

An American National Standard

IEEE Recommended Practice for Preparation of Equipment Specifications for Speed-Governing of Hydraulic Turbines Intended to Drive Electric Generators

Sponsor
**Power Generation Committee
of the
Power Engineering Society**

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 125-1988, IEEE Recommended Practice for Preparation of Equipment Specifications for Speed-Governing of Hydraulic Turbines Intended to Drive Electric Generators).

The 1977 revision of IEEE Std 125 was prepared by a joint IEEE-ASME Working Group formed in December of 1971. The personnel of this Working Group were appointed by J. T. Madill, Chairman, Hydroelectric Power Subcommittee, IEEE, at the direction of W. S. Morgan, Chairman, Power Generation Committee, IEEE, in cooperation with ASME.

The 1988 revision of the standard was initiated in 1982 by R. D. Handel, Chairman, Hydroelectric Power Subcommittee, Power Generation Committee, IEEE, in cooperation with W. O. Hays, Director, Power Test Codes, ASME. The Working Group that formulated the 1988 standard included representatives from IEEE and ASME.

The standard includes the latest practices on the North American continent and, insofar as possible, has been made consistent with ANSI/ASME Std PTC29-1980 (R1985), Speed-Governing Systems for Hydraulic Turbine-Generator Units, and IEC Std 308-1970, International Code for Testing of Speed Governing Systems for Hydraulic Turbines.

As the title implies, this document is a recommended practice and not a complete specification. It has been developed to be used by prospective purchasers of hydraulic turbine governors in preparing detailed procurement specifications for such equipment. In certain cases, performance criteria such as temperature range or fluid velocity, representative of North American practice, have been included; the specification writer may wish to verify their applicability to his job.

Section 2. defines terms, functions, and characteristics as commonly used in North America. Wherever possible, the 1988 revision utilizes symbols adopted by IEC Std 308-1970, International Code for Testing of Speed Governing Systems for Hydraulic Turbines. A number of definitions covering detailed aspects of control system frequency response have been deleted from the 1988 revision, as these definitions are well covered in ANSI Std MC85.1M-1981, Terminology for Automatic Control.

Section 3. describes specific components that may be included in a governor system. The purchaser should specify only those components he feels are required to interface with his equipment. The practice should not be incorporated verbatim, as it contains certain explanatory comments directed to the specification writer. When convenient, these explanatory comments have been enclosed in parentheses. The 1988 revision addresses equipment aspects that have gained prominence since release of the 1977 standard, in particular those related to electric-hydraulic governors. Included are new guide specifications on power supply design (reliability and redundancy considerations), transient immunity (emi and rfi), electronic components, test facilities, and accessories such as generation control circuits. Also, a number of the equipment specifications have been revised to reflect the latest industry practices and to provide consistency in terminology. In particular, clarification has been provided on the sizing of the hydraulic pressure tank for adjustable blade and impulse turbines. In addition to the special considerations affecting electric governors outlined above, guide specifications have been added for items common to both non-electric and electric governors. These include auxiliary components for pump turbines, cabinet construction, ac and dc control power, rotor creep detector, fire protection system, emergency stop controls, and hydraulic pressure supply system accessories.

Section 4. defines the performance characteristics of a good governor system and adjustments and tests to obtain and confirm the desired performance. Prior to or concurrent with the writing of the specification, the purchaser should make studies to determine the required performance and the adjustments associated with that performance. The purchaser should also determine what tests are necessary to confirm that the desired performance has been obtained. Specifications related to the adequacy of the damping system have been clarified in the 1988 revision. A paragraph has also been included on the requirements for stability studies to be conducted by the governor manufacturer.

Section 5. is intended to make sufficient information available to the purchaser so that he can assure himself that the governor equipment will interface properly with other equipment. It is also intended to provide adequate information for maintenance purposes.

Section 6. deals with the criteria for acceptance tests.

Section 7. lists the data that will be furnished by the purchaser. Tests for evaluating the speed control performance, included in Appendix I, have been clarified in the 1988 revision to reflect the current practices of users.

At the time of approval of the 1977 standard the personnel of the Joint IEEE/ASME Working Group on Updating IEEE Specification No 125 Covering Speed-Governing of Hydraulic Turbines Intended to Drive Electric Generators was as follows:

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1. Introduction

1.1 Purpose

The purpose of this practice is to recommend minimum performance characteristics and equipment relating to governors for controlling hydraulic turbines intended to drive electric generators and to aid in preparation of procurement specifications.

1.2 Scope

This practice shall apply to mechanical-hydraulic or electric-hydraulic type governors for all types of hydraulic turbines including but not limited to the following types:

- a) Impulse Turbines
- b) Francis Turbines
- c) Fixed Blade (Axial or Mixed-Flow) Turbines
- d) Adjustable Blade (Axial or Mixed-Flow) Turbines
- e) Pump Turbines

It is recommended that the issue in effect on the date of invitation to bid of ANSI/ASME PTC29-1980 (R1985), Speed-Governing Systems for Hydraulic Turbine-Generator Units [4],¹ be used with this practice.

Only those paragraphs that apply to the specific equipment to be purchased should be used when preparing the procurement specifications.

1.3 References

This recommended practice shall be used in conjunction with the following publications:

¹The numbers in brackets correspond to those of the References in 1.3.

