

ENG22LA049

POWERPLANT

Group Chair's Factual Report - Attachment 1

GE Passport 20 Core Compartment Fires In Service, dated March 14, 2023

April 11, 2023

GE Passport 20

Core Compartment Fires In Service
3/14/2023



Event Summaries



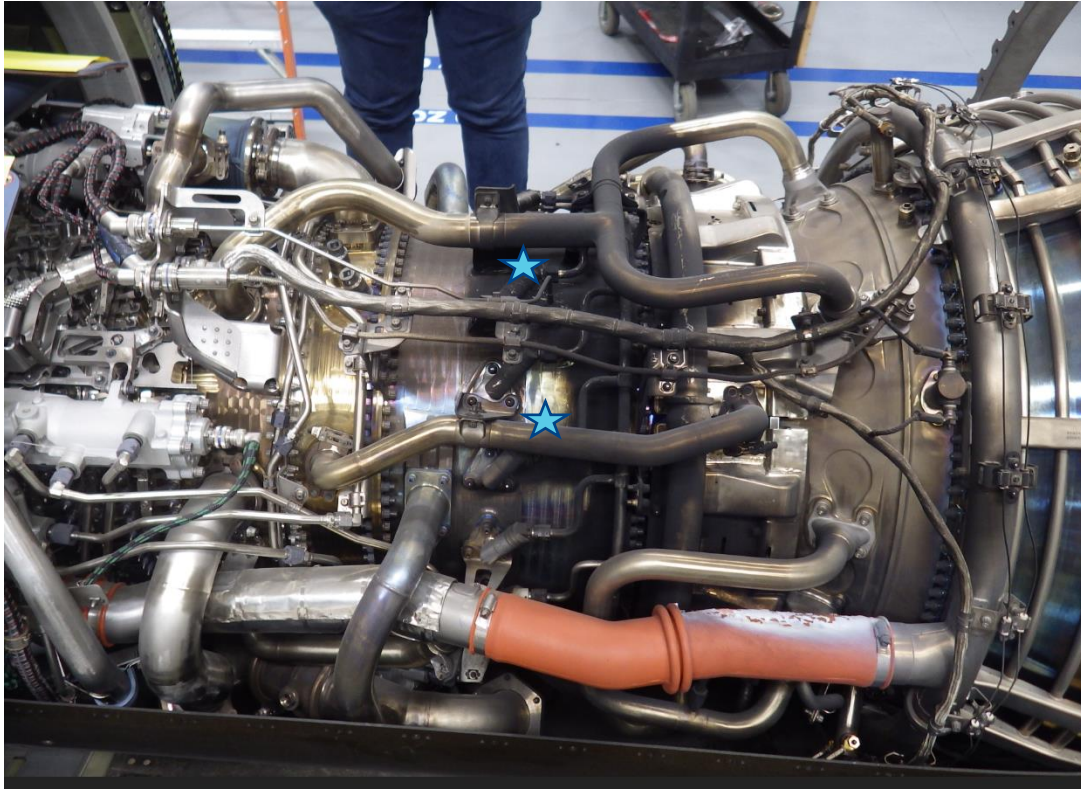
Event Summary – March 31, 2022

- Engine 904-292 experienced an IFSD during service due to a fire warning indication. The indication came on during takeoff but went away when throttle was reduced. Indication recurred when power was increased, and engine was shut down. Aircraft landed safely.

Event Summary – April 3, 2022

- Engine 904-265 experienced an air turnback. During takeoff pilots received LH engine fire warning. They held at 4000 feet and reduced engine power. Indication went away. Pilots notified ATC that fault was intermittent and were going to proceed on their flight. At subsequent climb, with engine at high power, fire indication again annunciated. Pilots turned back and landed safely. Indication went out again during decent.

