NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

June 18, 2018

POWERPLANT GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: WPR16FA035

A. ACCIDENT

Location: Apple Valley, California

Date: December 6, 2015

Time: 1407 Pacific Standard Time

Aircraft: Aero Vodochody L-39C, Registration Number N39AY

B. POWERPLANTS GROUP

Group Chairman: Harald Reichel
National Transportation Safety Board
Washington, DC

Safety Board IIC: Stephen Stein
Air Safety Investigator
Seattle, Washington

Member: Brook Stewart
Principal Maintenance Inspector - FAA
Sacramento, California

Member: Pavel Kŭcera
Design & Airworthiness - Aero Vodochody
Letiště, Czech Republic

Member: Minh Venator
Minh Jet
Hollister, California

Member: Stanislav Suchý
Air Accidents Investigation Institute
Czech Republic

Member: Jan Hrabak
Air Safety Investigator
LOM Praha

C. SUMMARY

On December 6, 2015, about 1407 Pacific standard time, an Aero Vodochody L-39C, registration number N39AY, powered by an Ivchenko (now Motor Sich) AI-25TL turbo-fan engine, was destroyed when it impacted terrain during takeoff from Apple Valley Airport (APV), Apple Valley, California. The airline transport pilot and pilot-rated passenger were fatally injured. Visual meteorological conditions prevailed, and no flight plan was filed for the local flight. The airplane was registered to and operated by Jettran LLC as a Title 14 Code of Federal Regulations Part 91 personal flight.

When the airplane was approximately halfway down the runway and about 125 feet above ground level, witnesses heard a "pop, pop, pop", which was immediately followed by bright orange flashes from the engine’s exhaust nozzle. Witnesses reported that the airplane maintained its altitude and an approximate 20-degree nose-up attitude until it reached the end of the runway, where it rolled left and impacted the ground.

The Ivchenko AI-25TL turbo-fan engine was separated from the airframe and sent to the Plain Parts, Pleasant Grove, California after the accident, where it was stored until the Powerplant Group met from May 3 to 6, 2016 to examine the engine and to establish if any further testing and/or examinations were necessary to complete the investigation. Disassembly and examination of the engine revealed localized thermal distress of the 2nd stage low pressure turbine vanes and blades leading to overload fractures. The fuel control unit, fuel pump, fuel nozzles and blast ignitors were removed, boxed and sent to the LOM Praha facilities, in Prague, Czech Republic where the Powerplant Group met from September 4 to 6, 2017 for the testing, and disassembly of the components.

The fuel control unit metered fuel delivery pressure was found to be adjusted above factory limitations. The fuel nozzles were all below factory allowable limits in terms of flow rate and spray pattern. All the fuel nozzles failed the factory functional test procedure. Two of the four exhaust gas thermocouples (EGT) had failed.

D. DETAILS OF THE INVSTIGATION

D.1 Engine Description

The accident engine was an Ivchenko (now Motor Sich) AI-25TL, low-bypass type turbo-fan engine, which has a 2-spool arrangement consisting of a low pressure (LP) and a high pressure (HP) spool (Figure 1). The LP spool shaft is comprised of three axial compressor stages driven by two stages of turbines and the HP spool shaft is comprised of nine axial compressor stages driven by a single turbine. The axially oriented, single annulus type combustor features 12 fuel nozzles, which, during starting, are assisted by two torching-type ignitors. According to the flight manual, the static thrust of the engine is 3,800 pounds. The engine starter is an air-turbine type which, through the main gearbox spins the HP spool. The main gearbox also drives the generator, fuel pump, fuel control unit (FCU), the main oil pump, and hydraulic pump.

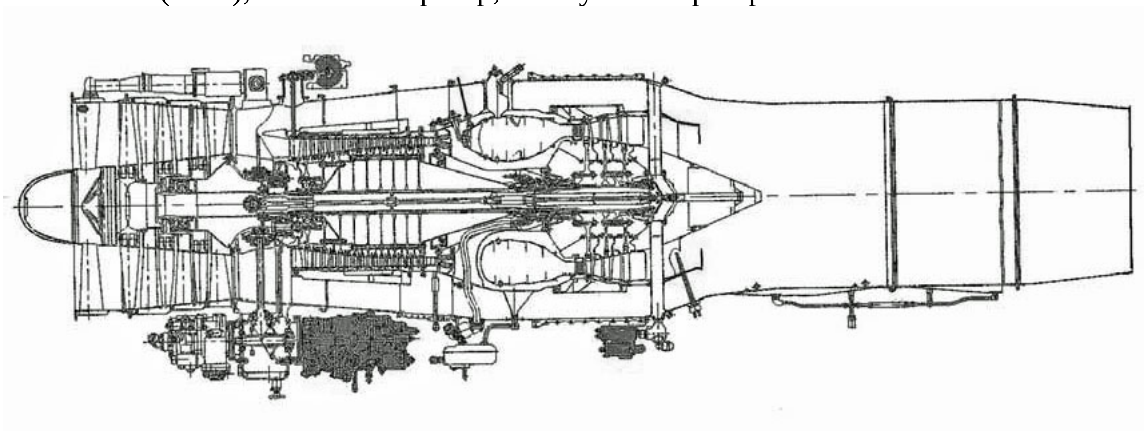

Figure 1 – Ivchenko (now Motor Sich) AI-25TL Cross Section

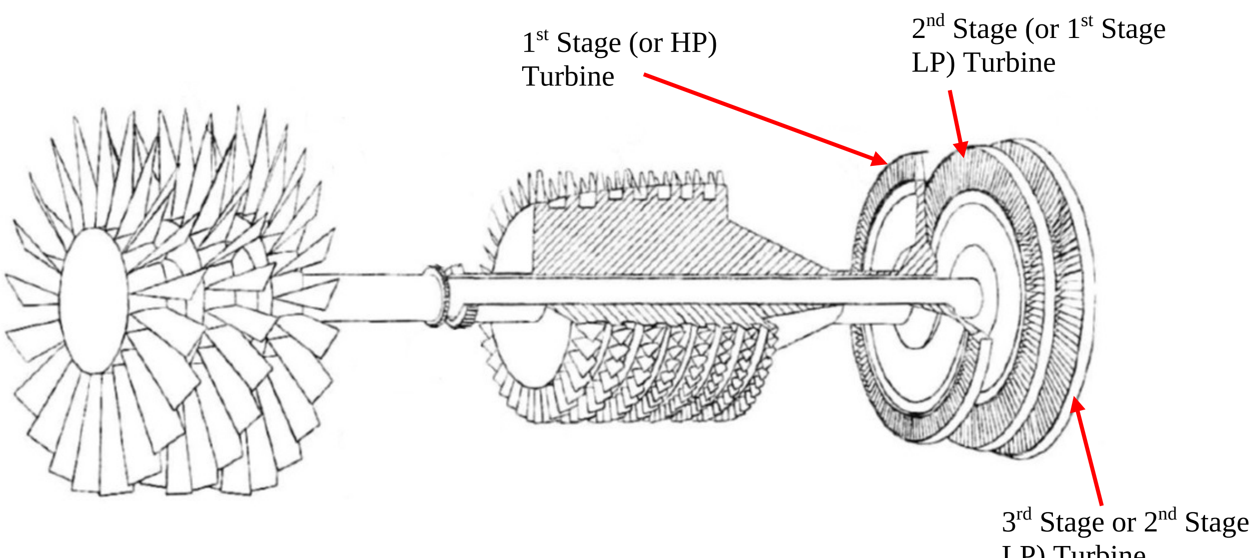

Figure 2 - Ivchenko (now Motor Sich) AI-25TL – Spool Diagram

D.2 Engine History

D.2.1 General

AI-25TL was designed for use in the Czechoslovak Aero Vodochody L-39 Albatros military trainer with the first flight occurring in 1968. About 2,900 L-39 airplanes were built during 1968 and 1992. The airplane remains in operational service with several air forces around the world, such as the Czech Republic, Estonia, Hungary, and Lithuania. The production run for the AI-25TL engine was approximately 30 years and approximately 4000 were built.

According to the factory records, the AI-25TL engine, serial number (S/N) 7082521100033, was manufactured on February 26, 1991 by Motor Sich JSC, Ukraine. According to foreign industry consultants, the engines' serial number (S/N), 70825221100033, is a coded type of number: The '708' component refers to the manufacturing location; the subsequent '25' refers to the engine model (in this case a AI-25 engine); the following '2' indicates the series (in this case, a series 'TL'); The next number '1' indicates the quarter of the year of manufacture (in this case, the 1st quarter); The subsequent number '1' indicates the year of manufacture (in this case, 1991); The final number '00033' is the sequential number engine built in the first quarter of 1991 (in this case, the 33rd engine built). This corresponds with the factory records.

D.2.2 Time Between Overhaul & Factory Extensions

According to factory documentation, the event engine was intended to have a time between overhaul (TBO) of 750 hours and a 'calendar service life'[1] of 8 years. At the time of the accident, the engine had accumulated 686.2 hours and was almost 25 years old. Recent Service Bulletins (SBs) by the manufacturer have extended the TBO times to 15 calendar years, however the TBO extension applies only to engines that have been operated and maintained in accordance with the manufacturers approved instructions for continuing airworthiness. According to the FAA approved maintenance inspection program (MIP), the engine must undergo a special inspection at 1,500 hours and 3000 hours. The inspection consists of the standard factory routine engine performance test and inspection, which according to the Motor Sich Engine Manual, should occur at 100-hour intervals. The MIP has no requirement to overhaul the engine.

D.2.3 Documentation & Logbook Review

According to foreign documentation and industry consultants, the engine, when new, was installed on this airplane in 1991 as a replacement, at which time the airplane was in the military service of the Ukrainian Air Force. The engine subsequently accumulated 532.26 hours while in military service until 2002, at which time it was

[1] A calendar service life is the maximum hard calendar time upon which the engine must be returned to the factory for overhaul, independent of its hours or cycles in operation.

decommissioned. The airplane was imported into the United States and on February 20, 2003, at which time the engine passed an FAA approved maintenance inspection with a TSN 532.26 hours. The AI-25TL engine record keeping requirements do not record cycles since new (CSN) or cycles since overhaul (CSO).

Date	TSN[2] (hours)	TSO (hours)	Notes
1991 – 1st Qtr	0	0	New – Ukrainian Air Force
2003-02-20	532.26	0	Imported into USA
2003-04-24	537.46	0	Importation flight test
2004-10-11	572.16	0	100 hr. / annual inspection
2005-01-05	N/A	0	Engine run and inspection
2006-12-15	583.3	0	50/100-hour inspection & annual
2008-03-06	599.2	0	Engine inspection
2009-04-19	604.2	0	Engine inspection
2010-04-08	624.7	0	Repair
2010-07-14	N/A	0	100-hour inspection
2011-02-09	630.3	0	Engine inspection
2012-04-20	633.1	0	Engine inspection / Service
2013-05-14	636.9	0	Engine inspection / Service
2014-10-22	641.3	0	Engine inspection / Service
2015-11-23	686.2	0	Engine inspection * / Service
2015-12-06			Accident

Table 1 - Engine Log Book & Discrepancy Entries

* It was reported that during this inspection, the 1st and 2nd stage turbine blades and wheel assemblies were inspected for condition, and no anomalies were observed. During the investigation, it was determined that, because of the engines' inherent design, that the 2nd stage nozzle cannot be inspected by borescope; only the disassembly of the engine can ascertain the condition of the 2nd stage nozzle. Only the front face of the 1st stage and rear face of the 3rd stage nozzles can be inspected (See Figure 2). In a review with technical staff of Aviation Classics with respect to the borescopic inspection of the 2nd stage turbine blades, they stated that a critical tip clearance inspection is made during this inspection, that determines if the blades have stretched in operation due to an overtemperature condition. Normally, there is a small clearance between the 2nd stage blade tips and the outer tip shroud. If the blades have stretched, then the tips will contact the shroud and causing the tip material of the blade to deform, producing a visible 'curl'

[2] Abbreviations for operations and service intervals: Time Since New (TSN), Time Since Overhaul (TSO), Dates are in year/month/day format.

on the tips' concave side. Aviation Classics technicians stated that they did not detect any blade curl during the November 23, 2018 boresopic inspection.

A review of entries in service documentation revealed that two adjustments of the FCU settings were done. During the July 14, 2010 inspection, the adjustments consisted of turning FCU screw No. 19 (Increase 3rd stage compressor bleed valve opening RPM)-9 clicks clockwise and screw No. 20 (Increase 5th stage compressor bleed valve opening RPM) – 15 clicks clockwise, both adjustments within acceptable maintenance manual (MM) limits. During the February 9, 2011 inspection, adjustments consisted of turning screw No. 28 (maximum fuel flow increase) – 4 clicks clockwise and screw No. 52 (N1 idle speed increase) - 3 clicks clockwise, were made and both adjustments were within acceptable MM limits.

The FCU maximum fuel pressure measured in the test cell was 85-atmospheres, (See Paragraph D.4.2 Fuel Control Unit (FCU) for details of the FCU test & examination) which is significantly above the allowable setting; however, a search of the logbooks did not reveal when or where this adjustment occurred. According to the maintenance provider, Aviation Classics, Ltd., during the last engine inspection that occurred in November 23, 2018, two engine performance check (ground) run ups were accomplished, during which an incorrectly set maximum fuel pressure would have been obvious to determine since the fuel pressure gauge can be seen in the cockpit (See Figure 6). The high fuel pressure would also have manifested itself by an elevated ITT value during the high-power test. According to Aviation Classics, Ltd., neither of these 2 discrepancies were observed.

D.2.4 Trend Monitoring

A significant difference between civil & military maintenance programs is the requirement for engine condition trend monitoring (TM). Although required for military programs, it is not performed in civil applications. TM records significant engine operational values to identify engine wear, deterioration, and internal damage. The TM process continuously monitors the health of an engine by tracking a set of engine performance parameters while on the ground and in flight and is required by the manufacturer to be performed about every 12 days. Parameters such as altitude, outside air temperature (OAT), pressure altitude, exhaust gas temperature (EGT), spool speeds (N1 & N2), and fuel flow (Wf) and fuel pressure (Wp) are recorded and tables in the engine manual must be consulted to convert recorded EGT and RPM values to 'corrected' values. The parameters are then compared to a set of charts which plots 'normalized' the new engine performance values and compares them with previous reference or 'trended' values. Although flight crews can notice big or sudden changes to performance, TM can identify subtle changes over time that a flight crew cannot. A continuous analysis of the TM trend is a predictive tool which can assist the owners and operators by providing early detection of engine performance deterioration due to contamination, wear or malfunction of engine components and accessories so that future corrective action can be scheduled. TM allows operators to better predict needed maintenance before secondary damage or a failure occurs. When performed properly by trained and experienced personnel, trend monitoring can detect faults such as:

- Hot section deterioration
- Hot starts
- Faulty fuel nozzles
- Dirty or eroded compressors
- Foreign object damage (FOD)
- Bleed leaks
- Instrumentation errors

Another aspect of performing a reliable TM is the quality of instrumentation. In military applications, the instruments are calibrated at 200-hour intervals. There is no such requirement in civil use. Aging of instruments is also a significant factor in obtaining reliable trends. It has been reported that the magnets inside the tachometers in the Aero Vodochody Albatros are of an older, traditional, pre-rare-earth type, which lose their magnetism over time, making tachometers installed in 20-year-old and over airplanes unreliable. Other instruments are also suspect if they are not calibrated on a regular basis.

