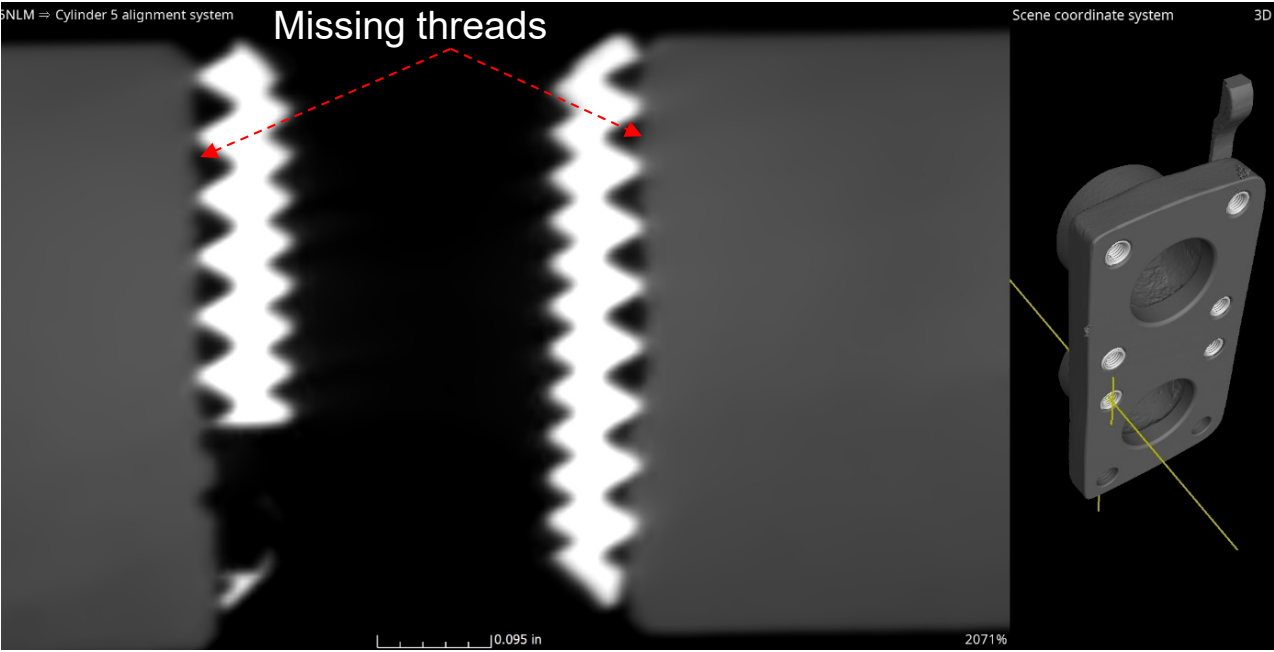


Insert 4

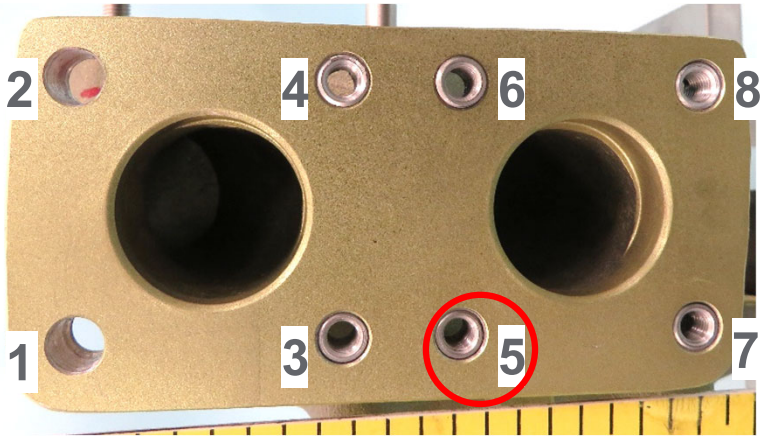


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 59: CT scan cross-section of thread insert position 4. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

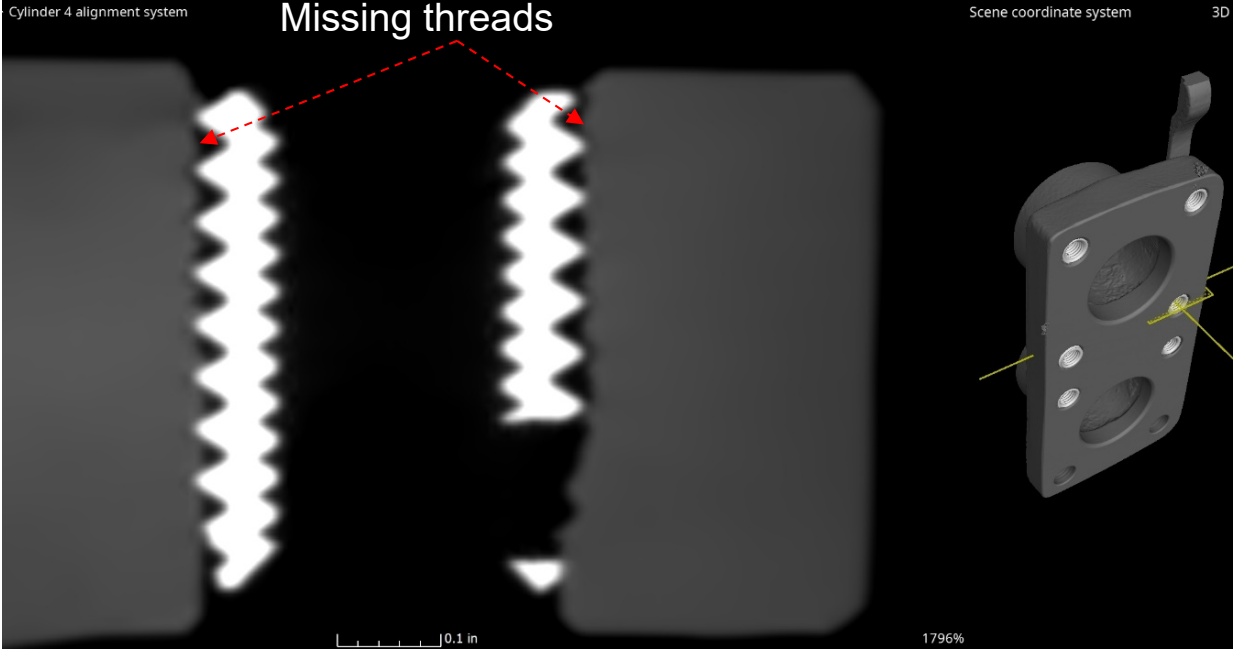
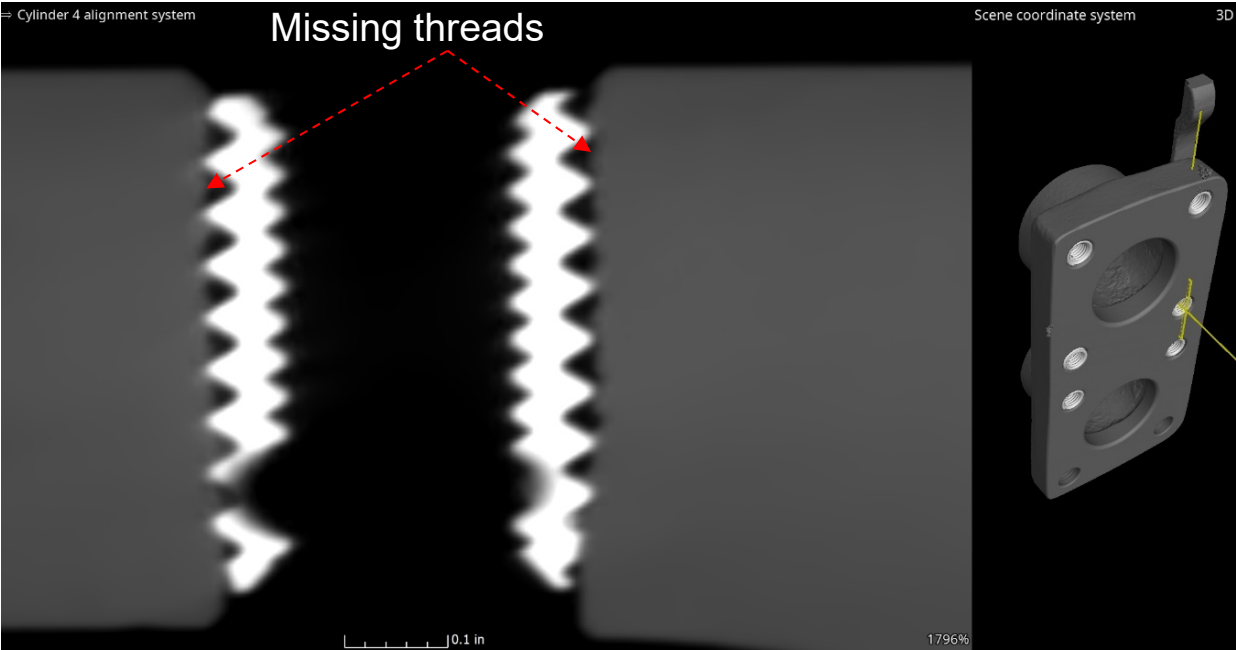


Insert 5

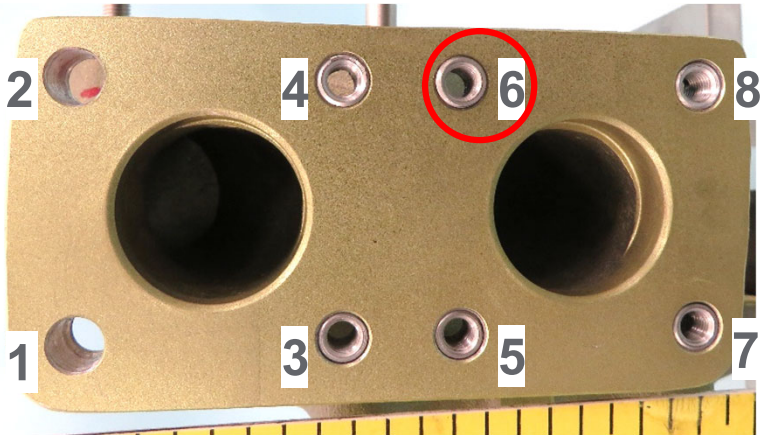


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 60: CT scan cross-section of thread insert position 5. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

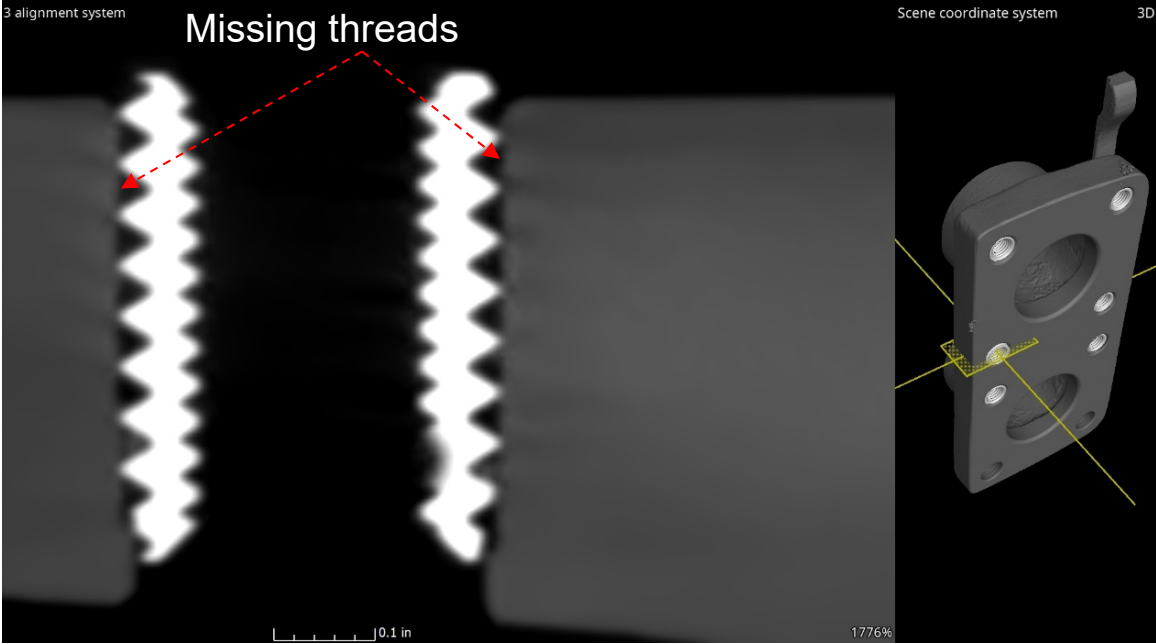
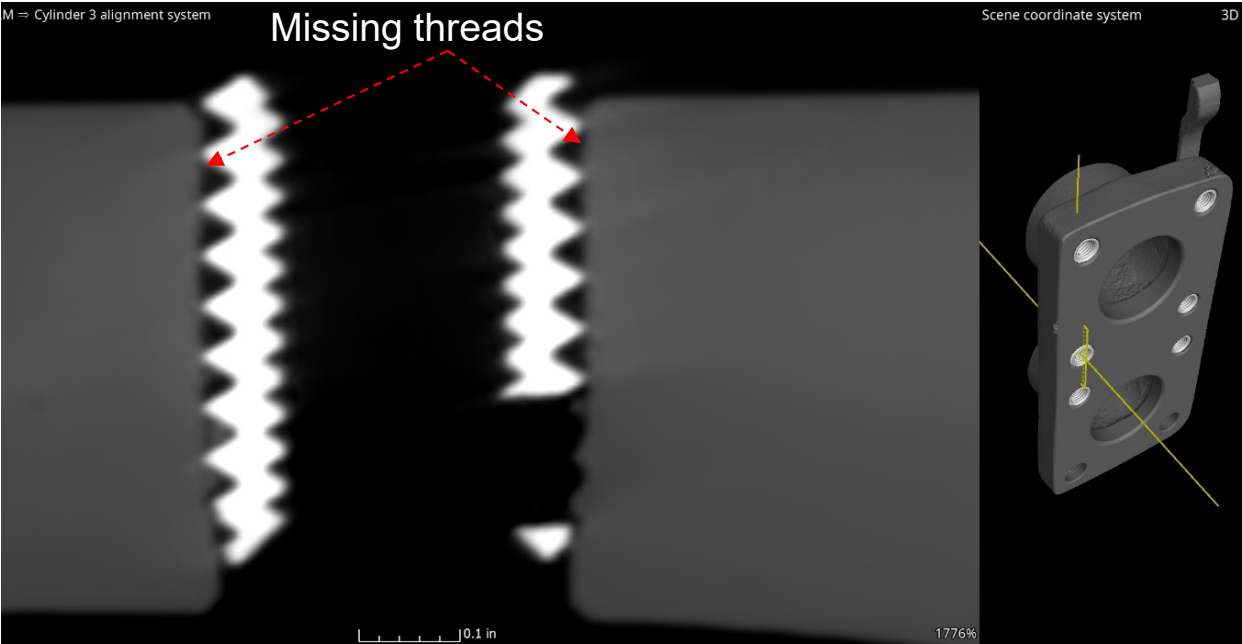


Insert 6

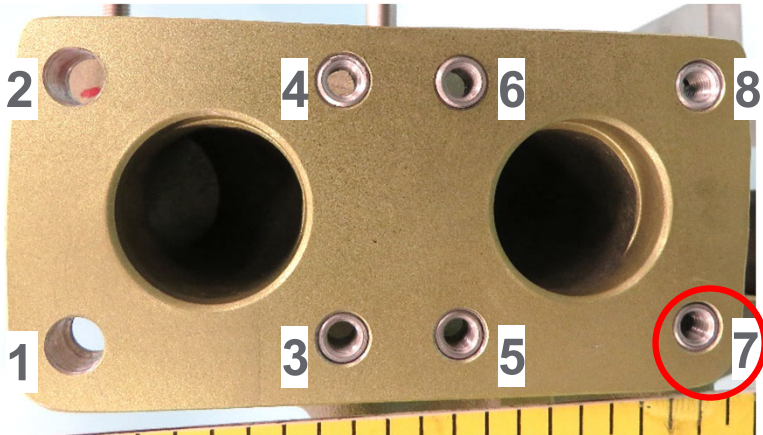


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 61: CT scan cross-section of thread insert position 6. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

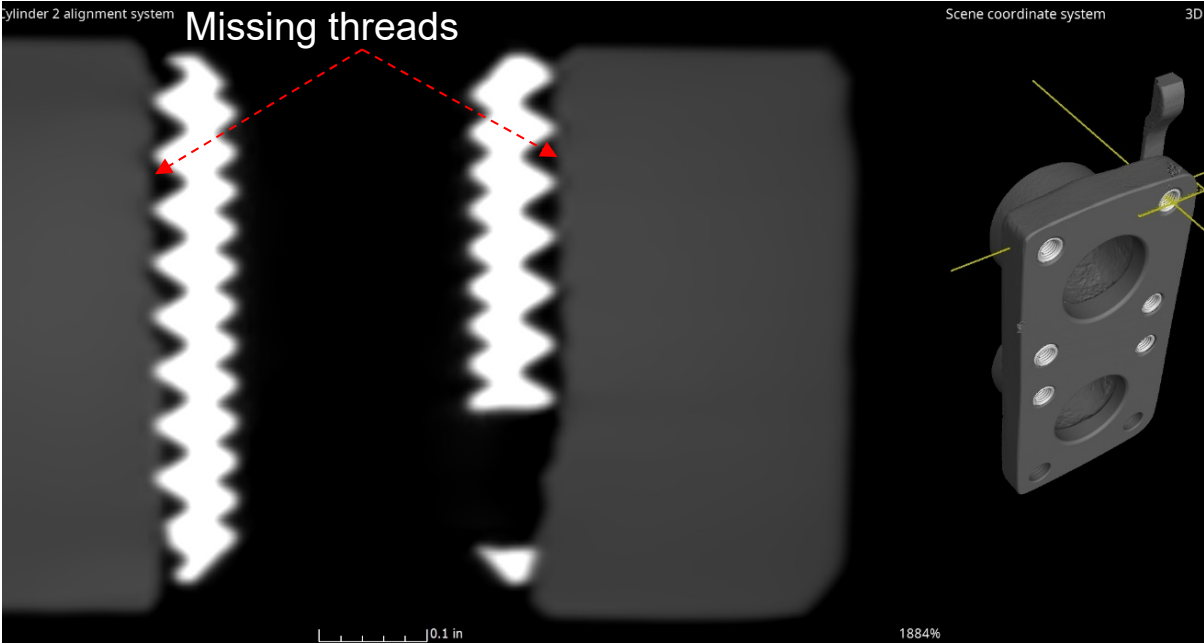
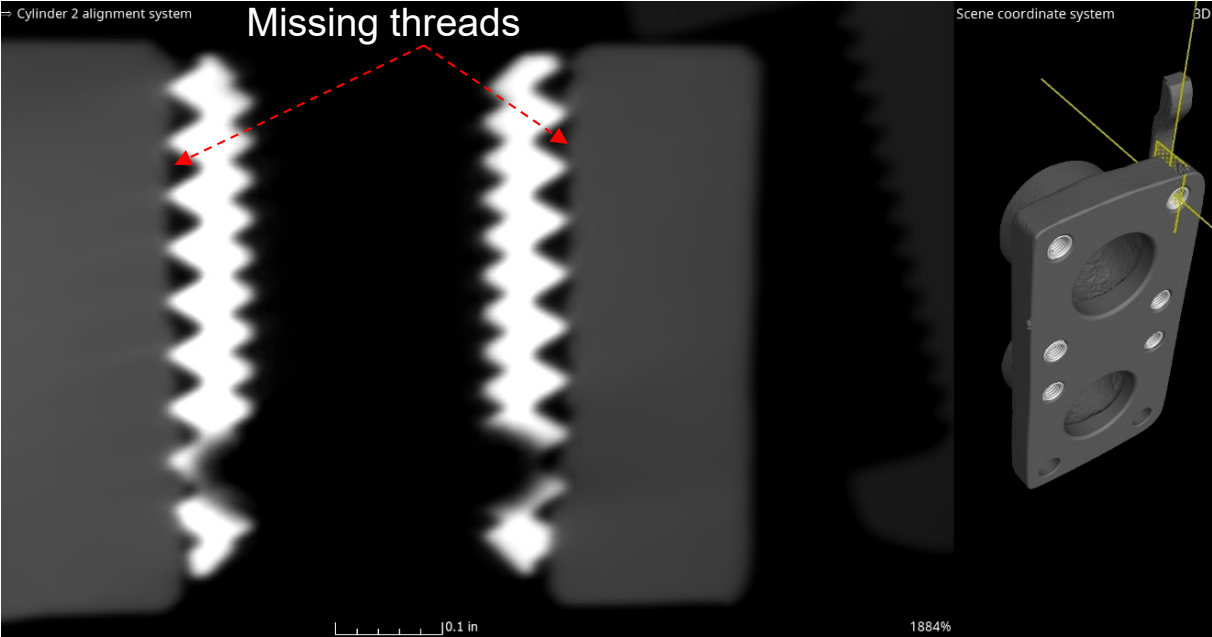


Insert 7

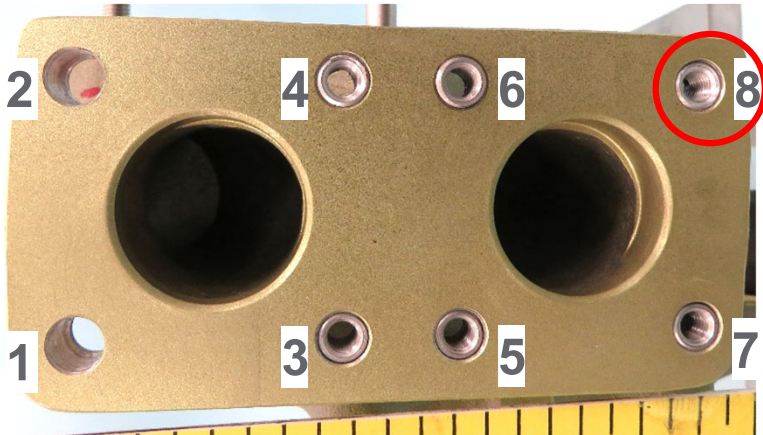


Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 62: CT scan cross-section of thread insert position 7. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.

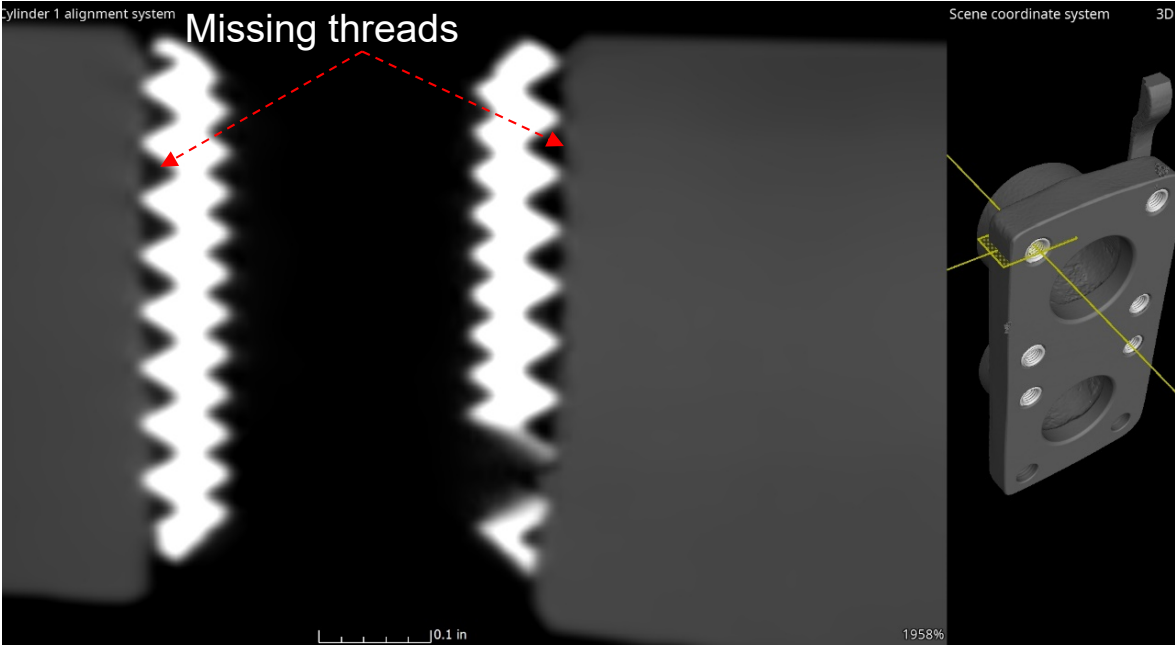
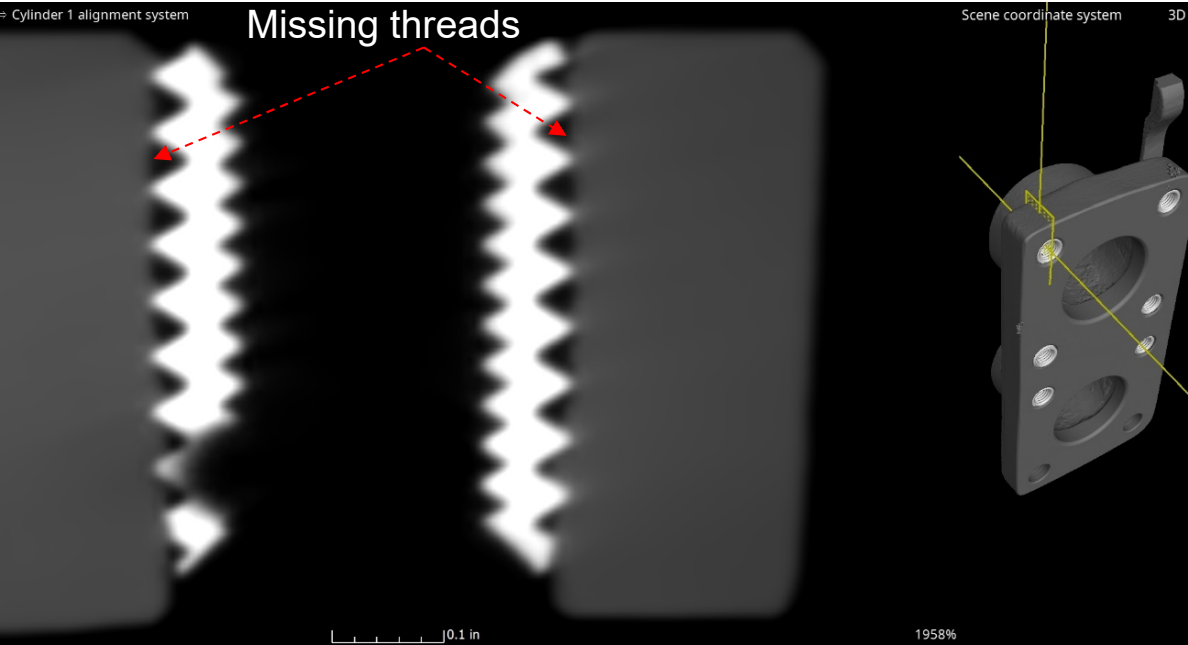


Insert 8



Insert #	CT Scan Thread Engagement
1	No
2	No
3	No
4	No
5	No
6	No
7	No
8	No

Figure 63: CT scan cross-section of thread insert position 8. The pre-tapped internal threads are missing. No thread engagement is observed into the flange material.



Insert 1 Side 1



Figure 64: Optical views of insert hole 1 reveals damaged threads.

