Turbomeca	INVESTIGATION REPORT No. 1361
ENGINEERING MTA/AES	Addressees: **DTA/THT – DTA/THT/ARRIEL**
Work order No. 04051	Copies: **DE, DE/EM , DI, DQ, DSO/T** **Component section: Turbines**

ENGINE FINDINGS REPORT No:		DATE: 23/10/2000		Written by: VL/NH
ENGINE: **ARRIEL 1B**	S/N 303	TSN 7838	TSO	**Name: V. LABRUCHERIE** Dept: **MTA/AES** Date: 21 November 00
MODULE: PART: Operator: Peace Helicopters		P/N	S/N	TSN

REASON FOR INVESTIGATION:

Examination of the various parts sent to TM France

REASON FOR RETURN: Accident

Key words: ARRIEL - Overheat

Note : *The original text of this document is in French. In case of dispute, it will take precedence over the English translation.*

CONCLUSIONS:

The examination of the various parts in our possession clearly shows that the engine has experienced a short duration overheating phenomenon.

This overheating is evidenced mainly by the following:

- On the gas generator 1st and 2nd stage blades:
  - Partial fusion of the IN100 material at mid-height of the blade profile, at a temperature higher than or equal to 1263°C
  - Transformation of the material microstructure in the lower half height of the blade profile until complete dissolution of the γ' precipitates at a temperature of approximately 1240°C.

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Signatures

The Manager

CONCLUSIONS (cont'd)

- Gas generator 2nd stage Nozzle Guide Vane assembly:
  - Partial fusion of the vanes
- Free turbine blades:
  - Transformation of the IN713 material microstructure until complete dissolution of the γ' precipitates, roughly at mid-height of the blade profile, at a temperature in the order of 1200°C
  - Deformation of the chromaluminizing coating
  - Localized fusion on the trailing edge of five blades, which has resulted, for four of them, in an open crack.
- Axial and turbine bolts, and injection wheel, made of INCONEL 718 material:
  - Various colorations revealing that these parts experienced temperatures which were much higher than their normal operating temperatures.

No impact mark was evidenced, in particular on the axial and centrifugal compressors.
In addition, the microanalysis of the various deposits sampled from the air path does not reveal any elements other than those constituting sand (laterite) and the materials of the parts.
This shows that the engine has not ingested any foreign object.

The circular rubbing marks appearing underneath the platform of the gas generator 1st and 2nd stage turbine blades show that the engine was operating normally at the time when the overheating occurred. No mechanical or metallurgical anomaly was evidenced, neither on the gas generator nor on the free turbine.

The material of the affected parts was found to be conforming.

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LIST OF ABBREVIATIONS

BEA : Bureau d'Enquêtes Accidents (French Accident Investigation Board)
FT : Free Turbine
GG : Gas Generator
LE : Leading Edge
NGV : Nozzle Guide Vane
NGV1 : Gas Generator 1st Stage Nozzle Guide Vane assembly
NGV2 : Gas Generator 2nd Stage Nozzle Guide Vane assembly
NTSB : National Transportation Safety Board
P/N : Part Number
S/N : Serial Number
TE : Trailing Edge

1 INTRODUCTION

Following the accident of an Ecureuil AS 350 B helicopter (S/N 1317, Peace Helicopters A-Star C-GPTT) in the American State of Utah, some parts of the engine (ARRIEL 1B S/N 303) were entrusted to the metallurgical laboratory of TURBOMECA France by the NTSB for further investigation (list of parts in Appendix 1).

It is reminded that this engine had been sent to TURBOMECA ENGINE CORPORATION - Texas, for disassembly and examination in the presence of the U.S. official authorities (Reference [1] Appendix 16).

The metallurgical investigation of the parts carried out at TURBOMECA Bordes under the supervision of the Bureau Enquête Accidents, the French official authorities, was conducted from 24 to 26 October 2000 in the presence of the engine owner.

The sealed cardboard box containing the parts was opened by the BEA in the presence of the various members of the investigation committee (list of participants in Appendix 15).

2 EXAMINATION OF THE PARTS

The main findings made on the various parts are the following:

2.1 MODULE 02

2.1.1 AXIAL COMPRESSOR (P/N 0 292 15 816 0, S/N 806 B)

- On the wheel (Pictures 1 and 2, Plate 1):

  - Blue coloration on the blades and the hub
  - Erosion on the leading edge of the blades
  - No impact marks

- On the shaft (Picture 3, Plate 2)

  - Bluish colorations at the location of the two bearings and behind the accessory drive gear position.

2.1.2 AXIAL BOLT (P/N 0 292 99 089 0, S/N F 299B)

- Brown colorations on the front side, at the location of the centrifugal compressor front (Picture 4, Plate 2).
- Blue colorations on the rear side. at the location of the centrifugal compressor rear.

2.2 MODULE 03

2.2.1 CENTRIFUGAL COMPRESSOR (P/N 0 292 25 543 0, S/N A 1301 B)

- Erosion on the LE of the blades
- No impact marks (Picture 5, Plate 3)
- Very slight laterite deposit on the front and rear faces (Pictures 5 and 6, Plate 3).

2.2.2 DIFFUSER 1ST AND 2ND STAGES (P/N 7 292 20 774 A, S/N 26 B)

- Slight laterite deposit on the diffuser front and rear faces, as well as on the injection manifold (P/N 0 292 20 812 0, S/N 1027 B), which is still in place on the diffuser (Pictures 7 and 8 Plate 4, Picture 9 Plate 5).
- Erosion on the LE of the radial vanes, particularly heavy on 5 consecutive vanes (« V » shaped erosion): Picture 10 Plate 5.

2.2.3 INJECTION WHEEL (P/N 0 292 25 401 0, S/N 0641 XB)

- Blue colorations on the front and rear faces, inside the curvic-couplings (Picture 12 Plate 6).
- Laterite deposit inside the front groove and on the rear face (Picture 13 Plate 6).

2.2.4 TURBINE SHAFT (P/N 0 292 25 179 0, S/N 426 AD)

- Pinkish coloration on the outer diameter of the front curvic-coupling (Picture 14 Plate 7)
- Bluish coloration on the sealing ring, inside the front curvic-coupling.

2.2.5 GAS GENERATOR 1ST STAGE NGV ASSEMBLY

The inner part of the combustion chamber and the NGV1 have not been separated (Picture 15 Plate 8).

The following can be observed:

- Laterite deposits on the inner part of the combustion chamber and on the leading edge of the NGV1 vanes (Picture 15 Plate 8)
- An extensive deposit on the pressure and suction faces of the vanes and in the 1st stage turbine shroud (Picture 16 Plate 8; Pictures 17, 18 and 19 Plate 9).