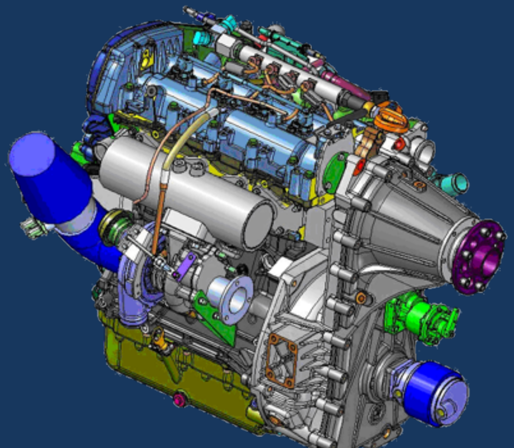
DieselJet Company and Products



DJ-HD-A-3500002 March 2016

Metatron Group Worldwide

Castel Maggiore-Bologna ITALY
Headquarters

- Management
- Finance&Control
- Sales
- Products Engineering
- R&D
- Operations

METATRON
Advanced Engine Control and Propulsion Systems

美塔特龍
Metatron Control System
SHANGHAI
China Branch

DIESEL JET
the flying diesel
Engines for Aviation
BOLOGNA/VOLVERA

METATRONIX
Powertrain Control Systems
VOLVERA
digigroup

Metatron Asia Pacific Branch

- Marketing & Sales
- Service
- Taylor-made solutions
- AP logistic hub

- Management
- Operations
- Sales
- Production
- Flight Stand

- Engineering
- EECS
- HW & SW
- R & D

Volvera – Turin ITALY

- Engines Engineering
- Systems Engineering
- Electronics Development
- Testing & Labs

Diesel Jet at a glance

- ***DieselJet*** was established in 2003 and grown through a partenership 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**

→ **Engine Electronic Control Systems (FADEC).**

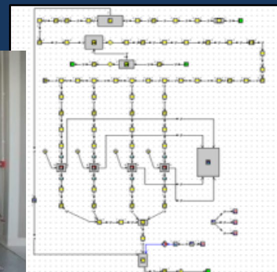
→ **Gear box and Engine installation kits**

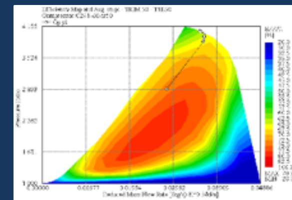
Highlight

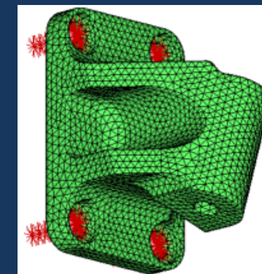
History of DieselJet and its products

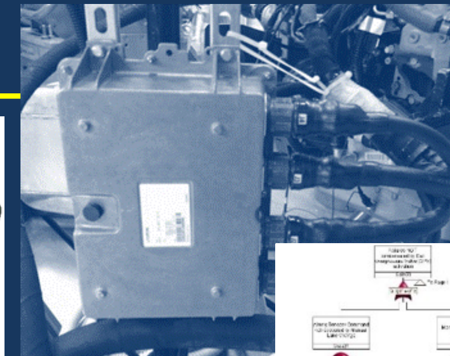
- **CY 2000**
  - CRF starts the development of an aviation diesel engine for an UAV manufacturer (IAI)
- **CY 2002 – 2004**
  - DieselJet is founded to support CRF activities in aviation engines
- **CY 2005 – 2006**
  - First flight on January 17th with an IAI Heron UAV powered with a TDA CR 1.9 8V 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

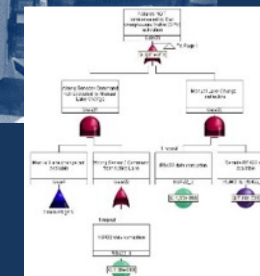
DieselJet Technology Leadership











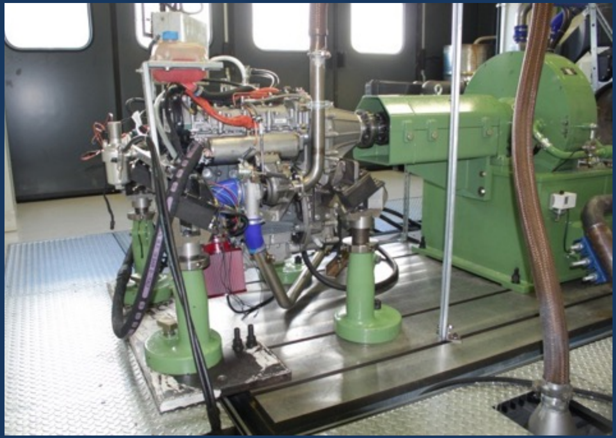
- First Italian diesel engines for aviation certified since 1943 in Italy