Insert 1 Side 1

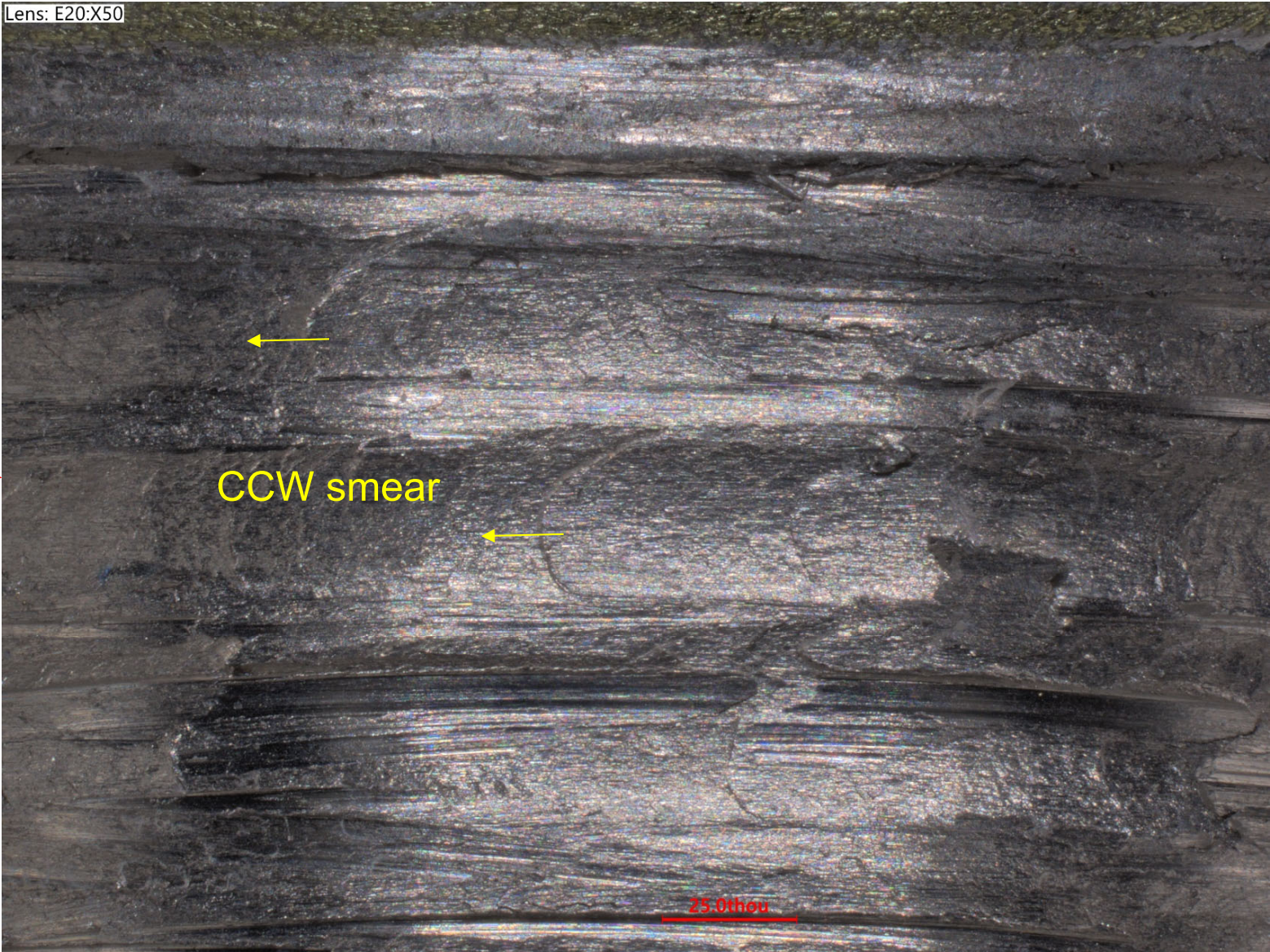
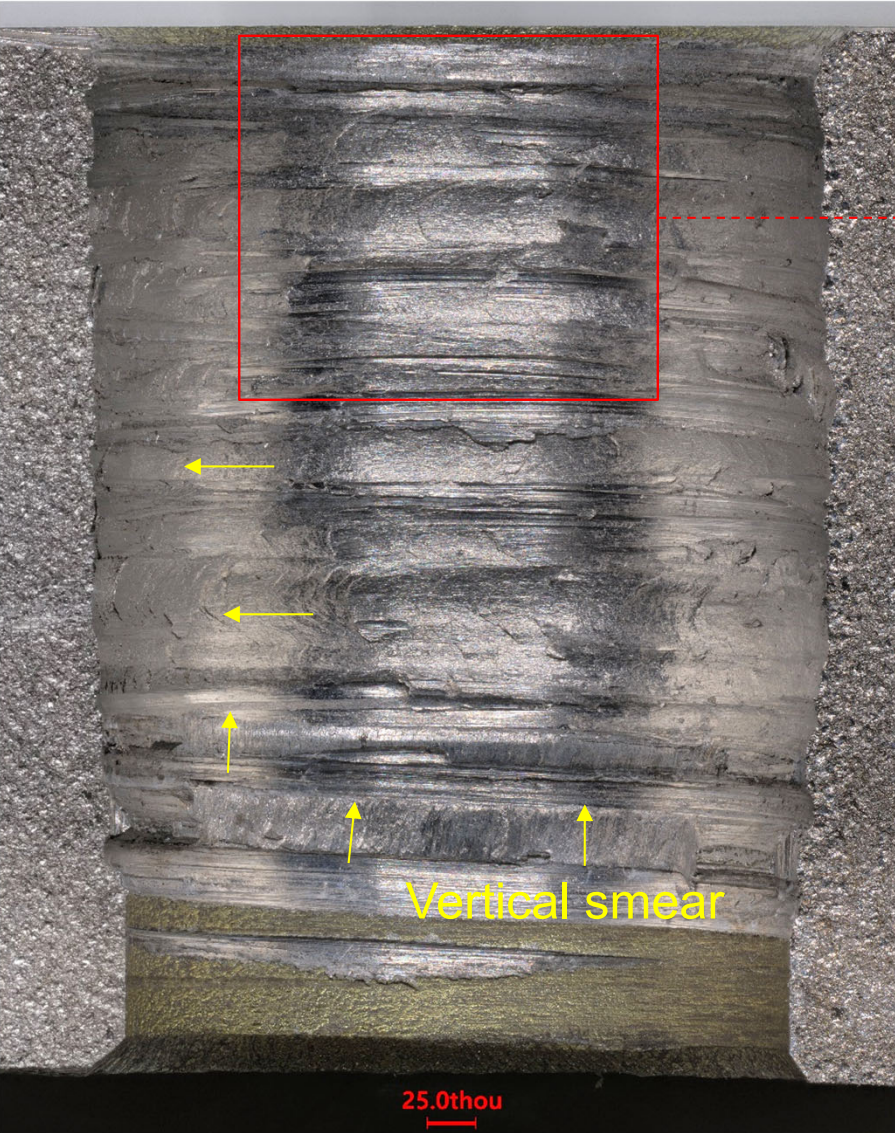


Figure 65: Optical view of insert hole 1 reveals vertical smear lines consistent with the insert pulling out and overlapping smeared material consistent with CCW rotation.



Hole 2 Side 1



Figure 66: Optical views of insert hole location 2 reveals damaged threads.



Hole 2 Side 1

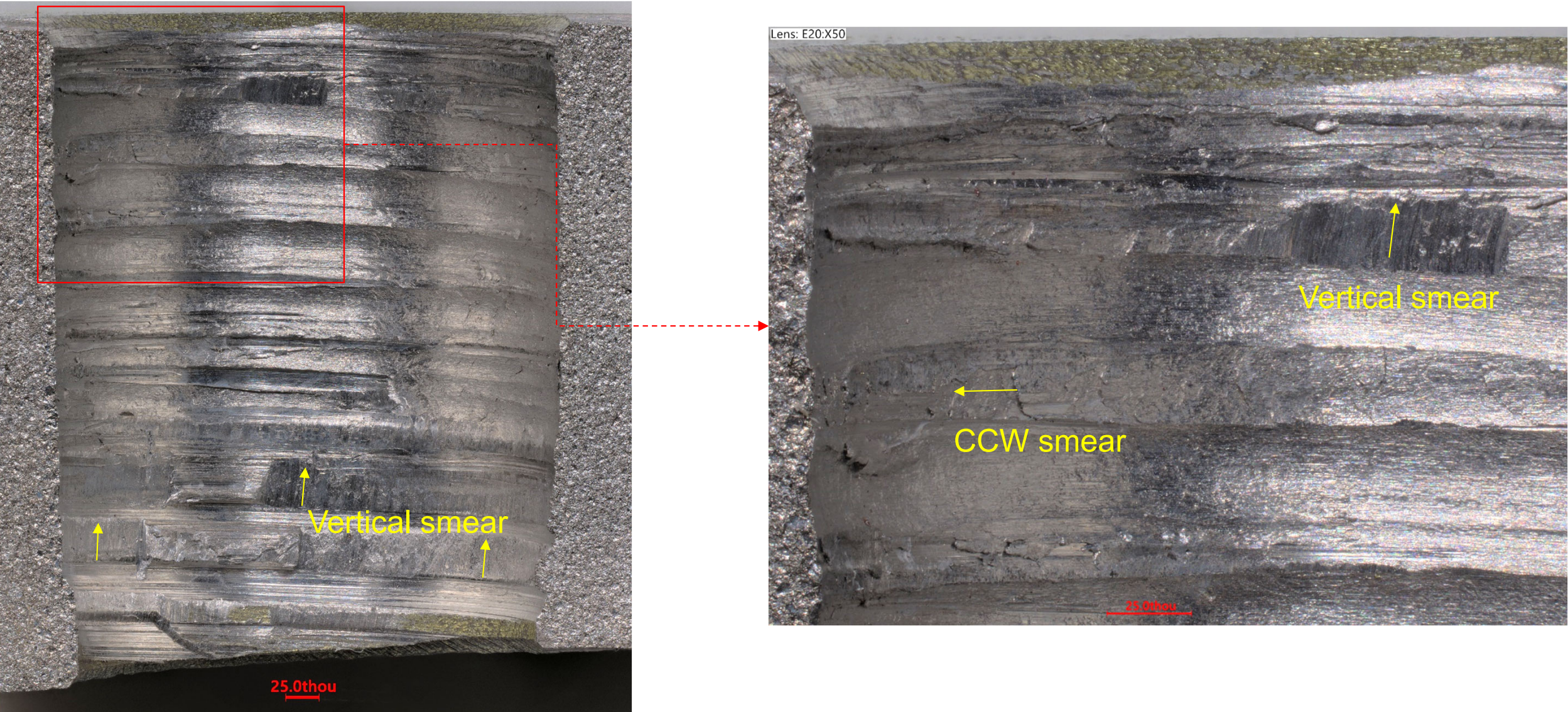


Figure 67: Optical view of insert hole 2 reveals vertical smear lines consistent with the insert pulling out and overlapping smeared material consistent with CCW rotation.



Hole 2 Side 1

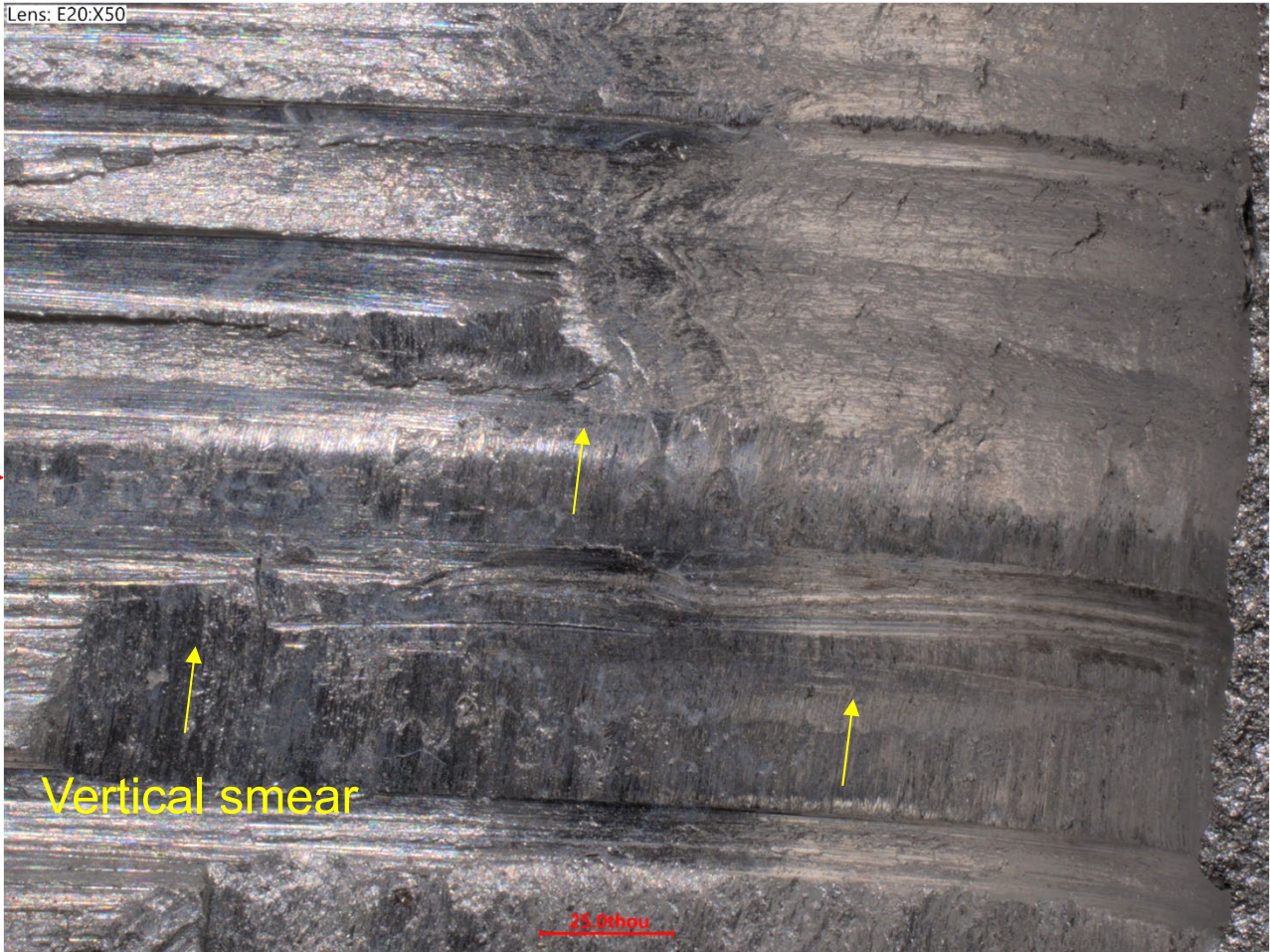
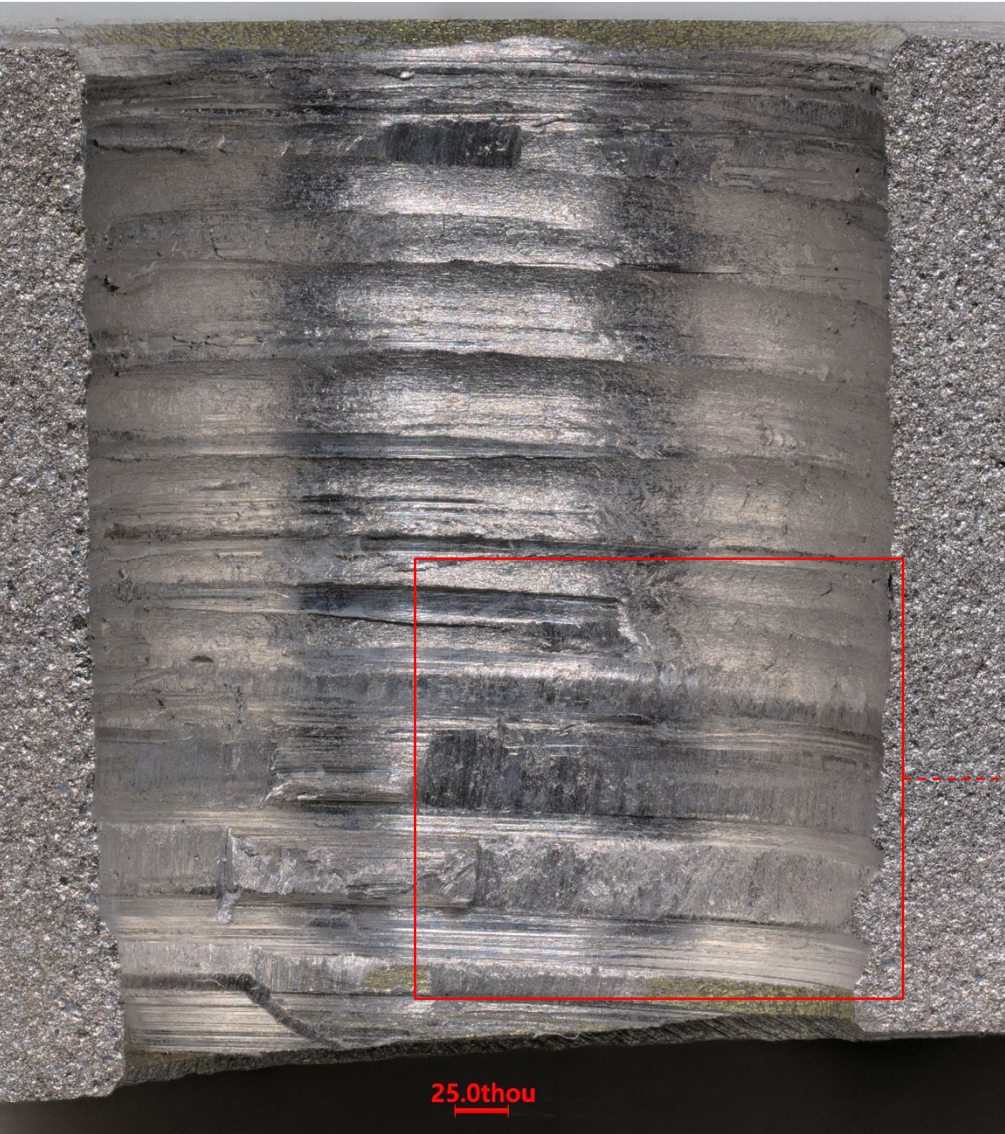
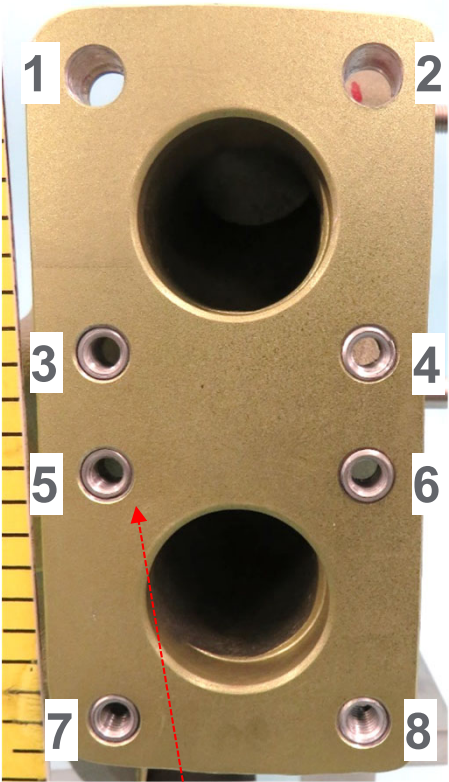


Figure 68: Optical view of insert hole 2 reveals vertical smear lines consistent with the insert pulling out and smeared material consistent with CCW rotation.



SN FIA231MR Holes 3 and 5



Inserts 3 and 5 cut in half with wire EDM

Inserts in place:

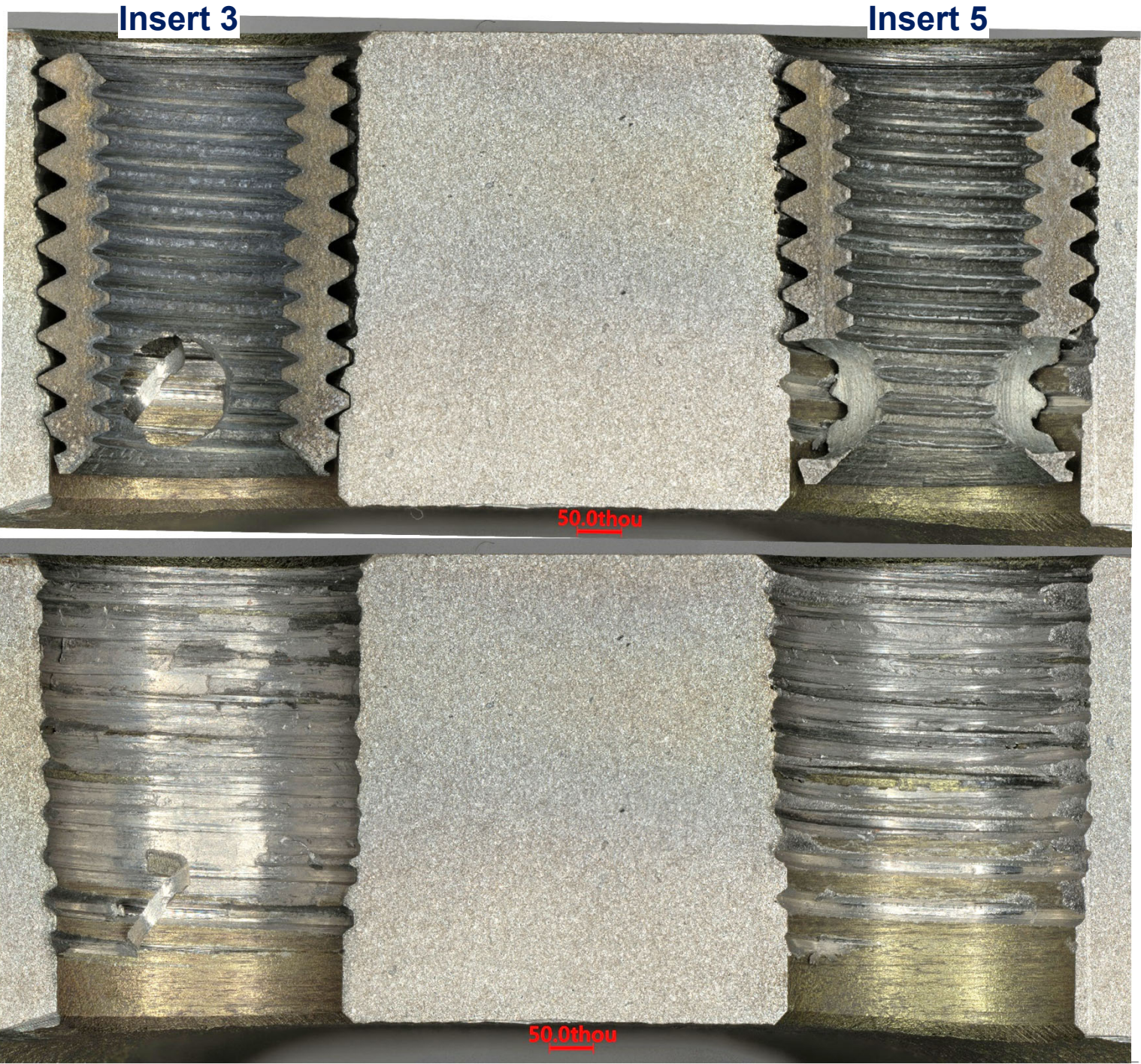


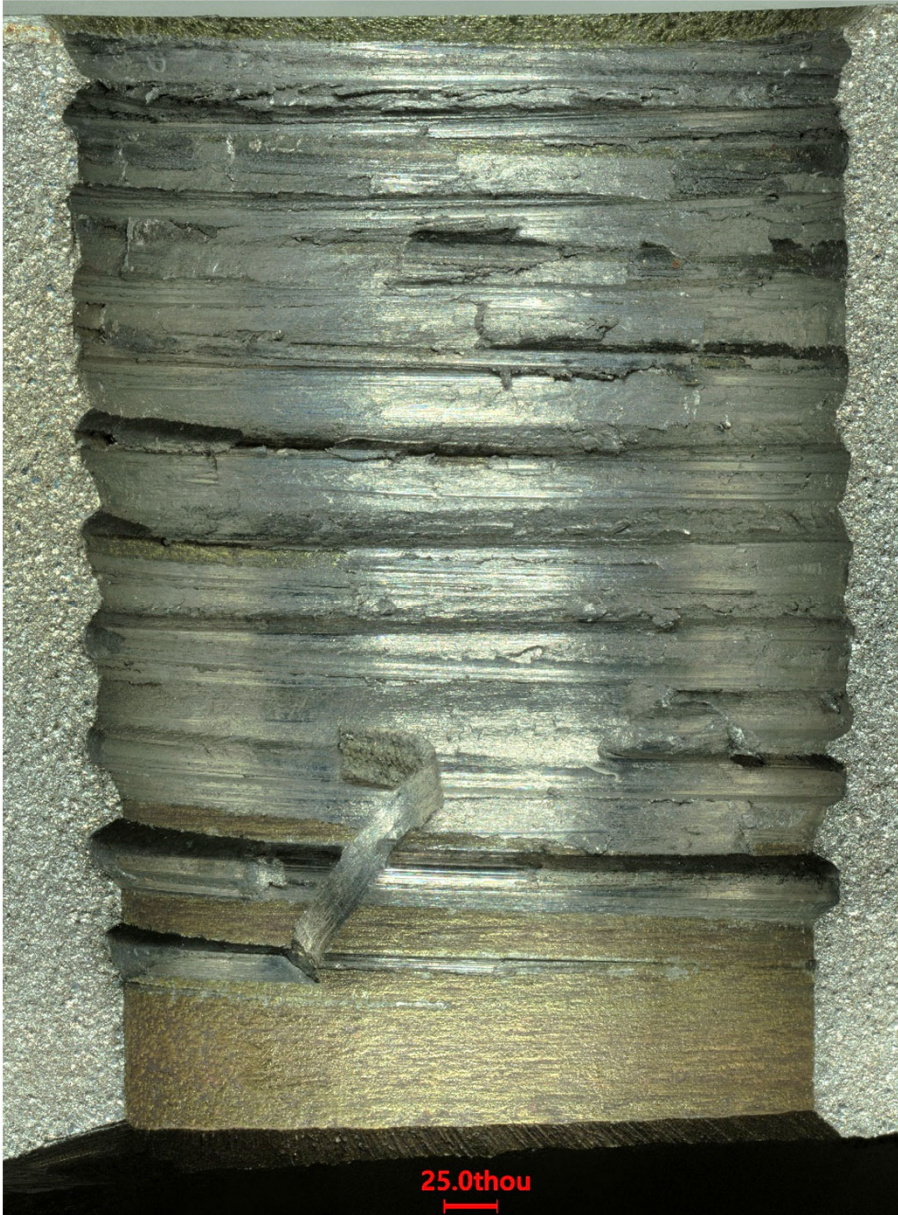
Figure 69: Optical views of insert locations 3 and 5 with the inserts in place and removed. Both insert holes have damaged and missing threads.





Figure 70: Optical views of insert hole location 3 reveals damaged threads.

Insert 3 Side 1



Insert 3 Side 2



Insert 3 Side 1

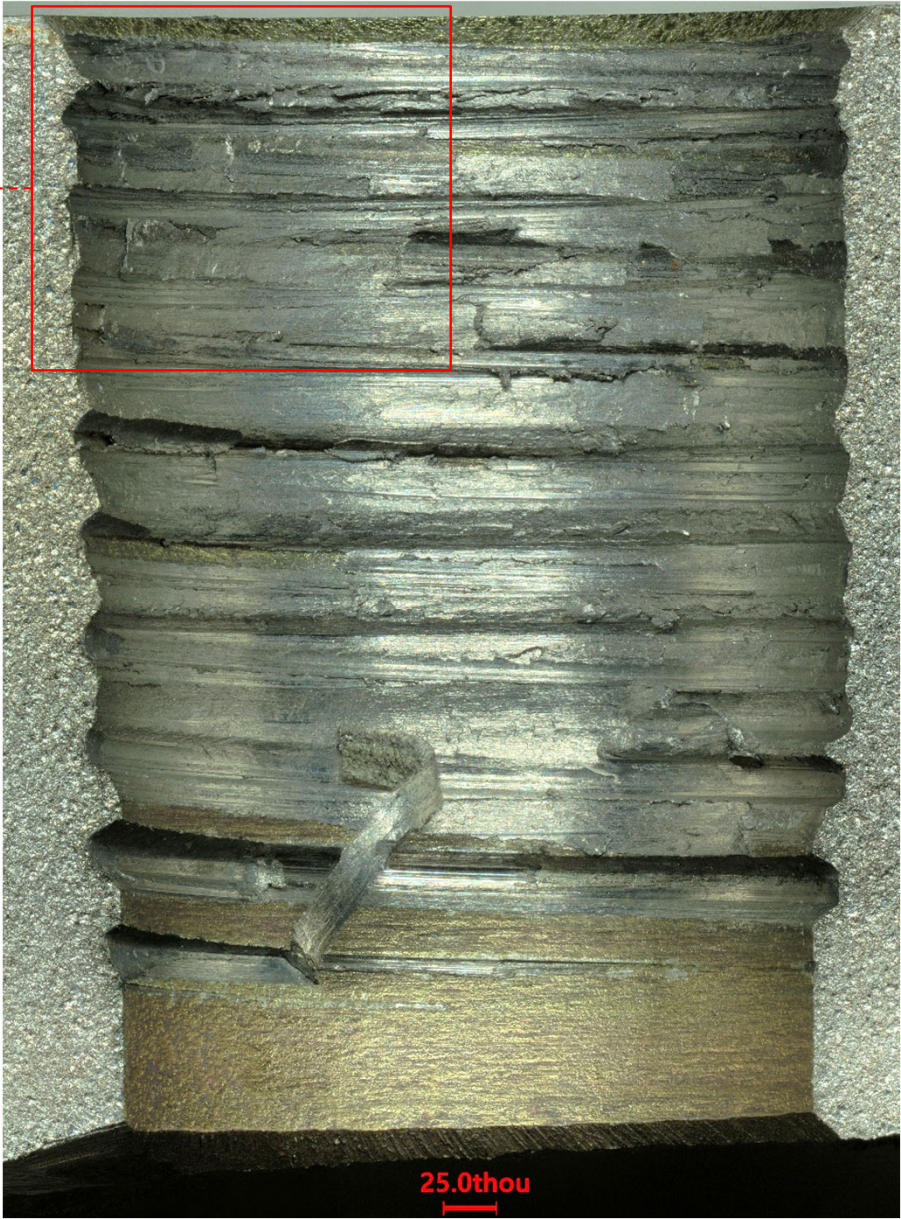
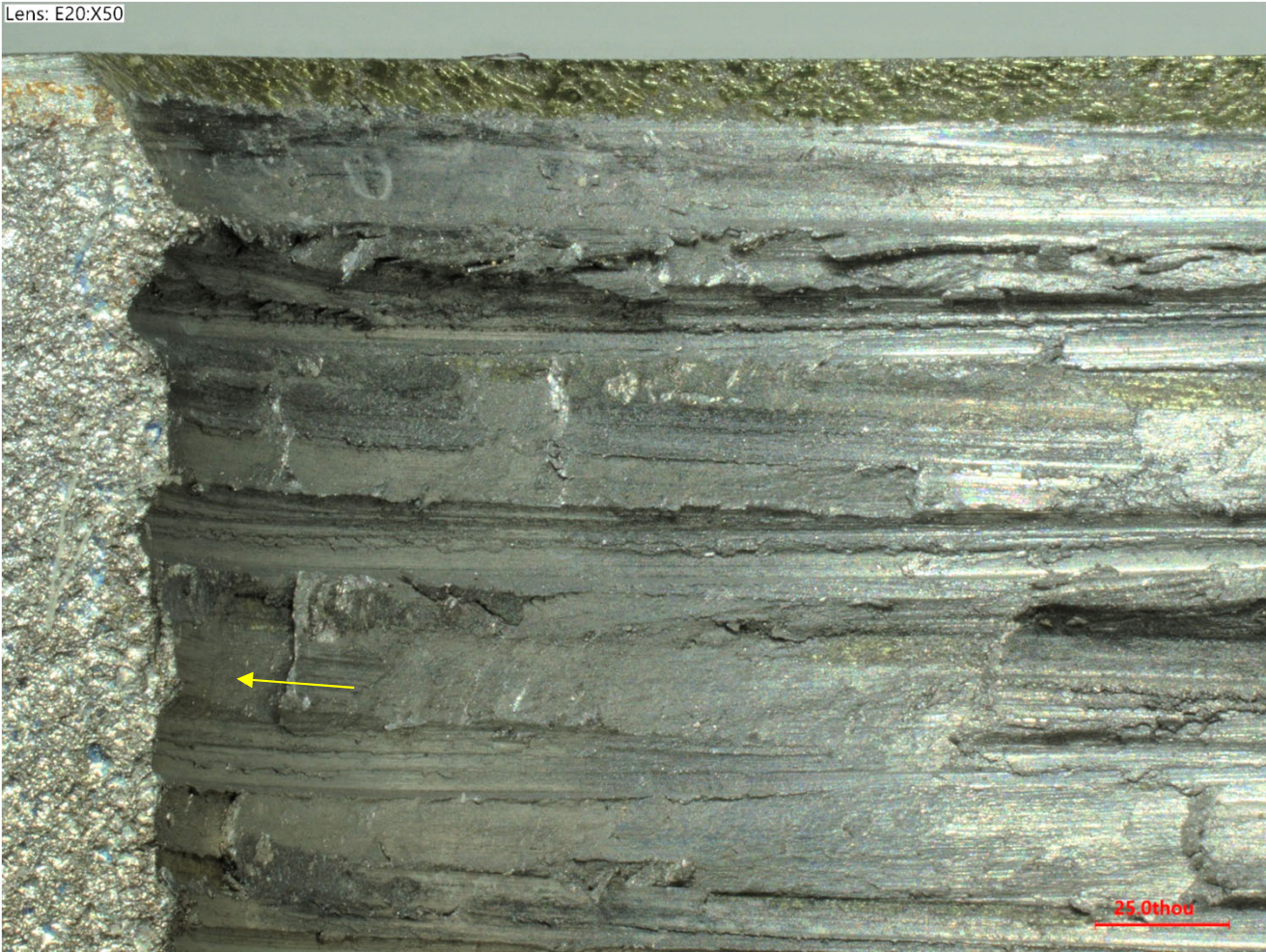


Figure 71: High magnification views show the damaged threads reveals overlapping smeared material consistent with CCW rotation.