Event Engines: Core Compartment Snapshots



IFSD in Riyadh, 904-292

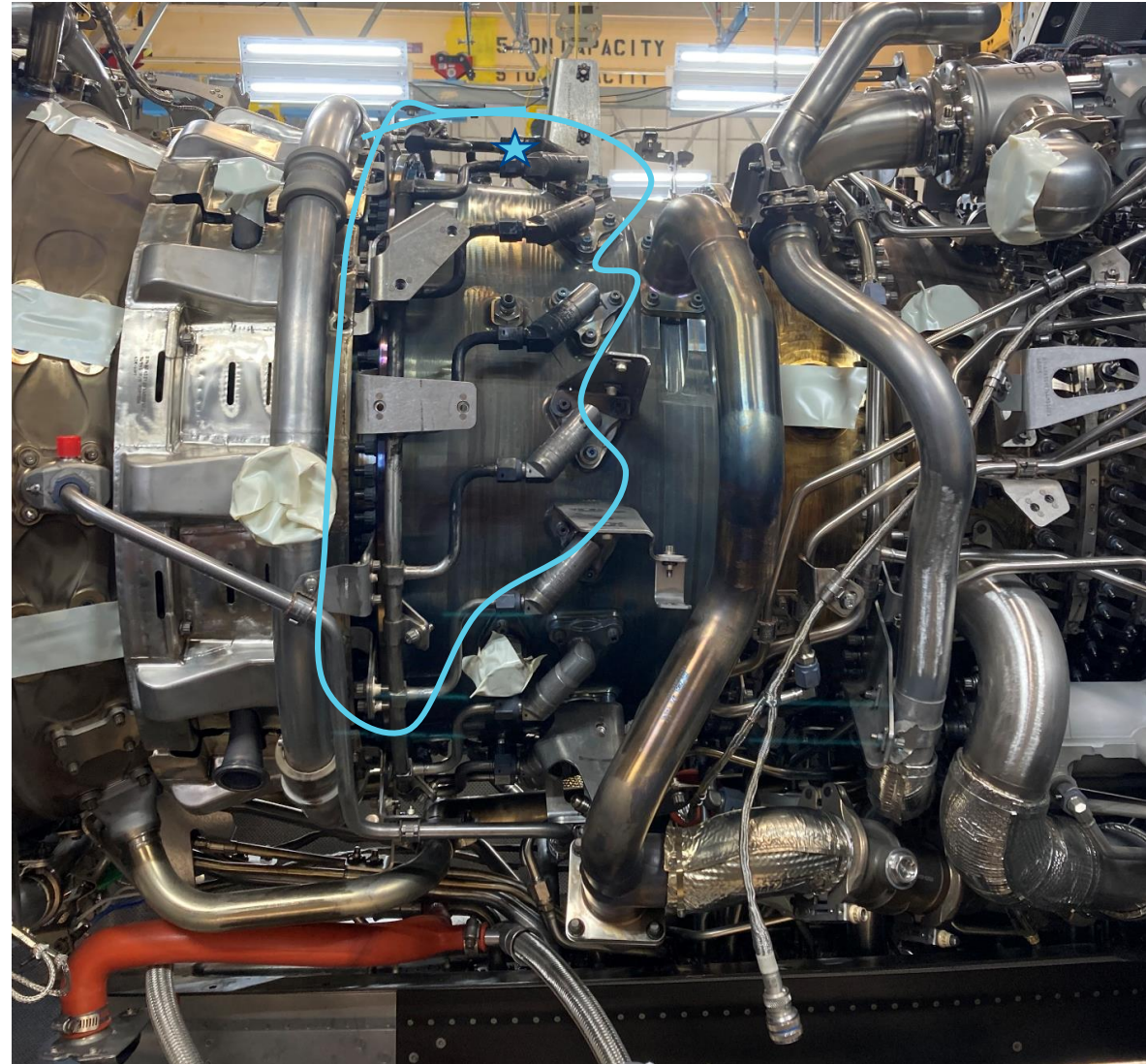


Air Turn Back in West Palm, 904-265

Non-Event Engine: Core Compartment Finding



- This engine was scheduled for fuel manifold nut tightening and core compartment soot was found on October 6, 2022
- No operational event occurred
- Deposits are consistent with fuel leakage and small fire
- Non-metallic hardware was not damaged



