The Engineering Society For Advancing Mobility Land Sea Air and Space®
SAE INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1456

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Submitted for recognition as an American National Standard

MAXIMUM ALLOWABLE ROTATIONAL SPEED FOR INTERNAL COMBUSTION ENGINE FLYWHEELS

***Foreword*—**This Reaffirmed Document has been changed only to reflect the new SAE Technical Standards Board Format.

1. ***Scope*—**This SAE Recommended Practice applies to flywheels and flywheel-starter ring gear assemblies used with internal combustion engines of the spark ignition and diesel type equipped with a governor or speed limiting device. Engine sizes are those capable of using SAE No. 6 through SAE No. 00 flywheel housings.

This document applies to methods used to determine the rotational speed capability of flywheels for stresses imposed by centrifugal forces only.

1.1 Purpose—This document is intended to establish maximum allowable rotational speeds for flywheels under centrifugally imposed stresses.

1.2 Exclusions

1.2.1 GENERAL—This document does not encompass the selection of flywheel profile, materials, and manufacturing methods.

The influence of the following items which may reduce the speed capability of the flywheel below acceptable speed limit are not considered in this document and must be evaluated separately:

a. Material fatigue
b. Material yielding before the limiting speed or burst speed is reached
c. Clutch heat loading and cracks
d. Additional loading due to drive coupling members assembled to the flywheel or due to the flywheel drive system type used

1.2.2 APPLICATION SPEED RESTRICTIONS—This document does not apply to any application where the engine is not equipped with a governor or speed limiting device or when overspeed (No.) may exceed 50% above the rated engine speed (N_R); (No. > 1.5 N_R).

1.2.3 FIELD USAGE AND REWORK RESTRICTIONS—This document does not apply when the following is done without the approval of the engine manufacturer:

1.2.3.1 The flywheel profile is reworked for another application.

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1.2.3.2 The flywheel clutch friction face is refaced beyond the material removal limits recommended by the engine manufacturer.

1.2.3.3 The engine and flywheel package are used in an application other than the one for which it was originally designed.

1.2.3.4 The flywheel is removed from the original engine and installed on another engine where the rated speed or overspeed requirement is higher.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1240—Flywheel Spin Test Procedure

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 8—Standard Test Methods of Tension Testing of Metallic Materials

3. Rotational Speed Criteria

3.1 General—Flywheel limiting speed or burst speed capability should be established by spin test(s) and must be adjusted to minimum expected material tensile strength value.

Flywheel speed capability may also be established by an analytical method, if the analytical method used closely correlates with the spin test results and spin test data are available on similar profile, size, and same material flywheels.

Flywheel material strength is to be established by test bars which are to be removed from the critical areas of the flywheel. Strength data obtained from separately poured test bars are to be used for burst speed evaluation.

3.2 Predetermined Speed Limit or Minimum Burst Speed—Flywheel predetermined speed limit or minimum burst speed is to be based on Equation 1:

$$N_B = 2.50 \times N_R \qquad \text{(Eq. 1)}$$

where:

N_R = Application full load, governed, rated engine speed (rpm)
N_B = Predetermined speed limit, actual or corrected minimum burst speed of flywheel (rpm)

3.2.1 BURST SPEED CORRECTION—When the spin test flywheel material has higher strength than the specified minimum tensile strength value, the measured test burst speed (N_T) shall be derated by Equation 2 to obtain the corrected minimum burst speed (Nc):

$$Nc = N_T \sqrt{\frac{\text{Minimum Specified Tensile Strength}}{\text{Measured Tensile Strength of Test Specimen}}} \qquad \text{(Eq. 2)}$$

The corrected minimum burst speed must be equal to or greater than the minimum burst speed requirement ($Nc \geq N_B$).

4. General Instructions

4.1 Flywheel Drawing Specifications—Flywheel material expected minimum strength and hardness specification should be defined and critical areas or sections of the flywheel should be shown on the drawings. Unless otherwise indicated, the following areas shall be considered as critical areas or sections:

a. Flywheel hub
b. Thin section in hub area with abrupt profile and section thickness change
c. Thick heavy outer rims joining with thin body sections utilizing a small filet radius
d. Thin rims of deep pot type flywheels where the rim has deep clutch or coupling mounting holes or balance holes
e. Rims of pot type flywheels which are interrupted by radially cut slots such as those used for driving the clutch intermediate pressure plate, etc.

4.2 Flywheel Redesign—Flywheel speed capability should be reconsidered when the flywheel profile or material specifications or heat treatment is altered, or when the casting process or supplier is changed.

4.3 Hardness Check

4.3.1 Hardness readings can be used to indicate the strength and the uniformity of the flywheel material after hardness-to-strength relationship has been established. Figure 1 for recommended hardness checking areas, and the number of checks for typical flywheel profiles.

CAUTION—Hardness readings are not a substitute for tensile test bar data. When estimating the tensile strength of gray iron from the measured hardness values, exercise caution; hardness to strength relationship can vary considerably.