- [1] ANSI Std B93.11M-1981, Seamless Low Carbon Steel Hydraulic Line Tubing.²
- [2] ANSI Std MC85.1M-1981, Terminology for Automatic Control.
- [3] ANSI/ASME Std B31.1-1986 (SI Edition, 1983), Power Piping.³
- [4] ANSI/ASME Std PTC29-1980 (R1985), Speed-Governing Systems for Hydraulic Turbine-Generator Units.
- [5] ANSI/IEEE Std C37.90.1-1974 (R1980), Relays-Surge Withstand Capability (SWC) Test.⁴
- [6] ANSI/SAE Std J514-1980, Hydraulic Tube Fittings.⁵
- [7] IEC Std 308-1970, International Code for Testing of Speed Governing Systems for Hydraulic Turbines.⁶

2. Glossary of Terms, Functions, and Characteristics

2.1 Glossary of Terms

governing system. The combination of devices and mechanisms that detects speed deviation and converts it into a change in servomotor position. It includes the speed sensing elements, the governor control actuator, the hydraulic pressure supply system, and the turbine control servomotor. The terms “governor” and “governor equipment” are commonly used in the industry to describe the governing system and will be used interchangeably with the term “governing system” in this specification.

speed sensing elements. The speed responsive elements that determine speed and influence the action of other elements of the governing system. Included are the means used to transmit a signal proportional to the speed of the turbine to the governor.

governor control actuator. The combination of devices and mechanisms that detects a speed error and develops a corresponding hydraulic control output to the turbine control servomotors, but does not include the turbine control servomotors. Includes gate, blade, deflector, or needle control, or all equipment as appropriate.

hydraulic pressure supply system. The pumps, means for driving them, pressure and sump tanks, valves and piping connecting the various parts of the governing system, and associated and accessory devices.

electric-hydraulic governor. A governor in which the control signal is proportional to speed error and the stabilizing signals are developed electrically, summed by appropriate electrical networks, and are then hydraulically amplified. Electrical signals may be derived by analog or digital means.

mechanical-hydraulic governor. A governor in which the control signal proportional to speed error and necessary stabilizing signals are developed mechanically, summed by a mechanical system, and are then hydraulically amplified.

2.1.7 distributing valve. The element of the governor-control actuator that controls the flow of hydraulic fluid to the turbine-control servomotor(s).

²All of the standards referenced in this recommended practice are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

³ASME publications can be obtained from the Order Department, American Society of Mechanical Engineers, 22 Law Drive, Fairfield, NJ 07007.

⁴IEEE publications are available from the Service Center, the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

⁵SAE publications are available from the Order Department, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

⁶IEC publications are available in the US from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

speed changer. A device for changing the governor speed reference (see 2.2.19).

speed regulation changer. A device for changing the speed regulation (see 2.2.5).

speed droop changer. A device for changing the speed droop (see 2.2.5).

servomotor limit. A device that acts on the governor system to prevent the turbine-control servomotor from opening beyond the position for which the device is set.

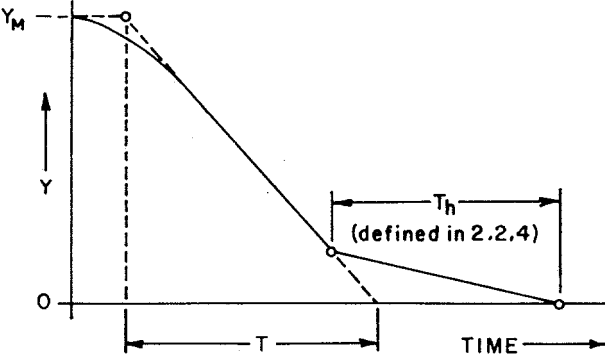
turbine control servomotor. The actuating element that moves the turbine-control mechanism in response to the action of the governor control actuator. Turbine-control servomotors are designated as:

- a) gate servomotor
- b) blade servomotor
- c) deflector servomotor
- d) needle servomotor.

slow closure device. A cushioning device that retards the closing velocity of the servomotor from a predetermined servomotor position to zero servomotor position.

servomotor velocity limiter. A device that functions to limit the servomotor velocity in either the opening, closing, or both directions exclusive of the operation of the slow closure device (above).

governor control actuator rating. The governor control actuator rating is the flow rate in volume per unit time that the governor actuator can deliver at a specified pressure drop. The pressure drop shall be measured across the terminating pipe connections to the turbine control servomotors at the actuator. This pressure drop is measured with the specified minimum normal working pressure of the hydraulic pressure supply system delivered to the supply port of the actuator distributing valve.

2.2 Functions and Characteristics	Unit	Symbol
2.2.1 Servomotor Stroke. Travel of the turbine-control servomotor from minimum (zero) position to maximum position without overtravel at the maximum position or “squeeze” at the minimum position (sometimes referred to as “effective servomotor stroke”). For a gate or needle servomotor this shall be established as the travel of the servomotor required to change the gate or needle position from no discharge to maximum discharge. For a blade servomotor this shall be established as the travel of the servomotor required to change the blade position from “flat” to “steep.” For a deflector servomotor this shall be established as the travel of the servomotor required to change the deflector position from the “no deflection” position to the “full flow deflected” position with maximum discharge under maximum specified head, including over-pressure due to water hammer.	inch or millimeter	Y_M
2.2.2 Servomotor Position. The instantaneous position of the turbine-control servomotor measured from its zero position expressed as a percentage of the servomotor stroke. This is commonly referred to as gate position, needle position, blade position, or deflector position, although the relationship between servomotor stroke and the position of the controlled device may not always be linear.	percent	Y
2.2.3 Servomotor Time. The elapsed time for one servomotor stroke (either opening or closing) at maximum servomotor velocity (see Fig 1). Servomotor time can be qualified as follows: (a) gate (b) blade (c) deflector (d) needle	second	T
	second	T_G
	second	T_B
	second	T_D
	second	T_N
 Figure 1—Servomotor Time and Cushioning Time		
2.2.4 Cushioning Time. The elapsed time during which the closing rate of servomotor travel is retarded by the slow closure device (see Fig 1).	second	T_h