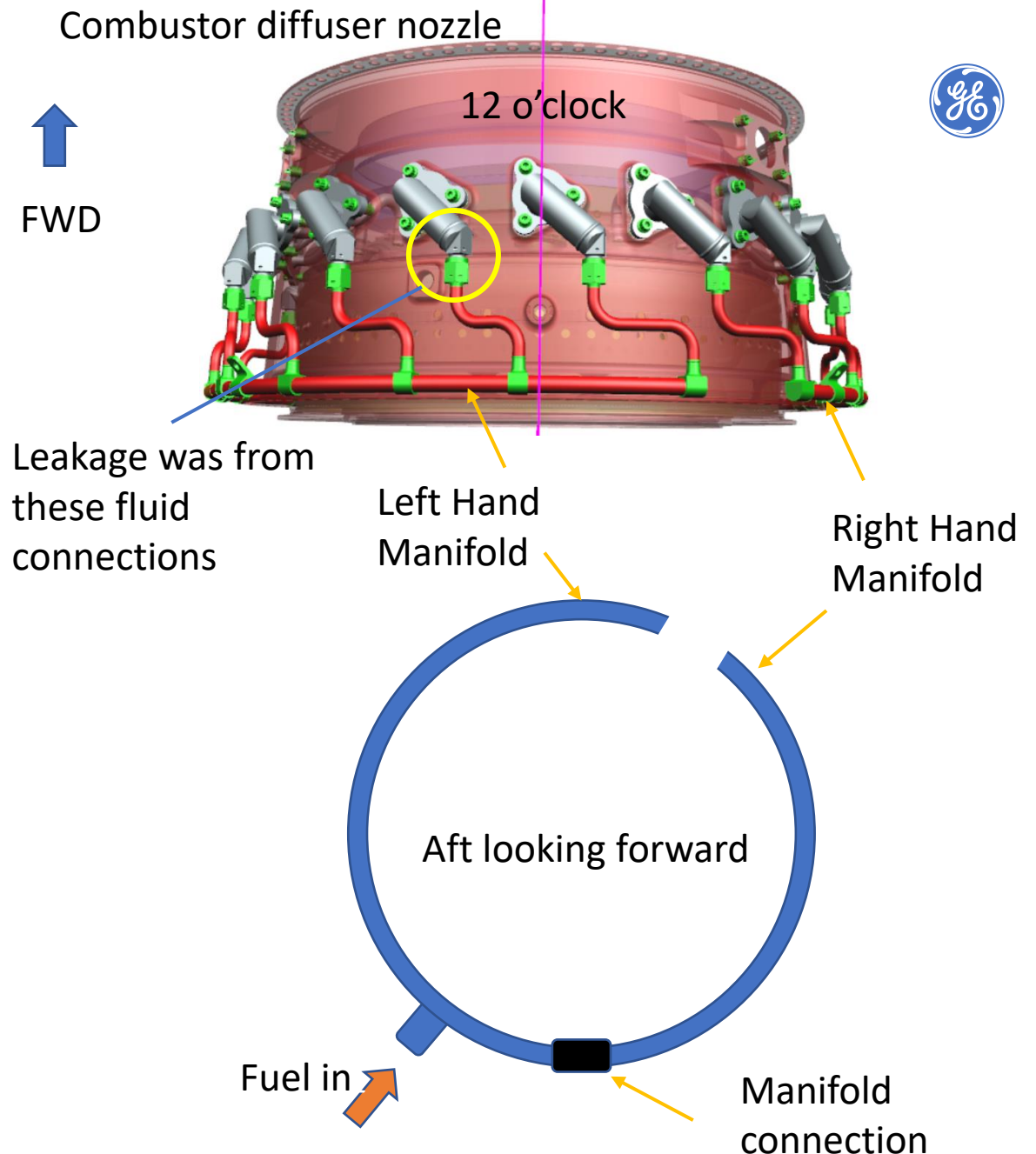
Factual Summary from Engine Inspections



- Both operational events occurred under 121 engine cycles
- Core fire on non-event engine estimated to have occurred at 241 cycles since new
- All engines show indications of fuel escaping from the fuel manifold/fuel nozzle attachment locations
- Event narratives are consistent with leakage occurring at high power since indications went away when throttle was reduced
- Both event engines were built in the same production site, site 'A'. The non-event engine was built in a different production site, site 'B'.
- Multiple fuel nozzle torques were found below expected torque value when torqued in the tightening direction
- Suspected leaking nozzles are located on the same piece of a 2-piece fuel manifold

