

A MEANS OF TESTING TURBOJET ENGINE STARTER PERFORMANCE

Issued 11-29-63
Revised

1. SCOPE

- 1.1 This Recommended Practice covers a means of determining the performance acceptability of new production or overhauled starters that will be used for cranking turbine engines and is intended for use where torque measuring equipment is not available or desirable. This method determines acceptability of the overall performance of the starter on a flywheel test stand, rather than the performance at specific speed conditions. It allows a slight variation of output torque outside specified limits, as long as the overall performance is up to standard.
- 1.2 This method involves measuring the time required in accelerating an arbitrary flywheel inertia, from rest to starter cutoff speed, and comparing this time with a calculated time based upon preproduction test data from the specific starter being tested.
- 1.3 This method is not intended for use during engineering development of starters where the actual torque of the starter is measured.

2. DEFINITIONS

- 2.1 The starter is a device used to accelerate the rotating parts of a gas turbine engine from rest to a suitable speed called the starter cutoff speed. The starter may be electric, hydraulic, or turbine-driven or other.
- 2.2 The test flywheel inertia is co-ordinated between the starter manufacturer and the customer. The inertia selected should result in start times roughly approximating the start time on an engine, and in the case of fixed energy starters, should be equal to or less than the time of operation on an engine. The windage loss of the flywheel is determined by the testing agency. The co-ordinated flywheel may or may not be a representative equivalent flywheel, and therefore the operating time with the test flywheel may be different from the operating time of the starter on an engine.
- 2.3 The cutoff speed limits used for test may require slight shifting if the cutoff switch on the starter is acceleration-sensitive. Also, other parameters peculiar to a specific unit, such as oil sump temperature rise, may require correlation to the new operating time.
- 2.4 The maximum and minimum torque vs. speed characteristic for a given operating condition is proposed by the starter vendor and accepted by the customer.

PREPARED BY COMMITTEE AE-6, STARTING SYSTEMS

Section 8.3 of the SAE Technical Board provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

3. METHOD

- 3.1 The maximum and minimum output torque vs. speed curve for each operating condition must be determined and co-ordinated.¹ (See Figure 1.)
- 3.1.1 This curve is usually prepared at a rated condition to determine the acceptability of the individual unit after manufacture or overhaul.
- 3.2 The flywheel size is determined. The windage loss of the flywheel is measured by the test laboratory and the data presented in the form of a curve similar to the curve shown in Figure 2.
- 3.3 The windage torque curve is subtracted from the starter torque curve, and the resulting net torque is applied to the flywheel inertia. By use of the basic equation $T = I\alpha$, a time vs. speed curve can be drawn for the minimum and for the maximum starter output similar to those shown in Figure 3.
- 3.4 The specification values of minimum and maximum starter cutoff or terminal speed are also shown in Figure 3. These speeds are co-ordinated between the starter manufacturer and the customer, based upon engine requirements.²
- 3.5 The useful area of Figure 3 on an enlarged scale is shown in Figure 4 which is the operating curve used by the starter test facility.
- 3.6 When a starter is tested, the time required to reach cutoff speed and the actual cutoff or terminal speed must be measured. These two points are plotted on Figure 4. If the point falls within the shaded zone, the starter output for the given test condition is acceptable. If the point falls outside the shaded zone, the output is not correct and a change to the starter to bring the performance within limits is indicated.³
-
1. In some cases there is a requirement that the maximum torque be limited to a specific value. It may be necessary to take other steps during testing to detect excessive torque where this requirement exists. Additional tests that will vary with the type of starter being tested may also be required.
2. To maintain maximum accuracy and to permit the use of test equipment incapable of accelerating the starter to cutout speed under load, the measured area may be taken at two speeds lower than starter cutoff minimum and maximum, such that the measured flywheel windage and drag torque do not exceed approximately 20% of starter output torque. Acceleration of the starter, with assist, if necessary, to its cutoff speed, should be required in such cases, or a no-load cycle conducted to check full-speed operation.
3. Starter rejection can be caused by a change in the test stand drag, and a recheck of drag must be performed as necessary. This can be checked by noting test stand deceleration time without braking during known intervals.