PART 1.6 - CONVENING AUTHORITY COMMENTS

1. The Service Inquiry (SI) Panel has conducted a thorough investigation into this accident which involved a difficult technical element and I commend them for their diligent work. They found the cause to be a failure of the epoxy resin in the Torque Motor bellows within the engine Fuel Control Unit, which ultimately led to an engine failure. It should be noted that the failure was not caused by the conduct of the air test or previous maintenance activity and could have occurred on any sortie. I agree with the cause of the accident and the recommendations as detailed by the SI Panel. Whilst the accident was caused by a technical failure, the SI Panel was tasked to look at the wider organizational factors which could prevent a similar or related occurrence. There are some key issues to be drawn out of this accident; firstly, the shortage of Suitably Qualified and Experienced Persons (SQEP) in the Tucano Glider Support Authority (TGSA) which likely prevented the identification of the bellows as an ageing component; also, the fact that the known (but not understood) failure had not previously been sentenced by operating or engineering authorities. Secondly, the lack of compatibility between the Training Group Orders (TGOs) and the Flight Test Schedule (FTS) for the conduct of Tucano air tests. Thirdly, the suitability of the weather on the day which forced the aircraft down below cloud to a height below that stated in the FTS. The evidence does show that the test flight was conducted within the overall rule set, including weather minima, and the engine failed when the Engine Electronic Control (EEC) switch was reasonably returned to Normal during the recovery phase of the sortie whilst conducting the final part of the Partial Test Flight (PTF); of note the EEC switch system is simple and reliable and the SI has found no reason to question Tucano operating procedures regarding it. Overall, whilst I agree that the air test played no role in the Torque Motor failure, and accepting that the orders and instructions provided a degree of ambiguity rather than clarity, I do question whether the air test should have been continued in the weather conditions that day.

2. TGOs, allow PTFs to be conducted in the weather conditions that prevailed but forced the aircraft to a height below that in the FTS. The Panel make a valid point in questioning whether the TGO weather minima was more appropriate for the case of an emergency recovery to the airfield from medium-level following an engine failure. The Handling Pilot did initially try to conduct the test flight at 1500 ft, in accordance with the FTS, but was prevented from doing so by the cloud base and elected to continue at a TGO compliant height within the 1200 ft weather minima. Whilst this could be determined as compliant and well intentioned for organizational gain, I would question if this risk was warranted in this case. The best chance of a successful forced landing from overhead an airfield is from the known parameters of the 1500 ft low key (or high key) position;

conducting the PTF (particularly the EEC to Manual selection) below this height significantly reduces the chance of a successful forced landing should an engine failure occur. Other experienced Tucano operators suggested that an appropriate place to make the PTF EEC switch to Manual is whilst approaching the low key position for potential engine failure reasons. Using parameters, including weather minima, to enable low key positioning would provide time to react, diagnose the failure, complete checks and intercept the known forced landing pattern should an engine failure occur. Therefore, whilst accepting that there is a lack of compatibility between the Orders and instructions and that the air test was conducted within the overall rule set, I do not believe the weather was suitable to provide reliable options should the engine fail, particularly when making the selection to Manual. Accordingly, the 1500 ft described in the FTS is more appropriate for this task for airmanship reasons. However, this does not suggest that the 1200 ft (TGOs) is incorrect for a recovery from medium-level following an engine failure during an air test. The bottom line is that we should ask why we would wish to place the aircraft at increased risk by conducting this test (EEC Manual selection), just below cloud at 1200 ft in the airfield overhead, whilst making significant post engine maintenance switch selections?

