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USER'S GUIDE TO AMS SPECIFICATIONS

FOREWORD

SAE has been the source of Aerospace Material Specifications since 1939 when the SAE Aircraft Materials Division issued the original 101 specifications. Aeronautical Material Specifications, as AMS were originally known, were created in response to a recognized need for industry-generated, industry-oriented specifications that would eliminate, or markedly reduce the number of individual company specifications covering the same materials or processes.

AMS specifications continue to be developed by the Aerospace Materials Division (AMD) under the direction of the SAE Aerospace Council. Commodity committees, with members from aerospace companies, material producers, and military organizations, meet at least twice each year to review and issue new or revised documents. There are now more than 2200 AMD documents used throughout the world to define, procure, and produce aerospace materials.

An AMS specification is designed to be an enforceable procurement document defining a product or a service, part of the contract between a purchaser and a vendor of products or services. It is necessary that it be complete, precise, unambiguous, and reasonable.

Although AMS specifications are said to be "user's specifications", they are the result of considerable discussion and negotiation between users and producers. An AMS specification has to be a compromise between the needs of the user and the capability of the producer to economically and reliably provide the product.

The Manual for Preparation of AMS is to be used when drafting AMS documents.

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1. SCOPE:

The reader of specifications sometimes needs some help understanding the reasoning behind certain usage of terms. The scope of this AIR is to explain the functions of the various sections of the specifications, why some of the terms in AMS specifications are used, and how the specification system works. After the introduction, the topics are shown in the order they usually appear in specifications.

2. REFERENCES:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP1876 Weldability Test For Weld Filler Metal Wire

3. INTRODUCTORY MATERIAL:

3.1 Metal Product Specifications:

The underlying philosophy behind most of the metal raw material specifications is:

If (1) we define the material composition limits, the basic methods of melting and alloying, the methods of working and shaping, and the heat treatment of the product, and if (2) we measure and meet selected requirements for certain properties of the product such as: tensile strength and ductility, hardness, grain size, microstructure, surface characteristics, or other properties pertinent to the specific product, then (3) we can be confident that the product is controlled and can be relied upon to have the other important engineering properties within statistically established limits.

Other properties which will be inherent in the product if the specified requirements are met, or which may be of interest to the user, but are not needed to define and control the product are not included.

The details of these definitions and limits differ considerably among the various alloy systems. The tests designated to measure the selected characteristics are those judged most likely to verify the overall performance of each alloy and product.

3.2 Nonmetallic Product Specifications:

Most nonmetal material specifications depend on definition and measurement of end item performance characteristics, rather than control of the ingredients and methods used to make the product.

3.3 Process Specifications:

These specifications generally define the basic materials, facilities, preparation methods, critical processing steps, control requirements, and end item performance requirements of a process. The specification normally does not provide the step by step "how to" details of a process because there are often numerous acceptable ways to do each step. The specification format for process specifications is different from the normal AMS format to address the needs of the process.

4. DOCUMENT IDENTIFIERS:

4.1 AMS Number, Revision Letter, Date:

The four digit specification number for a new AMS is established by SAE Headquarters office when the specification is ready for first release. The number is selected to place the new specification near similar materials and products or processes in the various indexes. The classification system is best understood by scanning the "SAE AMS INDEX".

Specification revisions are identified by the original number with the letter "A" added to indicate the first revision since first release, "B" for the second revision, etc. The date of initial issue and of the most recent revision are shown below the specification number on the first page.

4.2 Title Block:

The first line in the title block is the title of the specification, shown in all capital letters. It provides a brief identification of the principal product or products covered. If a specification covers too many forms for all to be in the title, the most important forms (as identified by the committee responsible for the specification) are shown in the title and the "less important" forms are mentioned in the scope paragraph.

The second and third lines are subtitles, to provide enough information to distinguish the specification from others which have similar titles. Usually, the second line identifies the alloy and the third line indicates the condition of the product.

A fourth line (in metals specifications) shows the UNS (Unified Numbering System) number which indexes to the composition of the alloy, but is not a part of the contractual requirements of the specification.

4.3 Scope:

This section (1) always includes paragraphs indicating forms of product covered, typical applications, classes, grades, or types covered and, if necessary, precautions to be observed in handling, processing, or usage of the product.