- 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

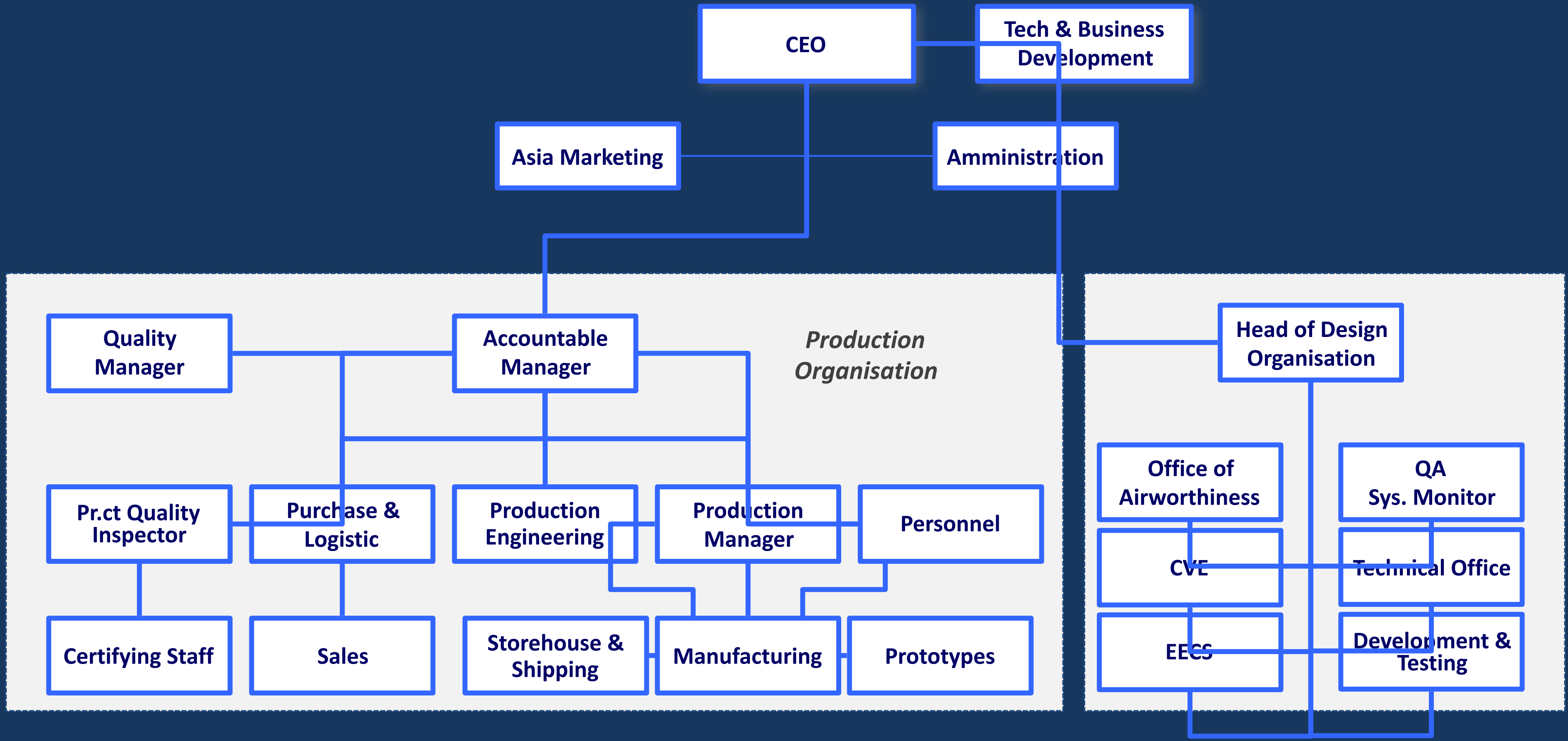
DIESEL JET the flying diesel

Facilities: Castel Maggiore (Bologna) Site

Facilities: Volvera (Turin) Site

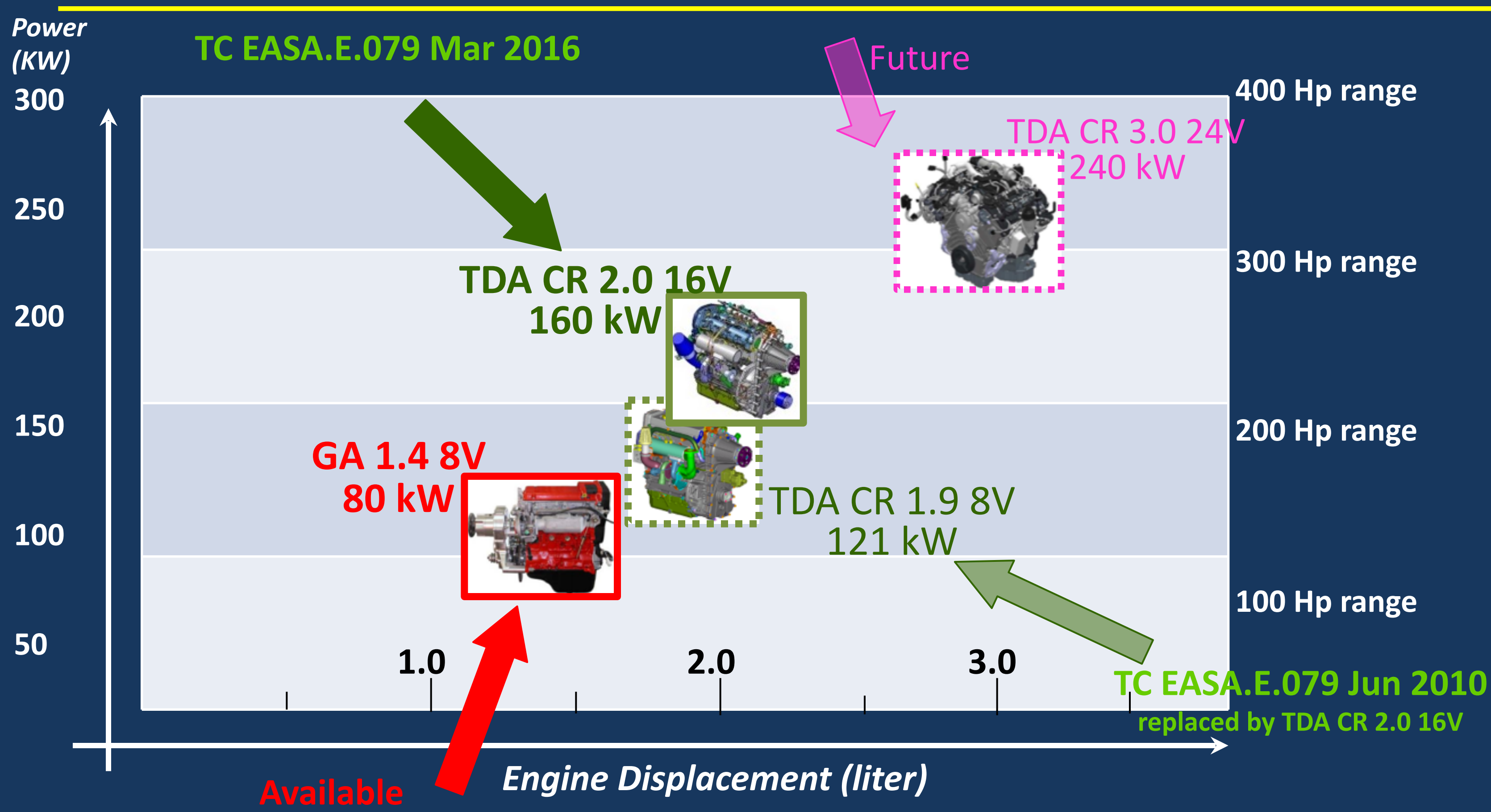
DieselJet Company Organization



DieselJet Product Range Family and Field of Applications

		UAV	General Aviation	Light Sport Aircraft
➢ Diesel Common Rail engines		✓	✓	
➢ Gasoline injection engines				✓
➢ Gear box and Engine support		✓	✓	✓
➢ Electronic Control (FADEC)		✓	✓	✓

DieselJet Engines Range



Certifications

European Aviation Safety Agency

APPROVAL CERTIFICATE

EASA.21J.283

Pursuant to Regulations (EC) 216/2008 and (EC) 1702/2003 and subject to the conditions specified below, the Agency hereby certifies

DIESEL JET
via Filippo Guarini 5/7
47100 Forlì
Italy

as a DESIGN ORGANISATION

approved according to Part 21, Section A, Subpart J

CONDITIONS :

1. The approval is limited to that specified in the enclosed Terms of Approval, and
2. This approval requires compliance with the procedures specified in the Design Organisation Handbook, reference DJ-DO-HB-001, in the latest revision, and
3. This approval is valid whilst the approved Design Organisation remains in compliance with Part 21, Section A, Subpart J.
4. Subject to compliance with the foregoing conditions, this approval shall remain valid until surrendered or revoked.

For the European Aviation Safety Agency,

Date of issue: 09 July 2008

Roger SIMON
Design Organisation Manager

EASA Form 83A, Issue 2

European Aviation Safety Agency

Terms of Approval

Design Organisation Approval Certificate
EASA.21J.283

1. Scope of approval
2. Categories of products
Piston engines
3. List of products
Types for which Diesel Jet is type-certificate holder:
- TDA CR 1.9 8V
- TDA CR 2.4 20V
4. Privileges

EASA

TYPE CERTIFICATE

EASA.E.079

This Type Certificate is issued by EASA, acting in accordance with Regulation (EC) No. 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation and in accordance with Commission Regulation (EU) No. 748/2012 to

DIESELJET S.R.L.

VIA MARABINI 11
40013 CASTEL MAGGIORE BO
ITALY

and certifies that the product type design listed below complies with the applicable Type Certification Basis and environmental protection requirements when operated within the conditions and limitations specified on the associated:

Type Certificate Data Sheet Number: EASA.E.079

Type Design - Model:		Date of Issue:
TDA CR Series	TDA CR 1.9 8V	11 June 2010
	TDA CR 2.0 16	08 March 2016

For the European Aviation Safety Agency

Date of issue: 08 March 2016

Klaus BOEWING
Propulsion Section Manager

- 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)

DIESEL JET the flying diesel

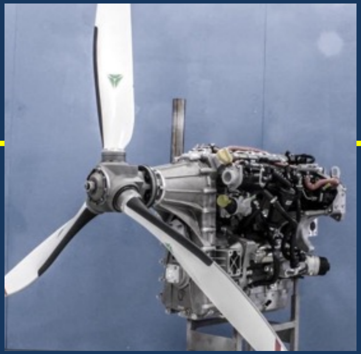
Advantages of aviation Diesel Engines as automotive spin-offs

- 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.

