CASE STUDY

Dry Air Protection of Operational Phantom FGR2 Interceptors in the Royal Air Force

BACKGROUND

The McDonnell Douglas Phantom F4 is a supersonic multi-role attack aircraft, capable of lifting up to eight tons of modern offensive armament. The Royal Air Force (RAF) have a largely redesigned version, with powerful Rolls Royce Spey turbofan engines. These are used as both defense interceptors and as low level attack and reconnaissance aircraft. The RAF have approximately 70 Phantom aircraft in service, operating in several theatres of the world.

THE PROBLEM

Since Phantom FGR 2 aircraft have been deployed to the South Atlantic, a general increase in the level of corrosion to the Spey Mk 202 engines fitted to the aircraft, has been noted. This is particularly apparent in the rejection rate of the compressor discs due to corrosion pitting of the dovetail slots into which the compressor blades attach. This is obviously an effect of the maritime role which the aircraft now operates.

The size of this corrosion problem is illustrated by the

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costs incurred to remove and repair a similar component the Spey Mk 250 HP Compressor Module (fitted to the Nimrod aircraft):

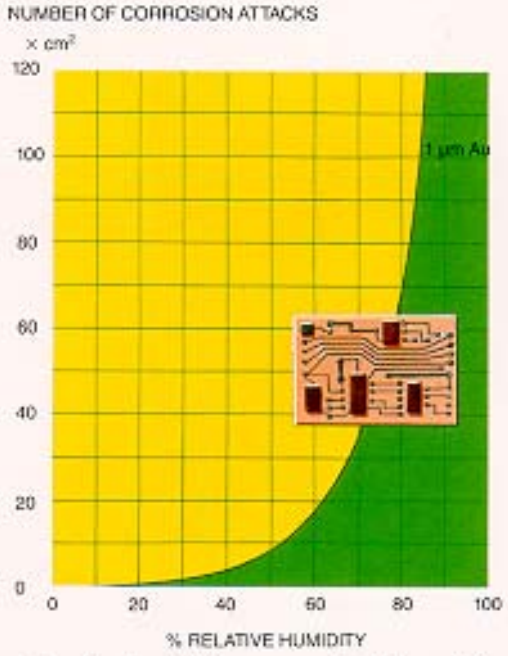
Engine removal	£1260
HP module replacement	£8025
Engine test	£960
Rolls Royce labor cost to overhaul	£13100
Average cost of spares during overhaul	£45719
Total Cost of Engine Overhaul	£69064 $130,530

These costs are only estimates and increase each year. But this is only for one section of the engine.

The Phantom radar and avionics are also prone to attack from moisture. A considerable amount of time, money and effort has gone into trying to increase the radar reliability, and to increase its mean time between failure.

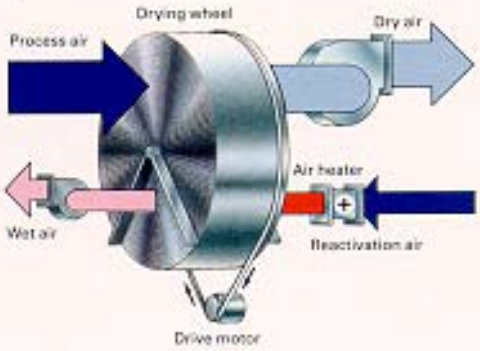
The relative humidity (RH) condition of the air affects the failure rate of electronics in two ways. As can be seen from figure 1 the corrosion of electronic contact material becomes a serious problem above 35% RH and in cables and wiring harness electrical resistance is dramatically reduced as relative humidity increases.

Figure 1 Corrosion Curve for Electronics



The graph shows the relationship between relative humidity and corrosion of gold contacts used in electronics. A value of 35% RH is recommended for the protection of electronics against corrosion.

Figure 2 Principle of Operation



The dehumidifier is based on Munters unique Honeycombe ® sorption* drying wheel:

- Process air passes through the drying wheel and leaves the dehumidifier as dry air.
- Heated reactivation air collects the moisture absorbed by the drying wheel and leaves the dehumidifier as wet air.

