INCH-POUND

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PERFORMANCE SPECIFICATION

POWDER FEEDSTOCK, AUSTENITIC CHROMIUM-NICKEL STAINLESS STEEL, CORROSION-RESISTANT, FOR USE IN LASER POWDER BED FUSION, ADDITIVE MANUFACTURING

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers corrosion-resistant austenitic chromium-nickel stainless steel pre-alloyed powder. This powder is intended for use as a feedstock in laser powder bed fusion (LPBF) additive manufacturing (AM), but usage is not limited to such application.

1.2 Classification. Material is of the following classes, as specified (see 6.2).

1.2.1 Classes.

a. Class 1 – Material with chemical composition similar to UNS S31603, meeting requirements in table I.

b. Class 2 – Material with chemical composition similar to UNS S31673, meeting requirements in table II.

1.3 Safety – hazardous materials. This specification does not address the hazards or risk involved with handling metallic powder. It is the sole responsibility of the user to ensure proper use and handling.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

(Copies of this document are available online at https://quicksearch.dla.mil.)

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A AREA AMPR

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A751	-	Standard Test Methods and Practices for Chemical Analysis of Steel Products
ASTM B215	-	Standard Practices for Sampling Metal Powders
ASTM E353	-	Standard Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E1019	-	Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques
ASTM E1086	-	Standard Test Method for Analysis of Austenitic Stainless Steel by Spark Atomic Emission Spectrometry
ASTM E1479	-	Standard Practice for Describing and Specifying Inductively Coupled Plasma Atomic Emission Spectrometers

(Copies of these documents are available online at www.astm.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Chemical composition. Chemical composition of class 1 powder shall conform to the percentages by weight specified in table I. Chemical composition of class 2 powder shall conform to percentages by weight specified in table II.

TABLE I. Chemical composition for class 1 powder (weight-percent).

	Minimum (%)	Maximum (%)
Carbon	---	0.030
Manganese	---	2.00
Phosphorus	---	0.020 1/
Sulfur	---	0.020 1/
Silicon	---	1.00
Chromium	16.00	18.00
Nickel	10.00	14.00
Molybdenum	2.00	3.00
Oxygen	---	0.10
Nitrogen	---	0.10
Cobalt	---	2/
Other Elements, each 3/	---	0.10
Other Elements, total 3/	---	0.50
Iron	---	Remainder

NOTES:

1/ Combined phosphorus and sulfur content shall not exceed 0.020 weight-percent.

2/ When specified (see 6.2), cobalt content shall be limited to the maximum quantity specified in the contract or order.

3/ Other Elements: Determination not required for routine acceptance except for Al, B, Cu, Mg, Ti, and Zr, which shall be measured and reported for information individually. They shall also be reported collectively, with any other measured elements, as "Other Elements, Total." Boron content shall be determined using analytical methods with sufficient sensitivity to report results to the nearest 10 parts per million (ppm).

TABLE II. Chemical composition for class 2 powder (weight-percent).

	Minimum (%)	Maximum (%)
Carbon	---	0.030
Manganese	---	2.00
Phosphorus	---	0.020 1/
Sulfur	---	0.020 1/
Silicon	---	1.00
Chromium	17.00	19.00
Nickel	13.00	15.00
Molybdenum	2.00	3.00
Oxygen	---	0.10
Nitrogen	---	0.10
Cobalt	---	2/
Other Elements, each 3/	---	0.10
Other Elements, total 3/	---	0.50
Iron	---	Remainder

NOTES:

1/ Combined phosphorus and sulfur content shall not exceed 0.020 weight-percent.

2/ When specified (see 6.2), cobalt content shall be limited to the maximum quantity specified in the contract or order.

3/ Other Elements: Determination not required for routine acceptance except for Al, B, Cu, Mg, Ti, and Zr, which shall be measured and reported for information individually. They shall also be reported collectively, with any other measured elements, as "Other Elements, Total." Boron content shall be determined using analytical methods with sufficient sensitivity to report results to the nearest 10 ppm.

3.2 Powder production. Unless otherwise specified (see 6.2), powder shall be produced by gas atomization, plasma atomization, solid-state processing, or other methods that ensure homogeneous alloy composition throughout each particle. Surface-coated powders, elemental powder blends, or any combination thereof are prohibited. For powder produced by melting, all melting shall be performed under vacuum or a fixed inert gas composition, and all atomization shall be performed using a fixed gas composition consisting primarily of argon, helium, or nitrogen. Air melting is not permitted. For powder produced by melting, purchased scrap shall not be used in the furnace charge unless it is traceable to individual heats with certified chemical analysis.

3.3 Powder lot identification. The final powder lot shall have a unique identification (see 6.5.1 for definitions regarding powder lots).

3.4 Powder reuse. Powder reuse is permitted. Reused powder shall be in accordance with all requirements of this specification. Unless otherwise specified (see 6.2), the frequency for sampling and recertification of reused powder shall be every 15 builds, at a minimum. The powder sample shall be tested in the condition in which it is intended to be reintroduced into the build cycle (e.g., post-sieve).

3.5 Powder blending. Blending multiple powder lots to create a new powder lot is permitted provided every powder lot to be blended conforms to this specification at the time of blending, and the combined blended lot also

conforms. Additionally, combined lots shall be of the same chemical composition class (see 3.1), shall be manufactured by the same vendor, and shall have a unique powder lot identification (see 3.3).