Common Rail Diesel Engines, born to fly



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

ref. fuel prices from a typical western country

- 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 <u>much less</u>
- 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 (<u>e.g. DieselJet engines</u>) the lower maintenance cost (no expensive part replacement for 2000 hours of TBO) will make the saving even more attractive

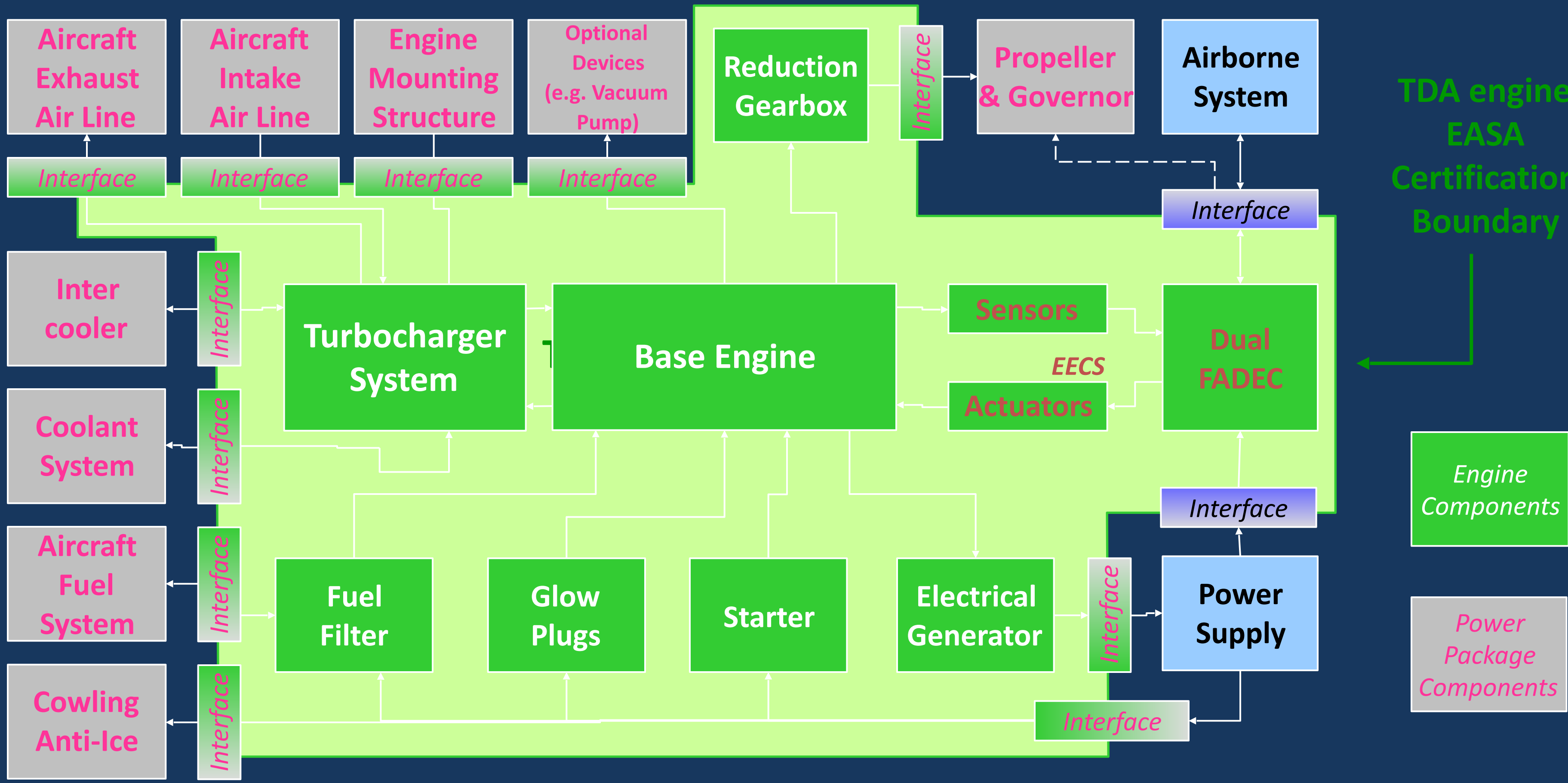
DieselJet main Customers Countries

DieselJet Engines and other Support

As shown in the next pictures, DieselJet can provide its Customers, at their choice, with:

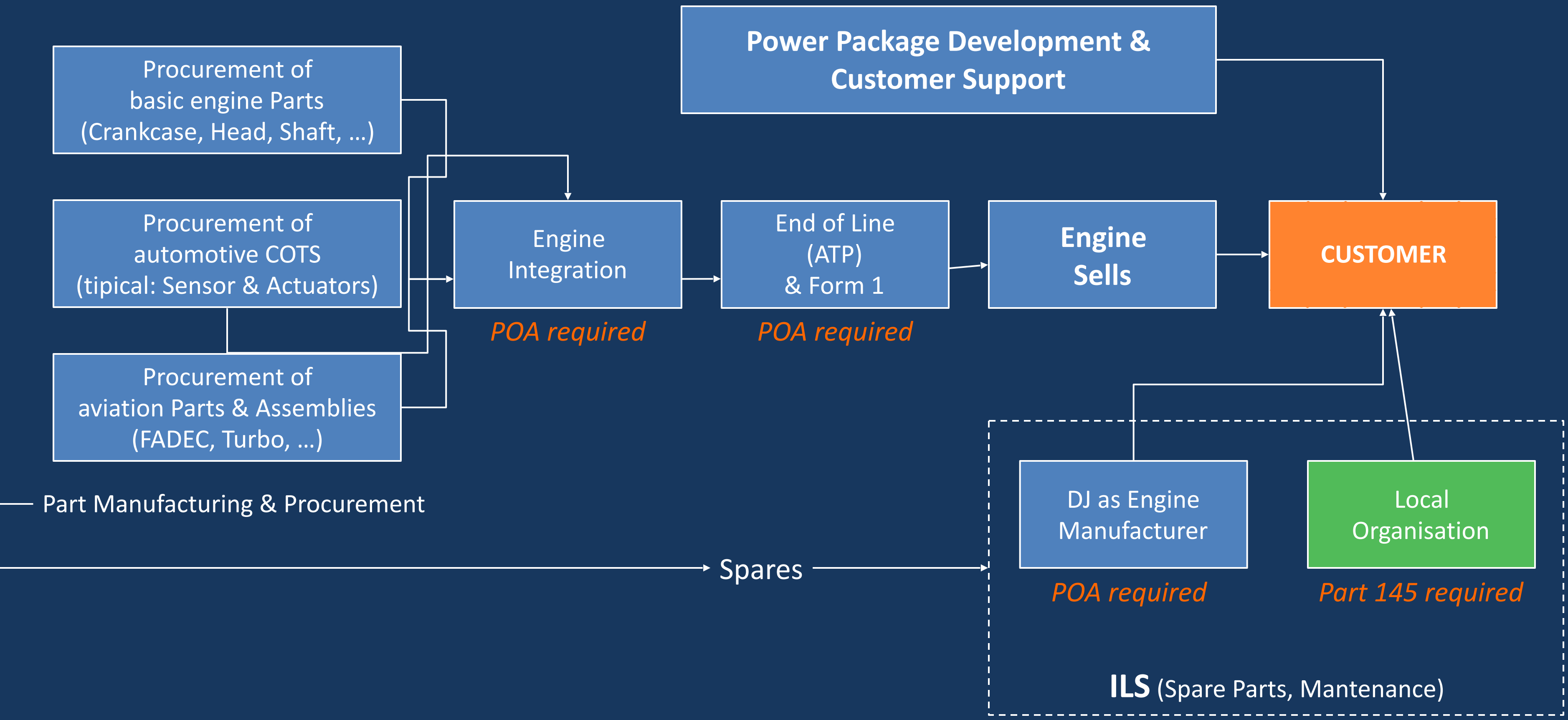
- The engines alone, as defined by the technical specification (certification boundaries)
- Engineering support for the application development, including personnel training, test set to perform development laboratory test with the FADEC, local support for engine test bench set-up, familiarisation and 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

