BET SHEMESH ENGINES LTD.

Israel's Engine Manufacturer and Maintenance Center

October 2014

Bet Shemesh Engines
History and major events

- 1968 Founded
- 1968 - 1981 Company owned by Turbomeca, France
- 1981 -1992 Government Owned Company
- 1992 Private Company, since 1997 traded on the Israel Stock Exchange
- 2003 Purchase of LPO, Serbia (full subsidiary)

Bet Shemesh Engines Organization

General information

Floor Area: 40,000 sq/m.

There are 607 employees

	BSEL, Israel	LPO, Serbia (subsidiary)
Shop workers & QC	412	39
Engineers	62	4
QA & Labs	21	7
General & Administration	55	7
TOTAL	550	57

List of selected customers

Hamilton Sundstrand	Israel Air Force	CN Airways, Israel
- Windsor Locks	Thai Air Force	Ayit Aviation, Israel
- San Diego, Poland	Thai Navy	Orange Aviation, Israel
Pratt & Whitney, USA	Colombian Air Force	Tel-Aviv Helicopters, Israel
GE Aviation, USA, Czech	Colombian Army	Ofek Aerial Photography, Israel
MTU Aero Engines, Germany	Hellenic Navy	Snunit Aviation (Elbit), Israel
Samsung, S. Korea	Philippine Air Force	Rotorflug GmbH, Germany
Snecma, France		Greek Air, Greece
Siemens, UK		Heliswiss Iberica, Spain
Eldim, The Netherlands		Air Touraine Helicoptere, France
Avio, Italy		Agro Flight Services, Finland
ITP, Spain		HSL Helicopter Services, UK
GTRE, India		ARM-SA Aviacion, Guatemala
HAL, India		SkyTech Ltd, Kazakhstan
MHI, Japan, USA		

Typical Applications

PWA	MTU	GE & Snecma	Hamilton Sundstrand	MHI Mitsubishi Heavy Industries	BSEL
JT8D	V2500	CF6	APS 1000	FT8	BS-151
JT9D	PWC305	CF34	APS 2300	PW210	BS-175
PW4000	PWC306	J79	APS 3200		Sorek 4
F100	PWC307	M-601	APS 5000		
PT6	PWC530	LM 6000	APS 3250		
	PWC545		APS 2800		
	GP7000				
	MTR390				
	PW1200				
	PW1500				
	TP400				
	LM6000				

Quality Management System

- Dynamic Quality - continuously monitoring customer requirements (Qualified for ISO9001, AS9100, PWA, GE, MTU, Hamilton Sundstrand, FAA, EASA, IAF and others)
- Quality at source - engineering, workers and equipment
- The voice of the customer is quality - PWA-ACE,

  GE 6-Sigma, MTU Kaizen
- Quality Motivators – team pride, strive for excellence, workers' responsibility
- Quality Environment - clean shop, health & safety in the work place, communication
- Quality Cost - continuous quantitative monitoring and drive for cost reduction

One Stop Shop

- Bet Shemesh Engines produces disks, casted air foils, machined air foils, assembly and balancing of disks and assembled modules for its customers.
- Bet Shemesh Engines produces complete parts, such as the air intake for Hamilton Sundstrand and the first stage nozzle for the Rolls-Royce Allison 250, including casting and machining, plasma, HVOF, EBW, plating and all other necessary processes.
- This means that our customers can purchase everything from one place and not have to deal with several different suppliers.

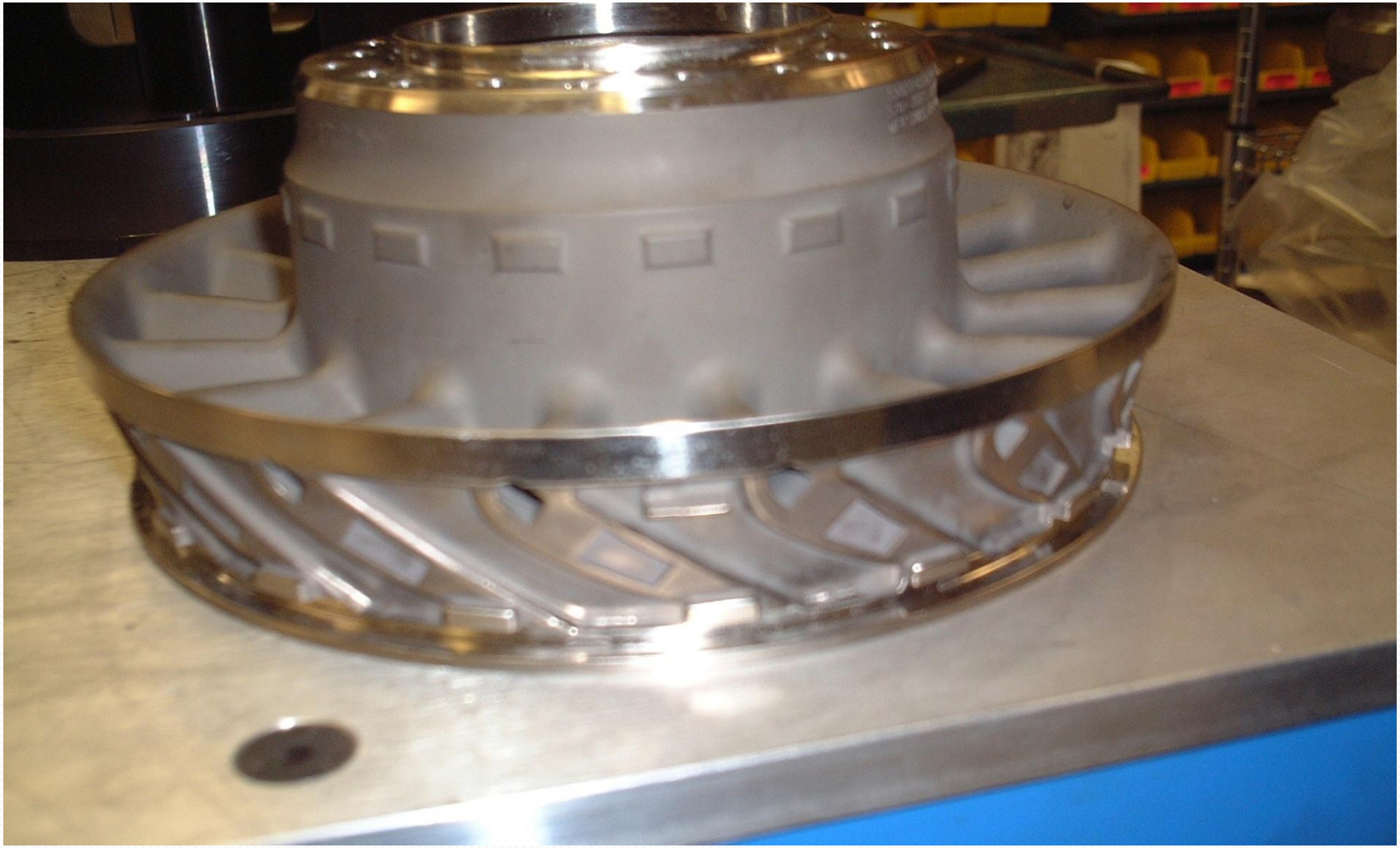
Assembled Disk

Disk–machining
Blade casting and machining
Dumper and lockers
Assembly and balancing

BSEL has delivered hundreds of assembled disks

Hamilton Sundstrand Disk

Hamilton Sundstrand Nozzle



APS-500R Air Intake

Air Intake

PWC307 Module

APS 2300

APS 3200

APS 5000

Logistics & Purchasing

- BSEL's Purchasing & Logistic Department has a lot of experience in purchasing raw materials for castings, forgings, equipment, etc. to the volume of $28-30M annually.
- This Department is part of the administration area of the company, which includes Finance, Warehouses, etc.

ENGINEERING CAPABILITIES

R&D Background

Through all the years of its existence:

- Development and Design
  - Small expendable jet engines (BS175, Soreq …)
  - Engines modules
  - Engines components (turbines, compressors, combustors, shafts, bearings etc.)
  - Engines auxiliaries (control, power control units, alternators, pumps, valves etc.).
- Manufacturing engineering
  - Plan and develop manufacturing operation methods, design tooling and introduce innovative technologies
- Test and assembly engineering
  - Design test and assembly rigs and test cells, assembly and repair procedures, subassembly operations, acceptance tests
- Material laboratory
  - Select materials for the BSEL genuine products; issue process sheets for thermal treatment, coating and lab inspection; conduct failures investigations

R&D Team

R&D and engineering teams include 60 engineers

- 37 years of experience in development, engineering and technology of jet/turbo engines
- A broad know-how base accumulated in all echelons and departments which enables a fast response to development challenges
- Focus today mainly on small expandable engines

Fields of R&D and Engineering Analysis

- System engineering and mechanical design
- Thermodynamics and thermodynamic cycles
- Gas flow, turbo machinery aerodynamics and heat transfer
- Stress and strain
- Vibration and rotor dynamics
- Control and simulation
- Combustion

Software

- Heat Transfer, Stress and Strain analysis
- CFD
- Rotor dynamics and vibrations
- Test data reduction and evaluation
- Matlab programs
- 5 axis CNC machining of highly twisted blades
- CAD programs – Unigraphics, Solid edge, Autocad

Examples of Development Projects

- System design
- Axial compressor development
- Turbine development
- Engine dynamics: Vibrations and resonance
- Combustion chamber (Slinger type)
- Exhaust Nozzle Design
- Fuel system (FMV and pump)
- Oil system
- Control system
- PCU – Power Control Unit and alternator
- Environmental Tests

BSEL R&D Projects

1969-72	Turbogenerator (750 kW) - M2TL - Development, production
1974	Turbogenerator (1000 kW) - M4TL - Development
1975-77	Gas turbine for tank - TURMO - Proof of concept
1977-80	Gas turbine tank - ARIEL
1979	Jet engine for U.A.V - SOREK - Development qualification
1983-85	SOREK engine production and Digital control development
1986	Gearbox development for F-20 A/C
1987	Engine development for armored vehicle - MTXT
1987-89	Thrust vectoring for SOREK engine
1988-90	Jet engine for U.A.V - AYALON 50
1990	Advanced engine for - POLEG -7X
1994	Small turbojet engines for U.A.V's - BS10, BS11

Small Engine Division

BSEL has developed a wide range of engines from 150 to 910 Lb thrust for unmanned aerial vehicles and target drones.