4.3.1 Form: This paragraph identifies all of the product forms covered by the specification, including those not in the title, and repeating those that are in the title. Examples of product forms include: bar, plate, castings, forging stock, forgings, brazing filler, etc.

When parallel specifications, AMS _____ (for the inch-pound system) and MAM _____ (metric system), are issued for the same product, both will have the same specification number but need not have the same revision letter. Each specification will refer to the other in a subparagraph of the form paragraph to advise the user that both versions exist.

4.3.2 Application: This paragraph informs the user of typical applications of the product, or of important properties of the material which may help determine if the product is suitable for the proposed application. The following introductory and closing phrases are used when appropriate:

"This product has been used typically for....., but usage is not limited to such applications."

This language was adopted to make it clear that although the paragraph offers examples of applications of the product, it does not suggest that users should avoid other applications which may not be similar to the examples.

For alloys and/or conditions known to be sensitive to stress-corrosion cracking, a subparagraph may be added to advise users that information regarding this problem is available as an ARP (Aerospace Recommended Practice) such as ARP823, ARP982, and ARP1110.

4.3.3 Classification: If the specification covers more than one surface condition, melting method, heat treatment, etc., a classification paragraph may be used to define such variations and their designation by type, grade, or class of the product.

4.3.4 Precautions: A standard general paragraph is included when appropriate, to notify that some materials, applications, and/or processes covered or referenced in a specification are considered hazardous and that the user must assume responsibility for identifying and implementing suitable precautions. It is up to the drafter and the responsible AMS committee to decide if precautions are needed.

A more specific warning may be expressed for some materials or processes when deemed appropriate by the committee.

5. APPLICABLE DOCUMENTS (Section 2):

This section (2) lists other specifications, standards, recommended practices, and publications that are included by reference in Sections 1, 3, 4, and 5. Documents referenced in other than these sections are not requirements and, therefore, are not listed in Section 2.

5.1 Referenced documents are listed in this sequence:

a. Aerospace Material Specifications (AMS and MAM)
b. Aerospace Standards (AS and MA)
c. Aerospace Recommended Practices (ARP)
d. Aerospace Information Reports (AIR)
e. SAE Standards And Recommended Practices
f. ASTM Specifications
f. U.S. Government Documents
g. Others

The standard introductory paragraph for applicable documents points out that the listed documents apply only as defined in the referring specifications to preclude inference that the entire document (and all its references) may apply.

The introductory paragraph also states that the latest issue of SAE documents applies when the specification is part of a purchase order; however, for other documents, the issue in effect on the date of the purchase order applies.

6. TECHNICAL REQUIREMENTS (Section 3):

This section (3) defines the required manufacturing methods and the product properties which must be measured and met to assure that the product or process will be satisfactory for the intended usage. Other properties which are inherent in the product if the specified requirements are met, or which may be of interest to some users but are not needed to define and control the product or process, are not included. This section (3) also defines the test procedures to be used to verify compliance with the requirements.

Certain terms or phrases that need explanations can appear anywhere in the technical section. These will be covered next, and those peculiar to certain paragraphs in the section will be covered later in the discussion of the paragraph.

6.1 "Unless Otherwise Specified":

These words are to advise the purchaser, the producer, and others (such as auditors, customers of the user, and accreditors or surveyors) that the purchaser is specifically authorized to specify an alternative to the requirement associated with the term.

There has been a trend to eliminate use of this language, based on the presumption that the purchaser is always at liberty to change any requirement in the specification if the supplier will comply, but recent experience demonstrates that auditors and prime contractors may declare noncompliance with specifications if such changes are made. Producers may also be at some liability risk if their product labeled AMS _____ has not met or been tested for all requirements in the specification.

6.2 "When Permitted By Purchaser":

This phrase allows a variation to be made in the specification requirements. For example, a rough, oxygen-rich, or decarburized surface may be allowed if the purchaser knows that the discrepant layer will be removed by machining during fabrication of the part.

6.3 Composition:

All metal specifications have a composition paragraph with a table showing the alloying elements and the required limits. The order of listing of the elements varies with the base alloy system, as does the label for "other impurities", "residual elements", "other elements", or other designation for unlisted elements. The following is a typical composition paragraph:

a. Composition:

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E ____, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

The term "acceptable to purchaser" was developed specifically for the composition paragraph to avoid a presumed requirement that the producer must have formal written approval by the user of any alternative analysis test method used, when the prior standard term "approved by purchaser" was used.