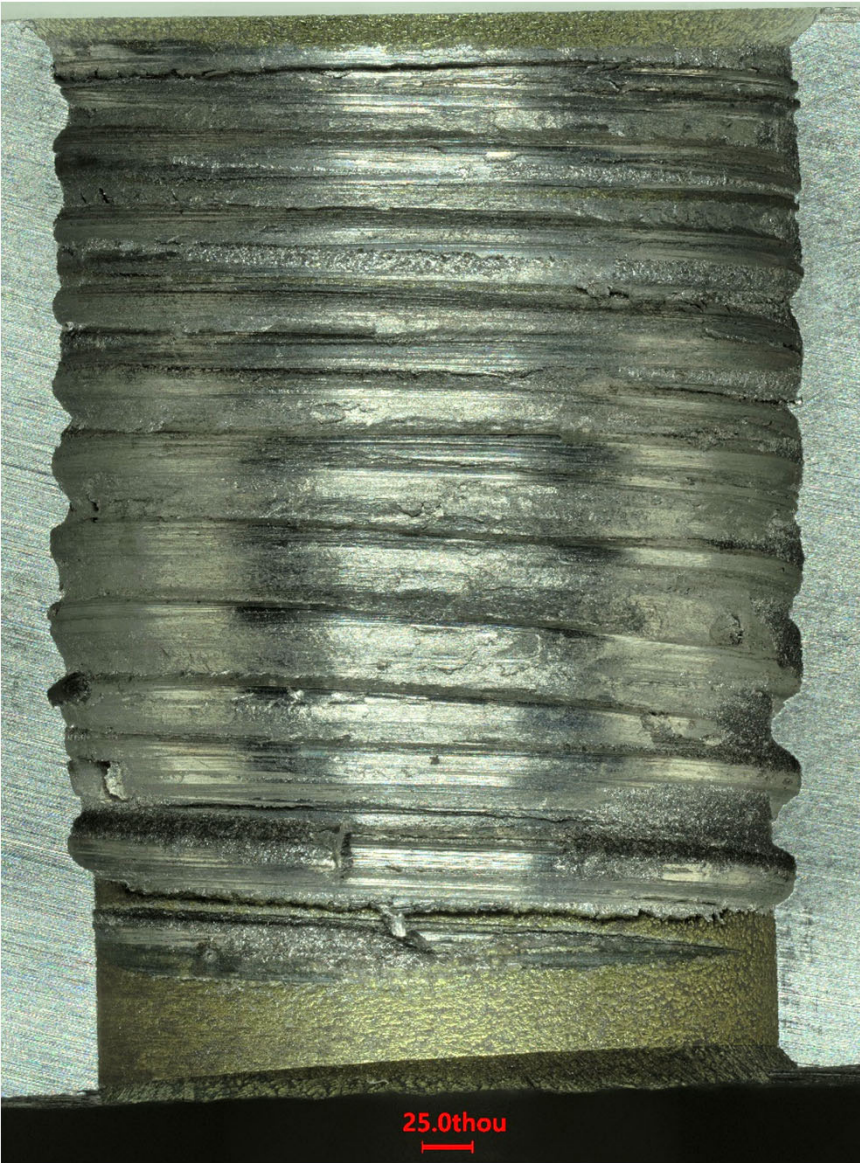


Figure 72: Optical views of insert locations 3 reveals damaged threads.

Insert 5 Side 1



Insert 5 Side 2



Insert 5 Side 1

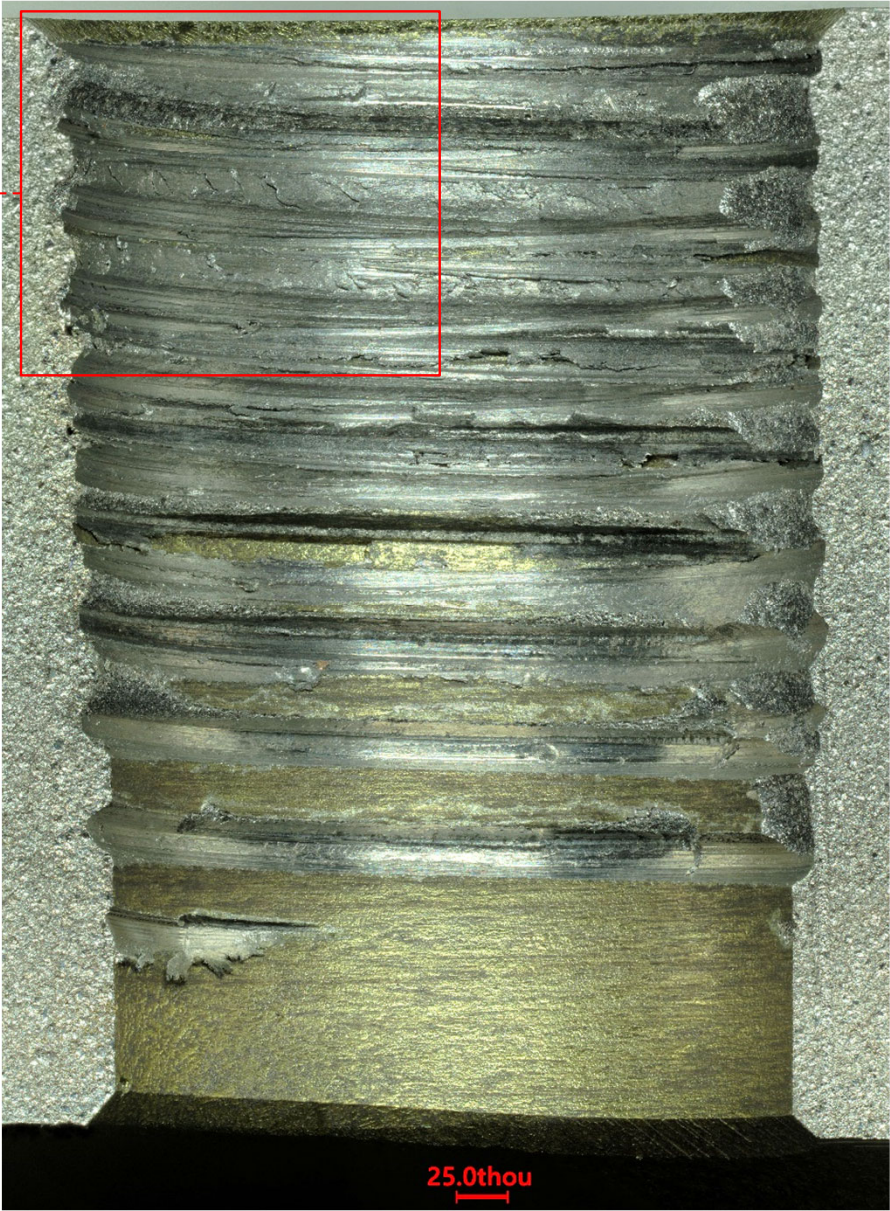
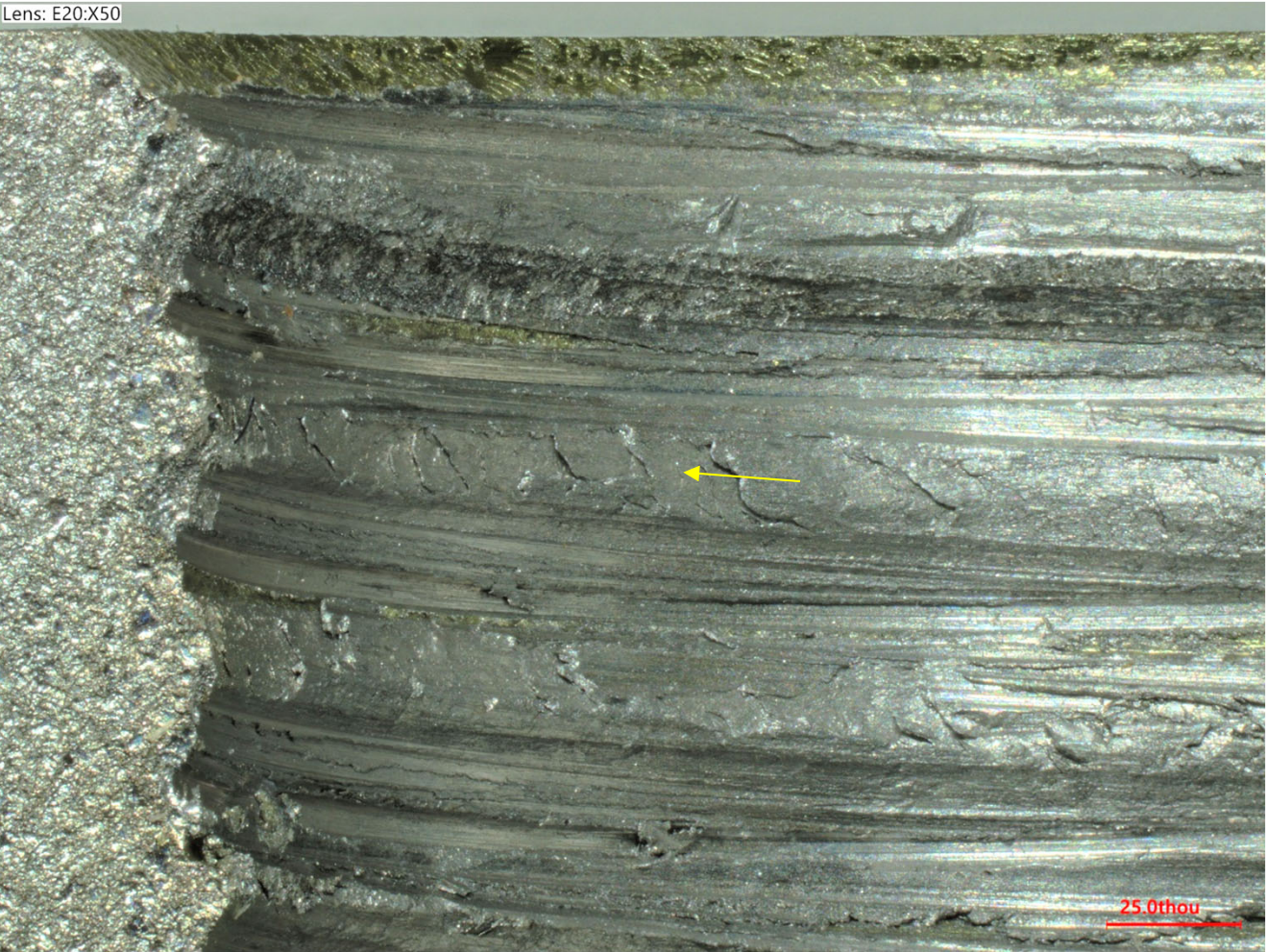


Figure 73: High magnification views show the damaged threads reveals overlapping smeared material consistent with CCW rotation.



Insert 5 Side 1

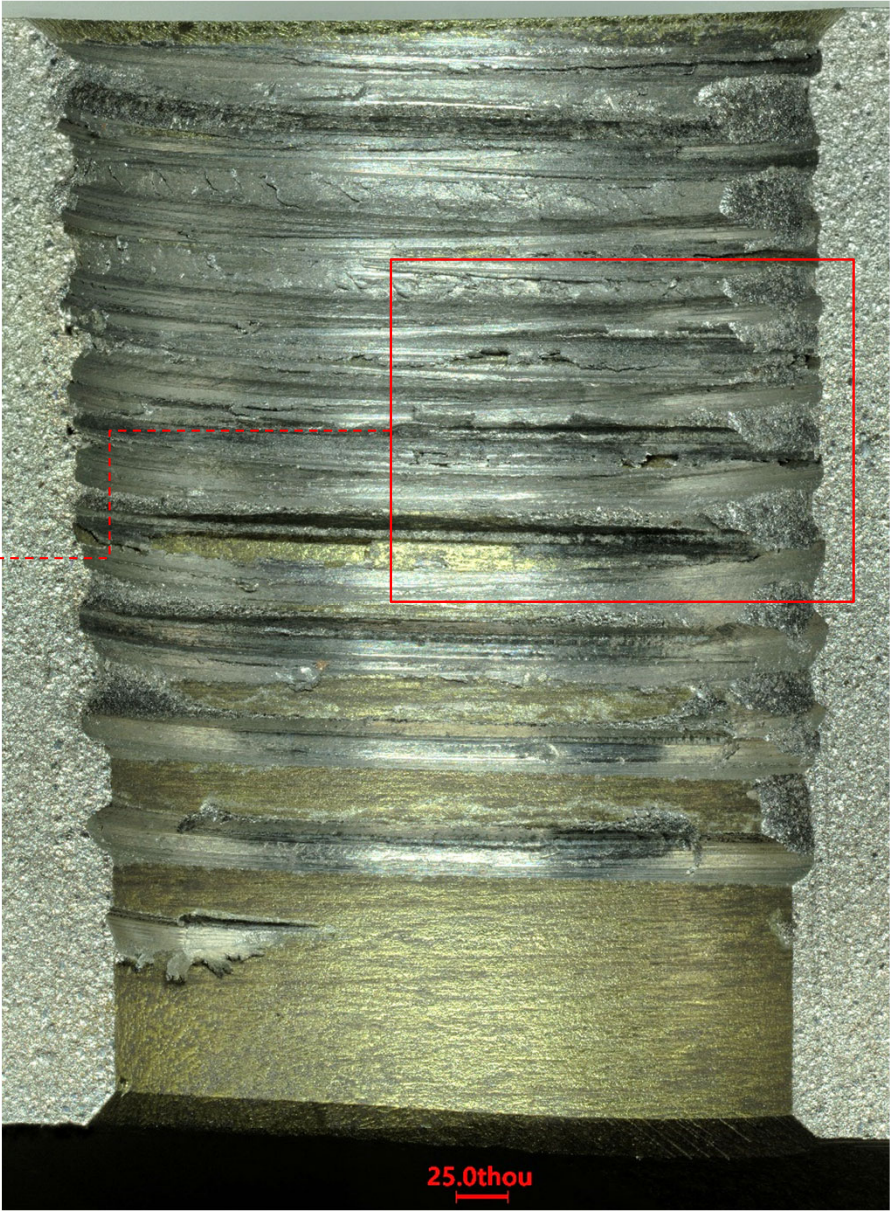
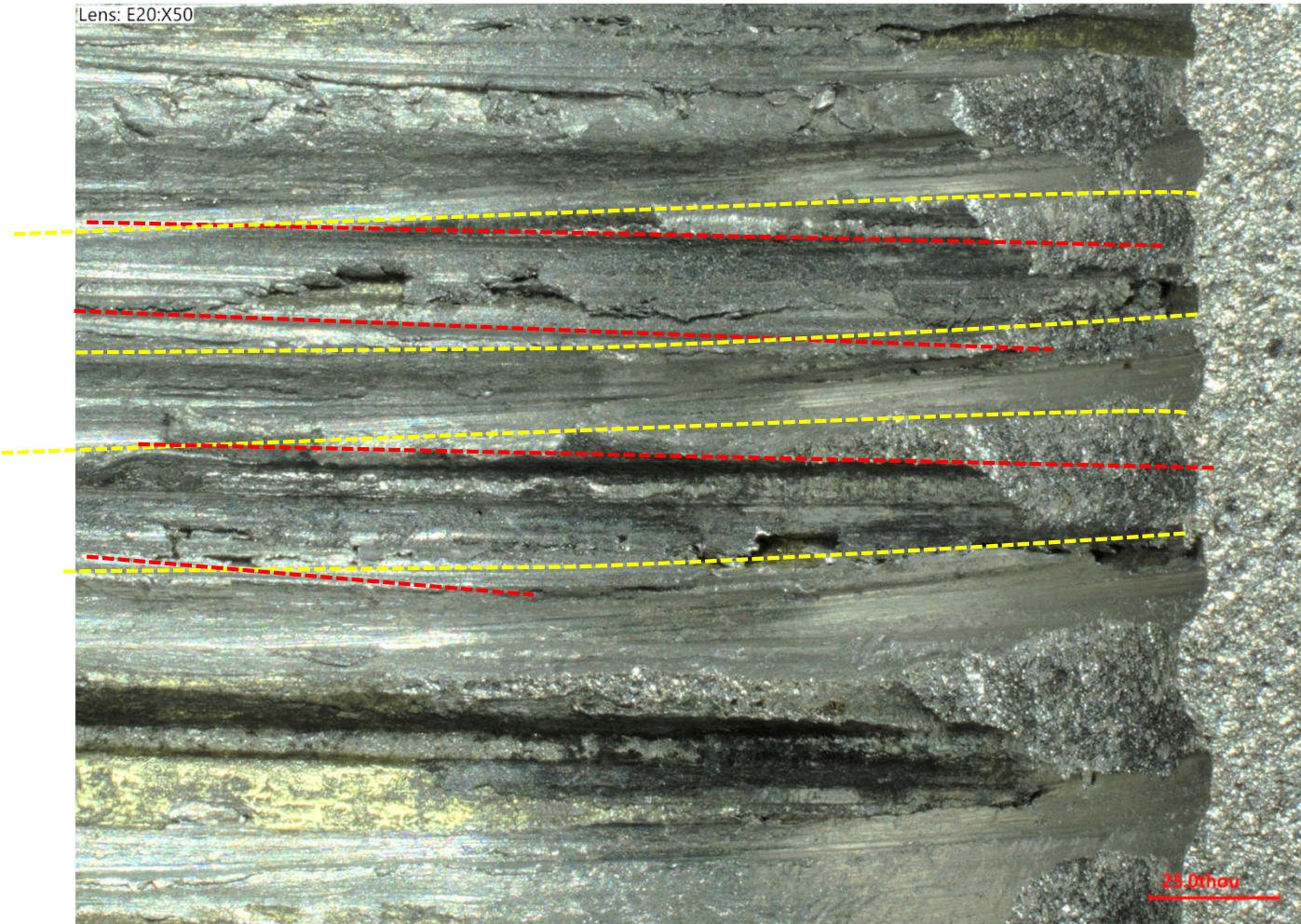
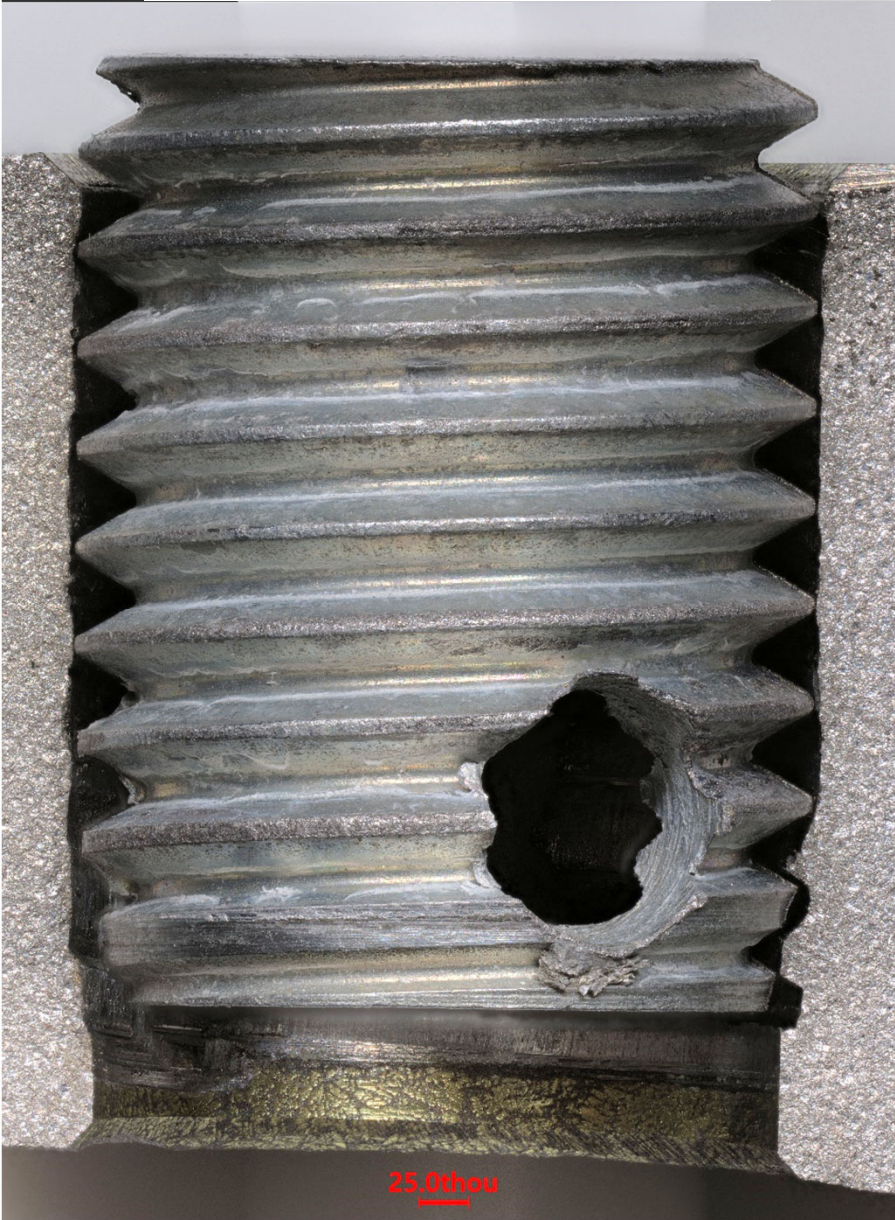


Figure 74: High magnification views show the damaged threads reveals angled cut lines through the flange female threads, consistent with the thread insert cross-threading and cutting through the flange threads.



Insert 6 Side 1 Insert In Place



Insert 6 Side 1 Insert Removed

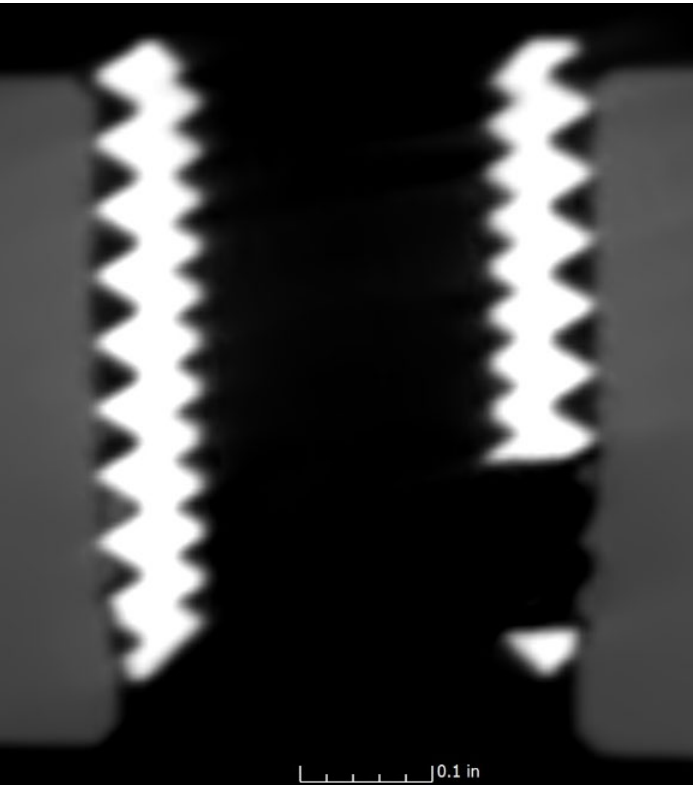


Figure 75: Optical views of insert location 6 reveals damaged threads.



Hole 6 Side 1

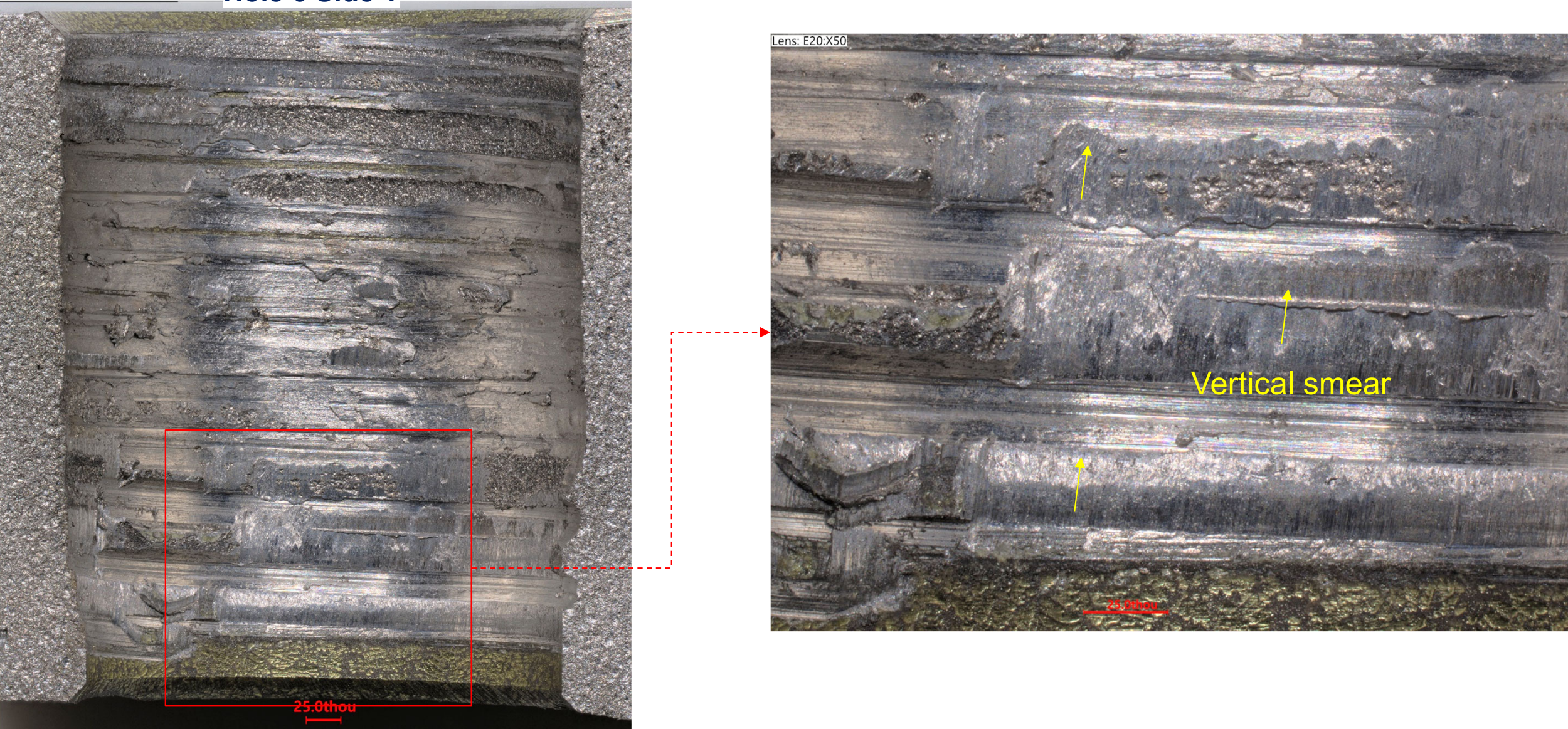


Figure 76: Optical view of insert hole 6 reveals vertical smear lines consistent with the insert pulling out and overlapping smeared material consistent with CCW rotation.