BSEL's operations involve:

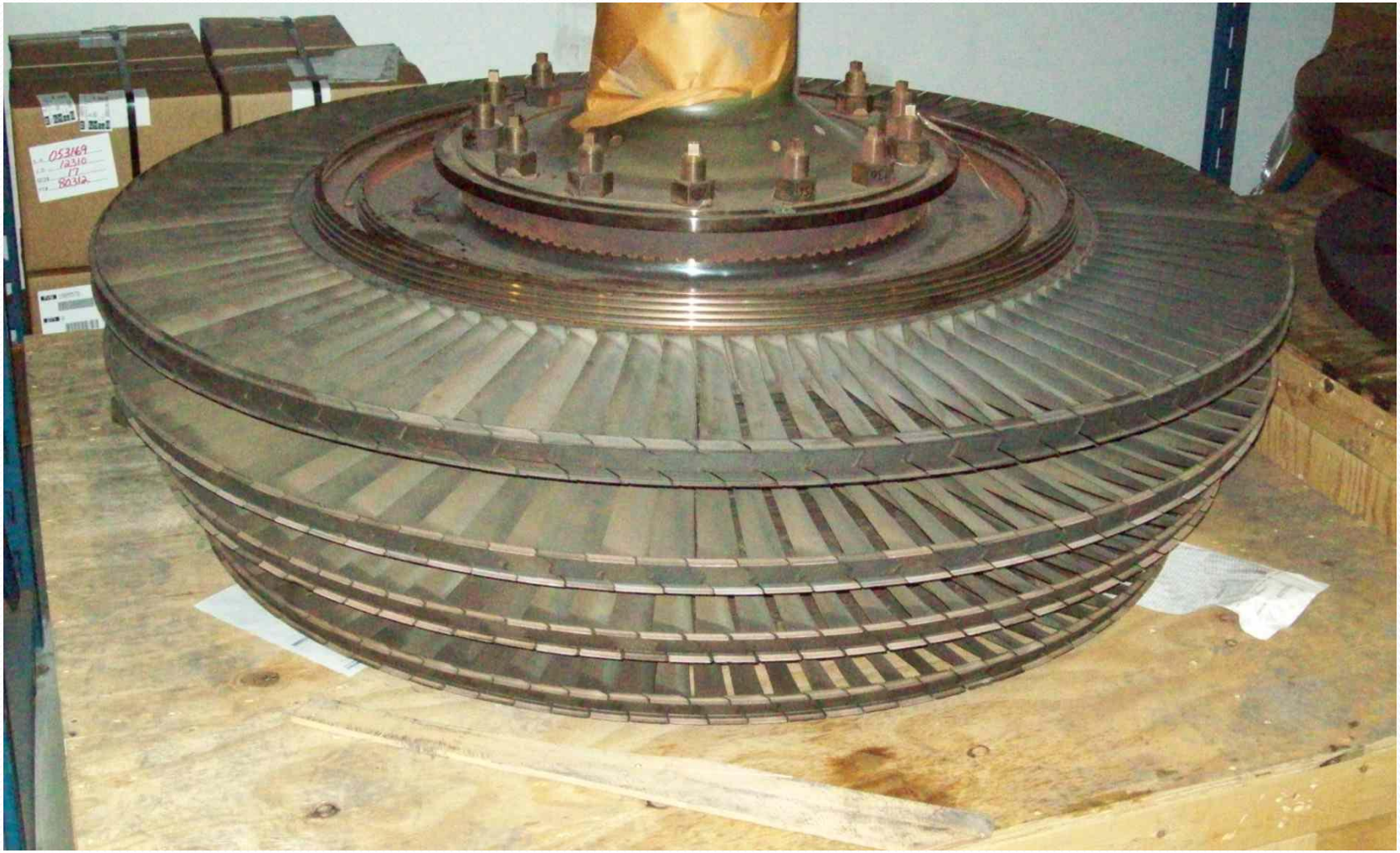
- Design
- Development
- Integration support
- Customization for specific applications
- Prototype and serial production including in-house investment casting

R&D Engineering Department

Manufacturing Engineering Dept.

