



Designation: ~~E1806 – 18~~ E1806 – 23

Standard Practice for Sampling Steel and Iron for Determination of Chemical Composition¹

This standard is issued under the fixed designation E1806; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the sampling of all grades of steel, both cast and wrought, and all types (grades) of cast irons and blast furnace iron for chemical and spectrochemical determination of composition. This practice is similar to ISO 14284.

1.2 This practice is divided into the following sections.

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¹ This practice is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.01 on Iron, Steel, and Ferroalloys.

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1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific statements, see 6.4.3.5, 9.4.4.3, and 12.5.1 as well as, and Section 5.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- [A48/A48M Specification for Gray Iron Castings](#)
- [A751 Test Methods and Practices for Chemical Analysis of Steel Products](#)
- [E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials](#)
- [E415 Test Method for Analysis of Carbon and Low-Alloy Steel by Spark Atomic Emission Spectrometry](#)
- [E1010/E1306 Practice for Preparation of Disk Specimens of Steel and Iron by Remelting Metal and Alloy Samples by Electric Arc Melting for Spectrochemical Analysis \(Withdrawn 2022\)](#)

2.2 ISO Documents: Standards:

- [ISO 9147 Pig irons—Definition and classification³](#)
- [ISO 14284 Steel and iron—Sampling and preparation of samples for the determination of chemical composition³](#)

3. Terminology

3.1 *Definitions*—For definitions of terms in this practice, refer to Terminology [E135](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cast product, n*—item of iron or steel which has not been subject to deformation, for example, an ingot, a semi finished product obtained by continuous casting, or a shaped casting.

3.2.2 *consignment, n*—quantity of metal delivered at one time.

3.2.3 *grinding, n*—method of preparing a sample of metal for a spectrochemical method of analysis in which the surface of the sample for analysis is abraded using an abrasive wheel.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3.2.4 *linishing*, *n*—method of preparing a sample of metal for a spectrochemical method of analysis in which the surface of the sample for analysis is abraded using a rotating disk or ~~continuous~~ belt coated with an abrasive substance.

3.2.5 *melt*, *n*—liquid metal from which a sample is removed.

3.2.6 *sample, probe*, *n*—sample taken from the melt using a sampling probe.

3.2.7 *sample, product*, *n*—specific item of iron or steel selected from a supplied quantity for the purpose of obtaining a sample.

3.2.8 *sample, spoon*, *n*—sample taken from the melt using a spoon and cast into a small mold.

3.2.9 *sampling, immersion*, *n*—method of probe sampling in which the probe is immersed in the melt whereand the sample chamber in the probe fills by ferrostatic pressure or gravity.

3.2.10 *sampling, probe*, *n*—method in which the sample is taken using a sampling probe inserted into the melt.

3.2.11 *sampling, spoon*, *n*—method in which the sample is taken from the melt, or during the pouring of the melt, using a long-handled spoon and cast into a small mold.

3.2.12 *sampling, stream*, *n*—method of probe sampling in which the probe is inserted into a stream of liquid metal whereand the sample chamber in the probe fills by force of metal flow.

3.2.13 *sampling, suction*, *n*—method of probe sampling in which the probe is inserted into the melt whereand the sample chamber in the probe fills by aspiration.

3.2.14 *test portion*, *n*—part of the sample for analysis, or part of the sample taken from the melt, actually analyzed.

3.2.14.1 *Discussion*—

~~In certain cases,~~ Sometimes, the test portion may be selected from the sample product itself.

3.2.15 *thermal method of analysis*, *n*—method for the determination of chemical composition in which the sample is submitted to a process of heating, combustion, or fusion.

3.2.16 *wrought product*, *n*—item of steel which has been subject to deformation by rolling, drawing, forging, or some other method, for example, a bar, billet, plate, strip, tube, or wire.

4. Significance and Use

4.1 This practice covers all aspects of sampling and preparing steel and iron for chemical analysis as defined in Test Methods, Practices, and Definitions **A751** and Specification **A48/A48M**. Such subjects as sampling location and the sampling of lots are defined.

4.2 ~~It is intended that this practice include~~ This practice includes most requirements for sampling steel and iron for analysis. Standard analytical test methods that reference this practice need contain only special modifications and exceptions.

4.3 ~~It is assumed that all~~ All who use these procedures ~~will~~ should be trained samplers capable of performing common sampling operations skillfully and safely. ~~It is expected that only~~ Only proper sampling equipment ~~will~~ should be used.