Hole 6 Side 1

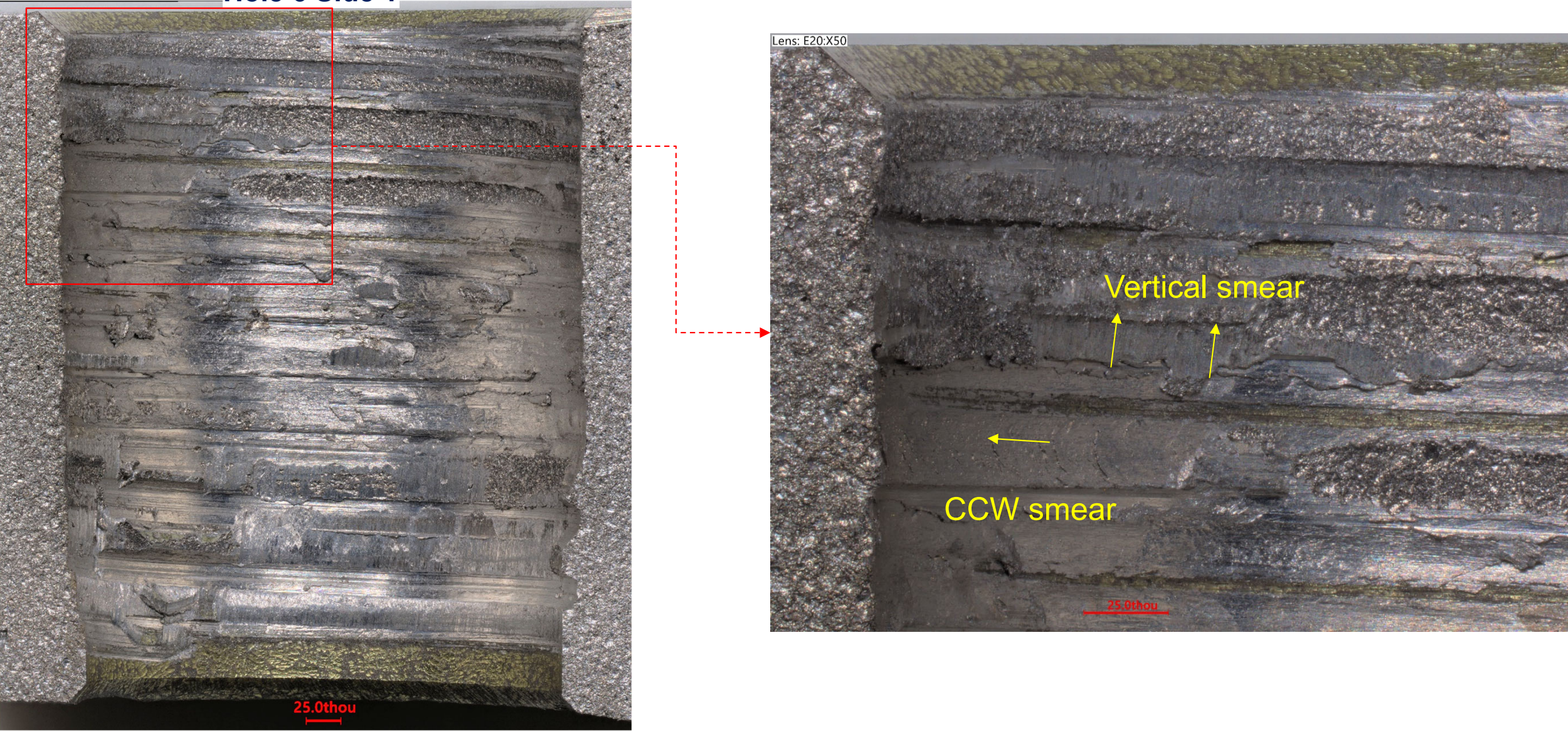


Figure 77: Optical view of insert hole 6 reveals vertical smear lines consistent with the insert pulling out and overlapping smeared material consistent with CCW rotation.



FA Lab Pull Out Test

Hole	Protrusion Depth Before Pull Out Test (in)	Protrusion Depth After Pull Out Test (in)	Total Pull Out Distance During Test	Max Torque at first torque drop
7	-0.009	0.014	0.023	150 in-lb

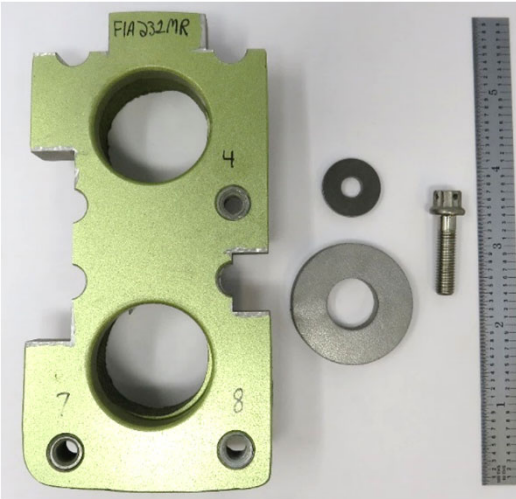
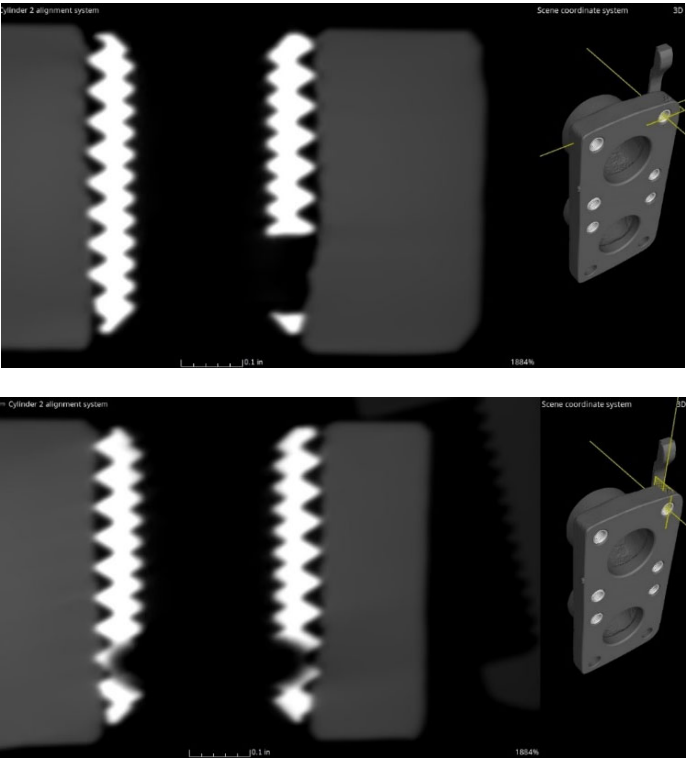


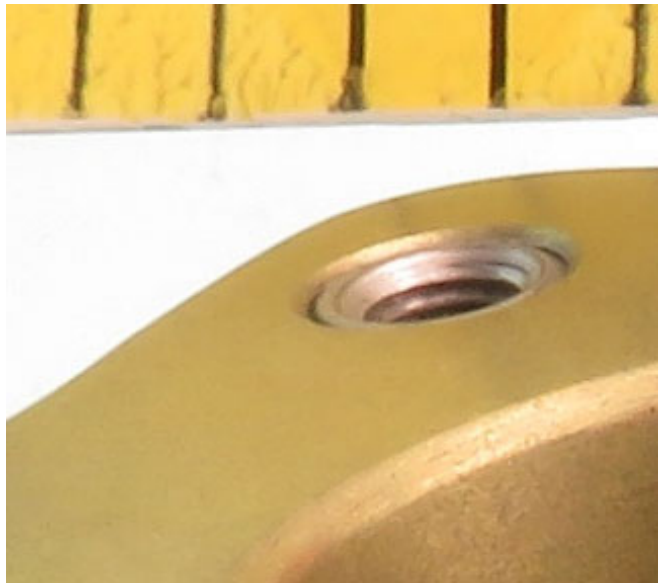
Figure 78: The SB 72-1577 pull out test was performed on insert location 7. The SB 72-1577 pull out test requires inserting a 1/4-28 bolt (PN MS9566) into the threaded insert and torquing to 190 – 210 in-lb. Prior to the test, insert 7 was measured to be 0.009-inches below the flange surface. During the test, the torque was slowly increased and experienced a torque drop at 150 in-lbs. The test fixture was removed, and the insert was found protruding 0.014-inches above the flange surface.



FA Lab Pull Out Test

Hole	Protrusion Depth Before Pull Out Test (in)	Protrusion Depth After Pull Out Test (in)	Total Pull Out Distance During Test (in)	Max Torque at first torque drop
7	-0.009	0.014	0.023	150 in-lb

Before Pull Out Test



After torque drop at 150 in-lb



FIA231MR
Hole 7 (Post Pull Out Test)



Figure 79: Images of insert 7 before and after the pull-out test show it started 0.009-inches below the flange surface and was pulled out to 0.014-inches above the flange surface during the test (0.023-inches of total vertical movement). The insert location was sectioned in half. Optical views (right) show the insert has similar vertical scoring lines as the event engine insert locations 2 and 3.



Appendix C: RTV Part

P/N: 9395M78G10

S/N: FIA23K9F

[Click here to return to summary table](#)



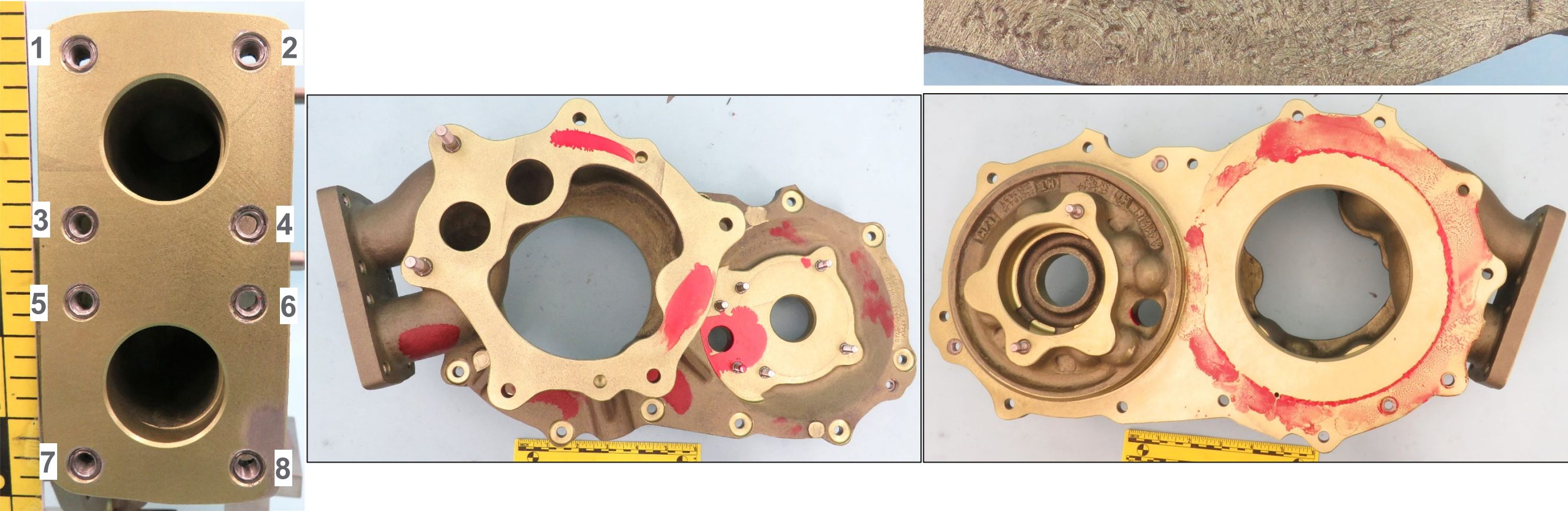
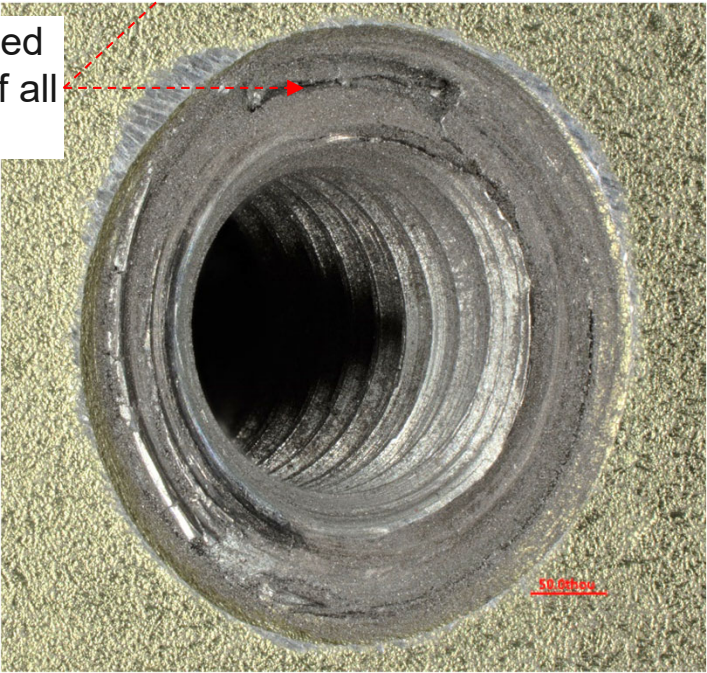
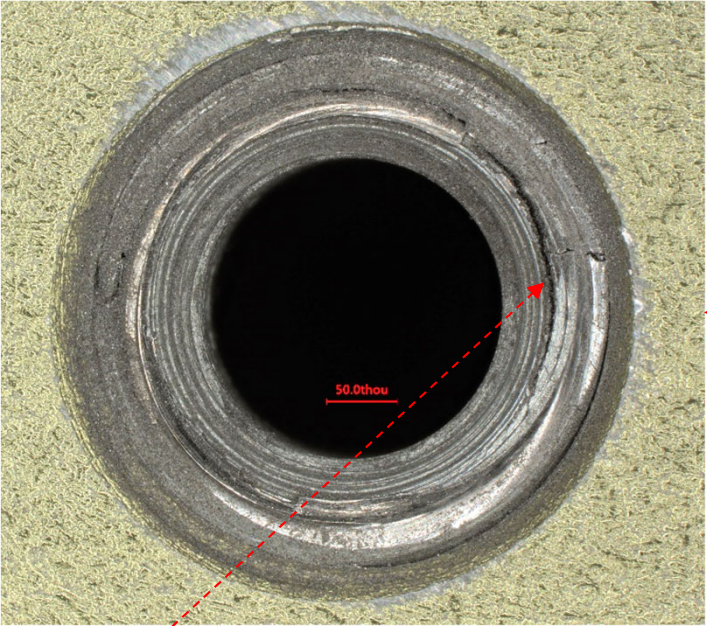


Figure 80: Images of a HMU idler adapter (P/N 9395M78G10, S/N FIA23K9F) which was manufactured at Avio. The part was returned to the manufacturer (Avio) from the Durham engine assembly facility.



Cracks are observed in the top thread of all eight steel inserts

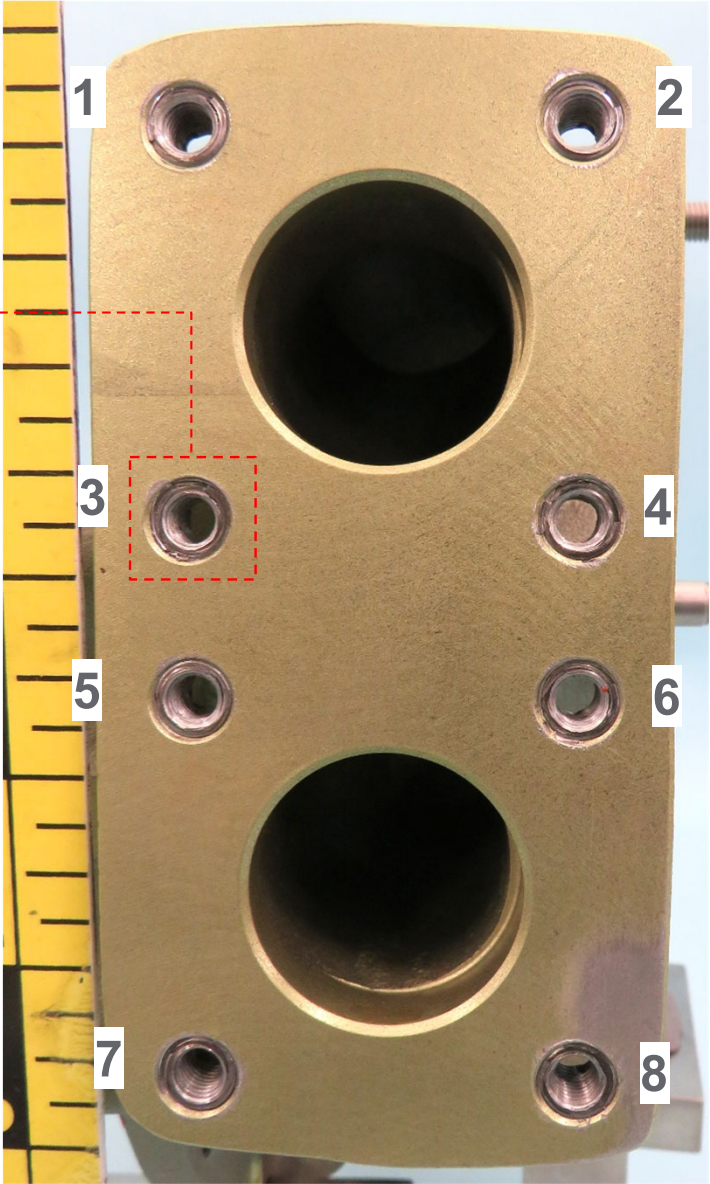
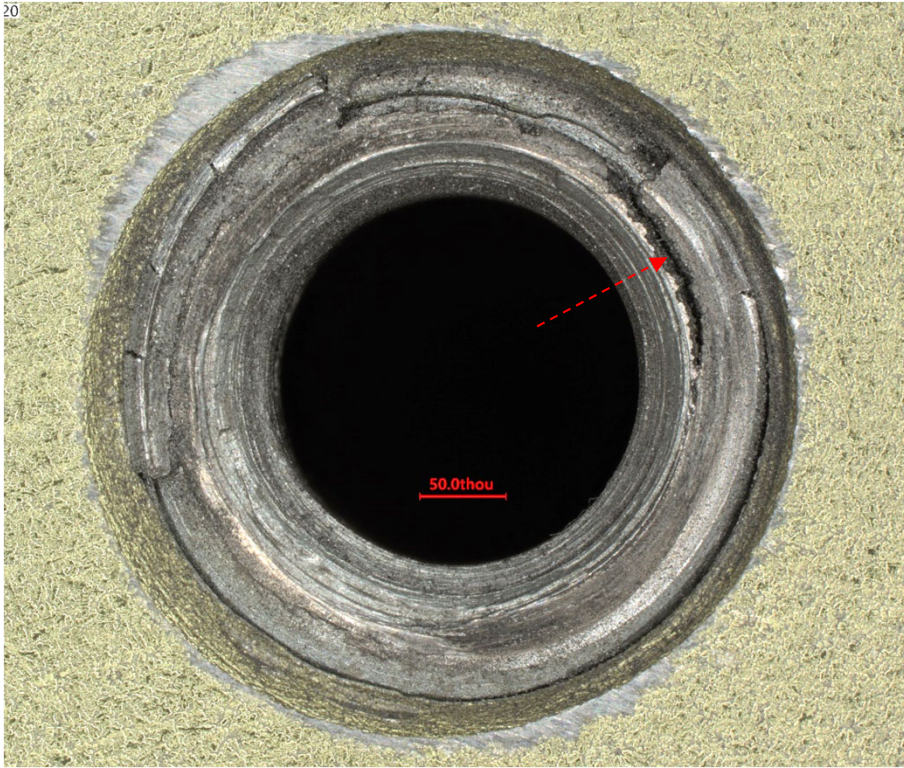


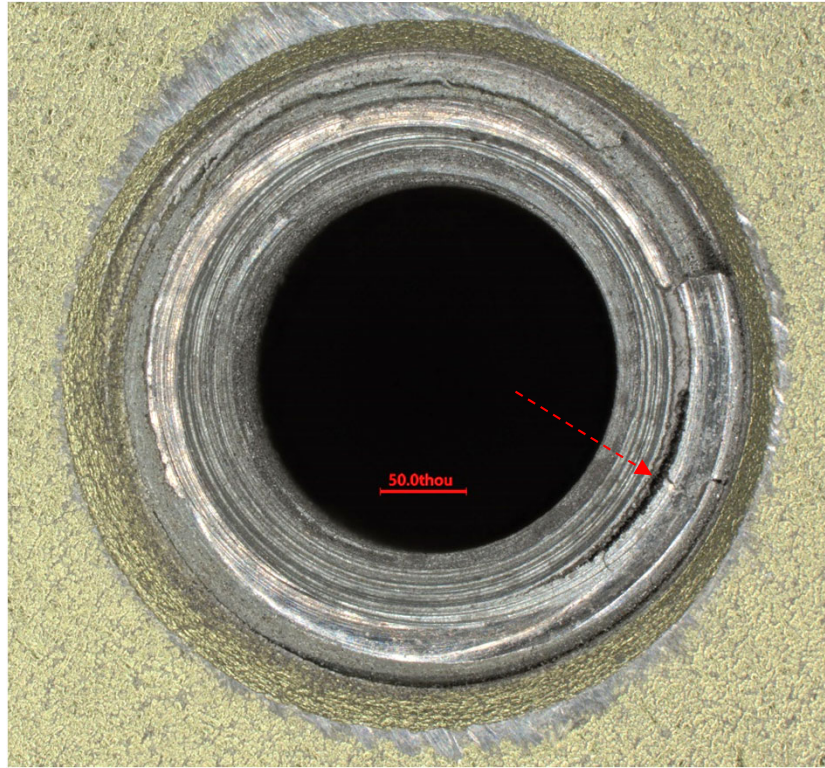
Figure 81: Images show none of the eight inserts were protruding from the flange surface. The top thread of all eight steel inserts are cracked.



Insert 1



Insert 2



Insert 3

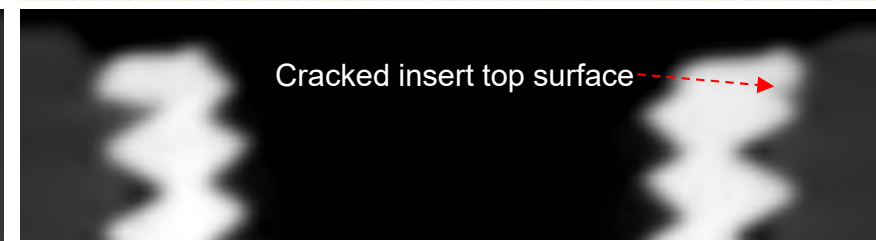
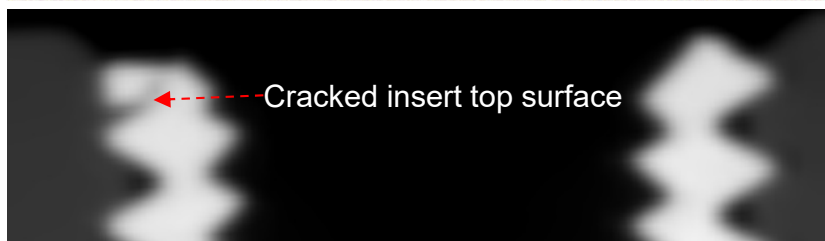
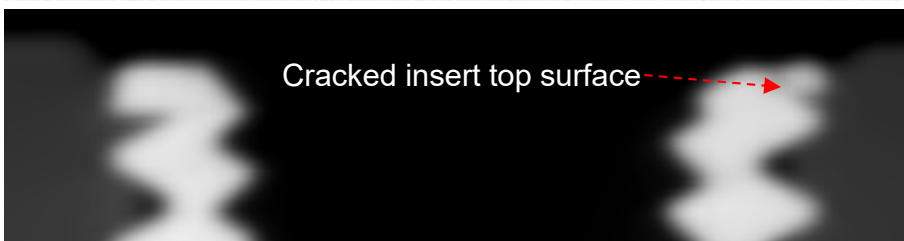
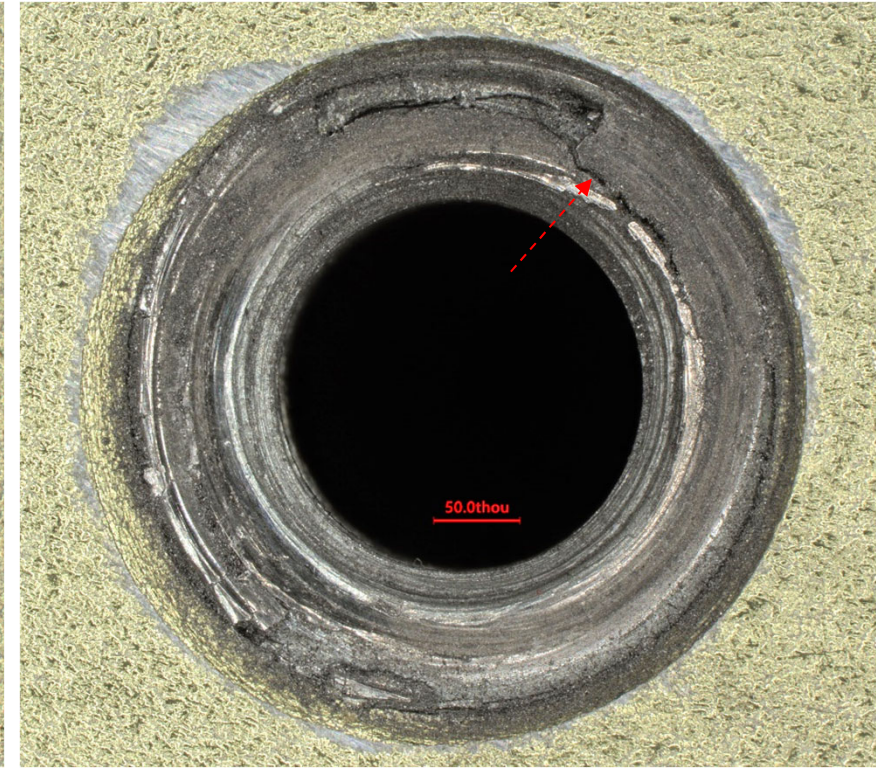
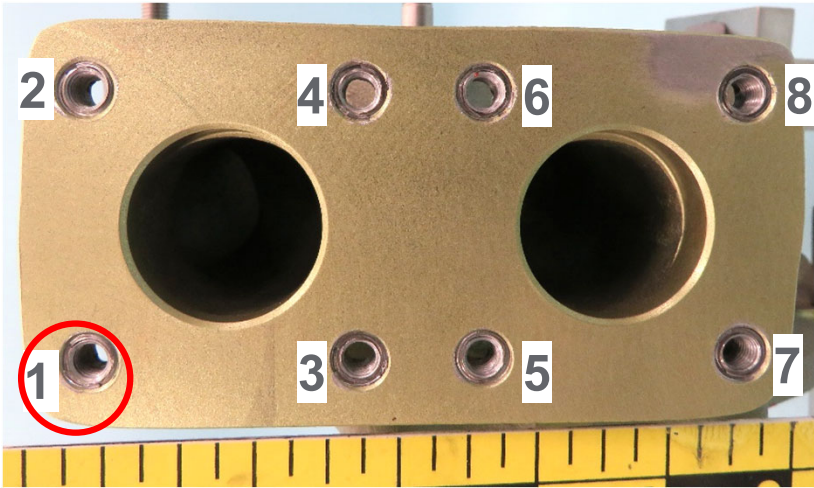


