

**Examination of Two Hydromechanical
Units from a CF6-80C2 Turbofan
Engine
Memphis, Tennessee, USA
Boeing 767-300F Incident
Aircraft
Registration N287FE**

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Approved by: 

Product Integrity

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TABLE OF CONTENTS

1	INTRODUCTION AND SUMMARY	5
1.1	PURPOSE.....	5
1.2	BACKGROUND	5
1.3	SUMMARY	6
2	FINDINGS OF INCIDENT HMU S/N BECK5069	7
2.1	GENERAL	7
3	FINDINGS OF NON-INCIDENT HMU S/N BECK5327	9
3.1	GENERAL FINDINGS OF ECU SERIAL NUMBER 89-AL0360.....	9
4	FUEL OIL HEAT EXCHANGER (FOHX).....	9
4.1	GENERAL FINDINGS.....	9
5	ANALYSIS AND CONCLUSIONS	10
5.1	ANALYSIS.....	10
5.2	CONCLUSIONS.....	10

1 INTRODUCTION AND SUMMARY

1.1 PURPOSE

This report presents the findings of the investigation of two hydromechanical units (HMU) performed at the Honeywell Aerospace facility in Rocky Mount, NC on February 7-8, 2024.

The investigation was conducted at the request of the National Transportation Safety Board (NTSB). Representatives from the NTSB, FAA, FedEx, GE and Honeywell were present at the examination.

1.2 BACKGROUND

Table 1 lists the pertinent information from the HMU data plates and reported operating times and cycles.

	Previously Removed HMU	Incident HMU
Part Number	06848-442637	06848-442637
PL ISS	29	29
MOD	CH-D2	CH-D2
Serial Number	BECK5327	BECK5069
GE Ident	07482SOCN	07482SOCN
GE PN	1383M68P23	1383M68P23
TSN	1410	11720
CSN	718	4908
Removed on	10/14/2023	n/a

Table 1. HMU Identifying Information

On October 18, 2023 at 16:15 Central Daylight Time, a FedEx Boeing 767-300F, registration number N287FE, powered by two General Electric CF6-80C2 turbofan engines, experienced a No. 1 (left) engine fire during initial climb from Memphis International Airport (MEM), Memphis, Tennessee. The flight crew reported that shortly after takeoff they heard a loud bang from the left side of the airplane and received an EICAS (engine indicating and crew alerting system) message and left engine fire warning. The flight crew pulled the No. 1 engine fire handle, discharged both fire suppression bottles, and performed an in-flight turnback. The fire indication eventually ceased as the airplane was returning to MEM and made an uneventful single engine landing. No injuries were reported. The airplane was operated as a Title 14 Code of Federal Regulations Part 121 cargo flight from MEM to Harry Reid International Airport (LAS), Las Vegas, Nevada.

Upon landing, airport rescue and fire fighting (ARFF) observed damage to the No. 1 engine thrust reverser and core cowl, but no indications of an active fire. No fire suppressant was applied to the engine. Ground inspection of the No. 1 engine with the cowl and thrust reverser opened revealed the engine had

experienced an undercowl fire and the main fuel pump (MFP) housing had fractured from the main fuel supply line. The MFP exhibited thermal distress and melting of the fracture surface.¹

1.3 SUMMARY

No preexisting conditions or findings were identified with either the incident or the previously removed HMU that would suggest that the HMU contributed to the undercowl engine fire.

¹ Summary of Aviation Incident Preliminary Report, ENG24FA003 from NTSB

2 FINDINGS OF INCIDENT HMU S/N BECK5069

NOTE

All observations reported herein are based on visual examinations with the unaided eye, unless otherwise noted.

2.1 GENERAL

- a. A general illustration of the fuel control (HMU) is provided in (Figure 1).

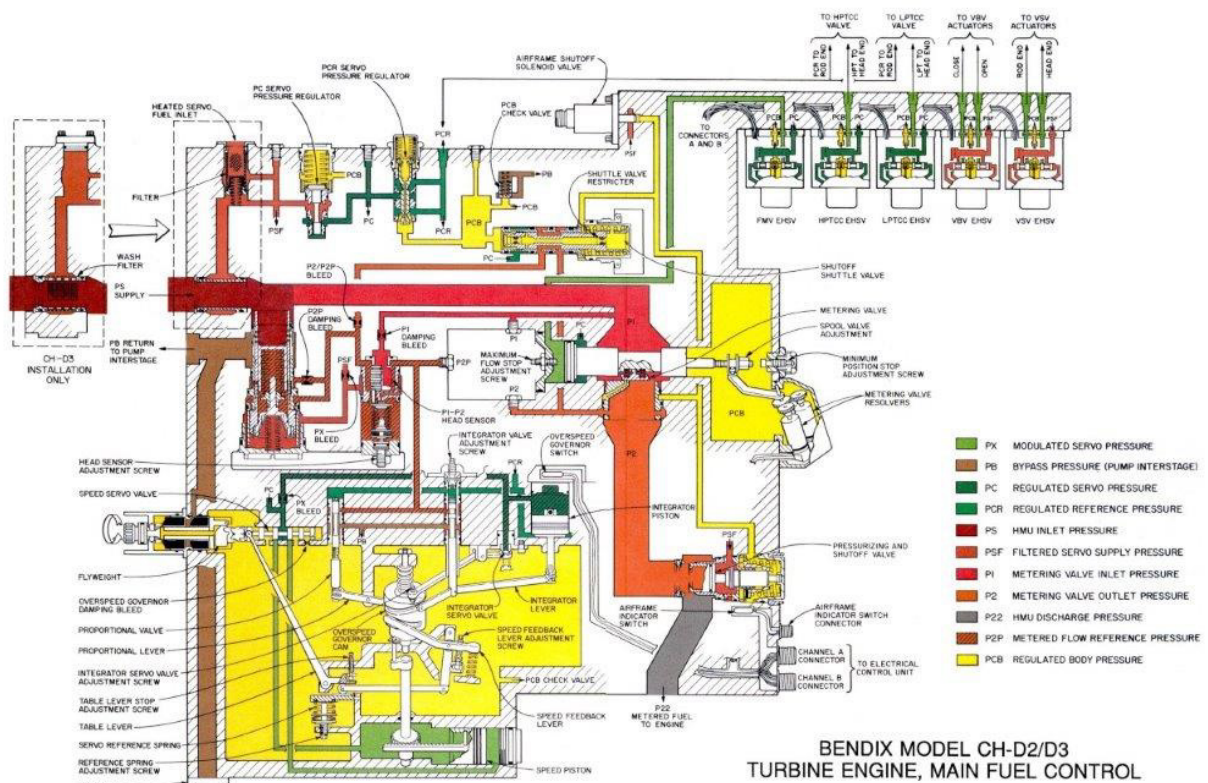


Figure 1. Bendix Model CH-D2/D3 Turbine Engine, Main Fuel Control.