5. Hazards and Safety Precautions

5.1 Provide personal protective equipment to minimize the risk of injury during sampling and sample preparation methods. Provisions shall include protective clothing, hand protection, and face visors resistant to splashes of liquid metal for use during the sampling of liquid metal; protective clothing and hand, eye, and hearing protection for use during the sampling and sample preparation of solid metal; and respiratory protection for use where necessary.

5.2 The use of machinery for sampling and sample preparation shall be in accordance with appropriate national standards. Grinding operations used for surface preparation may be covered by national legislation.

5.3 Reference should be made Refer to appropriate national regulations with respect to regarding the use of solvents for the cleaning and drying of samples and test portions.

6. Requirements for Sampling and Sample Preparation

6.1 *General:*

6.1.1 This section describes the general requirements for the sample and for the sampling and sample preparation of iron and steel. Special requirements apply to each category of liquid and solid metal, and these requirements are described in the relevant section.

6.1.2 The sequence of sampling and sample preparation of liquid iron and steel and cast iron and steel products is shown in Fig. 1. Special considerations apply to pig irons (see Section 10).

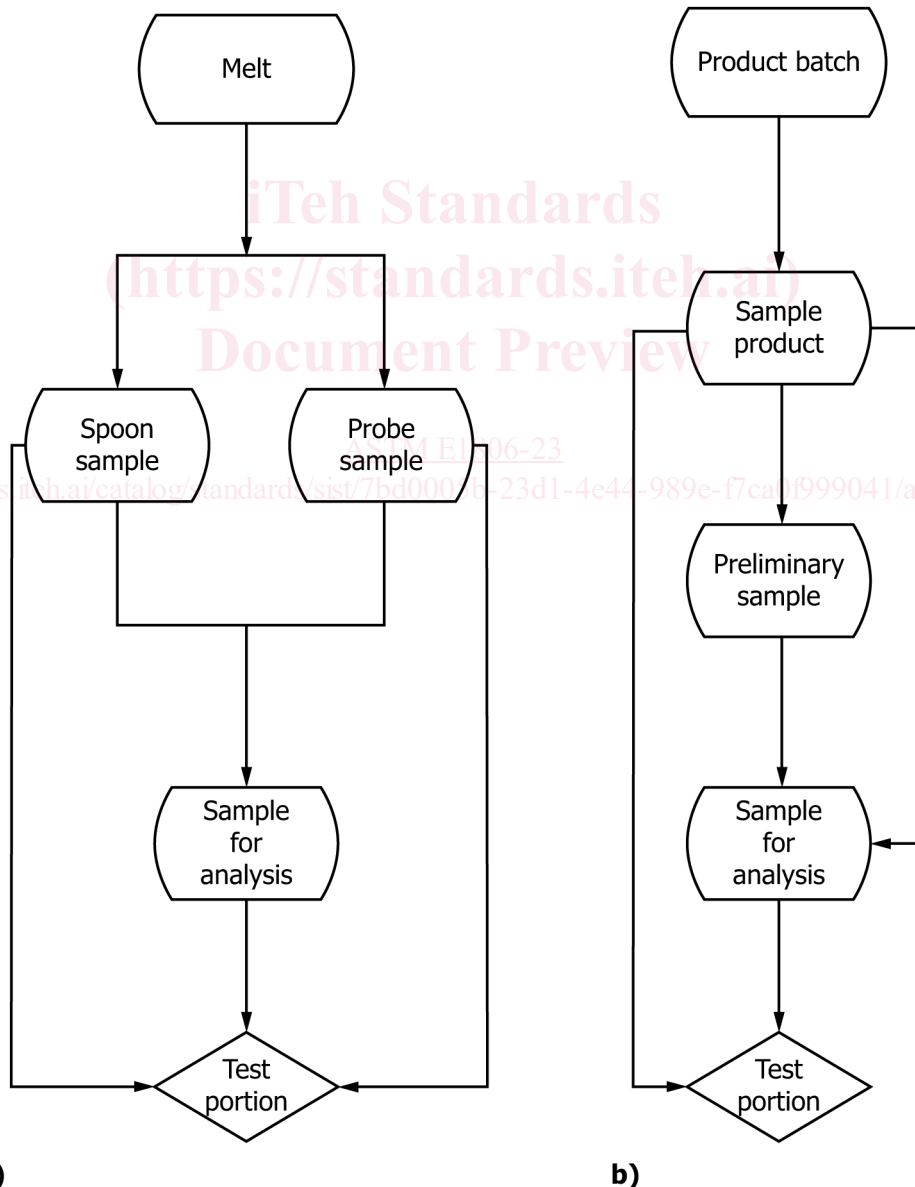


FIG. 1 Sequence of Sampling and Sample Preparation of (a) Liquid Iron and Steel and (b) Cast Iron and Steel Products

6.2 *Sample:*

6.2.1 *Quality:*

6.2.1.1 Sampling practices shall be designed to provide an analytical sample that is representative of the mean chemical composition of the melt or of the sample product.

