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SURFACE VEHICLE RECOMMENDED PRACTICE

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Methods of Sampling Steel for Chemical Analysis

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format

1. Scope

2. References—There are no referenced publications specified herein.

3. Definitions

3.1 Ladle Analysis (Heat Analysis)—The chemical analysis of a heat of steel as reported to the purchaser. It is the analysis for all the specified elements and is determined by analyzing one or more test samples obtained during the pouring of the steel. When such samples are unobtainable or if it is evident that the samples do not represent the analysis of the melt, additional samples are taken from the solid steel. An analysis based on these representative samples may be used

3.2 Ladle Sampling—A common practice in most melting operations to obtain more than one test sample; often three or more are taken representing the first, middle, and last portions of the heat. These samples are used to survey the uniformity of the heat and for control purposes

3.3 Check Analysis—As used in the steel industry, means an analysis of the metal after it has been rolled or forged into semifinished or finished forms, and is either for the purpose of verifying the average composition of a heat or lot as represented by the ladle analysis, or to determine variations in the composition of a heat or lot. It is not used, as the term might imply, for a duplicate determination made to confirm a previous result. The results of analyses representing different locations in the same piece or taken from different pieces of a lot may differ from each other and from the ladle analysis due to segregation.

3.4 Segregation—The result of that natural phenomenon in the solidification of steel in which various components of the steel having the lowest freezing points are concentrated in parts of the ingot last to solidify. This concentration at different locations results in such a distribution of elements in the ingot that certain areas contain more of a given element than the average composition of the ingot as a whole.

Segregation in varying degrees is found in all types of steel ingots. The principal factors affecting the amount of segregation are the type and composition of steel, the casting temperature, the ingot shape and size, and the inherent segregating characteristics of the elements being considered.

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Rimmed or capped steels are characterized by a lack of uniformity in their chemical composition, especially for the elements carbon, phosphorus, and sulfur, and for this reason check analysis is not considered appropriate for these elements unless misapplication is clearly indicated.

Certain qualities of some commodities are not subject to check analysis requirements except when misapplication is clearly indicated. Examples of these qualities are merchant quality in carbon steel bars and regular quality in carbon steel plates.

Due to the degree to which phosphorus and sulfur tend to segregate, check analysis for these elements is inappropriate for rephosphorized or resulfurized steels unless indications of misapplication clearly exist.

The effect of segregation makes the ladle analysis more representative of the average composition of a melt of steel than the analysis of a single sample from the finished material. However check analysis of properly located samples will afford a reasonable comparison with the ladle analysis if taken from a sufficient number of pieces of the finished material to constitute a fair average.

4. ***Methods of Sampling for Check Analysis***—Each heat of steel in a lot or shipment is considered separately. To indicate adequately the representative composition of a heat or lot, samples selected to represent the melt as fairly as possible are taken from a minimum number of pieces as follows:

Four pieces for lots up to 15 tons, (13.6 metric tons) inclusive
Six pieces for lots over 15 tons (13.6 metric tons)

If the number of pieces in a melt is less than the number of samples specified above, one sample shall be taken from each piece.

4.1 **Preparation of Samples**—Steel subjected to check analysis should be in the condition as received from the steel producer because if it has been subjected to subsequent heating operations it may not yield analytical results which properly represent its original composition.

Drillings or chips are taken without the application of water, oil, or other lubricant, and must be free from scale, grease, dirt, or other foreign substances. Steel drills, not carbide-tipped drills should be used in analysis for carbon. Provisions should be made to discard the surface metal before obtaining samples for check analysis to assure freedom from scale, decarburization, and so on, and thus obtain representative results. They should not be overheated during cutting to the extent of causing decarburization. Chips must be well mixed, and those too coarse to pass a No. 10 (2000 µm) sieve or too fine to remain on a No. 30 (590 µm) sieve are not suitable for proper analysis. Sieve size numbers are ASTM designations.