Engine & Power Package Architecture



DIESEL JET the flying diesel

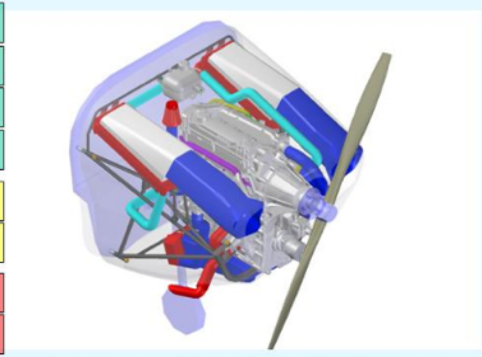
DieselJet Production & ILS Approach

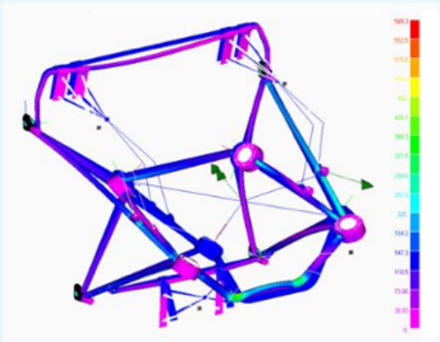


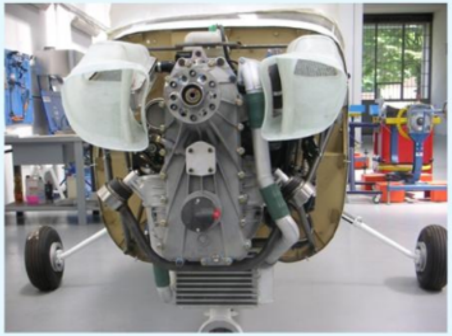
Engine TDA CR 2.0 16V Typical Power Package

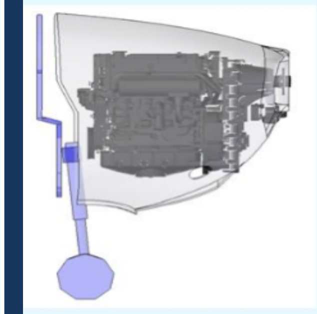
Cessna onboard installation for ground and flight testing

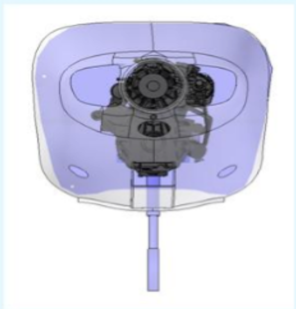
- ENGINE SUPPORT FRAME
- INSTALLATION LAYOUT
- COWLING MODIFICATION
- FADEC WIRING HARNESS
- AIRCAFT FUEL SYS MODIFICATION
- AIRCRAFT ELECTRICAL SYS MODS
- AIRCRAFT ASSEMBLY
- AIRCRAFT FLIGHT TESTS







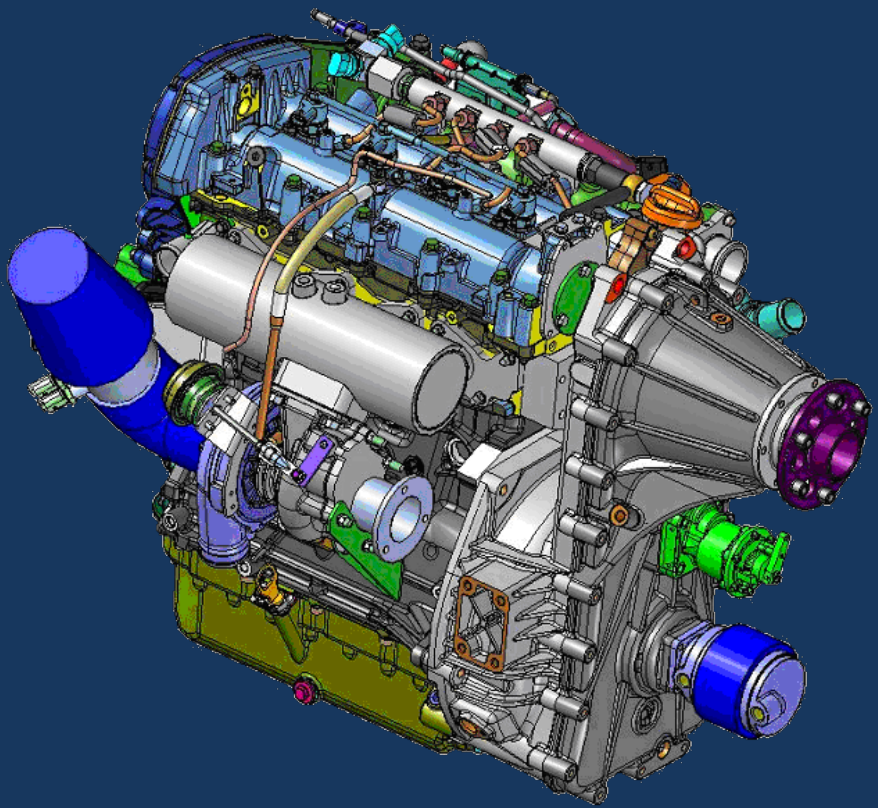




Engine TDA CR 2.0 16V

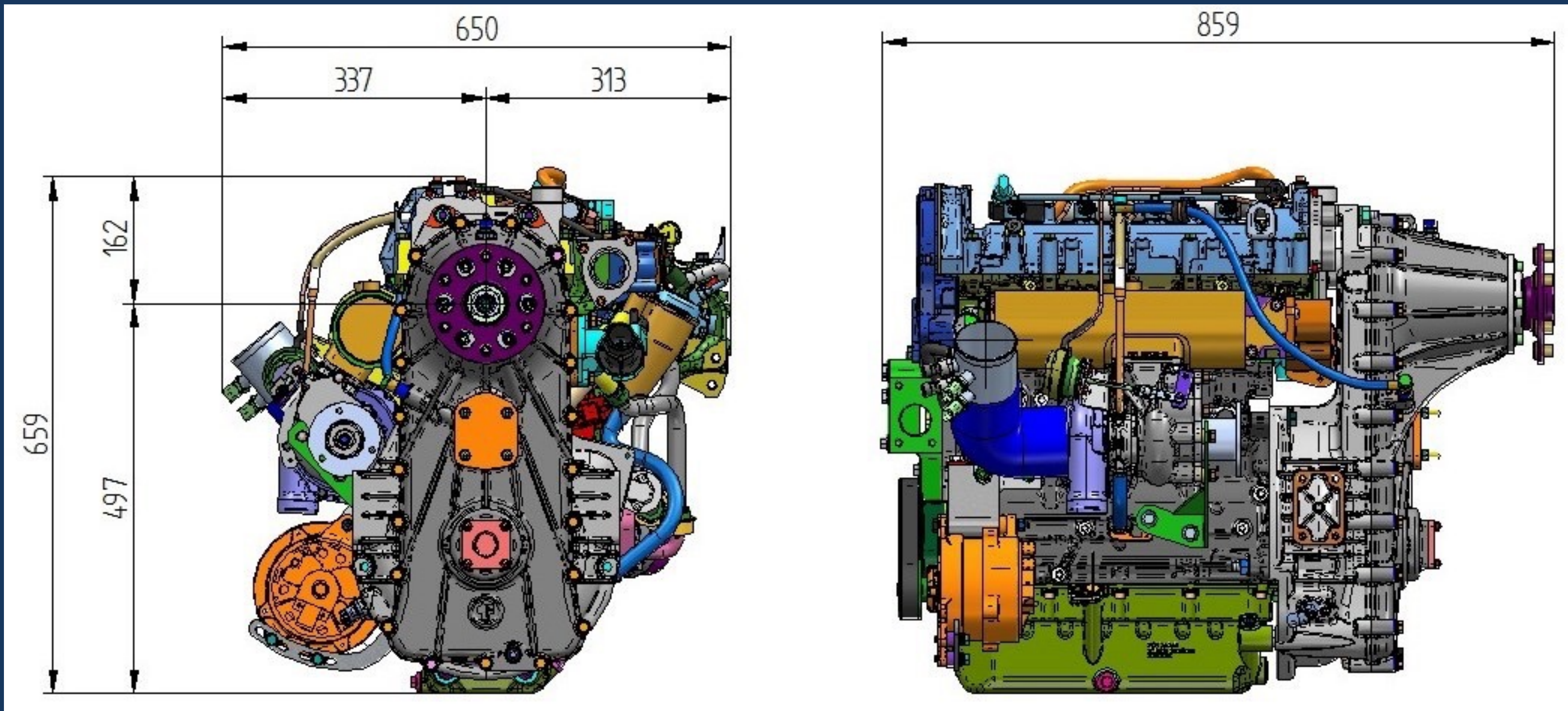
Presentation of Engine
TDA CR 2.0 16V
TC EASA.E.079