6.2.1.2 Ensure that the sample is sufficiently homogeneous ~~with respect to~~ regarding chemical composition so that inhomogeneity does not appreciably contribute to the error variability of the method of analysis. ~~In the case of~~ For a sample taken from a melt, however, some variability in analysis, both within and between ~~samples for analysis,~~ samples, may be unavoidable. This variability will form an inherent part of the repeatability and reproducibility of the analysis.

6.2.1.3 Ensure that the sample is free from surface coatings and from moisture, dirt, or other forms of contamination.

6.2.1.4 The sample should be free from voids, cracks, and porosity and from fins, laps, or other surface defects.

6.2.1.5 Take particular care when selecting and preparing the sample ~~whereif~~ a sample taken from a melt is expected to be heterogeneous or contaminated in any way.

6.2.1.6 A sample taken from a melt shall be cooled in such a manner that the chemical composition and metallurgical structure of the sample is consistent from sample to sample.

6.2.1.7 It is important to recognize that analysis by some spectrochemical methods may be influenced by the metallurgical structure of the sample, particularly ~~in the case of~~ for irons with white and grey iron structures, and steels in the as-cast and wrought conditions.

6.2.2 *Size:*

6.2.2.1 Ensure that the dimensions of a laboratory sample in the form of a solid mass are sufficient to permit additional samples ~~for analysis~~ to be taken for reanalysis when necessary using an alternative method of analysis.

6.2.2.2 A sample shall be prepared consisting of a sufficient mass to provide for any reanalysis necessary. Generally, a mass of 100 g will be sufficient for a sample in the form of chips or powder.

6.2.2.3 The dimensional requirements for a sample in the form of a solid mass will depend upon the method selected for analysis. ~~In the case of~~ For spark atomic emission and X-ray fluorescence spectrometric methods, the shape and size of the sample will be determined by the dimensions of the sample chamber. The dimensions for samples given in this practice are for guidance only. Refer to Test Method [E415](#) for sample size requirements for spark atomic emission spectrometry.

6.2.3 *Identification:*

6.2.3.1 Assign the sample a unique identification to determine the melt or sample product from which it was taken, and if necessary, the process conditions of the melt or the location of the laboratory sample in the sample product. For pig iron, this shall identify the consignment or part of a consignment and the increment from which it was taken.

6.2.3.2 Use labeling or some equivalent method of marking to ensure that the assigned identification remains associated with the ~~sample for analysis:~~ sample.

6.2.3.3 Record the identification of the sample to ensure that confusion ~~cannot arise as to~~ is prevented regarding the identity of the item to which the analysis and records refer.

6.2.4 *Conservation:*

6.2.4.1 Provide adequate storage facilities to segregate and protect the sample. During and after preparation, store the sample in a manner which prevents contamination or chemical change.

6.2.4.2 Keep the sample, or the laboratory sample in ~~the form of a solid mass,~~ mass form, for a sufficient period of time to permit retesting if necessary.

6.2.5 *Arbitration:*

6.2.5.1 Samples intended for arbitration shall be prepared jointly by the supplier and purchaser or by their representatives. Keep a record of the methods used for preparing samples.

6.2.5.2 Both parties or their representatives shall seal containers with the samples intended for arbitration. Unless agreed to the contrary, the representatives of each party responsible for the preparation of samples will keep these containers.

6.3 *Selection of a Sample:*

6.3.1 *Sample from a Melt:*

6.3.1.1 Melts are sampled at various stages in the manufacturing process for the purposes of monitoring and controlling the process. Samples can be taken during the casting of the melt to verify chemical composition in accordance with the specification of the cast product. ~~In the case of~~ For liquid metal intended for the production of a casting, the analytical sample may be selected from test bars or blocks specially cast from the same metal as that of the casting for purposes of mechanical testing in accordance with the product standard.