At the time of the accident, the engine was almost 25 years old and had never been returned to the factory or overhauled. No trend monitoring was performed after the engine was decommissioned by the Ukrainian Air Force.

D.3 Examination of The Engine Turbo-machinery

D.3.1 General and External Conditions

The engine was on a palette and wrapped in a tarpaulin sheet (Photo 1). A small amount of oil and water was found under the engine, captured in the tarpaulin. The engine was resting in an almost inverted position (Photo 2 & Photo 3) and it was noted that the re-solidified aluminum drips (Photo 4) on the engine were vertically oriented, indicating that this was the same orientation of the engine after it came to rest following the accident. The fan could not be rotated. There were no signs of an un-containment, such as case breaches or failed flanges.

Much of the external low-melting temperature metal, such as the aluminum outer bypass duct, fuel nozzle clearing canister, and some airframe sheet metal was melted and re-solidified around the engine and LRUs[3], consistent with a post-accident external engine fire. Some airframe structural parts were still attached to the engine mounting supports. All the electrical wires and most of the small electrical components were heat distressed.

[3] Engine accessories are external engine components that can be replaced in the field while the engine is still installed in the airframe. Examples of LRU's are: FCU, fuel pump, oil and scavenge pumps, hydraulic pump, starter, and generator.

The engine was generally intact, and all major assemblies were sessile. All the engine major assemblies and components were coated with a white powdery layer, consistent with fire retardant residue. The accessory gearbox was intact, undamaged and in its proper location, as were all the attached LRUs. All the LRUs were coated with a black sooty deposit (Photo 3). The oil tank was missing. The fuel-to-oil heat exchanger (FOH) was in its proper location, intact and coated with a black sooty deposit. The EPA canister was in its proper location; however, it was partially melted, exposing the interior. The high temp bleed air system was intact and still connected to the engine core flanges.

The LP compressor inlet guide vane assembly was intact (Photo 5), however, there were two small dents near the tip of the nose cone. The LP compressor assembly was externally intact. The bypass duct inlet housing and accessory gearbox drive and support was heat distressed. A segment of the bypass duct housing outer and inner ducts from the 10 to the 5 o'clock location was burned and missing, exposing the inner accessory gearbox bevel drive housing (Photo 6). The outer bypass duct aft of the bypass duct inlet housing was heat distressed and the segment from 9 to 6 o'clock[4] was melted. The HP compressor housing, combustor housing, turbine housing and the exhaust pipe were externally intact (Photo 7).

The 2nd stage LP turbine was intact, and all blades were present, however several blades were deformed (Photo 8). Approximately a handful of metallic debris was observed at the bottom of the duct on the plane of the 2nd stage turbine. Additionally, several fractured and overheated blade tip fragments (Photo 9), consistent with material from the 1st stage turbine were found lodged between the 2nd stage blade gaps. The four exhaust gas thermocouples were still present (Photo 8), however the 9 and 12 o'clock thermocouples were bent in the counterclockwise direction, while the one at 6 o'clock, although unbent, was radially translated inward and rested against the rear bearing housing inner duct. The 3 o'clock thermocouple appeared to be undamaged. (See paragraph D.4.5 Thermocouples (TC) for detailed thermocouple tests and examination results).

D.3.2 <u>LP Compressor</u>

The LP compressor housing was intact. The LP compressor inlet guide vane assembly was removed, allowing the examination of the 1st and 2nd stage LP compressor blades and stators, all of which were intact; however, were coated with a white powdery deposit, consistent with magnesium oxide, a byproduct of the magnesium bypass duct inlet housing fire.

Because the outer bypass duct was melted through, the 3rd stage LP compressor could be observed without disassembling the engine case (Photo 6). All blades and stators

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[4] All directional references to front and rear, right and left, top and bottom, and clockwise and counterclockwise are made aft looking forward (ALF) as is the convention. Top is the 12 o'clock position. The direction of rotation of the engine is counterclockwise.

were intact; however, were coated with a white powdery deposit, consistent with magnesium oxide, a byproduct of the magnesium bypass duct inlet housing fire.

D.3.3 Bypass Duct Inlet Housing and Accessory Gearbox Drive

A segment of the bypass duct housing outer and inner ducts from the 10 to the 5 o'clock location was burned and missing, exposing the inner accessory gearbox bevel drive housing (Photo 6). The accessory gearbox lower access panel was removed, and the bevel gear drive shaft and its associated bearings were observed to be intact and free to rotate (Photo 41).

D.3.4 HP compressor and Variable Guide Vane Actuator (VGV) Assembly

The HP compressor housing was intact and undamaged; however, all its components were coated with a white powdery deposit. The 1st stage HP variable guide vane (VGV) assembly, unison ring and bellcrank hardware for each vane were intact, however they exhibited surface corrosion and were coated with a white powdery deposit (Photo 10). The VGV actuator and its associated linkage were present and intact (Photo 11) and the indicated angle was – (minus)15 degrees (Photo 12), which, according to the maintenance manual is the 'home' or rigging position when the engine is not operating. The four air bleed-off valves (BOV) were present and in their correct location (Photo 13) on the HP housing plenum, however the outer housings of all the BOVs were melted, exposing the inner piston and spring assemblies. All BOV pistons could still be moved, and their springs were still capable of returning the pistons to the open (low power) position.

Because no factory tooling was available to correctly disassemble the HP compressor, a cutting wheel was used to remove a section of the HP compressor housing (Photo 14), revealing nine stages of blades and stators which were intact and undamaged. The leading edges of the blades and stators were examined for any nicks or other FOD damage and none was found. Additionally, a white powdery coating was observed throughout the HP compressor as well as some minor local surface corrosion.

D.3.5 Combustor

The fuel nozzle manifold (Photo 15) was intact as were the 12 individual fuel nozzle (FN) assemblies. Before their removal, the FNs were sequentially numbered in a counterclockwise manner, with number 1 chosen to be at the 11:30 location. All the FNs were removed from their combustor locating ferrules with ease and were found to be intact (Photo 16); however, most FN's were coated with a black carbon or coke deposit (Photo 17). The FNs were shipped to the LOM facility in Prague, Czech Republic, where they were tested. (See Fuel Nozzles D.4.3 for details)

Because no factory tooling was available to correctly disassemble the combustor housing to examine combustion chamber, a cutting wheel was used to remove a section of the housing (Photo 18). The intact combustor was sectioned, revealing carbon deposits within the fuel nozzle head assembly cooling and anti-carbon build-up holes (Photo 19).

A review of the AI-25TL maintenance manuals revealed critical features in the fuel nozzle head assembly that maintain cooling as well as prevent carbon build-up. The schematic on Figure 3 shows the fuel nozzle head assembly, into which each fuel nozzle is inserted and illustrates multiple hole patterns within the support ring.

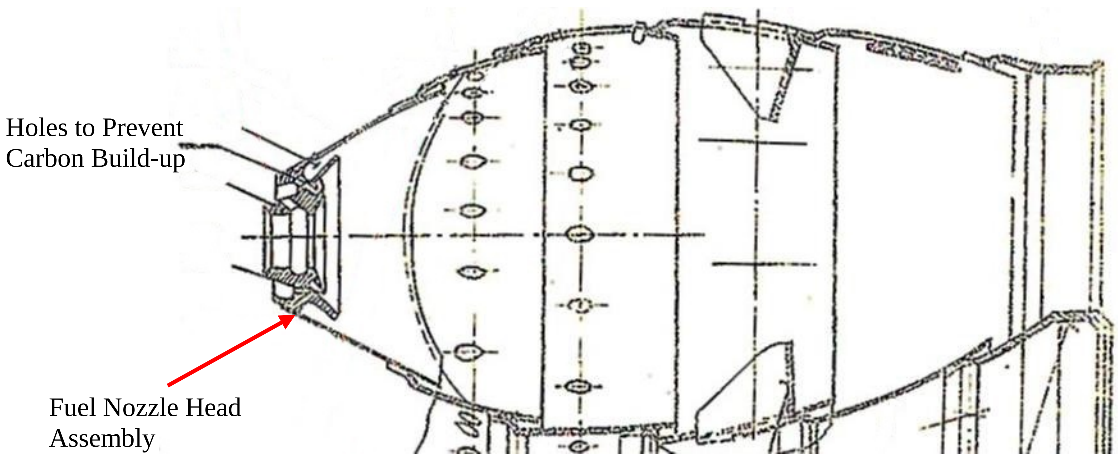


Figure 3 – Combustion Chamber Flame Tube – Section Schematic

(Fuel Nozzle is Not Shown)

The maintenance manuals and related factory technical bulletins illustrate the fuel nozzle head assembly and the importance of the anti-carbon-buildup holes in the combustion process. Figure 4 & Figure 5 highlight the difference in the combustor flame pattern between clean anti-carbon-buildup holes and those that are blocked with carbon buildup or coke.

The illustration on Figure 4 shows the fuel sprayed into the combustion chamber being properly mixed with the air from the anti-carbon-buildup holes, allowing the combustion process to occur early in the combustor housing and be complete by the time it reaches the end of the combustor.

In contrast, the Figure 5 shows a delay of the complete combustion of sprayed fuel because of the restriction of the air from the anti-carbon-buildup holes, causing the flame to become longer and the maximum heat profile to shift aftwards. The maximum heat profile, which is normally confined in the combustion chamber and focused on the cooled 1st stage vane ring and turbine, now passes further aft, thermally affecting the 2nd and 3rd stage turbines and vane rings. The 2nd and 3rd vane and turbine stages are not internally cooled and are not designed for the higher temperature profile, causing thermal degradation. The secondary affect is that this degradation causes a loss of engine performance, which the pilot may compensate for, by increasing the fuel flow, accelerating the thermal damage to the 2nd and 3rd turbine stages even more.

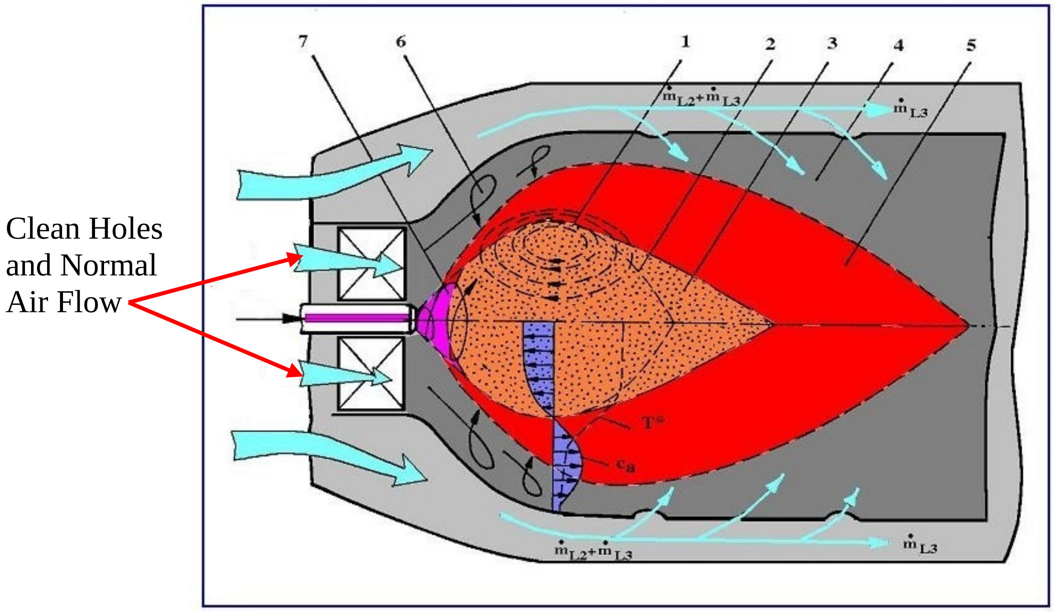


Figure 4 – Normal Combustion Shape Without Interference from Carbon Build-up

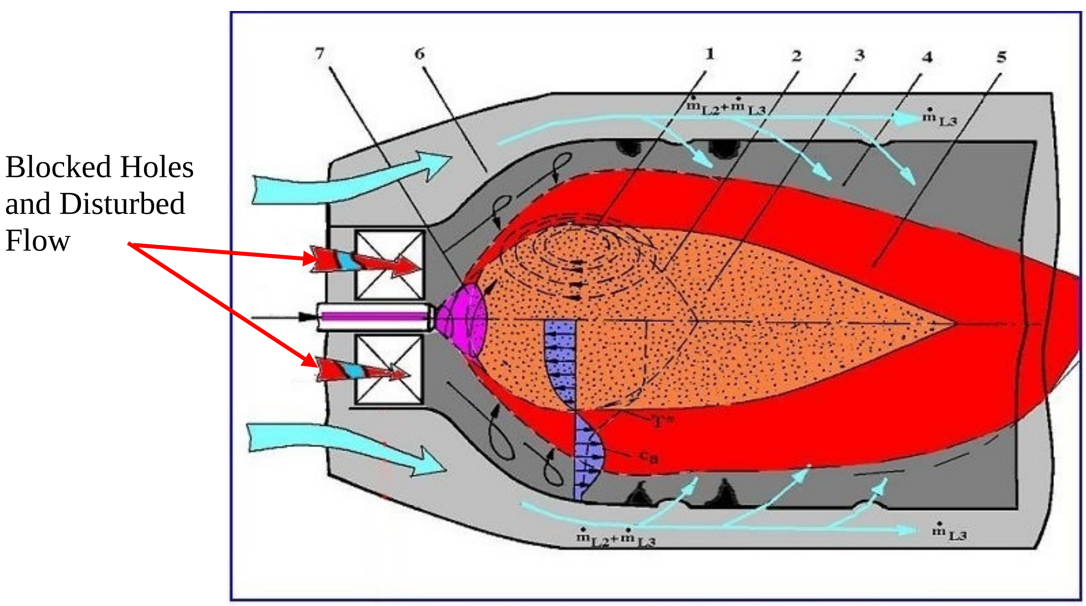


Figure 5 – Disturbed Combustion Shape with Interference from Soot & Blocked Holes

The damage observed on the 2nd and 3rd stage nozzles and turbines is consistent with overtemperature condition caused by a disturbed combustion process in the combustor consistent with restricted anti-carbon-buildup holes in the fuel nozzle head assembly.

In discussions with international specialists on the AI-25TL engine, carbon deposits on the fuel nozzle head assembly is a known phenomenon, however in discussion with North American maintenance providers, they seem to be unaware of this condition. The maintenance inspection program for this engine also does not mention this condition or require its inspection.

