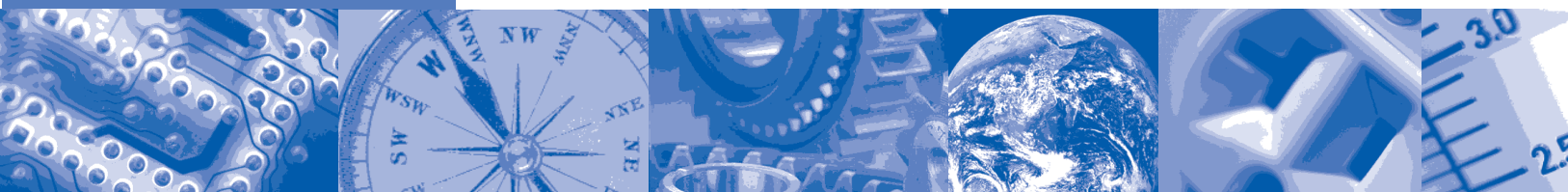


ISA-RP31.1-1977



Specification, Installation, and Calibration of Turbine Flowmeters



**ISA—The Instrumentation,
Systems, and
Automation Society**

Approved 30 April 1977



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ISA-RP31.1-1977, Specification, Installation, and Calibration of Turbine Flowmeters

ISBN 0-87664-371-3

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Preface

This preface is included for informational purposes and is not part of Recommended Practice ISA-RP31.1-1977.

This Recommended Practice has been prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Standards and Practices Board Secretary, ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709, telephone 919-549-8411, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI and SI-acceptable metric units as optional alternatives to English units in all new and revised standards to the greatest extent possible. *The Standard for Metric Practice*, which has been published by the American Society for Testing and Materials as ANSI-Z210.1 (ASTM E 380-76; IEEE 268-1975) and future revisions will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

The ISA Standards Committee on Turbine Flowmeters, SP31, operates within the ISA Standards and Practices Department, L. N. Combs, Vice-President. The men listed below serve as members of this committee.

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The assistance of others who aided in the preparation of RP31.1 by answering correspondence, attending many committee meetings, and in other ways is gratefully acknowledged. In particular, the assistance of Robert L. Galley, previously of General Dynamics, McDonald-Douglas, Bechtel, United Nations, and presently with Hallanger Engineers and his committee who prepared ISA Recommended Practice RP31.1, and of George J. Lyons of Pratt & Whitney Aircraft and his committee who prepared drafts of Recommended Practice RP31.1 (not published) is acknowledged.

In addition to the SP31 committee members, the following have served as a Board of Review for this Document.

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1 Purpose

This document establishes the following for turbine flowmeters, especially those 2-inch diameter and smaller.

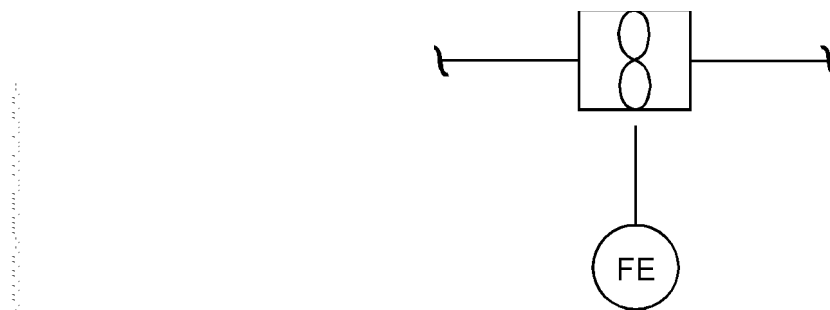
- 1.1 Recommended minimum information to be specified in ordering.
- 1.2 Recommended acceptance and qualification test methods including calibration techniques.
- 1.3 Uniform terminology and drawing symbols.
- 1.4 Recommended installation techniques.

2 Scope

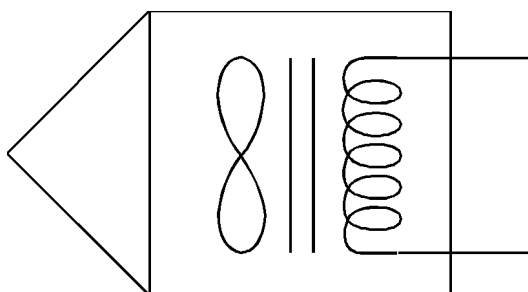
2.1 These recommendations cover volumetric turbine flowmeters having an electrical output. The flowmeters are used to measure either flow rate or quantity of liquids, and can be either self-generating or modulating. Their use in cryogenic fluids will require special considerations, which are not fully described herein.

3 Drawing symbols

3.1 The flow diagram symbol for a turbine flowmeter is shown below, in accordance with ISA-S5.1



3.2 The electrical diagram symbol for a turbine flowmeter is shown below.



4 Specifications

Terminology used is defined either in ISA-S37.1 or 4.3 Specific Terminology. An asterisk appears before these terms defined in ISA-S37.1; the terms defined in 4.3 Specific Terminology appear in *italics*.

4.1 Design characteristics

4.1.1 The following mechanical design characteristics shall be specified.

1) *Measured Fluids

The liquids to be in contact with the wetted parts, e.g., JP-4 fuel, hydrochloric acid, etc.