The new phrase does not require that the purchaser issue a specific approval of the alternative method or technique that may otherwise be used by the producer, but permits the purchaser to disapprove it if the method has been determined to be unsatisfactory to his requirements.

The need for the new phrase was also because of an inability to keep test method specifications up to date, to cover new test methods which are accepted in industry but not yet standardized, and to obtain agreement on some of the detailed techniques of modern analysis methods.

6.4 Melting Practice:

The melting practice is specified, when necessary, to prevent use of methods not deemed satisfactory for the product quality required. Standard language has been developed for the various alloys and grades needing such control.

6.5 Condition:

This paragraph is used in metal specifications to define the state of the product (or products when more than one is covered), usually by general terms describing typical methods of fabrication, finishing and/or heat treatment, such as "cold-rolled, hot-rolled, cold drawn, as-extruded, bright finished, descaled, annealed, strain-hardened, solution heat treated, etc. It is not necessary to precisely specify the details of these methods but to identify them sufficiently for the user to know what to expect when the product is received.

6.6 Properties:

The properties requirements paragraphs are often lengthy and complex, because the properties often vary with section size of the product. The methods of testing including the orientation and types of test specimens and any special considerations must be stated, as well as the required test results. The details of testing methods also vary considerably with the various alloy systems and product forms.

6.7 Quality:

This is a "general workmanship" or "general quality" statement that, in undefined parameters, expresses that the product must be of an overall quality consistent with good industry practices. The following is typical:

"The product shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product".

It provides a basis for rejection of product that has defects not specifically described in the specification but exceeding the level typically associated with the product. Examples are corrosion, surface damage, deformation, discoloration, staining, dirt, excessive variations within a lot in hardness, ductility, flarability, machinability, weldability, or other fabrication properties, etc.

6.8 Cast And Helix (Weld Wire):

Simple tests are used to determine if the weld wire is properly wound on spools, so it will feed satisfactorily in mechanical-feed welding equipment. The test requirements appear in all weld wire specifications.

6.9 Weldability:

On occasion, wire can meet all of the regular requirements for wire products but may not make a good weld when used as a weld wire. Since the property of wire that makes it weld satisfactorily is not understood sufficiently to allow precise definition of every parameter, a requirement is included in weld wire specifications that says: "Weld wire shall flow smoothly and evenly during welding, and shall produce acceptable welds." There is no standard test for measuring weldability, but ARP1876 is proposed as a referee test in case of dispute regarding weldability.

6.10 Microstructure:

The microstructure of many metal alloy products is controlled by reference to standard metallographic procedures because some fabrication and service performance requirements are dependent on proper microstructure.

6.11 Hardness:

Hardness test requirements appear in many specifications, but an out-of-range hardness value is not always grounds for rejection. For certain materials, the specification requires acceptance of product with out-of-range hardness if tensile testing is performed and demonstrates that the material meets the required tensile strength properties.

6.12 Dimension Tolerances:

Dimensional tolerances for products such as forgings, rings, castings, powder compacts, and stock for secondary metal-working are not mentioned in specifications and are specified on drawings or purchase orders when required. Tolerances for other standard products are included, either in the specification or by reference to other specifications.

7. QUALITY ASSURANCE PROVISIONS (Section 4):

This section (4) describes the type and intent of sampling and testing, sampling procedures, approval requirements, reporting requirements, and resampling and retesting options. Test procedures are not included, having been specified in the technical requirements section.

7.1 Responsibility for Inspection:

This standard paragraph makes it clear that the producer is responsible for the specified testing to certify that the product meets the specification, but the purchaser may also conduct the same tests for verification.

7.2 Classification of Tests:

Paragraphs under this heading identify the required frequency of testing by grouping tests under classes. The classes usually are:

a. Acceptance test: Testing is required of each lot, heat, or batch, as applicable, of product.

b. Periodic tests: Testing is not required for each individual lot, heat, or batch. Unless the purchaser specifies frequency of periodic testing, the producer needs to test only as often deemed necessary to ensure the conformance of untested lots. The objective is to reduce testing costs for characteristics that are capable within control of the process.

c. Preproduction test: Demonstration of producers ability to meet the requirements of the specification prior to or on first article shipment, and after changes are made that may affect the product characteristics.