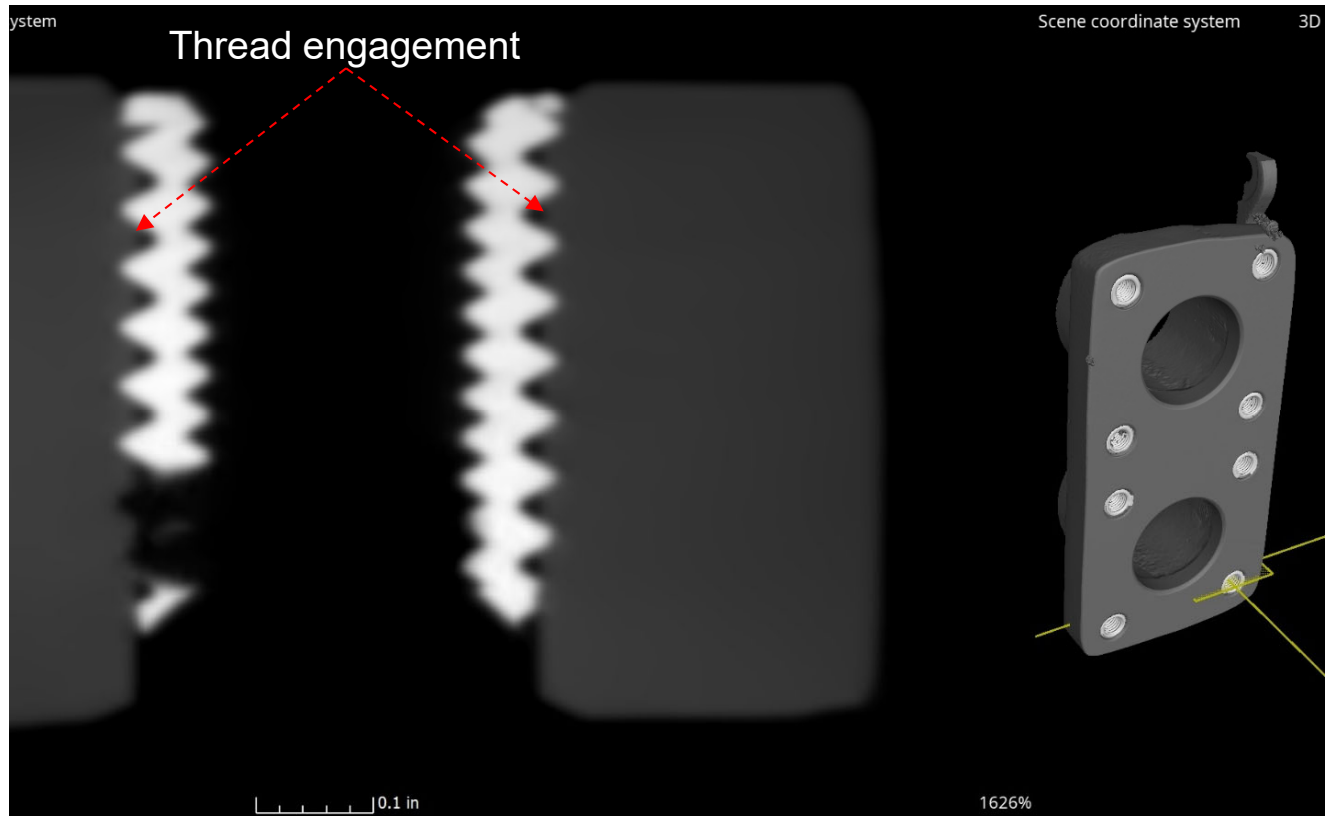
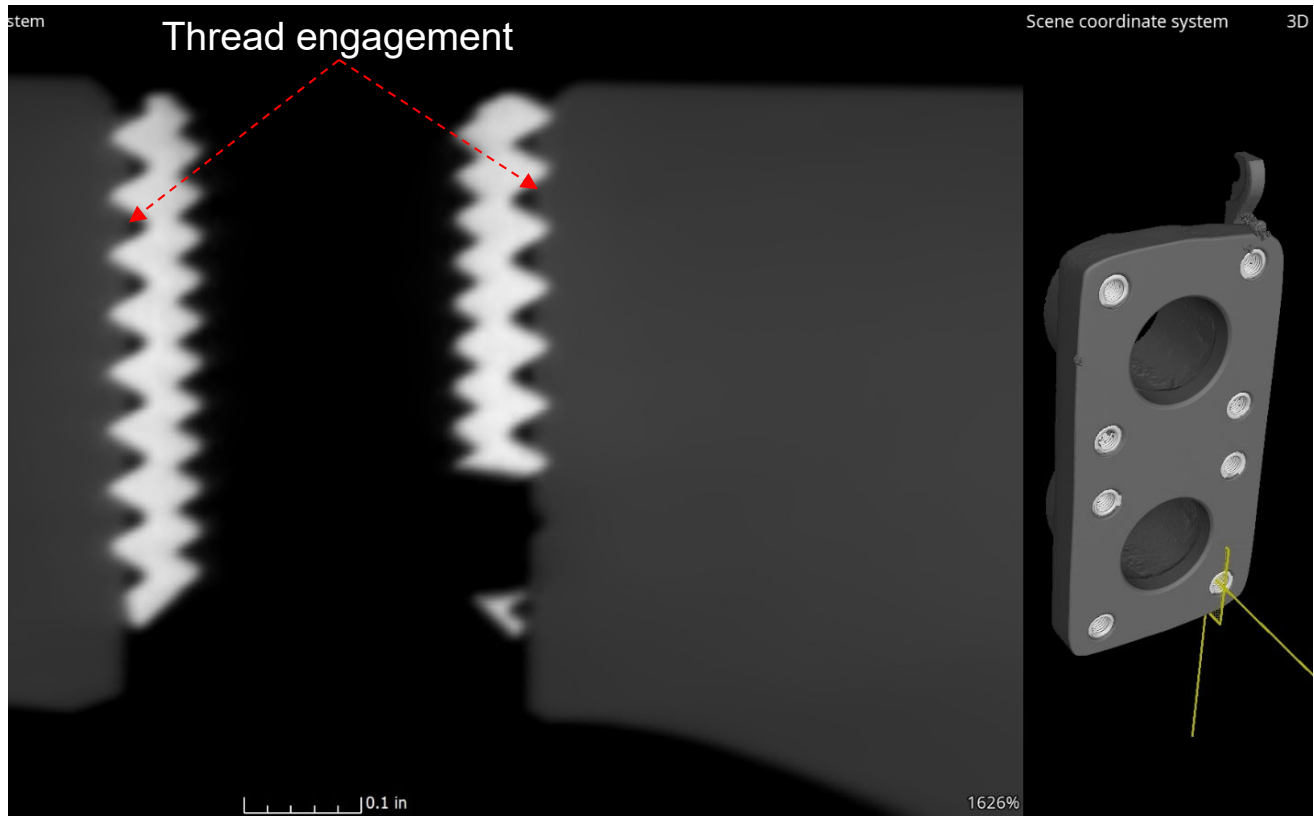
Figure 82: All eight steel inserts are cracked at the top surface. Images of inserts 1, 2, and 3 above show the crack locations. The CT scans reveal the cracks do not extent beyond the top insert thread.

Insert 1

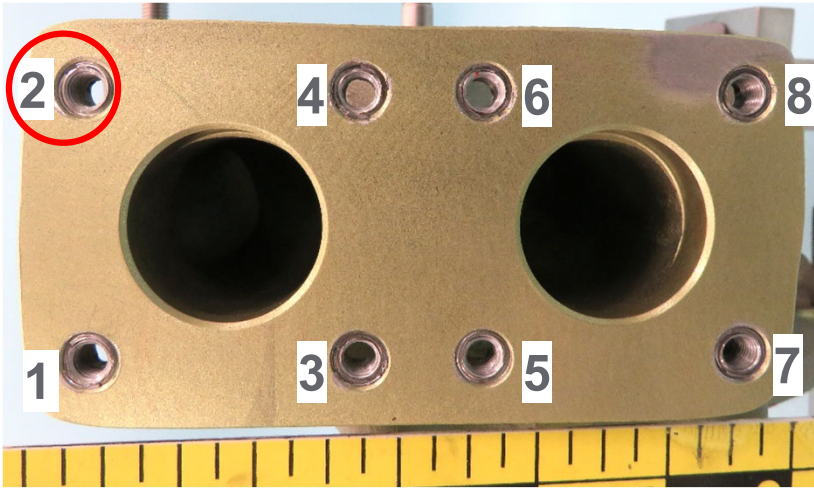


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 83: CT scan cross-section of thread insert position 1. Thread engagement is observed into the flange material.

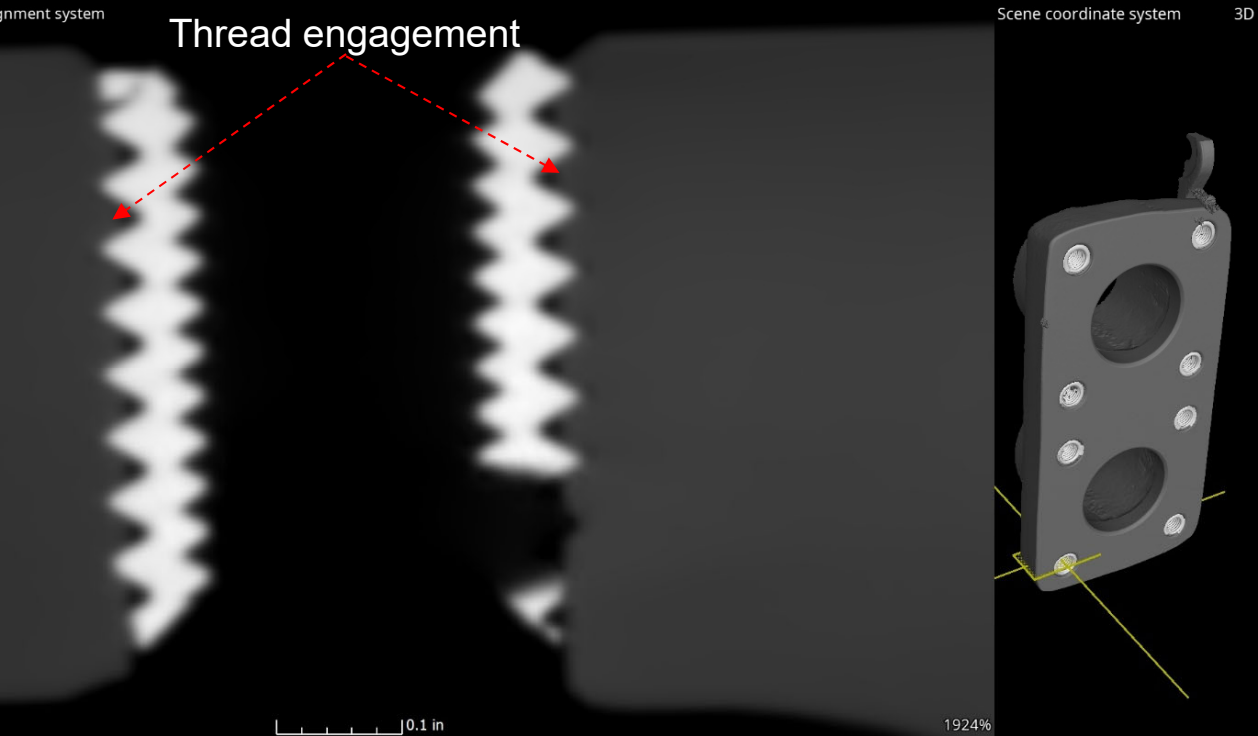
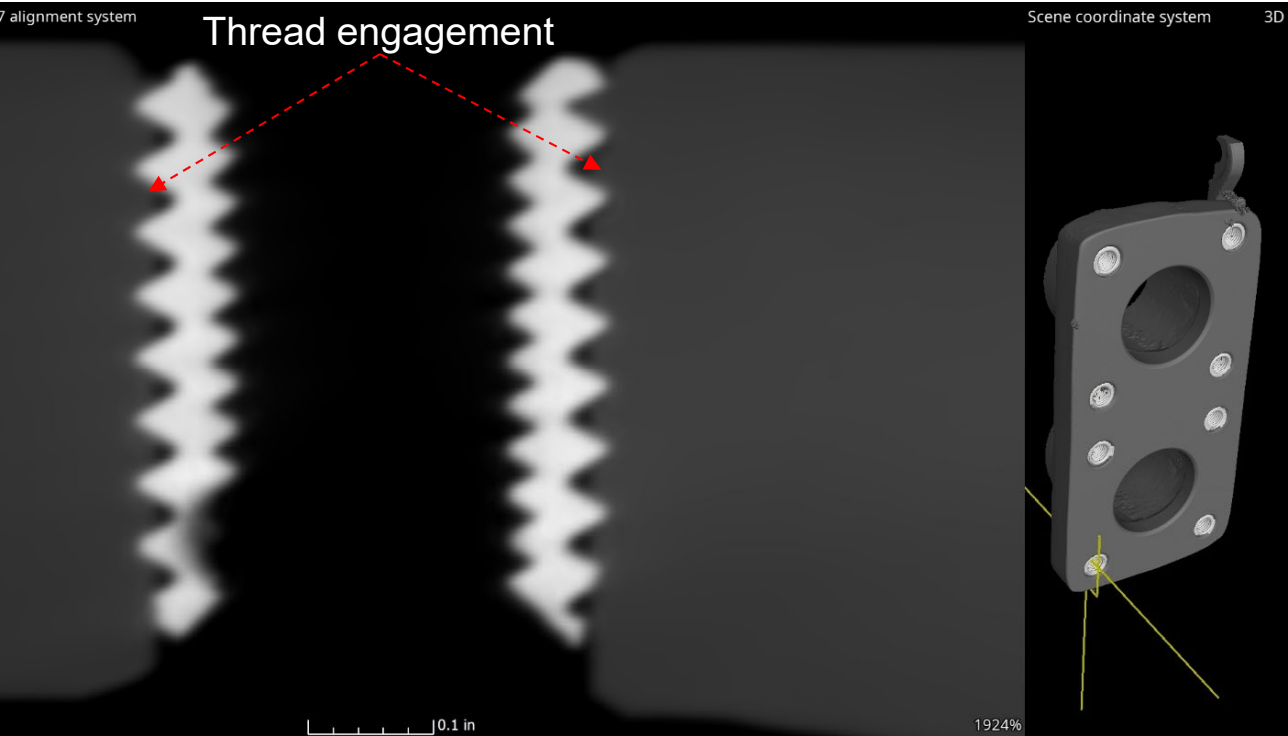


Insert 2

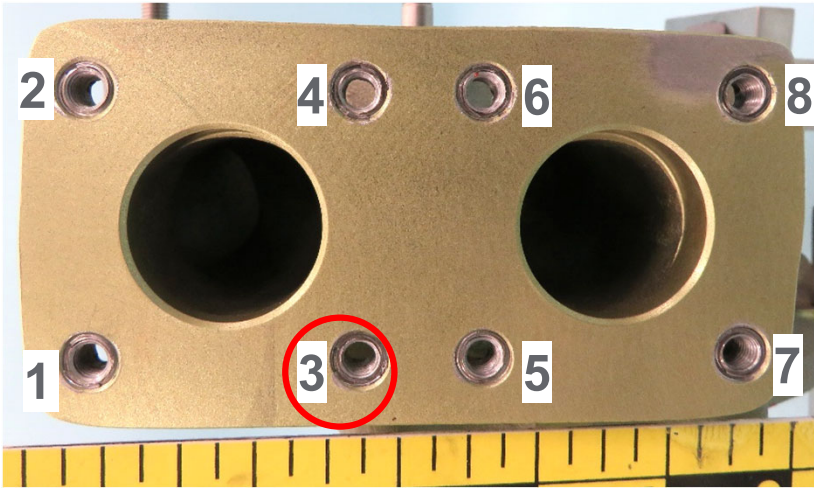


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 84: CT scan cross-section of thread insert position 2. Thread engagement is observed into the flange material.

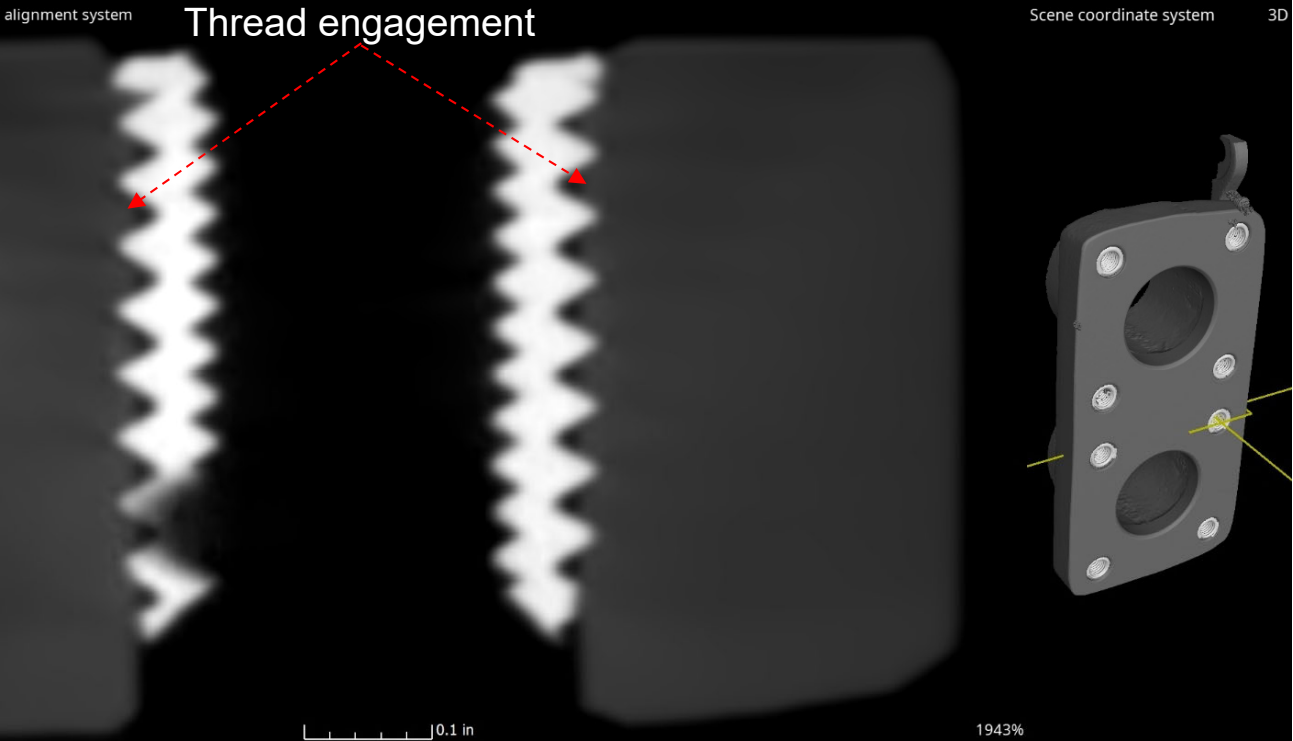
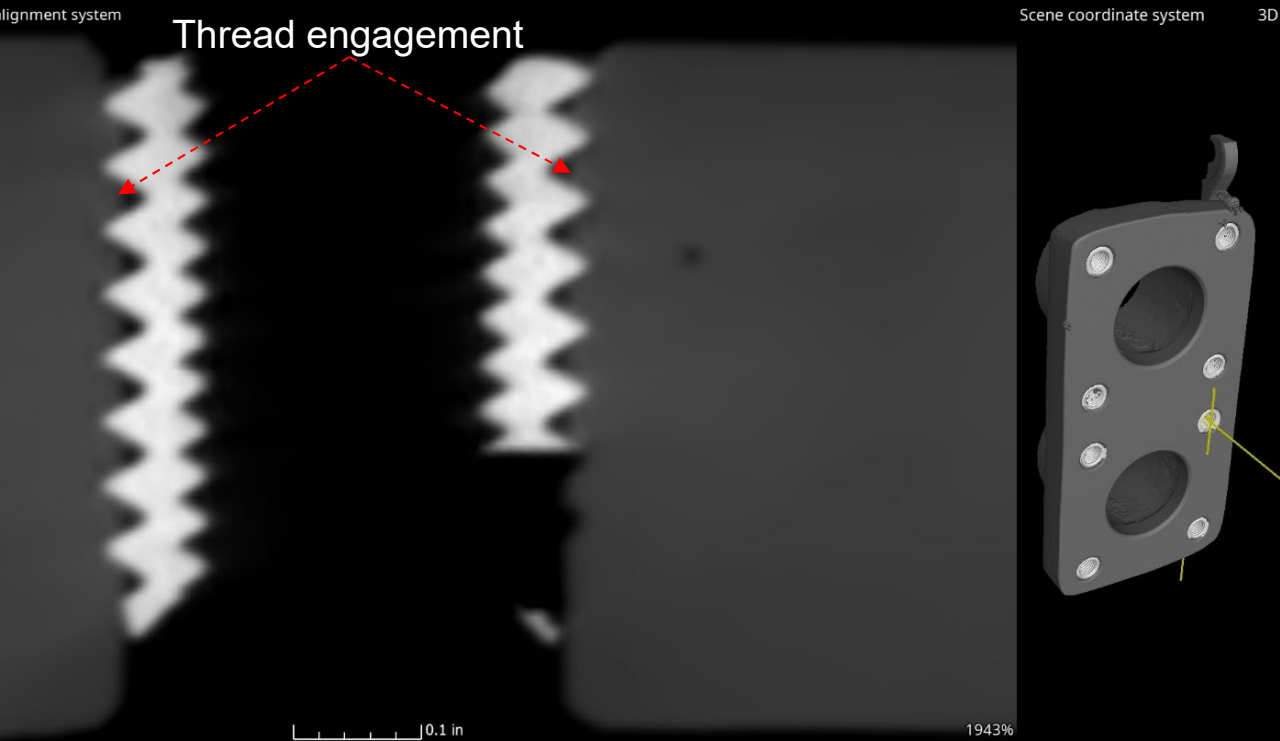


Insert 3

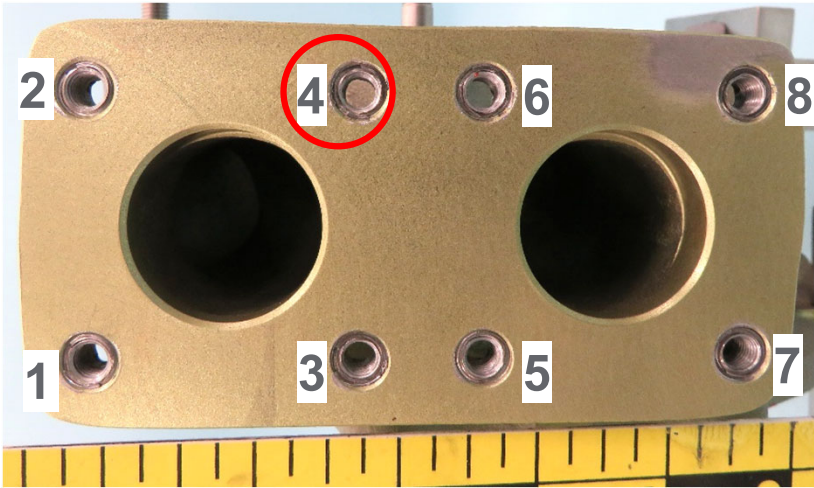


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 85: CT scan cross-section of thread insert position 3. Thread engagement is observed into the flange material.

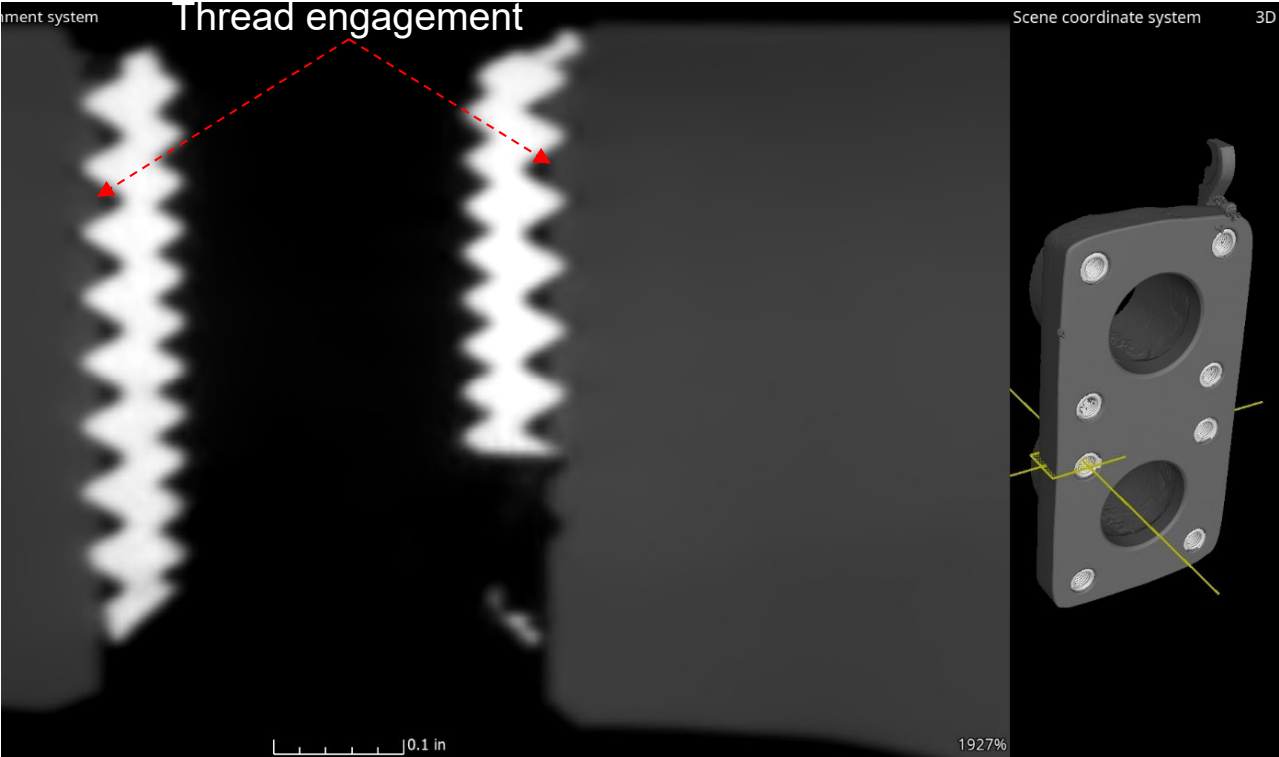
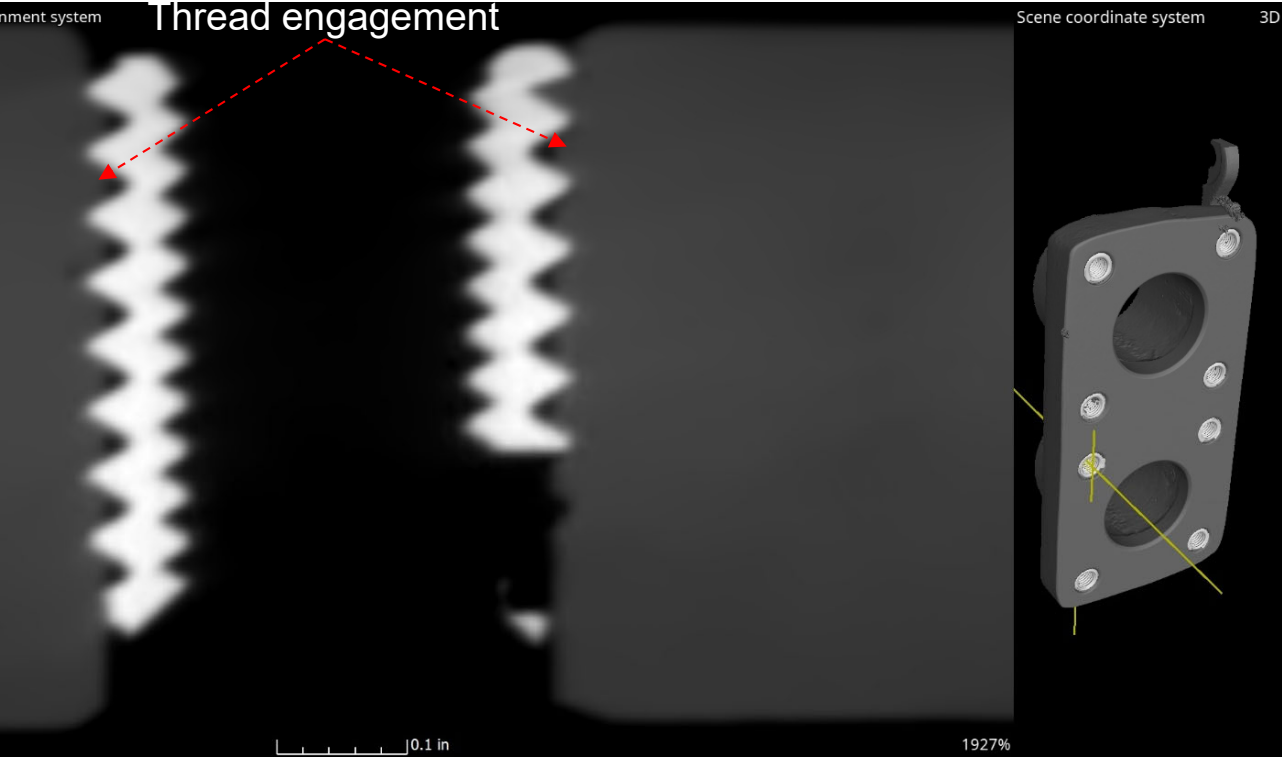


Insert 4

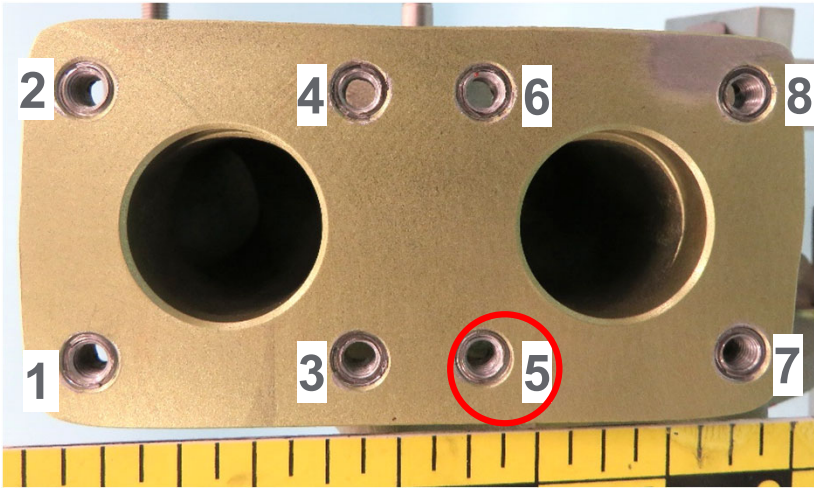


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 86: CT scan cross-section of thread insert position 4. Thread engagement is observed into the flange material.