* Sorption = combined absorption and adsorption.

THE SOLUTION

To combat these problems it was decided to trial the Phantom FGR 2 aircraft using the Munters Dry Air Method. This utilizes Munters desiccant dehumidifier (see fig. 2) to control the relative humidity in the aircraft through the supply of dry air.

The decision to utilize this dry air method of protection was based on the RAF experience on the Nimrod Airborne Early Warning (AEW) aircraft, Maritime Reconnaissance (MR) aircraft and preliminary trial results on the Tornado GR 1 aircraft.

The Airforce Engineering Authority (EA) believes that selective dehumidification of the aircraft would not only alleviate corrosion throughout the airframe and engines, but also increase the reliability of the avionic and electrical equipment.

Because of the complexity and concentration of equipment within the modern combat aircraft, it was decided to conduct an initial trial to determine the correct access points for the dry air supply and establish the required airflow

rating to ensure dry air reached all suspect areas.

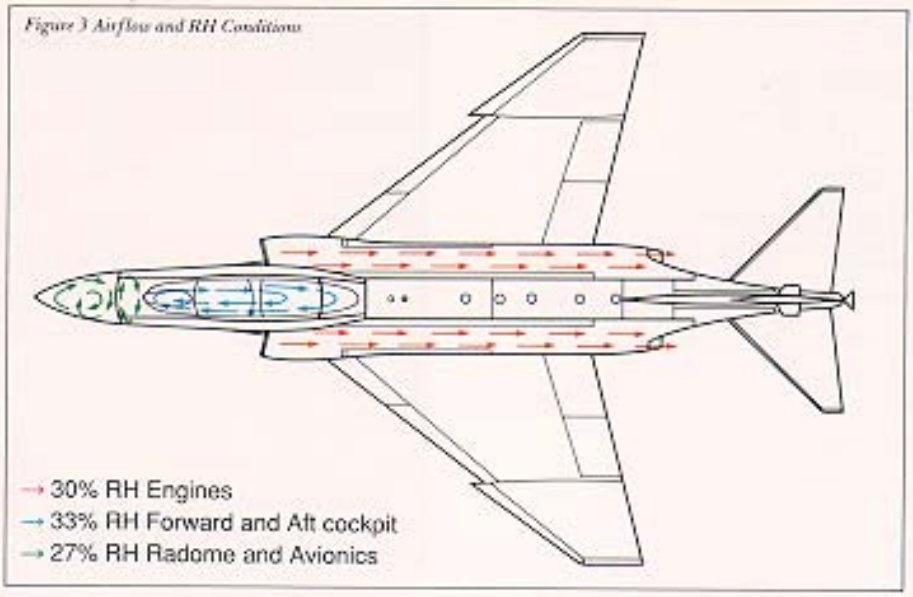
The trial proved to be a success (see fig. 3) and it established Munters model M120 (DEW 70 in U.S.A.) delivering 120m^3 (70 scfm) of dry air per hour as the unit to meet all performance parameters.

Based on the success of this initial study it was decided to go ahead with a full scale trial. This was conducted at RAF Wildenwrath in Germany with 4 operational Phantom aircraft of 19 Squadron situated in a Hardened Aircraft Shelter (HAS) environment.

The dehumidification equipment requirement was for a robust, compact and simple to operate unit. The dry air hose connections to the aircraft to be uncomplicated, quick in use and requiring no physical modifications to the actual aircraft.

To fulfill these parameters the M120 unit was mounted on a simple two wheeled towable trolley with storage space for hoses and fittings (see fig 4). It was connected via four 50mm (2 inch) diameter hoses and adaptors to the aircraft engines, radome/avionics, and forward/aft cockpits to provide approximately 30 m^3/h (17.5 scfm) of dry air to each area. Disconnection time was less than 5 minutes per aircraft, although it was realized this could be reduced even further with improved adaptors and dry air supply via overhead booms. Humidity readings within the above areas were constantly monitored during the trial, and the results showed a relative humidity level of less than 35% within an hour of the dehumidifier being switched on. Because of the low power requirement (1.20kW) of the model M120 it was not necessary to incorporate any energy saving

