MRO of military helicopter engines

Innovative solutions for a critical asset in military operations

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Les notes stratégiques

Policy Papers – Research Papers

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In December 2014, CEIS published a first Strategic Note, entitled ‘Aerospace MRO: a key issue of capability-based planning of the Armed Forces’\(^1\), focusing on the definition of and the major issues concerning Maintenance, Repair and Overhaul (MRO) operations of military aircraft. MRO can be defined as “the sum of tasks required to ensure the functioning and availability of equipment. […] MRO brings together the functions of maintenance, repairs, logistics (supply, storage and distribution of replacement parts) or, in other words aircraft or aircraft component support.” The relevance and ubiquity of helicopters in all modern operations is such that it seemed important to address the constraints, challenges and possible solutions to the issue of their maintenance, all the while analysing the indispensable link between MRO performance and the operational capability of the Armed Forces. This latest Strategic Note addresses the specific issue of propulsion, which constitutes one of the most important subsets, and one of the major cost centres of helicopters.

Executive Summary

At a time when budgetary constraints are increasingly pressing for the Armed Forces, exchanges between the forces and industry provide opportunities to improve optimization of costs. The British Ministry of Defence (MoD) has studied the transition from six separate support contracts for the same type of engine to one overall support contract and calculated that the direct and indirect gains amount to some £300m over twenty years. Their experience demonstrates that such contracts optimise the engines’ ‘time-on-wing’ (avoiding too many removals), improve their reliability, lengthen the lifespan of Life Limited Parts (LLP) and allow greater recourse to repairs as opposed to ordering replacement parts.

The establishment of such contracting solutions gives the armed forces greater visibility as to the use of their machines, with the necessary built-in flexibility in case of peak activity during operations or, alternatively, reduced activity. Maintenance is also subject to budgets constraints which, in turn, ultimately affect the operational capabilities of armed forces. Solutions for overall support can mitigate these budgetary risks and allow for optimal availability. On the basis of ongoing exchanges on needs and expectations during preliminary discussions and subsequently during implementation, the ‘virtuous’ side of this type of contract lies in this ability to provide visibility to all stakeholders while manufacturers will make gains in production planning. This type of solution therefore has real advantages over traditional ‘Time & Material’ contracts, under which there is typically an increase in the maintenance costs (Direct Maintenance Cost) and a decrease in the operational availability of an aircraft during its operational lifespan. A good example of these advantages is the support response provided by manufacturers to the problems faced by the French Caracal turboshafts in Mali, which demonstrated the flexibility of such ‘overall support’ contracts and enabled operators to focus on achieving their mission.
Introduction

In January 2007, during the seizure of Fort Jugroom in Helmand province, Afghanistan, 45 Commando Royal Marines led a rescue of one of their men surrounded by Taliban forces. The originality of the mission lay in the use of WAH-64 Apache attack helicopters which, aside from the fire-support provided to ground elements, allowed a recovery group of four men seated on the Apache’s avionics bays to deploy at close-quarters to the Royal Marine in difficulty. This improvised rescue highlighted the helicopter's adaptability in current theaters of operation. The helicopter is therefore a force multiplier: it allows decision-makers on the ground to shed light on the tactical situation and gives them a rapid reaction force which can be flexible in its uses. The essential nature of the helicopter's contribution to current military operations is based on its flight characteristics (vertical take-off and landing, manoeuvrability), which are based on complex mechanical and dynamic systems.

The sum total of the operational parameters which illustrate the complexity of a helicopter's workings demonstrates the meticulous maintenance which they require. The purpose of this note is to use specific examples to illustrate the evolution of MRO and the solutions put forward so that the Armed Forces may fulfil their operational contract, or as General Girier, central director of the SIMMAD, said: "Let them fly." Three examples from France, the United Kingdom and Brazil, based on the same type of service, demonstrate that overall support contracts can adapt to the different needs of each client and provide solutions to a single end: the accomplishment of the mission.

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2 It is interesting to note that, in this specific case, an attack helicopter was used as a transport helicopter in a rescue operation during combat.

Helicopter MRO

Types of military helicopters

The categorisation of military helicopters is not only based on the types of missions assigned to them. Modern aircraft are designed to fulfil a primary mission and also a number of secondary missions. It is therefore possible, by installing ‘kits’ or specific pieces of equipment (e.g. a winch, a cargo hook, an in-flight refuelling probe), to quickly adapt an aircraft to a new mission.