- b. According to an 8130-form dated September 18, 2023, by CIMA aviation, it noted the incorrect installation of shutoff solenoid and no fuel leakage found. It was also noted that the incorrect installation would not have affected operation.
- c. The unit was received in a wooden shipping container (Figure 2 and Figure 3).
- d. The HMU was soot covered and exhibited thermal damage to some of its features (Figure 4 - Figure 9).
- e. The HMU mounting gasket appeared to be intact (Figure 6).
- f. There were varying degrees of soot covering the area of the electrohydraulic servo valves (Figure 9).
- g. The housing cover on the high pressure turbine active clearance control electrohydraulic servo valve (HPTACC EHSV) was bulged and the name

- plate was not attached due to the distorted area – the exterior surfaces of the valve appeared to be damp (Figure 10).
- h. The Channel 'A' and 'B' cannon plugs' electrical connector pins appeared to be intact and did not appear to be thermally damaged (Figure 11).
 - i. The insulation/rubber on one of the P-clamp exhibited thermal damage (Figure 12).
 - j. The conduit feature of the resolver housing (Cover Assembly) exhibited thermal damage (Figure 13).
 - k. The data plate was present and legible (Figure 14).
 - l. The electrical check portion of the acceptance test procedure was performed on the unit (Figure 15 and Figure 16). Most of the resolver related checks did not pass the required test points. All other test points were acceptable as noted by the 'GO' finding.
 - m. No additional testing was performed on the unit due to the thermal damage and the resulting risk of contaminating the test bench.
 - n. The Airframe Shutoff Valve Solenoid was removed from the HMU (Figure 17). No foreign debris was noted within the housing once the shutoff valve was removed (Figure 18).
 - o. The airframe shut off valve solenoid was tested electrically on the bench. According to the technician, audible evidence of actuation was noted.
 - p. To facilitate removal of the resolvers, the connector cover assembly was removed from the housing (Figure 19) and resolver connector pins were removed from the 'A' and 'B' connectors (Figure 20). The Min Stop Adjustment Plug was also removed (Figure 21).
 - q. The metering valve resolvers were successfully removed from the HMU (Figure 22). However, due to the thermal damage to the resolver housing (Cover Assembly) the wires could not be easily pulled through as would normally be expected. Charring was noted to the wire insulation near the resolvers (Figure 23).
 - r. The conduit portion of the resolver housing (Cover Assembly) was fractured to facilitate removal of the resolvers (Figure 24). Once exposed, the wire insulation appeared charred (Figure 25).
 - s. Mechanical manipulation and physical material removal was used to separate the resolver housing (Cover Assembly) from the metering valve resolvers (Figure 26).
 - t. Thermal damage was noted to resolver potting compound (Figure 27). The resolvers were retained for further evaluation.
 - u. All of the interior (fuel wetted) surfaces within the HMU exhibited a brownish coloring.
 - v. The fuel shutoff shuttle valve was removed and appeared to be intact (Figure 28 and Figure 29).
 - w. DC510 Freezer oil was applied, and standard tooling was used to remove the fuel shutoff shuttle valve sleeve (Figure 30). Once removed and as result of removal, one O-ring was noted to have had a section cut and separated (Figure 31). When looking into the bore, the section of separated O-ring was located (Figure 32) and collected and the cut features matched (Figure 33). The sleeve appeared to be intact.

- x. The cover was removed from the bulging HPTACC EHSV ([Figure 34](#) and [Figure 35](#)). During removal, weeping fluid was noted at the joint of the cover. The O-ring was noted to have been cut when accessed.
- y. No additional work was performed on the HMU.

3 FINDINGS OF NON-INCIDENT HMU S/N BECK5327

3.1 GENERAL FINDINGS OF ECU SERIAL NUMBER 89-AL0360

- (a) The HMU was previously quarantined following its shipment to Honeywell Prince Edward Island (PEI) for repair. The unit had been unboxed, but no work had been performed. The unit was then returned to Honeywell Product Integrity for inclusion in this investigation.
- (b) The unit appeared undamaged and was photo documented ([Figure 36](#) - [Figure 40](#)).
- (c) Prior to performing the bench test, the electrical portion of the acceptance test procedure was performed. All test points were acceptable as annotated by 'GO'.
- (d) The unit was placed on the test bench and tested in accordance with the test specification ([Figure 41](#)).
- (e) All points were within limits with the exception of Test Point 7.040 [SPEED AND GOVERNOR SETTING], the tested value was 6480 CRPM versus specification 6493 MIN / 6516 MAX. .

4 FUEL OIL HEAT EXCHANGER (FOHX)

4.1 GENERAL FINDINGS

- (a) The fuel portion of the fuel oil heat exchanger (FOHX) assembly was flushed with 1010 oil ([Figure 42](#)) and metal particles were present within the captured oil. Also, after visual inspection it was discovered metal particles were present internally. Fine particle debris was recovered from the fuel inlet port and retained by GE for future analysis ([Figure 43](#)).

5 ANALYSIS AND CONCLUSIONS

5.1 ANALYSIS

No conditions were identified with either HMU to suggest a common cause or similar type failure mode.

The incident HMU failed almost all the electrical check related to the resolvers. However, this is likely due to thermal distress as evidence by the damage to the cover assembly as well as the charring to the wire insulation and the resolver potting compound.

Bulging was noted to the HPTACC EHSV cover. However, according to the Honeywell subject matter expert, the bulging condition does not affect operation of the component.

5.2 CONCLUSIONS

No preexisting conditions or findings were identified with either the incident or the previously removed HMU that would suggest that the HMU contributed to the undercowl engine fire.



