ORAO
1944

Production and overhaul of turbo jet engines

About us

- Established in 1944
- Number of employees: 410
- Over 100 employees have college or university degrees
- Total workshop area: 14000 m^2
- Location area: 9,7 ha
- Main partners: Pratt & Whitney Canada and WSK Rzeszow Poland
- Over 1000 customers are using the our laboratories' services

Activities

OVERHAUL


- Overhaul of the turbojet engines,
- On condition maintenance,
- Designing and equipping of the overhaul capacities and transfer technologies,
- Repair service using special technologies and process technologies: NDT, electroplating, plasma/HVOF/PVD coatings, shot peening, balancing, testing of assemblies & engines etc.

PRODUCTION


- production of parts and assemblies for the turbojet engines,
- production of special tools,
- production of parts according to requirements for technologies: CNC machining, EDM, EBW & TIG welding, forming (pressing, expanding), heat treatment etc.

LABORATORIES


- Metrology of electrical and non-electrical measures/values,
- Testing of materials / products,
- Development, investigation and design of laboratory capacities,
- Equipment: for calibrating momentuum of a force, angle, pressure & flow; primary length master/standard – interferometer, laser measuring system, atomic absorption spectrophotometry, electronic microscopy, NDT methods, etc.

Overhaul
Turbojet programs

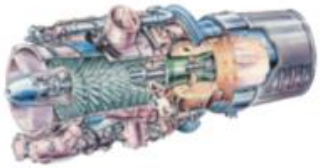
VIPER 22-6 for Galeb G-2

VIPER 531 for Jastreb J-21

VIPER 632-46 for Super Galeb G-4

VIPER 632-41 and 633-41 for Orao J-22

Overhaul
Turbojet programs



VIPER 632-43 for Alenia Aermacchi MB-339

VIPER 22-8 for HAL HJT-16 Kiran

R13-300 & R25-300 for MiG-21 & MiG-21 BIS

Overhaul

Technologies – Sandblasting, washing & cleaning

Washing and degreasing line according to all relevant Rolls-Royce requirements:

- Vapor degreasing according to RPS 128
- Liquid degreasing according to RPS 313

SCHLICK 1-155-S (dry)

SCHLICK 356-S (vapour)

Equipment for dry sand blasting and glass beads peening:

- Removal of corrosion and erosion pitting from the surfaces of the parts made of light metals.
- Cleaning and preparation of surfaces of parts for deposition of coatings by plasma process.
- Abrasive agents: natural corundum (AL_2O_3) and electro- corundum (30/40, 60/80, 120/220 and 320/400 mesh), glass beads (40 to 80 μm), quartz (SiO_2), SiC, diamond.

Overhaul
Technologies – NDT defectoscopy

FPI & MPI

Three diferent methods:
- Dye penetrant (highly sensitive red penetrant)
- High sensitive water removable fluorescent penetrant
- Ultra high sensitive emulsion removable fluorescent penetrant,

UV lamp for inspection under light of 350 nm wave length.

MAGNAFLUX line consists of the following modules: **H720** – inspection stand, **MV3** - inspection stand, **HWSL** – inspection stand & device for demagnetization.

- Possibility for circular and longitudinal magnetizing,
- Magnetizing current up to 4500 A

Overhaul
Technologies – NDT defectoscopy

Ultrasonic Inspection

Ultrasound inspection device
KRAUTKRAMER USM-25

- Locating and evaluating material defects,
- Measuring wall thicknesses,
- Saving and documenting test results,
- Frequency range: 0,5 to 20 MHz

Eddy current inspection device
ZETEC MIZ-20A

- Defect detection,
- Measurement of conductivity,
- Measuring of thickness,
- Frequency response: 50 Hz to 2 MHz,
- Setting range: 50 dB in steps of ½ dB

Overhaul

Technologies – NDT defectoscopy

X-Rays (Laboratories support)