Derived from
TDA CR 1.9 8V certified in 2010



DIESEL JET
the flying diesel

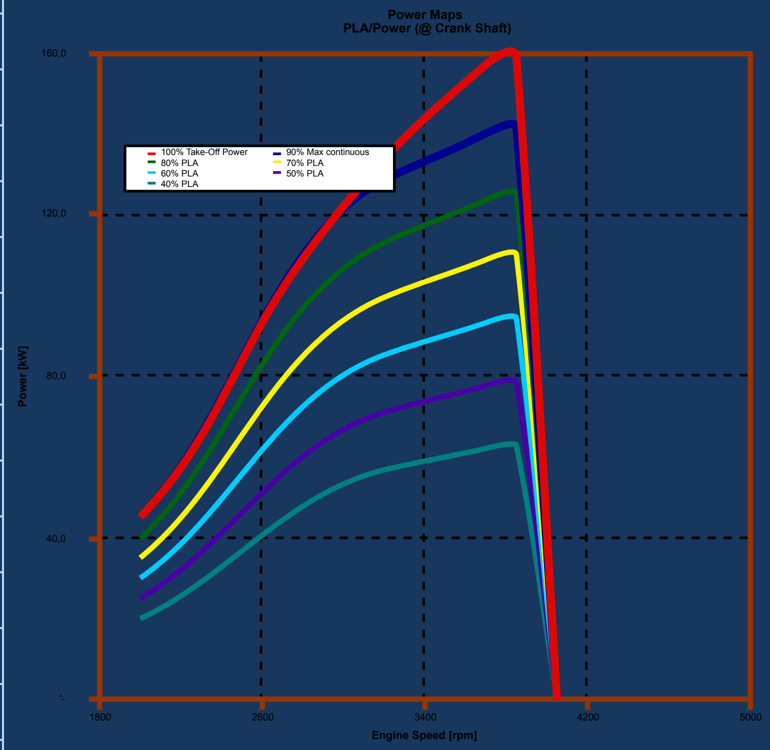
Engine TDA CR 2.0 16V



DIESEL JET
the flying diesel

Engine TDA CR 2.0 16V Key Features

Architecture	-	4 cylinder in line
Bore	mm	83.0
Stroke	mm	90.4
Displacement	**cm3**	**1955**
Valves / cylinder	#	4
Compression ratio	-	16.0
Turbocharger	-	Single Stage - WG
Fuel Injection System	-	Common Rail 1600 bar
Injector Nozzle	-	7 holes x 560 cm3/30 sec
Fuel		Kerosene & Diesel Fuel EN 590
Alternators available	volt	28 (sdt 2.8 kW - opt 3.5 kW)
EECS	-	DUAL FADEC ECU
Weight with gear box	**Kg**	**205**
Dimensions LxWxH	**mm**	**600 x 507 x 687 without GearBox**
Take Off Power	**kW**	**160 (at propeller shaft)**
Continous Power	**kW**	**142 (at propeller shaft)**
Altitude for max power	**ft**	**8700**
Min. BSFC	**g/kWh**	**210 (at propeller shaft)**



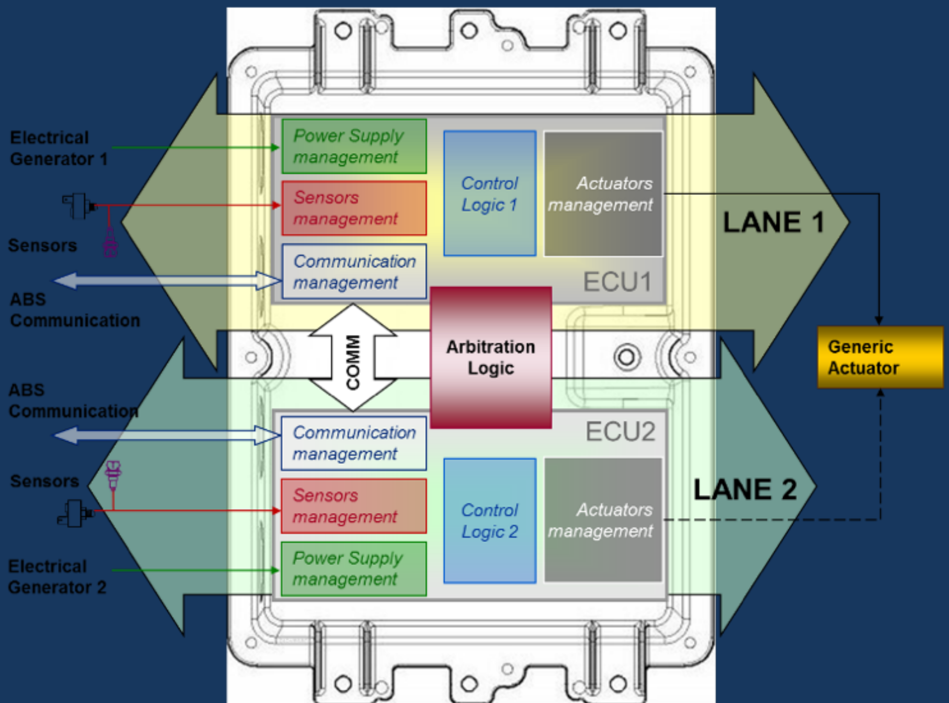
Engine TDA CR 2.0 16V FADEC

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.