It therefore seems more relevant to categorise according to the size and the number of engines on the aircraft:

- **Light helicopters**: within this category we can distinguish between Single Engine and Light Twin; their MTOW varies from one to four tons. Examples: Gazelles (SA341/342), H145M (ex-EC645 T2); OH-58 Kiowa Warrior, AW109.

- **Medium helicopters**: these are twin-engine and their MTOW\(^4\) varies from four to twelve tons. Examples: Panther (AS565), AW169, AW139, Ka-62, Bell UH-1H/N/Y/Z.

- **Heavy helicopters**: their MTOWs is over eight tons, with two or even three engines. Examples: UH-60 Black Hawk, AW101, H225M (ex-EC725) Caracal, CH-47 Chinook, CH-53E Sea Stallion

- **Tiltrotor, or convertible, helicopters**: the V-22 Osprey is currently the only aircraft in service with such characteristics.

\(^4\) Maximum Take Off Weight.
Today, there are around 19,500 military helicopters in service worldwide. Nearly a third of the fleet is used solely by the US Armed Forces (5 554 aircraft, 30%). In comparison, the individual shares of the other major military powers are much lower (from 2% to 6% for the other countries mentioned in the table below).

The worldwide fleet of helicopters has been steadily increasing for several years (18 400 aircraft in 2010, 18,700 in 2013), driven by deliveries to the United States and Asian countries, most notably China and India. Due to the increase in defence budgets in the Asia-Pacific region and the Middle East, the need to renew aging fleets and the rising cost of the latest platforms, the global market for military helicopters is expected to increase from $25.46bn in 2013 to $33.37bn in 2023.

Helicopters now constitute 37% of the global fleet of military aircraft (51685), which itself has decreased slightly since 2010 (-4, 3%).

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1 World Air Forces 2015, Flight International. This figure does not include helicopters dedicated to training.
3 Between 2010 and 2015, the Chinese helicopter fleet nearly doubled, rising from 488 to 806 aircraft.
5 53 915 military aircraft in 2010. Cf. World Air Forces 2010
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*Figure 1 - Evolution of World Combat Helicopters Combat Fleet between 2010 and 2015*¹⁰

Particularities of military MRO

MRO is a priority for armed forces because it contributes to the preparation of forces as well as the accomplishment of operations or fulfillment of operational contracts. MRO allows for the correction of defects, of the effects of aging on the aircraft (corrosion, wear-and-tear, technical obsolescence) and of the effects of usage (breakdowns, replacement of consumable items). The objective is to have aircraft available at the right time to meet operational requirements.

Therefore, it is normal that Armed Forces seek to maximise the availability of their equipment while managing the associated costs. It is in this context that new organisational, logistical and contractual models are established involving the Armed Forces and the manufacturers alike. In order to improve synergy and to do away with the silos in which the Armed Forces function when it comes to support for aircraft equipment, in September 2014, France established a new model of governance for aerospace MRO, the responsibility for which is entrusted to the Chief-of-Staff of the Air Force, which leans on the SIMMAD for its implementation. In the UK also, the time has come for the pooling of support equipment.

Support to weapon systems and aircraft in particular is down to Defence Equipment and Support (DE&S), born from the merger of the Defence Procurement Agency (DPA) and the Defence Logistics Organisation (DLO) in April 2007. Other countries are following this trend towards centralisation by entrusting joint bodies with the management of aircraft program from its development to its in-service support, as, for example, the COPAC (Comissão Coordenadora do Programa Aeronave de Combate) in Brazil responsible for the H-XBR helicopter program for which the Caracal H225M of Helicopters Airbus was chosen in 2011.
Consequently, in the field of MRO, the trend vis-à-vis suppliers is the introduction of overall contracts. The contractor no longer only delivers the equipment but also provides integrated logistics support, spare parts, training facilities and the training of technical teams. Manufacturers have been given greater responsibilities and must meet requirements for availability and for performance according to a specified format within the contract. The Armed Forces are thus relieved of the responsibility for part of the MRO and can concentrate on their core business as their maintenance activities are limited to those of an operational nature, in other words those carried out close to the forces, on bases or in operational theatres.