X-Ray tube - mobile	
Manufacturer	General Electric
Model, type	Eresco, 42MF3.1
Voltage up to	200 kV
Current up to	4,5 mA

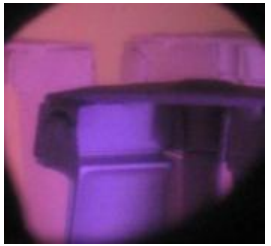
X-Ray tubes - stationary		
Manufacturer	Rich Seifert	Rich Seifert
Model	Isovolt 160/M2	Isovolt 320/13
Voltage up to	160 kV	320 kV
Current up to	19 mA	13 mA

Overhaul

Technologies – Reparation and reconditioning

Plasma & HVOF deposition of coatings

Plasma (by wire or powder feeding) & HVOF coatings by METCO Diamond Jet equipment)



Physical vapour deposition (PVD) device VPT-12M

Overhaul

Technologies – Reparation and reconditioning

Welding

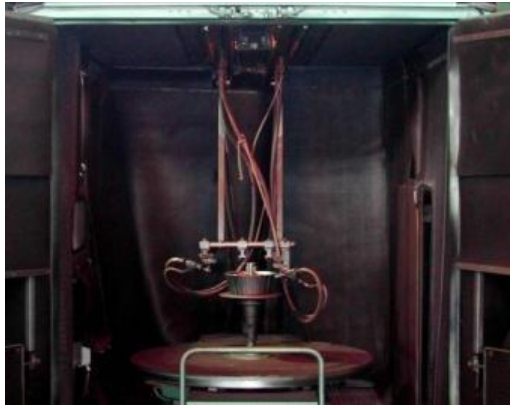
Muller Syncrowave 300P
TIG welding device

Manual TIG welding of front section combustion chamber of Viper 632-43 turbojet engine

Overhaul

Technologies-Reparation and reconditioning

Shotpeening



Shot peenning device – Schlick RotoJet

The Shot Peening Plant is used for reinforcement jet engine vital components such as:

- Compressor rotor discs and blades
- Turbine discs and blades
- Grooves of the blade base
- Other components for reinforcement their overloading surfaces

Characteristics:

Two blasting systems:

- injector blasting (0,18 ÷ 1,7 mm grain size)
- pressure blasting (1,7 ÷ 2,8 mm grain size)

Blasting cabinet dimension: 3300 x 2200 x 2500 mm

Both, automatic and manual operating modes are supported.

Overhaul

Technologies – Reparation and reconditioning

Electro-chemical plating

Technologies:

- Anodizing and heavy oxidation treatment line,
- Zn-Cd Treatment line,
- Nickel plating line,
- Hard chromium treatment line,
- Ag-Cu Treatment line,
- Phosphate & browning treatment line,
- Manual line

All galvanic & chemical processes are according to Rolls-Royce's TSD 594J.

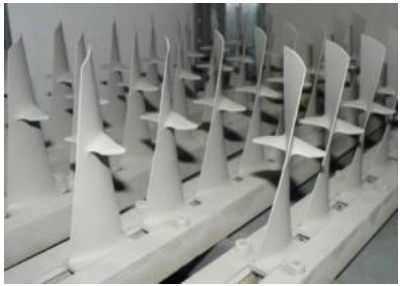
Overhaul

Technologies – Reparation and reconditioning

Painting, lacquering, gluing and potting

- Protecting and thermal resistance coatings: *SERMETEL W & SERMASEAL 570A* for compressor blades and vanes, shrouds rotating & discs - According to last Rolls-Royce modifications.
- Painting shop for organic coatings – available capacity:
  - Organic paintings 50%
  - Inorganic coatings 50%




Overhaul

Technologies – Assembling

Assembling of subassemblies

Overhaul
Technologies – Assembling

Static & dynamic balancing

Schenck equipment for balancing of rotors

Characteristics:

- Rotors up to 1000 kg
- Rotor diameter up to 1600 mm
- Load per pedestal up to 600 kg
- Pedestal span up to 2100 mm.

