ASHRAE® STANDARD

AN AMERICAN NATIONAL STANDARD

STANDARD METHOD FOR PRESSURE MEASUREMENT

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CONTENTS

1.1 This standard presents recommended practices and procedures for accurately measuring steady-state, non-pulsating pressures.

2. SCOPE

2.1 The scope of this standard is to describe methods for measurement of pressures appropriate for use in other ASHRAE standards, limited to the 1 psia (6.9 kPa) to 500 psia (3450 kPa) range. The descriptions include: type of pressure, range of suitable application, expected accuracy, and proper installation and operation techniques for attaining the desired accuracy. Pressure devices include: differential pressure (head) meters, elastic element (bellows, Bourdon tube and diaphragm sensor) gages, manometric gages; and pressure-spring gages. Reference to suitable ANSI/ASME and ISA/ANSI standards is used where appropriate.

3. DEFINITIONS

3.1 Pressure. The macroscopic effect of molecular collisions with surfaces confining a fluid; it is defined as the normal force per unit area. More specifically, if δA is a small area, $\delta A'$ is the smallest area over which the fluid can be considered a continuum, and δF is the component of force normal to δA, then pressure, P, is defined as

$$P = \lim_{\delta A - \delta A^{l}} (\delta F/\delta A) \qquad (3.1)$$

3.2 Pressure Terms. Pressures are expressed relative to a reference value. Pressure term relationships are shown in Fig. 1.

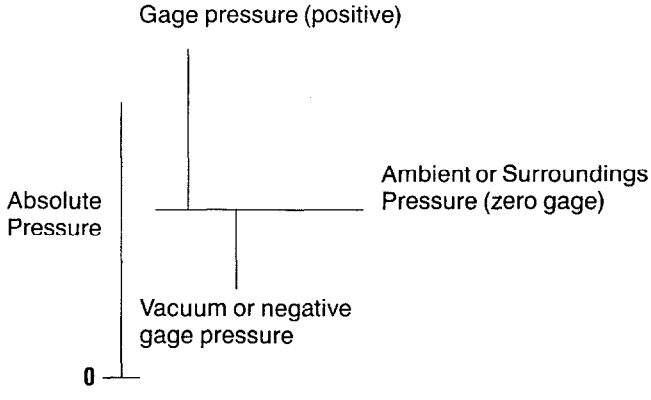

Fig. 1 Relationships Among Basic Pressure Terms

- ***absolute pressure:*** the pressure at any point in a fluid relative to a perfect vaccum.
- ***barometric pressure:*** the pressure of the atmosphere relative to zero absolute pressure (a perfect vaccum).
- ***ambient pressure:*** the pressure of the surroundings relative to zero absolute pressure.
- ***surroundings pressure:*** same as ambient pressure.
- ***gage pressure:*** the difference between absolute pressure and ambient or surroundings pressure.
- ***differential pressure:*** the difference between two pressures
- ***design pressure:*** maximum anticipated pressure the system being measured is expected to withstand.
- ***working pressure range:*** the range of pressures the system is expected to experience during normal operation.
- ***static pressure:*** pressure measured in fluid flow (gas, liquid and/or vapor) in a pipe or channel transverse to the flow direction where conversion of fluid kinetic energy to pressure is not included and the flow conditions are not significantly disturbed by the measurement.
- ***total pressure:*** the maximum pressure on a plane normal to the fluid flow direction in a pipe or channel.
- ***velocity pressure:*** the difference between the total pressure and static pressure (relative to the same datum).

3.3 Pressure Gage. A device for measuring pressure which includes means for sensing, conditioning, and displaying the measured value.

- ***accuracy (inaccuracy):*** deviation of the indicated pressure from the input value. (Usually expressed as percent of full scale.) The magnitude of the deviation is called the error.
- ***precision:*** the statistical error of an instrument subjected to repeated measurements over a range of input values.
- ***uncertainty:*** the expected range of measured values about a true value of unknown magnitude. (Note: not the same as accuracy; this includes bias and precision.)
- ***sensitivity:*** the ratio of the change in indicated value to the change in measured variable, e.g., degrees of needle movement per unit of pressure change.
- ***calibration:*** comparison of the particular instrument with:

  a. a primary standard;
  b. a secondary standard of higher accuracy than the instrument to be calibrated; or
  c. a known input source.

4. INSTRUMENT TYPES

4.1 Elastic Element, Indicating Dial Type Gage

4.1.1 C-type Bourbon Tube. Bourdon tube pressure sensors are the elastic elements most often used for industrial purposes. However, the increased use of computer-based data acquisition systems is decreasing the use of this type of pressure measurement device, unless modified with electronics. The measuring elements of mechanical indicating gages are not ideally suited to low-pressure, vacuum, or compound measurements requiring precision measurments at spans below 30 psi (207 kPa) gage.[1,2] However, the addition of electro-mechanical devices to the tube can produce accurate measurement in this range. These types of devices will be discussed later. Fig. 2 illustrates a C-type Bourdon tube gage used in a direct indicating gage. The tube, which usually has an arc of 250 degrees, has one end fixed and one free to move. The fixed end is open to the pressure to be measured; the free end is sealed. When pressure is applied, the tube tends to straighten out. In a dial indicating gage,