



## POWDER METAL, STAINLESS STEEL

WSS-M10A101-A1  
WSS-M10A101-A2  
WSS-M10A101-A3  
WSS-M10A101-A4

**1. SCOPE**

The materials defined by these specifications are low carbon, ferritic stainless steel powder metal alloys.

**2. APPLICATION**

These specifications were released originally for materials used in the manufacture of exhaust system and exhaust manifold flanges.

**3. REQUIREMENTS**

Material specification requirements are to be used for initial qualification of materials.

**3.0 STANDARD REQUIREMENTS FOR PRODUCTION MATERIALS**

Material suppliers and part producers must conform to the Company's Standard Requirements For Production Materials (WSS-M99P1111-A).

**3.2 CHEMICAL COMPOSITION (Weight percent after sintering)**  
(ASTM E 415/ASTM E 350/ASTM E 1019)

|            | A1          | A2          | A3          | A4          |
|------------|-------------|-------------|-------------|-------------|
| Chromium   | 16.0 - 18.0 | 16.0 - 18.0 | 10.5 - 13.5 | 10.5 - 13.5 |
| Nickel     | 0.50 max    | 0.50 max    | 0.50 max    | 1.1 - 1.4   |
| Carbon     | 0.03 max    | 0.03 max    | 0.03 max    | 0.03 max    |
| Manganese  | 0.95 max    | 0.95 max    | 1.00 max    | 1.00 max    |
| Molybdenum | 0.75 - 1.25 | 0.75 - 1.25 | 0.30 max    | 0.30 max    |
| Phosphorus | 0.04 max    | 0.04 max    | 0.04 max    | 0.04 max    |
| Silicon    | 1.00 max    | 1.00 max    | 1.00 max    | 1.00 max    |
| Sulfur     | 0.03 max    | 0.03 max    | 0.03 max    | 0.03 max    |
| Niobium    | -           | 0.30 - .80  | 0.30 - 0.80 | 0.30 - 0.80 |
| Nitrogen   | 0.03 max    | 0.03 max    | 0.03 max    | 0.03 max    |
| Oxygen     | 0.50 max    | 0.50 max    | 0.50 max    | 0.50 max    |
| Iron       | Balance     | Balance     | Balance     | Balance     |

The composition shall be selected from within the above range in order to meet microstructural and strength requirements. The specific composition limits and sintering practice to meet performance and manufacturing requirements will form part of the control plan for each individual component geometry and supplier.

**3.3 OVERALL QUALITY**

The finished component must have minimal inclusion content and shall be free of laminations or cracks.

| Date       | Action    | Revisions                                                      |
|------------|-----------|----------------------------------------------------------------|
| 2010 11 19 | Revised   | Editorial changes only. See Summary of Revisions C. Mracna, NA |
| 2010 07 20 | Revised   | See Summary of Revisions G. Mracna, NA                         |
| 1998 02 05 | Activated | P. Lee                                                         |

**3.4 INTERCONNECTED POROSITY, %, max**  
(ASTM B 328/ MPIF STD 57)

0.5

Samples for determination of interconnected porosity shall be taken from locations as described in the Engineering Specification or on the Engineering Drawing. Critical areas shall be defined in the Engineering Specification or on the Engineering Drawing. The volume percent interconnected porosity shall be determined by using either ASTM B 328, or MPIF STD 57 standard test method..

**3.5 MICROSTRUCTURE**  
(ASTM E 3)

A1, A2, and A3: The microstructure shall consist of a ferritic matrix. There should be little or no evidence of original particle boundaries, chromium carbides, nitrides, or oxides. In the case of A2 and A3, only niobium carbides shall be present in the microstructure.

A4: The microstructure shall consist of martensite and ferrite. There should be little or no evidence of original particle boundaries, chromium carbides, nitrides, or oxides. Only niobium carbides shall be present in the microstructure.

**3.6 MECHANICAL PROPERTIES**

In order to confirm analytical analysis calculations for new designs, the property specifications below shall be verified. Locations, frequency, and procedures of testing are outlined in the Engineering Specification or SDS and will form part of the agreed control plan.

All test samples shall be machined from the component if possible. A pressed and sintered test bar may be used if the microstructure and density are representative of the component.

**3.6.1 Tensile Properties**  
(ISO 6892/ASTM E 8M)

|                             | A1  | A2  | A3  | A4  |
|-----------------------------|-----|-----|-----|-----|
| Tested at 25 °C             |     |     |     |     |
| Tensile Strength, MPa, min  | 340 | 340 | 340 | 520 |
| 0.2% Offset Yield, MPa, min | 210 | 210 | 190 | 400 |
| Elongation, %, min          | 10  | 10  | 10  | 3   |
| Tested at 650 °C            |     |     |     |     |
| Tensile Strength, MPa, min  | 160 | 160 | 200 | 230 |
| 0.2% Offset Yield, MPa, min | 125 | 125 | 90  | 220 |
| Elongation, %               | 8   | 9   | 10  | 5   |
| Tested at 872 °C            |     |     |     |     |
| Tensile Strength, MPa, min  | 30  | 41  | 22  | 45  |
| 0.2% Offset Yield, MPa, min | 23  | 41  | 14  | 28  |
| Elongation, %               | 38  | 38  | 42  | 40  |

**3.6.2 Impact Strength, J, min**  
Unnotched Bar  
(ASTM E 23, Figure 9)

|     |     |     |    |
|-----|-----|-----|----|
| 115 | 115 | 115 | 70 |
|-----|-----|-----|----|