Overhaul
Technologies – Testing

Testing of Accessories

Device ''**AMS**'' model **BPH 1340/B** for testing of hydraulic pumps & other hydraulic components (valves, actuators, hoses etc.)
Power: 73,6 kW @ 3200 rpm
Drive speed: 300 to 6000 rpm
Pressure gauge range: up to 345 bar (690 bars for static pressure)
Flow gauge range: up to 95 l/min

Device "**AMS**" model **PFC 1339** with two independent testing chambers for testing of fuel pump, barometric flow control unit, air/fuel ratio control, fuel valve, governor pump, fuel distributor etc.
Drives power: 125 hp & 15 hp
Drives speed: 0-7000 & 0-10000 rpm
Flow range: 0-491 & 0-66,7 l/min
Pressure range: 0-345 bar

Overhaul
Technologies – Testing

Testing of Accessories

Device **DOWTY** model **4400** for testing fuel pumps, governors, valves, different types of control units including pneumatic accessories.
Power drive: 45 kW
Drive speed: up to 6000 rpm
Flow: up to 10000 l/h
Equipped with two vacuum pumps and hand pump for static pressure testing.

Device ”**AMS**” model **BEA 1367 B** for casings and tubes flow testing and flushing oil pass ways of casings, etc.
Applicable to following components: tubes, hoses, air inlet casing, accessories gearbox casing etc.
Flow: up to 76 l/min
Pressure: up to 10,5 bar

Overhaul

Technologies – Assembling

Final assembling of turbojet engine

Overhaul

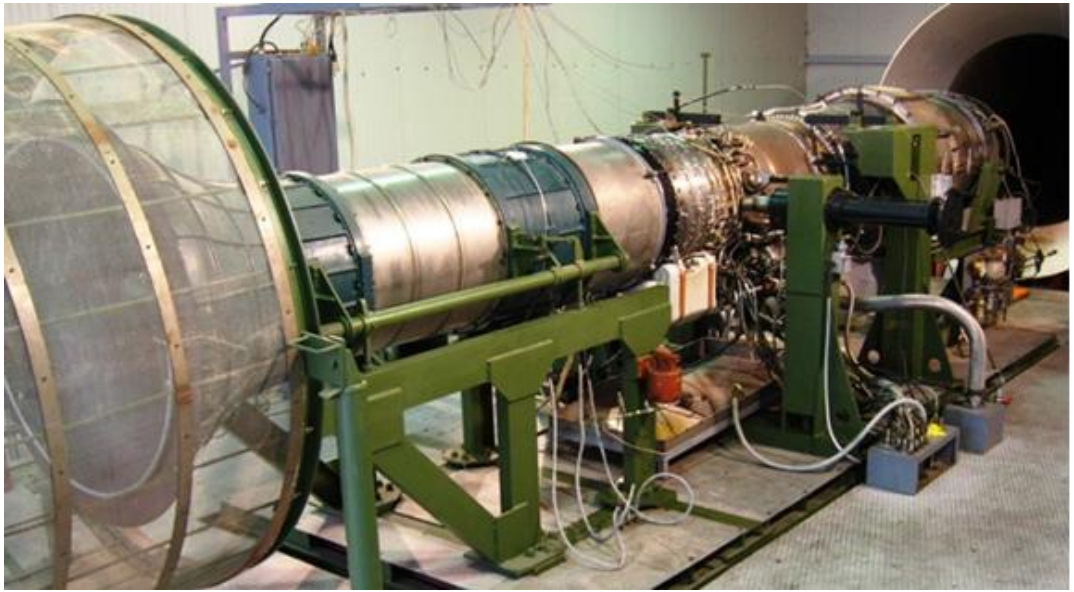
Technologies – Testing

Final testing of turbojet engine

Orao's Test cell in Bijeljina for all VIPER series engines equipped with data acquisition system – up to 10000 daN thrust.

