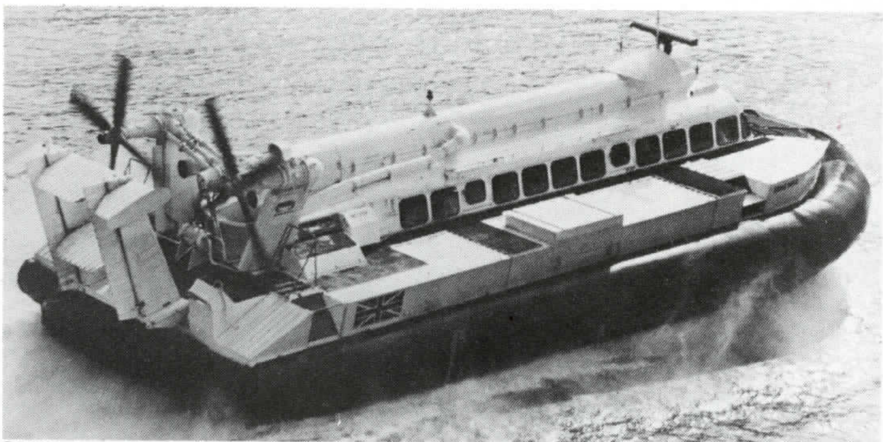
Dowty Rotol NEWSLETTER

COMPOSITE BLADE DEVELOPMENT

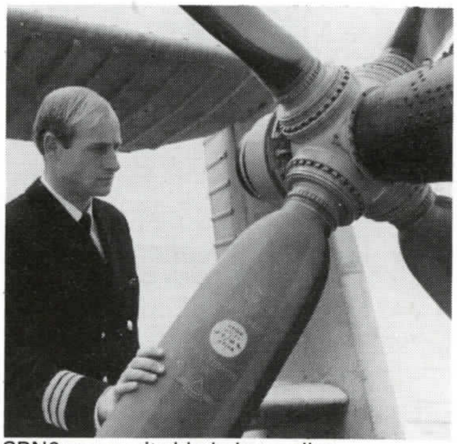
Dowty Rotol commenced development of composite blades for propellers during the mid 1960s. Initially blades were made of glass fibre reinforced resin. By 1970 Dowty Rotol was producing composite blades similar to those in current operation. These use internal carbon fibre spars, polyurethane foam filling and a glass fibre reinforced resin aerofoil shell covered with a tough polyurethane coating for erosion protection. Further protection is provided by replaceable leading edge strips.

Composite bladed propellers and fans were installed on single and twin engined air cushion vehicles which operate under extremely harsh conditions involving sand and sea spray. For the last 12 years, Dowty Rotol composite bladed propellers have been successfully proven on ACV passenger carrying service.

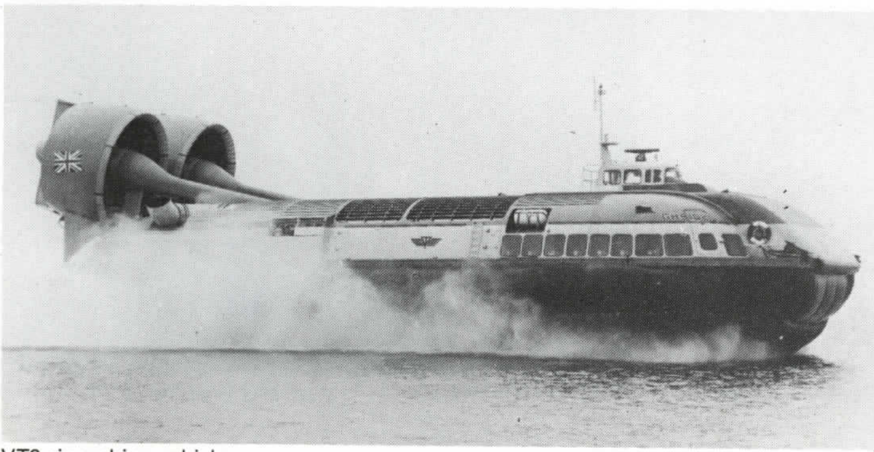
During the late 1970s, Dowty Rotol began incorporating composite blades in their advanced technology propellers for new generation aviation, commuter and corporate aircraft. These aircraft propeller blades were subjected to further stringent testing leading to full certification. No other make of propeller has undergone such exhaustive testing. First, individual blades were tested, then followed tests on complete hub and blade assemblies. Details of the various tests are given in this Newsletter.



