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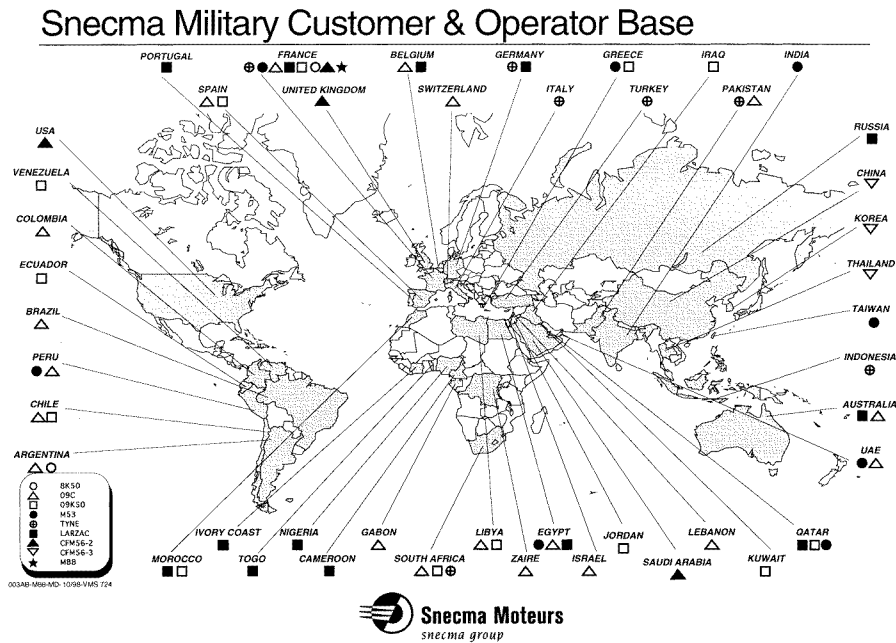
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Snecma ATAR Engines Cost Effective Maintenance in a 1960-2020 Life time

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1. **Introduction :**

Today, 47 airforces are operating more than 6000 engines sold by Snecma or by CFMI, the joint company (50/50) of Snecma (France) and GE (USA) – (fig1).



Among those engines, some have been operated for more than 30 years (fig.2).

SNECMA Military Engine Experience (as of December 31st, 1999)

| ENGINE | AIRCRAFT | ENGINES IN SERVICE | OPERATORS | SERVICE EXPERIENCE |
|--------------------------------|---|--------------------|-----------|---------------------|
| • Atar 08/09K50 | Super Etendard, Mirage F1, 50, Cheetah, Pantera | 842 | 14 | 1,870,680 h |
| • Other Atar (08C/09B/09C/09K) | Etendard, Mirage III, IV, V | 768 | 14 | 4,126,240 h |
| • Tyne | Transall, Atlantic 1, Atlantique 2 | 838 | 9 | 5,798,510 h |
| • Larzac | Alphajet, MiG-AT | 1,129 | 12 | 2,665,675 h |
| • M53 | Mirage 2000 | 620 | 8 | 781,616 h |
| • CFM56-2A/-2B/-2C | E3, KE3, E6, C135FR, KC135R, DC8-72 | 2,018 | 7 | 7,480,000 h |
| • CFM56-3 | B737-300 *(12-31-1999) | 13* | 3* | 78,000 h* |
| TOTAL | 22 | 6,228 | 47 | 22,800,721 h |