Overhaul
Technologies – Testing

Final testing of turbojet engine



Orao is coowner of two testing stations in Batajnica (near Belgrade, Serbia) in separate buildings with independent installations:

1. *Testing station for VIPER engines – up to 10000 daN thrust*
2. *Testing station for R13-300, R25-300 (MiG-21) & RD-33 (MiG-29) engines – up to 12000 daN thrust*

Production

Production pallete:

- parts and assemblies production of the turbojet engines,
- special tools production,
- parts production according to requirements.

Main technologies:

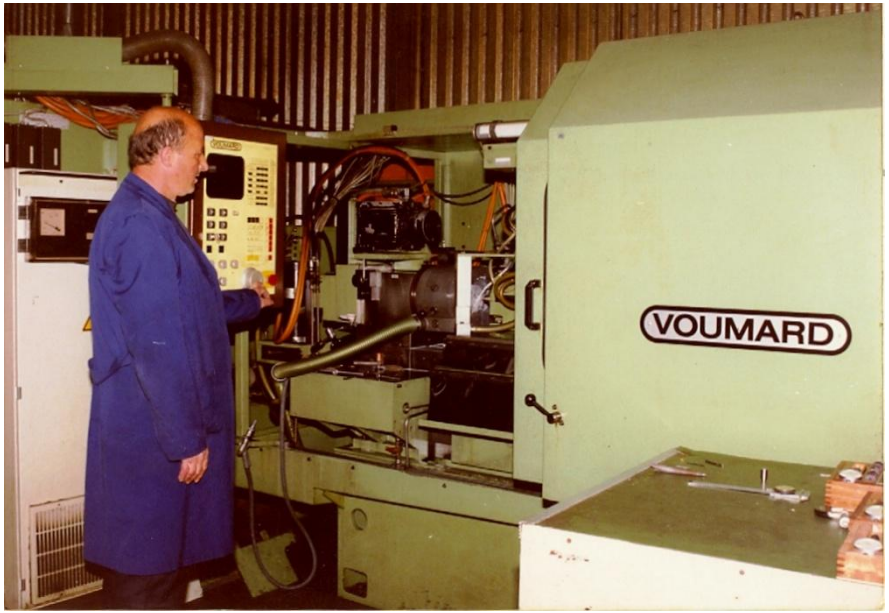
- CNC machining,
- CNC EDM,
- forming,
- welding,
- heat treatment,
- NDT.

Production
Technologies

1. Turning – machining diameters up to 1600 mm
2. Milling - 3D machining (CATIA software)
3. Grinding – cylindrical and flat grinding accuracy up to 0.005 mm
4. Forming & Pressing – cutting, punching, extruding by mechanical and hydraulic press, force up to 400 tons.
5. Welding - TIG, EBW, electric resistance, seam and spot of stainless and heat resistance steels, nickel alloys....
6. Heat treatment in vacuum, cooling by inert gas Argon, process in furnaces with protecting atmosphere.
7. EDM – Electric Discharge Machining by electrode and by wire.

Production
Technologies – CNC turning

Turning diameters up to 1600 mm



Cylindrical and flat grinding accuracy up to 0.005 mm.

Production

Technologies – CNC milling

New CNC Milling Machines DECKEL MAHO GILDEMEISTER:

1. Type DMU 85 monoBLOCK, 5-axis:
   - Travel range X/Y/Z : 850x850x650 mm
   - Swivel rotary table - size: Ø850 mm
   - Workpiece up to: Ø1040x590 mm, 1000 kg
   - Accuracy of positioning and repositioning: ± 5 µm
2. Type DMU 65 monoBLOCK, 5-axis:
   - Travel range X/Y/Z : 650x650x560 mm
   - Swivel rotary table - size: Ø650 mm
   - Workpiece up to: Ø840x500 mm, 600 kg
   - Accuracy of positioning and repositioning: ± 5 µm
3. Type DMU 65 monoBLOCK, 3-axis:
   - Travel range X/Y/Z : 735x650x560 mm
   - Rigid table - size: 1000x650 mm
   - Workpiece up to: 1000x840x560 mm, 1800 kg
   - Accuracy of positioning and repositioning: ± 5 µm