6.3.1.2 Sampling practices shall be designed for melts to provide samples during a particular manufacturing process in accordance with requirements for sample quality (see 6.2.1). The sample obtained from a melt ~~usually is in the form of~~ is usually a small ingot, a cylindrical or rectangular block, or a chill-cast disk or a combination of a disk with one or more attached ~~pins, in some cases pins.~~ Sometimes small lugs are attached to a disk sample.

NOTE 1—Sampling probes for use with liquid iron and steel may be obtained from a number of suppliers. The main features of the different types of probe are distinguished in [Annex A1](#) and [Annex A2](#), which include dimensions for information only.

6.3.2 *Sample from a Product:*

6.3.2.1 The laboratory sample can be selected from the sample product at the location indicated in the product specification for the selection of material for mechanical testing when available.

6.3.2.2 ~~In the case of~~ For an iron casting, the sample can be selected from a bar or block cast-on to the casting.

6.3.2.3 ~~In the case of~~ For a forging, the sample can be selected from the initial starting material from which the forging has been made or from prolongations of the forging or from additional forgings.

6.3.2.4 In the absence of requirements given in the product standard or of a specification when ordering the product, the sample may, following agreement between the supplier and the purchaser, be selected from the sample for mechanical testing or from the test piece, or directly from the sample product.

6.3.2.5 The laboratory sample can be obtained from the sample product by machining or by using a cutting torch. Special considerations apply ~~in the case of~~ to sampling for the determination of certain elements.

6.4 *Preparation of a Sample:*

6.4.1 *Preliminary Preparation:*

6.4.1.1 If any part of the sample is ~~liable to be~~ potentially nonrepresentative in chemical composition, remove those parts that have changed. Following this operation, the sample shall be protected from any change in composition.

6.4.1.2 Remove any coating that has been applied during manufacturing. If necessary, degrease the surface of the metal with a suitable solvent, taking care to ensure that the manner of degreasing does not affect the ~~correctness~~ accuracy of analysis.

6.4.2 *Sample in the Form of Chips:*

6.4.2.1 Obtain the sample by ~~drilling or~~ drilling, milling or turning to produce chips of a ~~regular~~ consistent size and shape. Do not machine on a part of the sample that has been affected by the heat of a cutting torch.

6.4.2.2 ~~Clean~~ Before preparation, clean the tools, machines, and containers to be used during preparation ~~of the sample beforehand~~ to prevent any contamination of the ~~sample for analysis~~ sample.

6.4.2.3 Machine in such a way that the chips are not subject to overheating as indicated by a change in the color (blueing or ~~blackening~~) of the ~~chips~~ blackening). Unavoidable coloration of chips obtained from some types of alloy steels, for example, manganese and austenitic steels, can be minimized by selection of appropriate tools and cutting speeds.

6.4.2.4 Heat treatment may be required to soften the sample for machining.

6.4.2.5 The use of coolants during machining is only permitted in exceptional cases, after which the chips shall be cleaned by means of a suitable solvent that does not leave any ~~deposit~~ residue.

6.4.2.6 Mix the chips thoroughly before weighing the test portion. For most purposes, it is satisfactory to mix the chips by rolling the container on a level surface, gently tumbling the ~~container~~ chips.

6.4.3 *Sample in the Form of a Powder or Fragments:*

6.4.3.1 ~~Where~~ If drilling ~~of~~ the sample to obtain chips is impracticable, cut or break the sample into pieces. Crush the pieces using a percussion mortar or a vibratory grinding mill, also known as a disk mill or ring mill, to obtain a sample in the form of a powder the whole of which passes through a sieve of a specified aperture size.

6.4.3.2 In some applications the sample is crushed in a percussion mortar to obtain a sample ~~for analysis~~ in the form of fragments suitable for use with the selected method of analysis.

6.4.3.3 Equipment used for pulverization shall be constructed from material that does not alter the sample composition. Tests may be necessary to show that such equipment does not affect the composition of the sample.

6.4.3.4 Sieve the sample taking precautions to avoid contamination or loss of material. Take care when sieving hard materials to avoid damaging the fabric of the sieve.

6.4.3.5 Homogenize the sample before weighing the test portion. Powders can be homogenized by stirring. (**Warning**—Finely divided metals of particle size less than approximately 150 μm can present a fire risk. Ensure adequate ventilation during pulverization.)

6.4.4 *Sample in the Form of a Solid Mass:*

6.4.4.1 Obtain the sample by cutting from the sample product or laboratory sample a piece of suitable size and shape for the method of analysis. Cut samples by sawing, abrasive cutting, shearing, or punching.