A wash procedure has been developed for cleaning the entire airflow path of the engine in which a cleaning detergent is injected with a specialized spray bar into the igniters hole as well as between the LPC and the HPC. The detergent takes hours to soften the carbon soot and coke and must be repeated at least twice. The overall task takes days but will clean the important anti-carbon-buildup holes. A review of the logbook and maintenance history of the engine did not find the cleaning task performed.

The 2 ignition torching fuel nozzles were intact and exhibited a mild internal surface corrosion.

D.3.6 1st Stage or High Pressure (HP) Turbine Assembly

D.3.6.1 1st Stage or High Pressure (HP) Turbine Nozzle

The HP turbine nozzle consists of an assembled set of individual vanes locked in place via inner and outer retaining flanges and clips. The vanes are hollow and during operation, compressor air is directed through their internal cooling passages for cooling purposes. All the vane segments were present, locked in their proper location and intact[5] (Photo 20). The concave side of the vanes exhibited a slight lightened discoloration on the forward 1/3 span. Additionally, a mild streaking in the airflow direction was noted on approximately the forward ½ span (Photo 21). Only one vane segment at the 4 o'clock location exhibited heat induced erosion at the trailing edge (Photo 22).

D.3.6.2 1st Stage (or HP) Turbine

The HP turbine features a bladed hub design. The blades are hollow and during operation, compressor air is directed through their internal passages for cooling purposes. The hub was intact, and all the blades were present, locked in their proper location and intact (Photo 23). Light debris was noted, adhering to the inside surfaces of the blade tip platforms as well as the outer span of some of the blades. A rippling of the parent material near the outer span at the trailing edges of the blades was observed on many blades (Photo 24 & Photo 25), consistent with blade material becoming plastic during

[5] The two vane segments in the image at the 11:30 location slipped out of location upon disassembly.

operation at elevated temperatures. Additionally, a streaking pattern in the airflow direction was noted on the entire convex surface of each blade (Photo 26).

D.3.7 2nd Stage Turbine (or 1st Stage Low Pressure (LP)) Turbine Assembly

D.3.7.1 2nd Stage (or 1st Stage LP) Turbine Nozzle

The 1st stage LP turbine nozzle consists of an assembled set of individual vanes locked in place via inner and outer retaining flanges and clips. The vanes are solid and therefore uncooled. All the vane segments were present and locked in their proper location (Photo 27); however, the vanes within the two segments between 9 and 2 o'clock as well as between 4 and 5 o'clock had fingernail-sized fractures on the trailing edges due to impact (Photo 28). Additionally, most of the vanes exhibited a rippling pattern on the vane airfoil surfaces along the inner half of the vane span, consistent with a melted plastic flow (Photo 29). Those vanes within the 2 segments between 4 and 9 o'clock as well as 10 to 12 o'clock exhibited the greatest rippling distortion.

D.3.7.2 2nd Stage (or 1st Stage LP) Turbine)

The 1st stage LP turbine features a bladed hub design, the blades being solid castings and uncooled. The hub was intact, and all the blades were present and locked in location, however approximately half of the blades were fractured in a sequential fashion near the tip shroud blend radius, while those with their tip shrouds still intact, had fractures near the trailing edges with fingernail-sized particles missing (Photo 30). A visual examination of all the fractures revealed only overload type failure. No evidence of fatigue was observed. All the blades exhibited a rippled pattern on the mid-span, consistent with a melted plastic flow (Photo 31). Several tip shrouds were found at the bottom of the turbine housing (Photo 32).

D.3.7.3 3rd Stage (or 2nd Stage LP) Turbine Nozzle

The 2nd stage LP turbine nozzle consists of an assembled set of individual vanes locked in place via inner and outer retaining flanges and clips. The vanes are solid and therefore uncooled. All the vane segments were present and locked in their proper location (Photo 33), however the vanes within the 2 segments between 9 and 12 o'clock as well as between 4 and 5 o'clock were deformed, distorted and fractured due to impact. The fractures displayed a soft, large radius deformation instead of the typical brittle fractures, damage which is consistent with impact while the material was in an elevated temperature, softened state (Photo 34 & Photo 35).

D.3.7.4 3rd Stage (or 2nd Stage LP) Turbine

The 2nd stage LP turbine features a bladed hub design, the blades being solid castings and uncooled. The hub was intact, and all the blades were present, locked in their proper location, intact and undamaged (Photo 36). Two non-consecutive blades were bent. Blade tip shrouds from the 1st stage LP turbine as well as other metal debris was found between the blades and at the bottom of the housing.

D.3.8 Main Spool Bearings

On initial examination of the engine, the LP spool shaft could not be rotated by hand; however, once internal debris and the bound LP rotors and stators were removed, the shaft could be turned by hand. The aft LP rotor roller bearing was examined, and was found to be oil wetted, intact and undamaged (Photo 37). When the LP shaft was turned, no noise from the forward bearings could be heard.

The HP spool bearings could not be visually examined because the engine was not torn down to that level, however once the line replaceable units (LRU's) were removed from the accessory gearbox, the HP spool shaft could be rotated by hand and no significant noise could be heard from the HP spool bearings.

D.3.9 Accessory Gearbox (AGB)

All LRUs were removed from the AGB and the input splines were examined, revealing intact, and undamaged teeth (Photo 38 & Photo 39). The bottom oil pan/access cover to the AGB was removed, revealing the inner gear mechanism, which was oil wetted, intact and undamaged (Photo 40).

D.4 Examination of the Engine Accessories

D.4.1 General Notes and Summary

After the examination of the engine at Plain Parts, Pleasant Grove, California, the FCU, FP, fuel nozzles and blast ignitors were removed, boxed and sent to the LOM Praha facilities, in Prague, Czech Republic where the Powerplant Group met from September 4 to 6, 2017 for the testing, and disassembly of the components.

The FCU maximum metered fuel delivery pressure was found to be adjusted significantly above the maximum allowable factory limit. The fuel nozzles were all below allowable factory limits in terms of flow rate and spray pattern. All the fuel nozzles failed the factory functional test procedure. Two of the four thermocouples had failed.

The adjusted settings of the FCU and the deteriorated conditions of the fuel nozzles could explain the heat-deteriorated condition of the turbine section. The asymmetrically deteriorated conditions of the installed fuel nozzle set matched the asymmetrically deteriorated condition of the second stage vane ring.

D.4.2 Fuel Control Unit

The FCU was intact, and externally undamaged. In the in-situ condition, the fuel control input lever was observed to be in the cutoff condition. Additionally, it was coated with drippings of solidified, previously molten aluminum as well as a light white powdery deposit. When removed from the AGB, the input and drive splines were observed to be intact and undamaged. When the fuel line connectors were removed from the FCU, clean fuel was seen to exit the unit (Photo 41). Approximately 1 ½ pints were recovered.

The FCU was part number 4001 and serial number 11530105. Inspection of the FCU at the LOM Praha facilities revealed that it was covered in oily soot and LOM technicians were reluctant to test it, for fear of damaging their test rig or contaminating their test rig fluid. The fuel pump fuel filter was removed and found to be clean and contain a straw-colored fluid, consistent with turbine fuel. The FCU input shaft turned freely and when turned, clean fuel was seen to exit some ports. With this knowledge, LOM engineering decided that the FCU was in good enough condition and prior to placing it into the LOM test rig (Photo 42), had the FCU externally cleaned.

When fuel pressure was introduced to the FCU, a leak was seen on the air bleed fitting cover and when it was removed, no sealing gasket could be found in the cover. A new seal was obtained, and the test continued.

A full acceptance test procedure for the FCU typically take three days, however it was decided to perform a simplified test procedure. The FCU was tested to the basic test plan outlined by test procedures TE-5200 and TE-5300 (See Appendix I).

The start fuel flow was too high and adjustment screws # 32 and # 40 had to be turned several flats in the counterclockwise direction to reduce the fuel flow into the acceptable checkered area on the graph. LOM engineers stated that it was not unusual to have the start fuel flow out of adjustment considering the age of the FCU.

The Ivchenko AI-25TL engine has an unusual feature in that it measures the fuel pressure of the metered fuel: that is the pressure between the FCU and fuel nozzles. The typical maximum metered fuel delivery pressure for a normally operating engine to produce maximum approved thrust is 48 to 50 atmospheres of pressure[6]. A review of the aircraft manual engine field adjustment worksheet values revealed that the absolute maximum fuel pressure for takeoff conditions is 65 atm. According to the consulted L39 specialists, any fuel pressure over 55 atm. for the engine to produce approved thrust is

[6] One atmosphere (atm) is 101.325 kPa or 14.7 psi.

cause for further maintenance investigation. A gauge on the pilot's instrument panel displays the engine metered fuel delivery pressure (Figure 6) and clearly has a redline at 65 atm.

The maximum fuel delivery pressure measured for the event FCU was 85 atm. Screw number 28 had to be adjusted by several turns in the counterclockwise direction to bring the fuel delivery pressure back to 50 atm., indicating that there was no internal fault with the FCU but rather it had been purposely adjusted to 85 atm. fuel pressure.

Figure 6 – Exemplar 3-in-1 Gauge in Cockpit – Note Fuel Pressure Redline of 65 Atmospheres

After the FCU tests were completed, the FCU was partially disassembled so that critical internal elastomeric membranes and seals could be inspected. The covers of two membranes and one fuel pressure shuttle valve were removed and the components inspected (Photo 43). The elastomeric membranes were all still flexible and had retained their original rubber-like softness. The part markings, which were still visible, indicated that they were manufactured in July 1990 and that they were likely the original parts (Photo 44). One membrane displayed two small half inch long crusty deposits of corrosion most likely from aluminum housing. The main shuttle valve elastomeric sliding seal lip was slightly worn, which is consistent with normal wear (Photo 45).

D.4.3 Fuel Nozzles

The Ivchenko AI-25TL turbofan engine, features an axially oriented single annulus type combustor, into which the fuel is fed by 12 FNs, all supplied by a single manifold. During the engine examination in May 3 to 6, 2016, at Plain Parts in Pleasant Grove, California the FNs were sequentially numbered in a counterclockwise manner with number 1 chosen to be at the 11:30 location.

Inspection of the FN assemblies at the LOM Praha facilities revealed black, sooty deposits on the nozzle tips and shrouds. Prior to testing, the FNs, were cleaned in a solvent bath overnight to remove the soot. They were then tested in a factory-specialized apparatus (Photo 46).

The testing consisted of supplying a test fluid to each FN with at a delivery pressure of 2.3 Megapascals[7] (333.58 psig) and measuring the flow rate, spray angle and spray pattern consistency (or streakiness). The FN flow rate is determined by measuring the quantity of fuel that is collected after a 30 second spray interval. The spray angle is measured by observing an optical viewer on the apparatus which contains a protractor (Photo 47). The spray pattern consistency is measured using a 12-segment collector within the cone of the spray which separates the flow into 12 distinct zones (Photo 48). The flow of fuel that is collected from each zone is sent to separate calibrated cylinders and after 30 seconds, the quantity in each cylinder is measured and compared to the others. A fuel nozzle with an even spray pattern would be expected to deposit the same amount of fuel in each of the 12 zones. A deteriorated or 'streaky' fuel nozzle would deposit different amounts of fuel in the 12 cylinders. The spray pattern consistency value is a statistical calculation made by the operator and recorded on the test sheet. (See Appendix II for individual FN test results and Table 2 for the summary of FN findings.

LOM stated that when new or overhauled, FNs are adjusted to one of three classes of flow: The flow rates per class are:

Class I – 1,255 to 1,265 Liter/minute (L/min)
Class II – 1,265 to 1,280 L/min
Class III – 1,280 to 1,290 L/min

LOM could not explain the need for classes of nozzles since they are vendors of components and not the engine manufacturer. It was noted that the flow rate of all the tested FNs were between 1,037 L/min and 1,250 L/min, all below the Class I rating.

Nozzle class is not marked on the actual nozzle body, but rather on the mounting plate of each nozzle. These two parts must always be retained together. A conflict was noted with the Class rating marks on each tested FN. All the mounting plates of the tested nozzles were marked as Class III (Photo 49). LOM could not explain this discrepancy.

[7] Megapascals (MPa). A pascal (symbol: Pa) is an International System of Units (SI) derived unit of pressure used to quantify internal pressure and is defined as one newton per square metre.

Nozzle No.	Spray Angle	Flow Rate (Class I) *	Spray Pattern Variance
Acceptable Values	80° – 90°	1,255 – 1,265 liters/minute	20% Maximum
1	85°	1,250 L/min	53%
2	85°	1,224 L/min	48%
3	80°	1,147 L/min	97%
4	81°	1,156 L/min	70%
5	80°	1,185 L/min	65%
6	78°	1,180 L/min	60%
7	80°	1,068 L/min	73%
8	75°	1,234 L/min	80%
9	75°	1,084 L/min	86%
10	70°	1,074 L/min	76%
11	73°	1,079 L/min	83%
12	75°	1,037 L/min	67%
* Flow rate for nozzle with constant pressure of 2.3 MPa (333.58 psi)			

Table 2 – Fuel Nozzle Flow Characteristics Summary

All FNs failed the factory functional test procedure, would have been rejected for continued use and required overhaul.

A record of the locations of the fuel nozzles was made during their removal at the Plain Parts facility in Pleasant Grove, California and their performance was overlaid on a sketch of the combustor in Figure 7.