PW Power System FT-8 (25MW)
1st stage Disk Assembly

PW Power System FT-8 (25MW)
1st, 2nd, 3rd and 4th stage Assembly



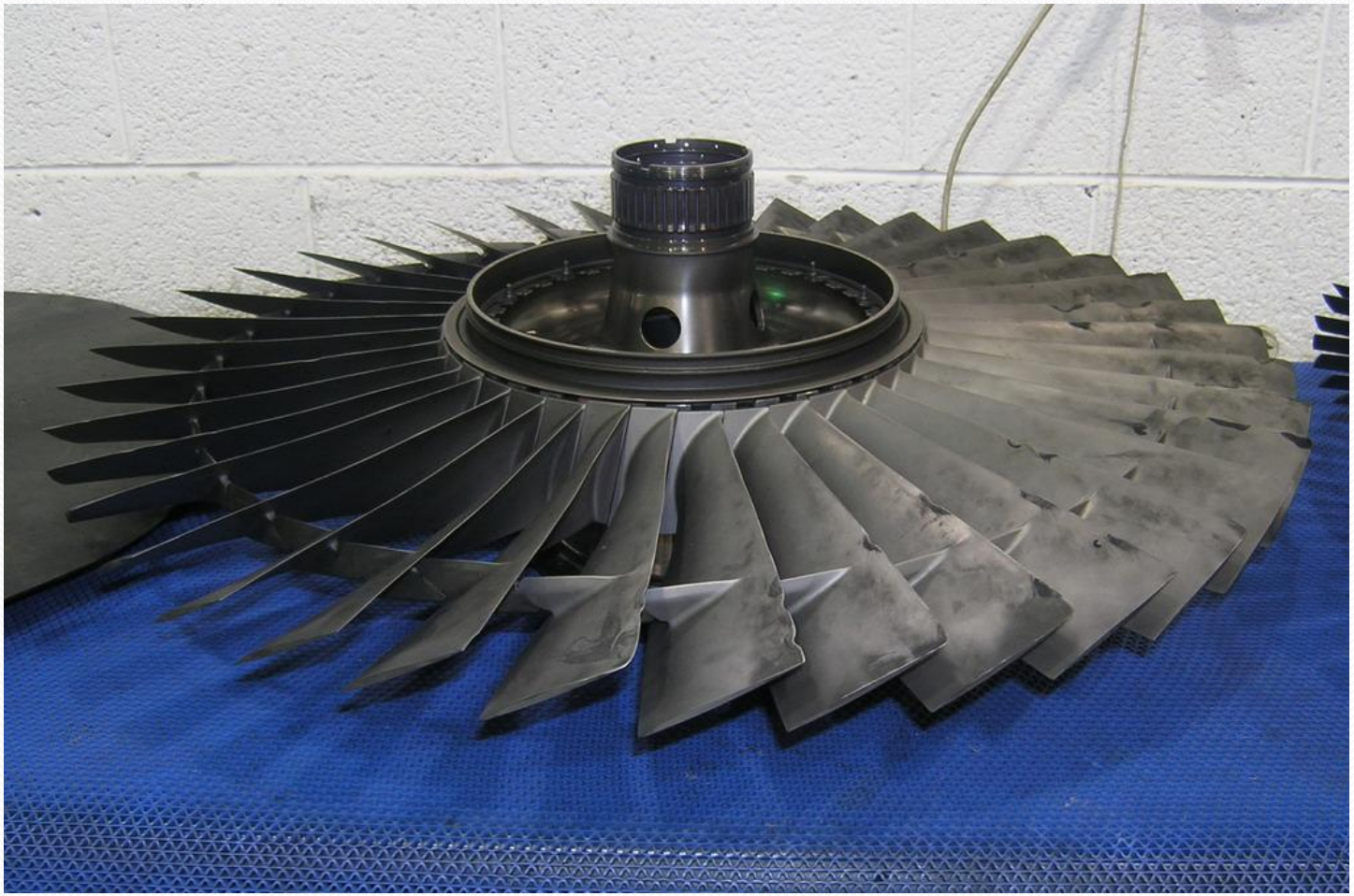
PW Power System FT-8 (25MW) PT Case

PW Power System FT-8 (25MW) PT Case

PW F100-229 Core Assembly

PW F100-229 HPC Assembly

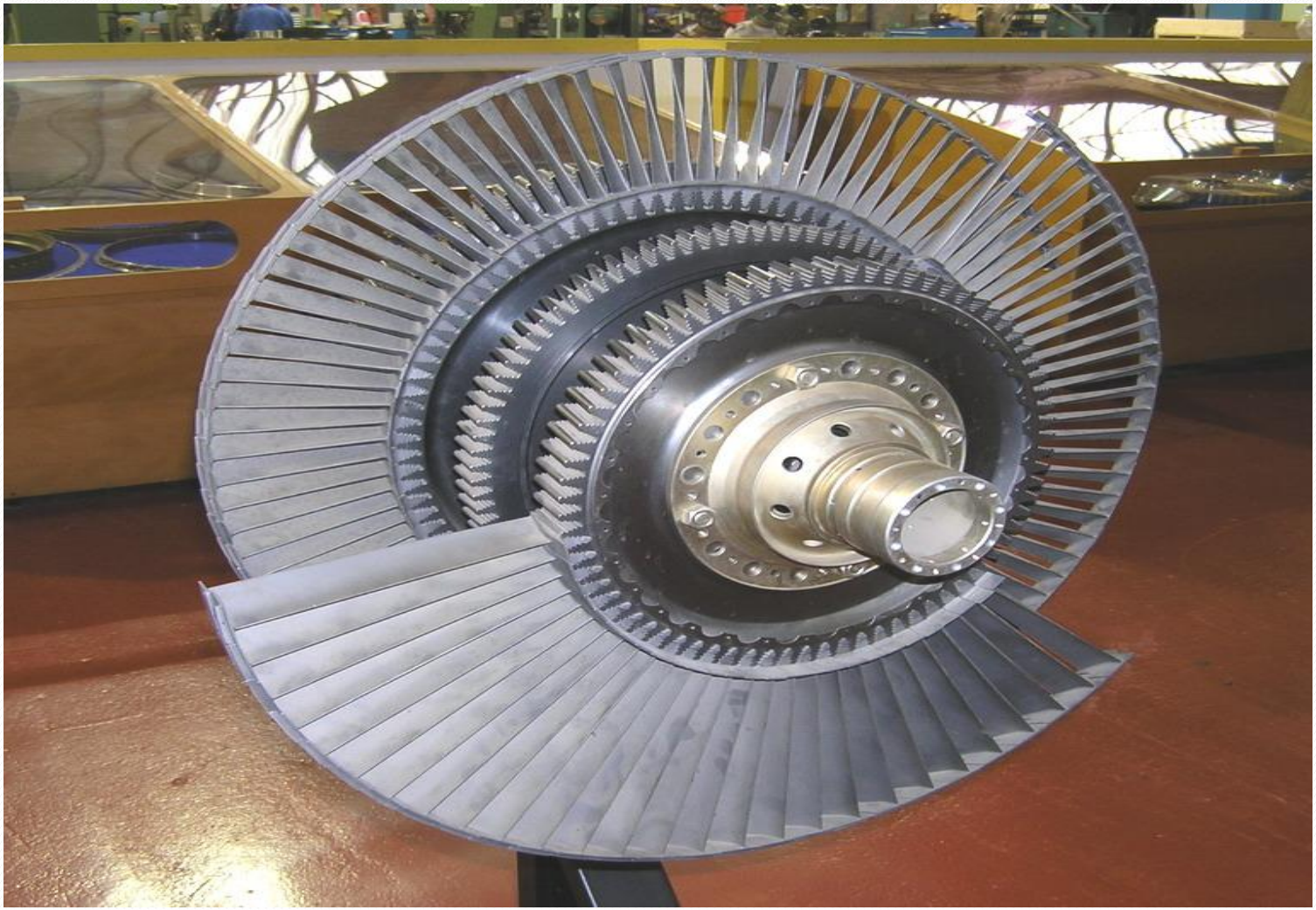
PW F100 Fan
1st stage Disk & Blade



PW F100 Fan
2nd stage Disk & Blade

PW F100 -220 Fan Module