When chips are taken by drilling, for pieces having a cross sectional area up to 16 in^2 (100 cm^2) inclusive, the diameter of the drill is approximately 1/2 in (13 mm); for steel over 16 in^2 (100 cm^2) cross sectional area, the diameter of the drill is approximately 1 in (25 mm). Each sample commonly consists of not less than 2 oz (50 g) of drillings.

In referring samples to other analysts for check analyses, pieces of the original full size section, when possible, should be submitted rather than cuttings unless the latter are specifically requested.

4.2 **Sampling Steel Products, Rolled and Forged**

4.2.1 LARGE SECTIONS—For large sections, including blooms, billets, rounds, squares, shapes, and so forth, samples shall be taken at any point midway between the outside and the center of the piece by drilling parallel to the axis. In cases where this is not practicable, the piece shall be drilled on the side (see Figs. 1B and 1C), but the drillings shall not be collected until they represent the portion midway between the outside and the center. The tensile test specimen may be used for sampling if it conforms to the above conditions.

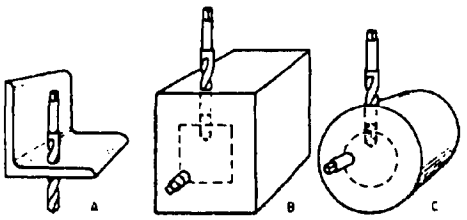

FIGURE 1—LOCATION OF SAMPLES FOR CHECK ANALYSIS

4.2.2 SMALL SECTIONS—For material of small cross section, if the method described in the section for large sections is not applicable, the sample shall be taken by machining off the entire cross section, or, if this is not possible, by drilling entirely through the material at a point midway between the outside and the center (Fig. 1A).

4.2.3 BORED FORGINGS—FORGED, TURNED, AND BORED PIPE—For bored forgings, samples shall be taken midway between the inner and outer surface of the wall. For forged, turned, and bored pipe, samples shall be taken by drilling through the pipe wall, or cuttings shall be taken across the end of the tube, or millings shall be taken from a broken tensile test specimen cut from the wall of the tube.

4.2.4 PLATES—For plates, samples shall be taken at a point midway between the center and the edge of the plate. For thicknesses 2 in (50 mm) and less, samples are customarily taken by drilling through the thickness of the plate. For thicknesses over 2 in (50 mm), samples are taken by drilling the edge of the plate at a point midway between the rolled surface and the midthickness.

4.2.5 SHEETS ROLLED LONGITUDINALLY—For sheets rolled from slabs or bars longitudinally, the specimen for sampling shall be cut 2 in (50 mm) in width and across the full width of the sheet as rolled. The specimen shall be cleaned by pickling or grinding and then folded once or more by bringing the ends together and closing the bend. The sample for analysis shall be taken in the middle of this length by milling the inside sheared edges or drilling entirely through from the flat surface. Sampling by milling is preferable. For sheets of a light gage, more than one specimen may be taken and stacked together before folding.

4.2.6 SHEETS ROLLED TRANSVERSELY—For sheets rolled from slabs or bars transversely, the specimen shall be cut from the side of the sheet, halfway between the middle and end as rolled 2 in (50 mm) in width and 18 in (45 cm) in length. If the sheet is 0.037 in (1 mm) in thickness or lighter, the specimen shall be cut from the full length of the sheet as rolled. The specimen selected shall be cleaned by pickling or grinding and then folded once or more by bringing the ends together and closing the bend. The sample for analysis shall be taken in the middle of this length by milling the inside sheared edges or drilling entirely through from the flat surface. Sampling by milling is preferable.

4.2.7 SHEETS NOT OF THE FULL SIZE ROLLED—Sheets cut from larger sheets and not of the full size rolled shall be sampled by milling or drilling the sheet in a sufficient number of places so that the sample is representative of the entire sheet. The sampling may be facilitated by folding the sheet both ways.

PREPARED BY THE SAE IRON AND STEEL TECHNICAL COMMITTEE