Figure 2. BECK5069 as Received



Figure 3. BECK5069 Packaging as Received



Figure 4. BECK5069 as Received



Figure 5. BECK5069 as Received

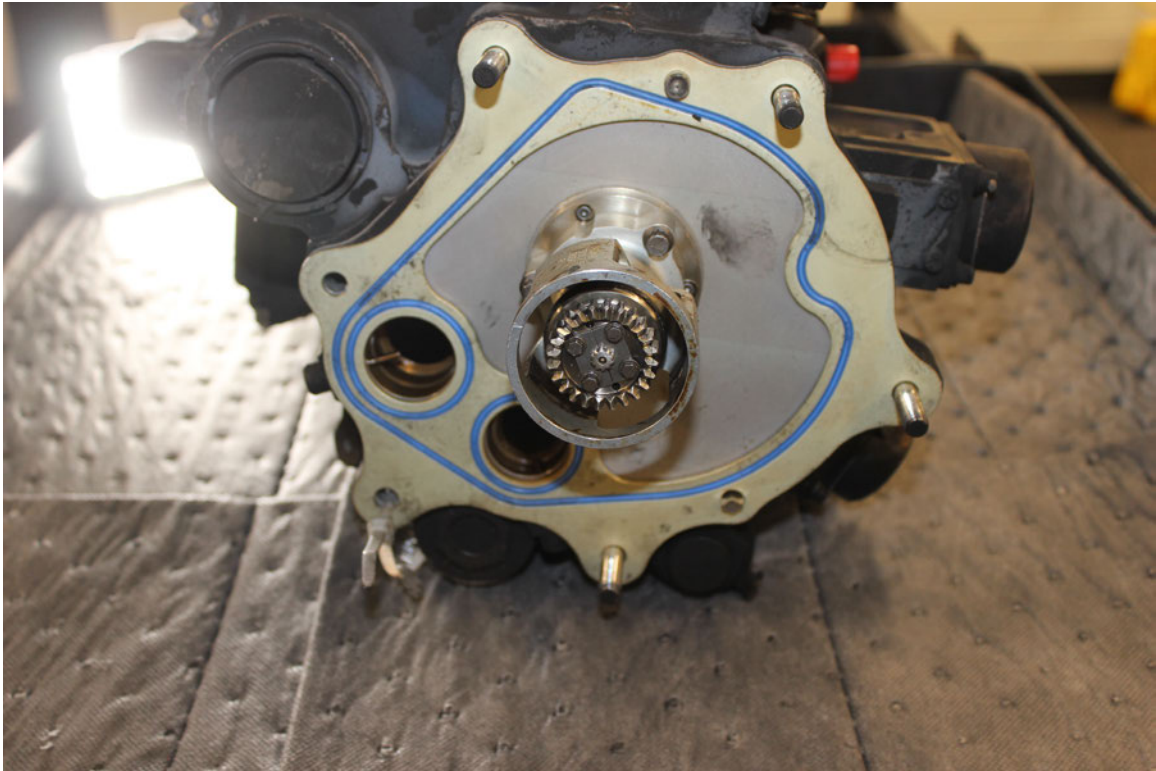


Figure 6. BECK5069 as Received

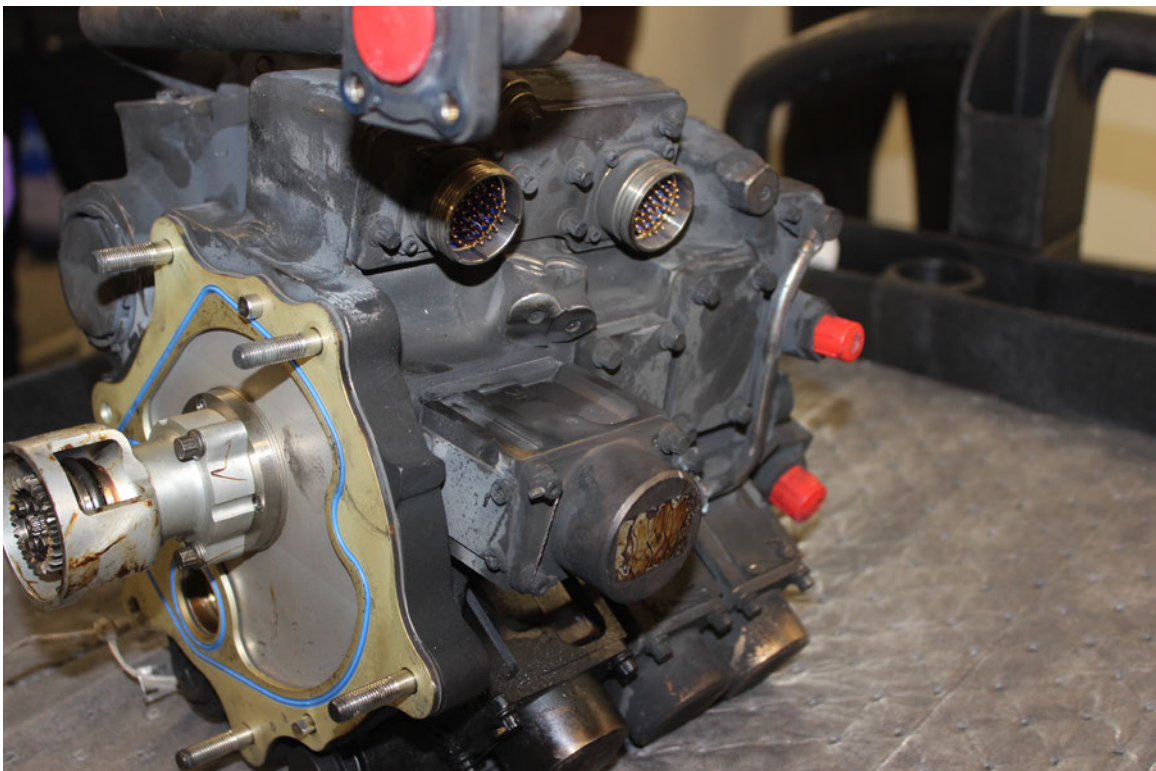


Figure 7. BECK5069 as Received



Figure 8. BECK5069 as Received



Figure 9. BECK5069 as Received