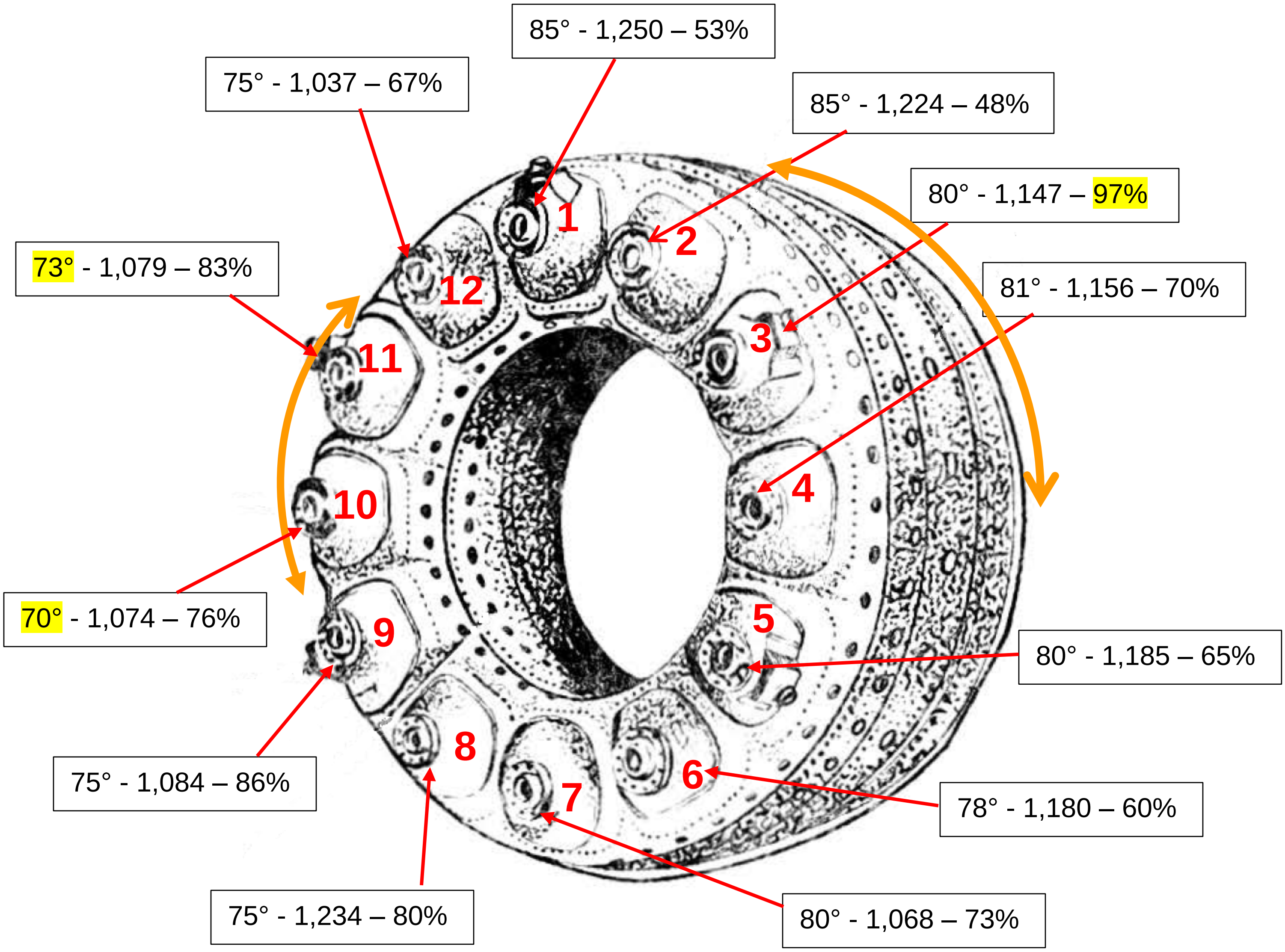


Figure 7 – Combustor with Fuel Nozzles Performance and Maximum Damage to 2nd Stage LP Nozzle Overlaid (Orange Arcs)

(Note: FLA)

The upstream nozzle locations were overlaid on a photo of the 3rd stage (or 2nd stage LP) nozzle, (Ref. Photo 33 taken during the engine examination at the Plain Parts facility in Pleasant Grove, California) which revealed a circumferentially varying heat distress damage pattern, highlighted on Figure 8. Each star marking represents a fuel nozzle location and referenced FN number. The two orange arcs highlight the areas of greatest thermal distress on the 3rd Stage (or 2nd stage LP) nozzle vanes.

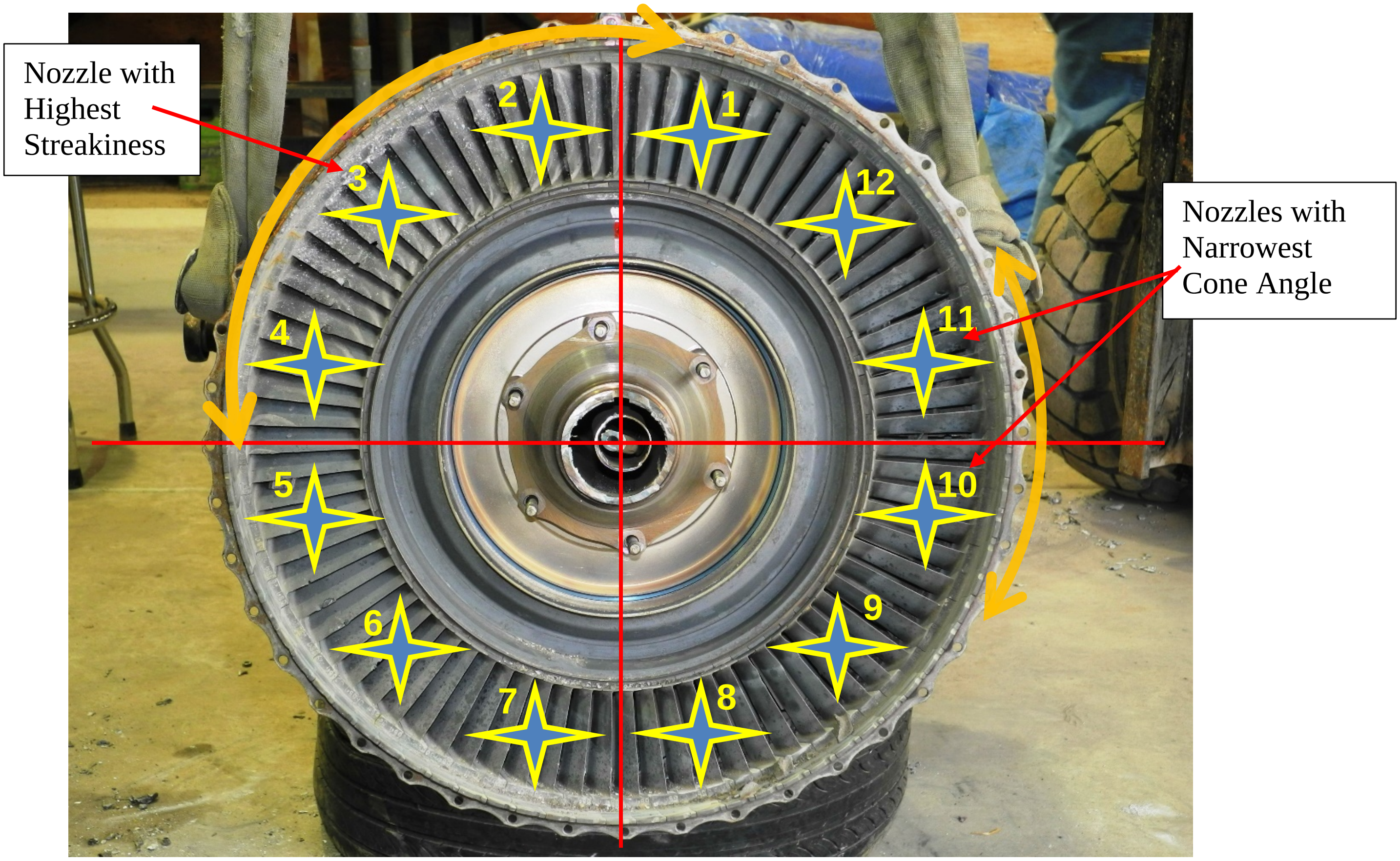


Figure 8 – Fuel Nozzle Locations Overlaid on Damaged 3rd stage (2nd Stage LP) Nozzle (Note: ALF)

It was noted that FN No. 3 had the highest spray pattern variance or streakiness (97%), matching the location of the thermal distress between 9:00 and 12:30 o'clock on the 2nd stage LP nozzle. Additionally, FNs No.10 & 11 had the narrowest spray cone angle (70° & 73° respectively), matching the location of the 2:00 and 4:00 o'clock on the 3rd stage (or 2nd stage LP) nozzle.

The condition of the FNs significantly affects all the components in the downstream gas path, such as the combustor (See Combustor D.3.5), HP nozzle and turbine, and LP nozzles and turbines. Streakiness and general flow unevenness of the FNs manifest themselves by producing uneven combustion and high local temperatures. A streaky nozzle will spray a sharp streak of fuel into the combustion chamber, rather than a fine mist and will delay the complete combustion of the fuel, causing the heat profile of the flame to migrate aft in the flowpath, increasing the heat to the 2nd and 3rd stage turbines. See (Combustor D.3.5) for a more complete description and illustrations. The temperature unevenness around the circumference of a turbine nozzle causes the turbine blades to encounter highly variable conditions as they rotate through the disturbed airflow, causing fore and aft load variations on individual blades, leading to one-per-revolution vibrations, which is detrimental to the fatigue life of the blades. Hot streaks also thermally shock the blades and lead to blade overtemperature.

The damage noted on the 2nd and 3rd stage nozzles and turbines is consistent with overtemperature condition caused by a disturbed combustion process in the combustor due to poor fuel atomization by the fuel nozzles.

D.4.4 Fuel Pump

The FP was intact and externally undamaged. In the in-situ condition, the FP was coated with drippings of solidified molten aluminum as well as light white powdery deposit. When removed from the AGB, the input drive splines were observed to be intact and undamaged. With the fuel line connections removed, the internal surfaces were observed to be fuel wetted.

The FP was P/N 4000 and S/N 11510105. Inspection of the FP at the LOM Praha facilities revealed a clean fuel filter, which was reinstalled. The FP was cleaned externally before it was placed into the test stand (Photo 50). It passed the factory acceptance test procedure.

D.4.5 Thermocouples (TC)

The AI-25TL engine has four thermocouples (TC) in the exhaust duct (Photo 8) that measure the exhaust gas temperature. Each TC unit contains two separate and independent sensors. The sensors are in two different axial locations along the length of the probe and each is a separate temperature sensing circuit. The two different axial positions allow for the measurement of the exhaust gas at different radial positions in the exhaust stream, for a more accurate or stabilized reading.

The four TCs were removed from the engine and shipped to LOM facilities in Prague, Czech Republic for testing. All four TCs were Termočlánek T-99 units with S/Ns 0761152, 1284825, 1233422, and 0963029 (Photo 51). Visual examination revealed that one TC was bent near the tip. They were tested in a factory test apparatus and the results are summarized on Table 3 - Thermocouple Isolation Resistance Results.

Number	Serial Number	Isolation Resistance Sensor 1	Isolation Resistance Sensor 2
1	0761152	100 K Ohm	70 K Ohm
2	1284825	1.5 M Ohm	20 Ohm
3	1233422	5 K Ohm	3 M Ohm
4	0963029	150 Ohm	32 K Ohm

Table 3 - Thermocouple Isolation Resistance Results

TCs Nos. 2 and 4 have at least one failed sensor, both marked in red. Those probes with resistance in the K Ohm range are suspect and are marked in yellow. Only TCs Nos. 2 and 3 had one acceptable sensor in each unit.

One important measurement of the health of a TC is the isolation property of each sensor. This is measurement of the electrical resistance between the internal probe and the housing when the probe is hot. It measures the condition of the insulation material within the assembly. As a probe ages, the insulation begins to deteriorate. If the resistance is low, then an incorrect temperature signal, usually, too low, will be sent to the cockpit, giving the pilot an incorrect indication of the performance of the engine.

Another deterioration problem with a turbine engine TC system is that the probes in the hotter section of the gas flow tend to burn out quicker than those in the cooler sections. Because the TC electrical system measures the average temperature of all the TCs, if a thermocouple in the hot zone fails then the temperature indicated to the pilot will go down, giving him the false indication that the engine is performing cooler than it really is.

D.4.6 Air Turbine Starter

The air turbine starter was intact and externally undamaged. When removed from the AGB, the input drive clutch was observed to be intact and undamaged. When turned by hand, the step-down gearbox and air turbine could be heard to rotate.

D.4.7 Generator

The generator was intact and still attached to the AGB. It was externally coated with a white powdery deposit. The electrical connector plug was still attached, however the insulation on the wires were burned away. When removed from the AGB, the input drive splines were observed to be intact and undamaged. The cooling fan housing inlet was melted.

D.4.8 Hydraulic pump

The hydraulic pump was removed from the AGB, revealing and intact input spline. It was not examined further.

D.4.9 Fuel – Oil Cooler (FOC)

The FOC was intact and externally undamaged. When the oil fittings were disconnected, oil was seen to drain from the unit. It was not examined further.

D.4.10 Oil Pump

The oil pump was intact and undamaged.

D.4.11 Oil Tank

The oil tank was missing and could not be examined.

D.4.12 Oil Chip Detector / Magnetic Plug

The oil chip detector / magnetic plug was removed and examined, revealing a very small amount of fine magnetic particles.

D.5 FAA Guidance and Owner Airworthiness Documentation

D.5.1 FAA Guidance

D.5.1.1 Advisory Circular AC43-209 – L39 Albatross Military Jet Recommended Inspection Program

This Advisory Circular (AC) 43-209 was released in October 2003 and was written to provide a recommended inspection program for owners of L-39 Albatross aircraft operating under an Experimental Exhibition Special Airworthiness Certificate. It was cancelled on April 12, 2013 and replaced with AC43-209A.

D.5.1.2 AC43-209A – Recommended Inspection Procedures for Military Aircraft

The stated purpose of this AC is: "This AC is for the development of inspection program requirements for the certification of former military aircraft in the experimental category for the purpose(s) of exhibition and air racing that operate in the United States in accordance with Title 14 of the Federal Code of Regulations (14 CFR) part 21, § 21.191(d) and (e). This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, for developing inspection program requirements for former military aircraft."

It gives broad guidelines for the inspection, storage and certification of all ex-military aircraft and is not specific to the L39 aircraft type.

The document put the onus onto the owner/operator of the aircraft to submit inspection program documentation to the FAA that is based on the manufacturer or military service maintenance requirements of the particular aircraft type.

D.5.1.3 Owner Maintenance Program

The owners' FAA-approved 'Maintenance Program L-39C' for airplane serial number 332703, N39AY (MP) was originally approved on July 11, 2002 and the first revision was approved on December 17, 2014. Book 3, section 10 pertains to the AI-25 TL engine. The engine is listed under the 'Life Limited Items' and requires a 'Condition Inspection' at 1,500 and 3,000 hours and must be overhauled at 4,000 hours. A Spectrometric Oil Analysis Program (S.O.A.P.) is required every 50 hours of flight or 6 calendar months, whichever comes first.

The engine 'Condition Inspection' consists of the standard factory prescribed engine run-up performance test and inspection, which according to the Motor Sich Engine Manual, should occur at 100-hour intervals. The Condition Inspection frequency is 15 times this value.

The MP also requires a "Bore Slope (sic) [Borescope] inspection through the ignitor holes". No other details are specified, and no engine manual references are made.

A review of the Motor Sich Engine Manual, Chapter 5.27 – entitled INSPECTION OF COMBUSTION CHAMBER, FACES OF MAIN FUEL NOZZLES VANES AND HOUSING OF NGV ASSEMBLY, HP TURBINE ROTOR BLADES, reveals that the manufactured recommends a borescope inspection of the hot section, which includes a close examination of the fuel nozzle condition at intervals of 100 hours.

D.6 Findings

The 2nd stage turbine blades failed in overload, consistent with an overtemperature condition.

A bench test of the FCU revealed that the maximum metered fuel pressure was adjusted to 85 atm., which is above the maximum allowable value of 65 atm. The FCU could be adjusted back to the original 50 atm. pressure, confirming that there was no internal FCU malfunction.