6.4.4.2 In the absence of any indication in the product standard, perform a spectrochemical analysis on that part of the sample corresponding to a transverse section of the product, provided that the material has sufficient thickness.

6.4.4.3 Prepare the sample to expose a surface suitable for the analytical method. Do not prepare a surface for analysis on part of a sample that has been affected by the heat of a cutting torch. The equipment used for sample preparation shall be designed to minimize overheating the sample, and, where appropriate, shall incorporate systems of cooling.

6.4.5 *Main Types of Equipment Used for Surface Preparation:*

6.4.5.1 A milling machine capable of removing a preselected depth of metal in a reproducible manner, for use with samples that are within a hardness range suitable for milling. The equipment should be capable of use, if required, with a sample taken from a melt ~~where~~ while the sample is still hot.

6.4.5.2 A grinding machine with a fixed, rotating, or oscillating head capable of removing a preselected depth of metal in a reproducible manner.

6.4.5.3 A flatbed finishing machine with abrasive grinding disks, or machines with continuous abrasive belts, capable of preparing the surface of the sample for analysis to varying grades of finish.

6.4.5.4 A machine for blasting with sand or grit, or metal shot, capable of cleaning the surface of the sample for analysis or the test portion when required.

6.4.5.5 Ensure that the surface of the sample after preparation is flat and free from defects that could affect correctness accuracy of analysis.

6.4.5.6 Cutting and surface preparation can be performed either manually or automatically. ~~In the case of~~ For samples taken from melts, commercially available systems may be used that perform each stage of preparation automatically. Systems for the automatic surface preparation of dualthickness probe samples (see A2.3) and for the punching of slugs as test portions may incorporate facilities operations for the sandblasting of the sample and for heat treatment to soften the sample before punching.

6.4.5.7 Select the abrasive substances used in the final stage of preparing the sample that do not contaminate the surface with elements that are to be determined by the analysis method. Ensure that the grit size of the abrasive is in accordance with the grade of surface finish required for the analysis method.

6.4.5.8 ~~In the case of~~ For spark atomic emission spectrometric methods, an abrasive with a gradesize of 60 grit to 120 grit normally is suitable. ~~In the case of~~ For X-ray fluorescence spectrometric methods, it is essential to ensure that the method selected for surface preparation produces a grade of surface finish that is sufficiently smooth and reproducible from sample to sample. Also, there should be no smearing of the surface.

6.4.5.9 The effect of abrasive materials depends on the analytical method. When using spark atomic emission spectrometric methods, the action of pre-sparking normally will clean the surface of the sample for analysis by volatilizing any grinding contaminants. Particular care is required, however, to avoid surface contamination when using a new abrasive disk media.

6.4.5.10 When using X-ray fluorescence spectrometric methods, examine all phases of surface preparation for potential surface contamination effects.

6.4.5.11 Examine the sample visually after preparation to establish that the surface is dry and free from particulate matter and that there are no defects. Resurface or discard the sample if defects are present. Protect the prepared surface from contamination.

6.4.6 *Preparation of a Sample for Analysis by Remelting-Melting:*

6.4.6.1 A sample in the form of small pieces or chips, or a part of the sample product itself, can be ~~remelted~~ melted in an atmosphere of argon using commercially available melting equipment of the type described in Practice ~~E1010~~ E1306. The sample is converted into a disk, 40-mm to 30-mm diameter by 6 mm thick, which is suitable for analysis by a spectrochemical method. Some types of remelting melting equipment incorporate facilities operations for the centrifugal casting of the disk sample.

6.4.6.2 Partial losses of some elements can be experienced during the remelting melting process. It is essential to ensure that any selective volatilization or segregation of elements, or any other change in composition, which occur are known quantitatively and do not significantly influence the analysis results. ~~Carry out~~ Conduct suitable tests to show that any change in composition is both small in magnitude and reproducible.

6.4.6.3 The equipment used and the method adopted for remelting melting shall be designed to prevent or minimize change in composition and to ensure that any change is reproducible. A deoxidant, for example 0.1 % (m/m) zirconium, should be used during remelting. ~~Take into account~~ melting. Consider any change that does occur when using the method for calibration of analytical measurement ~~any change that does occur~~ measurement.

6.4.6.4 Not all ferrous metals can be ~~remelted~~ melted in this manner. Do not use remelting melting as a method of sample preparation for the determination of an element that is subject to a significant and nonreproducible change in composition.