Figure 10. BECK5069 as Received



Figure 11. BECK5069 as Received

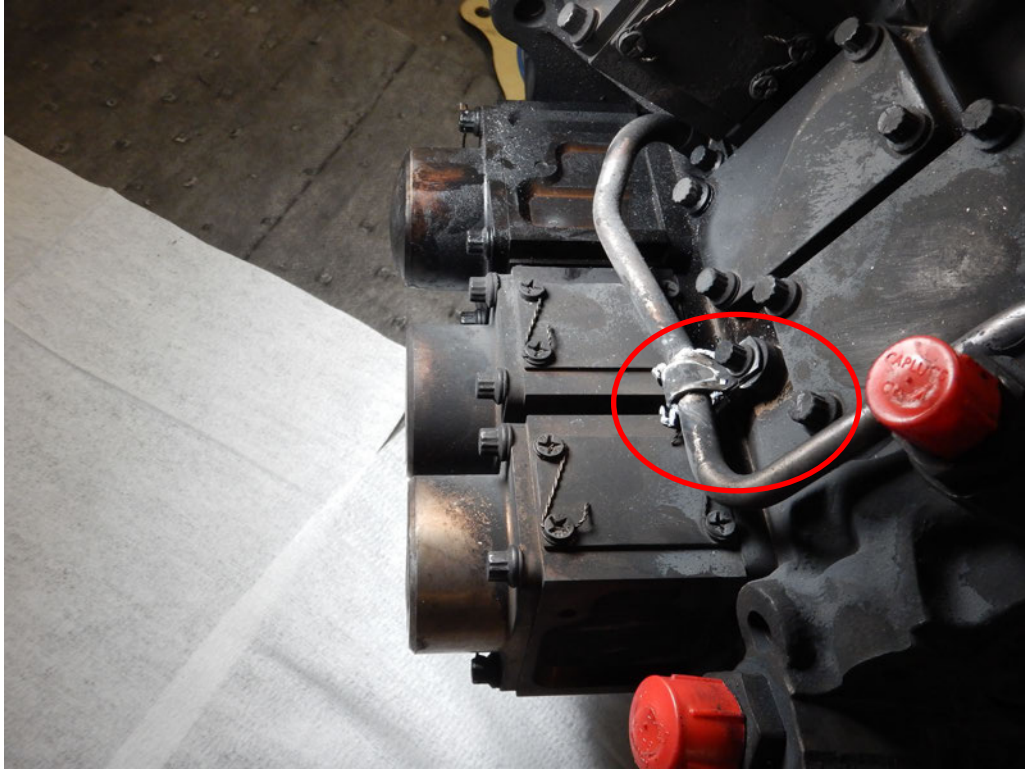


Figure 12. BECK5069 as Received

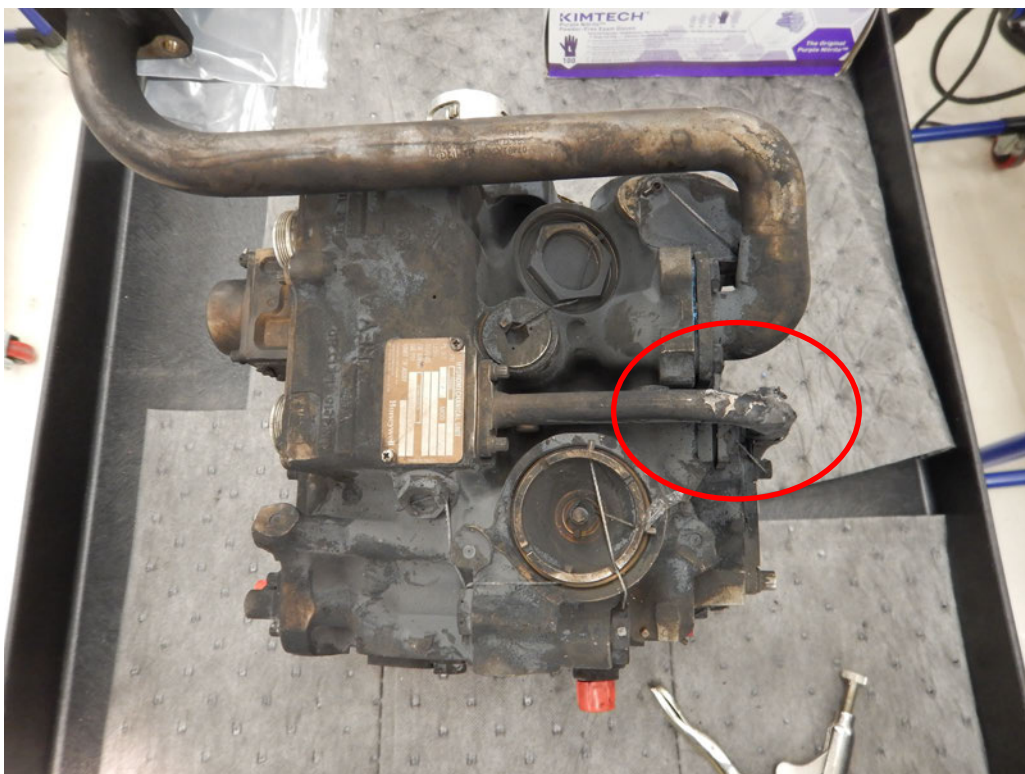


Figure 13. Damaged Resolver Housing

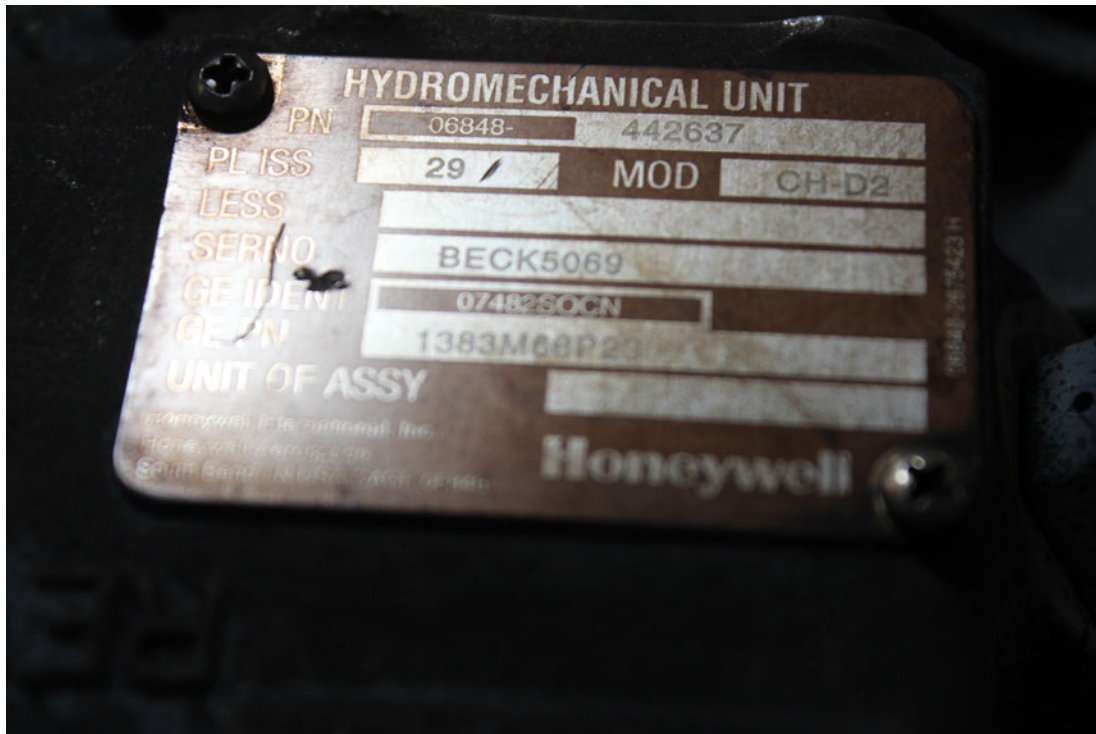


Figure 14. Data Plate



Figure 15. Electrical Test Bench

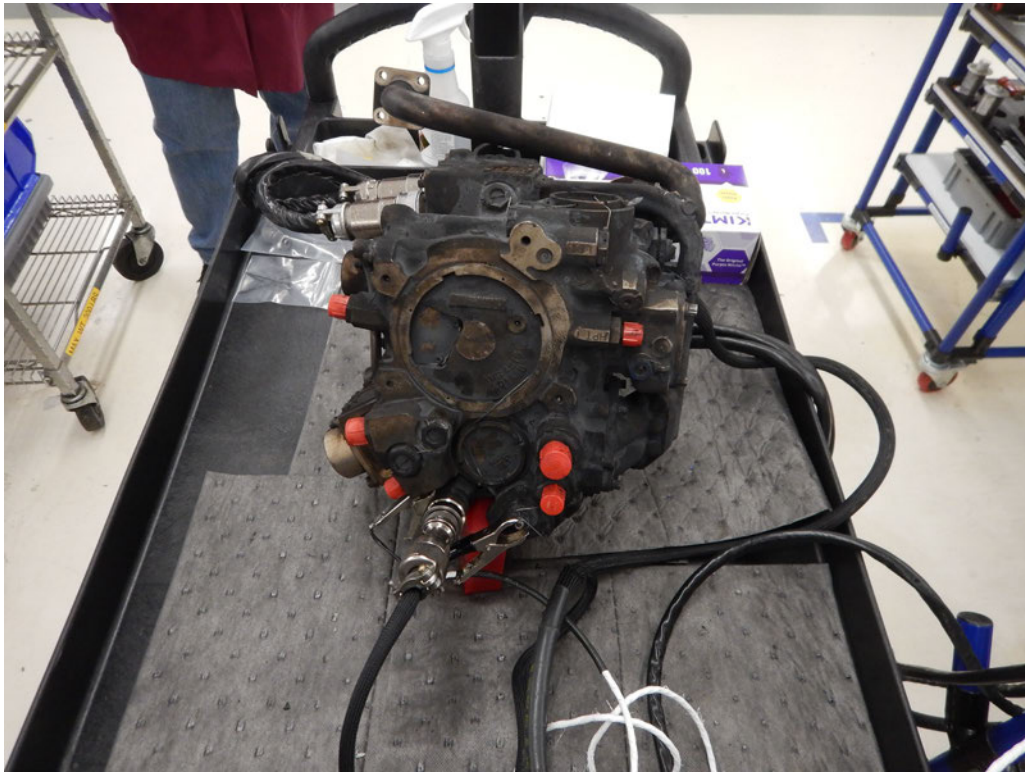


Figure 16. Electrical Test Bench