Examination of the 2nd and 3rd stage turbine nozzles revealed localized overtemperature conditions within the airflow annulus.

The fuel nozzles were significantly deteriorated, the flow rate and spray patterns were below acceptable values, increasing the likelihood of an uneven flame pattern within the combustor. A fuel nozzle test would have been rejected all nozzles for further service.

The pattern of thermal degradation on the 2nd and 3rd stage turbine nozzle matched the placement of the most deteriorated fuel nozzles.

The fuel nozzle head assemblies were partially blocked with carbon, increasing the likelihood of an uneven flame pattern within the combustor and consistent with the observed overtemperature condition in the 2nd and 3rd stage turbines.

Despite the significantly deteriorated condition of the fuel nozzles, it is unlikely that a borescopic inspection would have identified this. A spray pattern analysis on a test stand can give a true condition of the fuel nozzles.

A borescope inspection of the head assemblies, which had accumulated some carbon deposits may have rejected the components and required corrective action such as a wash procedure or an overhaul of the fuel nozzles. The effect of carbon deposits on the fuel nozzles is a phenomenon known in military applications however; it is a lesser known phenomenon in the North American tribal knowledge database.

Two thermocouples had failed, increasing the likelihood of an incorrect cooler-than-actual temperature reading in the cockpit.

The combustor and turbine borescope inspection interval of 1,500 hours in the approved Aero L-39ZA Albatros Maintenance Inspection Program was 15 times that required on the Motor Sich Engine Manual (at 100 hours). Further, the owner's inspection program did not require inspection of the fuel nozzles or fuel nozzle head assemblies during the borescope inspection.

Harald Reichel
Aerospace Engineer – Powerplants

Photo 1

Ivchenko AI-25TL, S/N 7082521100033 – As Stored

Photo 2

Right Side (As Installed) of Engine

Photo 3

Left Side (Orientation is as Installed) of Engine

Photo 4

Solidified Material Indicative of Post-Accident Engine Orientation

Photo 5

Front View - LP Compressor Inlet Guide Vane Assembly

Photo 6

Bypass Duct Housing Outer and Inner Ducts

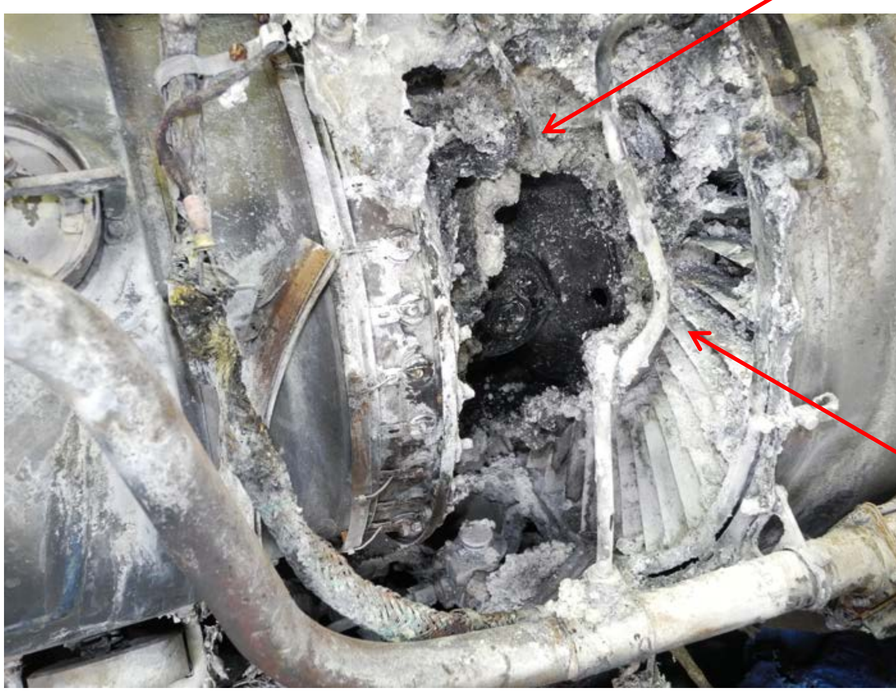
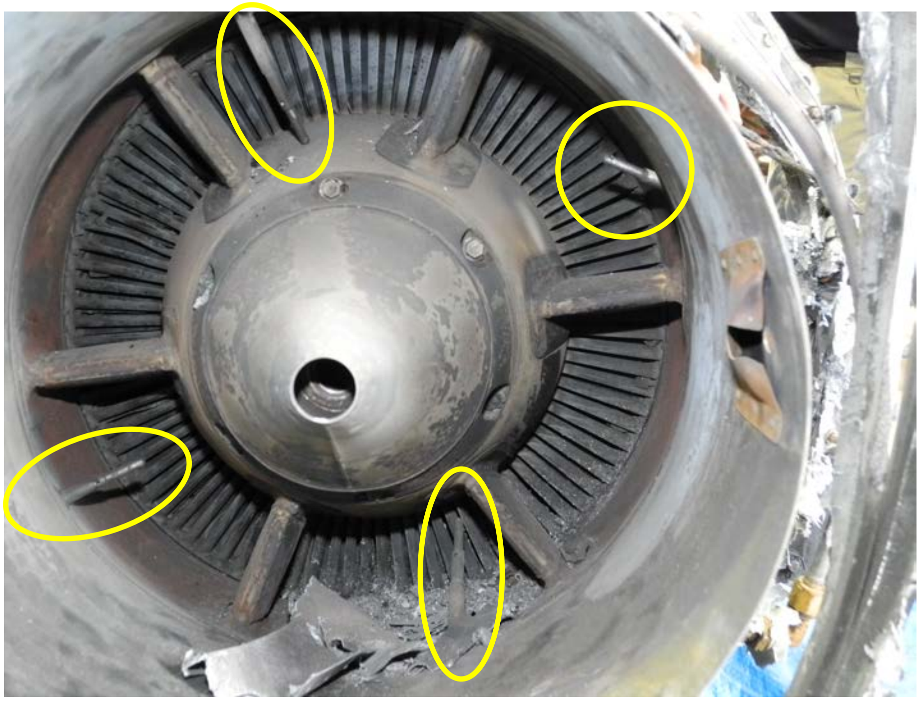


Photo 7

HP Compressor, Combustor & Turbine Housings and Exhaust Pipe

Photo 8

Aft View: 2nd Stage LP Turbine, Rear Bearing Housing



Yellow Circles Indicate Exhaust Gas Thermocouples

Photo 9

Fractured Blade Tip Segments Found in Exhaust Duct

Photo 10

1st Stage HP Variable Guide Vane (VGV) Assembly

Photo 11

Variable Guide Vane (VGV) Actuator Assembly

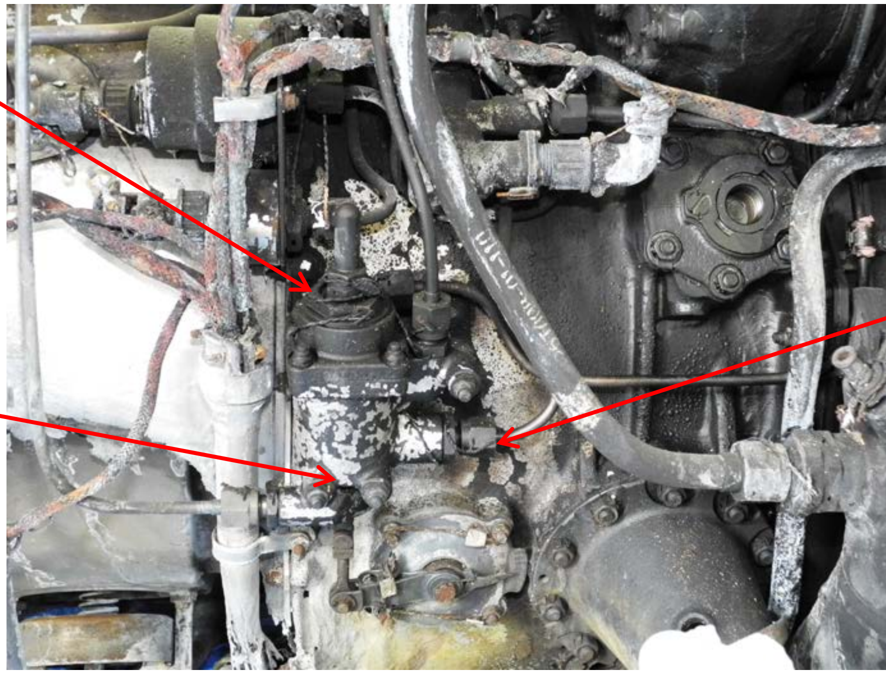


Photo 12

VGV Angular Position Indicator

Photo 13

Bleed-Air Valve (Typical)

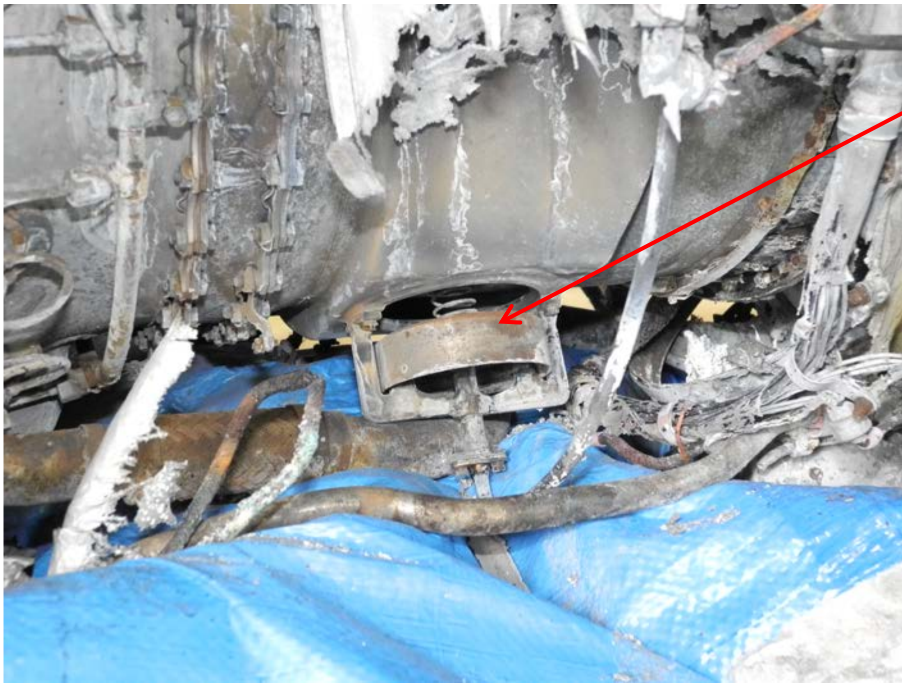


Photo 14

HP Compressor (Housing and Plenum Cut)