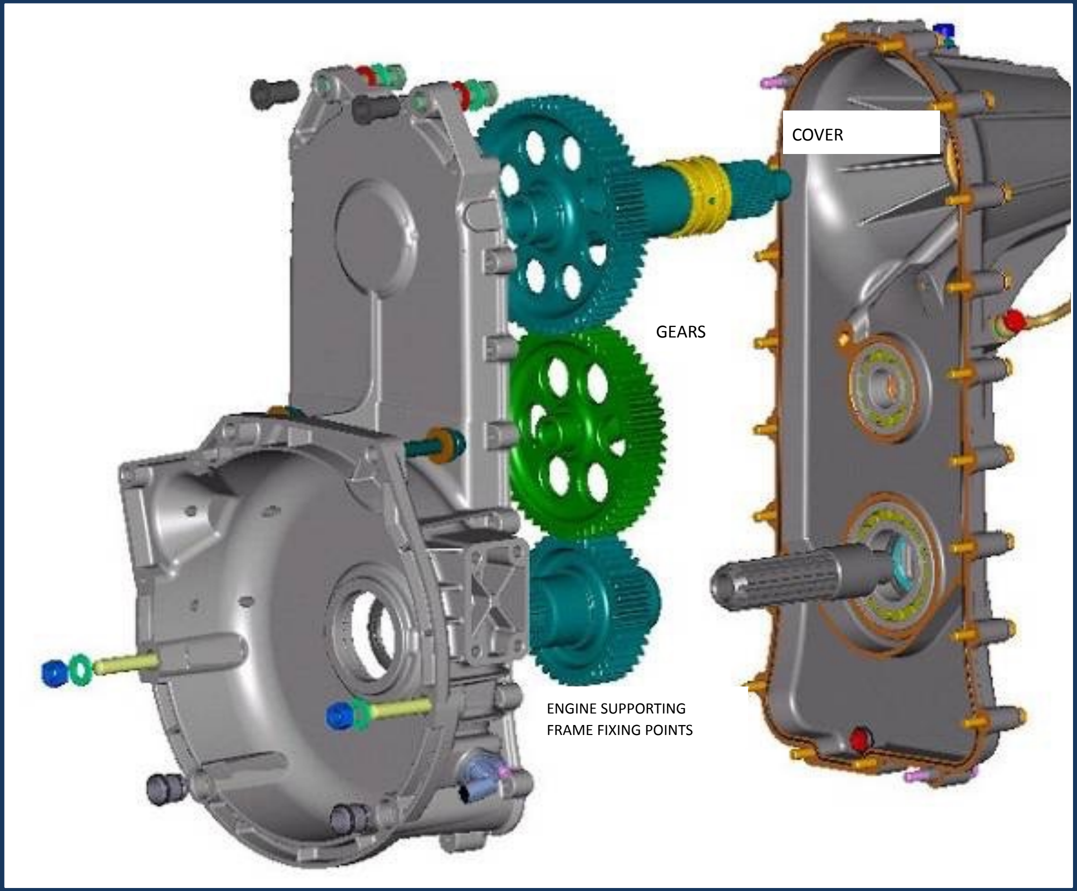
By means of a dedicated internal communication media and software, each LANE exchanges its own engine parameter with the other LANE in order to detect faults, isolate them and perform recovery action in real time.

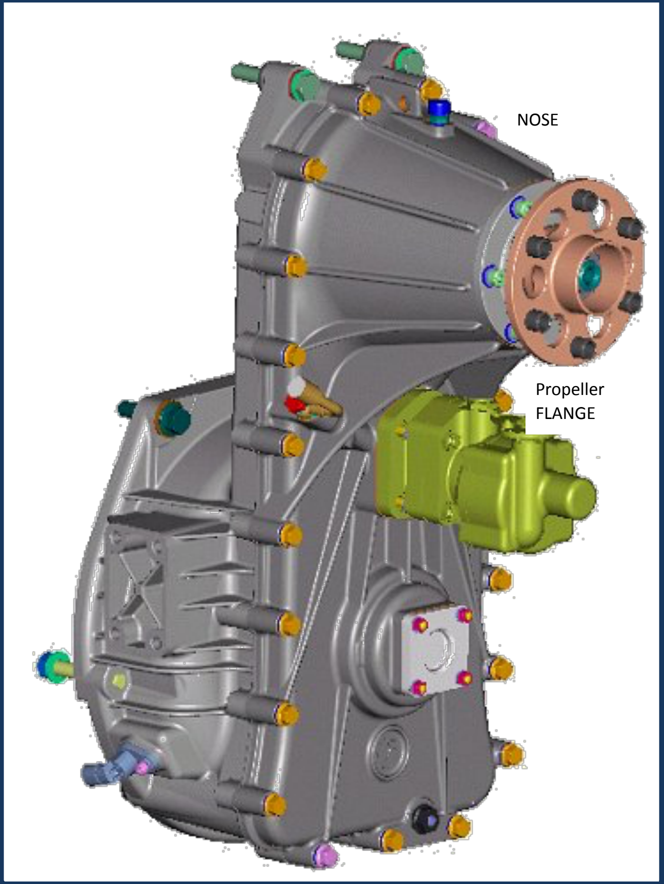
The **BUL** manages the LANE's operation by monitoring run time, health and correct availability of each **FADEC** section thanks to dedicated hardware signals. The scope is to keep only one LANE in charge of the engine control and maintain the engine running with optimum performance in safe conditions.