Figure 17. Airframe Shutoff Valve Solenoid



Figure 18. Airframe Shutoff Valve Solenoid Housing

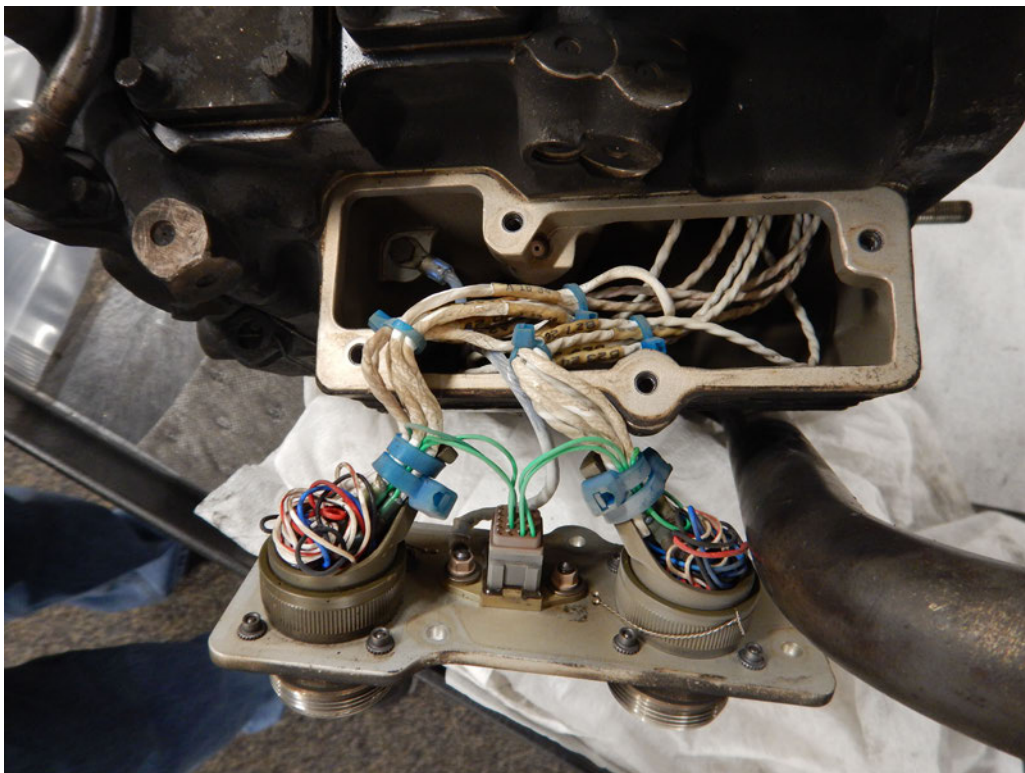


Figure 19. Channel 'A' and 'B' Connectors



Figure 20. Resolver Wires



Figure 21. Min Stop Adjustment Plug



Figure 22. Metering Valve Resolvers Removal



Figure 23. Resolver Wire Damage



Figure 24. Cover Assembly