The helicopter: a complex ensemble of mechanical elements

The helicopter provides exceptional maneuverability (e.g., hovering, lateral movement) which enables it to meet a great many requirements. This operational capacity is the result of the complexity of the component elements: airframe, major mechanical components around the rotary wing (main rotor, tail rotor, and main gearbox), propulsion system, flight controls, fuel system, electrical systems, hydraulics and environmental control system. The complexity of a helicopter, however, lies above all in its numerous mechanical systems, especially around the propulsion system and the rotary wing.

Unlike the jet engine which powers an aircraft, the turbine engine of a helicopter delivers mechanical power and not thrust. Specifically, the power generated by the turbine engine is delivered via the main gearbox (MGB) to the rotors responsible for providing lift (i.e. the main rotor and the anti-torque tail rotor). Most of the energy from the turboshaft is absorbed by the rotors and by a marginal part of the mechanical drives (approximately 10%). Helicopters are mechanically complex machines that are subjected to dynamic stresses generated by the rotors (vibration, centrifugal force, gyrosopic precession) and aerodynamics (vortex, blades loss of
lift) that affect, to varying degrees, the entire machine (fuselage, motor, transmission systems).

The MRO market for military helicopters

The MRO market for helicopters was estimated at $10.2b in 2013\(^{11}\). It should see an average annual growth rate (AAGR) of 2.4% between 2014 and 2018.

The share represented by MRO throughout the life cycle of a product is often greater than that of the acquisition costs. For example, through a mix of FMS\(^{12}\) and direct commercial sale procedures, Canada acquired fifteen heavy transport CH-47F Chinook helicopters in 2013 for $2.3bn, with an estimated $2.7bn support cost over twenty years of the aircraft’s life-cycle (parts, training and support all included).

Added to this are the constraints inherent to the area of operations (domestic or foreign). Depending on the geographic areas where the aircraft are deployed, several factors may impact the availability of equipment: high temperatures and high air pressure limit the lift of helicopters and affect their performance; maritime environments are known to be very arduous for aircraft (salinity, corrosion); desert or semi-desert environments are also harsh because of the sand which finds its way into the turbines causing erosion. These conditions affect aerial mobility to varying degrees; they shorten the maintenance cycles and demand additional human and financial resources if not anticipated beforehand. Therefore, to ensure the best possible availability in theatres of operation, the Armed Forces should establish a complete supply chain from home territory all the way to the maintenance workshops forward-deployed in theatres of operation.


\(^{12}\) Foreign Military Sales (the acquisition procedure for defence equipment through the Department of Defense and not through the manufacturer.)
MRO for helicopter engines

The context

Aerospace MRO is based on several elements: logistics, information exchange systems and maintenance procedures. These are based on corrective maintenance and preventive maintenance, with the latter tending to be replaced by predictive maintenance or condition-based maintenance. The terms ‘scheduled maintenance’ and ‘unscheduled maintenance’ are also sometimes used.

On helicopter turboshafts, around 80% of the DMC (Direct Maintenance Cost) is made up of scheduled maintenance and 20% of unscheduled maintenance (curative). In the case of turbine engines, scheduled (or preventive) maintenance is often defined by a TBO (Time Between Overhaul) which fixes its potential operating time. At the end of this period, the engine is sent to the workshop for an overhaul, i.e. for regeneration of its operating potential. According to typical preventive maintenance, general revision should allow reconditioning of the engine up to its full potential. Although straightforward as regards the management of engines in the fleet, it is nevertheless very expensive.

This financial matter has led manufacturers to conduct a thorough review of their support procedures. The business model of the helicopter industry involves very different types of customers, from the commercial and aerial work pilot, working alone with his helicopter in his small business, to the Army Aviation Branch of a country with hundreds of helicopters and thousands of pilots. This reality led manufacturers early on to find solutions in order to adapt flexibly to the diverse needs of these different customers by offering a new type of contract, dubbed ‘fly-by-the-hour’.

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13 http://handle.dtic.mil/100.2/ADP014136
This type of MRO and logistical solution allows an operator to control the costs associated with his/her engine through financial and operational cover of scheduled and unscheduled maintenance. Maintenance costs are thus calculated based on hours of use, with a fixed cost per hour of flight, and not based on the cost of ownership.