7. Liquid Iron for Steelmaking and Pig Iron Production

7.1 General:

7.1.1 The following methods are applicable to the sampling of liquid blast-furnace iron intended for steelmaking, and commonly described as hot metal, or for the casting of pig iron. The liquid iron is normally sampled from the blast furnace runner during the pouring of the melt into torpedo ladles, or from transfer vessels or during secondary treatment processes in the ladle, or during the casting of the melt into pig iron.

7.1.2 The chemical composition of iron may fluctuate during run-out from the blast furnace. Two or more samples should be taken from the melt at timed intervals and an average analysis determined.

7.1.3 When spectrochemical methods are used for analysis, the method of sampling should be designed to chill the liquid metal in a manner that ensures that the metallurgical structure of the sample is suitable for the requirements of the analysis method selected.

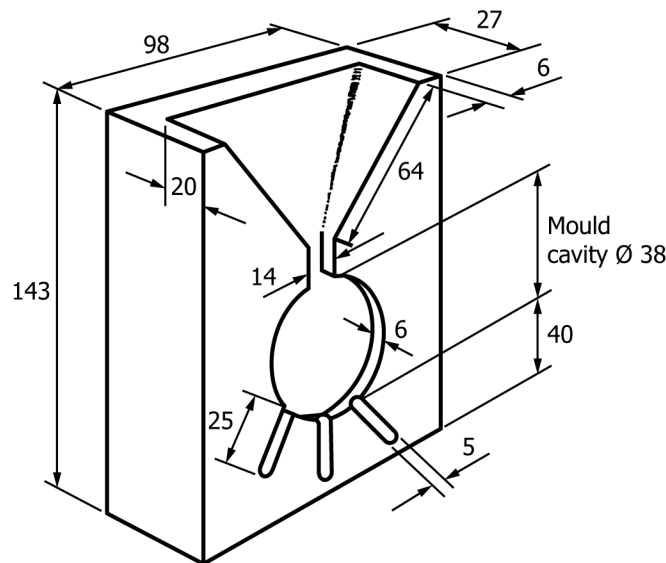
7.2 Spoon Sampling:

7.2.1 Hold Types:

7.2.1.1 A disk-shaped sample, commonly described as a coin sample, can be obtained using a two-piece steel mold. The dimensions of the sample are typically 35 mm to 40 mm in diameter with thickness varying from 6 mm to 12 mm. The mold is constructed in two pieces that are clamped together in use: one piece is a flat chill plate and the other is a block with the mold cavity. The edge of the mold cavity may be tapered, for example, from 38 mm to 32 mm, to facilitate removal of the sample from the mold.

7.2.1.2 A coin sample with one or more attached pins can be obtained using a combination-type mold. The pins are broken off from the disk and used, if required, as test portions for analysis by a thermal method. A combination-type mold for use with liquid iron intended for the production of cast iron is shown in Fig. 2.

7.2.1.3 A thin slab-shaped sample with a rounded end can be obtained using a cast iron or steel split-mold. The dimensions of the sample are typically 70 mm by 35 mm with a thickness of 4 mm. The two halves of the mold are bevelled at the top to give a feeder head and are clamped together in use. This type of mold may be preferred for use with liquid iron containing high percentages of carbon.



NOTE 1—All dimensions are in millimetres.

All dimensions are in millimetres.

The flat chill plate (not shown) has similar overall dimensions.

NOTE 2—The flat chill plate (not shown) has similar overall dimensions.

FIG. 2 Combination-Type Vertical Mold Used for Sampling Liquid Iron Intended for Cast Iron Production

7.2.2 Procedures:

7.2.2.1 For sampling from a melt, immerse a preheated steel spoon into the melt and fill with liquid iron. Withdraw the spoon and remove any slag by skimming the surface of the liquid iron.

7.2.2.2 For sampling from a stream, introduce a pre-heated steel spoon into the stream from the ladle and fill with liquid iron.

7.2.2.3 Pour the liquid iron from the spoon without delay into a metal mold to chill the iron as rapidly as possible. Remove the sample from the mold and break off any riser.

7.2.2.4 It is essential that the liquid iron ~~should~~ be poured into a mold that is cold to ensure adequate chilling. If necessary, the mold should be air-cooled before use. The mold should be free from moisture.

7.2.3 Maintenance of Equipment:

7.2.3.1 It is essential to maintain sampling spoons and molds in a clean and dry condition. After use, remove any slag and skull and brush the faces of the mold with a wire brush.

7.2.3.2 Molds should be re-machined if the internal surfaces become worn. This avoids the need for additional machining of the sample during surface preparation.

