Proposed Means of Compliance for CS-E900
"Propeller Parking Brake"

Introductory note:

The hereby presented Means of Compliance has been classified as important because of directly addressing the airworthiness codes, environmental protection certification specifications and/or applicable Means of Compliance with Part 21 and as such shall be subject to public consultation, in accordance with EASA Management Board decision 02/04 dated 30 March 2004, Article 3 (2) which states:
"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

Statement of Issue:

CS-E900 states:
"If a Propeller parking brake is provided it must be operated 100 times during the endurance test. It must be applied at the maximum Propeller speed recommended by the Engine constructor"

Under current CS-E regulations the only endurance test is as defined under CS-E 740 – Endurance Tests. Engine constructors typically adopt cyclic endurance testing to demonstrate Initial Maintenance Interval (IMI) inspection limits. IMI testing is currently defined by FAR33.90 regulations and as yet has not been adopted by EASA.

The limitation of concurrent availability of propeller equipped engines on outdoor test beds leads to a proposal to conduct CS-E 900 Propeller Parking Brake testing on an engine conducting FAR33.90 IMI cyclic testing.

The mandatory implication of the wording of the CS-E 900 requirement demands a public consultation process in order to introduce an alternative Means of Compliance.

Discussion:

Endurance testing to CS-E 740 primarily tests speed, power and turbo-machinery temperature margins through endurance stages. The endurance stages include low oil pressure testing and also simultaneous high oil temperature testing. The CS-E 740 endurance test generically consists of six 25 hour stages totalling 150 hours as defined in CS-E 740(c). Each stage generically consists of 5 sub parts and if CS-E 900 Propeller Parking Brake testing is being conducted, the Propeller Brake can be dynamically activated at the end of sub parts 3, 4 and 5 due to the continuity requirements between sub parts 1, 2 and 3.

During the 6 endurance stages this results in the nominal activation of the Propeller Brake 75 times resulting in the need for up to 25 penalty engine start/stop cycles to complete the CS-E 900 requirements.
The Propeller Parking Brake components, considered as Equipment, are tested to CS-E 80 for which AMC E 80 accepts the testing to EUROCAE ED-14/RTCA/DO-160. This covers environmental testing to include temperature and vibration elements.

A proposal to conduct CS-E 900 Propeller Parking Brake Testing during IMI cyclic testing leads to the assessment of the relative testing impact between the CS-E 740 test cycle and an IMI test cycle.

Comparison of CS740 and FAR33.90 test objectives:

The IMI cycle is generally constructed to reflect the average aircraft mission cycle with respect to propeller speed and power/torque for a turbo-prop engine, in order to demonstrate representative maintenance inspection requirements including the maximum out of balance level to be declared for the engine. As a result the cycle tends to be cyclic in nature and much shorter than a CS-E 740 stage. The IMI mission cycle typically consists of a cool down period between cycles in order to increase the severity of turbine thermal stresses.

The FAR33.90 cycle is generally constructed to cover the cyclic application of all nominal rated propeller speeds and nominal rated powers or torques in alignment with the equivalent aircraft/engine mission at maximum out of balance on all spools. The CS-E 740 cycle is constructed to demonstrate “Red Line” speeds and power/torque levels with type test margins to cover variability and deterioration margins for the establishment of declared rating limitations and as such is more thermodynamically demanding.

Impact on propeller brake:

In consideration of Propeller Parking Brake Components which are mounted to a turbo-prop engine in order to dynamically brake and park the engine rotor and Propeller, the rating margins applied to the engine during a CS-E 740 endurance test do not have any significant impact. The higher power/torque levels and slightly higher speeds are not recognised by the Propeller Brake components. Any engine pylon mounted equipment is also unaffected by the higher CS-E 740 margins.

FAR33.90 IMI cyclic testing is typically conducted with maximum service levels of engine rotor out of balance limits as opposed to CS-E 740 endurance testing for which the engine rotors are normally balanced within new engine limits. This represents a more severe test environment for the propeller parking brake when tested during an IMI test.

IMI test stages are typically conducted at normal engine oil pressures and temperatures. In consideration of the engine high oil temperature testing per CS-E 740(e)(1) and low oil pressure testing per CS-E 740(f)(V) that is carried out during CS-E 740 testing; provided that the propeller brake is not oil lubricated it does not see any impact from the low oil pressure test stage. High oil temperatures can be expected to increase the mounting pad temperatures for any engine mounted components particularly on transmission mounted components where the hot oil will tend to influence metal temperatures at the mounting pad.

As such the higher oil temperatures run at Take-off power ratings will potentially influence the running metal temperatures of the engine mounted propeller brake equipment. The application of the propeller brake at the shut-down of the engine will generally generate higher component metal temperatures due to friction heating and subsequent heat conduction although the extreme heat conditions from worst case side wind impact on propeller wind generated torque are generally not achievable during out door test bed running. As such the impact of hot oil testing and dynamic braking events will require high energy bench testing and/or thermal analysis to support this proposal.

Proposed Means of Compliance for CS-E 900:

For propeller parking brake components that are not oil lubricated and are covered by CS-E 80 equipment testing, it is proposed that in the context of the CS-E 900 requirement, endurance testing is considered to apply to IMI testing defined under FAR33.90 regulations as well as endurance testing to CS-E 740.

This proposal is contingent on supplementary high energy bench testing and/or analysis be considered as part of the accepted means of compliance to address the effects of hot oil testing on engine mounted components.