3.6 Detrimental material controls.

3.6.1 Mercury. Suppliers shall certify that powder supplied to this specification has not come in direct contact with mercury, mercury-containing compounds, or mercury-containing devices employing a single boundary of containment. The presence of mercury in a product or contact material may be determined by reviewing product labeling, material safety data sheets, or safety data sheets for declarations that mercury is a constituent of the product. The absence of a declaration of mercury on product labeling, material safety data sheets, or safety data sheets is considered as evidence of no mercury or mercury-containing compounds in the product or contact material. Chemical analysis is not required. If a product is reported to contain mercury, up to 10 ppm is acceptable.

3.6.2 Powder handling controls. All powder shall be controlled to prevent contamination that is deleterious to powder or parts fabricated using the powder. This includes atomization, screening, blending, and storage in addition to other processes completed by suppliers performing work to this specification.

3.6.3 Powder purity. In addition to conforming to the chemical compositions in either table I or table II, the metal powder shall be free from detrimental amounts of inclusions and impurities. No substance shall be added to the powder at any time to aid powder flowability, spreadability, or any other powder characteristics.

3.6.4 Additional detrimental material controls. When needed, additional detrimental material controls shall be as specified (see 6.2).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Conformance inspection (see 4.2).

4.2 Conformance inspection. Conformance inspection shall include the examinations and the tests of table III.

TABLE III. Conformance inspections.

Examinations and tests	Requirement	Conformance inspection	Sampling requirements
Chemical composition	3.1	4.4	4.3
Powder production	3.2	4.5	---
Powder lot identification	3.3	4.5	---
Powder reuse	3.4	4.5	---
Powder blending	3.5	4.5	---
Mercury	3.6.1	4.5	---
Powder handling controls	3.6.2	4.5	---
Powder purity	3.6.3	4.5	---
Additional detrimental material controls	3.6.4	4.5	---

4.3 Sampling for chemical composition. Unless otherwise specified (see 6.2), powder samples shall be taken in accordance with ASTM B215. A minimum of one sample shall be taken from each powder lot for analysis.

4.4 Chemical analysis. Chemical analysis shall be performed in accordance with ASTM A751, ASTM E353, ASTM E1086, ASTM E1479, or ASTM E1019, or other validated analytical methods, as specified (see 6.2). Phosphorus content shall be determined using Inductively Coupled Plasma Atomic Emission Spectrometers (ICP-AES) in accordance with ASTM E1479 or a validated equivalent method with verified interference correction, as specified (see 6.2). Carbon, sulfur, oxygen, and nitrogen content shall be determined in accordance with ASTM E1019.

4.5 Certificate of conformance. Unless otherwise specified (see 6.2), a certificate of conformance (COC) shall be provided for each lot of material offered for acceptance. The COC shall include the following:

a. The unique powder lot identification.

b. Statement that the powder lot has been manufactured, sampled, tested, and inspected in accordance with the requirements specified herein.

c. If powder has been reused, statement that powder has been reused, and sampling frequency for retesting (see 3.4).

d. If powder has been blended, statement that powder has been blended, and the COCs from the parent powder lots (see 3.5).

e. Certification that mercury is either absent or present in quantities no greater than 10 ppm (see 3.6.1).

f. Statement that no substances have been added to the powder (see 3.6.3).

g. When additional detrimental material controls are required (see 6.2), statement certifying that requirements have been met (see 3.6.4).

g. A complete record of chemical analysis and any other powder characterization performed under the order or contract (see 6.4).

h. A safety data sheet (SDS) in accordance with FED-STD-313 for the powder.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Packaging environment. The packaging and packaging environment shall be suitable to prevent contamination or degradation (foreign object debris, other powders, undesired lots, moisture, or oxygen ingress).

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Powder produced in accordance with this specification is intended to be used as feedstock to produce material for use in applications specified in MIL-PRF-32802.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Powder class (see 3.1).

c. When a cobalt maximum is required and what the maximum value is (see table I and table II).

d. Acceptable powder production methods, if applicable (see 3.2).

e. Powder reuse sampling frequency, if applicable (see 3.4).

f. When needed, additional detrimental material control requirements (see 3.6.4).

g. Additional sampling requirements, if applicable (see 4.3).

h. Acceptable chemical analysis methods (see 4.4).

i. Acceptable validated chemical analysis method with verified interference correction for measuring phosphorus content (see 4.4).

j. When a certificate of conformance is not required (see 4.5).

k. Packaging requirements (see 5.1 and 5.2).

l. Additional powder characterization requirements, if applicable (see 6.4).

6.3 Other ordering considerations. SAE AMS7037, “Steel, Corrosion and Heat-Resistant, Powder for Additive Manufacturing, 17Cr – 13Ni – 2.5Mo (316L)” gives recommendations concerning information for other powder characteristic considerations.

6.4 Additional characterization. The characteristics of powder used in the L-PBF process are known to affect performance outcomes. Metrics such as flowability, particle size distribution, tap density, apparent density, and morphology may be measured and regularly monitored during continued use. ASTM F3049 specifies further testing recommendations. Any additional powder characterization requirements should be as specified (see 6.2).

6.5 Definitions.

6.5.1 Powder lots. Definition of powder lots are in accordance with SAE AMS7002, “Process Requirements for Production of Metal Powder Feedstock for Use in Additive Manufacturing of Aerospace Parts.”

6.6 Subject term (key word) listing.

316L
3-D Printing
Metal Powder Printing
Metal Printing
Powdered Metal

CONCLUDING MATERIAL

Custodians:
Army – MR
Navy – SH

Preparing activity:
Navy – SH
(Project AMPR-2025-003)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.