SRN6 air cushion vehicle

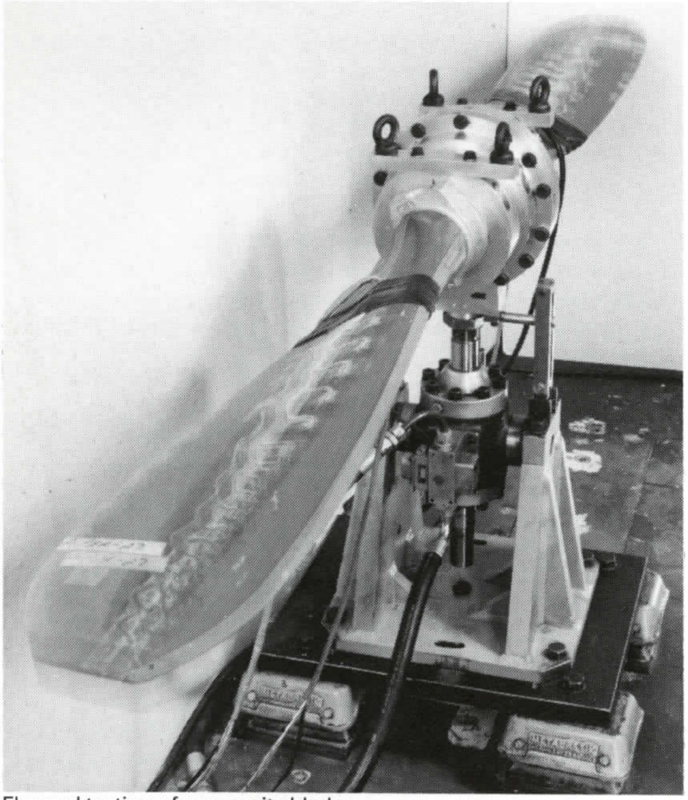


SRN6 composite bladed propeller

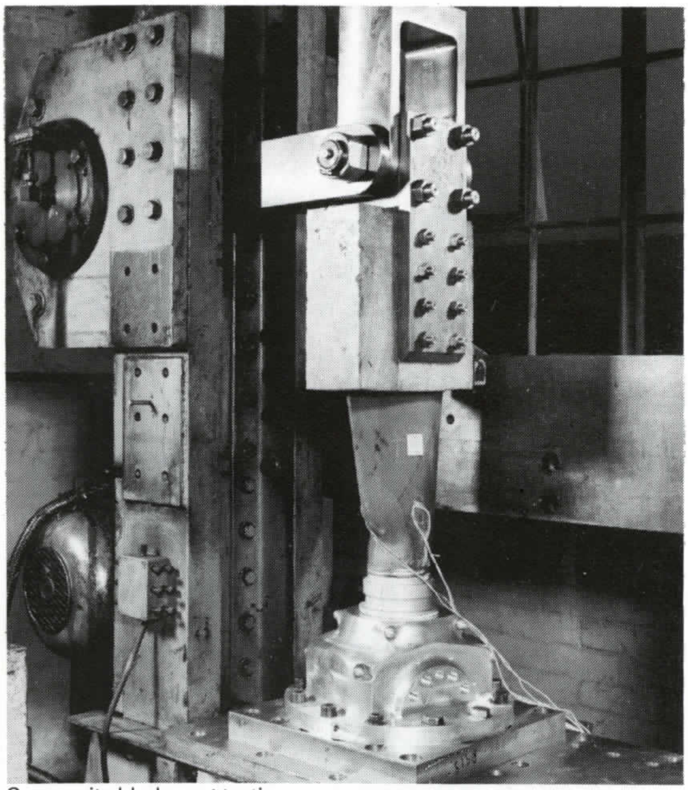


VT2 air cushion vehicle

VT2 composite bladed fan



Flexural testing of composite blades



Composite blade root testing

FATIGUE TESTING

These tests are carried out in both the flexural and torsional modes.

Flexural is carried out by running paired blades at their resonant frequency on a vibrator rig. Blade spars are subjected to high vibratory compressive stresses greatly exceeding those in flight. Test results on composite blades show an infinite life – i.e., exceeding 100×10^6 cycles.

Torsional testing is carried out with the blade suspended in a rig and excited by a pair of vibrators. The vibrators are driven at the correct phase relationship to excite a torsional vibration mode. The results of these tests again show infinite blade life – i.e., exceeding 100×10^6 cycles.