System Description

- The combustor diffuser nozzle is a structural case where fuel is injected into the engine
- Fuel is delivered externally through a two-piece fuel manifold (left hand & right hand)
- Fuel manifolds are connected to the fuel nozzles with a threaded nut connection that holds male (ball nose) and female (ferrule) together
- Manifolds are connected at 6 o'clock with a threaded connection

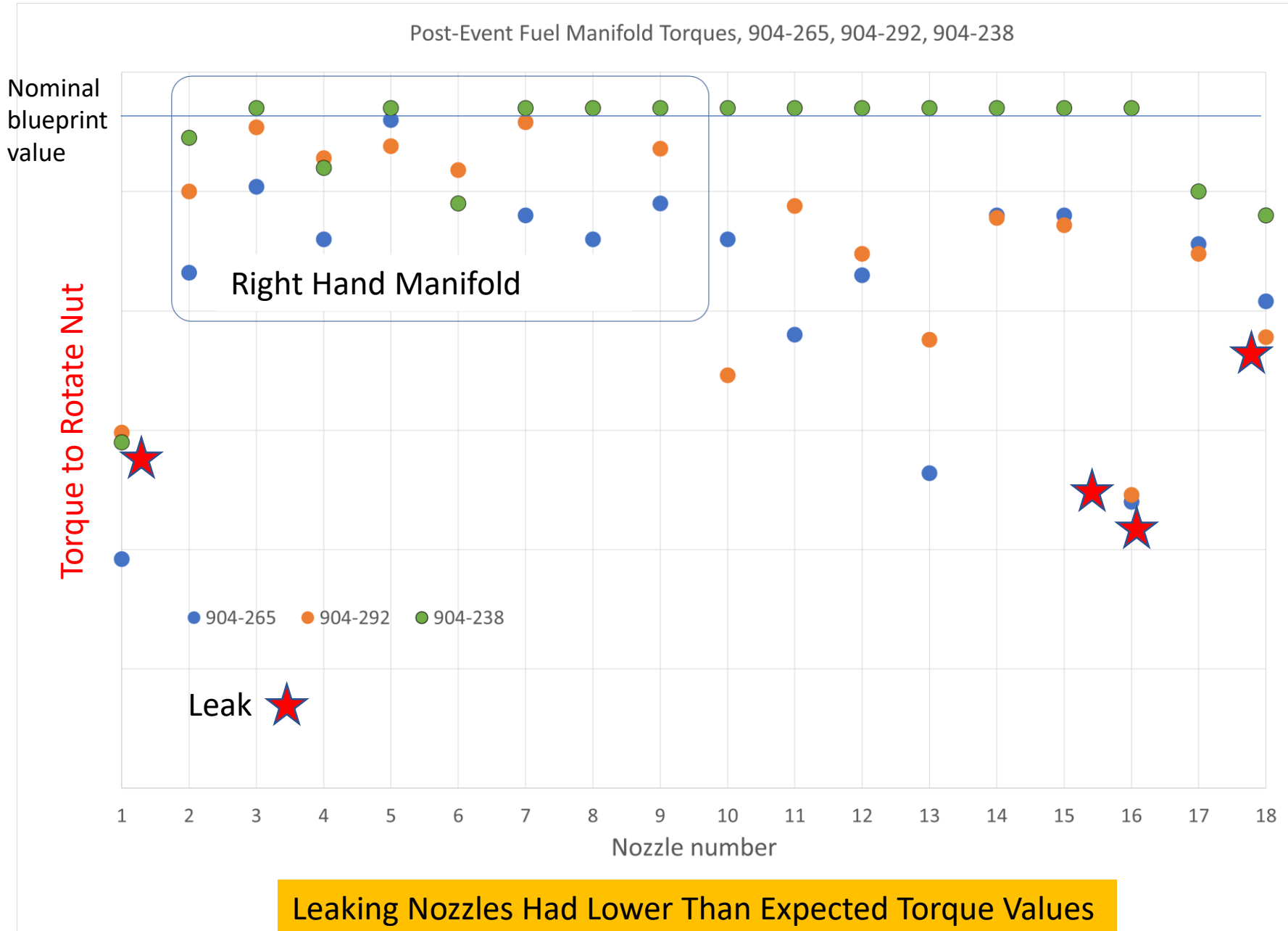


Event Engine Investigation Summary



- Engines were returned to GE and examined in detail
- Fire mapping and highly likely leakage locations were determined using soot patterns
- Torques at all fuel manifold to fuel nozzle fluid connections were checked
- Manifolds and fuel nozzles were visually examined for damage or assembly evidence
- Components were returned to GE – Evendale for detailed metallurgical inspection
- Dimensional inspections were carried out

