DieselJet
Company
and Products
Metatron Group Worldwide

Castel Maggiore-Bologna ITALY
Headquarters
- Management
- Finance & Control
- Sales
- Products Engineering
- R&D
- Operations

Metatron Control System
SHANGHAI
China Branch
- Management
- Operations
- Sales
- Production
- Flight Stand

Volvera – Turin ITALY
- Engines Engineering
- Systems Engineering
- Electronics Development
- Testing & Labs

Metatron Asia Pacific Branch
- Marketing & Sales
- Service
- Taylor-made solutions
- AP logistic hub

Engines for Aviation
BOLOGNA/VOLVERA
- Engineering
- EECS
- HW & SW
- R & D
DieselJet was established in 2003 and grown through a partnership with Centro Ricerche FIAT (CRF), University of Bologna and ISAERS for the development of the first projects.

Since 2011 it is part of the METATRON industrial group, operating in the automotive field as CNG and LPG systems manufacturer.

METATRON and DieselJet now have their main locations in Castel Maggiore (Bologna) and development centre in Volvera (Torino).

DieselJet is focused on the engineering design, development and industrialization of Common Rail Diesel Engine and Gasoline engines derived from the auto industry for aviation rotary and fixed wings applications.

- New Generation Diesel Common Rail engines
- Gasoline injection engines
- Gear box and Engine installation kits
History of DieselJet and its products

- **CY 2000**
  - CRF starts the development of an aviation diesel engine for an UAV manufacturer (IAI)

- **CY 2002 – 2004**
  - DieselJet is founded to support CRF activities in aviation engines

- **CY 2005 – 2006**
  - First flight on January 17th with an IAI Heron UAV powered with a TDA CR 1.9 8V engine
  - Completion of the development of the electronic control DUAL FADEC, fully redundant

- **CY 2007 – 2008**
  - Two TDA CR 1.9 8V engines supplied to AleniaAeronautica: flight of SKY-Y on June 20th
  - EASA approval process successfully completed for the DieselJet DOA

- **CY 2009 – 2010**
  - License Agreement signed by DieseJet with Lycoming for TDA engines
  - EASA certification successfully completed for TDA CR 1.9 8V, 117 kW (TC EASA.E.079)

- **CY 2011 - 2013**
  - 15 prototypes of TDA CR 2.0 16V supplied to Lycoming for an US new UAV, and 48 hours flight
  - IAI Super Heron first flight powered by TDA CR 2.0 16V

- **CY 2014 - 2016**
  - Completion of the special application of the TDA CR 2.0 16V on the US UAV
  - Development of the new gasoline engine GA 1.4 8V for LSA, 80 kW
  - ENAC approval process successfully completed for the DieselJet POA
  - EASA.E.079 certification of the new model: TDA CR 2.0 16V, 160 kW
➢ First Italian diesel engines for aviation certified since 1943 in Italy
➢ Strong Electronics and mechanical skills engineering
➢ Big experience in Diesel Control Propulsion systems
➢ Metrological laboratory and test facilities including Dyno test cell and Propeller test rig
➢ Connections with major Research Centres and University
Facilities: Castel Maggiore (Bologna) Site
Facilities: Volvera (Turin) Site
## DieselJet Product Range Family and Field of Applications

- **Diesel Common Rail engines**
  - **UAV**: ✔
  - **General Aviation**: ✔
  - **Light Sport Aircraft**: ✔

- **Gasoline injection engines**
  - **UAV**: ✔
  - **Light Sport Aircraft**: ✔

- **Gear box and Engine support**
  - **UAV**: ✔
  - **General Aviation**: ✔
  - **Light Sport Aircraft**: ✔

- **Electronic Control (FADEC)**
  - **UAV**: ✔
  - **General Aviation**: ✔
  - **Light Sport Aircraft**: ✔
DieselJet Engines Range

<table>
<thead>
<tr>
<th>Engine Displacement (liter)</th>
<th>Power (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ga 1.4 8V</td>
<td>80 kW</td>
</tr>
<tr>
<td>TDA CR 1.9 8V</td>
<td>121 kW</td>
</tr>
<tr>
<td>TDA CR 2.0 16V</td>
<td>160 kW</td>
</tr>
<tr>
<td>TDA CR 3.0 24V</td>
<td>240 kW</td>
</tr>
</tbody>
</table>

TC EASA.E.079: Mar 2016
TC EASA.E.079: Jun 2010

Future

- TDA CR 3.0 24V
  - 240 kW

Replacement:
- TDA CR 2.0 16V
  - 160 kW

TC EASA.E.079 Jun 2010 replaced by TDA CR 2.0 16V
➢ On 6 December 2006, DieselJet obtained the first engine manufacturing approval for TDA CR 1.9 8V according to EASA Part 21 subpart F by ENAC (Italian Aviation Authority)