In addition blade roots are mounted in rigs representing propeller hubs for the application of simulated centrifugal forces, steady and vibratory bending moments. No failures have occurred in the composite structure during tests exceeding 50×10^6 cycles on many specimens.

ENVIRONMENTAL TESTING

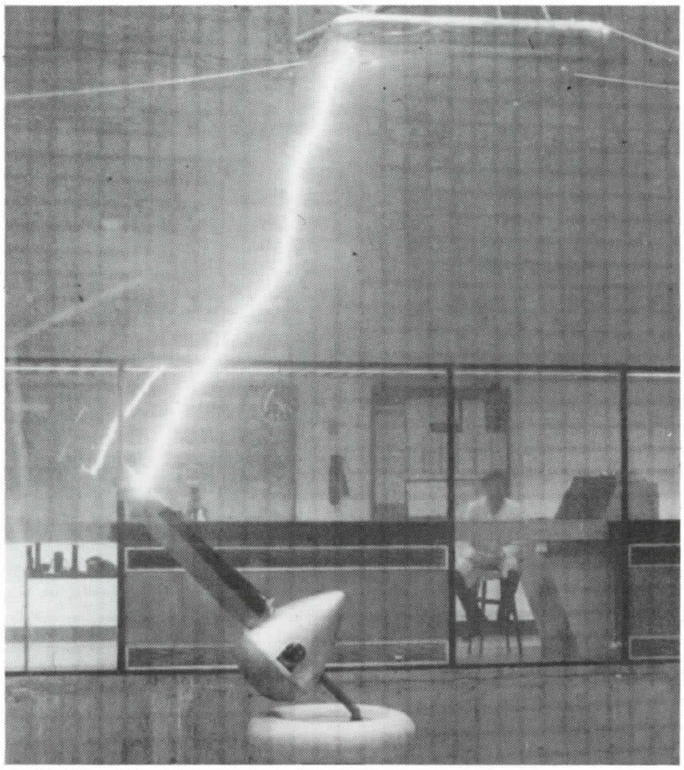
All composite blade materials have undergone natural and accelerated weathering tests. Water intake is low and strength changes are negligible. Composite blades cut up after 10 years in service on ACVs showed almost unchanged strength and fatigue properties. Environmental testing successfully completed includes solar radiation tests, ultraviolet degradation trials, temperature and altitude cycling.

SPIN TESTING

Dowty Rotol composite bladed propellers have been spin tested at the Royal Aircraft Establishment, Farnborough to 110% overpower and 126% overspeed with no adverse effects.