Tightening Torques



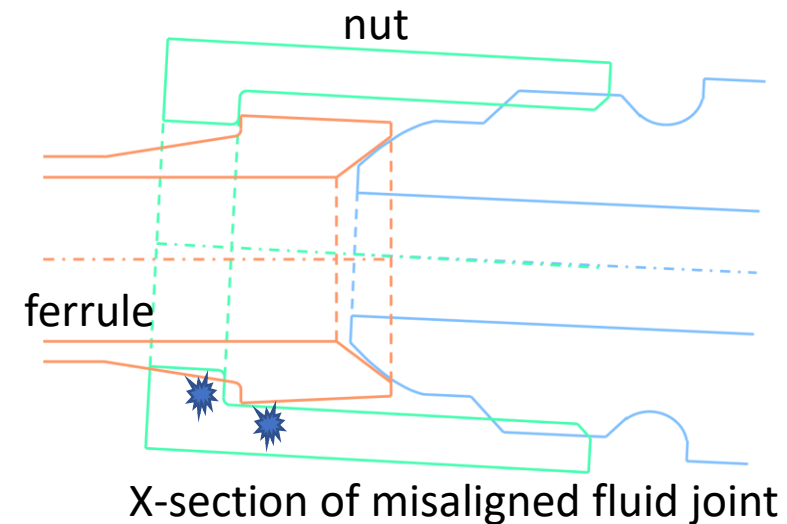
- Left hand manifold contains nozzles #1, #10-#18
- Right hand manifold contains nozzles #2-#9
- Both event engines exhibit similar torque signature – made at assembly site ‘A’
- Non-event engine was made at assembly site ‘B’ and exhibits a different torque signature
- RH manifold has more consistent and higher tightening torques
- LH manifolds had lower tightening torques
- All leaks occurred on the LH manifolds
 - #1 on 904-238
 - #18 and #16 on 904-292
 - #16 on 904-265

Fuel Manifold Ferrule OD / Nut Contact

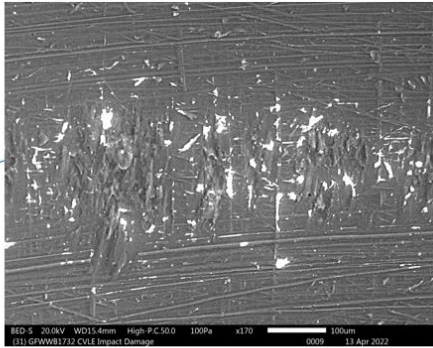
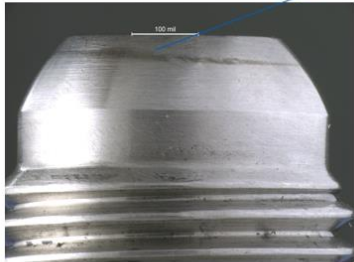


All Leaking Nozzles Had Evidence of Misalignment

Examination of the outside diameters of ferrules show evidence of joint misalignment – signs of ‘galling’ on the outside surface indicative of metal transfer between the nut and the ferrule outside diameter

