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Proposed
IEEE Recommended Specification for
SPEED GOVERNING AND TEMPERATURE
PROTECTION OF GAS TURBINES INTENDED
TO DRIVE ELECTRIC GENERATORS

(Published for Trial Use)

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FOREWORD

The Joint IEEE-ASME Committee on Recommended Specifications for Speed Governing of Prime Movers Intended to Drive Electric Generators was initially formed in 1941 by the AIEE Board of Directors, predecessor of the present IEEE, and by the ASME Council. The personnel of this Joint Committee were appointed jointly by the Chairmen of the AIEE Power Generation Committee and the ASME Standing Committee on Power Test Codes under sponsorship of the ASME Power Division.

The Joint Committee and Subcommittees under its sponsorship have developed and issued the following Recommended Specifications since the Joint Committee was formed.

IEEE Standards Publication	Former AIEE Number	Title	Date Issued
120	600	Recommended Specification for Speed Governing of Steam Turbines Intended to Drive Electric Generators Rated 500 kW and Larger	Originally issued May, 1949. Revised and reissued December 1959.
125	605	Recommended Specification for Speed Governing of Hydraulic Turbines Intended to Drive Electric Generators	September 1950.
126	606	Recommended Specification for Speed Governing of Internal Combustion Engine-Generator Units.	January 1959.

The Recommended Specification for Speed Governing and Temperature Protection of Gas Turbines Intended to Drive Electric Generators consists of four Sections. It is to be noted that either Section III or Section IV is to be specified by the purchaser. The preface in each of these Sections describes the applications to which the Section is applicable.

Several terms are described or defined in Section II, Definitions and Descriptions of Terms, which are not mentioned in Sections III or IV. These terms, so defined, have general usage, but they may not apply to all turbines of any type or size range. The Subcommittee recognizes that there are other terms entering the gas turbine application field, for example, in the waste heat boiler and "total energy" applications, and perhaps additional terms and specification requirements may be added in a future revision when general use of new terms warrants.

ACKNOWLEDGMENT

The Joint IEEE-ASME Subcommittee on Recommended Specification for Speed Governing of Gas Turbines Intended to Drive Electric Generators was appointed and initial meetings were held in 1958. Some changes in the personnel of the Joint Subcommittee have occurred due to changes in responsibilities of the individuals. We acknowledge the work of Wayne C. Astley, in organizing the Subcommittee and acting as Chairman until October 1960; G. W. Taylor, and J. R. Anderson, for their attendance at the Subcommittee meetings, participation in the discussions, and contributions in preparation of the draft.

The Chairman appreciates the contributions of the Joint Subcommittee members, and particularly the suggestions and comments of the user representative members without which the Recommended Specification would not be able to fulfill its ultimate usefulness.

The Subcommittee wishes to acknowledge the National Electrical Manufacturers Association (NEMA) Standards Publication No. SM32-1960, "Gas Turbine Governors", from which many of the terms, definitions, and specifications have been extracted or developed.

Personnel of the Joint IEEE-ASME Subcommittee on Recommended Specification for Speed Governing and Temperature Protection of Gas Turbine Generator Units

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Errata for
IEEE STANDARDS PUBLICATION NO. 282 — AUGUST 1968

Page 2, right-hand column, line 24:

“ paragraph 4 of Section IV.”
should read
“ paragraph 7 of Section IV.”

Page 4, paragraph 16, line 5:

“value” should be “valve”

Pages 6 and 7, Figures 5 and 6:

Curves should be interchanged, as follows
(the legends remain as printed)

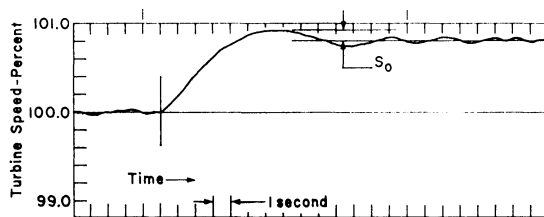


Fig. 4. Typical Turbine Speed Versus Time Trace Showing Transient Speed Deviation (Load Decrease) S_0 , with Steady-State Speed Regulation Greater Than Zero.

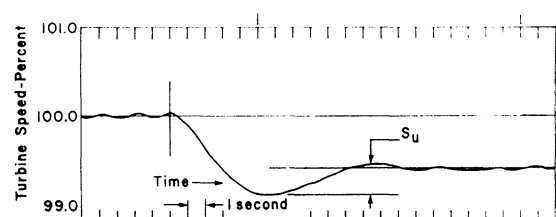


Fig. 6. Typical Turbine Speed Versus Time Trace Showing Transient Speed Deviation (Load Increase) S_u , with Steady-State Speed Regulation Greater Than Zero.

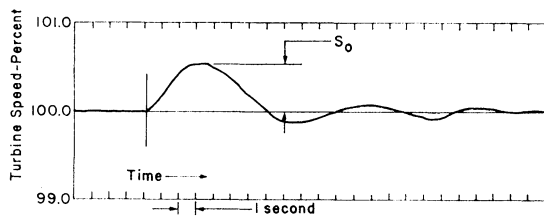


Fig. 5. Typical Turbine Speed Versus Time Trace Showing Transient Speed Deviation (Load Decrease) S_0 , with Zero Steady-State Speed Regulation.