PW JT8D LPT



GE J79 Turbine Rotor

GE J79 Compressor Rotor

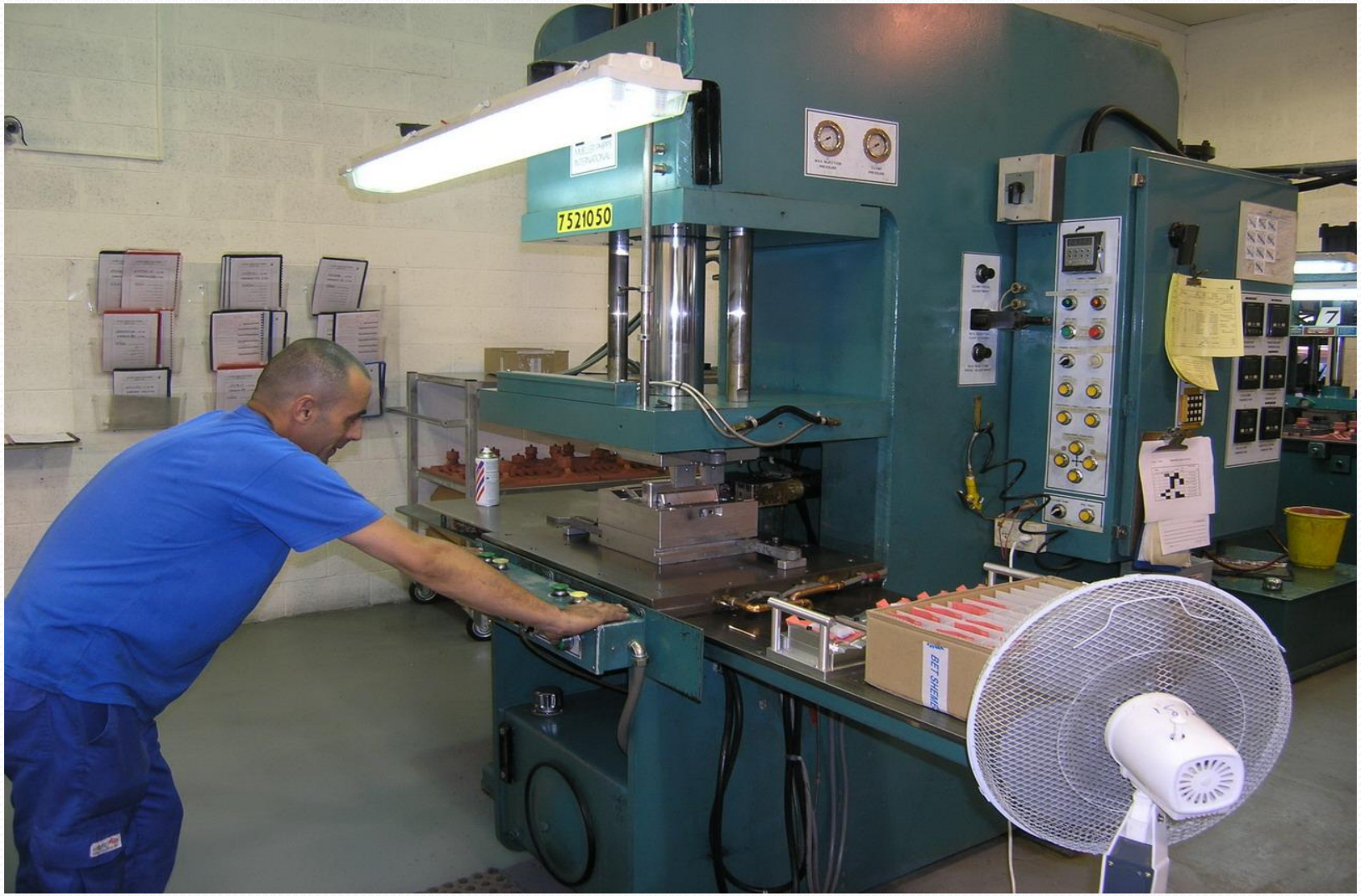
PW F100 engine

Rolls Royce-Allison 250-C20 engine

GE T700 engine

Casting Division

Wax Injector



Waxing

Waxing

Casting Dipping Line

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Vacuum Casting

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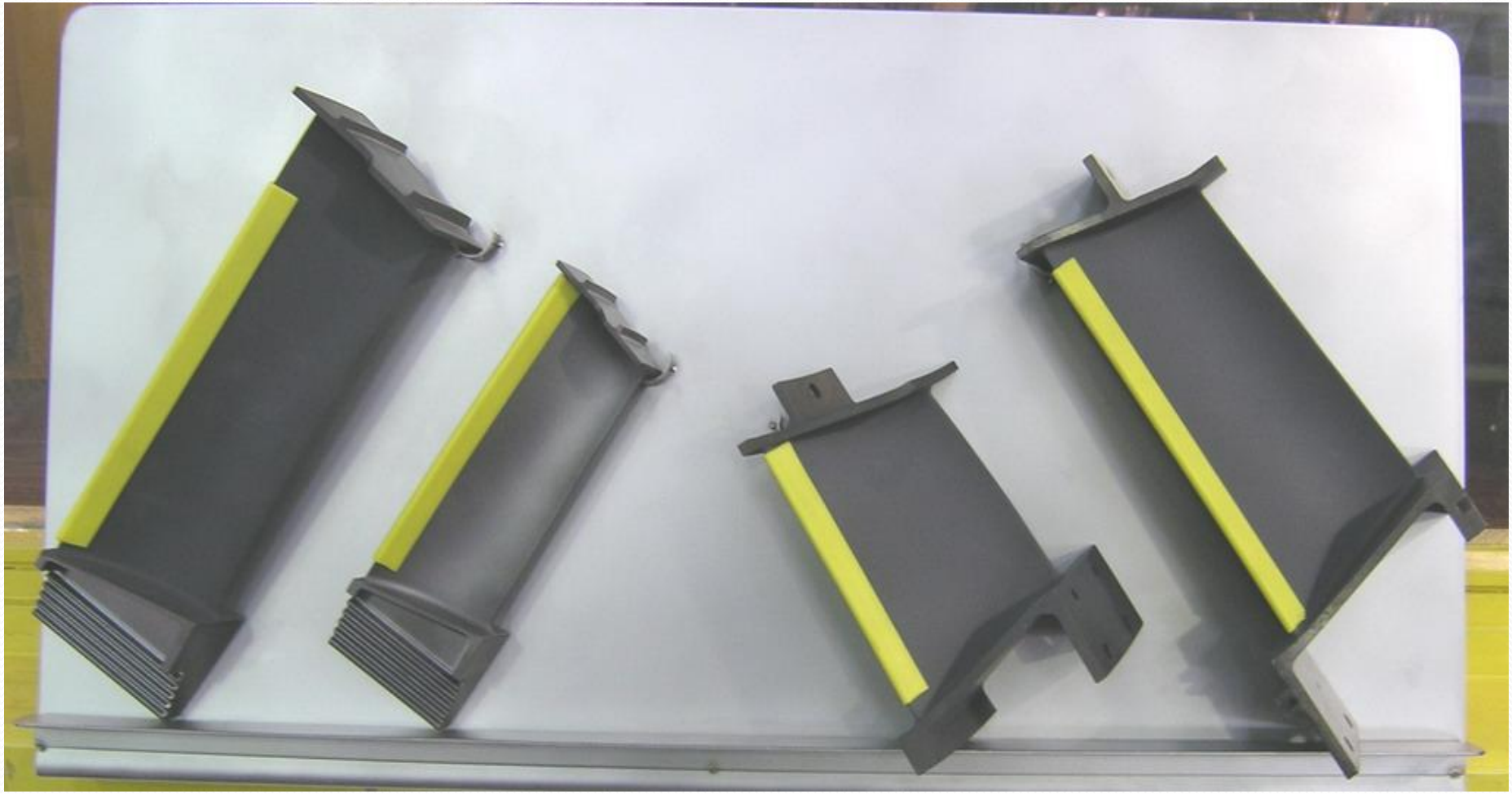
Waxing