➢ On 9 July 2008, DieselJet was approved by EASA as Design Organization with c.a.n. EASA. 21J.283

➢ On 11 June 2010, DieselJet obtained the Type Certificate for its engine TDA CR 1.9 8V n. EASA.E.079 (117 kW)

➢ On 29 January 2016 DieselJet was approved by ENAC as Production Organization with c.a.n. IT.21G.0053

➢ On 8 March 2016 DieselJet completed the Type Certificate process EASA.E.079 for the derived engine TDA CR 2.0 16V (160 kW)
Advantages of aviation Diesel Engines as automotive spin-offs

➢ By making the most of the experience gained in large-scale product manufacturing, the result is a considerable reduction of the (hardly recoverable) costs and time that would have been necessary for designing, developing and producing a specific engine.

➢ Thanks to a statistically relevant population, the conspicuous and reliable data at hand allow to evaluate the product safety.

➢ The fast and continuous technological evolution of the automotive industry results in potentially interesting innovations in the aviation engines field.
Advantages of Diesel Engines for Aviation use

➢ Around 30% of fuel saving, with increased mission range

➢ Possibility to use low cost kerosene Jet A-1 or JP 8 or diesel fuel, even mixing the different fuels, in place of expensive AVGAS, worse and worse difficult to find in many airfields in the World

➢ The use of the same diesel fuel for trucks and tanks and aircrafts brings to logistic advantages and easier availability in particular for defence applications

➢ Higher safety due to the lower fuel flammability, with improved operability in critical conditions (e.g. take off and landing from aircraft carriers)

➢ Low lubricant consumption and long flying capability (48 hours already demonstrated in flight)

➢ Higher robustness and reliability, maintenance lighter and cheaper @ longer intervals

➢ Good suitability for turbocharging with consequent high specific power and capability to keep good performances in altitude

➢ High torque at low speed, with positive results in terms of gearbox weight reduction
The Diesel Engine is much cheaper than Gasoline

➢ The price of a commercial aviation diesel engine is about twice the price of a gasoline engine of the same power (e.g. gasoline 35,000 Euro and diesel 70,000 Euro)

➢ Notwithstanding that, at the end of life the diesel engine will have costed much less

➢ After the 2,000 hours of operations at a typical cruise power of 90-100 kW, a gasoline engine will have consumed about 50,000 l of AVGAS fuel, for about **140,000 Euro**

➢ After the same 2,000 hours, a diesel engine will have consumed about 40,000 l of Jet-A1 fuel, for about **56,000 Euro** (cost saving of 84,000 Euro)

➢ The DieselJet engine useful service life is 4,000 hours, so that at the EOL the saving will be of **168,000 Euro**, i.e. about five time the initial cost difference

➢ For a good engine (e.g. DieselJet engines) the lower maintenance cost (no expensive part replacement for 2000 hours of TBO) will make the saving even more attractive

ref. fuel prices from a typical western country
DieselJet main Customers Countries
As shown in the next pictures, DieselJet can provide its Customers, at their choice, with:

- The engines alone, as defined by the technical specification (certification boundaries)

- Engineering support for the application development, including personnel training, test set to perform development laboratory test with the FADEC, local support for engine test bench set-up, familiarisation and testing, specific calibrations

- A complete Power Package, designed, tested and qualified for the application, including all the accessories necessary for an easy mating with the aircraft
Procurement of basic engine Parts (Crankcase, Head, Shaft, ...)

Procurement of automotive COTS (typical: Sensor & Actuators)

Procurement of aviation Parts & Assemblies (FADEC, Turbo, ...)

Power Package Development & Customer Support

End of Line (ATP) & Form 1

Engine Sells

CUSTOMER

DJ as Engine Manufacturer

Local Organisation

Part 145 required

POA required

POA required

POA required

ILS (Spare Parts, Maintenance)

Part Manufacturing & Procurement

Spare
Cessna onboard installation for ground and flight testing
Presentation of Engine