**EVERY MINUTE,
 A SNECMA MILITARY ENGINE TAKES OFF**

008-SNECMA-GB00-VMP-1197

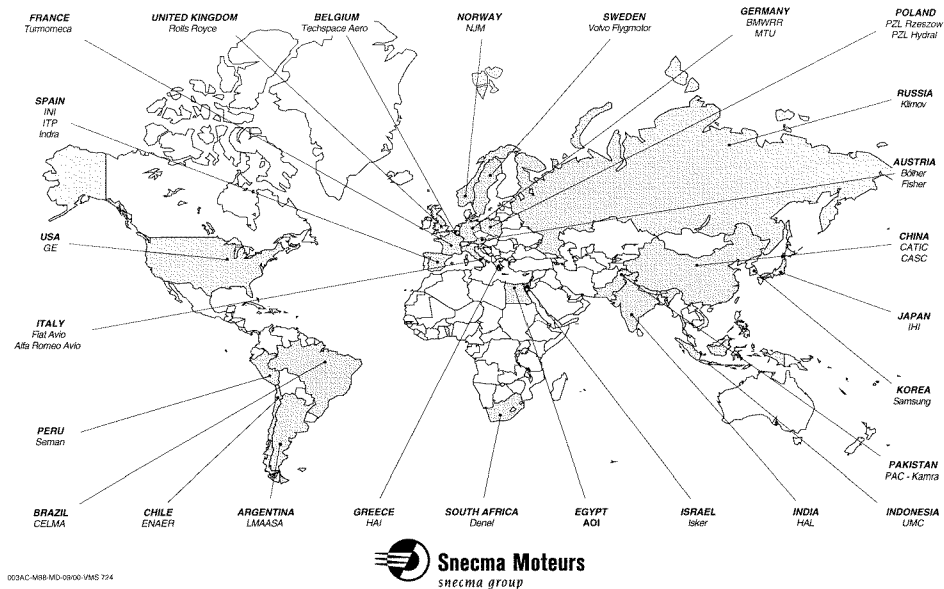


Snecma's target is to have all our customers satisfied. Therefore, we have developed a philosophy of product and service continuous improvement, covering in particular:

- Life extension and maintenance cost reduction programs.
- Modification proposals triggered by mission profile evolution.
- Better involvement of customers national industry (fig 3).

Snecma Moteurs Industrial Cooperation Network

A Tradition in an Ever Changing World



The following paragraphs of this paper will explicit how those principles have been implemented on the ATAR engine program between Snecma and the operators.

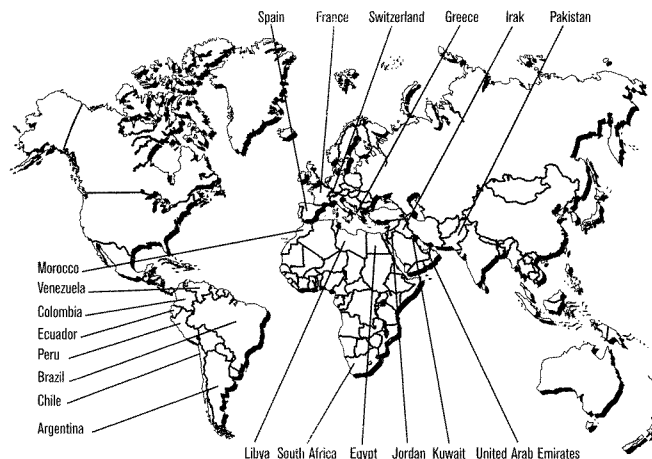
2. The Snecma commitment.

- ATAR 9C engines are installed on Mirage 3s and Mirage 5s
- ATAR 9K50 are installed on Mirage F1 and Mirage 50.

The present operators base (fig 4) includes a large number of operators with limited resources and who have planned to operate the engines up to 2020.

***Snecma is committed to support the ATAR customers
until the end of service of the ATAR engines.***

A WIDE ATAR OPERATORS BASE (as of January 1st, 2000)



20 operators - 1,589 engines in service - 6 MEFH



SLC - 031-99 / 1

The traditional way to maintain ATAR engines is to send the complete engines to the Depot Level maintenance shop once the operating life limit has been reached and then perform the DLM overhaul and repair.

This scheme fits well the needs of large fleet operators. However, it was found a little too expensive by some operators with smaller fleets and more limited resources. This is the reason why Snecma has developed the following tools:

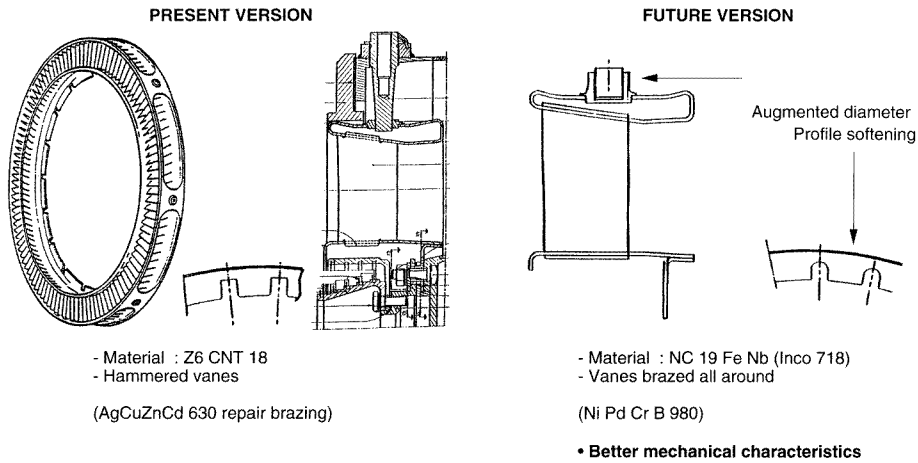
- Long term support contracts
- Modular maintenance
- Second hand hardware availability.
- Standard exchange instead of repairs.

3. The ATAR Plus program

France, South Africa and Spain have jointly determined that one of the ways to limit ATAR 9K50 maintenance costs was to introduce a series of modifications known as the "ATAR Plus" program, including

- Compressor OGV upgrade (fig.5)
- HP turbine NGV upgrade (fig.6)

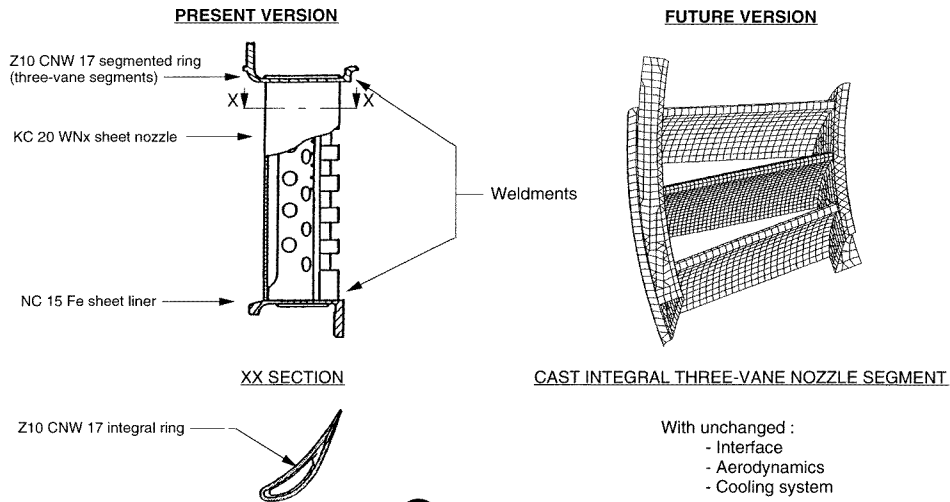
08K50 & 09K50 Engine Improvement OGV - Mechanical behaviour improvement



9-ANR-MDP-02/96-VMS.783



08K50 & 09K50 Engine Improvement IGV - Mechanical behaviour improvement



11-ANR-MDP-02/96-VMS.783



The ATAR Plus program has been launched by a consortium of three companies:

- Sneema (France)
- Industria de Turbopropulsores (Spain)
- Denel Aviation (South Africa)

and is now entering production.

4. Long term support Contracts Initiative

Cost limitation implies cost control.

Snecma has identified the need, voiced by some customers, to have a complete support contractual package based on the following principles:

- The operator performs maintenance operation only at the airfield location.
- Snecma Moteurs performs all the rest of the engine maintenance and support on a design to cost basis.

This leads to contracts between Snecma and the customers with the following typical features:

- Time of the contractual package : 5 years
- Fixed yearly price for general support (engine, test cell, GSE) and Technical assistance - training - documentation.
- Snecma commitment to maximize the involvement of the customer's national industry.

5. Modular maintenance.

ATAR engines family was designed between 1946 and 1960s at a time where performance was found more important than cost and particularly maintenance cost.

The engine maintenance could be split into modules only at the Depot Level.

Some years ago, Snecma has proposed to some customers to split the engines into modules (fig.7) at the airfield level in order to:

- Improve drastically the engine availability in the fleet
- Reduce the overall maintenance cost by about 30 %.