Chord Blade

GTRE Kaveri
1st & 2nd stage blades and vanes



GTRE-Kaveri 1st stage blade

GTRE-Kaveri 2nd stage blade

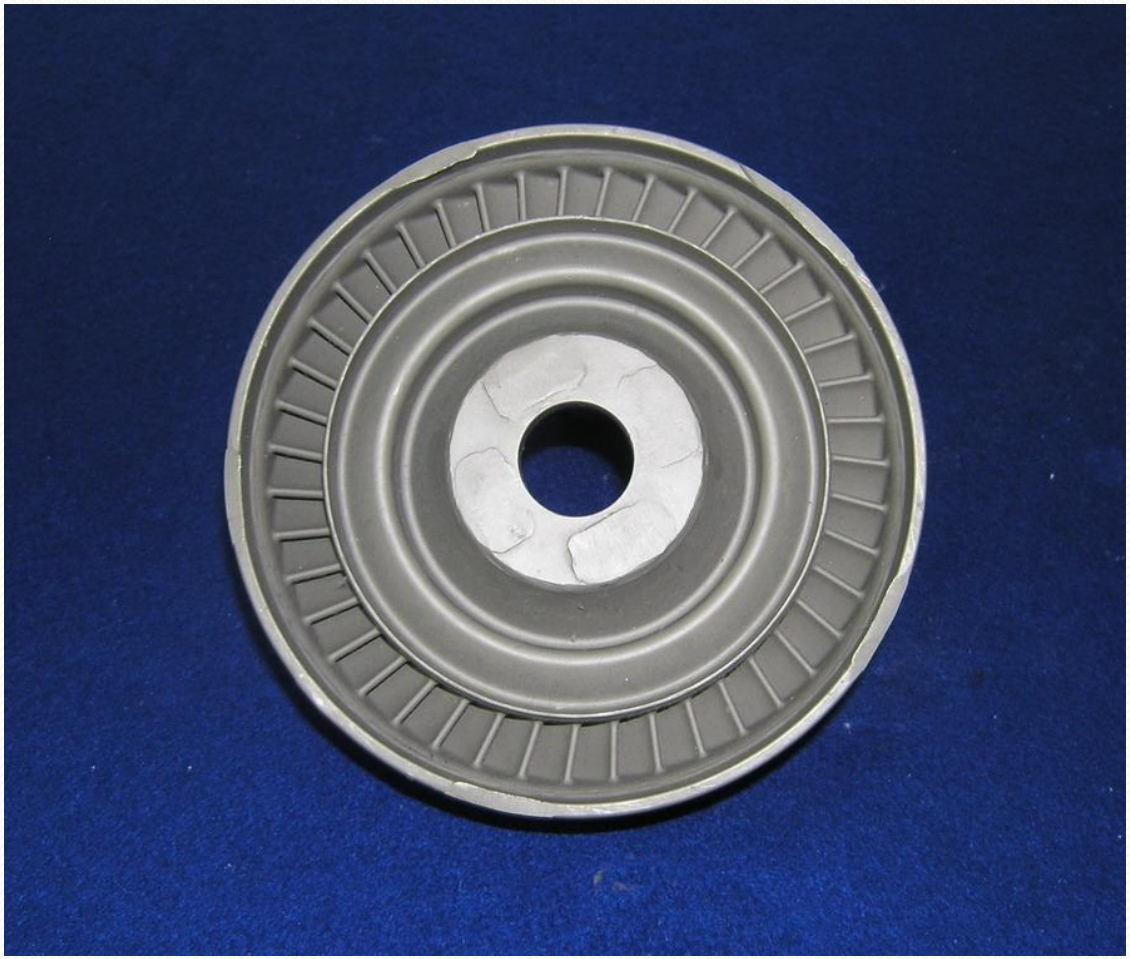
GTRE-Kaveri 1st stage vane

GTRE-Kaveri 2nd stage vane

GE Bearing Housing

Centrifugal Rotor

Nozzle Guide Vane Stator



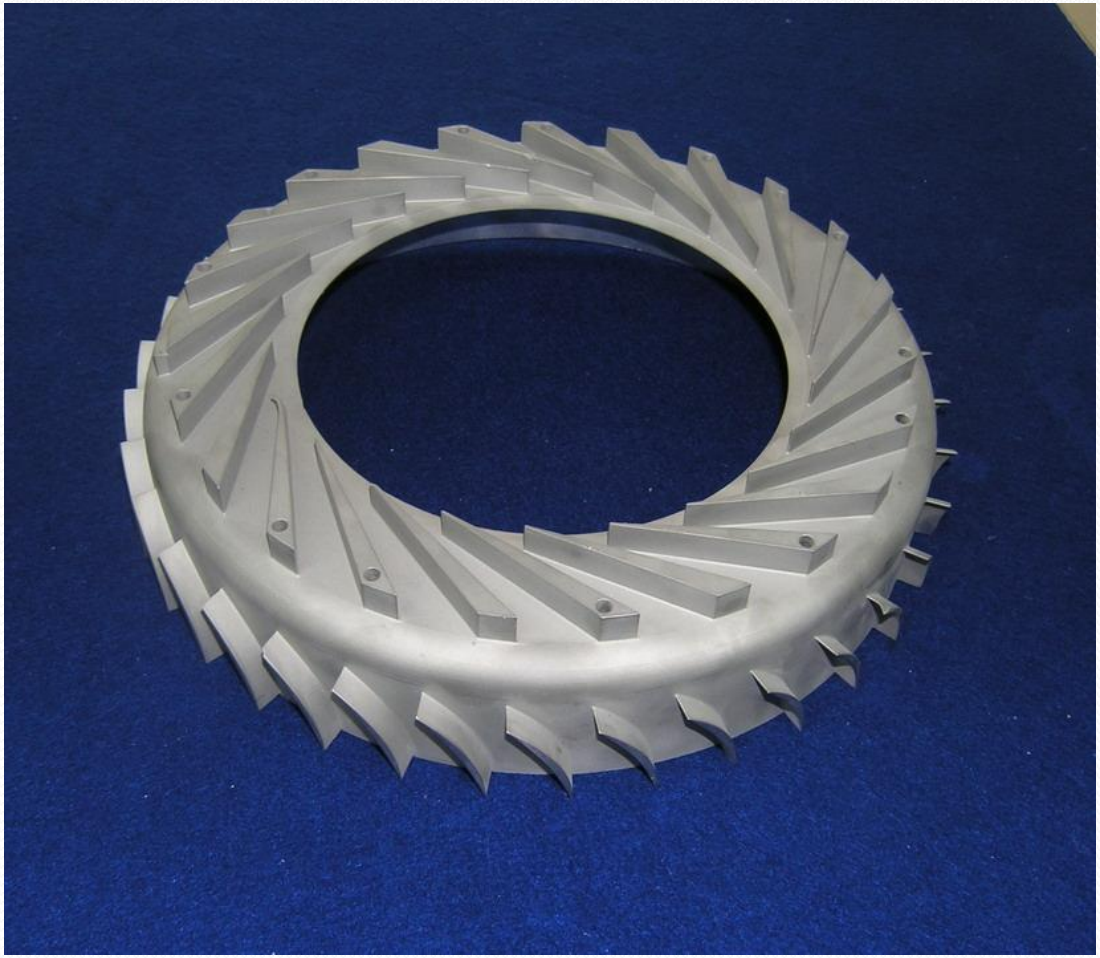
Nozzle Turbine 2nd Stage

Header Hot Inlet

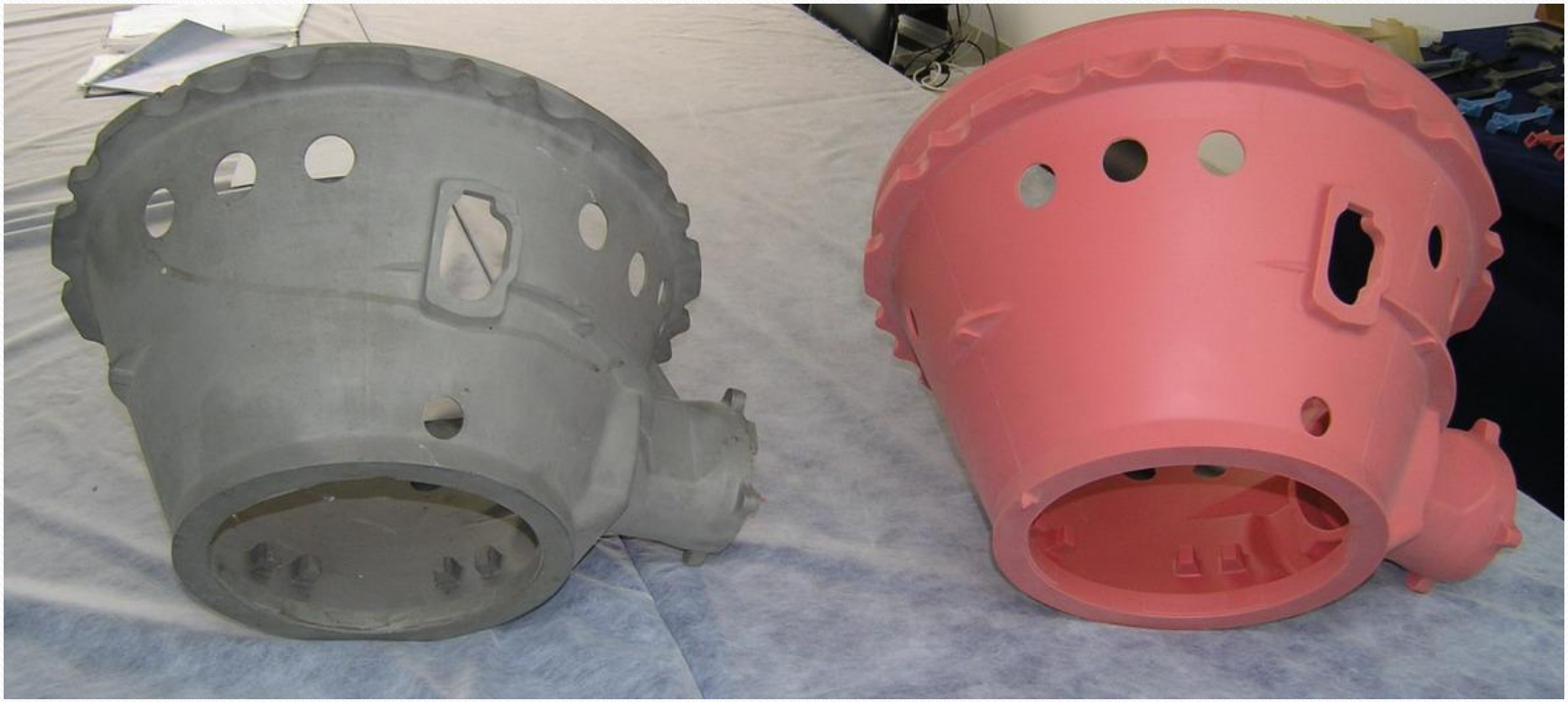
Turbine Rotor