FADEC Architecture

Engine TDA CR 2.0 16V GEAR BOX

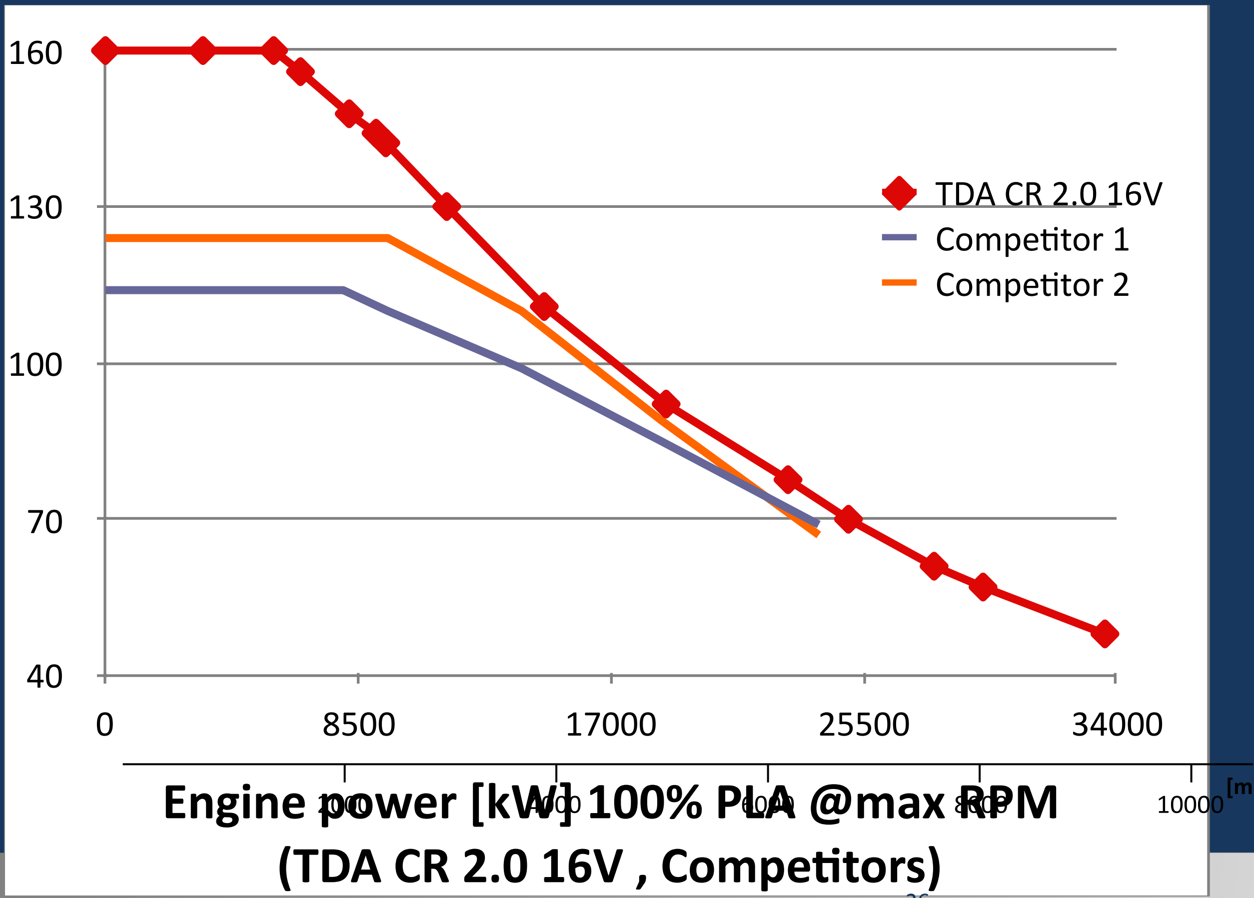




DieselJet TDA CR 2.0 16V Engine toward best competitors

Comparison Item	DieselJet Engine	Competitors
Dry Weight (kg)	205	150 - 210
Take Off Power 100% (kW)	160	114 - 124
Max Continuous Power 90% (kW)	142	114 - 115
Rate Max Power/Weight	0,78	0,76 - 0,59
Full autonomous redundancy management by FADEC	Yes	Partial
MTBF (hours)	1.500	1.100
Known reliability issues		• Head and Sump • Gear Box • Sensors
TBO (hours) *[initial ➢ full service]*	1.000 ➢ 2.000	600
TBO Cost (Euro)	25.000	46.000
Service Life (hours) *[initial ➢ full service]*	2.000 ➢ 4.000	1.000

DieselJet TDA CR 2.0 16V Engine toward best competitors



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

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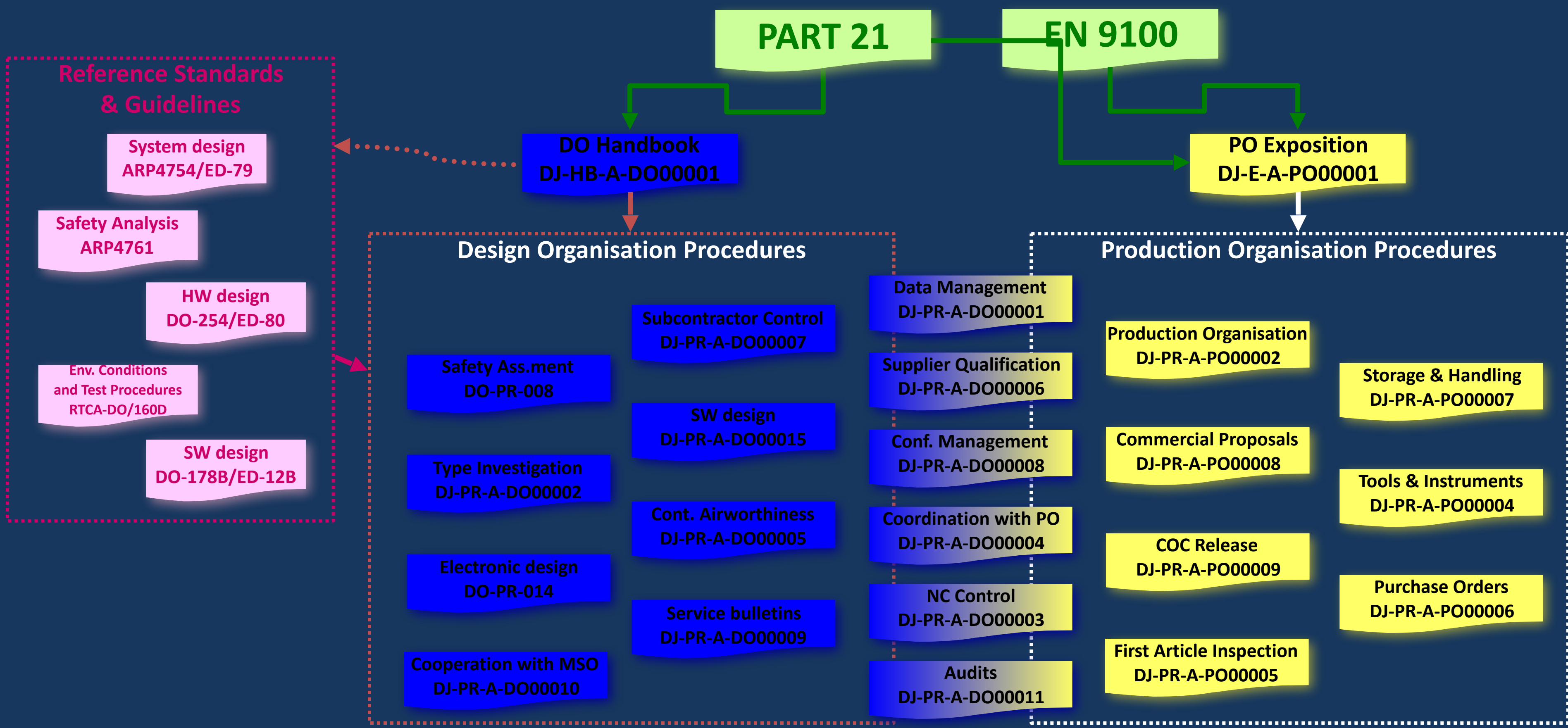
DieselJet Quality System

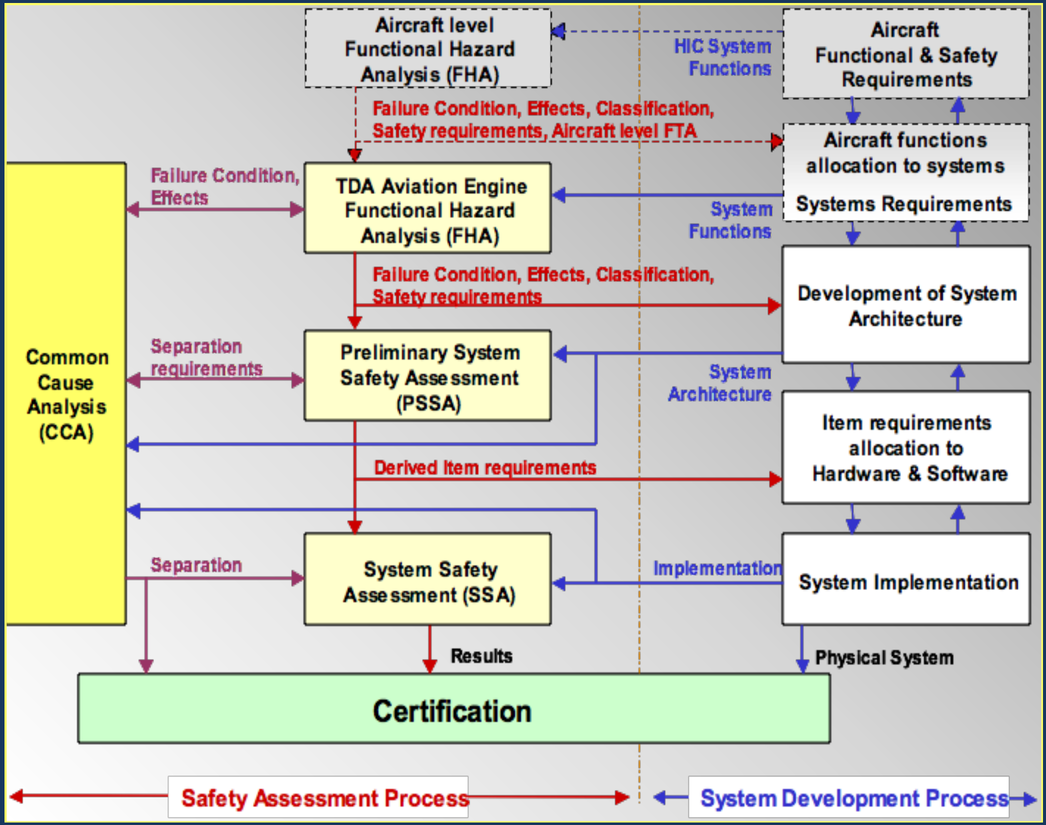


DJ Aviation Engines Safety Assessment Process

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.

