



Standard Practice for Describing and Specifying Inductively-Coupled Plasma Atomic Emission Spectrometers¹

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1. Scope

1.1 This practice describes the components of an inductively-coupled plasma atomic emission spectrometer (ICP-AES) that are basic to its operation and to the quality of its performance. This practice identifies critical factors affecting accuracy, precision, and sensitivity. It is not the intent of this practice to specify component tolerances or performance criteria, since these are unique for each instrument. A prospective user should consult with the vendor before placing an order, to design a testing protocol to demonstrate that the instrument meets all anticipated needs.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific safety hazard statements are given in Section 13.

2. Referenced Documents

2.1 ASTM Standards:

E 135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials²

E 158 Practice for Fundamental Calculations to Convert Intensities into Concentrations in Optical Emission Spectrochemical Analysis²

E 172 Practice for Describing and Specifying the Excitation Source in Emission Spectrochemical Analysis²

E 416 Practice for Planning and Safe Operation of a Spectrochemical Laboratory³

E 520 Practice for Describing Photomultiplier Detectors in Emission and Absorption Spectroscopy³

3. Terminology

3.1 **Definitions**—For terminology relating to emission spectrometry, refer to Terminology E 135.

4. Summary of Practice

4.1 An ICP-AES is an instrument used to determine elemental composition. It typically is comprised of several assemblies including a radio-frequency (RF) generator, an impedance matching network (where required), an induction coil, a plasma torch, a plasma ignitor system, a sample introduction system, a light gathering optic, an entrance slit and dispersing element to sample and isolate wavelengths of light emitted from the plasma, one or more devices for converting the emitted light into an electrical current or voltage, one or more analog preamplifiers, one or more analog-to-digital converter(s), and a dedicated computer with printer (see Fig. 1⁴).

4.1.1 The sample is introduced into a high-temperature (>6000 K) plasma that is formed from the ionization of the gas stream contained in the torch. The torch is inserted through metal tubing formed into a helix, which is called the load coil. Energy is applied to the load coil by means of an RF generator.

4.1.2 The term inductively-coupled refers to the fact that the physical phenomenon of induction creates a plasma by transferring energy from the load coil to the gas stream that has been momentarily preionized by a high voltage ignitor electrode that functions only during plasma ignition.

4.2 When material passes through the plasma, it is vaporized, atomized, and many elements are almost completely ionized. Free atoms and ions are excited by collision from their ground states. When the excited atoms or ions subsequently decay to a lower energy state, they emit photons, some of which pass through the entrance slit of a spectrometer. Each element emits a unique set of emission lines. Photons of a desired wavelength may be selected from the ultraviolet and visible spectra by means of a dispersing element.

4.2.1 Instruments may determine elements either simultaneously or sequentially. The output of the detector generally is directed to a preamplifier, an analog-to-digital converter, and a computer which measures and stores a value proportional to the electrical current or voltage generated by the detector(s). Using blank and known calibration solutions, a calibration curve is generated for each element of interest.

4.2.2 The computer compares the signals arising from the various elements in the sample to the appropriate calibration curve. The concentrations of more than 70 elements may be determined.

¹ This practice is under the jurisdiction of ASTM Committee E-1 on Analytical Chemistry of Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.20 on Fundamental Practices.

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² Annual Book of ASTM Standards, Vol 03.05.

³ Annual Book of ASTM Standards, Vol 03.06.

⁴ Courtesy of PerkinElmer, Inc., 761 Main Ave., Norwalk, CT 06859.