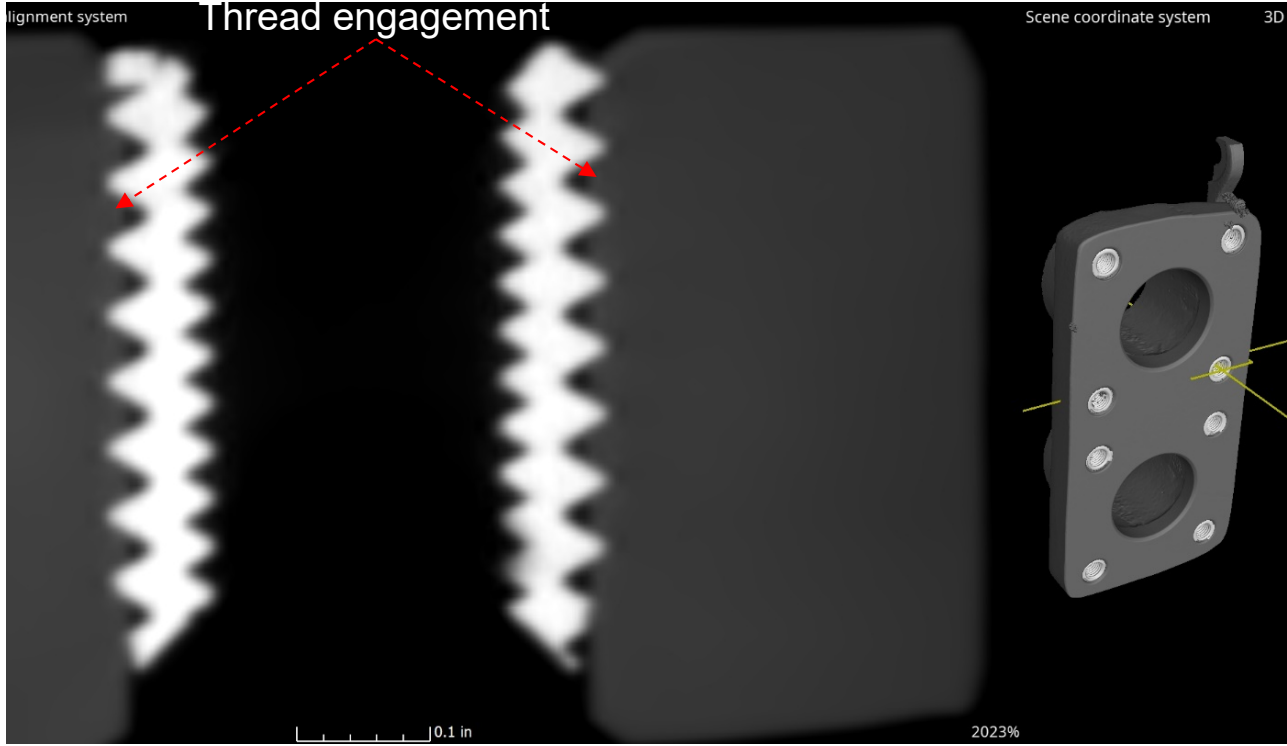
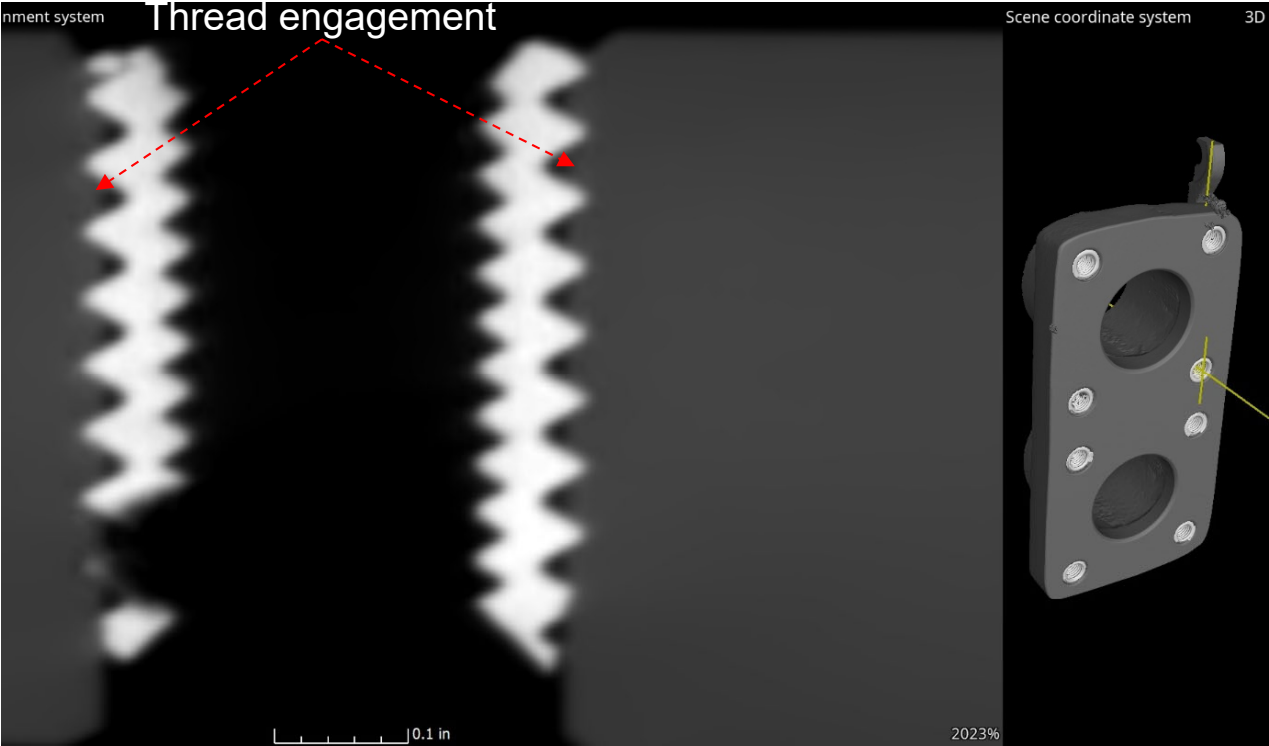


Insert 5

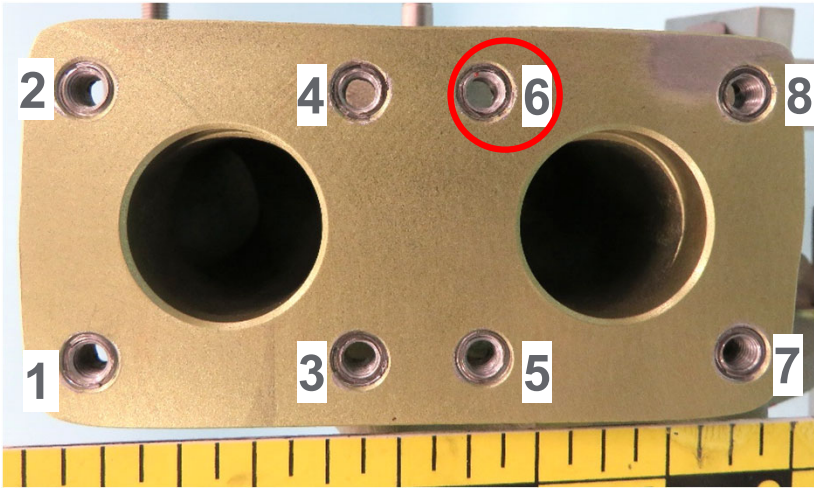


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 87: CT scan cross-section of thread insert position 5. Thread engagement is observed into the flange material.

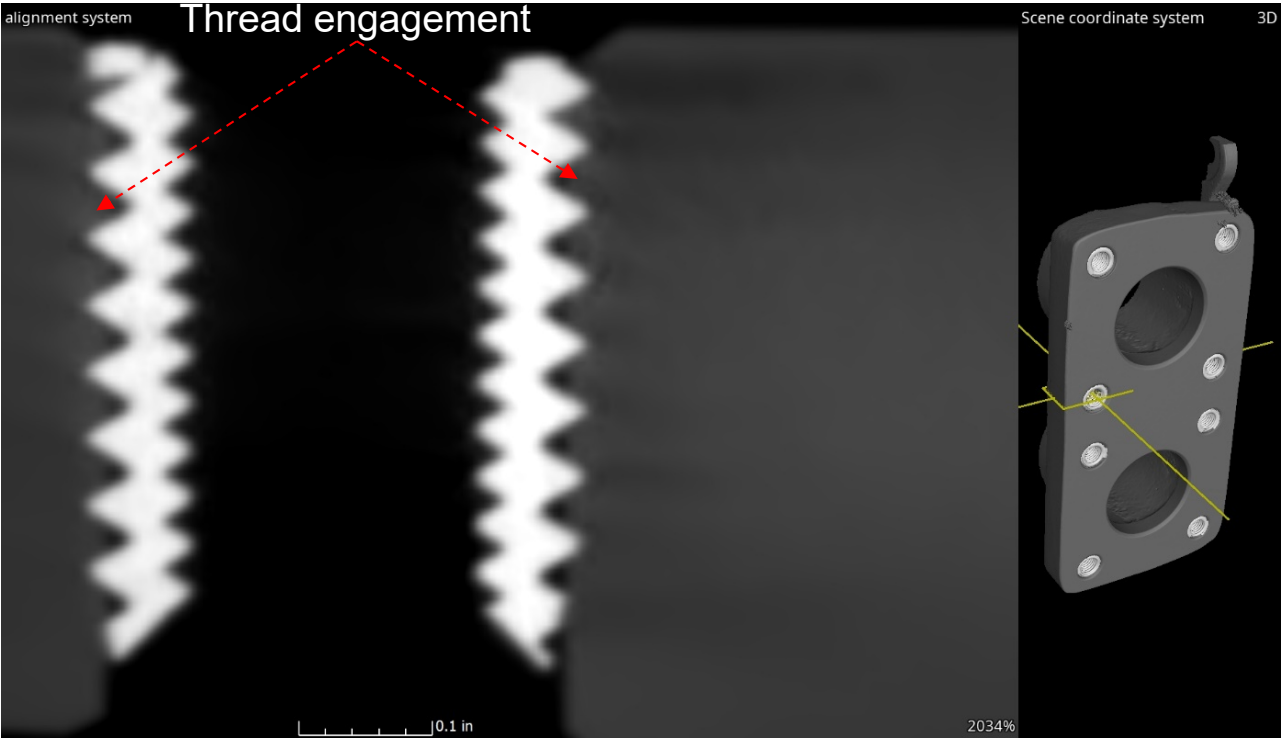
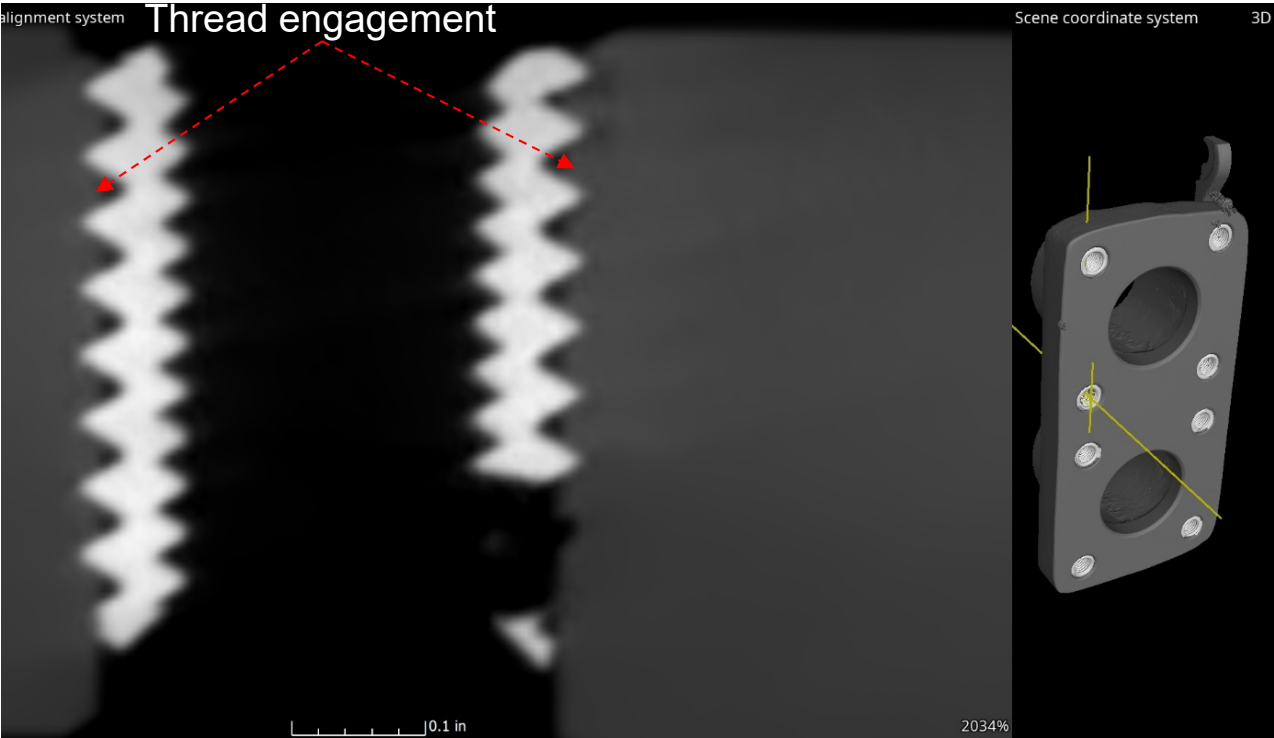


Insert 6

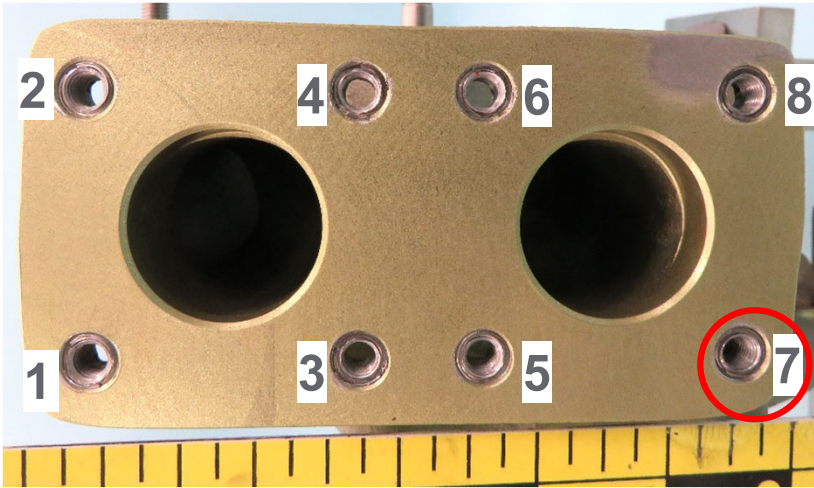


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 88: CT scan cross-section of thread insert position 6. Thread engagement is observed into the flange material.

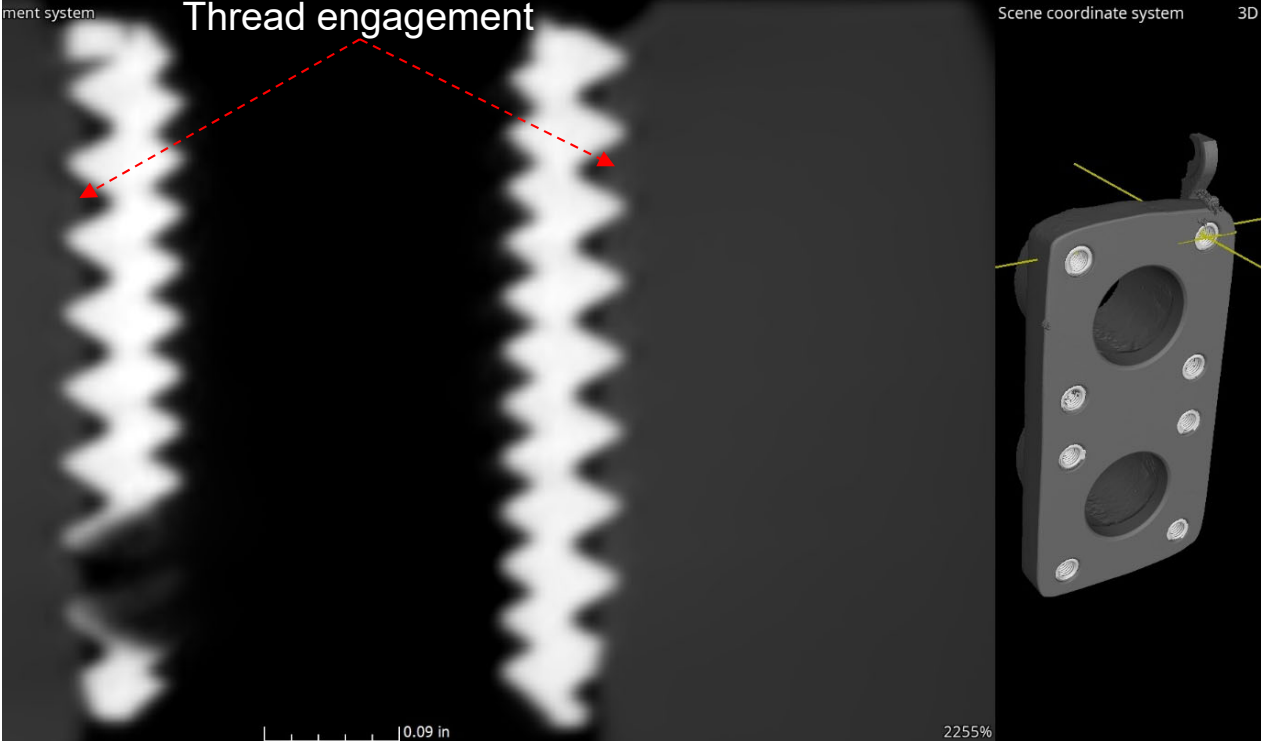
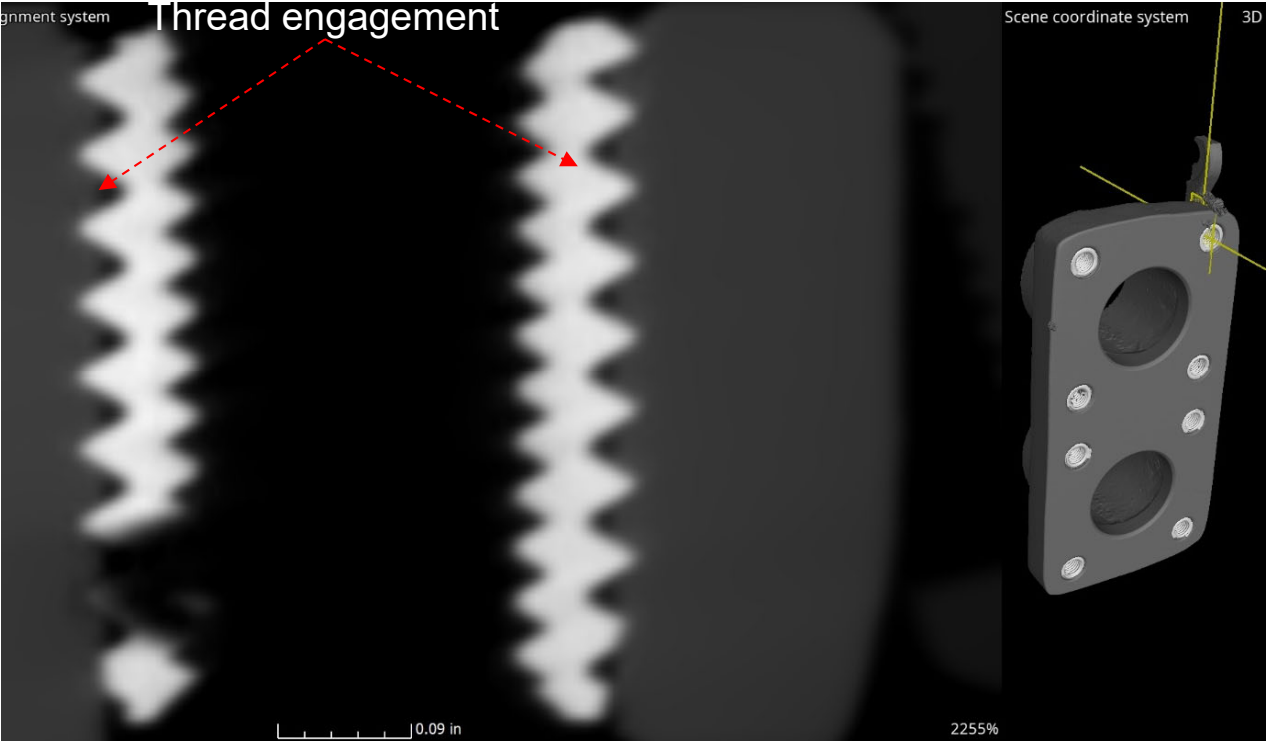


Insert 7

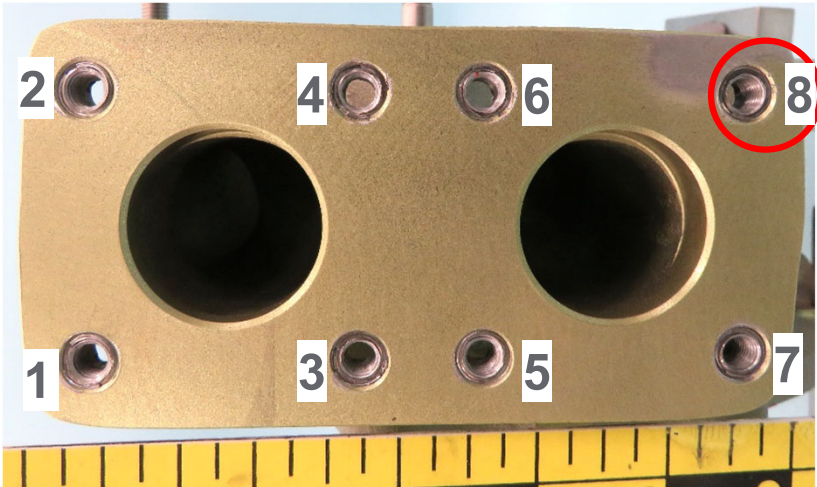


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 89: CT scan cross-section of thread insert position 7. Thread engagement is observed into the flange material.

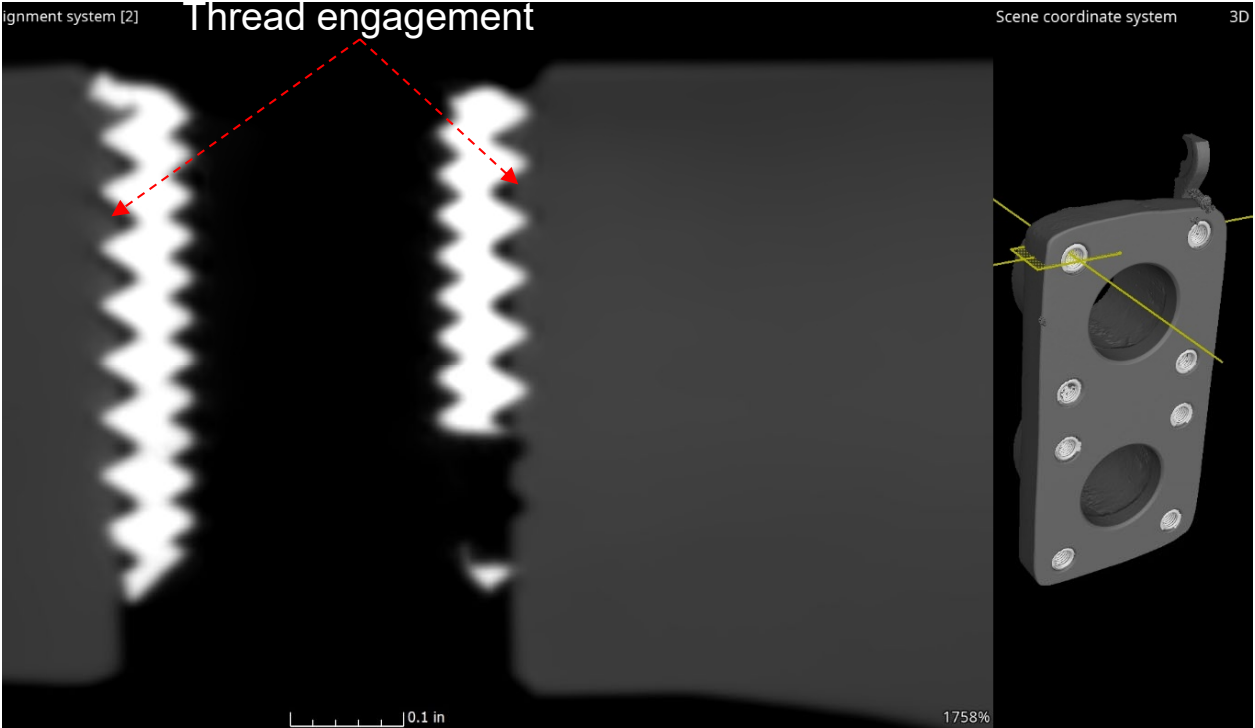
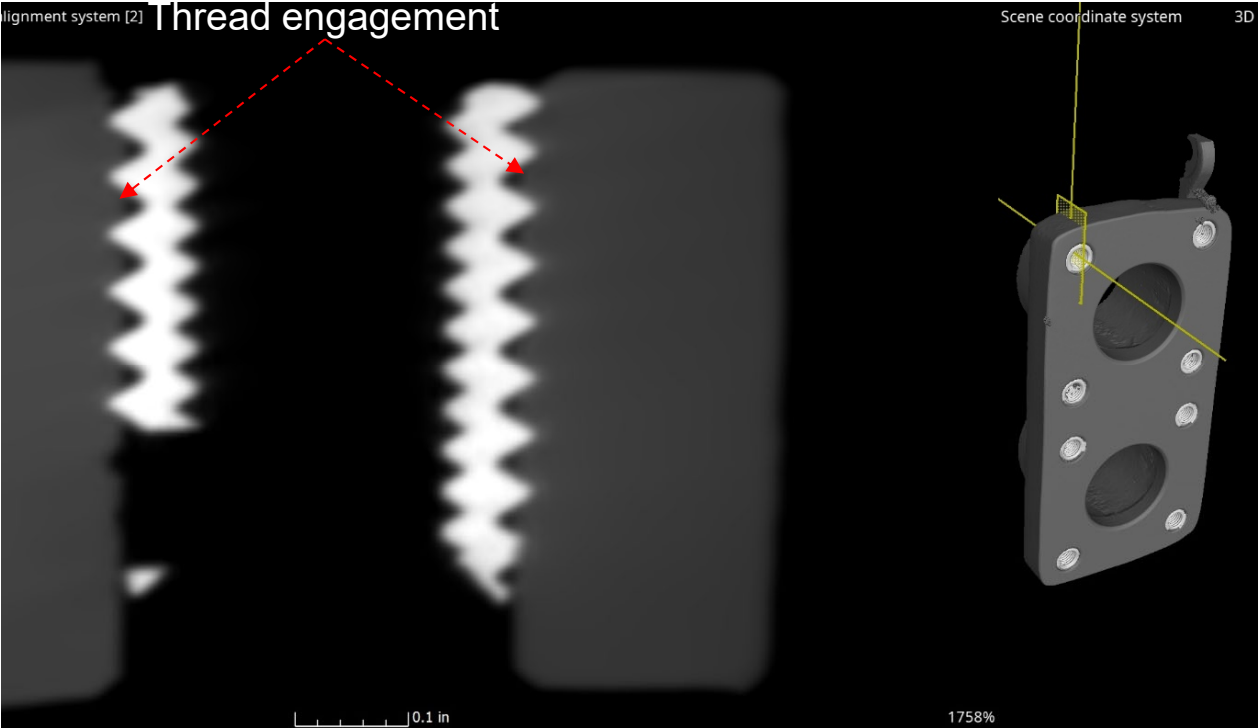


Insert 8

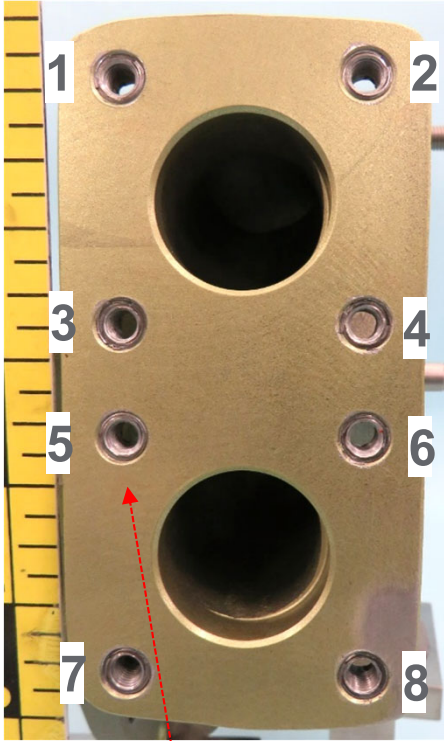


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes

Figure 90: CT scan cross-section of thread insert position 8. Thread engagement is observed into the flange material.