Turbine Wheel

Diffuser

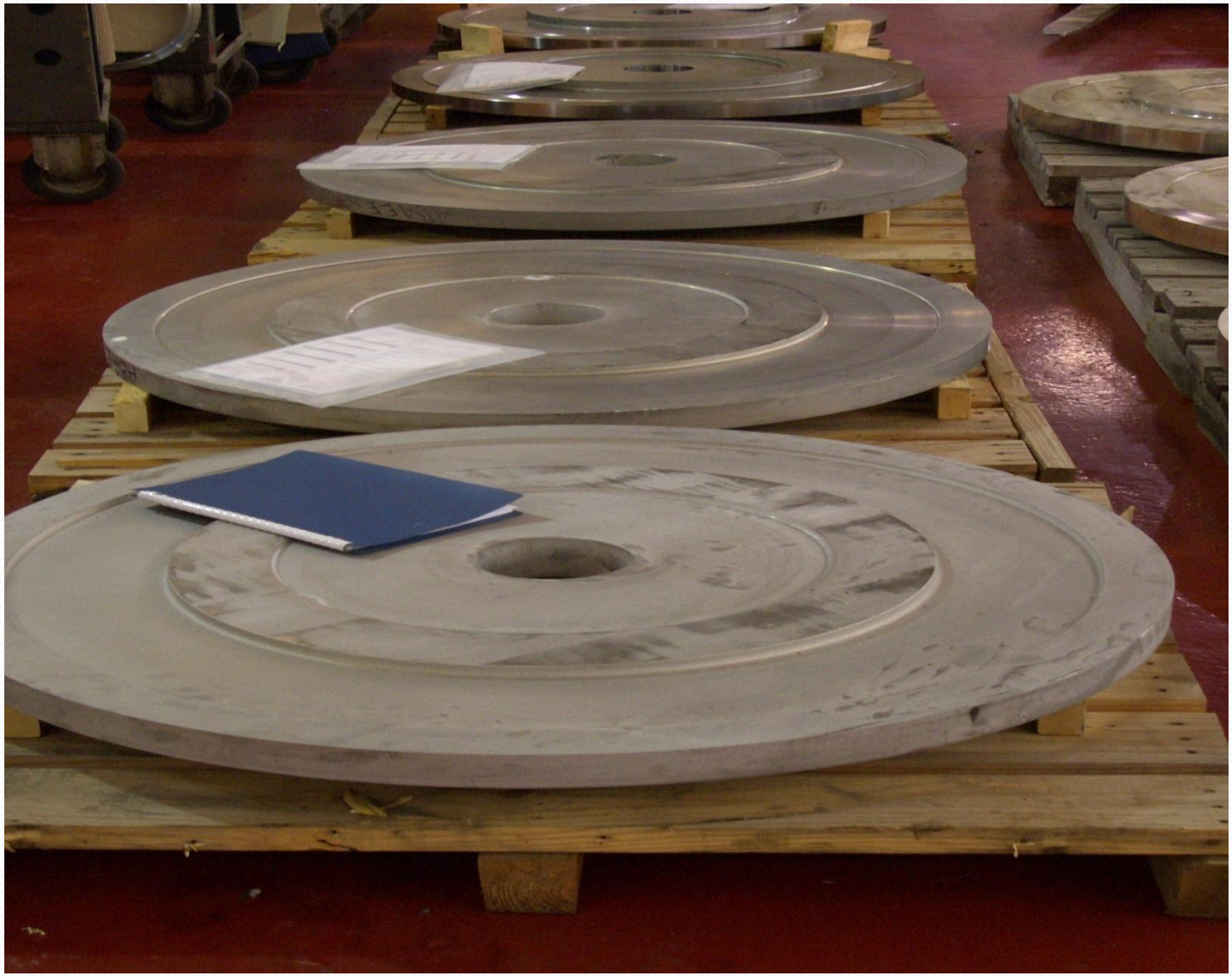


PW4000 Bearing Support



Processes and Equipment

Forging



Turning

FT8 1st stage disk turning

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Turning

PW JT8 2nd stage disk turning

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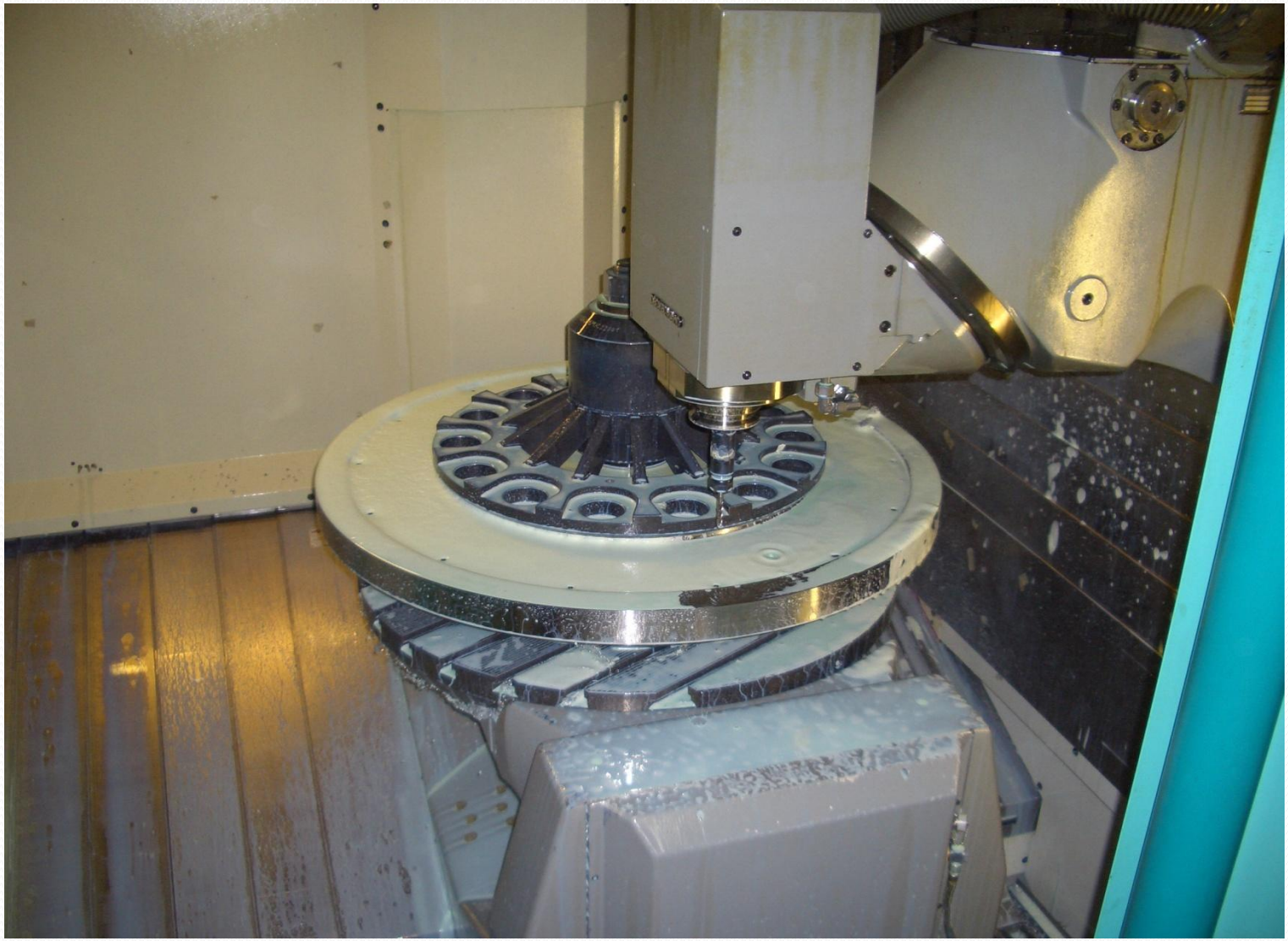
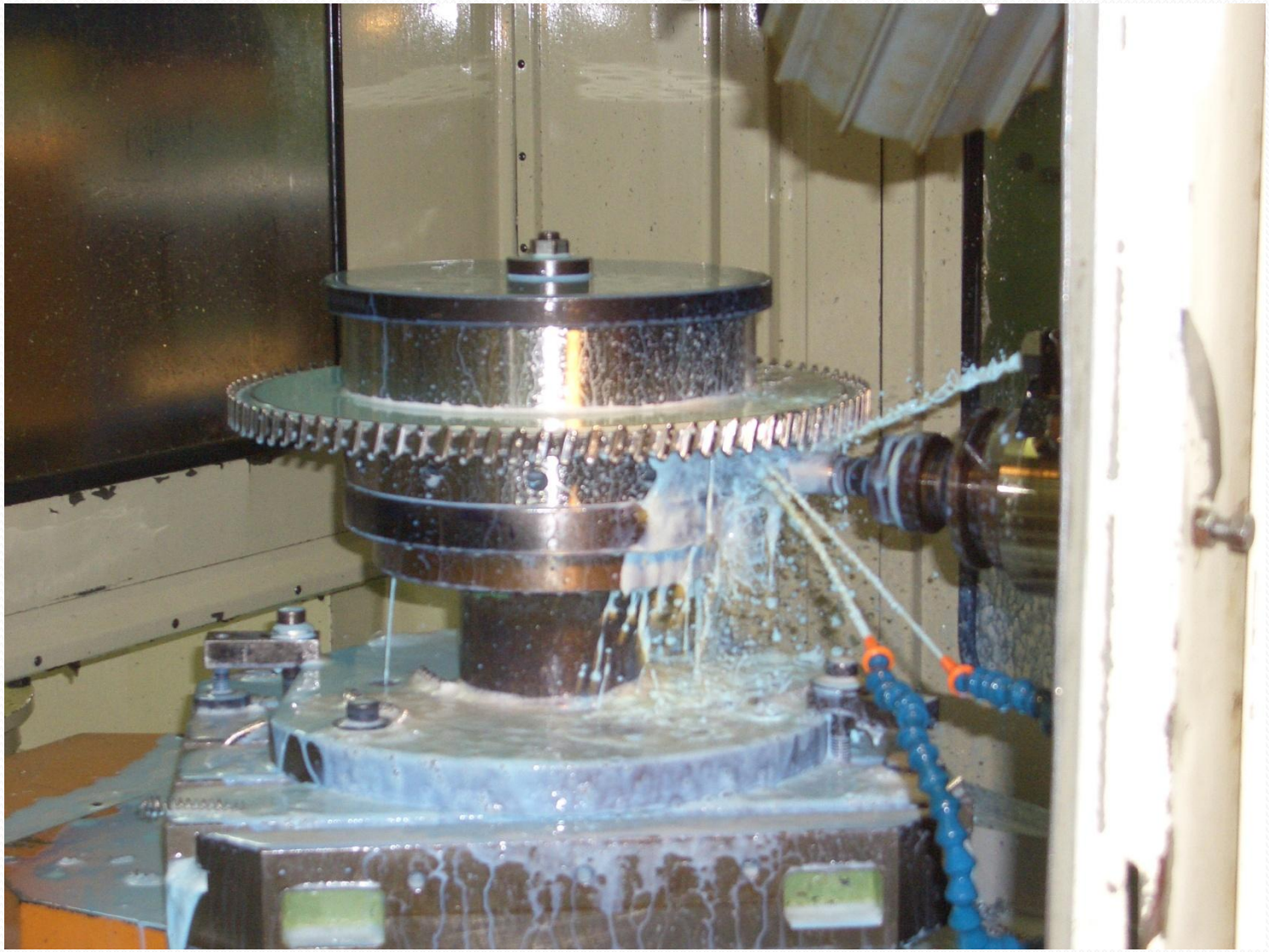
Milling Department