4.3.2 Hardness readings are to be taken on surfaces ground flat to 3.2 µm (125 µin) AA or less on flywheels selected for spin testing.

4.4 Tensile Test Bars—Tensile test bars removed from the critical areas of the flywheels should be machined per ASTM E 8 (latest issue).

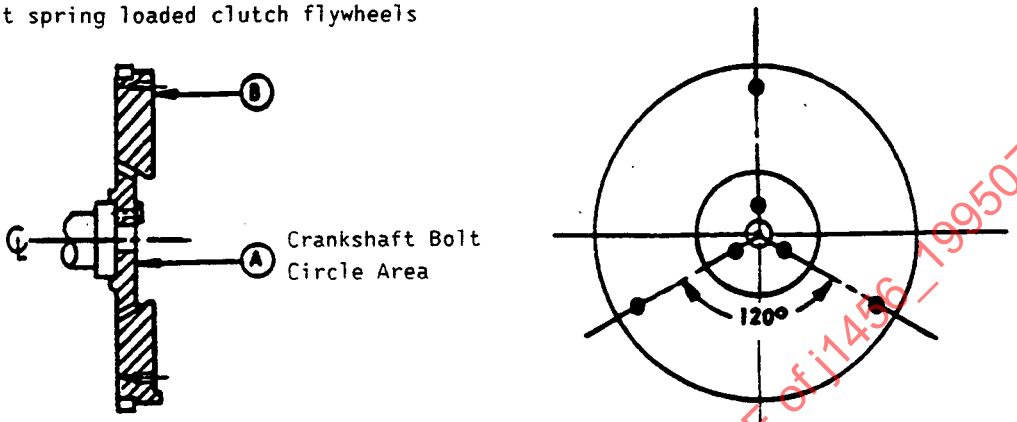
4.5 Spin Testing

4.5.1 The required number of flywheels for spin testing is to be selected by the engine manufacturer. It is recommended that three flywheels, randomly selected, be spin tested. If the flywheels burst, the lowest test burst speed is to be used for establishing the rotational speed capability of the flywheel. See 3.2.1 for correcting the test burst speed.

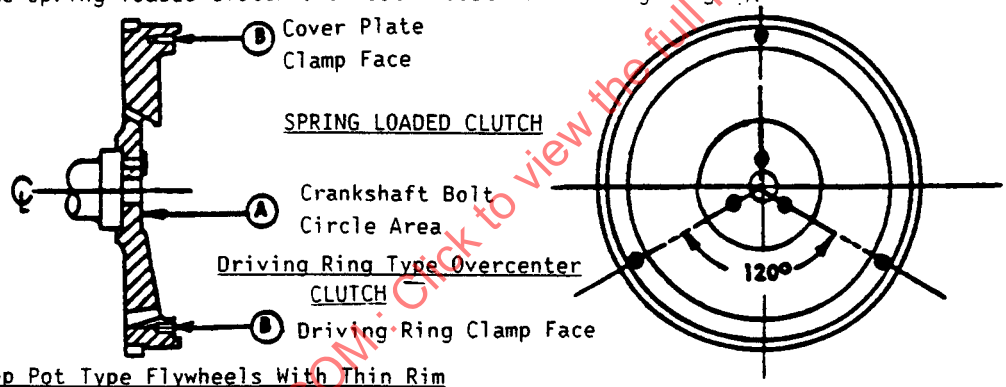
4.5.2 For flywheel spin testing procedure and inspection of test parts after spin testing, see SAE J1240.

Three (3) hardness readings; approximately 120° apart, are recommended on all locations. Preferably hardness readings should be taken on the same radial line to establish possible hardness variations on casting sections.

1. Flat Type Flywheels
   Most spring loaded clutch flywheels



2. Medium Pot Type Flywheels
   Some spring loaded clutch and most industrial driving ring type overcenter clutch flywheels.



3. Deep Pot Type Flywheels With Thin Rim
   Some multi-plate spring loaded clutch, hydraulic coupling, etc. flywheels.

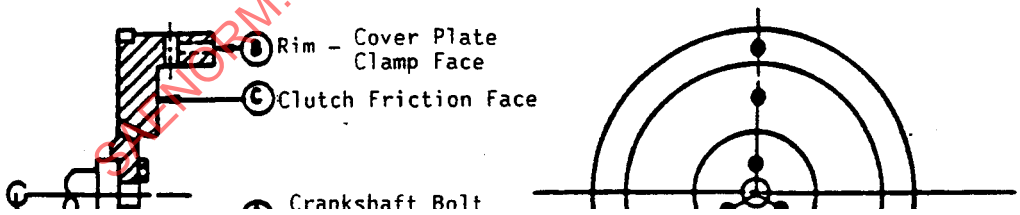


FIGURE 1—TYPICAL FLYWHEEL PROFILES AND RECOMMENDED HARDNESS CHECKING AREAS

PREPARED BY THE SAE CLUTCH, FLYWHEEL, AND HOUSING STANDARDS COMMITTEE