Production
Technologies–Forming

SMG hydraulic press -force up to 400 MPa

LITOSTROJ hydraulic press–force up to 100 MPa

LITOSTROJ hydraulic press – force up to 63 MPa

Heilbronn excentric press

Production

Technologies – Welding: TIG & EBW

TIG welding equipment

CNC machine for EBW

Welds by TIG & EBW technology

Advantages of Electron Beam Welding (EBW): able to hold close tolerances, repeatability of weld parameters, low heat input results in minimal distortion, high-strength weld integrity (clean, strong and consistent), joins similar and dissimilar metals without filler, cost-effective joining meets difficult design requirements and restraint etc.

EBW 5-axis CNC device Messer Griesheim K100/G 150 K:

EB canon power: 15 kW @ 150 kV
Working chamber: 12 m^3
Work piece: Φ800 x 1200 mm
Vacuum in working chamber: $5x10^{-4}$ mbar
Welding speed: 100 mm/s
Accuracy: ±0,05 mm

Production

Technologies – Heat treatment

Ipsen furnace VVFC48X60

Workspace: Φ1200 x 1500 mm
Temperature: from 500 to 1300 °C
Vacuum: $1x10^{-3}$ mbar
Argon pressure for cooling: up to 1 bar.

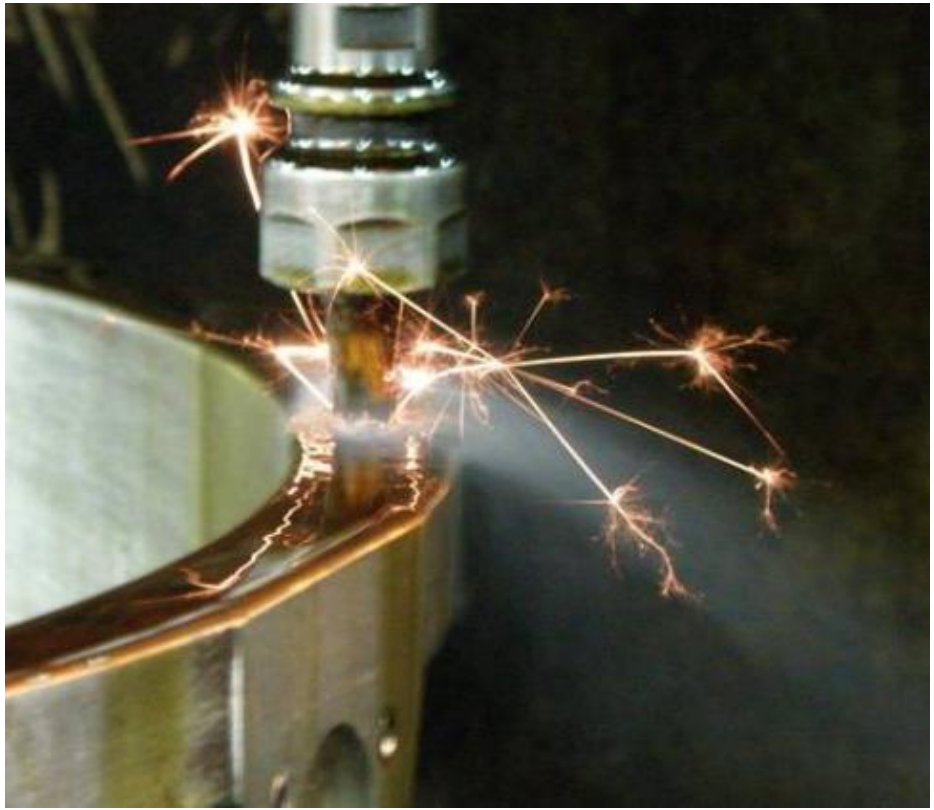
Chamber furnace Hofmann BW 1500

Workspace: 1000x1000x1000 mm;
Heating power: 72 kW
Temperature range: up to 950 oC