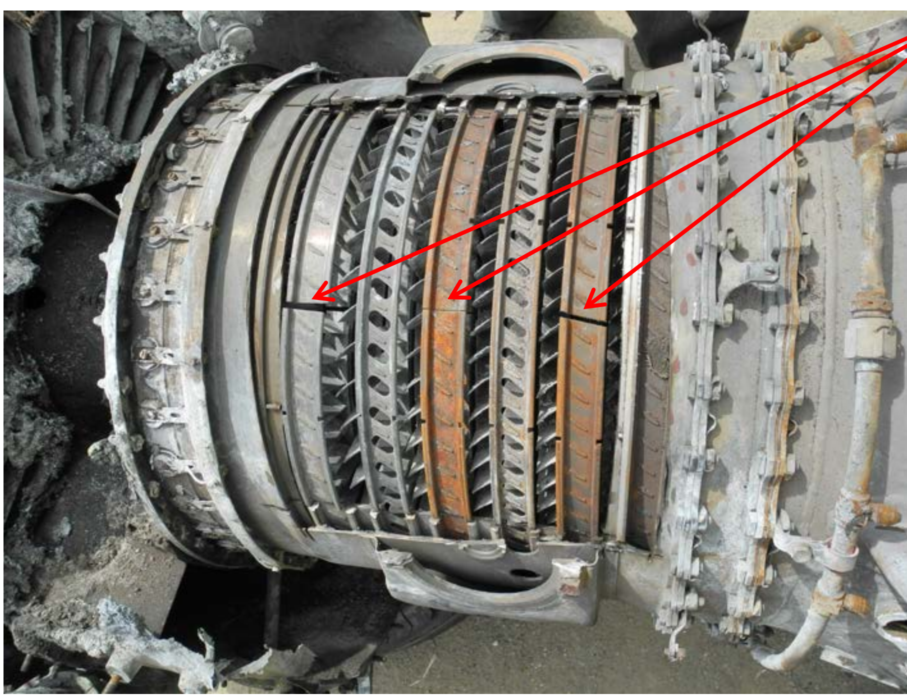


Photo 15

Combustor Housing & Fuel Nozzle Assembly

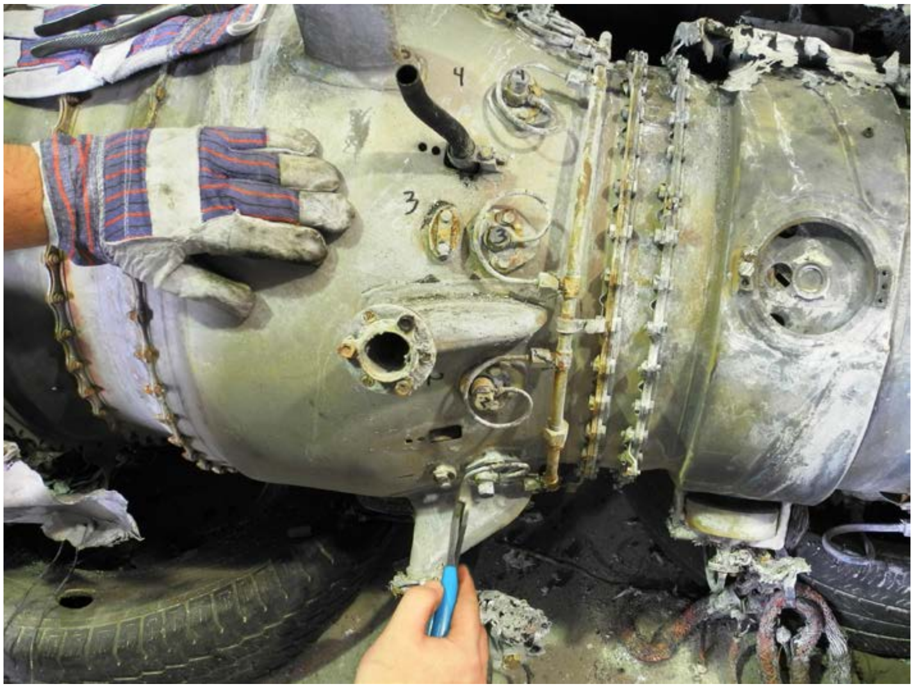


Photo 16

Fuel Nozzles – Numbered and Removed

Photo 17

Fuel Nozzle – Carbon Deposits

Photo 18

Removal of Combustor Housing – Exposing Combustor

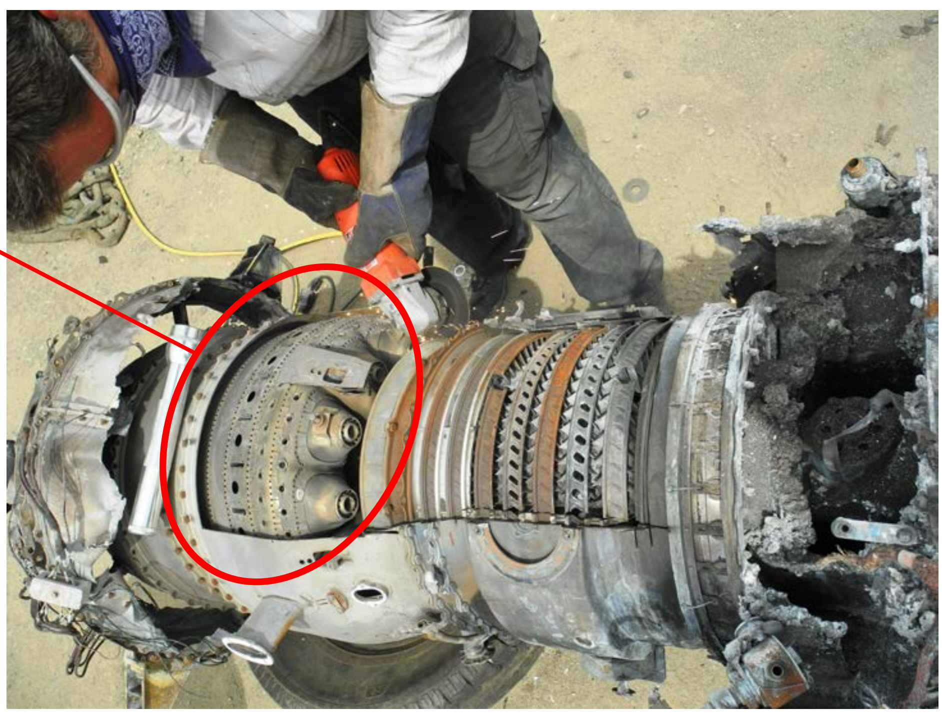


Photo 19

Fuel Nozzle Head Assemblies – Carbon Deposits & Restricted Cooling Holes

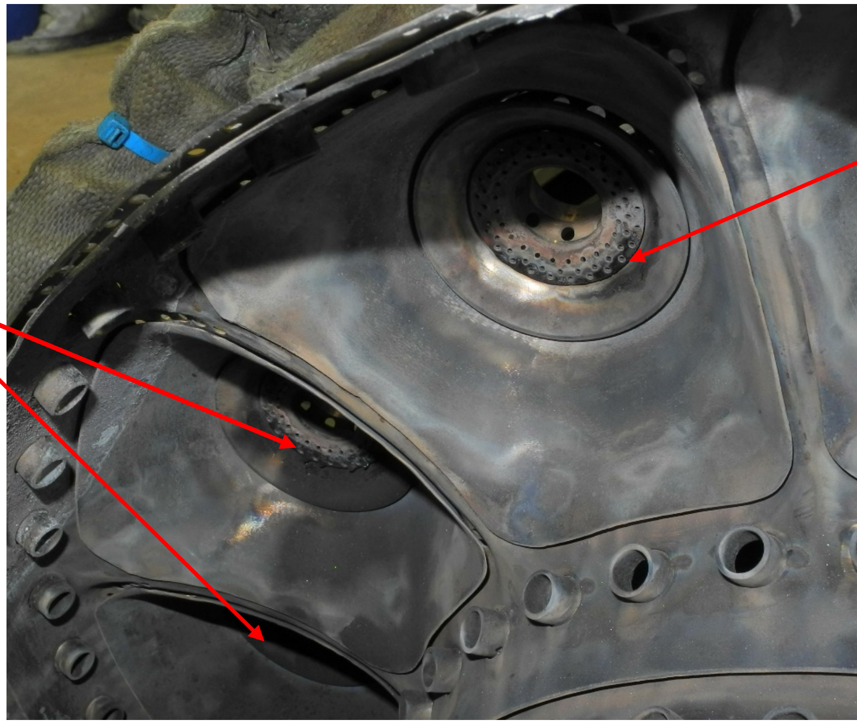


Photo 20

1st Stage (High-Pressure) Turbine Nozzle

Photo 21

1st Stage (High Pressure) Turbine Nozzle - Detail

Photo 22

Details of Eroded HP Turbine Nozzle Vane Trailing Edge

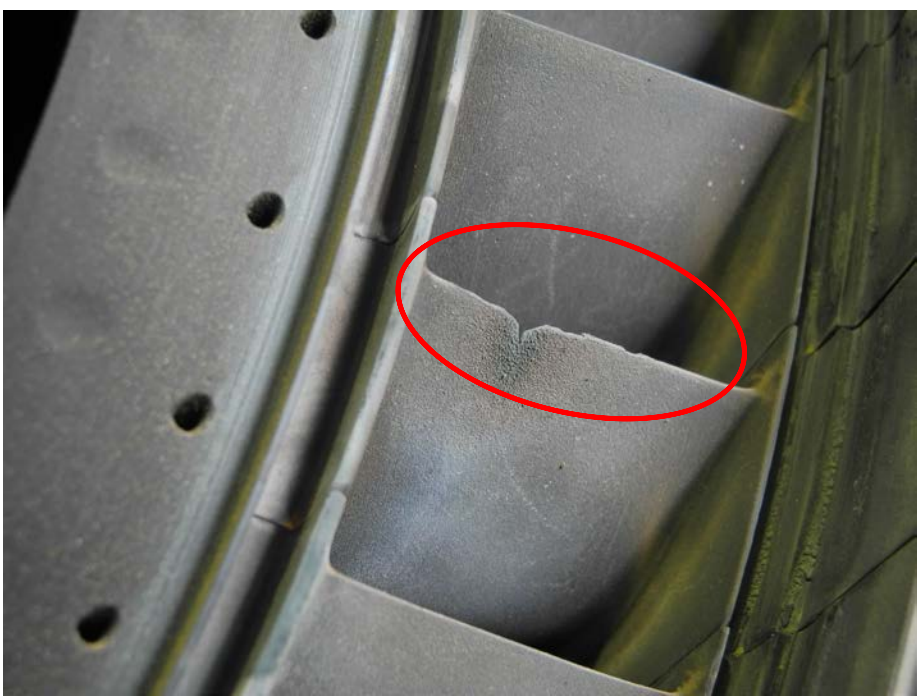


Photo 23

1st Stage (High Pressure) Turbine – Aft View

Photo 24

HP Turbine Blades – Concave Side Trailing Edge Rippling

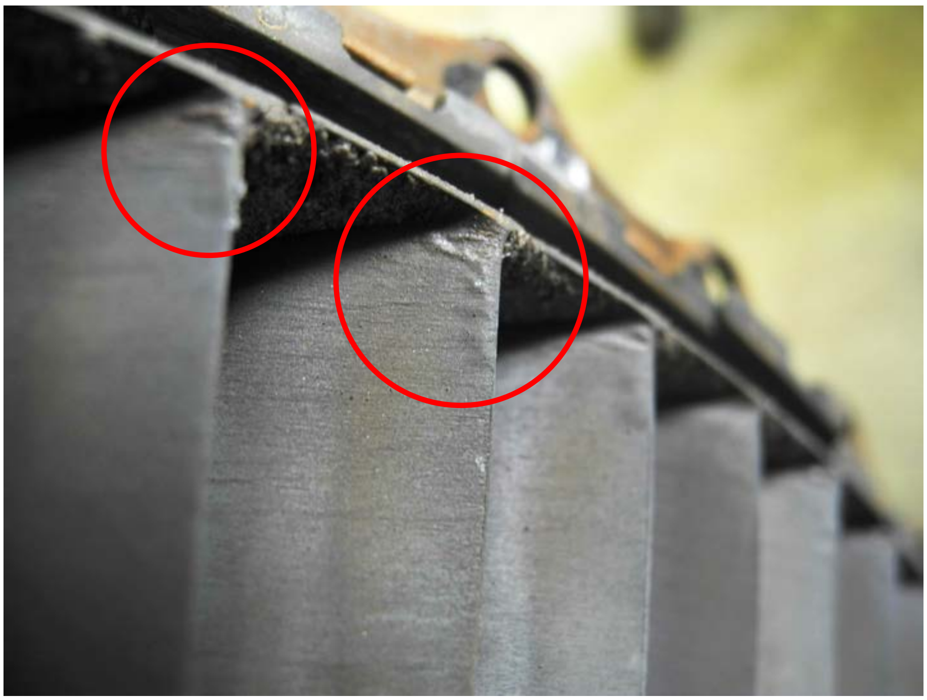


Photo 25

HP Turbine Blades - Concave Side Trailing Edge Rippling

Photo 26

HP Turbine - Details of Streaking Marks

Photo 27

2nd Stage (1st Stage LP) Turbine Nozzle – In Situ - Aft View

Photo 28

2nd Stage (1st Stage LP) Turbine Nozzle – Trailing Edge Fracture Details

Photo 29

2nd stage (1st Stage LP) Turbine Nozzle – Surface Rippling Details

Photo 30

2nd Stage (1st Stage LP) Turbine – In Situ – ALF

Photo 31

2nd Stage (1st Stage LP) Turbine – Rippled Pattern Near Mid-Span

Photo 32

2nd Stage (1st Stage LP) Turbine - Fractured Tip Shroud Debris

Photo 33

3rd Stage (2nd Stage LP) Turbine Nozzle – In Situ - Aft View

12 o'clock location of engine

Note discolored pattern and greater heat distortion from 9:00 to 12:30 and 2:00 to 4:00 o'clock positions. Highlighted as Orange Arcs.

Photo 34

3rd Stage (2nd Stage LP) Turbine Nozzle – 8:30 to 1:00 O'clock

12 o'clock location of engine

Photo 35

3rd Stage (2nd Stage LP) Turbine Nozzle – Fracture Details

Photo 36

3rd Stage (or 2nd Stage LP) Turbine – In Situ – Aft View

Photo 37

Rear LP Rotor Roller Bearing - Undamaged

Photo 38

Accessory Gearbox – Aft View - Splines Undamaged.