ATAR 9K50 / Modular Maintenance

- The ATAR 09K50 is broken down into Overhaulable Sub-Assemblies (OSA) which are interchangeable as far as their dimensions and operation are concerned
- There are 23 structural sub-assemblies, 4 sub-assemblies for equipment parts and 93 accessories included in the sub-assemblies but which may be replaced individually

Main Sub-Assemblies

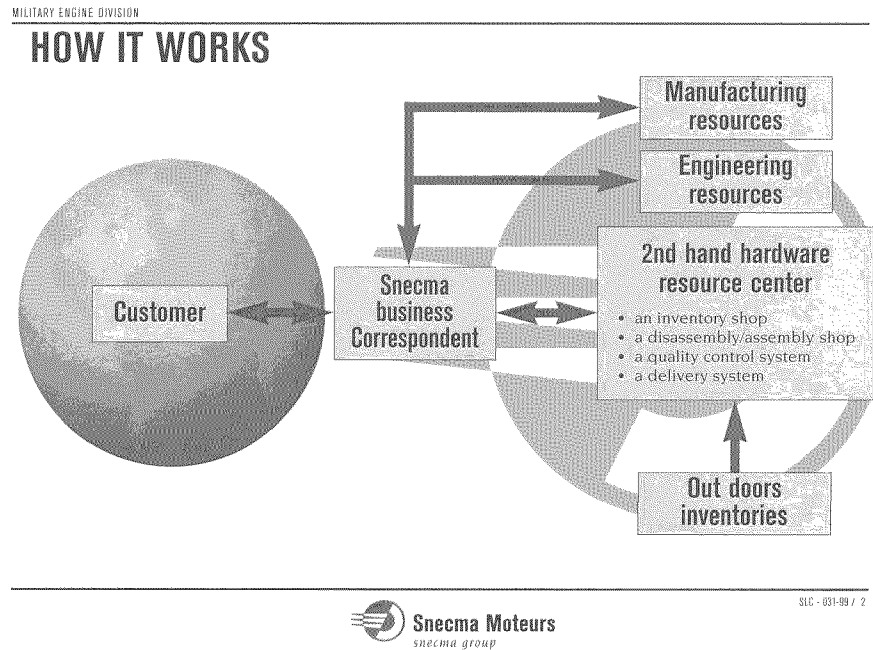


30A-9K50-M5D-0500-VMS-750

6. Second hand hardware Resources

French Air Force has progressively retired its Mirage 3 and ATAR 9C in the 1980s time period. A large number of modules and parts, either stored but not used, or operated for a certain time, but still with an interesting life time have become available.

Snecma has installed recently a “ATAR Second Hand Resource Center” (fig.8).



Snecma regularly publishes the list of the available second hand parts and modules and when a request for proposal is received at Snecma, the response mostly includes a mix of new parts and second hand parts.

This approach allows the customer to optimize its ownerships cost of the parts, while maintaining a high level of quality on its engines since

Snecma grants any second hand hardware the same level of quality and guarantee than the one granted for new parts

7. Standard exchange vs repair approach

The availability of low cost engine modules with an interesting remaining life time (paragraph 6) allows Snecma and customers to consider module standard exchange, at a cost substantially lower than a module repair.

This standard exchange can be done either at the airfield level or at the Depot Level, according to the customer's choice.

In any case, Snecma supports the customer and is assisting him in the implementation of his decision.

8. **Critical parts management**

Second hand hardware allows to reduce maintenance costs, but all the customer's needs are not fulfilled by to second hand parts.

Some ATAR parts still need to be manufactured by Snecma and subcontractors.

As the manufacturing quantities are declining, manufacturing prices are rising.

Because Snecma wants to have ATAR operators satisfied until the end of their operation, we have initiated a Critical Parts Management dialogue with our customers as follows:

Step 1 : The operators have provided Snecma their critical parts needs evaluation covering operations until the end of their ATAR operation.

Step 2 : On this basis, Snecma has issued a preliminary possible critical parts production plan explaining what parts are likely to stay on the production line.

Step 3 : Snecma will issue last batch production offers including prices, schedule and launching conditions.

Step 4 : For the parts where launching conditions are met, Snecma will launch critical parts last batches manufacturing and subsequent deliveries.