Flight data recording and analysis functions available from a QAR/DAR system

Aircraft-performance monitoring
Fuel-burn analysis (fuel burn with limits)
Performance degradation (anti-icing failure, aircraft trim)
DFDR mandatory parameters for performance stored on QAR/DAR over a longer timeframe:
- IAS
- Mach number
- flap angle versus airspeed
- GPWS alarms
- stick-shaker/stall warning;
- turbulence causing a level excess;
- general data about flight characteristics;
- placard speed exceeded (VNE)
- N2 and EPR used for variable inlet guide-vane adjustment
- raw data stored for complete flight, allowing analysis at all phases
- low-cost cartridge allows for inexpensive mass storage for database building

Engine health monitoring
ECM programs:
- QAR/DAR can record engine parameters from DFDAU outside mandatory frame layout (N1, N2, EPR, EGT etc)
- From raw data, ECM program recommends fuel controller adjustment as necessary
- N2 and EPR used for variable inlet guide-vane adjustment
- raw data stored for complete flight, allowing analysis at all phases
- low-cost cartridge allows for inexpensive mass storage for database building

Engine maintenance tool:
- N1, N2, EPR, EGT assists in determining which engine module requires service (pressure and temperature changes through compressor stages can be predicted)
- engine take-off power analysed over period of time and derates applied for increased on-wing time

Autoland analysis
(Original application of the QAR was autopilot certification)
local/sensor/glide path deviation (ILS interference?)
flare time
pitch angle during flare
roll attitude at too low altitude (wingscrape risk) autopilot engagement status (triplex system in operation?)

Incident investigation
QAR survival allows incident analysis by airlines and may prevent fleet grounding when DFDR impounded by local regulatory authority:
- GPWS
- stick-shakes/stall warnings
- near-misses (sharp bank, radio altimeter)
- rushed approaches
- fire warnings

Hugh Chase of Teledyne, points out that in modern FMC-controlled aircraft, crews simply cannot be expected to detect all subtle events, which makes maintenance-oriented QAR analysis all the more imperative. “For flight operations, where you’re watching for statistical data to pick up trends, if you miss one flight it’s a lesser problem. But for engineering purposes, you can’t afford to miss a flight on which there’s an event,” says Chase.

In another initiative, Rolls-Royce is working with carriers to quantify de-rated engine operation on take-off and climb using QARs. The quantum of de-rated operation will be converted to credits which will extend the overhaul lives of major “Group A” engine components, such as shafts, discs and structural casings. Increases available wear-out in a limited life-span of on-wing engine life, but could extend in some cases to 50% with multi-million dollar savings in the long term.

With (typically) over 2,000 parameters in the available data-stream, the QARs are useful in constructional engineering and maintenance diagnostic analysis, limited only by their data-storage and extraction capacity, and that is where QARs will have major advantages, according to Chase, an opinion echoed by Peter Walker, marketing manager at P&G. Also, the analytical capability of the new QARs is already being improved by software upgrades to protect the new systems from early obsolescence.

Chase points out that optical disk-drives use non-contact recording technology, so that the intrinsic reliability of the device will be higher than that of tape recorders, of which the heads of the early versions were prone to wear out in a limited life-span that dictates their maintenance cycles.

Additionally, data recovery from a random-access disk is less time-consuming than the physical rolling of a tape to locate the position of a particular piece of data — and it allows selective downloading.

LONG HAUL
For long-haul carriers in particular, QAR’s increased capacity has advantages. They do not need to download data at the end of each sector, since several flights can be stored and the data recovered on return to home base. In fact, with cartridge, this is no problem, points out P&G, because the standard DC300-type cartridge can simply be removed and replaced like video casettes, with the “full” tape being carried back to base for download.

On some particularly long flight sectors, continuous recording on a single tape was impossible at very high data rates (ie greater than 256 w/s), so QARs were sometimes de-activated in cruise. Current cartridge-