Photo 39

Accessory Gearbox - Front View - Splines Undamaged

Photo 40

Accessory Gearbox - Lower Access Panel Removed

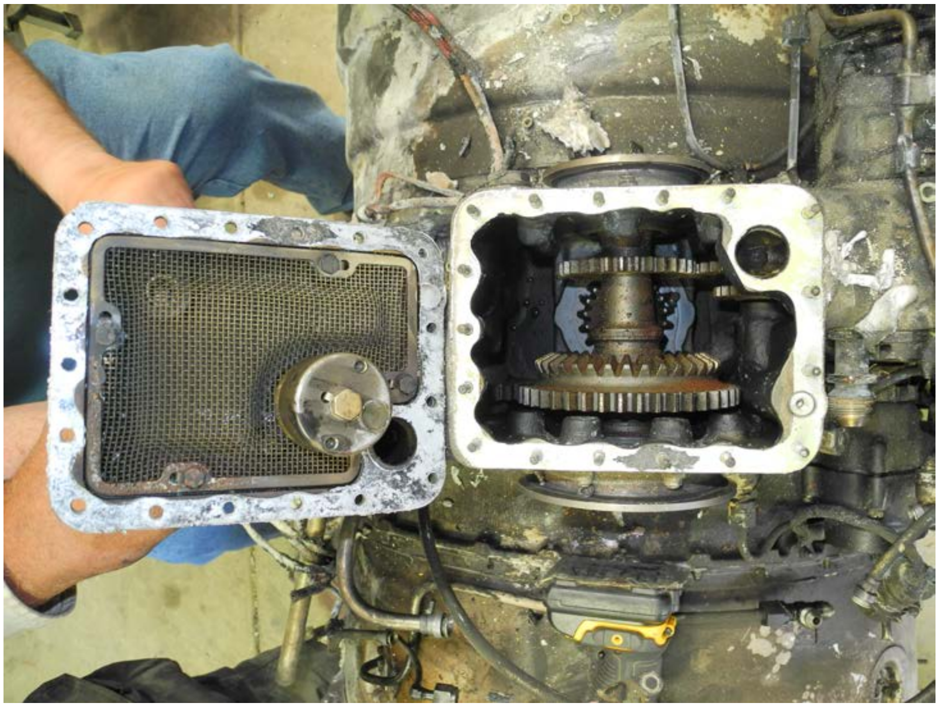


Photo 41

Fuel Control Unit with Recovered Fuel

Photo 42

FCU Test Rig

Photo 43

FCU Membrane Cover Removed

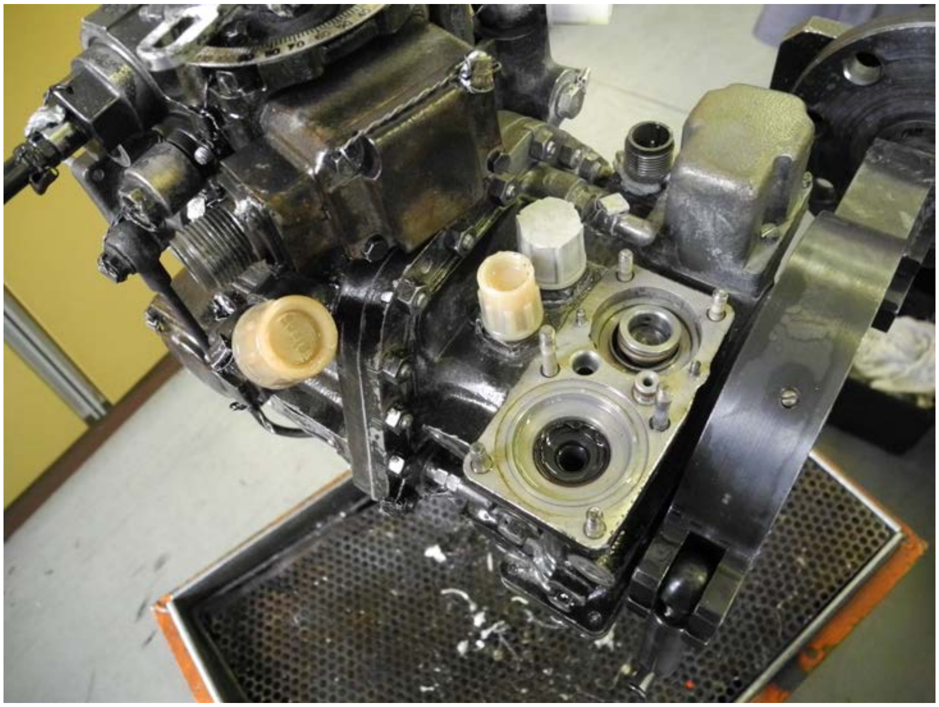


Photo 44

Membrane with Manufacture Date of July 1990 – Undamaged

Photo 45

Shuttle Valve – Slightly Worn Sliding Seal

Photo 46

Specialized Factory Fuel Nozzle Testing Apparatus

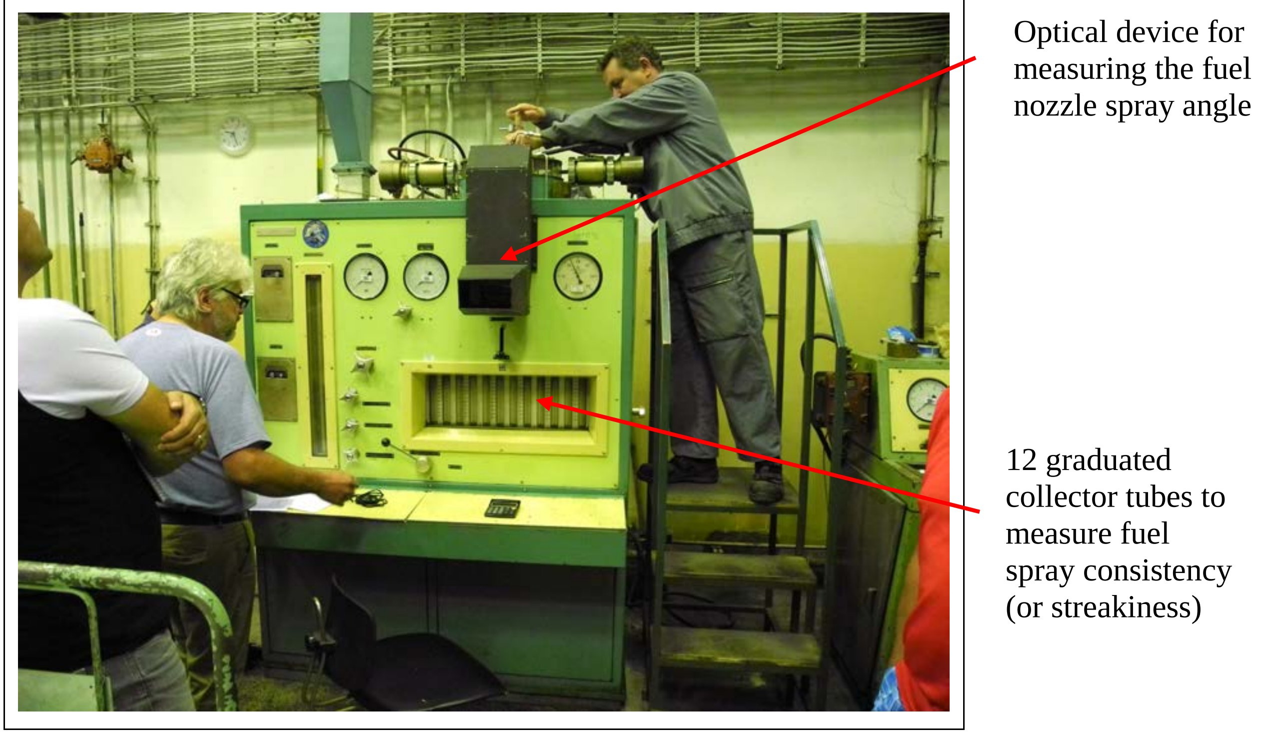


Photo 47

Device to Measure Fuel Spray Cone Angle

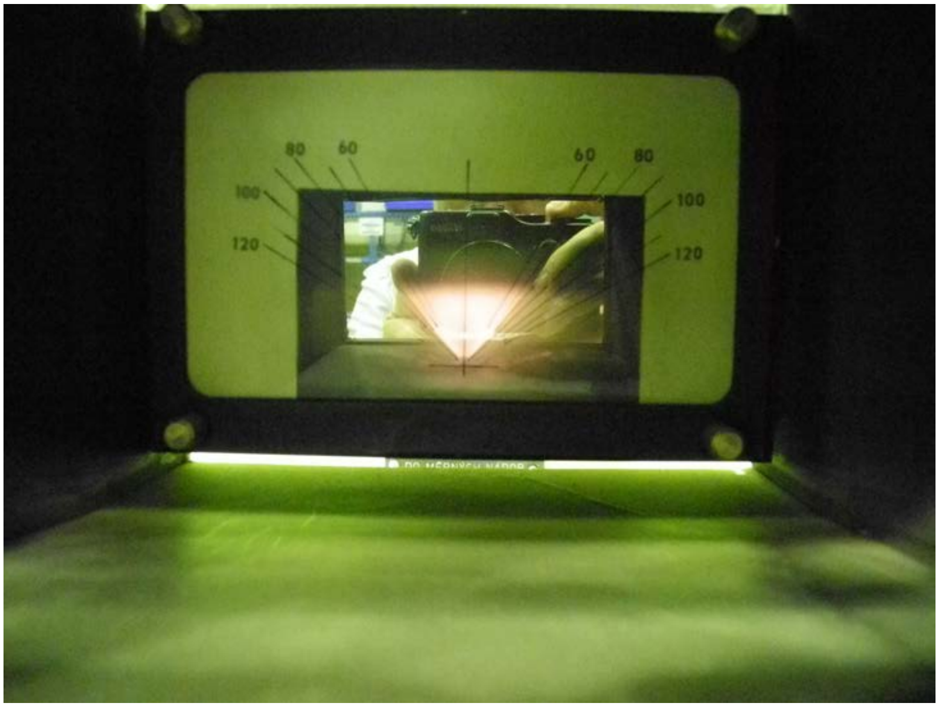
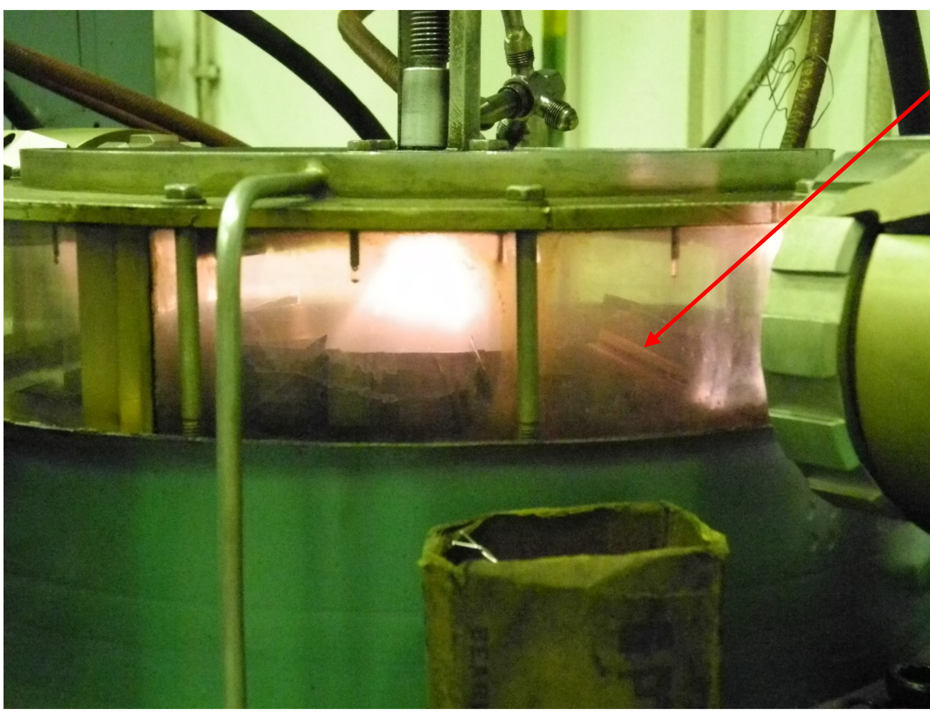


Photo 48

12-Segment Fuel Collectors Beneath Glass Cover



Spray Cone
Zone Collector

Photo 49

Fuel Nozzle Mounting Plate w3ith Class III Indications

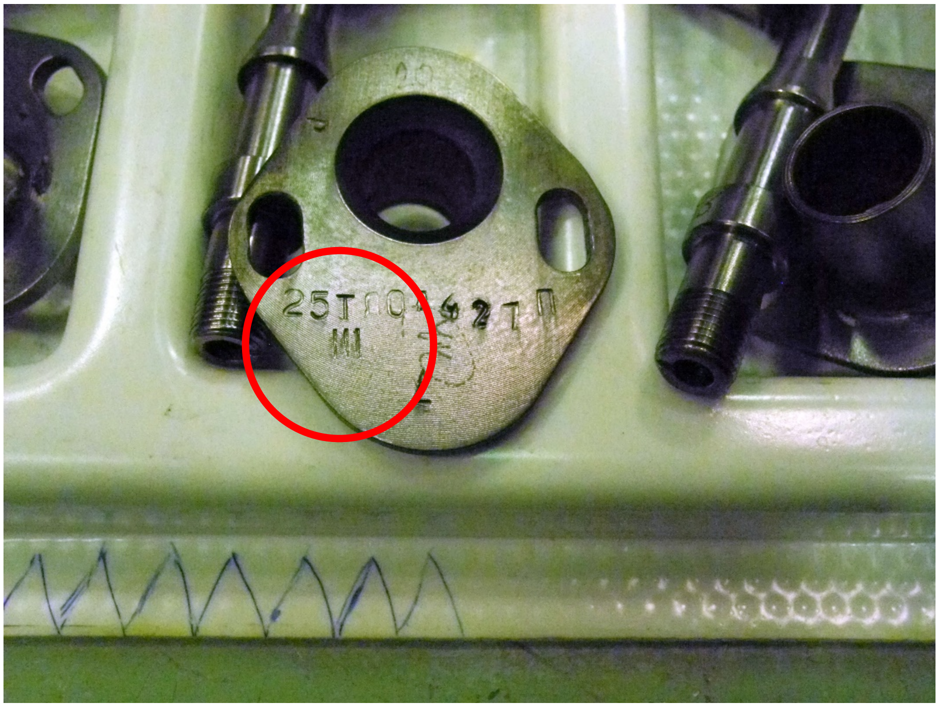


Photo 50

Fuel Pump in Test apparatus

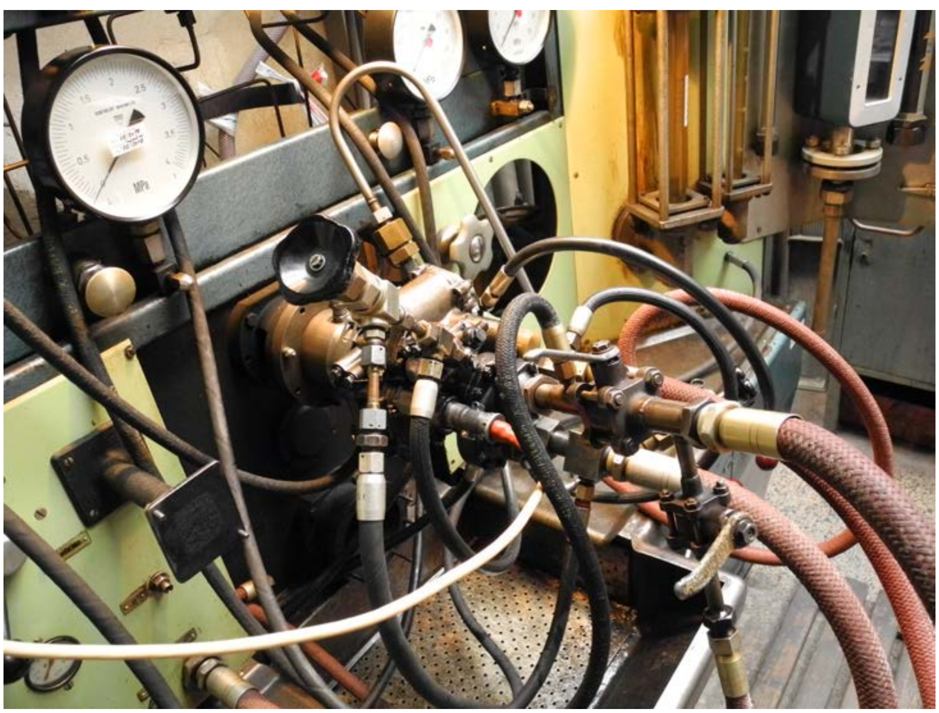


Photo 51

Thermocouples – At LOM Facilities - Prior to Testing

APPENDIX I

AI - 25TL	PRŮVODNÍ LIST OPRAVY čerpadlo 4001	TE - 5200 list: 16 listů: 17

Čís. zak.:	Čís. agr.:	serie:

S e ř í z e n í

Zkušební zařízení: ZOO-0143 teplota prostředí: 25

Zkušební kapalina: F34 teplota paliva: 23

Není-li určeno jinak, udržovat během seřizování vstupní tlak paliva do odstředivého čerpadla 250±10 kPa (absol.) a tlakový spád mezi čerpadly 60 kPa.

