

MX-1 Propeller Speed Reduction Unit Test Results

By Gwen Maxwell

Since the early days of converting automotive engines to experimental aircraft use, a variety of PSRU designs have been developed to provide torsional vibration dampening between the engine and PSRU. These include gears, belt drives, clutches and other gear reduction systems. To our knowledge, despite the fact that many designs have experienced mechanical and/or structural failures, there has been little, scientific testing and analysis of the affect of engine vibration on the PSRU. In Fall 2006 Maxwell Propulsion Systems, Inc. (MPS) made the decision to develop a new geared propeller speed reduction unit (PSRU). Our goal was to bring into the experimental aviation marketplace a scientifically-designed and -tested system that would address the critical issue of fatigue and/or failure resulting from torsional vibration. The design requirements included a projected TBO of at least 1500 hours.

While the heart of an automotive conversion for aircraft use is the PSRU, MPS also believes in building quality from the start. We begin with a Subaru EJ25 STI Turbo block and the stock EJ25 normally aspirated heads. The short block is disassembled, then race-engine balanced and blueprinted. The stock Subaru long block is coupled with a dual ignition system, custom throttle body, exhaust, cooling, and mounting system.

Guided by preliminary market research, the initial MPS PSRU development proceeded along two parallel paths to address the design and testing objectives. The first approach tested used an automotive-style racing clutch to engage and disengage the PSRU. We chose the Tilton 5.5" rally clutch assembly coupled with the Tilton disc pack and hydraulic release bearing. MPS assembled a complete firewall forward system on a mockup of a GlaStar cockpit/firewall then mounted this to a flatbed trailer (see attached). The package was ground tested between July and September 2007. The test results demonstrated that an automotive clutch could effectively minimize the damaging effects

of torsional vibration, however, designing an effective process to engage and disengage the clutch would require cumbersome activators that were not *pilot-friendly*.

Given these results, MPS immediately moved to incorporate a one-piece elastomeric coupler from Lord Corporation into their design. Testing included vibration analyses conducted using procedures described in Steve Boese's Contact!¹ article. Analysis demonstrated harmonic frequencies that were outside the acceptable range described by Mr. Boese. Disappointed, but convinced that we were on the correct path we contacted Lord Corporation for their input on appropriate next steps in the development process. Their first advice was to investigate whether the engine mounting was a contributing factor to the observed vibrations. To do this, the original mounting bushings were replaced with different density materials and vibration readings obtained. The end result was that, while there was some minimal change to the results observed after each of four different density bushings, the primary source of the vibration was determined to be in the elastomeric coupler.

To address this issue, the MPS engineer worked with the engineering staff at Lord Corporation to analyze the vibration data. The proposed remedy was to use a plate to house eight J-6250 rubber bushings. This design was completed and another series of vibration tests were performed. The results of the tests shown here demonstrated that all observed vibrations fell below or within the acceptable range.

After 5 months and 140+ ground test hours, MPS believes that we have a PSRU that will meet the requirements for a Subaru automotive conversion. Initial ground testing was completed in January 2008. Flight testing is ongoing at SportCopter International on their new SportCopter II; as well as N787MX - Maxwell *Dream Liner*.²

¹ Steve Boese, *A Vibration Study of a Mazda 13B Installation in a Van's RV6A*; *Contact! Issue 90 Pages 22-29*.

² N787MX first flew June 26, 2008. As of July 20, 2008 it has logged 51 flight hours.