3. Back to the cause, once the Torque Motor failure occurred, there was little chance of a successful diagnosis in the time available. Indeed, despite this being a known failure mode, there was no training made available to crews to help them recognize the Torque Motor failure or help them resolve it as the hazard had not been previously sentenced. The pilot correctly concentrated on flying the aircraft and positioning for the difficult height, speed and position relationship that presented itself (high, fast and close to the runway). In the daytime, overhead an airfield with four runways available, there should be a reasonable expectation of conducting a successful forced landing, particularly if able to reach a low key position, which in this case was possibly in or above cloud. The pilot was therefore poorly placed; it is possible that Runway 28 would have provided another option, including more time for checks and a controlled ejection decision. However, the pilot elected to land straight ahead on Runway 21 which gave only 32 seconds from the engine failure to touchdown. This resulted in the gear still travelling and being in an unknown configuration at touchdown. Any further analysis of the decision making in relationship to runway options would be subject to significant hindsight, so we should respect the pilot's decision to land on Runway 21. Of note, once committed, a verbalized ejection decision was not made at the 300 ft point which could have resulted in uncertainty between the crew or at worst a command ejection mishap. In any event, having elected to remain with the aircraft, the crew were now largely within the realms of luck with the aircraft touching down at speed, well down the runway, with the gear in an unknown travelling configuration and safe ejection options likely to have passed. In this

instance, luck did play a part and a successful ground egress was conducted and no injuries fortunately resulted. It is possible that the captain's sound judgement in using rudder to put the aircraft on the grass, thus keeping it on the airfield, prevented loss of life.

4. The Tucano has been life-extended by the ever changing UK Military Flying Training System Programme but there appears to have been no safety management oversight to provide a whole life perspective of the aircraft's continued safety. The Torque Motor bellows was a known failure mode from a previous incident in 2009 but it was believed at the time to be a one-off manufacturing fault. Accordingly, the potential hazard had never been previously identified or sentenced by the engineering or operating communities; admittedly, it is unreasonable to apply the high safety standards of the post Haddon-Cave operating model to historic judgements made by our predecessors. However, the lack of recognition of the hazard resulted in no mitigation (training) being put in place to protect the pilot on the day of the accident. SQEP in some key safety related posts did not exist in the TGSA at the time of the accident including: a requirements manager; integrated aviation specialist; dedicated safety manager and independent safety advisor, the absence of which potentially exacerbated the chance of missing age related issues. Indeed, the bellows failure in the FCU was a result of the absence of a sub-component lifing policy[1]. It is clear from Tucano data that the mean-time between-failures for the Torque Motor has decreased markedly since 2009 and this should have been a warning signal that there was an ageing sub-component within the aircraft which should have led to hazard sentencing as previously discussed. Of course this needs the right SQEP to provide the capability to detect such an issue and it is likely that this was not unreasonably outside the capacity of the TGSA at the time of the accident. The actual Torque Motor which failed in ZF349 dated back to 1987, with the epoxy eventually de-bonding through age around the day of the accident; indeed, this small bellows had no control or inspection regime over its 26 year lifespan yet was critical to the safety of the Tucano - its failure coming close to causing the loss of 2 pilots.

5. In summary, the cause of this accident was a technical failure which occurred during an engine PTF but could have occurred on any sortie. From a wider organizational point of view and TGO perspective, the flight was conducted within the weather minima but the orders were not compatible with the FTS which suggested a height of 1500 ft for airmanship reasons (not specified), to cater for the eventuality of an engine failure. In this case, airworthiness SQEP shortages within the DE&S have impacted the safety management of this ageing aircraft; not

[1] Engineering procedural policy to apply a life metric to aerospace components that are assessed as having a fundamental link to airworthiness or to Air Safety should that component fail in use.

having the capacity to detect the increasing possibility of sub-component failure is a missed opportunity to identify this particular hazard. Since the accident the hazard has now been sentenced appropriately. Once the engine failed, the crew were faced with a difficult scenario due to their combination of height, speed and geographic location which gave them only one or two low probability options for a successful forced landing. The crew handled the emergency to the best of their abilities but once committed past their 300 ft ejection decision point were largely in the realms of luck, critically with regard to the unknown configuration of the travelling landing gear and subsequent behaviour of the aircraft after touchdown. Had there been a better understanding of sub-component life within the Tucano engine unit, proper understanding and sentencing of a potential hazard and aircrew training for such an eventuality this unfortunate accident may have been avoided. In addition there are some useful lessons to come from the conduct and documentation of Tucano PTFs. The bellows failure would eventually happen and when it did the crew were faced with a very difficult scenario from which it was down to good fortune that they were able to walk away.