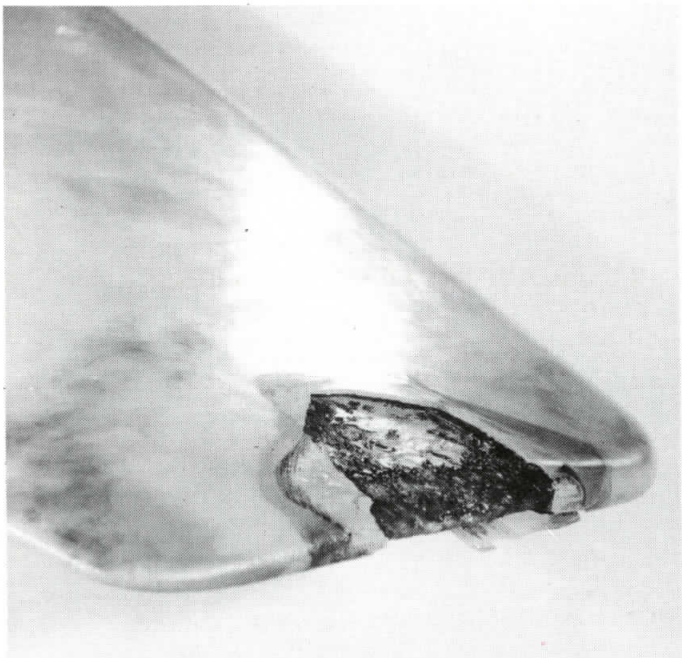
LIGHTNING TESTING

Lightning strike tests have been carried out on complete composite blades in a hub with a spinner attached. The blade lightning protection system comprises a strip of aluminium braid moulded into each of the two blade surfaces and earthed to the metallic blade root. Tests were at peak currents of approximately 200 kilo amps and action integrals to 2×10^6 amps^2 seconds.

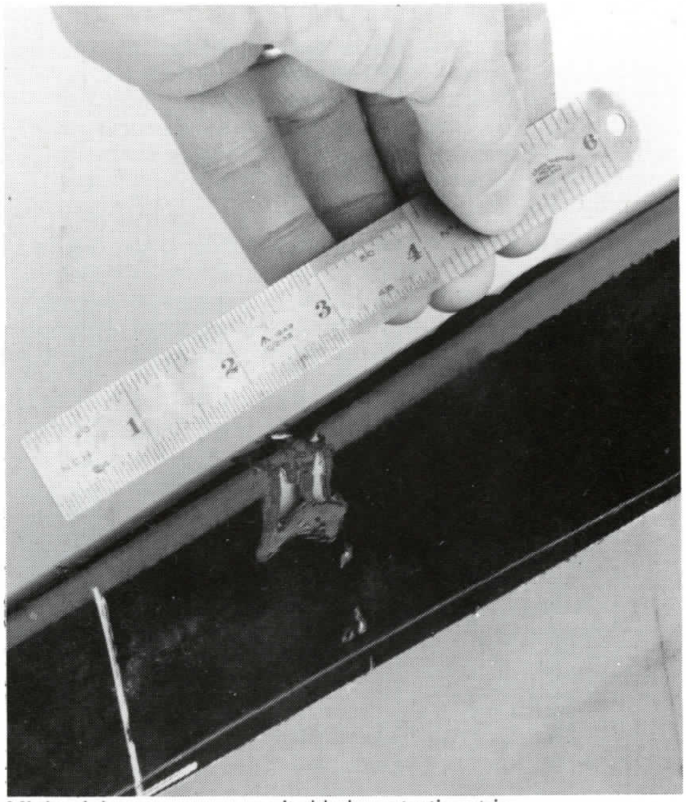


Lightning strike test

The photographic enlargement below of a composite blade tip shows the effect of nine repeated full threat lightning strikes. It will be seen that there is only local vaporisation of the polyurethane erosion coat leaving the blade structure completely undamaged.