7.3 Probe Sampling:

7.3.1 General:

7.3.1.1 The different types of probes used for sampling blast furnace iron are described in **Annex A1**. Probes are designed to provide a disk-shaped sample with a depth of white iron structure that is sufficient for the requirements of the spectrochemical method selected for analysis.

7.3.1.2 Probe sampling is influenced by such factors as the angle and depth of immersion of the sampler in the melt, and immersion times can vary depending on the temperature of the liquid iron. These factors should be determined for the particular iron-making practice, and thereafter, strictly controlled to maintain the standard of quality of the ~~sample for analysis~~ sample.

<https://standards.iteh.ai/catalog/standards/sist/7bd0005b-23d1-4e44-989e-f7ca0f999041/astm-e1806-23>

7.3.2 Procedures:

7.3.2.1 For sampling from a melt, immerse a suitable immersion probe sampler into the melt at an angle as near as possible to the vertical plane.

7.3.2.2 When sampling from the runner of a blast furnace, select the position of immersion to give sufficient depth of liquid metal for the use of a probe sampler. A depth of approximately 200 mm is adequate for most types of sampling probe.

7.3.2.3 For sampling from a stream of liquid iron, introduce a suitable suction probe sampler into the metal flow from a ladle, at an angle of approximately 45° to the vertical plane, at a position as near as possible to the nozzle of the vessel.

7.3.2.4 Withdraw the probe sampler from the melt after a predetermined interval of time, break it apart, and allow the sample to cool in air.

7.4 Preparation of a Sample for Analysis:

7.4.1 *Preliminary Preparation*—Remove any surface oxidation from a sample taken from the melt that may contaminate the sample during subsequent preparation.

7.4.2 Sample for Analysis by a Chemical Method:

7.4.2.1 Break the sample into small pieces and crush pieces using a percussion mortar or a vibratory grinding mill to obtain a sufficient mass of sample ~~for analysis~~ of particle size less than 150 μm.

7.4.2.2 Alternatively, obtain chips by drilling the sample at a low speed as described in 10.3.1.2.

7.4.3 *Sample for Analysis by a Thermal Method:*

7.4.3.1 Break the pin of a disk-shaped sample into pieces of a suitable mass for use as test portions or use the lugs of a probe sample. Analyze a representative number of test portions to obtain an average value.

7.4.3.2 Alternatively, crush the pin or lugs using a percussion mortar to obtain a sufficient mass of sample for analysis of particle size approximately 1 mm to 2 mm. Avoid the production of fine material during crushing. ~~In the case of~~ For a slab-shaped sample, break the sample into small pieces and crush the pieces in a similar manner.

7.4.4 *Sample for Analysis by a Spectrochemical Method:*

7.4.4.1 In the case of a disk-shaped sample, remove any lugs or pin, as necessary, and grind the surface of the sample to expose a white iron structure that is representative of the sample. The amount of material to be removed in this way should be determined for the chemical composition of the particular iron, and the conditions of sampling. The thickness of the layer to be removed is normally between 0.5 mm and 0.5 mm to 1 mm.

7.4.4.2 ~~In the case of~~ For a slab-shaped sample, break the slab into two pieces to obtain a sample of suitable ~~size for analysis~~ size.

7.4.4.3 Prepare the surface of the sample by grinding and finishing. Grinding should be ~~carried out~~ performed wet to avoid overheating the sample but the final surface preparation should be dry finishing. Alternatively, cool the sample after grinding by immersion in water, and then finish by dry finishing.

7.4.4.4 Particular care is required when preparing the surface of thin samples. A chuck should be specially designed to hold the sample securely during grinding and finishing operations.

8. Liquid Iron for Cast Iron Production

8.1 *General:*

8.1.1 The following methods are applicable to the sampling of liquid iron from cupola furnaces and electric furnaces, holding furnaces in duplex processes, and ladles and treatment vessels.

8.1.2 Liquid iron intended for the production of iron castings may be subject to inhomogeneity and particular care is required in the design of strategies and methods of sampling to meet the requirements of the particular production process. For example, liquid iron in holding furnaces tends to stratify, and sampling should ensure that analysis is representative of the melt as a whole.

8.1.3 In batch processes, two or more samples should be taken from melting furnaces preferably when approximately one third and two thirds of the melt has been discharged and an average analysis determined. In continuous processes, samples should be taken at regular intervals of time.

