Rotor Blade De-icing

SPRAYMAT TRIALS ON WESSEX

The Napier Spraymat de-icing system has been extended for application to helicopter rotor blades, and three prototype sets of heating mats are now being manufactured, on a production basis, for trials in Canada next winter. The system will be tested on the Westland Wessex. Spraymat de-icing being incorporated in an all-weather version of this anti-submarine helicopter entering production next year.

Unlike the majority of Spraymat de-icers produced for fixed-wing applications, the helicopter heating mats are prefabricated, for bonding to the components by the aircraft manufacturers. This will avoid the transport of vulnerable rotor blades from the makers to Napier's Spraymat shops at Luton and back again.

Actual Wessex rotor spars are being used for the moulds on which the 24ft-long prototype mats are being made. These follow standard Spraymat practice in containing Kumanal heat-sprayed copper-manganese heating elements between two glasscloth laminates. Six such elements, with electrical power supplied at the root, run spanwise, and are connected by a copper contact at the tip. The circuit is completed by a low-resistance pure copper foil bus-bar running spanwise along the upper surface of the heating mat. The whole laminate is symmetrically disposed around the leading edge, extending on both surfaces to 30 per cent chord, but the heating elements are asymmetrically disposed, their coverage extending to eight per cent chord on the top surface and 27 per cent on the lower surface, where the ice catchment area is greater, due to positive angles of incidence in flight. The heating mats for the tail-rotor blades are essentially similar, but each comprises only one element along the extreme leading edge.

Heating is required to a greater degree over the inboard sections of the blade than toward the tip, where both centrifugal force and kinetic heating aid ice-shedding. This is achieved by lowering the specific resistance of the heating elements in four stages, from 30W/sq in at the root to 20W/sq in at the tip, simply by increasing the thickness of the sprayed element. To speed ice-shedding, and so reduce the possibility of asymmetrical shedding, which leads to rotor imbalance—very high power-loadings are applied. For speed of surface heating the insulation gaps between elements have been reduced to only 0.030in.

The heating mats, and blades, are protected from hail and rain erosion, and from stone damage, by bonding over the outboard 10ft of the leading edge a 2in electrolamin microgran nickel sheath. Inboard, where blade flexure is greater, and the erosion problem less critical, the mat is protected by the application of Napier Stoneguard, a synthetic resin heavily loaded with stainless-steel particles, and further coated with Erocoat anti-erosion paint. The nickel sheath is used along the whole length of the tail rotor blades.

Napier work to very close weight and balance tolerances, so that any blade assembly will be interchangeable with all others of its type. Two complex balance-rigs have been built for chordwise and spanwise balance, and heating mats are at present tested for balance at all stages in their manufacture. If the balance is out it can usually be made good in subsequent stages. The primary requirement for the system is about 18kVA.

To avoid asymmetrical ice-shedding, matching heating elements on opposite blades are cycled together, so there are twelve cyclic areas for the four main-rotor blades. Two phases of a three-phase Rotax alternator, driven from the main gearbox, provide the power for main-rotor heating, while the third phase supplies the power for the tail-rotor mats. An 8lb "cyclic interrupter," developed for Napier by Austinite Ltd and housed within the fuselage, switches the current, which passes through an 8lb cyclic distributor mounted on the rotor head. The distributor contains a rotary solenoid which is activated when current is pass- ing to one pair of elements and winds a spring device which moves the contacts to connect the subsequent pair. The total power requirement for the system is around 120kVA.

The tail rotor is cycled four times for every full cycle of the main rotor, for, although the aerodynamic effects of ice on the tail blades are negligible, asymmetrical self-shedding leads to very pronounced vibrations. Cycling and cycle timings have not been finalized but will be determined during the winter tests in Canada.

Napier claim that the Spraymat de-icing system can be adapted to any type of helicopter, and one projected application is on the Rotodyne, where the 250°C gases ducted through the rotor blades in the helicopter regime will introduce new problems.