2) Configuration and Dimensions

- a) For flared tubing (MS 33656) the nominal tube size, overall length, and equivalent fittings.
- b) For flanged types the nominal pipe size, and length between flanges.
- c) For male pipe-threaded flowmeters the nominal pipe size and overall length.

3) Mountings and Mounting Dimensions

Unless the process connection serves as a mounting, the outline drawing shall indicate the method of mounting with hole sizes, centers and other pertinent dimensions, including thread specifications for threaded holes, if used.

4) The weight of the flowmeter.

5) The following information shall be permanently marked on the flowmeter housing.

- a) Manufacturer
- b) Part or Model No.
- c) Serial No.
- d) Flow Direction
- e) Nominal Tube or Pipe Size

4.1.2 Supplemental mechanical design characteristics

The following mechanical design characteristics shall be specified at the option of the purchaser.

1) Minimum and maximum temperatures

The minimum and maximum temperatures of the measured liquid, and of the surrounding environment.

2) Pressure

The maximum pressure of the measured liquid.

3) Speed

The maximum output frequency which the flowmeter can produce without physical damage.

4.1.3 Required electrical design characteristics

The following electrical characteristics shall be specified.

1) *Excitation (modulating type only).

Expressed as "___volts at ___ hertz."

2) *Electrical output

a) Output voltage

Expressed as "___volts" minimum peak-to-peak at any flow within the operating range.

b) Frequency at maximum rated flow expressed as "___ Hz."

4.2 Performance characteristics

The pertinent performance characteristics of turbine flowmeters should be specified in the order shown. Unless otherwise stated, they apply at *Room Conditions, as defined in ISA-S37.1 and are expressed in SI units. (Equivalent units may be substituted.)

4.2.1 *Range

Expressed as "___ to ___ meter³ per second."

4.2.2 Linear range

Expressed as "___ to ___ meter³ per second."

4.2.3 *Sensitivity

The sensitivity (K factor) is expressed as "___ cycles per meter³." Often used as $\bar{K}$, which is the average sensitivity across the flow range of interest to the user. Average is used here in the sense of $(K_{\max} + K_{\min})/2$.

4.2.4 *Linearity

The normal presentation of the calibration data is in cycles per meter³ vs. frequency, which is the slope of a curve of flow vs. frequency. Linearity is then expressed as " $\pm$ ___ % of the average sensitivity (K factor)." (See *Linearity* in [4.3 Specific Terminology](#).)

4.2.5 Pressure drop

The pressure drop across the flowmeter at maximum rated flow, expressed as "___ differential pascals at ___ meter³ per second" when used with specific measured liquid.

4.3 Specific terminology

Actual flow: Refers to the actual volume of liquid passing through the flowmeter in a unit time as computed by applying all necessary corrections for the effects of temperature, pressure, air buoyancy, etc. to the corresponding readings indicated by the calibrator.

Air buoyancy: The lifting effect or buoyancy of the ambient air which acts during a "weighing" procedure with open gravimetric calibrations. This is caused by displacement of air from the measuring vessel during the calibration run. The standard air (50% R.H.) for correcting to "weights" in vacuum has a density of 1.217 kg/m³ at 288.7 K and 1.013 250E+05 Pa. When "weighings" are made against "weights," the buoyancy force on these must also be considered. For brass "weights" the net effect of air buoyancy in air at standard conditions is about 0.015%. Exact values can be determined by procedures outlined in paragraphs 3059 and 3060 of API Standard 1101, 1960 Editions, and NBS Handbook 77, Volume III, Pages 671-682.

Apparent flow: The uncorrected volume flow as indicated by the calibrator.

Back pressure: The absolute pressure level as measured four pipe-diameters downstream from the turbine flowmeter under operating conditions, expressed in pascals.

***Calibration curve:** A graph of the performance of a turbine flowmeter, showing sensitivity as the ordinate and volume flow, flowmeter frequency, or frequency divided by kinematic viscosity as the abscissa, for a liquid of specified density, viscosity, and temperature.

Calibration system: A complete system consisting of liquid storage, pumps, and filters; flow, pressure, and temperature controls; the quantity measuring apparatus; and the associated electronic instruments used to calibrate turbine flowmeters.

Correlation check: A procedure whereby the performance and accuracy of a calibration system is checked against another calibration system using "Master Flowmeters" as the standards.

Density: The mass of a unit volume of a liquid at a specified temperature. The units shall be stated, such as kilograms per meter³. The form of expression shall be: Density ___ kg/m³ at ___ Kelvin.

Dynamic calibration: A calibration procedure in which the quantity of liquid is measured while liquid is flowing into or out of the measuring vessel.

Flow: the rate of flow of a liquid expressed in volume units per unit of time. Examples are: meter³/second (m³/s).

Flow straightener: A supplementary length of straight pipe or tube, containing straightening vanes or the equivalent, which is installed directly upstream of the turbine flowmeter for the purpose of eliminating swirl from the fluid entering the flowmeter.

Gravimetric: A descriptive term used to designate an instrument or procedure in which gravitational forces are utilized. However, the results or indications of such procedures are not necessarily influenced by the magnitude of the acceleration of gravity. See discussion on mass, weight, and weighing (5.4.1 (1) Mass, Weight, and Weighing).

Linear range of a turbine flowmeter: the flow range over which the output frequency is proportional to flow (constant K factor) within the limits of linearity specified.

Linearity of a turbine flowmeter: the maximum percentage deviation from the average sensitivity ($\bar{K}$) across the linear range.