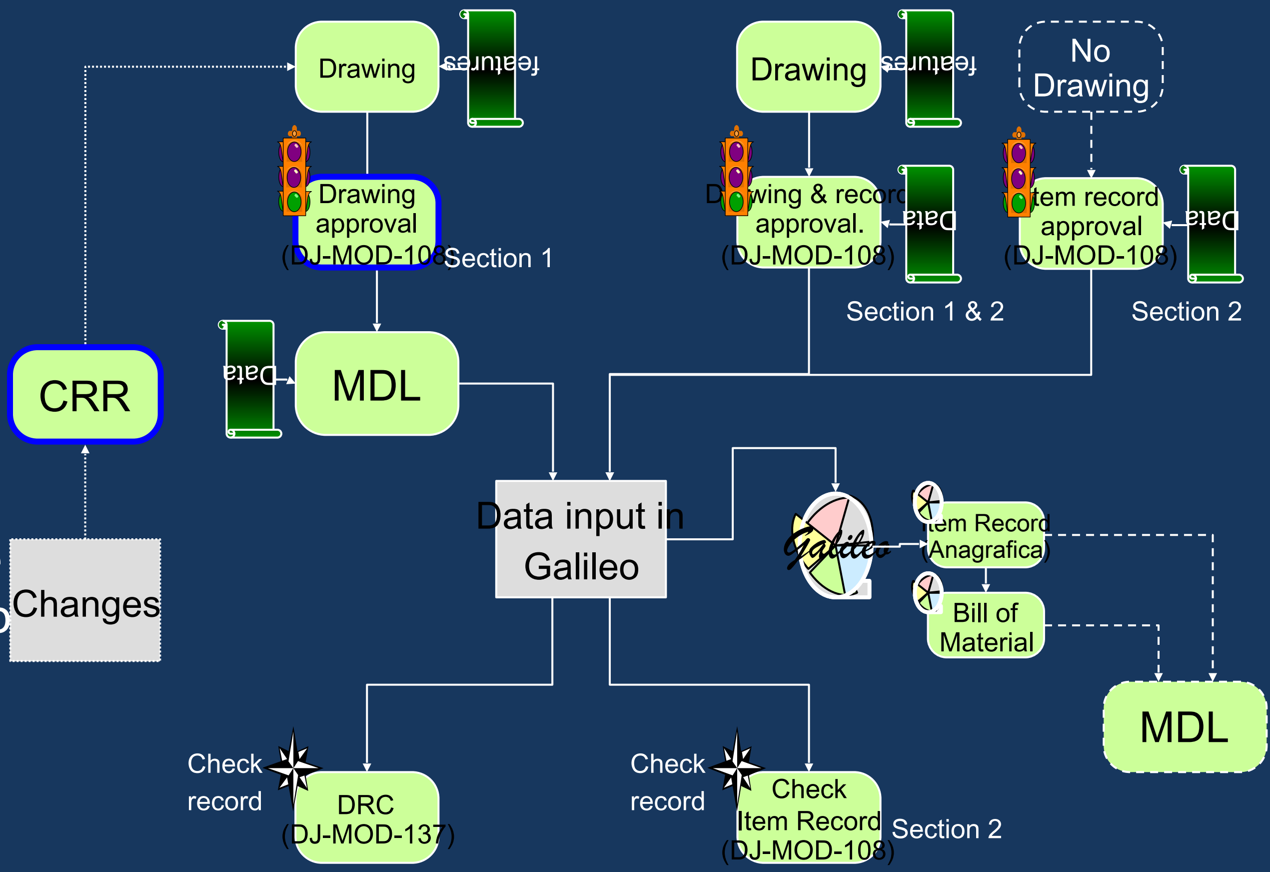
The Procedure [DO-RP-008](DO-RP-008) is part of the DieselJet Design Organization approved by EASA



DieselJet Configuration Control Process

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

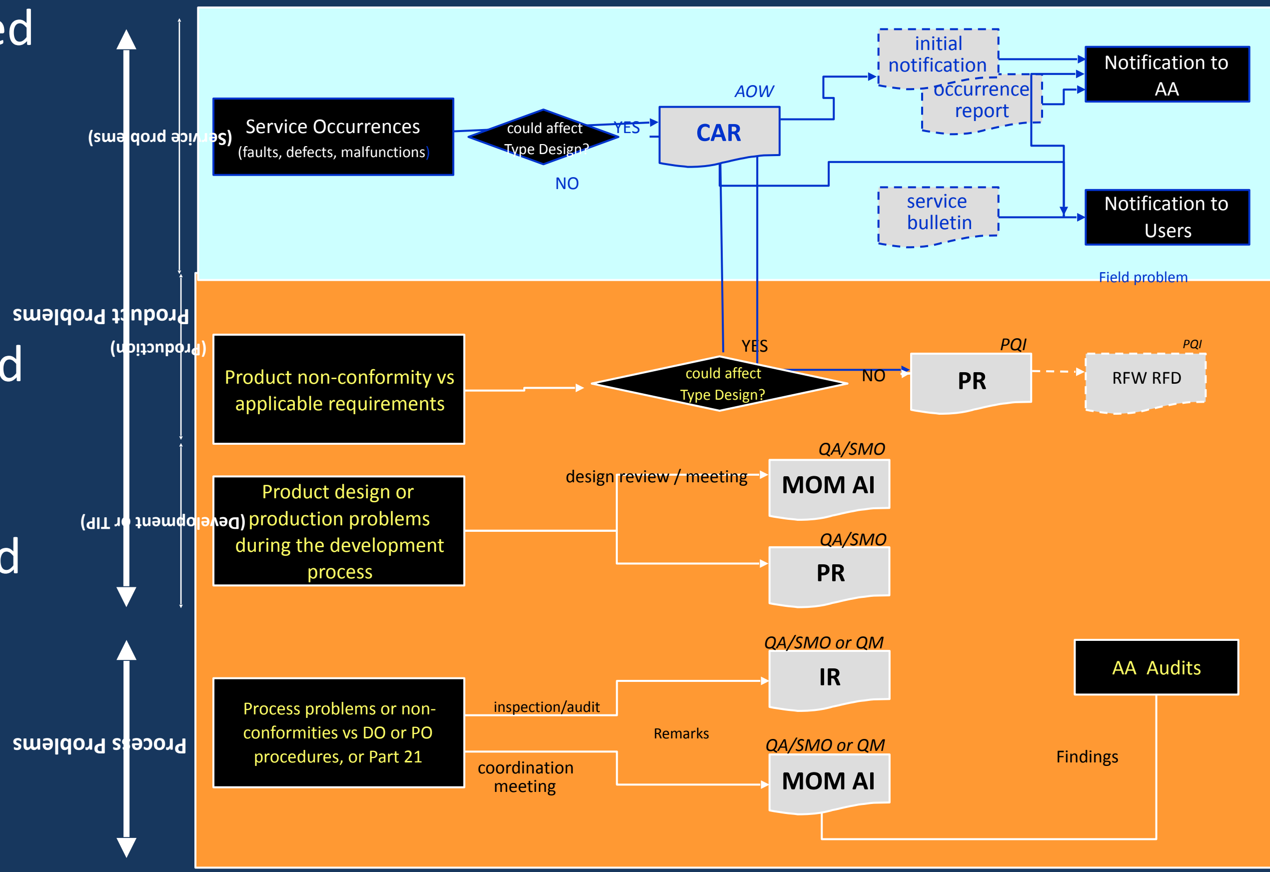


Problems & Non Conformity Process

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

PROBLEM MANAGEMENT



Thanks for your attention