Minor damage to polyurethane coat only

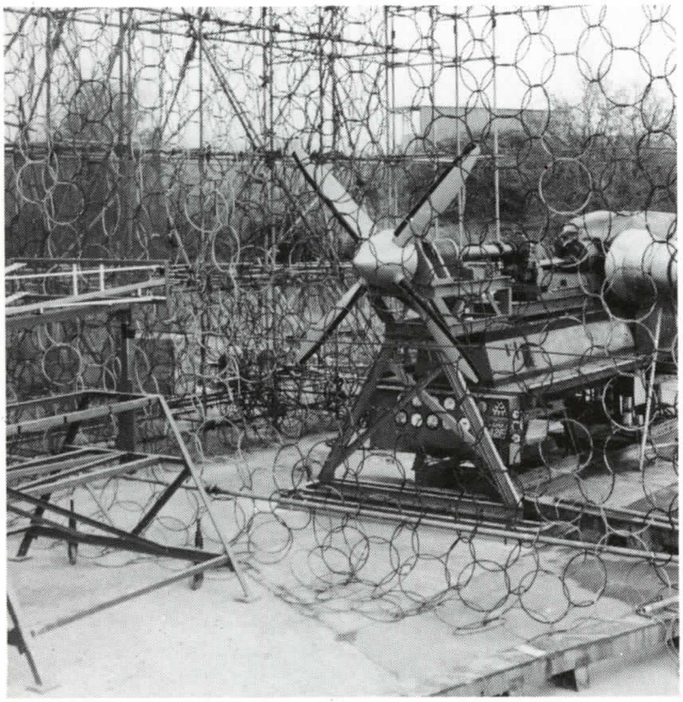


Minimal damage to composite blade protective strip

IMPACT TESTING

Dead birds weighing 4lb were projected into a composite bladed propeller rotating at take-off speed with no damage to any of the blades apart from a nick in the field replaceable edge protective strip as shown in the above right photograph.

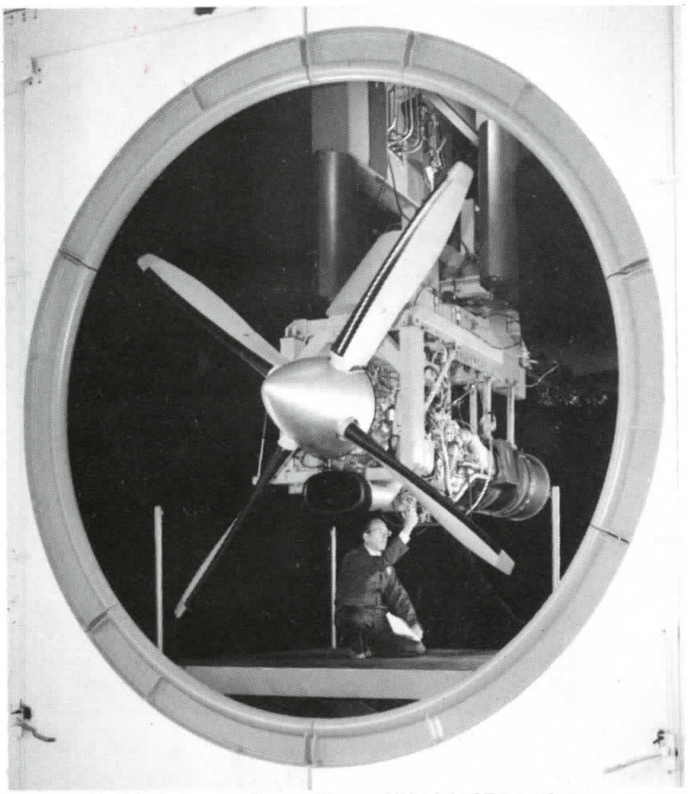
Impact testing to demonstrate a wheels-up landing has also been carried out using high impact energies, with only small blade debris being generated. These tests have been continued on rotating propellers in the field.



SF340 propeller in bird strike test rig

ENGINE TESTING

Dowty Rotol composite bladed propellers have been extensively tested on Garrett TPE 381, General Electric CT7 and Pratt and Whitney PT6 engines. Hangar testing to date amounts to hundreds of hours and is continuing, being supplemented by flight testing as covered overleaf.



