SPEY SM1C GAS TURBINES IN H.M.S. 'BRAVE'

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ABSTRACT

H.M.S. *Brave*, hitherto operating with 12·75 MW Spey SM1A gas turbines, has now been fitted with the uprated Spey SM1C (18 MW). The main design changes are summarized, and the process of conversion on board described.

Introduction

The SM1C Propulsion Unit has been developed jointly by MOD and Rolls-Royce plc to give additional power at higher ambient temperatures and extend the current life expectancy beyond that of the SM1A unit.

In order to gain early in service experience of the SM1C unit, Rolls-Royce approached the Ministry of Defence in the Spring of 1988 with a request to fit the newly developed Spey SM1C (18 MW) Gas Turbine propulsion system in H.M.S. *Brave* (FIG. 1). The request was made in support of the Company's

commercial aspirations for the SM1C. The Company's prime aim was to see the SM1C operate at sea with the Royal Navy in early 1990. Such was the Rolls-Royce committment to this project that they agreed to fund the conversion work, supply the SM1C Gas Turbine Change Units (GTCUs) and support the installation for the duration of the trial period, nominally 17 months.

The benefits of the Company's offer were seen to be significant in terms of early confidence in the SM1C engine for the R.N. with increased performance for the frigates in which it is fitted, and the possibility of significant foreign sales for the Company. It was therefore decided to progress the Company's proposal as a Fleet Trial. Designated Fleet Trial 93/88, it was approved in September 1988.

FIG. 1—H.M.S. 'BRAVE'

The Spey SM1C

The SM1C propulsion module incorporates the latest gas turbine design technology giving improvements over the SM1A unit, particularly in terms of life expectancy and availability of increased power at high ambient temperatures. The primary changes can be summarized as follows (see FIG. 2):

(*a*) New LP compressor.
(*b*) Revised combustion system.
(*c*) New turbines.
(*d*) Revised shaft arrangements.
(*e*) Cooled interturbine duct.
(*f*) Improved power turbine blade sealing arrangements.
(*g*) The engine is designed using proven 80s technology and the latest aero designs and materials where suitable.

The Conversion

The work of converting H.M.S. *Brave* to SM1C falls neatly into two phases—the power turbine and ancillaries, and the gas generator.

Phase One

In order to convert to the SM1C power turbine within the Assisted Maintenance Period (AMP), it was at first thought by Rolls-Royce that a fully built power turbine assembly would be required at the dockside. Although feasible, this procedure would have needed the services of a shipyard/dockyard to carry out alterations to the ship structure and the removal of the uptakes to provide a shipping route. Further consideration by the Company enabled a much simplified proposal to be made, namely that the conversion should be effected by *in situ* replacement and rework at component level. This method did not require any special craneage or changes to the ship structure, routeing of components being via the usual GTCU exchange route.

Phase One of the conversion was planned for the 10 weeks when the ship was due to be alongside for post-deployment and Christmas leaves and an AMP. Much preparatory work was however completed by Rolls-Royce during the preceeding months. This included the purchase and assembly of large SM1C module components, the production of conversion tooling and, in the last few weeks before the ship returned to the U.K. the marshalling of all this equipment for transport to Devonport in over 50 crates.

It is not intended, in this article, to cover the detail of how the conversion was effected. The basic procedure involved the removal of the SM1A GTCUs and subsequent strip of the modules to release the power turbines. Some *in situ* machining and shop work then allowed the installation of new SM1C power turbines and module components. Concurrent with this work, module ancillaries and controls were updated to the SM1C standard.

The SM1C module is designed to accept either the SM1A or the SM1C GTCU, with only minor associated changes. H.M.S. *Brave*'s modules are, by exception, dual wired to allow rapid reversion to SM1A, without the need for any further control system work.

As the owner and supplier of the equipment and the prime contractor for the work, Rolls-Royce undertook the majority of the work using their own staff seconded from their factory at Ansty, Coventry. Some work such as torque tube removal and component machining was sub-contracted to DML. An extremely good working relationship built up amongst the Rolls-Royce/DML/Ship's Staff team involved in the conversion and Phase One generally proceeded ahead of schedule throughout. Shortly before the ship returned to the U.K. it became apparent that she would need to undergo a docking to effect underwater repairs. Together with the associated landing and re-embarkation of ammunition, it was expected that a resultant 5 days would be lost to the conversion programme. The team therefore aimed to complete most of the heavy lifting work before the ship moved to the dry dock in early December. Before the move, the ship was berthed at Devonport's new Weston Mill Jetty which is as yet uncluttered and has new alongside offices and messes. The ample space on the jetty and the provision of office and domestic space in the Fleet Maintenance Group 'owned' building on the jetty contributed greatly to the efficiency of the early conversion work. With no major problems, Phase One was thus completed ahead of schedule.