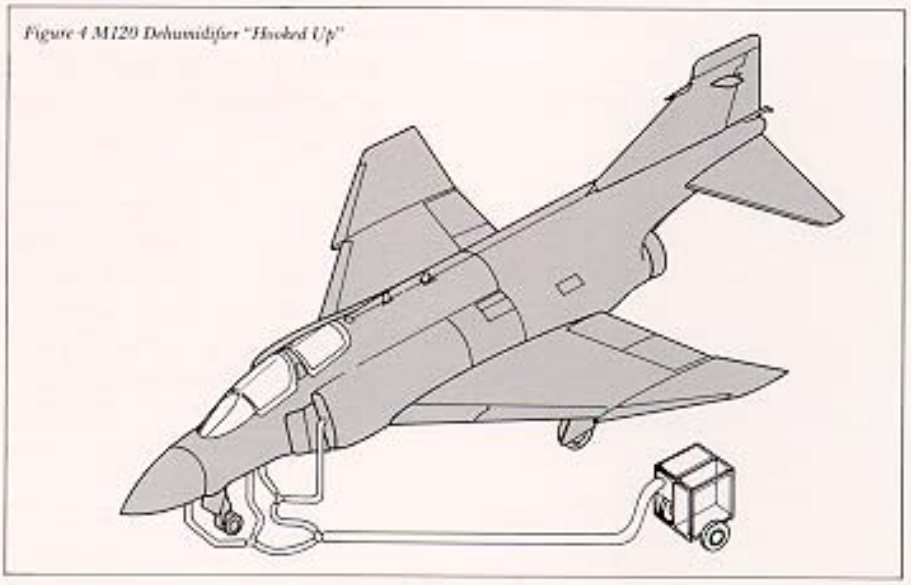
Figure 3 Airflow and RH Conditions



control system and the unit was set to manual and run continuously.

As well as the trial at RAF Wildenwrath a similar trial has also been undertaken at RAF Leuchas in Scotland with 6 Phantom FGR 2 aircraft being dehumidified in a hangar environment. This has produced an immediate benefit when dehumidification was used to dry out flooded cockpits.

Figure 4 M120 Dehumidifier "Hooked Up"



BENEFITS

INCREASED AIRCRAFT READINESS

- Trial results show a large increase in the Mean Time Between Failures (MTBF) and the Mean Time Between Arisings (MTBA).

REDUCED OPERATING COSTS

- Percentage Manhour reduction for selected avionic systems was;

Missile Control System	22%
Inertial Navigation System	23%
Communication Systems	25%

Total manhour reduction for 1st line fault arisings, all causes, was 27%.

REDUCED COMPONENT REPLACEMENT COSTS

- The reduced incidence of corrosion on engine components and airframe results in longer life expectancy of components and allows a lower level of component stock to be maintained.

COST JUSTIFICATION

- The M120 trolley mounted dehumidifer is less than 2% of the combined cost to repair just one Spey Mk 250 HP Compressor Module and of the excess manhours used in fault arisings over a mere 4 month period.

LOW EQUIPMENT OPERATING & MAINTENANCE COSTS

- The M120 is NATO approved and effective in all climates. It's rugged construction and low maintenance requirement give it a high level of reliability. It is simple to install, easy to operate and requires minimal supervision.

  Over the trial period the dehumidifiers totalled 10,253 on aircraft running hours without the need for service support or repair.

  On several occasions the M120 Trollies were used on aircraft parked in revetments due to shortage of HAS space, proving their suitability for operation in non-HAS 1st line environments.

RECOMMENDATION

- The RAF Strike Command Trial Report indicates major benefits have been obtained from the application of dry air to the Phantom FGR 2 aircraft and it's use should extend to cover the whole Phantom fleet.

- The Report calculates this action would reduce 1st line manhours by 33,829 hours giving an annual saving of £1.1 million ($2.1 million) and a payback on the necessary Munters equipment of less than 5 months. It concludes that these figures would be improved further with the inclusion of 2nd and 3rd line manhour reductions, estimated at over 20,000 hours.

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