This type of contract first appeared in 1962 within the Viper turbojet program at Armstrong-Siddeley\(^\text{14}\), later taken over by Rolls-Royce\(^\text{15}\). Dubbed ‘Power-by-the-hour’ (PBH), the contract was for engines and engine accessories replacements on the de Havilland / Hawker Siddeley (HS) 125 business jet. This solution gave operators a guarantee of fixed costs for engine overhaul and planned support services\(^\text{16}\). As regards helicopter engines, ‘Power-by-the-hour’-type contracts began to be used in the 1970s. Turbomeca, the world leader in helicopter gas-turbine engines, was one of the first to develop this type of on-site support for the civilian market with the ‘Support-by-the-hour’ program in 1978.

This program involved a commitment on fixed maintenance costs per hour of flight-time for commercial customers who signed up to the program. To the clients, the formula was simple: if the helicopter was not flying, they did not pay. This type of contract, however, did not fully meet the requirements of the Armed Forces whose primary need was the availability of equipment. In 2000, the French government awarded a contract to Turbomeca for the overall support of all the helicopter engines in the Ministry of Defence inventory. This MRO contract, the Global Support Package (GSP), is largely based on the principles of engine availability and speed of resupply. The pool of spare engines remains the property of the French State but its management is the responsibility of the engine manufacturer which guarantees the availability of a certain number of engines. To take into account the inherently unpredictable nature of military operations, the military overall support contract


\(^{15}\) Founded in 1919, Armstrong-Siddeley merged with Bristol Aero Engines – forming Bristol Siddeley – in 1960 as part of a rationalisation process of British engine manufacturers. This consolidation was ultimately concluded in 1966 when Bristol Siddeley was bought by Rolls-Royce.

includes both fixed costs and variable costs, which represents a major difference from its civilian counterpart.

The contract integrates several technical aspects involving a partnership between the Ministry of Defence and the manufacturer: these include, among others, the provision of Technical Representatives (Tech Reps) and a back-office by the supplier to address questions or problems faced by the operators, technical assistance on site, obsolescence management, modifications, team training.

When applied to the organisational level of the Armed Forces and their entities which use helicopters, we can distinguish four levels of maintenance provided by two types of actors:

- L1 (Level 1): Online Service provided internally at the operational unit level;
- L2: disassembly of engines for replacement of parts is undertaken by maintenance crews from the military or from the manufacturer;
- L3: disassembly of parts undertaken by the manufacturer;
- L4: Repair and Overhaul provided by the manufacturer.

The manufacturer works in this way with its operating customers as defined by a customised GSP contract and following several Key Performance Indicators (KPI) to help ensure the fulfilment of the contractual obligations. France, the UK and Brazil are three examples of specific requirements which illustrate the benefits of this new contractual mode.
Overall support contracts: three search for optimisation examples

France: the MCO\textsuperscript{17} contract

To understand the implementation of an overall support contract applied to the defence market, it is necessary to go back to the creation of the SIMMAD in France in 2000. Previously, the military operated in siloes (Army, Navy, Air Force, Gendarmerie, DGA, civil security) and purchased repair services, spare engines when an engine broke down or when the budget at the end of the fiscal year allowed it. This situation resulted in a major imbalance between the number of engines owned by the Ministry of Defence and the number of engines actually flying, leading to substantial stocks, and an overly long physical immobilisation of the engines. The Ministry of Defence owned some 1,700 engines at the time with only around 900 in flight.

With the centralization of MRO through the SIMMAD, the issue was addressed in terms of managing a large fleet of helicopters, of several different types and dedicated to six distinct uses (search and destroy, reconnaissance, medical evacuation, multirole, anti-submarine warfare / anti-surface, search and rescue). The size of the fleet of engines (1700 engines: Turmo, Astazou, Makila 1 and 2, Arriel and Arrius, Gem) led the SIMMAD to look for opportunities to improve the visibility of flight hours. The overall support contract now in place has integrated the services of maintenance and engine fleet management. However, as it is highly difficult to predict the launch of overseas operations in response to crises, this contract also provides the variable options necessary for any major increases in helicopter activity and therefore the need for engine maintenance.