Režim	Kontrola parametru--funkce	Nastavené parametry	Měřené parametry Předeps.	měření	měření
1	Kroutící moment hnací hřídélky		5,4 N maxim.	4,5	
2	Omezování ventilu maximálního tlaku	otáčky 3000 ±20 ot.min.⁻¹ x) škrcením výstupu při poklesu dodávky o 150 lit.hod.⁻¹	8,8+0,5 MPa	8,7	
3	Odstř. čerp. a) výkon	otáčky - 3800 ±20 ot.min.⁻¹ x) a) vstupní tlak 98 ±10 kPa x) b) výstup. tlak 80 kPa minim.	2200 lit.hod.⁻¹ minim.	2300	
	b) výstupní tlak paliva	b) vstupní tlak - 264⁻0,10 kPa el.mag. vent.zastavení 27V průtok paliva zubovým čerpadlem 250+30 lit.hod.⁻¹	260 kPa maxim.	255	
4	Zubové čerpadlo	a) otáčky 850+20 ot.min.⁻¹ výstupní tlak 1 ⁻0,1 MPa	350 lit.hod.⁻¹ minim.	415	
		b) otáčky 3800 +20 ot.min.⁻¹ x) výstupní tlak $6^{+0,1}_{-0,3}$ MPa	1500 lit.hod.⁻¹ minim.	1980	
5	Ventil STS	otáčky - 2000+50 ot.min.⁻¹ výstupní tlak 4± 0,2 MPa otevřít odpouštění z STS	pokles na prst. +300kPa	150	
6	Ventil zastavení	otáčky 2000+50 ot.min.⁻¹ výstupní tlak 4± 0,2 MPa a) el.mag. vent.zastavení 27V ~~b) el.mag. vent. zastavení 18V~~ (A)	pokles na prst. +500kPa	250	
7	Ventil přepínání	otáčky - 2820 ±50 ot.min.⁻¹ x) výstupní tlak 1,6 +0,1 MPa x) a) el.mag. vent.přepnutí 27 V ~~b) el.mag. vent.přepnutí 18 V~~ (A)	zvýšení tlaku po přepnutí maxim. 200 kPa	0	

x) TZ-932 H. [signature] 5.3.99 (A) TZ-4123 H. [signature] 17.8.05 TZ-926 15.1.99 [signature]

Režim	Kontrola parametru-funkce	Nastavené parametry	Měřené parametry		
			Předeps.	měření	měření
8	Spoušt. vent. a) tlak paliva	a) otáčky 320 +15 ot.min.⁻¹ průtok zubovým čerpadlem 50 ±5 lit.hod.⁻¹ el.mag. vent. zastavení 27V	$P_{sp.pal}$ 250+50 kPa	255	
	b) Průtok spoušt.paliva	b) otáčky 840 +40 ot.min.⁻¹ tlak spoušt.paliva 250+50kPa průtok zubovým čerpadlem 200 ±10 lit.hod⁻¹ el.mag.vent. zastavení 27V	Qsp.pal. 21 l/hod. minim.	22	
	c) stabilita průtoku	c) otáčky 300 až 2000 ot.min⁻¹ tlak spoušt.paliva 250+50kPa průtok zubovým čerpadlem 200 ±10 lit.hod.⁻¹ el.mag. vent.zastavení 27V	Qsp.pal. 21 l/hod.	22	
9	Čistota dutin	otáčky 3000 ±50 ot.min.⁻¹ x) výstupní tlak 5,8 ±0,3 kPa x) doba průplachu 7 min.	prosté nečistot	/	
10	Těsnost povrchu a drenáže ucpávek	otáčky 3000± 50 ot.min.⁻¹ výstupní tlak 8,5 kPa	naprostá těsnost	/	

Závady zjištěné při seřízení:

Seřízení provedl: [signature] dne: 7.9. 2017 ÚŘJ:

V ý p r a v a a k o n z e r v a c e

Název úseku	Provedl	Datum
Vnitřní konzervace TE-5200 oper. 200		
Zajištění dle TE-5200 oper. 200		
Vnější konzervace dle TBT-58		

Čerpadlo seřízeno, nakonzervováno a zajištěno dle technologického postupu a odpovídá platným technickým podmínkám.
Vystaveno osvědčení o jakosti.

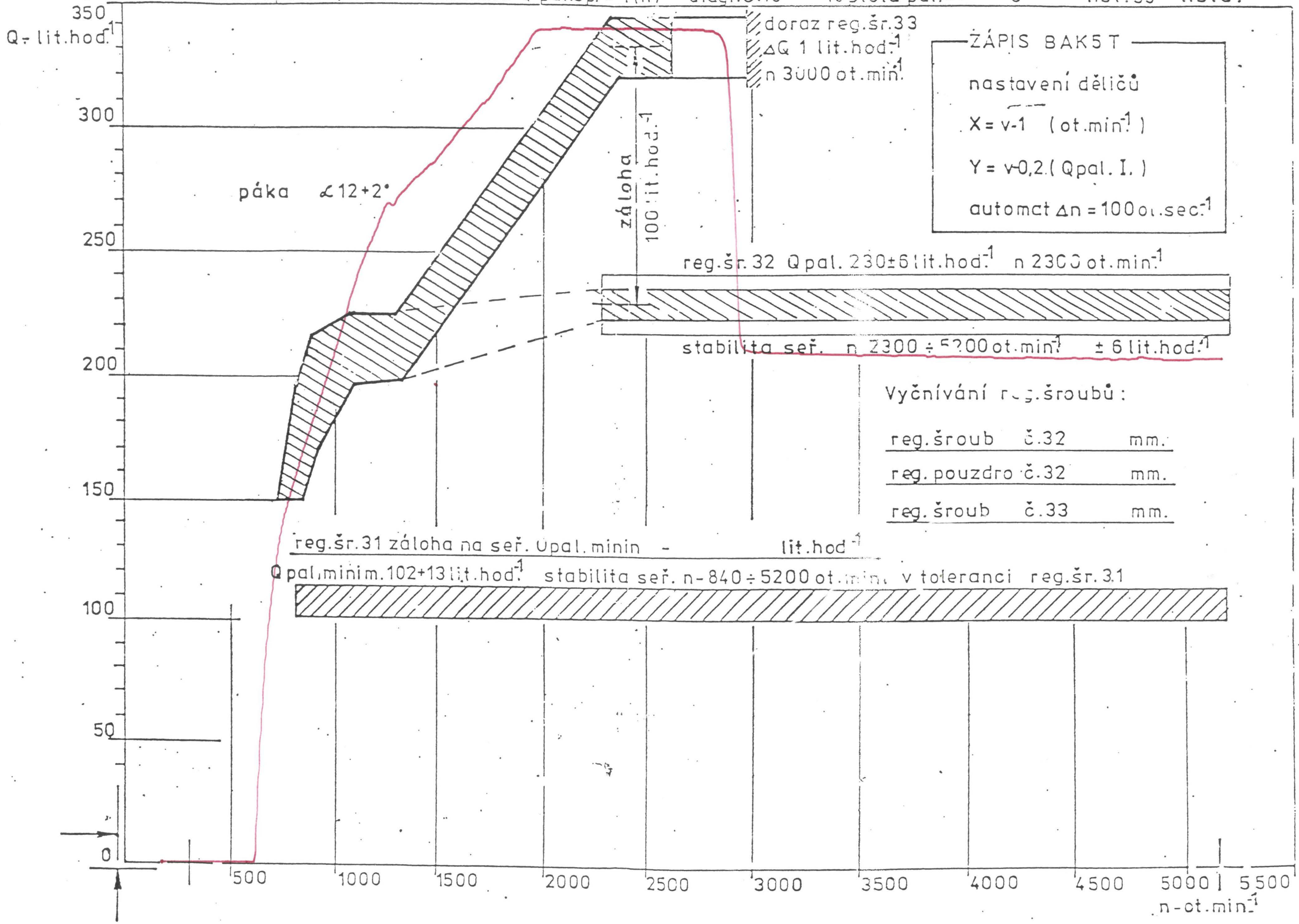
ÚŘJ: dne:

x) TE-932 [signature] 5.3.93

TZ-926 15.1.99. [signature]

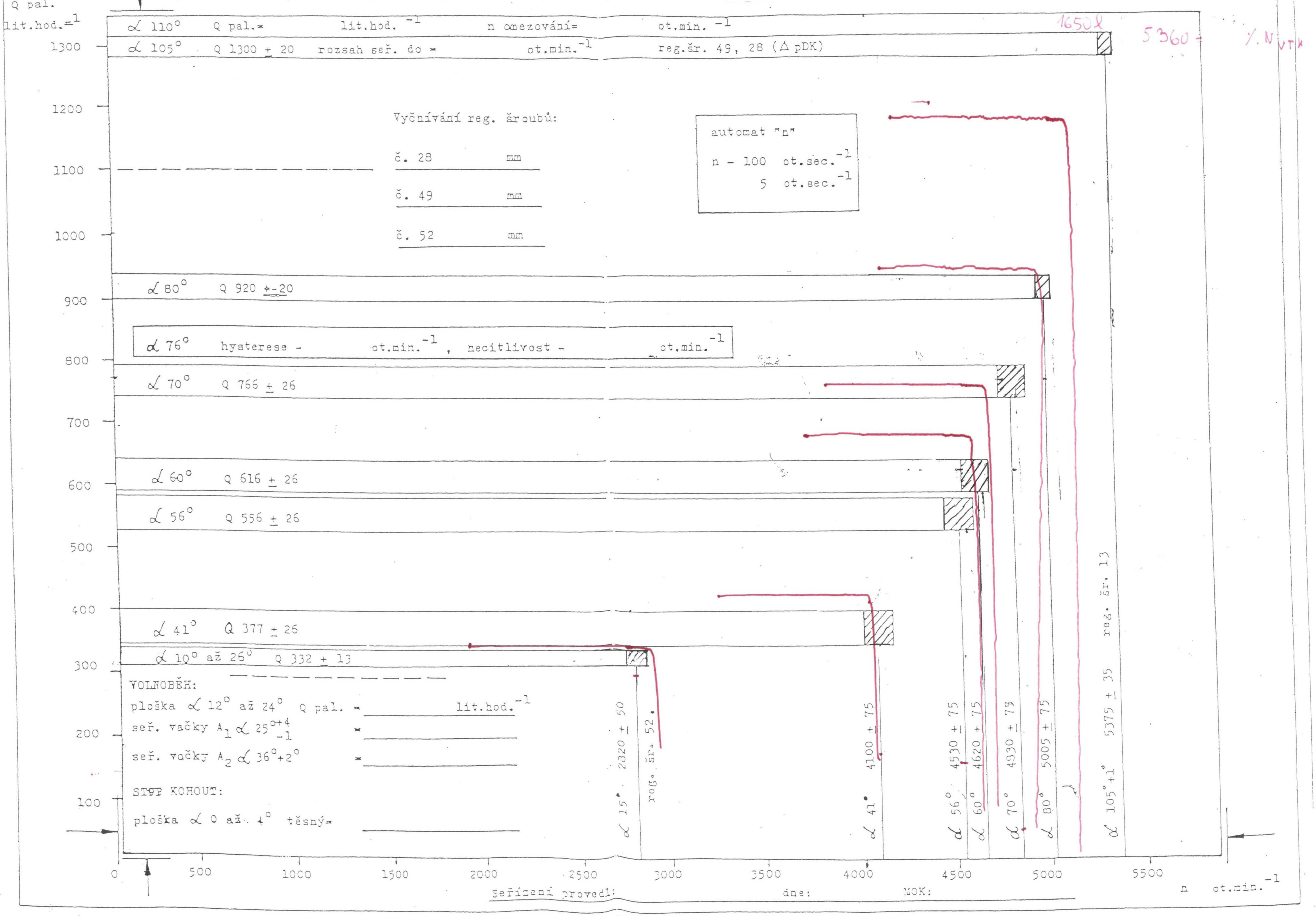
Čís. agr.:

TE 5300 oper. 140 seř. Q minim. a Q pal.sp. = f(n) – diagr. č. 10 teplota pal. = °C list: 53 listů:



Seřízení provedl: dne: MOK:

TE-5300 op.140 Seřízení diagram č.11 Q pal. = f (α), diagram č.13 n=f (α) t pal.= °C List: 54 Listů:



APPENDIX II

FUEL NOZZLE č. 1

LOM PRAHA	Průvodní list opravy AI-25TL pro: Palivová tryska	Č. motoru: Č. agregátu: Zpracoval/dne: Vohánka 18.3.2013	TE – 5400 List: 3 Listů: 4	5

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,250					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	5 %					

č. 1

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:** Vohánka 18.3.2013	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	85°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 2

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: Palivová tryska	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka / 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,224					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	48 %					

č. 2

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** 18.3.2013	**TE – 5400** **List: 4** / **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	85°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 3

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: Palivová tryska	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:Vohánka 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut**.	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,147					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	97 %					

č. 3

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** 18.3.2013	**TE – 5400** **List: 4** / **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	80°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 4

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: **Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** 18.3.2013	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut**.	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,156					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	~~110 %~~ 70 %					

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: **Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** /18.3.2013	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení Б při tlaku **2,3 MPa**	**80° ÷ 90°**	81°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 5

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle Б	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,185					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	65 %					

č. 5

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka/18.3.2013**	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	80°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

Č. 6

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka/18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut**.	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,180					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	60%					

LOM PRAHA	Průvodní list opravy AI-25TL pro: Palivová tryska	Č. motoru: Č. agregátu: Zpracoval/dne: Vohánka 18.3.2013	TE – 5400 List: 4 Listů: 4	5

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení Б při tlaku **2,3 MPa**	**80° ÷ 90°**	78°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 7

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka / 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,068					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	73 %					

č. 7

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** 18.3.2013	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení Б při tlaku **2,3 MPa**	**80° ÷ 90°**	80°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr ØA	**$18_{-0,05}$ mm**						

č. 8

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut**.	----						
120 bod 2 ús.2	Kontrola vůle Б	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,234					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	80 %					

č. 8

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: **Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:** Vohánka / 18.3.2013	**TE – 5400**	**5**
			List: 4 **Listů: 4**	

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	75°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 9

LOM PRAHA	**Průvodní list opravy AI-25TL** pro: **Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka/18.3.2013**	**TE – 5400**	**5**
			List: 3	**Listů: 4**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut**.	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,084					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	86 %					

č. 9

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** /[signature]/ **18.3.2013**	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	75 %					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

č. 10

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:Vohánka** /18.3.2013	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,074					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	76%					

č. 10

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:** Vohánka 18.3.2013	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	70°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						

Č. 11

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne:** Vohánka 18.3.2013	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,079					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	8,3%					

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka 18.3.2013**	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	73°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr ØA	**$18_{-0,05}$ mm**						

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka 18.3.2013**	**TE – 5400** **List: 3** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
120 list 1	Dohotovení svazku trysky	----						
120 bod 2 ús.2	Průplach tělesa trysky tlakem **0,8 až 1 MPa po dobu 5 minut.**	----						
120 bod 2 ús.2	Kontrola vůle **Б**	**2,5 ± 0,2 mm**						
140	**Seřízení a konzervace**	----						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa I.skupina**	**1,255 ÷ 1,265 lit/min.**	1,037					
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa II.skupina**	**1,265 ÷ 1,280 lit/min.**						
140 bod 1 ús.3	Kontrola průtoku trysky při tlaku **2,3 ± 0,01 MPa III.skupina**	**1,280 ÷ 1,290 lit/min.**						
140 bod 2 ús.3	Kontrola nerovnoměrnosti průtoku trysky při tlaku **2,3 MPa**	**max. 20%**	67%					

č. 12

LOM PRAHA	**Průvodní list opravy AI-25TL** **pro: Palivová tryska**	**Č. motoru:** **Č. agregátu:** **Zpracoval/dne: Vohánka** 18.3.2013	**TE – 5400** **List: 4** **Listů: 4**	**5**

Op./úsek	Název operace	Předepsáno	1. montáž			2. montáž		
			zjištěno	mechanik	MOJ	zjištěno	mechanik	MOJ
140 bod 3 ús.3	Kontrola trysky na úhel rozprášení **Б** při tlaku **2,3 MPa**	**80° ÷ 90°**	75°					
140 bod 4 ús.5	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min.1 minuty**	těsný						
140 bod 4 ús.6	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 1,5 minuty**	těsný						
140 bod 4 ús.7	Zkouška trysky na těsnost při tlaku **10 MPa** po dobu **min. 10 s.**	těsný						
140 bod 4 ús.11	Kontrola trysky na průtok a nerovnoměrnost po zkoušce těsnosti.	----						
140 bod 6 ús.2	Pročerpání trysky olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 7 ús.2	Konzervovat trysku olejem při tlaku **100 ÷ 300 kPa** po dobu **20 sec.**	----						
140 bod 8 ús.2	Kontrolovat rozměr **ØA**	**$18_{-0,05}$ mm**						