



Hot Flywheel and Pressure Plate Burst 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. This Test Procedure describes the verification of burst failure occurring during the test of sets of Manual Transmission clutch assemblies and flywheels in hot condition while free revving the engine to fuel cut off speed.

1.2 Applicability. Applicable to all dry clutch systems and flywheels used in Manual Transmission Powertrains.

1.3 Remarks. This standard is extended to include optional use of an electric dyno engine or a combustion engine in the test setup.

It was formerly known as Powertrain internal standard TP1164.

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.

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. The use of a combustion engine or an electric dynamometer drive are both valid.

3.2.1 Electric Dyno Engine Set-up. If an electric dyno engine is used, the dyno shall be capable of reaching the applicable engine cut-off speed (maximum RPM) of the combustion engine that the clutch system and flywheel will be used with. It shall be capable of reaching the torque levels required to ensure that all test conditions are met. Acceleration rates under load shall be identical to the applicable combustion engine which shall be simulated (reference value / estimation of maximum required acceleration rate: 9000 min⁻¹/s). The electric dyno engine shall be sufficiently protected to withstand the maximum temperatures that may occur during test (up to +750 °C). Broken flywheels / clutches may lead to significant imbalance in the test rig set-up, the electric dyno engine shall be adequately protected to withstand this (including any bearings / intermediate mountings).

3.2.2 Combustion Engine Set-up. If a combustion engine is used, the engine shall be the correct engine to accept the test pieces (clutch system and flywheel) without any modification of the attachments and interface. The engine shall be in full working order to achieve the test conditions specified.

Note: Safety precautions shall be taken in supplying fuel to engine to minimize exposure of fuel system to potential high temperature shrapnel from burst flywheel and pressure plate.

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3.2.2.1 Necessary equipment to run the engine; 12 V power supply, jacketed radiator or water tower or equivalent engine cooling water supply, and fuel supply.

3.2.2.2 Control to operate the throttle.

3.2.2.3 Oil and coolant temperature gauges.

3.2.3 Equipment for Electric Dyno Engine and Combustion Engine Set-up.

3.2.3.1 Special burst box with sufficiently dimensioned steel plate used as a safety precaution around the bell housing.

3.2.3.2 Bedplate space adequate to mount burst box with engine assembly, clutch bell housing and engine clutch controls. Approximate space required 1.52 m x 3.050 m.

3.2.3.3 Closed air ventilation system recommended to handle clutch dust.

3.2.3.4 Hydraulic control to enable fully automated clutch operation (modulation must be controlled to achieve constant engine speed during test).

3.2.3.5 A transmission input shaft located with a front bearing retainer and both attached to a plate to prevent rotation.

3.2.3.6 Transmission input shaft dummy with interchangeable clutch spline and electric connectors.

3.2.3.7 Thermocouples, located between front and rear surfaces of clutch driven disc facing material – minimum 3 locations (see Figure 1).

3.3 Test Vehicle/Test Piece.

3.3.1 Three (3) sets of clutch systems and flywheels (Dual Mass Flywheels if applicable). The flywheels shall be free of crack indication.

3.3.2 In addition: 1 set of clutch system and flywheel to enable try-out and set-up of test bench. This set shall be replaced by the actual test pieces once all parameters for test execution have been checked.

3.3.3 Clutch discs must have minimum 3 thermocouples attached to record the temperatures that are attained between flywheel and pressure plate (see Figure 1).

3.4 Test Time.

Calendar time: 3 weeks

Test hours: 1 week

Coordination hours: 16 h

3.5 Test Required Information.

3.5.1 Continuous (hot) idle speed and maximum RPM (fuel cut off) of applicable combustion engine.

3.5.2 Maximum engine speed gradient and maximum WOT (wide open throttle) torque vs. RPM curve of applicable combustion engine to enable realistic simulation if electric dyno engine is used.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation.

4.1.1 Sample Inspection.

4.1.1.1 Inspect 3 flywheels before test. Check for 100 % dimensional and balance conformance and material composition. Documentation on the part inspection report to be provided by supplier.

4.1.1.2 The 3 pressure plate assemblies shall be inspected to verify there are no crack indications.

4.1.2 Sample Preparation.

4.1.2.1 Engine Preparation (for combustion engine set-up).

4.1.2.1.1 Mount the engine in the cell (do not connect to a brake dynamometer).

4.1.2.1.2 Install a single dynamometer exhaust system.

4.1.2.1.3 Install jacketed radiator, water tower, or straight water hose to engine water pump.

4.1.2.1.4 Install remote throttle controls and remote clutch controls.

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4.1.2.2 Flywheel Clutch Assembly Preparation.

4.1.2.2.1 Modify the transmission input shaft to allow the wires for the 3 thermocouples to extend through the clutch disc hub, then rearward through the shaft splines and out the transmission retainer to the temperature recorder.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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.**4.3.1 Temperature Buildup.**

4.3.1.1 Start the engine and run at idle speed with the clutch disengaged.

4.3.1.2 Slowly open the throttle (equivalent control in case of electric dyno engine) and simultaneously engage the clutch until the throttle is wide open and the engine speed is $\approx 3000 \text{ min}^{-1}$ (rpm).

Note: No clutch rotation will occur due to the non-rotating input shaft.

4.3.1.3 Continue slipping the clutch maintaining engine speed of $\approx 3000 \text{ min}^{-1}$ (rpm) until the desired clutch disc temperature is obtained, $\approx (+620 \pm 10) ^\circ\text{C}$.

If the design is such that a temperature of $\approx (+620 \pm 10) ^\circ\text{C}$ cannot be reached within 3 minutes, run test at highest temperature obtainable.

4.3.1.4 Disengage the clutch and rapidly close the throttle to idle speed (equivalent control in case of electric dyno engine).

4.3.1.5 Start rapid acceleration test.

4.3.2 Rapid Acceleration Test.

4.3.2.1 Disengage the clutch and rapidly accelerate the engine from idle to fuel cut off speed, hold at this speed for 3 s, then return to idle. Repeat this cycle 9 times.

Note: If the Rapid Acceleration Test cannot be completed (e.g. due to engine stall and inability to re-start) it is acceptable to execute with these test parts a burst test in cold condition on a separate rig (acceptance criteria shall then be defined by the responsible Release Engineer in agreement with the SSTS and BoD targets).

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results.

5.2.1 Post Test Inspection. Visually inspect flywheel and clutch pressure plate for any cracks or breakages. Use the Magnetic Particle Inspection Method for flywheels only (as indication to find potential cracks).

5.2.2 Acceptance Criteria.

Flywheels: Test is rated as "passed successfully" if 3 separate flywheel samples are without any cracks and crack indications of the flywheel. The starter ring gear on the flywheel shall not be loose and shall not have shifted in position on the flywheel. No grease leakage from dual mass flywheels onto other components is allowed (small grease marks on the dual mass flywheel itself are permissible). No ignition of grease or any other components is allowed.

Pressure Plates: Test is rated as "passed successfully" if 3 separate pressure plate samples are without any breakages of the pressure plate. Cracks in pressure plate are allowed if they are initiated cracks only and not cracked through complete component. Example pictures of permissible and unacceptable cracks can be found in Appendix B. In case of a damaged clutch disc that prevents the test to be performed according to this standard, the Design Release Engineer for the component shall be consulted.

5.3 Test Documentation. Provide full report including photos of tested components and plots of data recorded during test (RPM, torque and temperature over time).

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