8.1.4 Methods of sampling normally are designed to chill the liquid metal of a sample cast from a spoon, as rapidly as possible, to produce a metallurgical structure of white iron free from graphite. A white iron structure obtained by chill-casting is required generally for analysis by spectrochemical methods.

8.1.5 Non-chilled samples also may be used. ~~In this case,~~ These samples can be cast ~~specially~~ from a spoon, or selected from a test bar or keel block intended for mechanical testing. Test bars or blocks are cast separately from the same metal as that used to produce the ~~casting or~~ castings.

8.1.6 By agreement with the customer, when large castings or large numbers of castings are produced, two or more samples should be obtained.

8.1.7 Special considerations apply to the sampling and sample preparation of liquid iron for the determination of hydrogen, oxygen, and nitrogen (see 8.5).

8.2 *Spoon Sampling:*

8.2.1 *General:*

8.2.1.1 Sampling should take place before any additions of inoculating agents ~~have been made~~ to the melt.

NOTE 2—~~Where~~When sampling takes place before addition of inoculating agents, ~~it should be recognized~~recognize that the sample obtained will not be representative of the chemical composition of the cast product.

8.2.1.2 Alternatively, sufficient time should ~~be allowed to elapse~~ for the immediate effect of the additions to ~~have faded~~fade and the melt should be thoroughly stirred before sampling. Failure to allow adequate standing time before taking the sample will seriously impair the representivity of sampling.

8.2.1.3 Ductile iron ~~particularly~~is difficult to sample due to the possibility of contamination by dross during the production process. ~~In this case, a~~A suitable sample may be obtained by filtering the iron using a ceramic disk.

8.2.2 *Methods*—A graphite spoon or a steel spoon lined with a layer of a refractory, such as ganister, is suitable for use in accordance with one of the following methods.

8.2.2.1 Remove any slag from the surface of the melt by skimming, and then immerse a preheated spoon into the melt and fill with liquid iron.

8.2.2.2 Introduce a preheated spoon into the stream during pouring and fill with liquid iron.

8.2.3 *Chilled Sample:*

8.2.3.1 Pour the liquid iron from the spoon without delay into a split mold made from graphite, hematite iron, or copper to obtain a sample in the form of a small, flat plate, 4 mm to 8 mm in thickness. Remove the sample from the ~~mold, as soon as it is solid,~~mold when solidified to avoid overheating the mold and the risk of ~~breakage of the sample.~~sample breakage. Break off any riser.

8.2.3.2 The sample, commonly described as a coin sample, may be circular, rectangular, or square ~~in shape~~ with typical sizes, respectively, 35-mm to 40-mm diameter, (50 by 27) mm and (50 by 50) mm. Generally, disk samples are cast vertically and rectangular and square samples are cast horizontally.

8.2.3.3 The mold is constructed in two pieces that are clamped together in use: one piece is a flat chill plate, and the other is a block with the mold cavity. The edge of the mold cavity may be tapered to facilitate removal of the sample from the mold.

8.2.3.4 A coin sample with one or more attached pins can be obtained using a combination-type mold. The pins are broken off from the disk and used, if required, as test portions for analysis by a thermal method. A vertical mold of this type, commonly described as a book mold and made from low-phosphorus, high-carbon grey iron, or from copper or graphite, is shown in Fig. 2. The sample obtained is a disk, 38 mm in diameter by 6 mm thick, with three 5-mm diameter pins.

8.2.3.5 The temperature of the liquid iron in the spoon should be as high as possible and compatible with the mold material. It is essential that the mold is cold to ensure adequate chilling for the production of a sample ~~for analysis~~ with a white iron structure. If necessary, the mold should be air-cooled before use. The mold should be free from moisture.

8.2.3.6 ~~In the case of a process~~For processes where samples are required to be taken at frequent intervals, provide several molds to ensure the availability ~~for use~~ of a mold that is cold.

8.2.3.7 Thermal stress due to overheating of the mold can cause breakage of the coin sample and should be avoided.

8.2.4 *Non-Chilled Sample:*

8.2.4.1 Pour the liquid iron from the spoon without delay into a sand mold to obtain a cylindrical block-shaped sample approximately 50 mm in diameter by 40 mm to 50 mm long.

8.2.4.2 Alternatively, a sample can be selected from a test bar or keel block intended for mechanical testing. Test bars or blocks are cast either from liquid iron taken from a ladle using a pouring spoon, or, if a small hand-ladle is used for pouring, directly from the ladle itself. Bars are typically 30 mm in diameter by 150 mm long and may be cast vertically or horizontally in a sand mold.