Figure 25. Resolver Wires



Figure 26. Resolvers Separated from Cover Assembly



Figure 27. Resolver Potting Compound



Figure 28. Fuel Shutoff Shuttle Valve Cover



Figure 29. Fuel Shutoff Shuttle Valve

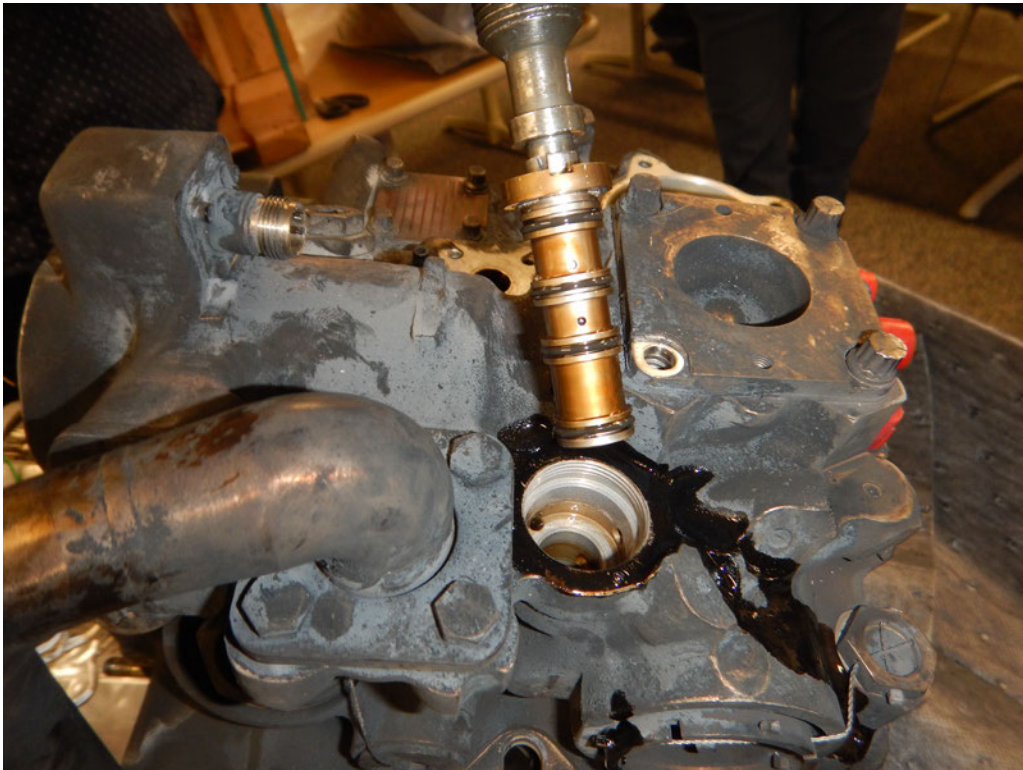


Figure 30. Fuel Shutoff Shuttle Valve Sleeve



Figure 31. Fuel Shutoff Shuttle Valve Sleeve O-ring