Drilling



Drilling



Large Broaching

Snecma CF6 2nd stage disk turning

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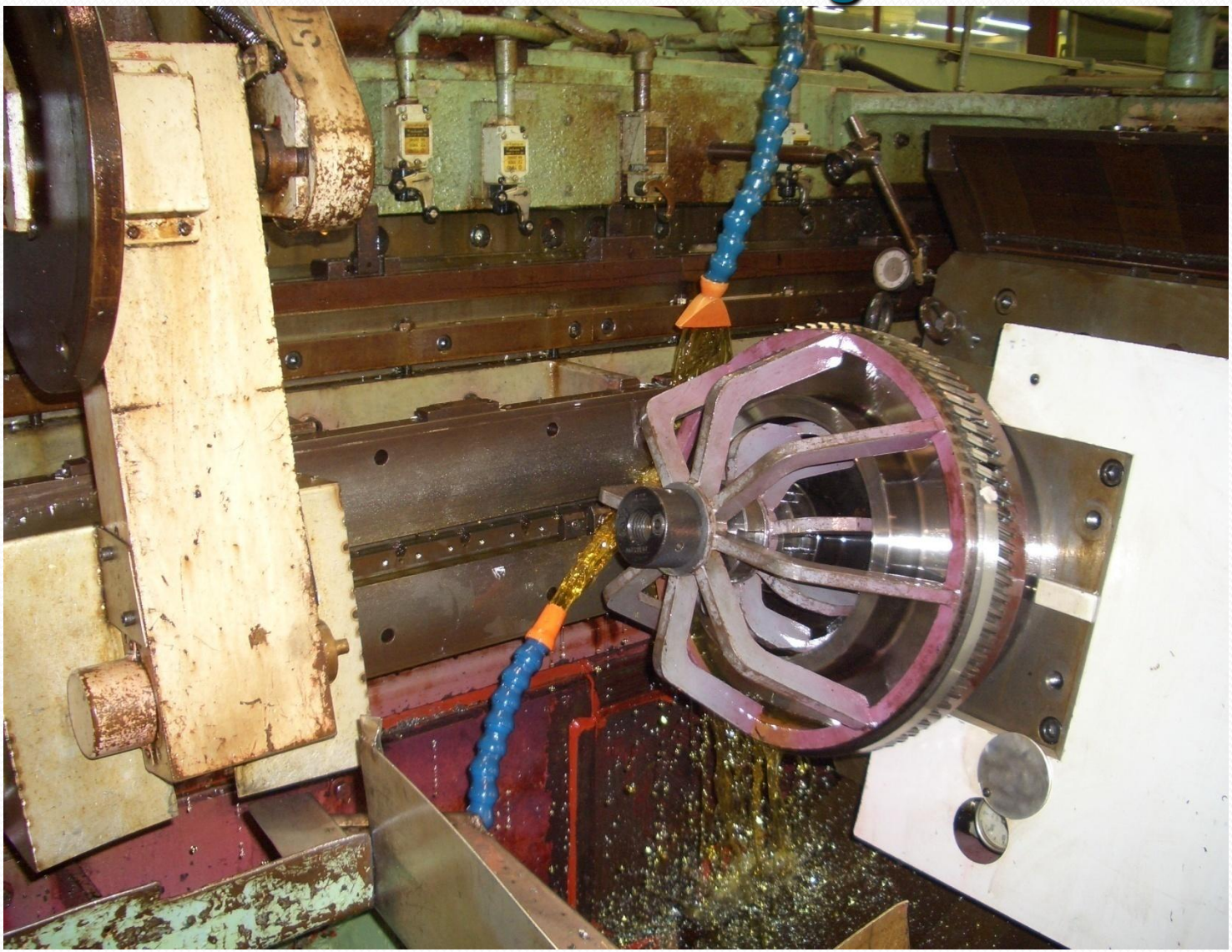
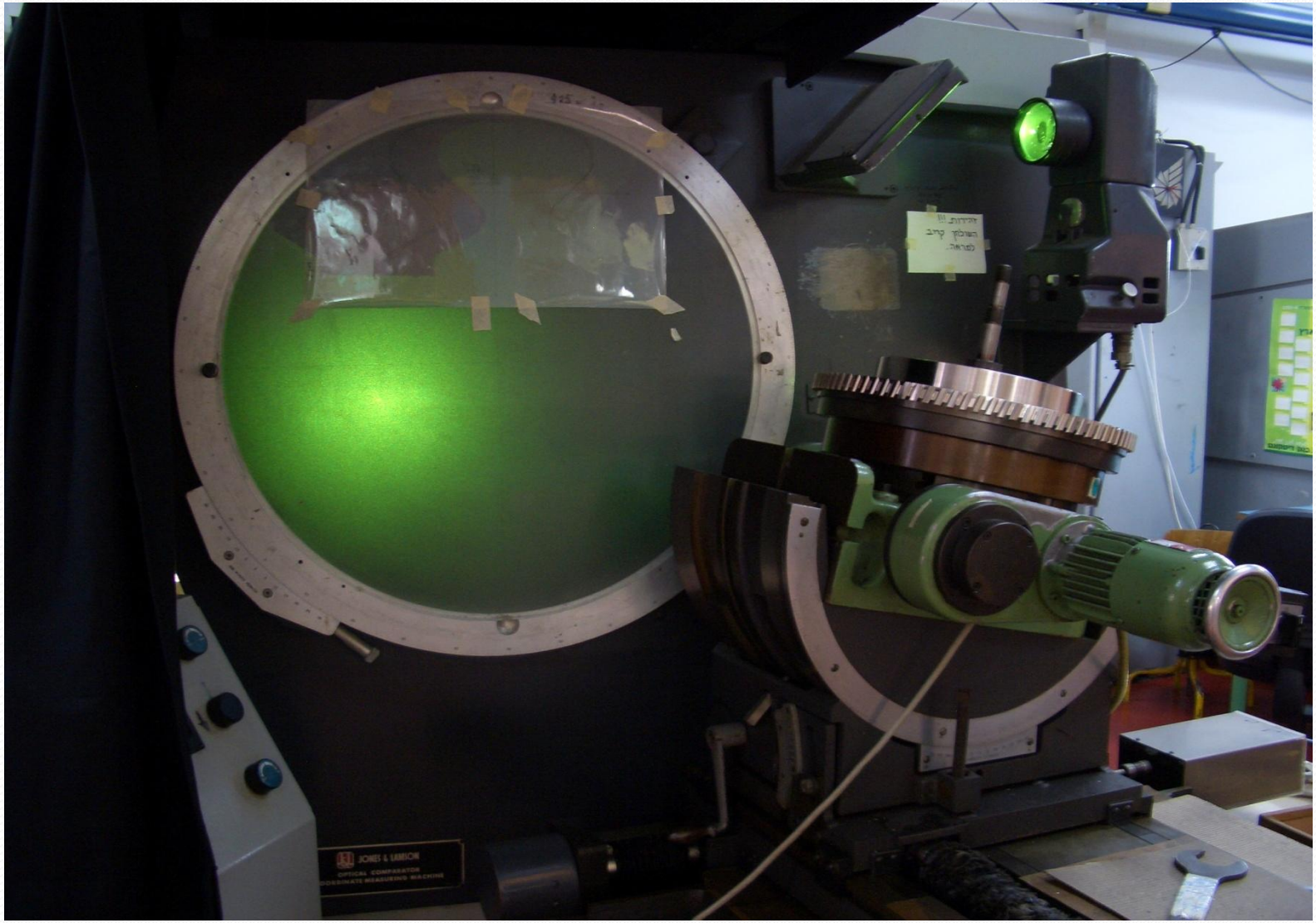
Medium Broaching