This new type of contract intend for the Armed Forces to undertake missions at an optimised cost with well-functioning MRO, meaning that the manufacturer must

\textsuperscript{17} Maintien en Conditions Opérationnelles
perform accordingly. Risk sharing is divided between the parties, whereas beforehand all risks were run by the end user. For their part, the client has ‘only’ to ensure that its stock of available (i.e. ‘flying’) engines is sufficient for the training of its personnel and its overseas operations. It is the supplier’s responsibility to ensure that the resupply of the aircraft available to fly is guaranteed for the operator. The contract has also helped to unify the different standards of Turmo engines (approximately 700 units) equipping SA330 Puma utility helicopters operated by the Army Aviation and the Air Force, to which the engine manufacturer had no access before. As a client, France thereforetransitioned from fifteen separate markets based on purchase orders to one single availability-based market for the supply of spare engines.

Until then, maintenance was subject to fiscal risks. The operations in Mali, a particularly demanding theatre for the aircraft, have done much to highlight the capabilities available through an overall support contract for helicopter engines. This is especially the case for EC725 Caracal helicopters and their Makila 2 engines, as the problems they encountered in the Malian theatre of operations were singled out in a Senate report on the Special Forces. The launch of Operation Serval very quickly brought to the fore several major challenges posed by the operating environment, notably very high temperatures and desert conditions. These conditions proved extremely testing for the equipment as stated by Colonel Esnault of the CDEF: “Given the ground conditions, any fleet would have suffered.” The equipment however stood up to the requirements of a major logistical and MRO effort, with which the manufacturers were closely involved, and as a result the operational tempo was maintained.

As regards helicopter engines in particular, the geographic nature of the Sahelian theatre requires substantial use of multirole helicopters, most notably the Caracal.

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18 Today known as H225M by Airbus Helicopters.
20 Centre de Doctrine et d’Emploi des Forces.’ French Forces Employment Doctrine Center (Army).
Their engines particularly suffered in the Malian sand, especially the axial and centrifugal compressors and the diffuser of the Makila 2 engines. The first enemy of the Caracal in Mali would have been the camel grass encountered by the helicopters when landing in grassy areas. During these landings, the grass would be sucked into the vortex of the Versatile Air Inlets and lead to gradual blockage of the filter and an absence of sand centrifugation until eventually it passed through into the engine. This premature wear-and-tear caused a greater number than expected of Makila 2 engines to be disassembled, thus putting strain on the supply chain of Operation Serval.

Two solutions were adopted in order to overcome this constraint: the development of a new filtration system and above all Turbomeca’s undertaking to abide by the KPI of the MCO contract with France, or in other words the spare engines stock replenishment within ten days. For sixty engines covered by the MRO contract (thirty on aircraft, ten spare and twenty in stock at the manufacturer’s for repair or overhaul), the engine manufacturer initiated several measures during Operation Serval, intended to guarantee the availability of the stock of spare engines, a guarantee which ultimately was kept. On the one hand, the engine manufacturers adapted their industrial process by increasing its rate of repair from around 25 engines repaired per annum to 50 per annum. In addition, since the Makila 2 engine also powers civilian H225s (ex-EC225), the company opened its pool of commercial engines (used in particular for ‘Support By the Hour’ contracts) to replenish the engine fleet of the French State. In the end, only four engines were taken from the civilian pool to reinforce France’s stock. This example demonstrates that France’s MRO contract represents an effective solution for overall support. The contract also includes annual review clauses allowing for necessary adaptation to the situation with, in the short term, flexibilities in terms of contractualisation with both fixed and variable parties.


CEIS I 2015 I MRO of military helicopter engines
Every year, review clauses allow for a revision of the number of flight hours or the integration of new service elements in the overall contract (e.g. shortening the reverse logistics\textsuperscript{23} for the redeployment of engines from theatres of operation to home territory, sending engine on site).

**United Kingdom: the Future Support Arrangement (FSA) programme**

In the UK, the problem is different and more complex. The Crown’s FSA support contract concerns a single engine, the RTM322, which equips two platforms: the Merlin (and its many versions in the Royal Navy\textsuperscript{24}) and the British version of the Apache\textsuperscript{25} (Army Air Corps), all assembled by AgustaWestland. For several reasons, including a real desire to bring down costs and reduce the ‘turnaround’ time of its engines, the British Ministry of Defence (MoD) sought an overall support contract for its RTM322. The MoD wanted this contract to reduce the costs of support to the RTM322, to transfer some of the risk to the manufacturers and to simplify support procedures.