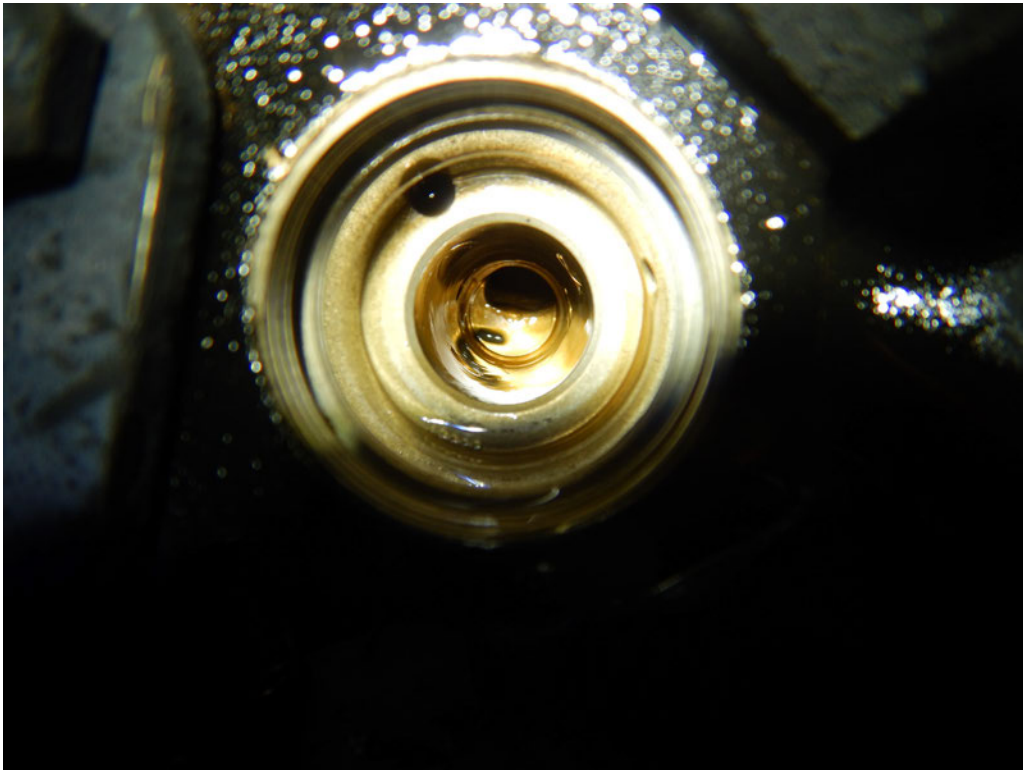


Figure 32. Fuel Shutoff Shuttle Valve Sleeve O-ring



Figure 33. Fuel Shutoff Shuttle Valve Sleeve O-ring

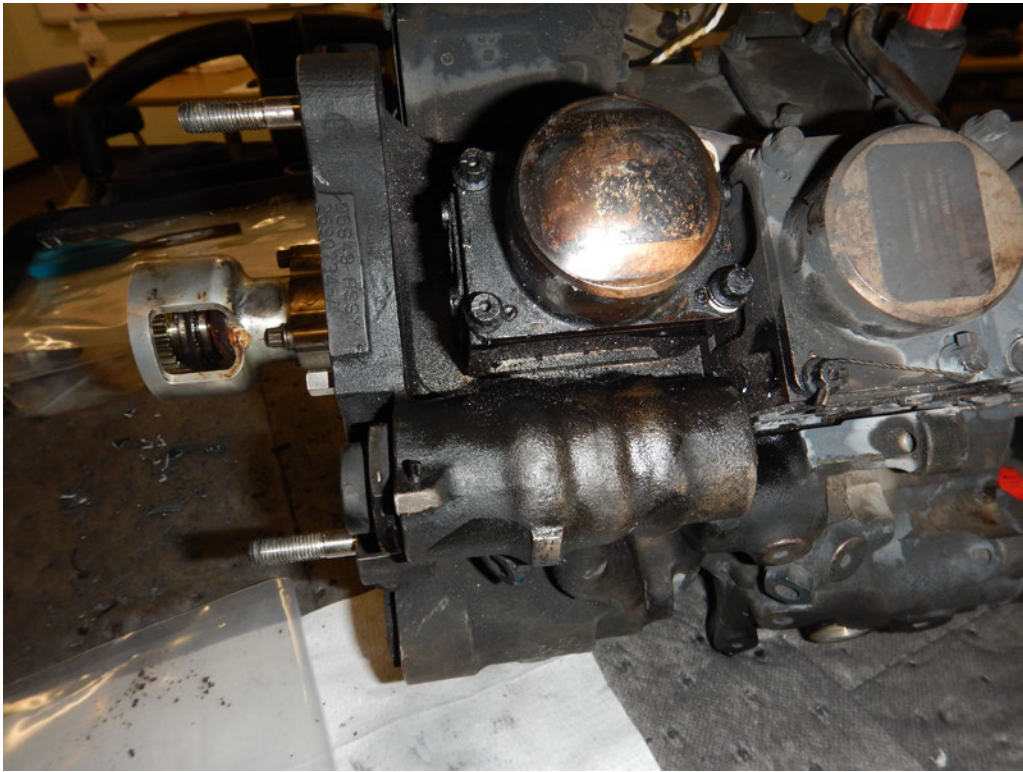


Figure 34. HPTACC EHSV

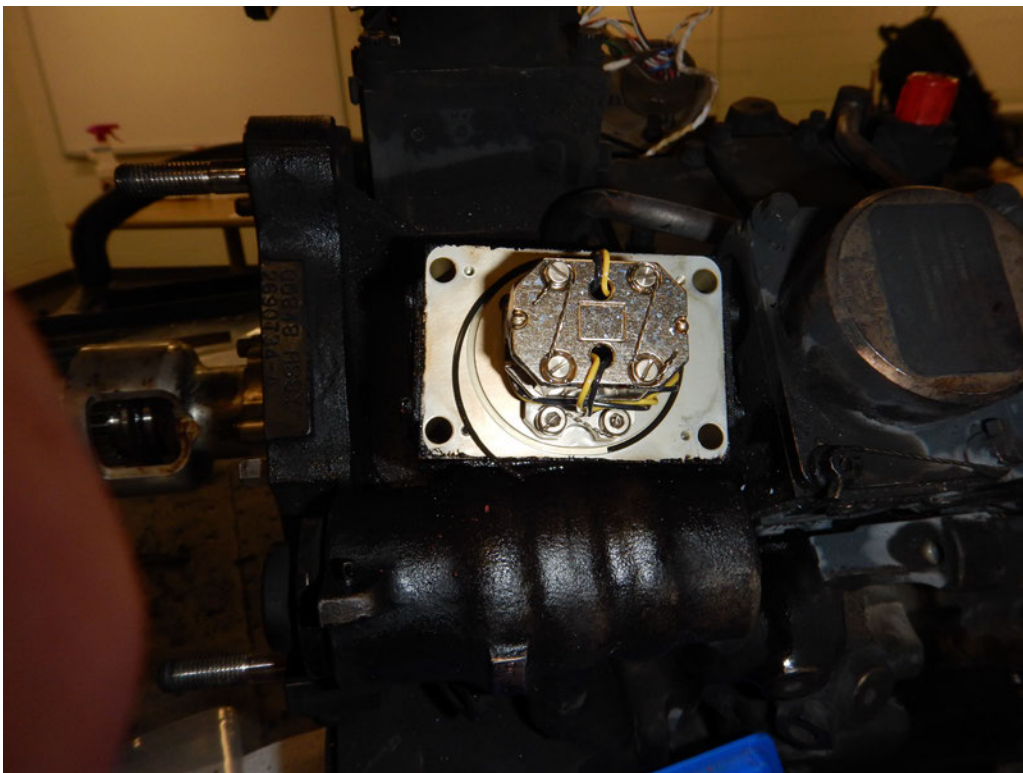


Figure 35. HPTACC EHSV



Figure 36. BECK5327 as Received



Figure 37. BECK5327 as Received

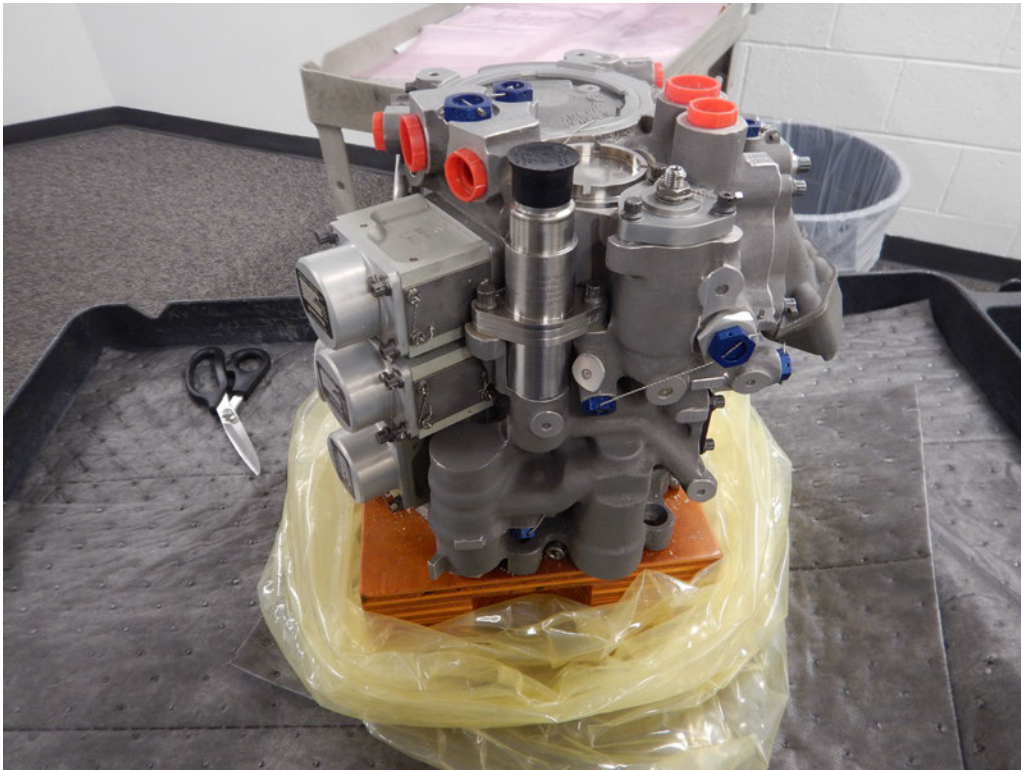