Phase Two

The final production standard of the 'C' rated GTCU could not be fully defined at the time that the Company's proposal was made for H.M.S. *Brave*. It was, however, seen by all parties to be important that the standard of GTCU to be fitted into the ship should be closely representative of the final production standard. Hence, the ordering of parts for and the building of the GTCUs was delayed as long as possible commensurate with the plan to fit the engines during the AMP conversion. A contingency plan was agreed

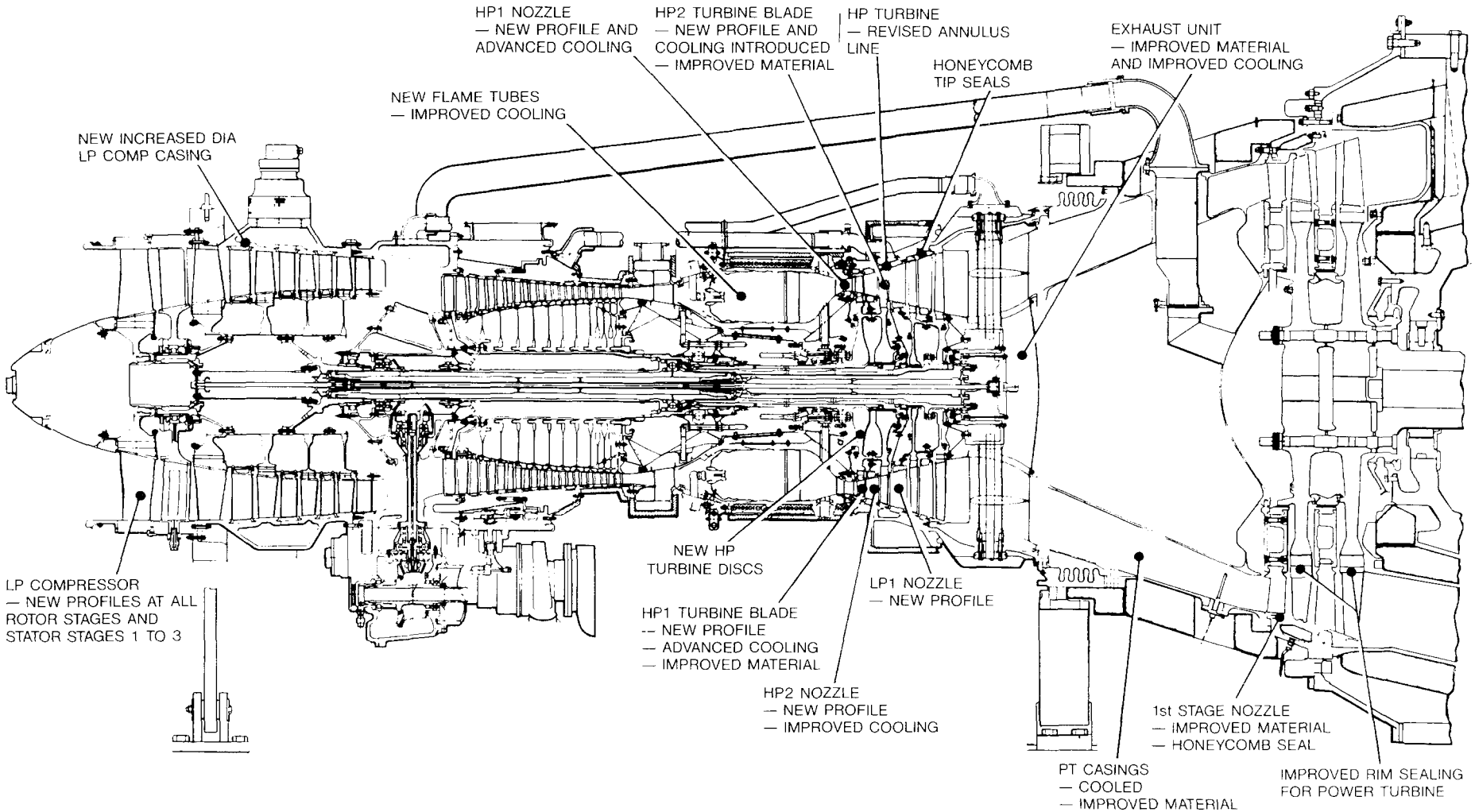

FIG. 2—SM1C DESIGN CHANGES

which would allow fitting of the GTCUs during a week in April 1990. However, this was not implemented as both SM1C GTCUs were completed and tested in December 1989, allowing them to be installed as part of the conversion in mid January 1990 by a Rolls-Royce/Fleet Maintenance Group team.

Trials

Post-installation trials of the SM1C were planned during H.M.S. *Brave*'s busy new year programme. Basin trials were completed under the watchful eye of the Machinery Trials Unit in the last week of January 1990. Sea trials of the installation took place from 29 January to 2 February, allowing the ship to develop, for the first time, 36 MW and regain its design speed (the ship was designed for two Olympus GTCUs).

Although much information regarding operating with increased power and life expectancy will be gathered for analysis by Rolls-Royce and MOD, the primary aim of the trial will be met by proving that the ship, when fitted with the SM1C, can operate normally and with no greater requirements for logistic support than that experienced with the SM1A. The trial is due to continue until the ship enters her first Repair Period (RP1). Thereafter, a decision will be made regarding the future ownership and support of the installation.

Support

H.M.S. *Brave* once again finds herself in an unusual situation with respect to the support of its Spey propulsion system. The Spey SM1A installation was the subject of a Commercial Support arrangement, whereby all spares were held and supplied by Rolls-Royce although owned by the MOD. Rolls-Royce have agreed to support the SM1C installation at their own cost for the duration of the trial period. Many of the existing SM1A Commercial Support spares will suit the SM1C application and will be augmented with SM1C-unique items supplied by the Company. Rolls-Royce will also supply technical assistance worldwide should it become necessary.

The Future of the SM1C

The experience of the SM1C in H.M.S. *Brave* will be watched with interest by many, not least those who will operate the first production units to be fitted in Type 23 – 10 in the mid 1990s.