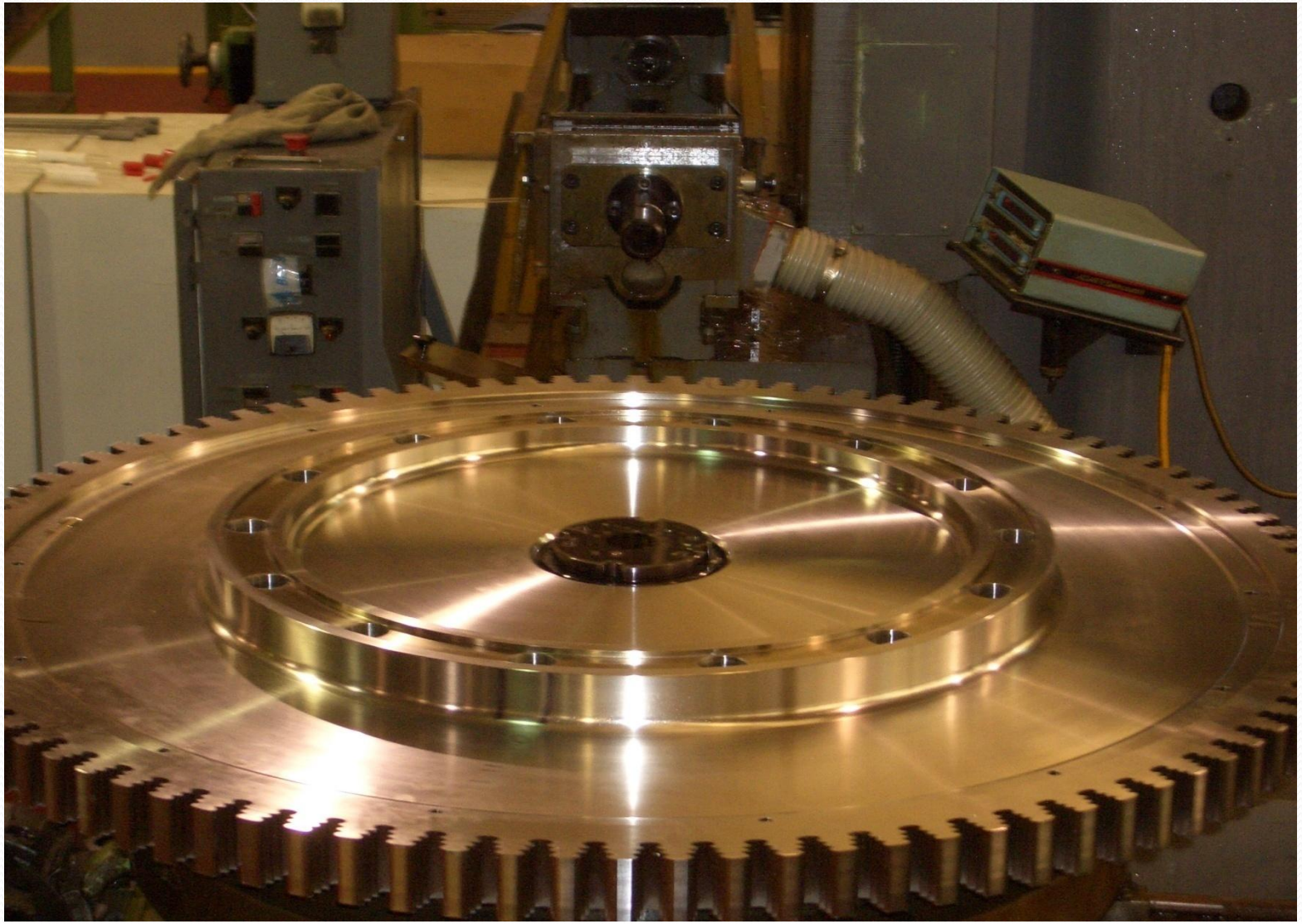
Small Broaching

Broach Inspection



Hand Work

Gun Drilling



Grinding

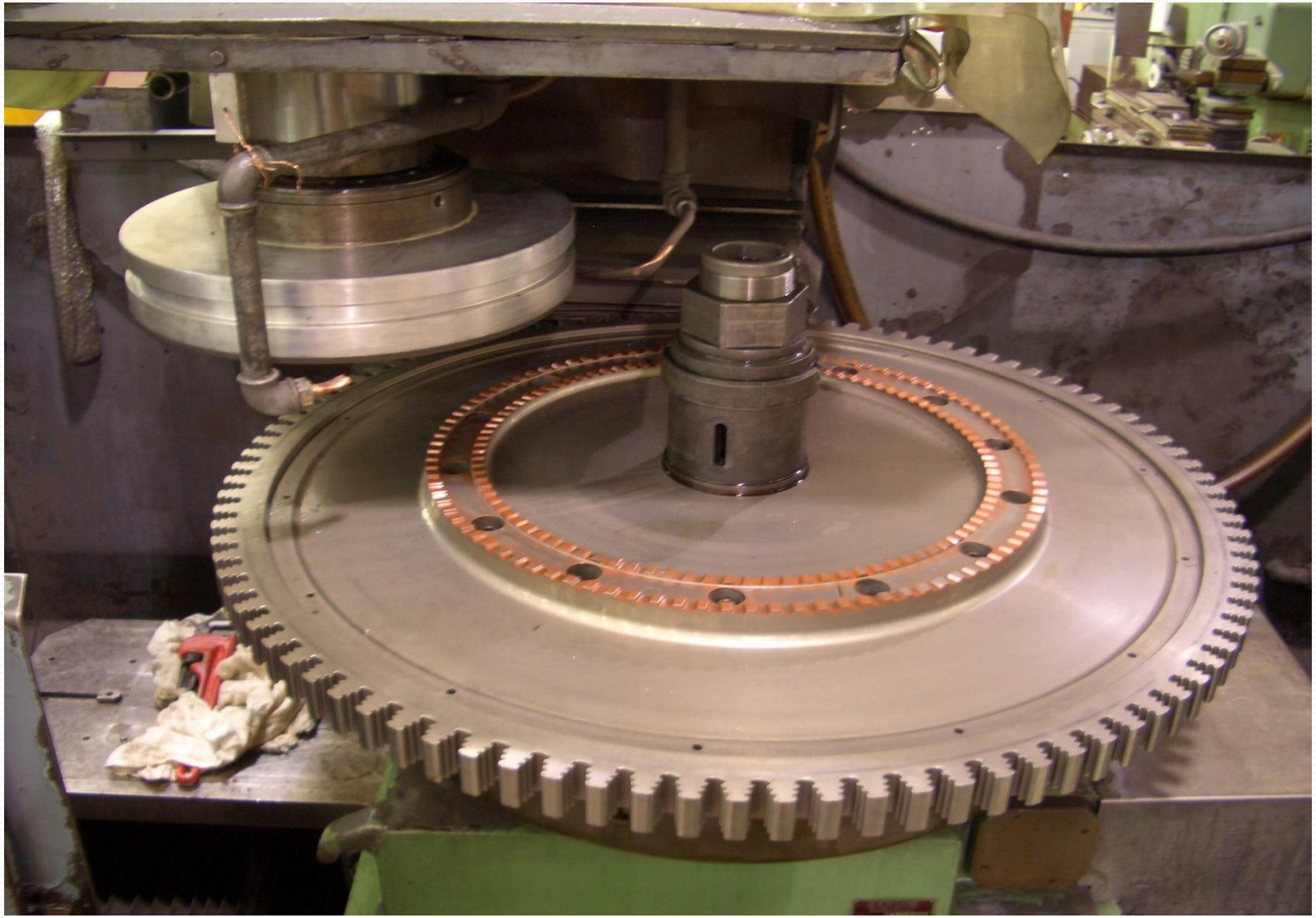
Heat Treatment

Etching (EIM)

FPI

Handling

Curvic Coupling

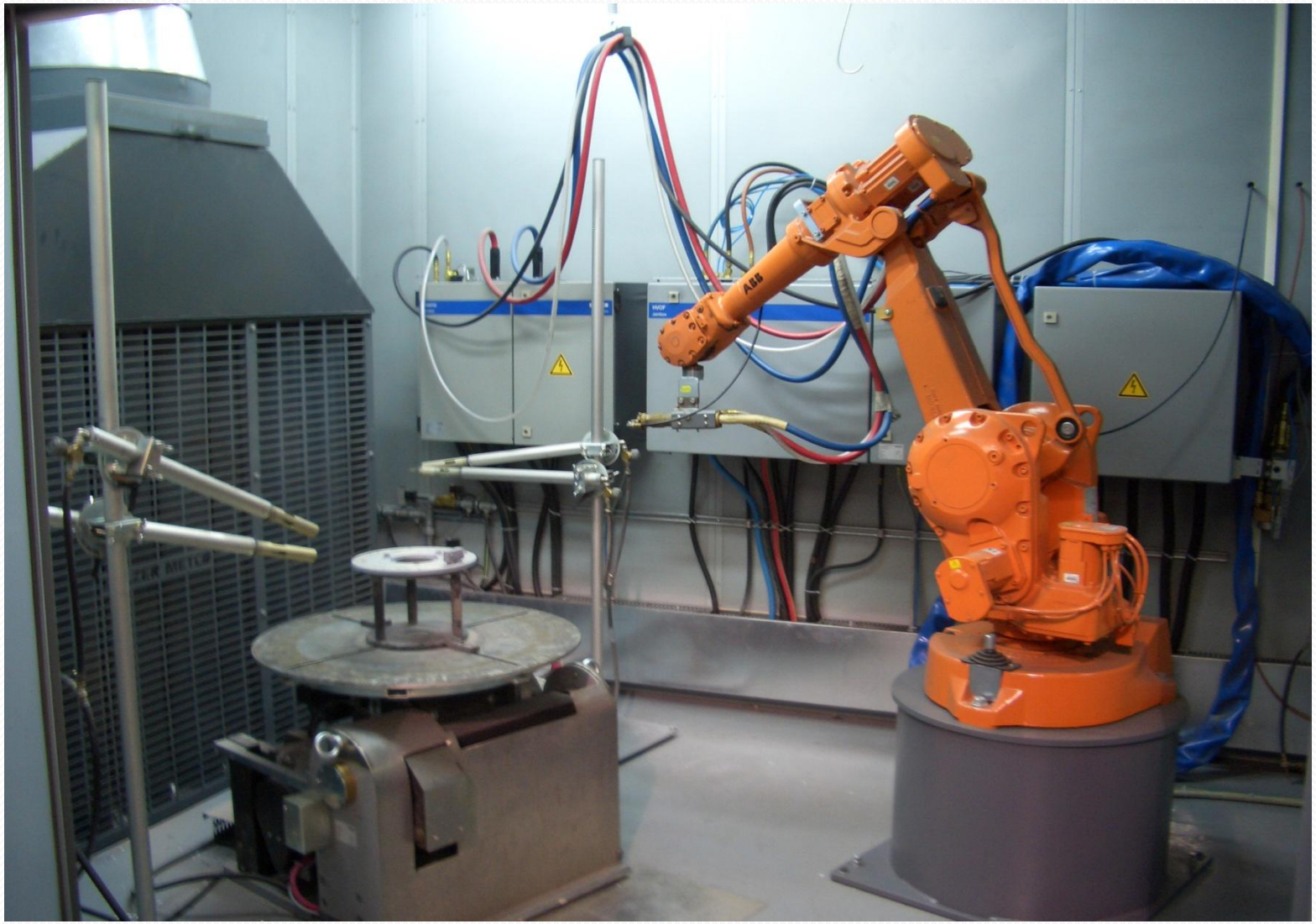


Shot Peening

Sutton

Plasma Spray

Plasma Spray (HVOF)



Eddy Current

Eddy Current

EBW

HIP Process Control Room

HIP Furnace

Final Inspection