Before the establishment of the FSA contract for six years in April 2013, RTM322 support was based on six contracts covering spare parts, logistics, repairs and technical support respectively. Thus, the principle need of the MoD was to reduce the total maintenance costs for all RTM322 engines.

Therefore, the FSA contract is not strictly speaking an availability contract, but a contract that ‘allows’ availability. According to the British MoD, the reductions achieved by unifying the different support contracts and optimising MRO procedures would amount to a gain of £300m over a period of eighteen years in comparison with previous agreements.

\textsuperscript{23} Return logistics’ refers to all means required to repatriate used equipment to home territory for repairs as part of an ‘after sale service’.
\textsuperscript{24} EH-101 ou AW101: Merlin Mk1/Mk2, Merlin Mk3/4, Merlin Mk3A/4A.
\textsuperscript{25} WAH-64D Apache AH Mk1: Boeing AH-64D Apache produced under licence by AgustaWestland.
As regards platforms equipped with RTM322 engines, the helicopter fleet represents a total of 198 RTM322 on the Merlin fleet and 134 RTM322 on the Apache fleet. On the support aspect, the Defence Equipment and Support (DE & S) has two distinct teams monitoring helicopter support: the Apache Project Team and the Merlin Project Team. The latter is responsible for support to the entire RTM322 fleet within the British MoD and therefore functions as the project manager of the FSA contract.

The FSA contract is based on several types of service:

- **Provision of engines’ Line Replaceable Units (LRU) on the four Main Operating Bases (MOB) hosting the Merlins and Apaches:** AAC Middle-Wallop, Wattisham Airfield (AAC), RNAS Yeovilton, and RNAS Culdrose\(^{26}\). The expected level of service is 95%.

- **L2, L3 and L4 maintenance for engines and accessories:** the British MoD only keeps as for now L1 maintenance in squadrons while the three other levels are provided by the manufacturer. Maintenance relates to changes of parts, heavy-duty maintenance and repair of accessories.

- **Logistics:** the manufacturer collects and returns the set of engines and components to the MOBs up to the ‘Purple Gate’, which symbolises entry into the MoD’s distribution network, the Joint Supply Chain (JSC), where the handover of responsibility from the manufacturer to the MoD takes place. This procedure only applies to British territory as the MoD is responsible for transport of its engines during overseas deployments.

- **Cost per hour of flight-time:** a fixed price according to expected hours of flight-time with supplementary billing during operations in harsh environments likely to be challenging for the engines.

- **Technical assistance:** the British MoD requested that the engine manufacturer place six Field Service Representatives (FSR) at their permanent disposal, distributed across the MOBs.

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\(^{26}\) AAC: Army Aviation Centre, RNAS: Royal Navy Air Station.
While the FSRs are present on the four large bases hosting Merlins or Apaches, British forces benefit from their presence during their deployments exercises. They do not however participate in overseas operations for several reasons, notably security issues. Merlins deployed on operations have access to Deployable Spares Packs (DSP) for their support.

These DSPs integrate a range of spares (Main Gearbox, rotors, engine spare parts) packaged in aluminium containers. Currently, the MoD has between twelve and sixteen DSPs, all centralised at RNAS Culdrose and maintained at a level of preparation (‘readiness’) set by the MoD. The engines are changed in-theatre and then returned to the UK for MRO operations.

In 2014, the FSA contract was put to the test. A new nozzle approved on the RTM322s equipping the NH90 caused problems on some versions of engines fitted to certain Merlins. To request a complete removal of all engines would have had a catastrophic impact on the availability of British aircraft. The procedures stipulated within the FSA contract allowed the engine manufacturer to manage the problem without significantly reducing the operational activity of the aircraft.