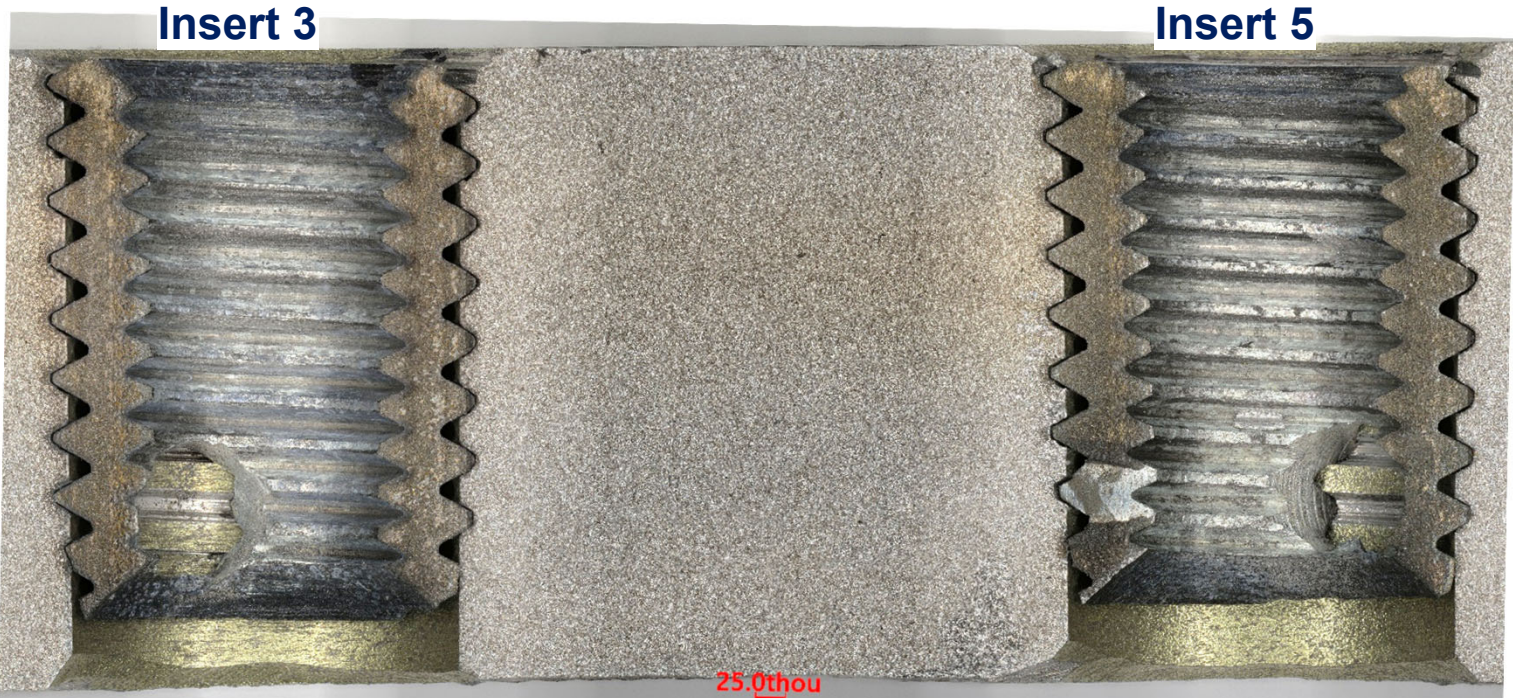


SN FIA23K9F



Inserts 3 and 5 cut in half
with wire EDM

Inserts in place:



Inserts removed:



Figure 91: Optical views of insert locations 3 and 5 with the inserts in place and removed.



Insert 3

Insert 5

Fragment of the fractured steel insert top thread

Figure 92: Optical views of insert locations 3 and 5 reveal intact threads with the gold-colored anodized surface.



Appendix D: RTV Part

P/N: 9395M78G10

S/N: FIA1YN6T

[Click here to return to summary table](#)



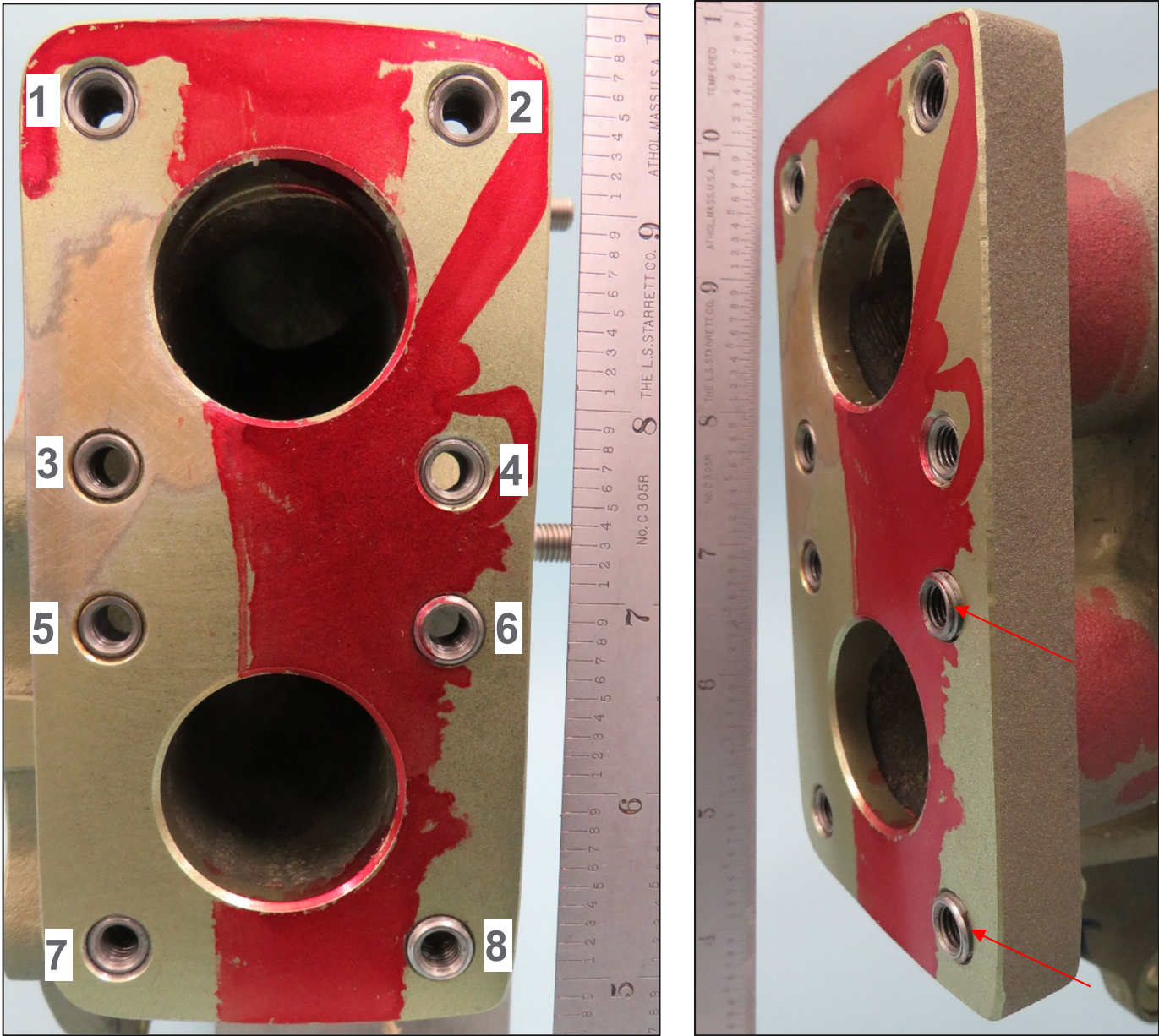
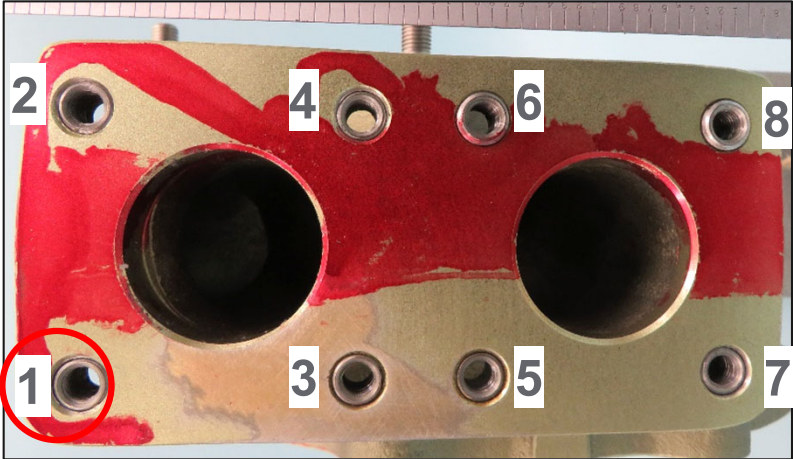


Figure 93: Optical views of SN F1A1YN6T flange as received by the lab. The red paint is to indicate a scrapped part. Insert location numbers 6 and 8 backed out prior to arrival at the FA lab.

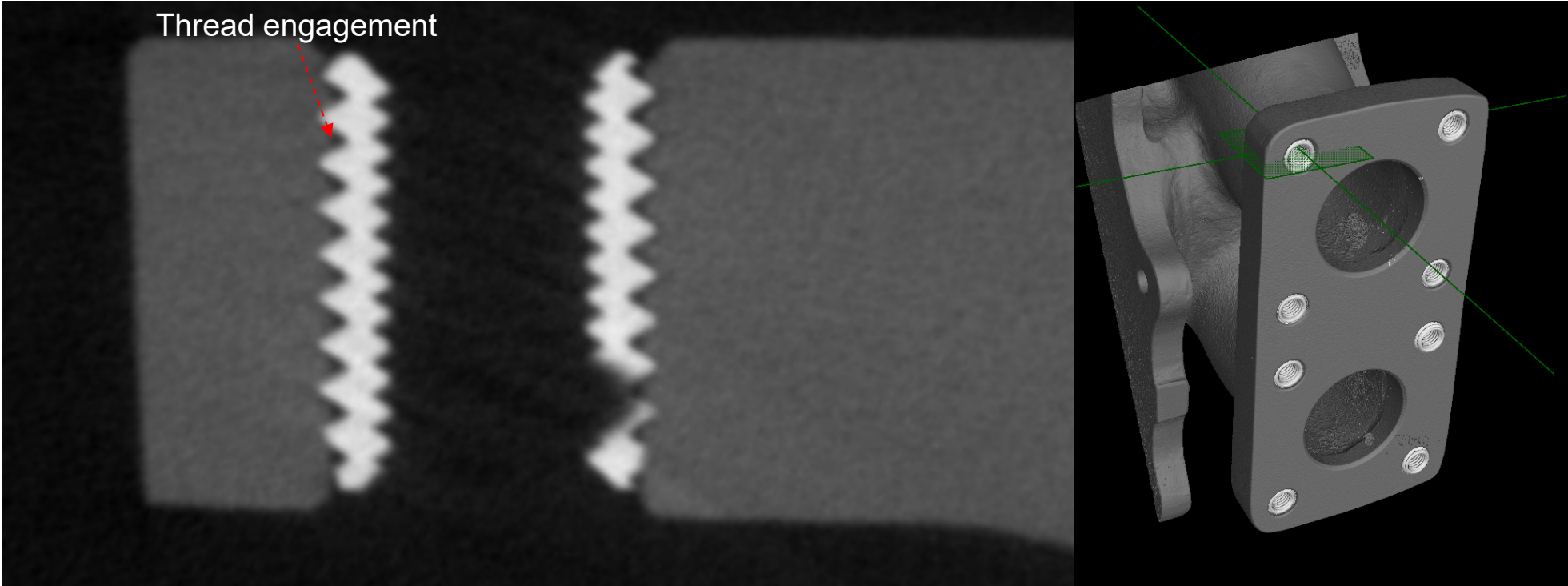


Inserts 1

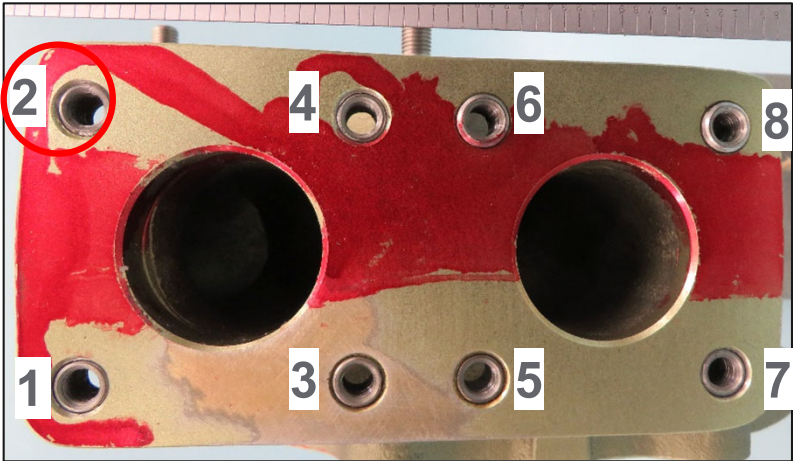


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 94: CT scan cross-section of thread insert position 1. Thread engagement is observed into the flange material.

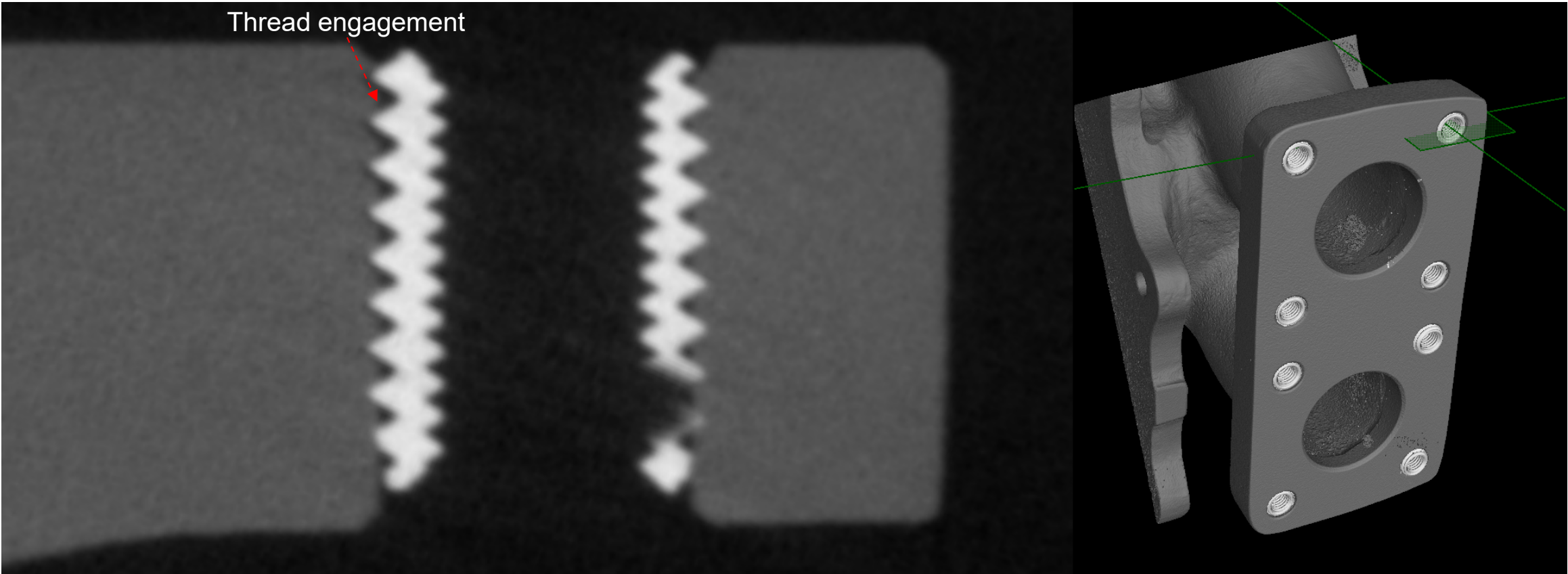


Inserts 2

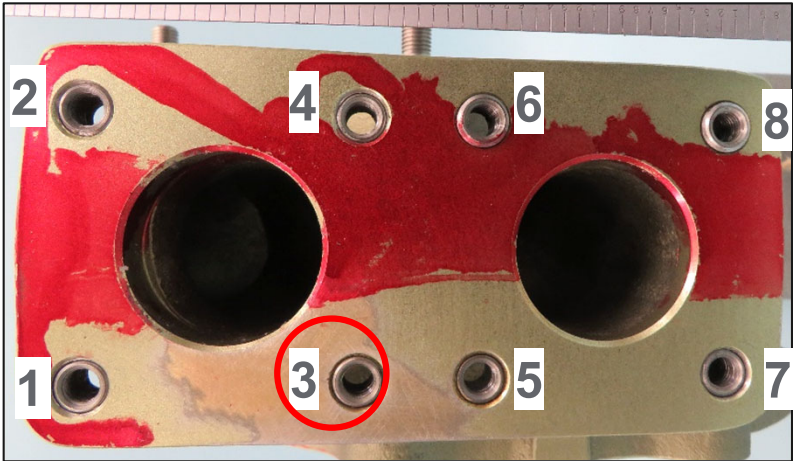


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 95: CT scan cross-section of thread insert position 2. Thread engagement is observed into the flange material.

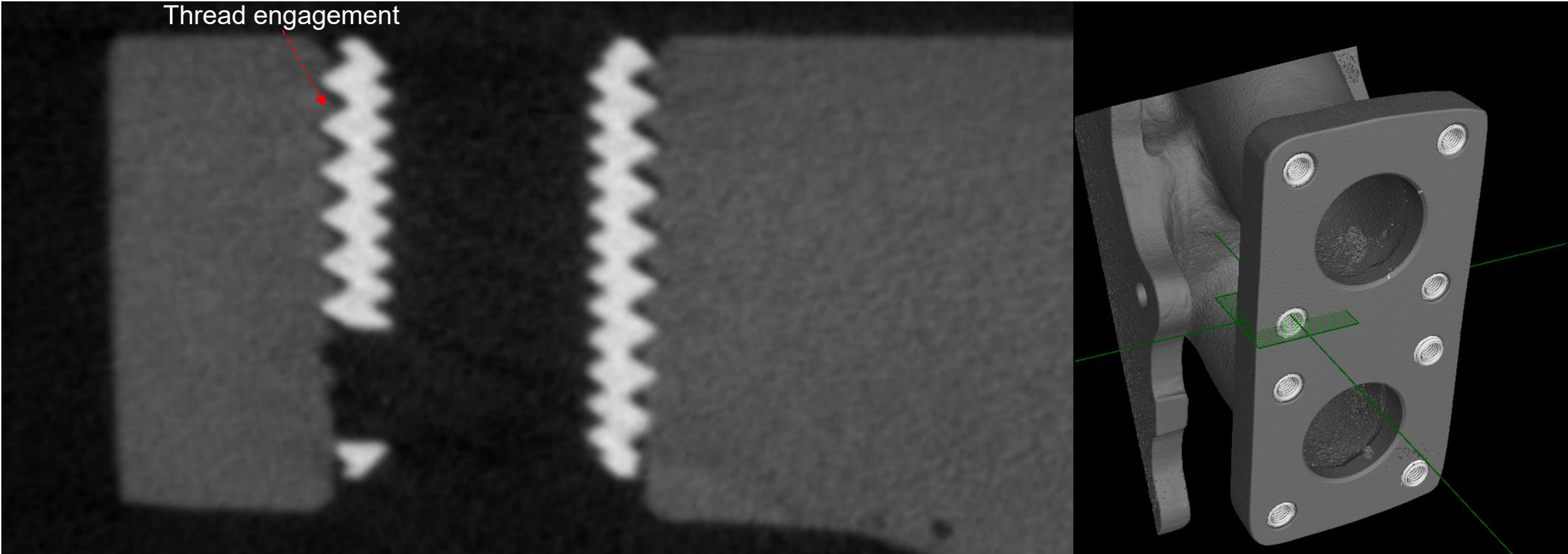


Inserts 3

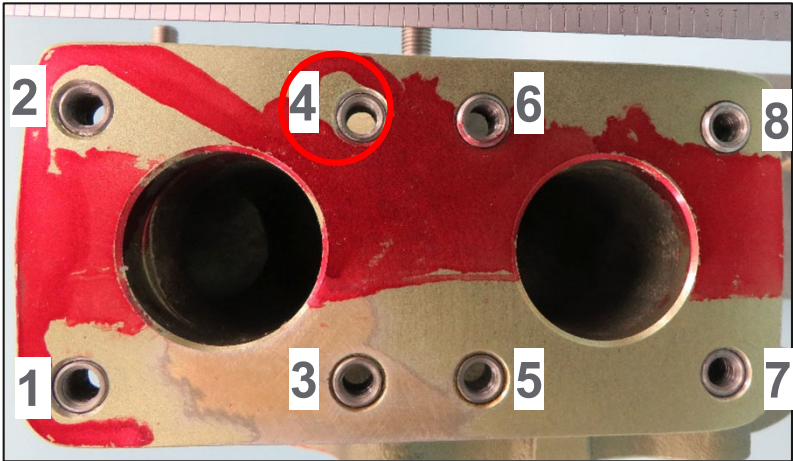


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 96: CT scan cross-section of thread insert position 3. Thread engagement is observed into the flange material.

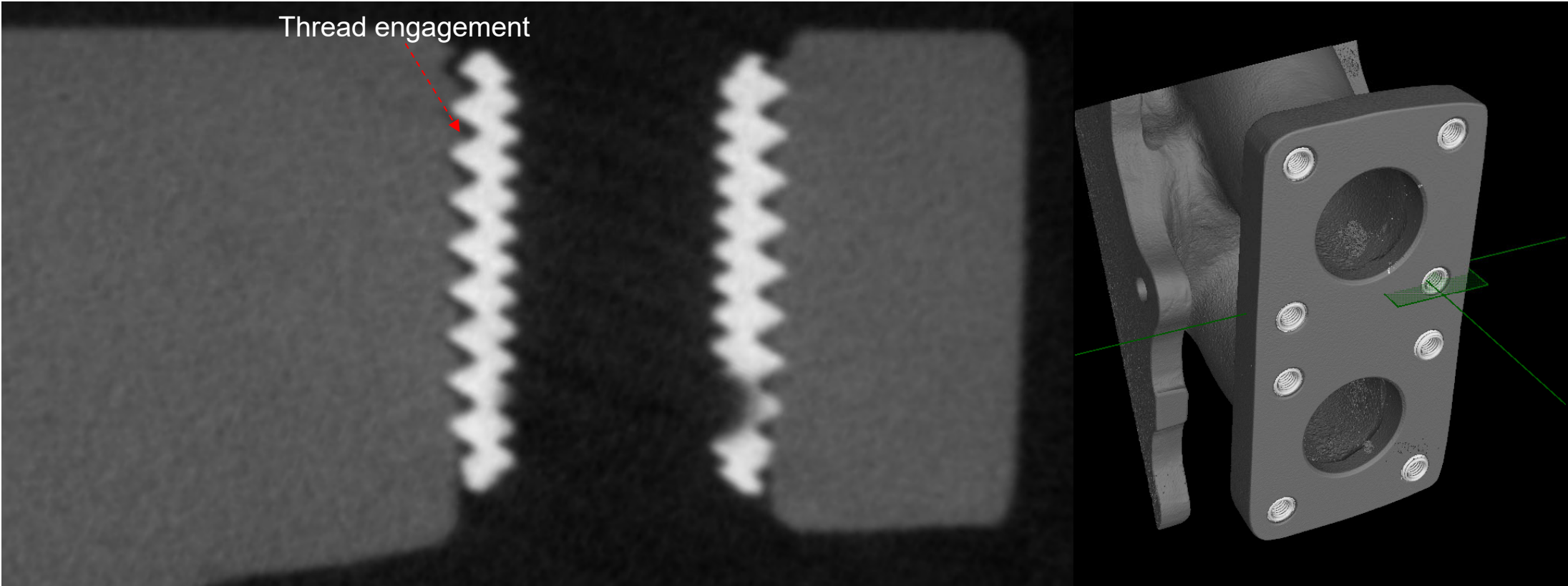


Inserts 4

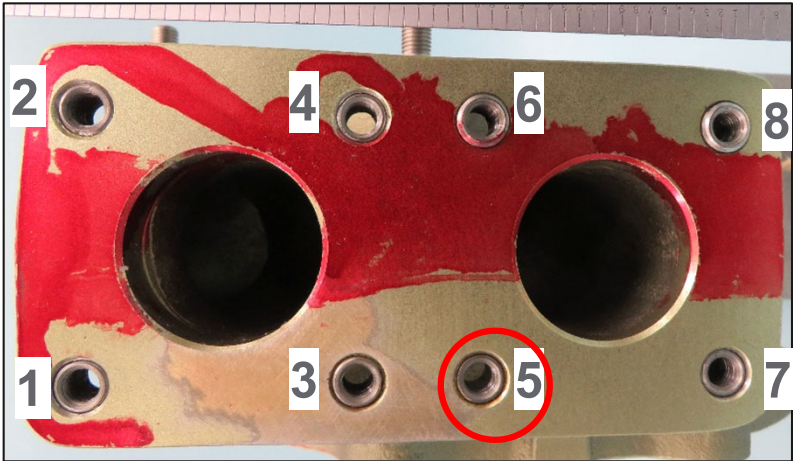


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 97: CT scan cross-section of thread insert position 4. Thread engagement is observed into the flange material.

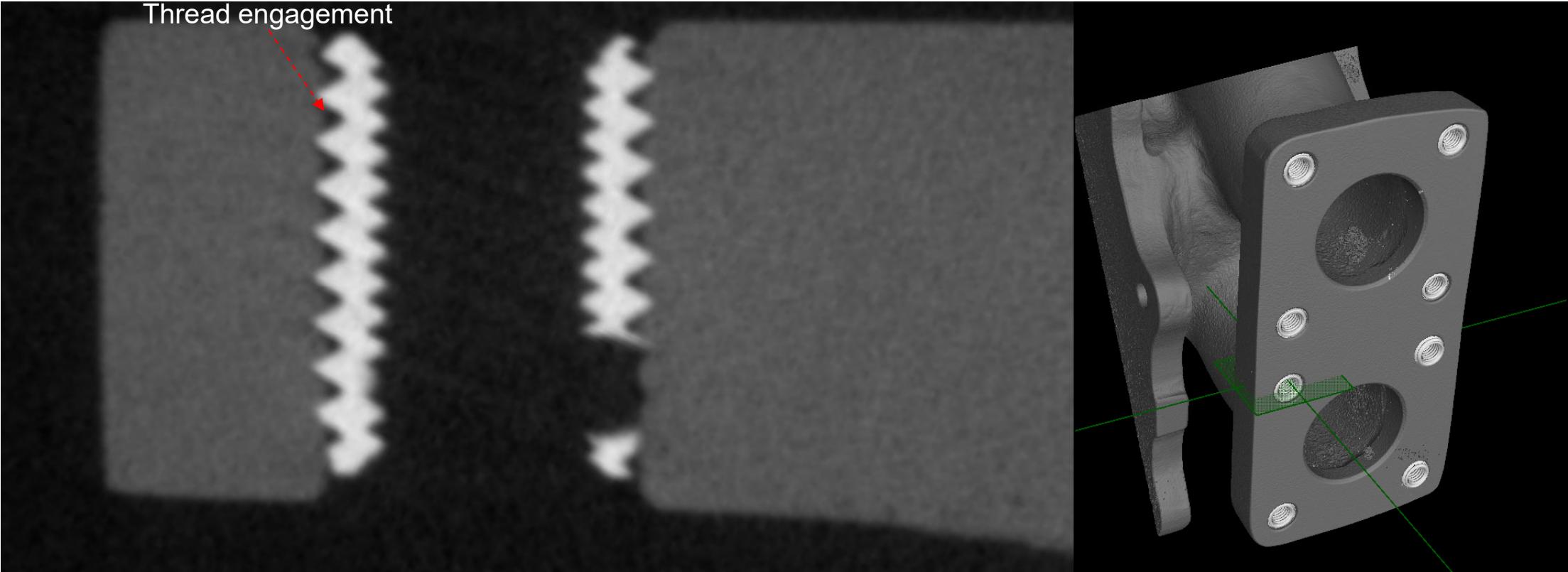


Inserts 5

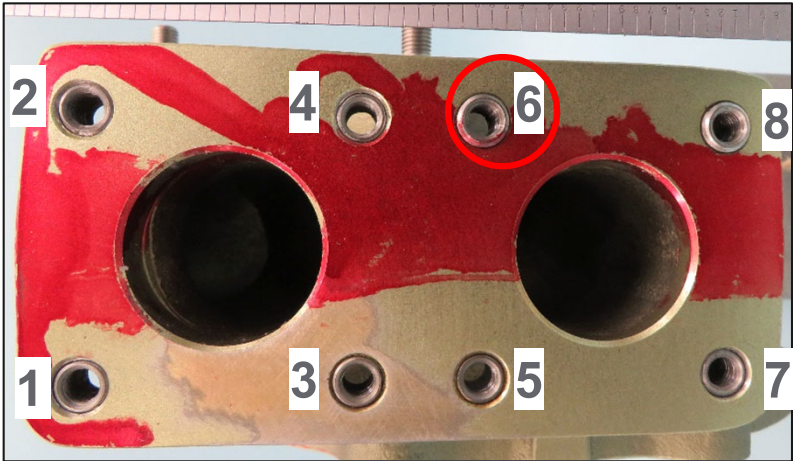


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 98: CT scan cross-section of thread insert position 5. Thread engagement is observed into the flange material.