TDA CR 2.0 16V

TC EASA.E.079

Derived from
TDA CR 1.9 8V certified in 2010
Engine TDA CR 2.0 16V
### Engine TDA CR 2.0 16V Key Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architecture</strong></td>
<td>4 cylinder in line</td>
</tr>
<tr>
<td><strong>Bore</strong></td>
<td>mm 83.0</td>
</tr>
<tr>
<td><strong>Stroke</strong></td>
<td>mm 90.4</td>
</tr>
<tr>
<td><strong>Displacement</strong></td>
<td>cm³ 1955</td>
</tr>
<tr>
<td><strong>Valves / cylinder</strong></td>
<td># 4</td>
</tr>
<tr>
<td><strong>Compression ratio</strong></td>
<td>- 16.0</td>
</tr>
<tr>
<td><strong>Turbocharger</strong></td>
<td>Single Stage - WG</td>
</tr>
<tr>
<td><strong>Fuel Injection System</strong></td>
<td>Common Rail 1600 bar</td>
</tr>
<tr>
<td><strong>Injector Nozzle</strong></td>
<td>7 holes x 560 cm³/30 sec</td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td>Kerosene &amp; Diesel Fuel EN 590</td>
</tr>
<tr>
<td><strong>Alternators available</strong></td>
<td>volt 28 (sdt 2.8 kW - opt 3.5 kW)</td>
</tr>
<tr>
<td><strong>EECS</strong></td>
<td>DUAL FADEC ECU</td>
</tr>
<tr>
<td><strong>Weight with gear box</strong></td>
<td>Kg 205</td>
</tr>
<tr>
<td><strong>Dimensions LxWxH</strong></td>
<td>mm 600 x 507 x 687 without GearBox</td>
</tr>
<tr>
<td><strong>Take Off Power</strong></td>
<td>kW 160 (at propeller shaft)</td>
</tr>
<tr>
<td><strong>Continous Power</strong></td>
<td>kW 142 (at propeller shaft)</td>
</tr>
<tr>
<td><strong>Altitude for max power</strong></td>
<td>ft 8700</td>
</tr>
<tr>
<td><strong>Min. BSFC</strong></td>
<td>g/kWh 210 (at propeller shaft)</td>
</tr>
</tbody>
</table>
The **FADEC** (Full Authority Digital Electronic Control) is the digital control system managing the Common Rail Diesel engine and is connected to the cockpit instruments and control. It can also be controlled by a **FCS** (Flight Control System).

**FADEC** is based on a « hot redundant » architecture concept adopting identical dual LANEs and redundant **Power Supply Units plus BUL (Back-Up Logic)**. This means that each section (named LANE) has its own microprocessor with dedicated hardware and software capable of independently controlling the engine; it includes diagnostic features monitoring the LANE’s health and, if required, the correct operation & use of the engine.

By means of a dedicated internal communication media and software, each LANE exchanges its own engine parameter with the other LANE in order to detect faults, isolate them and perform recovery action in real time.

The **BUL** manages the LANE’s operation by monitoring run time, health and correct availability of each **FADEC** section thanks to dedicated hardware signals. The scope is to keep only one LANE in charge of the engine control and maintain the engine running with optimum performance in safe conditions.
Engine TDA CR 2.0 16V GEAR BOX
### DieselJet TDA CR 2.0 16V Engine toward best competitors

<table>
<thead>
<tr>
<th>COMPARISON ITEM</th>
<th>DIESELJET ENGINE</th>
<th>COMPETITORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Weight (kg)</td>
<td>205</td>
<td>150 - 210</td>
</tr>
<tr>
<td>Take Off Power 100% (kW)</td>
<td>160</td>
<td>114 - 124</td>
</tr>
<tr>
<td>Max Continuous Power 90% (kW)</td>
<td>142</td>
<td>114 - 115</td>
</tr>
<tr>
<td>Rate Max Power/Weight</td>
<td>0,78</td>
<td>0,76 - 0,59</td>
</tr>
<tr>
<td>Full autonomous redundancy management by FADEC</td>
<td>Yes</td>
<td>Partial</td>
</tr>
<tr>
<td>MTBF (hours)</td>
<td>1.500</td>
<td>1.100</td>
</tr>
<tr>
<td>Known reliability issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Head and Sump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gear Box</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sensors</td>
</tr>
<tr>
<td>TBO (hours) [initial ➔ full service]</td>
<td>1.000 ➔ 2.000</td>
<td>600</td>
</tr>
<tr>
<td>TBO Cost (Euro)</td>
<td>25.000</td>
<td>46.000</td>
</tr>
<tr>
<td>Service Life (hours) [initial ➔ full service]</td>
<td>2.000 ➔ 4.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>
NOTE:

The diagram reports TDA measured data, confirmed in several UAV flights up to 31000 ft.

DieselJet understanding is that the TDA CR 2.0 16V has still some improvement margins for high altitude performances to be assessed during any specific aircraft installation.

Competitor data obtained from papers available in the relevant WEB sites.
The aviation engines design is based on a safety assessment process derived from the CRF Safety Assessment Procedure DO-RP-008.

The main tasks and inter-relations with other development process activities are shown in the figure at the side.

The Procedure **DO-RP-008** is part of the DieselJet Design Organization approved by EASA.
DieselJet has implemented an efficient and sound Configuration Control System, based on a Data Base infrastructure.

The correctness of each phase of the process, is granted from the Specification release to the manufacturing drawings, to the transfer of the data to the Production, and to the release of the ABDL.
DieselJet has implemented an integral Problem Handling process, based on specific tools and procedures that cover all the aspects of the company organization and of the product life cycle.

Problems are handled and fixed from the product development to its continue airworthiness.
Flight test with DieselJet common rail diesel engine