Production

Technologies – EDM (Electrical Discharge Machining)

EDM by wire



EDM by electrode

BASIC ACTIVITIES OF THE LABORATORIES:

- Metrology of electrical and non-electrical measures - METROLOGICAL LABORATORIES
- Destructive and non-destructive testing of materials – LABORATORIES FOR MATERIALS/ PRODUCTS TESTING
- Development investigation and designs of laboratory capacities

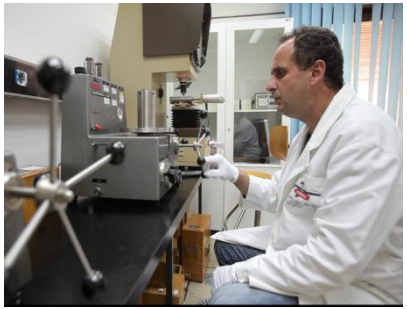
Laboratories & Quality Assurance
Length, angle and surface roughness

- primary length master - interferometer for calibration parallel slip gauges, class „00" and „K"
- laser measuring system for calibration of three-axes measuring and tool machines
- devices and masters for surface finish ranging from 0,01µm to 100 µm
- precise etalon for generation and measuring of angle, ranging from 0 to 360°, accuracy ± 0,1 seconds
- laboratory three-axes measuring machine, accuracy 0,5 µm, ranging up to 410 mm, with software package for measuring and data processing

Laboratories & Quality Assurance

Mass, pressure, force, momentum, liquid flow and hardness

- equipment for pressure generation and measuring in full range from 10^{-6} mbar do 5000 bar
- measuring equipment and masters for generation and measuring of momentum of a force up to 2700 Nm
- equipment and masters for measuring of the fluid flow (stable and movable) from 1,5 to 1500 l/min



Laboratories & Quality Assurance
Temperature, thermometers, thermocouples, humidity

- equipment for temperature measuring and testing of temperature homogeneity ranging from -40°C to 1100°C with the computer processing

Laboratories & Quality Assurance
Electromagnetical values

- equipment for AC/DC voltage & current, resistance measurement
- equipment for time & frequency measurement

Laboratories & Quality Assurance

Laboratory for testing of materials

Electronic microscope

X-Ray device

AAS device

Laboratory for chemical testing

Tearing machines, hardness check machines, presses, Sharpy's swing-wheel method for toughness test

Certificates and approvals

Certificates:

• NF EN ISO 9001:2008 (BVC, Paris),
•AS/ EN/JISQ 9100:2009 (BVC, Paris),
• SRPS ISO 9001 (MOD Srbije),
• SORS 9000/05 (MOD Srbije),
• BAS ISO/IEC EN 17025. (BATA, Sarajevo)
• Part 145 (BHDCA, Banjaluka)

Approvals:

- Pratt & Whitney internal approvals for heat treatments, FPI, MPI, X-Rays, welding and anodizing treatment
- JAT Tehika approvals for: plasma Spraying process, chromic acid anodizing, hard chromium plating, electrodeposited nickel plating – watt nickle, nickel sulphamate plating and bright cadmium plating
- UTAS (Hamilton Sundstrand) for FPI, anodizing, passivation and heat treatment

Mastering & production of spare parts

- Hot section parts and assemblies,
- Casings made from castings,
- Parts for accessories,
- Other parts: rings, supports, shafts etc,
- Mandatory replacement parts: sealing rings, locking washers...

Contacts

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