Composite bladed propeller on General Electric CT7 engine

FLIGHT TESTING

Dowty Rotol composite bladed aircraft propellers commenced their flight testing on a converted Gulfstream 1 in 1982. The composite propeller was fitted to a General Electric CT7 engine in the left hand nacelle. The right hand engine was a Rolls-Royce Dart on which type Dowty Rotol metal bladed propellers have achieved over 100 million flying hours in airline operation.

The Saab-Fairchild 340 with Dowty Rotol composite bladed propellers made its first flight on 25 January and the Piper Cheyenne IV on 23 February 1983. These and other aircraft/engine applications using Dowty Rotol composite bladed propellers are rapidly building up test hours and confidence in the composite bladed propeller.

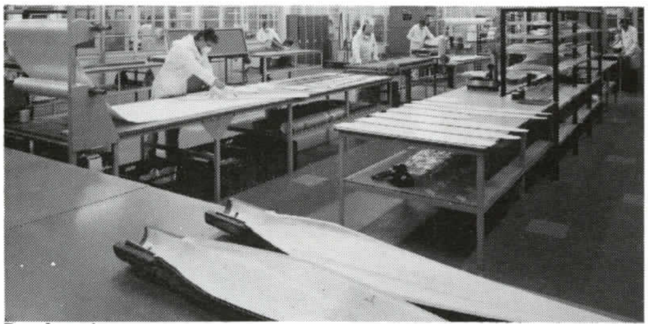
Gulfstream I

Saab-Fairchild 340

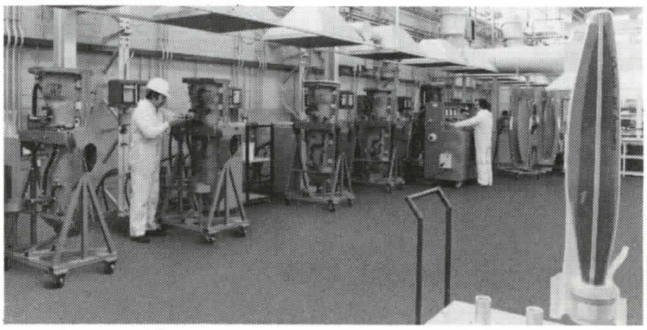
Piper Cheyenne IV

COMPOSITE BLADE FACILITY

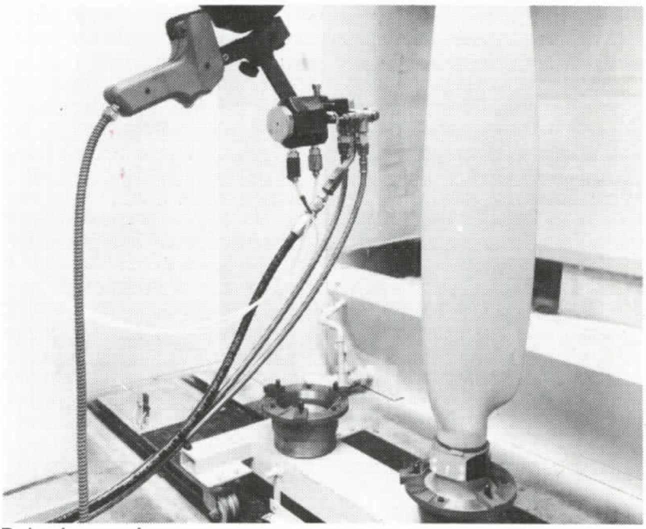
For further development and quantity production of composite propeller blades required on aircraft and air cushion vehicles, the company has constructed, equipped and staffed a new 18 000 ft^2 facility capable of manufacturing 2500 blades a year. The facility has controlled environmental areas for blade lay-up and robotic equipment for polyurethane spraying of finished blades.



Pre-forming



Injection moulding



Robotic spraying

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