



Engine Crankshaft Torsional Vibration Test

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. To identify the angular vibratory behavior of cranktrains, in a dynamometer configuration, and for the specific purpose of generating data to be used in torsional vibration absorber development.

1.2 Applicability. This test applies to all cranktrain systems tested for torsional vibration absorber development and for verification of acceptable angular crank vibrations.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities. Dynamometer test cell.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. Engine dynamometer with motoring capability.

3.3 Test Vehicle/Test Piece.

3.3.1 Select an engine complete with all the dress items of the type required for this test. Engine condition must be such that it is capable of obtaining the design intent fuel cut off.

3.3.2 Install one of the three allowed configurations of the accessory drive as requested (3.3.2.1 thru 3.3.2.3).

3.3.2.1 No accessory drive (i.e., belt removed). Supply engine with external coolant pump and other peripheral equipment if necessary.

3.3.2.2 Durability test configuration with short belt.

3.3.2.3 Full dressed accessory drive.

3.3.3 Do not install the cooling fan unless specifically requested.

3.3.4 Install the requested torsional vibration absorber and/or crank pulley.

3.4 Test Time.

Calendar time: 1 day

Test hours: 8 hours

Coordination hours: 16 hours

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3.5 Test Required Information. Engine data such as engine speed, torque and power are required.

3.6 Personnel/Skills. Familiarity with instrumentation and test setup.

4 Procedure

4.1 Preparation.

4.1.1 Stabilize engine temperature to standard test temperature at 2000 rpm.

4.1.2 Install the designated flywheel, degree wheel, dynamometer adapter and the propshaft for that engine. If any of this equipment does not fit or interferes with other dynamometer equipment, modify the dynamometer, not the engine components.

4.1.3 Tighten all bolts to design torque specification.

4.1.4 Mark the torsional vibration absorber, absorber's bolts and the flywheel bolts in order to check for slippage after the test.

4.1.5 Install shields and/or safety blankets around the engine, especially for early development absorbers.

4.1.6 Install the torsional vibration transducer (optical encoder) at the nose of the crankshaft and mark its position against the crank (or absorber's hub) in order to check for slippage after the test.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Standard Test Temperatures. Coolant out: $90^{\circ}\text{C} \pm 5^{\circ}\text{C}$. Engine oil: $90^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

If the test is being run with a functional absorber, a cold and a hot damper test should be run. The cold test is a 33.33 rpm/s Wide Open Throttle (WOT) sweep with the damper's elastomer at room temperature at the start of test. The hot test should be run by slowing engine speed down to the start speed in 20 s, and immediately start running another 33.33 rpm/s WOT sweep while the elastomer is still hot from the first test.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions. Run one of the tests in 4.3.1 thru 4.3.2 as specified by the requestor.

4.3.1 WOT Sweep. Run engine at WOT from 1200 rpm to fuel cut off at a rate of 33.33 rpm/s.

4.3.2 Motored sweep. Motor engine at closed throttle from 1200 rpm to the fuel cut off rpm at a rate of 33.33 rpm/s.

4.3.3 Data collected should be saved for subsequent processing.

4.3.4 Stop the engine after the test and measure the rubber temperature of the absorber within 5 s.

4.3.5 Check all marked parts and bolts to identify any slippage during the test.

4.3.6 Fill out Data Sheet B1, Appendix B with the required information. For rpm dependent quantities, report minimum and maximum values and the engine speed at which they occur.

5 Data

5.1 Calculations.

5.1.1 Data Acquisition. Use Time Domain data acquisition as specified in 5.1.1.1.

5.1.1.1 Time Domain Parameters.

5.1.1.1.1 Minimum Sampling Rate: 12 800 Hz.

5.1.1.1.2 Trigger Signal: One pulse per crank revolution.

5.1.1.1.3 Filtering: High pass at 25 Hz.

5.1.2 Data Processing Parameters.

5.1.2.1 Data Processing Method: Cyclic processing.

5.1.2.2 Processed Function: Complex spectrum.

5.1.2.3 Averaging: Four (4) engine cycle long data blocks, four (4) averages.

5.1.2.4 Windowing: None.

5.1.2.5 Units and Scale: Peak amplitude (degrees).

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5.1.2.5.1 Magnitudes must be processed to give peak spectral magnitude. Double Degree Amplitude (DDA) or peak to peak and the Root Mean Square (RMS) amplitudes are not good measures of angular vibrations and should be avoided.

5.1.2.6 Frequency (Hertz).

5.1.2.7 Order Cuts: Peak magnitude (degrees).

5.1.2.8 Engine Speed (rpm).

5.1.2.9 The calibrated raw time data together with the once per revolution pulse must be stored in Binary Universal File 58 (UFF58b) format and made available to the requesting parties in that format.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. Each report should include the required plots and Data Sheet B1, Appendix B.

5.3.1 Waterfall Plots. Waterfall plots can be presented either in Frequency Map or Order Map style.

- In either case the plotted functions must be the peak spectral magnitudes.
- The magnitude scale must range from 0 degrees to one of 0.25 degrees, 0.50 degrees, 0.75 degrees, 1.00 degrees, 1.25 degrees, 1.50 degrees, 1.75 degrees or 2.00 degrees.
- The frequency range of the Frequency Map must be either 0 Hz to 500 Hz, or 0 Hz to 1000 Hz, whichever represents the data better.
- The order axis range of the Order Map must be 0 orders to 10 orders, which ever represents data more accurately.
- The rpm scale must start from 2000 rpm and extend to the nearest 500 rpm higher than the maximum measurement rpm.
- Magnitude, frequency and rpm scales of all plots for a given project must be the same.

5.3.1.1 The Frequency Map style waterfall must have the rpm axis plotted vertically and the frequency axis plotted horizontally (Figure A1, Appendix A).

5.3.1.2 The Order Map style waterfall must have the rpm axis plotted at 30 degrees from the vertical. The order axis could be horizontal or 30 degrees from the horizontal (Figure A4, Appendix A).

5.3.2 Order Cut Plots. Order cut plots must have the same magnitude and rpm scales of the associated waterfall plot, and correspond to peak vibration amplitudes at that order. Order cuts obtained by integration in a given frequency (or order) band are not acceptable.

Order cut plots should not contain a plot of Total Vibration Magnitude, unless it truly represents the maximum time domain magnitude of the processed signals. (Note that most analyzers do not calculate the time domain amplitude and the results are misleading.)

There may be one to three types of order plots included in each report.

5.3.2.1 The first type of order plot is one with order cuts corresponding to all integer orders. These orders should range from the first order, up to and including twice the firing order (Figure A2, Appendix A).

5.3.2.2 The second type of order plot is one which contains only the half orders up to and including the half order below the firing order (Figure A3, Appendix A). (There is no need to include the half order plot for the motored tests.)

5.3.2.3 The third type of order plot may be included to report any other important order related vibrations that are not included in the first two plots.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

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