**Brazil : the Global Support Package (GSP) programme**

Brazil’s need for support solutions is more recent and stems from the order of fifty EC725 helicopters (known today as H225M) in 2011 under the H-XBR program. Designated HM-4 Jaguar, UH-15 and H-36 Caracal respectively by the Brazilian Armed Forces, these aircraft are operated by the Brazilian Army (Exército Brasileiro, EB), the Brazilian Navy (Marinha do Brasil, MB) and the Brazilian Air Force (Força Aérea Brasileira, FAB). At the time of writing, sixteen helicopters have been delivered. The production schedule anticipates the delivery of seven H225M per annum over the next five years in order to fulfil the order of fifty aircraft.
The H-XBR program is the first joint program of the three armed services and, for this reason, Brazil wanted overall support contracts with Helibras and Turbomeca do Brasil for airframes and engines respectively. Under the GSP Brasil contract, the three armed services have delegated the management and operational coordination of the contract to the COPAC (Comissão Coordenadora do Programa de Aeronave de Combate), responsible for all air systems implemented by the Brazilian Ministry of Defence. The fifty H225Ms ordered will be distributed among the three armed services with sixteen aircraft for the Army, sixteen for the Navy and eighteen for the Air Force (including two for transport of VIPs on behalf of the Brazilian Presidency). In addition to this special role as transport authority, the aircraft will be used for Combat Search and Rescue (CSAR) and Search and Rescue (SAR) missions, maritime patrol missions (MP), anti-surface operations, support to naval operations, Special Forces missions, and transport missions and operational support especially in the Amazon region.

As an entity attached to the FAB, the COPAC is the link between all the entities involved in the implementation of H225M currently operated within each of the three armed services: the Chiefs-of-Staff of the FAB/EB/MB, the operational units, the area commanders, the logistics command and finally the command responsible for human resources. As part of this operational use, H225Ms undertake about 300 flight hours per aircraft per annum with a modulation of ± 20%. The helicopters of the Brazilian Presidency operated by the FAB undertake, for their part, a slightly higher volume of 400 hours per annum per machine. To allow optimum availability of these aircraft, the COPAC has put in place a GSP contract ensuring full support for the Makila 2s equipped Brazilian H225Ms.

27 Brazilian subsidiary of Airbus Helicopters, responsible for the assembly of EC725s in the XBR programme.
This support is distributed around several sites:

- Levels 1 and 2: twelve sites host maintenance elements at squadron-level for L1 (9 squadrons\textsuperscript{28}) and at base-level for L2 (three bases).
- Levels 3 and 4: Turbomeca do Brasil in Xerém and Turbomeca Tarnos (France).

The GSP contract includes various supporting elements:

- **Initial Provisioning List (IPL):** spare stock (engines, modules, components) including nine pooled engines belonging to the Brazilian Armed Forces.
- **Support By the Hour (SBH):** an innovative aspect of the contract. Although operated by a military customer, the Brazilian contract includes an SBH element geared towards a fixed hourly operating cost for the flight-time of the engines.
- **Technical assistance:** six people are dedicated to all technical and commercial aspects, including three Field Technical Representatives (Field Reps) placed within the main base of each Armed Force.
- **Extraordinary expenses:** in order to ensure the customer operations continuity in any case, even for those events not covered by the GSP contract.
- **Training.**

The contract KPIs includes each of the elements with a goal of 100\% availability.

Beforehand, the contracts for the rest of the fleet of helicopters powered by Turbomeca in the country were managed according to Time & Material (T & M) principles. As in the United Kingdom and France, this type of contract did not guarantee an optimised cost to the Brazilian forces and did not provide timely

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\textsuperscript{28} This number may rise to ten if a tenth squadron or battalion of H225M is stood up.
visibility to the manufacturer. As in the British case, the COPAC has nevertheless been able to assess the benefits of the GSP contract over traditional support contracts. Thus, some H225s and H225Ms had experienced problems with engines false fire alarms in-flight. The Brazilian fleet appeared to have been more particularly affected than other operators worldwide. The incident was of particular concern to the Brazilian Armed Forces in that this type of alarm requires that the engines be systematically turned off for safety reasons. Under the GSP contract, a customised analysis of the Brazilian situation allowed the manufacturer to develop a specific response to implement technical updates in the engines and avoid grounding the H225M fleet.
Conclusion

At a time when budget constraints are ever more pressing on the Armed Forces, exchanges between manufacturers and the Forces give the opportunity for the implementation of cost optimisation solutions. Overall support contracts allow for operational participation and better performance and availability in the context of a classic Time & Material contract. This concerns the optimisation of "time-on-wing" engines (avoiding excessive removal), improvement of reliability, extending the usage time of Life Limited Parts and allowing greater recourse to repairs instead of ordering spare parts. Operators will also gain visibility over the use of their machines through planning of flying hours and therefore the availability of aircraft by incorporating the flexibility necessary in the event of a peak in activity for operations or, alternatively, in the event of reduced activity.
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