Figure 38. BECK5327 as Received



Figure 39. BECK5327 as Received

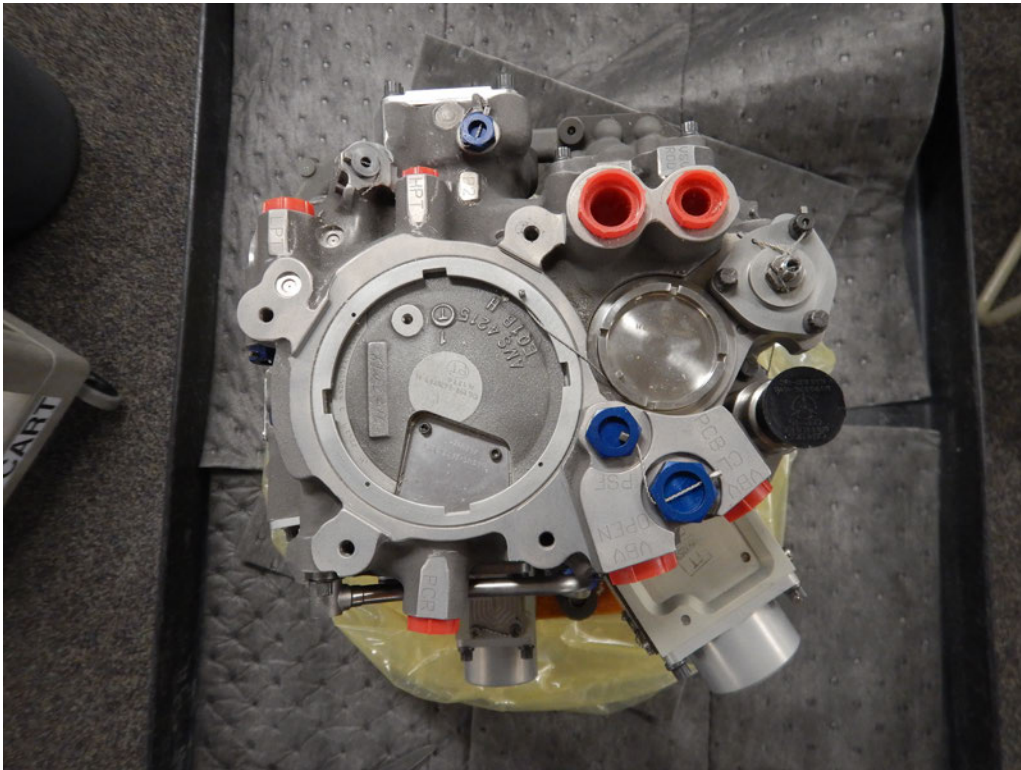


Figure 40. BECK5327 as Received

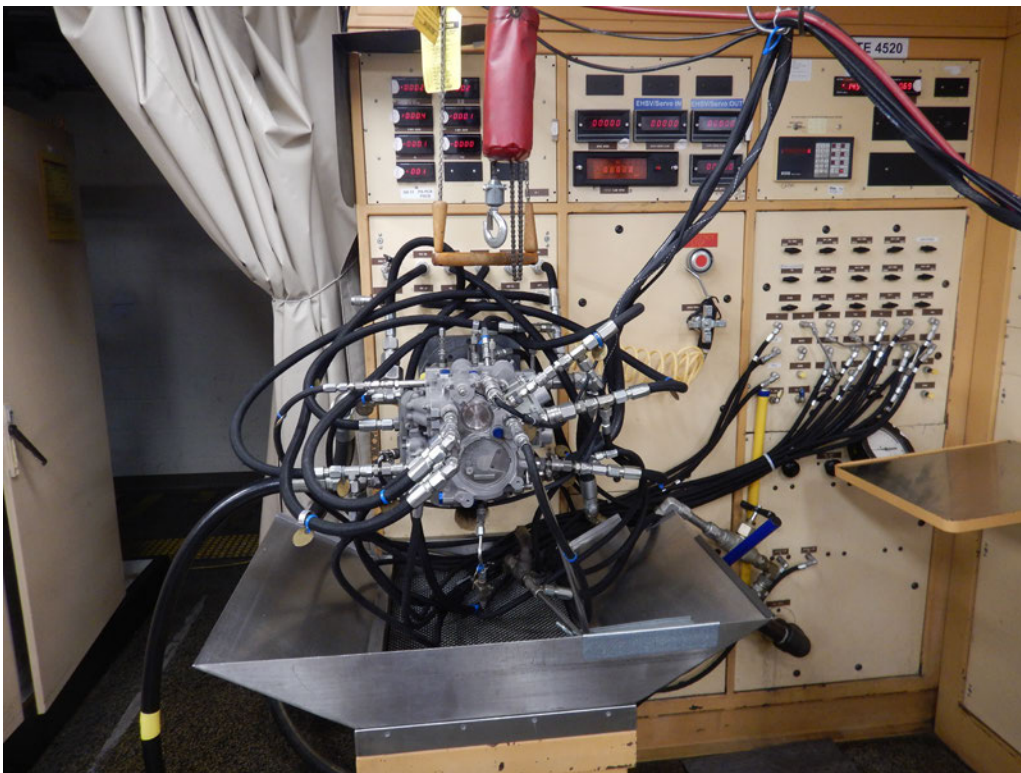


Figure 41. BECK5327 on Test Bench

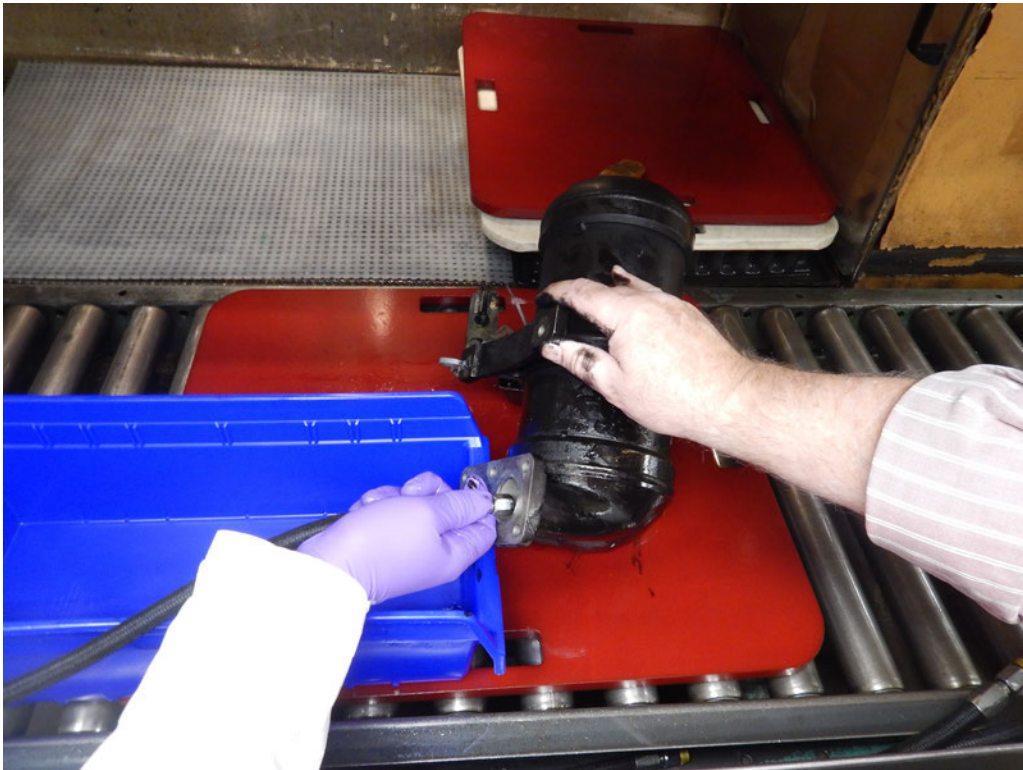


Figure 42. Fuel Oil Heat Exchanger

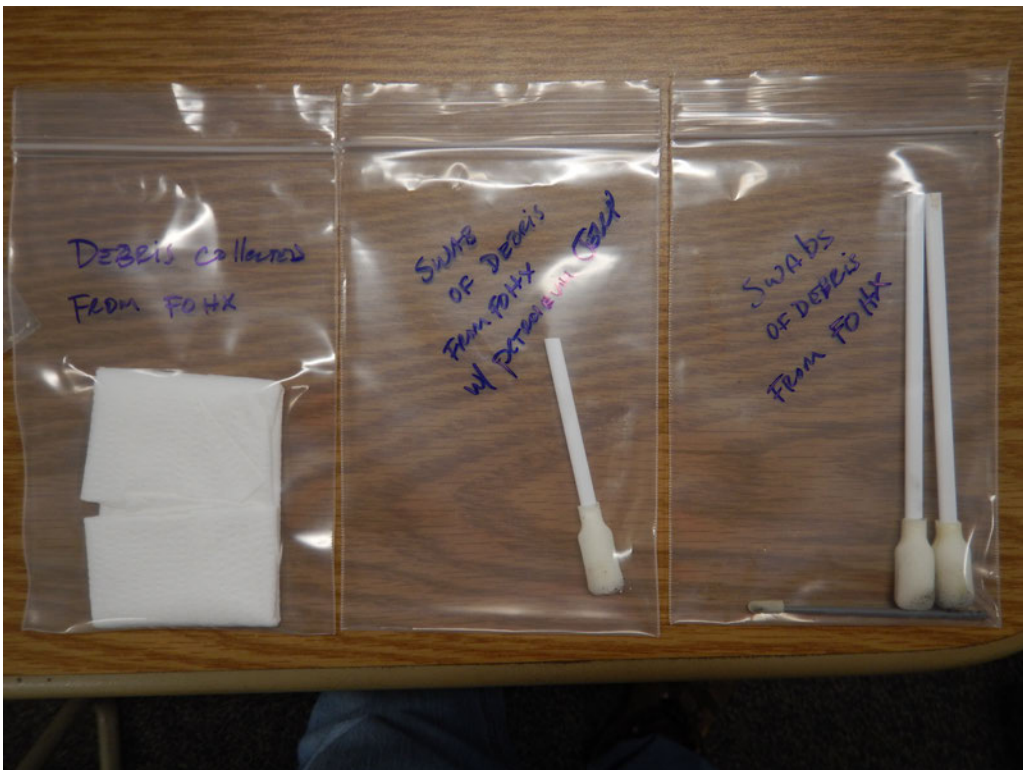


Figure 43. Captured Debris