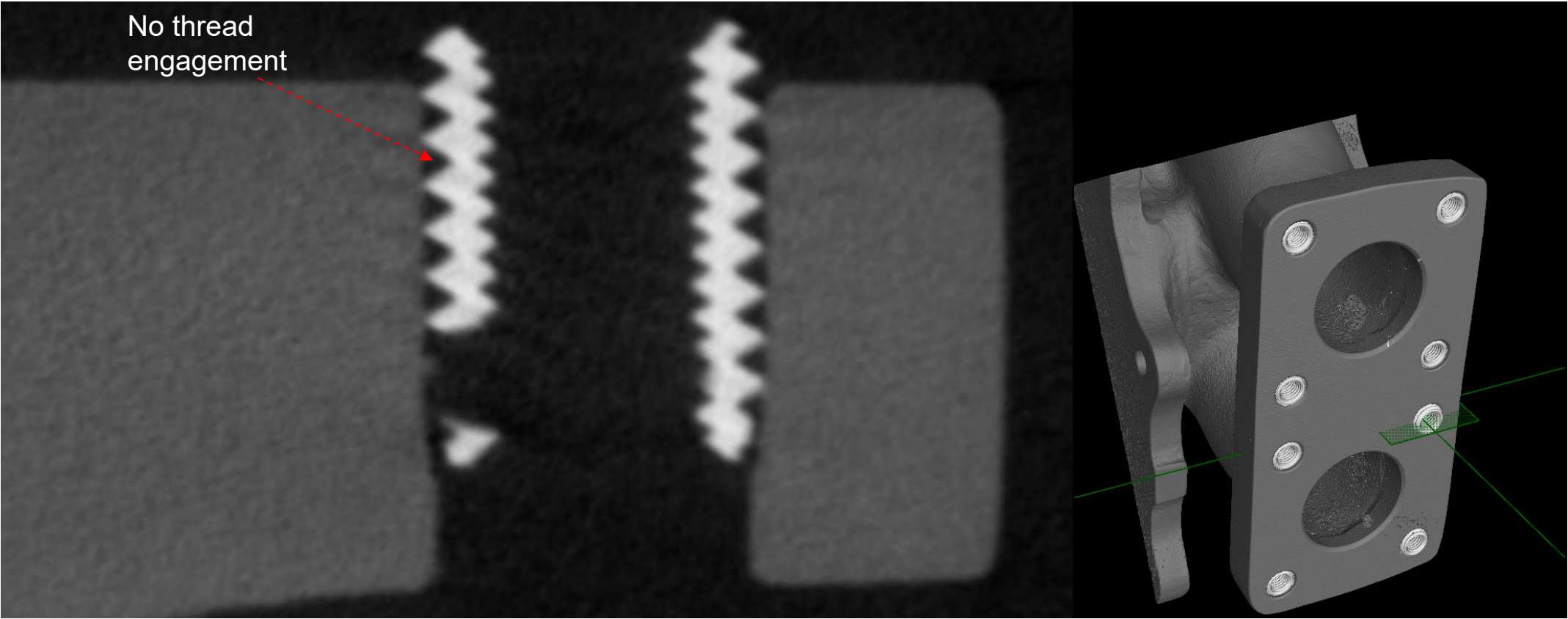


Inserts 6

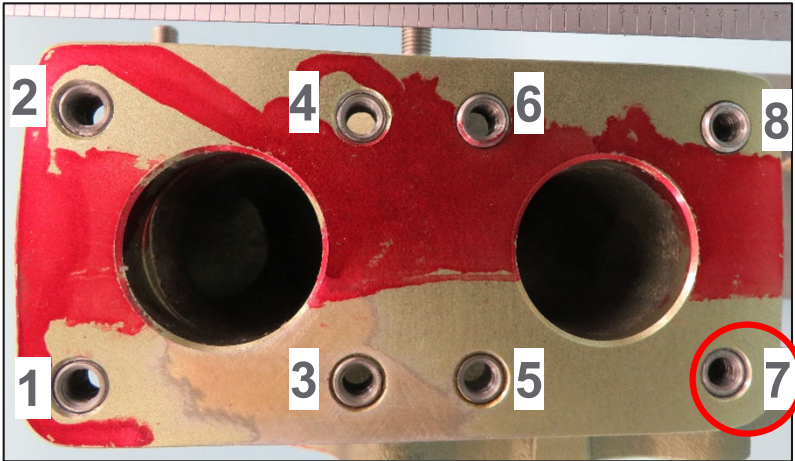


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 99: CT scan cross-section of thread insert position 6. No thread engagement is observed into the flange material.

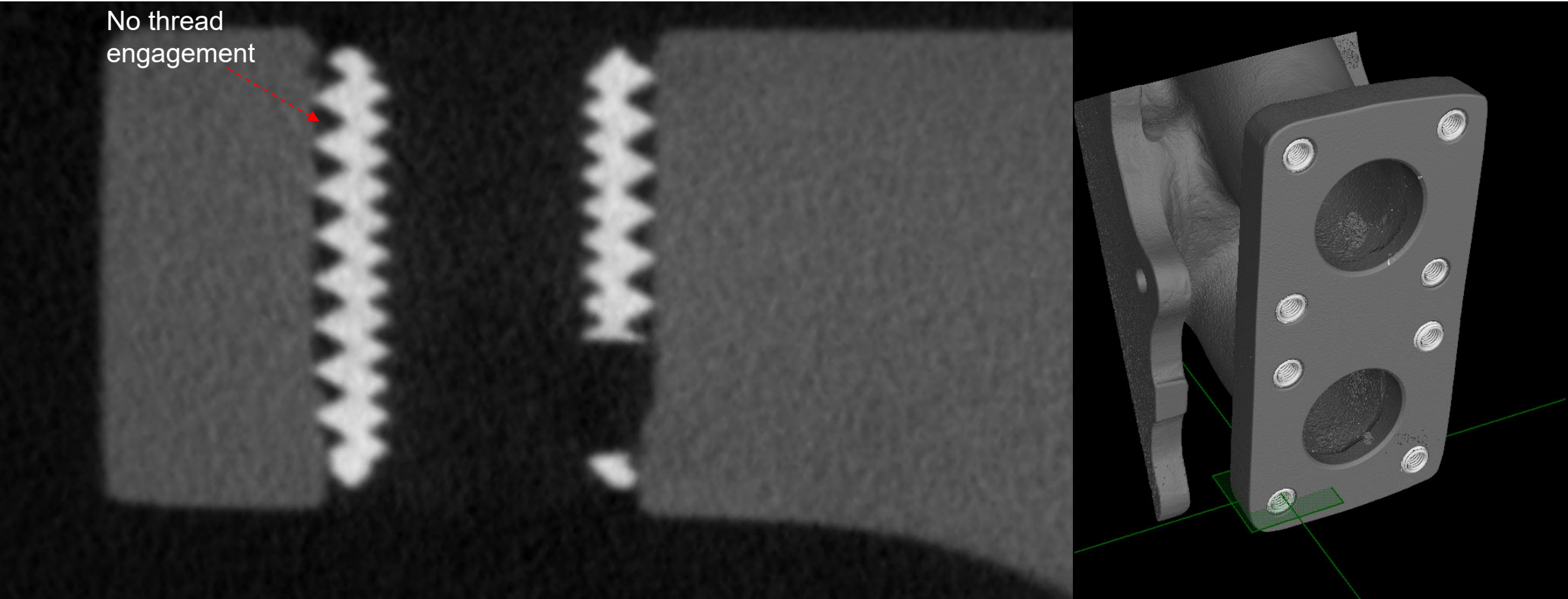


Inserts 7

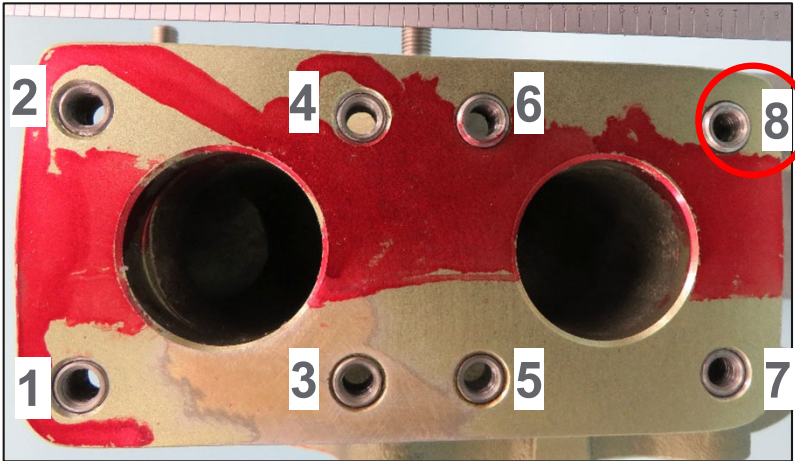


Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 100: CT scan cross-section of thread insert position 7. No thread engagement is observed into the flange material.

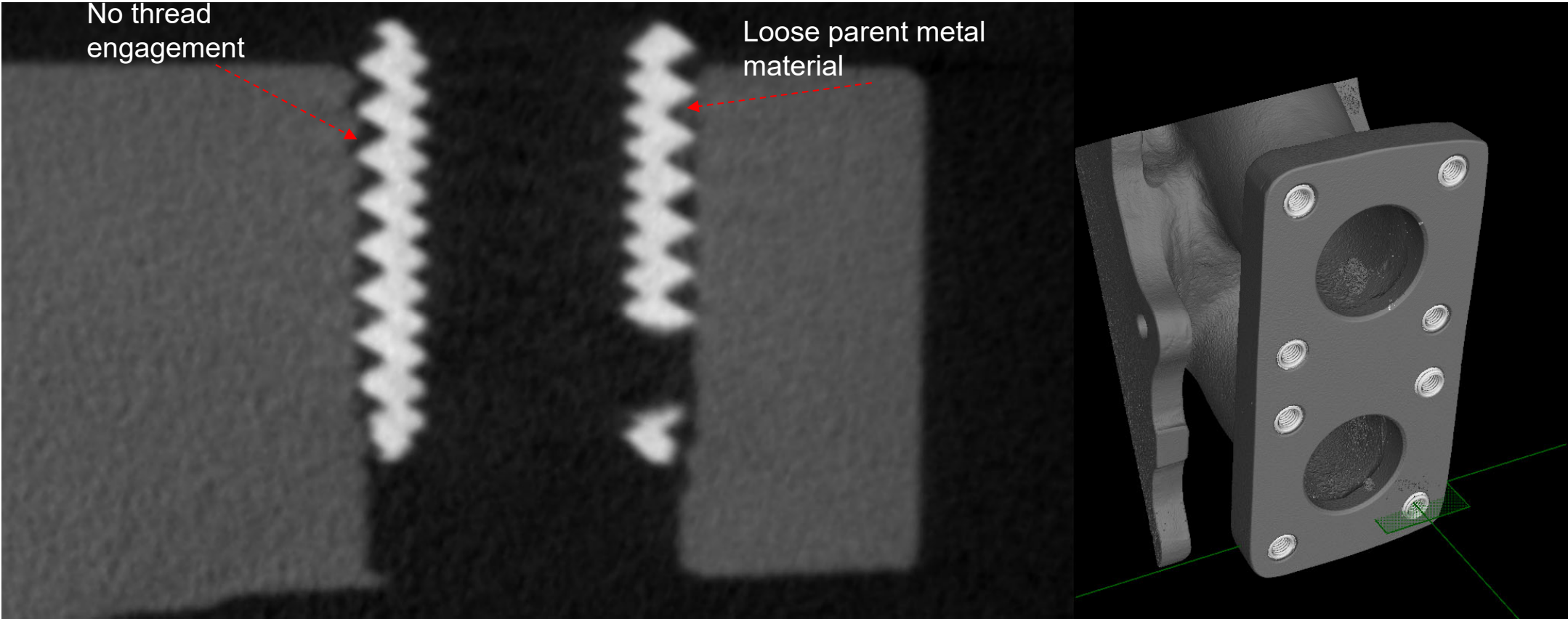


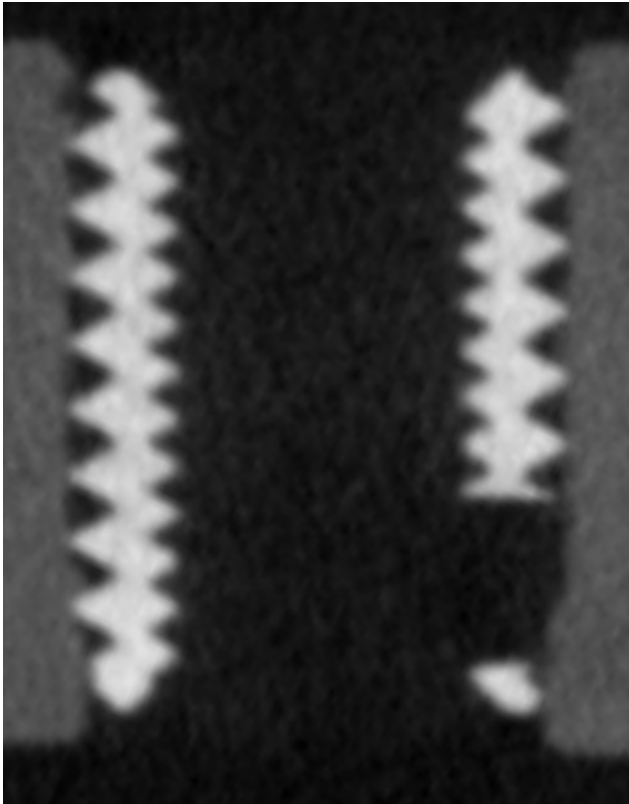
Inserts 8



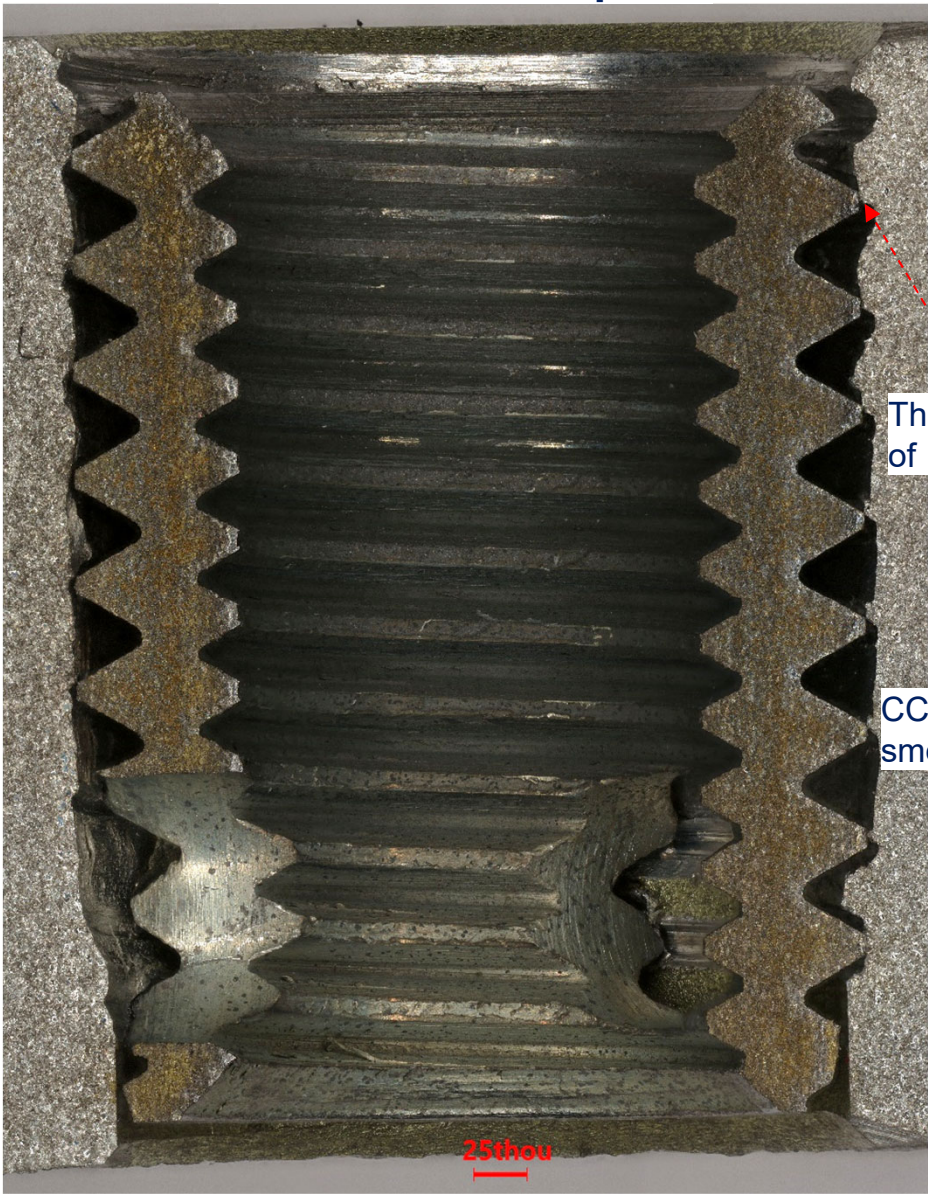
Insert #	CT Scan Thread Engagement
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	No
7	No
8	No

Figure 101: CT scan cross-section of thread insert position 8. No thread engagement is observed into the flange material.





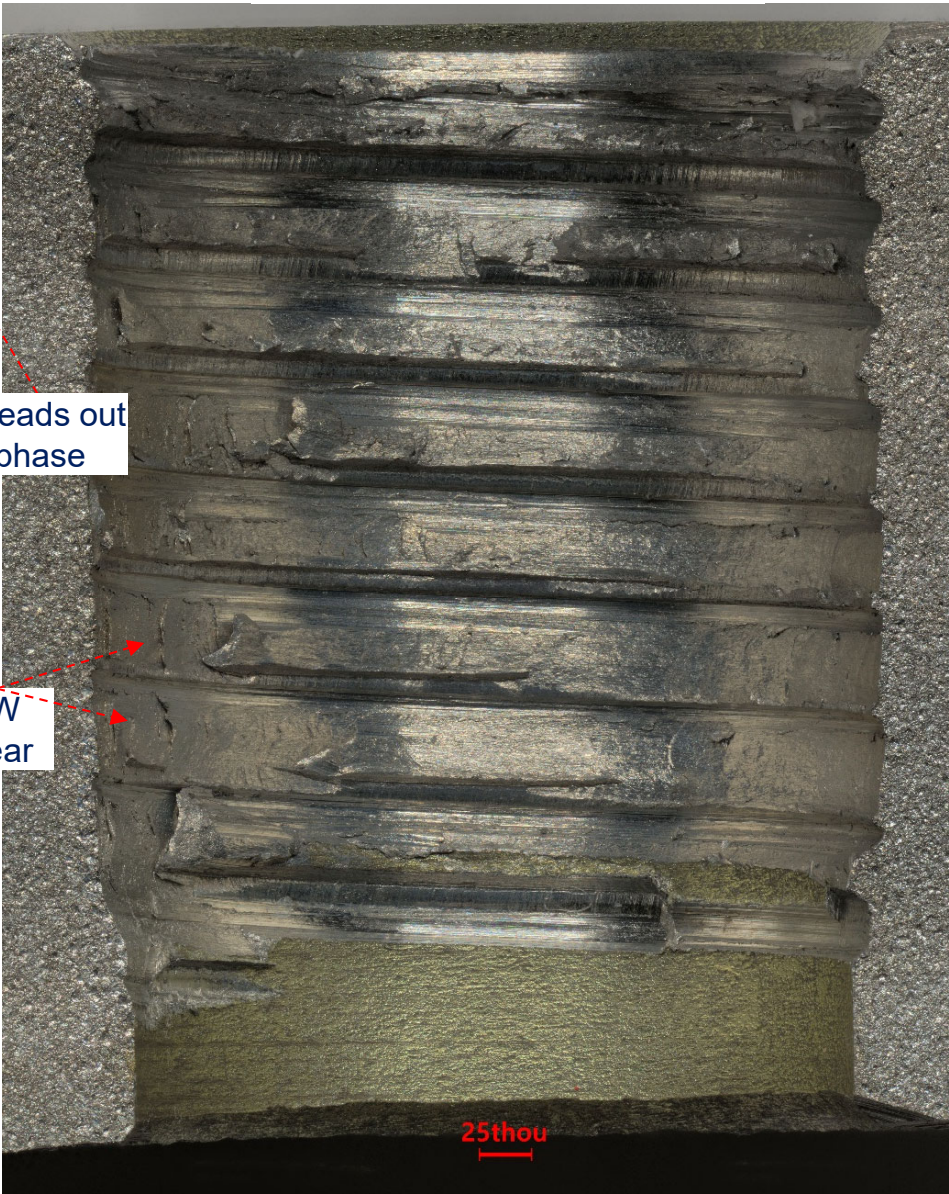
Insert 7: Insert in place



Threads out of phase

CCW smear

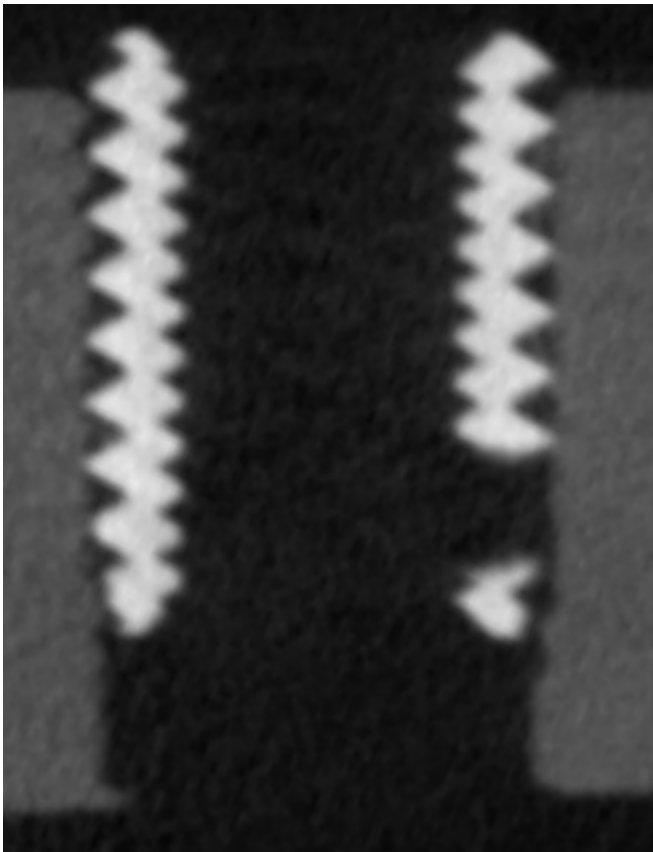
Insert 7: Insert removed



25thou

Figure 102: Optical views of insert location 7 with the inserts in place and removed. The threads have been removed 360-degrees around the hole and the insert is observed out of phase with the original pre-tapped threads, consistent with cross-threading. CCW smear is also observe in the damaged area.





Insert 8: Insert in place (pulled out)



Insert 8: Insert removed

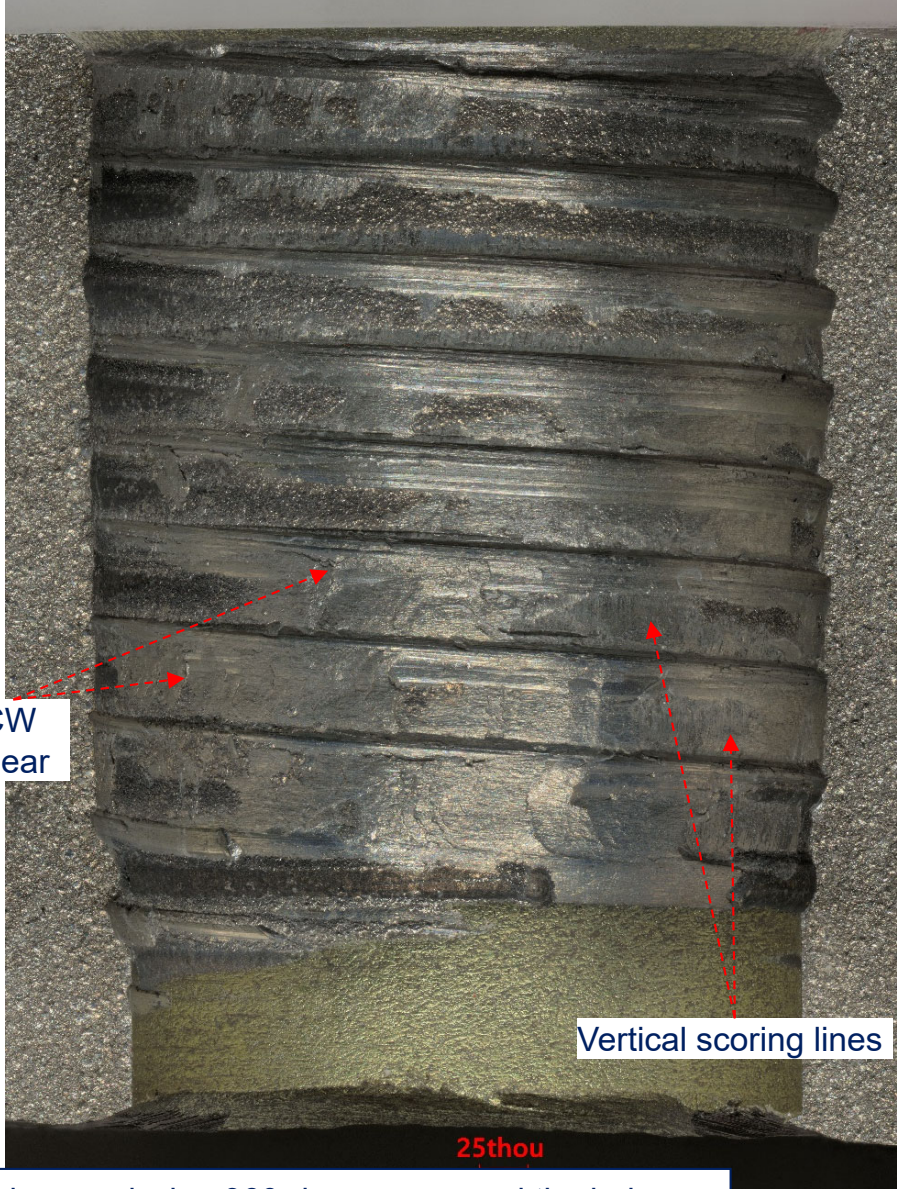


Figure 103: Optical views of insert location 8 with the inserts in place and removed. The threads are missing 360-degrees around the hole. The damaged area has vertical scoring lines consistent with the insert being pulled out. CCW smear is also observed in the damaged area.



Appendix E



Flange thread insert post flight inspections performed at GE Celma

1. **Run-on torque procedure** called out in “FedEx 707605 – Work Scope Investigation” document instructions:

- Run-on torque: the torque required to turn the bolt before it is completely seated to perform an axial tightening action on the bolt

Record position of the flange inserts

- Were the inserts flushed and secured to the flange?
- Record condition of the insert threads
- Rolled, fretted & galled threads?
- Does insert thread condition corresponds to bolt thread condition?
- Measure insert thread running torque.
- Mark and photo document the insert position which also corresponds to the bolt position.



2. **Pull out test as called out in SB72-1577 HMU Idler Adapter Inspection** document:

- If thread inserts are found loose or protruding the pull-out test is not performed (test not performed on inserts 1, 2, and 7)

(4) Do a pull-out test at all eight bolt locations as follows:

(a) Use the locally manufactured pull-out test tool. Refer to [Figure 2](#) and do as follows:

- 1 Insert a 1/4-28 bolt and torque to 190 to 210 lb in. (21.4 to 23.7 Nm).
- 2 Loosen and remove the 1/4-28 bolt.

(b) Do a check of the insert again for protrusion. Refer to paragraph 3.C.(3) and do as follows:

- 1 If you find protruded insert(s), replace the protruded insert(s). Refer to paragraph 3.C.(5).
- 2 If you do not find protrusion, install the removed fuel pump tube and fuel tube. Refer to [Figure 1](#), Item 1 (Fuel Pump Tube) and Item 2 (Fuel Tube), Table 1 for applicable AMM installation instructions, and do as follows:

- a Put a mark 72-1577 on the HMU/MEC idler adapter to show compliance with this Service Bulletin. Use a light vibro-peen on the area showed on [Figure 3](#). Refer to the SPM, 70-16-04, VIBRO-PEEN MARKING.

GE Celma’s locally manufactured tool (LMT):



Figure 104: Idler adapter thread insert inspections performed at GE Celma