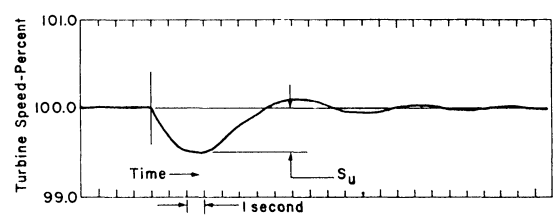


Fig. 7. Typical Turbine Speed Versus Time Trace Showing Transient Speed Deviation (Load Increase) S_u , with Zero Steady-State Speed Regulation.

Note: This errata sheet is printed on gummed paper so the above figures may be cut out and pasted into the publication.

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APPLICATION OF THE RECOMMENDED SPECIFICATION

1. The Recommended Specification for Speed Governing and Temperature Protection of Gas Turbines Intended to Drive Electric Generators consists of four sections. The Scope, Section I, limits the types of open-cycle gas turbines to which the Recommended Specification may be applied. The Definition and Description of Terms, Section II, is applicable to all units and types stated in the Scope and to the Equipment and Performance Specification Sections III and IV. Two Sections of Equipment and Performance Specifications, Section III and Section IV, are included. The broad range of gas turbine ratings and the broad range of applications of gas turbine-generator units make it necessary to have separate Equipment and Performance Specifications Sections for these two principal fields of applications. Therefore, purchase specifications should specify the applicable Section such as "Speed Governing and Temperature Protection of the Gas Turbine Generator Unit shall be in accordance with Section III of Recommended Specification for Speed Governing and Temperature Protection of Gas Turbines Intended to Drive Electric Generators, IEEE No. 282." The prefaces in Section III and in Section IV state the application for which these Sections may be specified in purchase specifications.

2. The specification requirements and related terminology are clearly expressed in terms of measurable quantities. Of particular importance is the concept that all required performance shall be measurable under test conditions that can be produced in the typical installation.

3. To further explain application of the Recommended Specification, it is helpful to consider some of the interrelationships that are introduced by: action of the speed governing and temperature protection system; action of the other parts of the gas turbine-generator unit; and effects caused by actual variations in the load as imposed at the generator terminals.

4. The speed-governing system, as an automatic control device, enables the gas turbine within its power output capacity to drive the generator at desired speed corresponding to different values of constant load as imposed on the unit, or with due consideration to the time lag characteristics of the gas turbine-generator as an assembly, to recover quickly the desired speed following rapid changes in the load. Two typical operating conditions are indicated: 1) with steady-state electric loads and gradual changes between these loads, and 2) with rapidly changing loads. Two basic governing properties, regulation and stability, are involved under all conditions of operation. However, the regulation characteristics predominate under the first set of operating conditions. Here conditions of equilibrium are most favorable due to limited influences of various possible disturbances, particularly the external load disturbances. It is under the second set of operating conditions that the stabilizing influence contributed by the speed-governing system is of particular importance.

(a) Definitions for steady-state speed regulation and steady-state incremental speed regulation as used in the Recommended Specification are based on observations that can be made under reproducible operating conditions. They have practical meaning in terms of gas turbine applications. Determination of steady-state speed regulation performances are simple. The results are not influenced too critically by minor variations from the prescribed generator load conditions of the various elements of the gas turbine-generator unit and its associated accessories. Determinations of individual steady-state incremental speed regulation performances, while relatively simple, are time consuming.

(b) Definitions for stability of the speed-governing system and for stability of the temperature control system are given in Section II of the Recommended Specification. These definitions of necessity are defined in terms of "operation under sustained load or following a change to a new sustained load" for stability of the speed-governing system and "operation under constant system frequency" for stability of the temperature control system. It is the "steady-state" condition before and/or after a transient condition during which steady-state sustained oscillations must be limited. Some previous specifications have specified speed-governing stability performance in terms of a transient condition and settling time. Due to the large variety of types of gas turbines included in the scope of the recommended specifications and the large range of moment of inertia within each type, transient speed deviations, load increase or load decrease, and settling time are not indicative of speed-governing stability, nor would similar transient temperature deviations and their settling time be an indication of temperature-control stability. Therefore, values of performance for maximum transient speed deviation, load decrease or load increase, and settling time have not been included in Section III or Section IV since the magnitude of these terms will vary widely from application to application. The performance of the speed-governing system "upon the sudden and complete loss of generator load" is specified in paragraph 8 of Section III, and paragraph 4 of Section IV. If sudden or instantaneous load decrease other than this, or if sudden or instantaneous load increase greater than 25 percent of the gas turbine rating are expected to be applied in normal operation, a complete description of the type and magnitude of load change, frequency of load increase or load decrease, and maximum permissible instantaneous gas turbine speed change during the transient should be given the manufacturer of the gas turbine-generator unit, and if agreed upon by the two parties should be made a part of the complete purchase specification for the particular gas turbine-generator unit.

5. Experience in the field of application of prime movers indicates that limits for deadband are desirable as this is one of the major factors influencing performance of the speed-governing system of the prime mover. If the deadband is significantly large it can be the primary source of governing instability.

6. It is presumed in the Recommended Specification that those considerations which may affect the performance results, and are beyond the scope of the Recommended Specification, will be controlled separately by specification or otherwise provided for as needed to meet the requirements of accepted standards and good practice. Examples of these considerations are:

- (a) speed and load drift during the starting warm-up period and also during environmental changes;
- (b) steady-state governing speedband.

Further, these qualifications are of importance, first, because the components of complete installation, even gas turbines and generators, may be procured separately and variously assembled by the buyers, and second, because the performances of the components included in the complete installation depend upon the manner of assembly and also to a considerable extent upon the nature of the maintenance and operating techniques. Because of these considerations, it may be necessary to conduct other conventional tests before evaluating performances of the speed-governing system to determine its inherent stability.