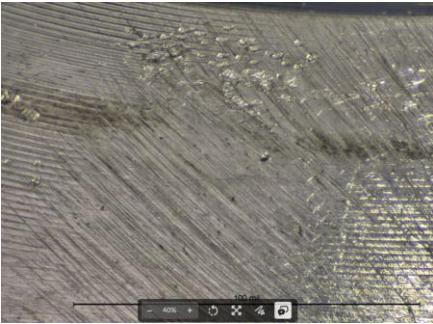


Sealing Surface Condition – leaking nozzles



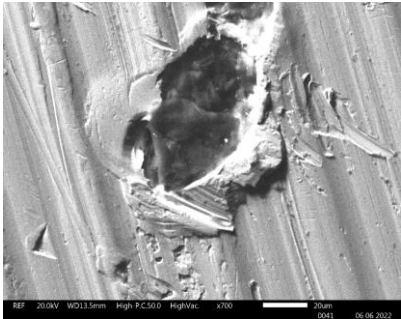
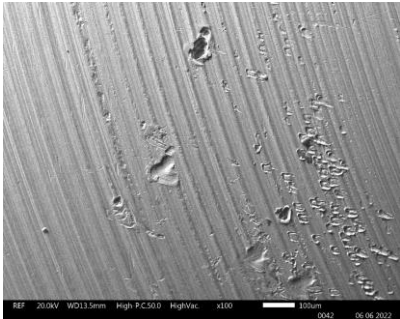
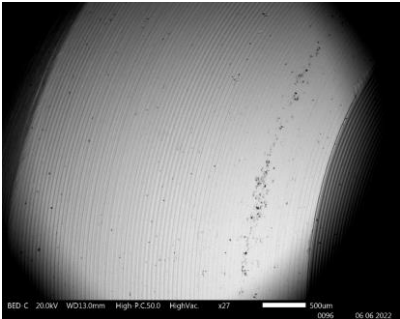
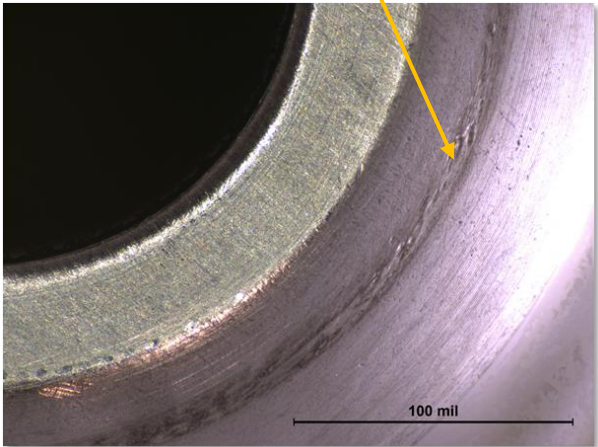
Sealing surface shows sign of relative movement, likely during assembly

- Most leaking nozzles had sealing surface damage, in addition to low tightening torque and signs of misalignment
- Surface damage is an aggravator for fuel leakage, making it more difficult for a fluid seal



Abrasive operation had been performed on one of the leaking nozzles

Surface shows signs of relative movement between ferrule and ball nose



Debris damage present

Root Cause

Loss of clamp and fluid leakage is caused by:

- Fuel manifold and fuel nozzle dimensional variation, combined with a sequential assembly method, can create potential misalignment between manifold ferrule and fuel nozzle.
- Dimensional variation can preload the nut and fuel nozzle thread interfaces, creating resistance and/or false torques due to metal-to-metal contact between nut and ferrule if alignment is not maintained during torquing
- Higher resistance in threads during torquing causes less clamp force at seal which can relax during engine operation as manifold geometry normalizes
- Aggravating factors (sealing surface damage) in addition to lower clamp makes joint more vulnerable to leak
- Differences between right-hand and left-hand manifolds are caused by assembly sequence and angular variation permitted at the manifold-to-manifold connection

Permanent corrective action

- Permanent corrective action contains two elements:

1. Assembly process change that improves alignment control during the nut torque process

- ★ Protects alignment at fluid joint (minimizes risk of false torque)

2. Assembly process improvements to add:

- Engine lubricating oil to b-nut threads
- Fuel nozzle position optimization during assembly

- ★ Limits in-process assembly loads and reduces frictional resistance in threads



Fuel nozzle being assembled