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Designation: A 312/A 312M – 05

Used in USDOE-NE standards

# Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes[1]

This standard is issued under the fixed designation A 312/A 312M; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope*

1.1 This specification[2] covers seamless, straight-seam welded, and heavily cold worked welded austenitic stainless steel pipe intended for high-temperature and general corrosive service.

NOTE 1—When the impact test criterion for a low-temperature service would be 15 ft·lbf [20 J] energy absorption or 15 mils [0.38 mm] lateral expansion, some of the austenitic stainless steel grades covered by this specification are accepted by certain pressure vessel or piping codes without the necessity of making the actual test. For example, Grades TP304, TP304L, and TP347 are accepted by the ASME Pressure Vessel Code, Section VIII Division 1, and by the Chemical Plant and Refinery Piping Code, ANSI B31.3, for service at temperatures as low as −425 °F [−250 °C] without qualification by impact tests. Other AISI stainless steel grades are usually accepted for service temperatures as low as −325 °F [−200 °C] without impact testing. Impact testing may, under certain circumstances, be required. For example, materials with chromium or nickel content outside the AISI ranges, and for material with carbon content exceeding 0.10 %, are required to be impact tested under the rules of ASME Section VIII Division 1 when service temperatures are lower than −50 °F [−45 °C].

1.2 Grades TP304H, TP309H, TP309HCb, TP310H, TP310HCb, TP316H, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP309Cb, TP309S, TP310Cb, TP310S, TP316, TP321, TP347, and TP348, and are intended for service at temperatures where creep and stress rupture properties are important.

1.3 Optional supplementary requirements are provided for pipe where a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, it is permitted to specify in the order one or more of these supplementary requirements.

1.4 Table X1.1 lists the standardized dimensions of welded and seamless stainless steel pipe as shown in ANSI B36.19. These dimensions are also applicable to heavily cold worked pipe. Pipe having other dimensions is permitted to be ordered and furnished provided such pipe complies with all other requirements of this specification.

1.5 Grades TP321 and TP321H have lower strength requirements for pipe manufactured by the seamless process in nominal wall thicknesses greater than ⅜ in. [9.5 mm].

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the "M" designation of this specification is specified in the order.

NOTE 2—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as "nominal diameter," "size," and "nominal size."

## 2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe

A 1016/A 1016M Specification for General Requirements for Ferritiic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E 112 Test Methods for Determining the Average Grain Size

E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-312 in Section II of that Code.

[3] 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.

***A Summary of Changes section appears at the end of this standard.**

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E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *ANSI Standards:*[4]

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 *ASME Standard:*

ASME Boiler and Pressure Vessel Code: Section VIII[5]

2.4 *AWS Standard:*

A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes[6]

2.5 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[7]

2.6 *Other Standard:*

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing[8]

## 3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Specification A 999/A 999M and Terminology A 941 are applicable to this specification.

## 4. Ordering Information

4.1 Orders for material to this specification shall conform to the requirements of the current edition of Specification A 999/A 999M.

## 5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 999/A 999M unless otherwise provided herein.

5.2 *Heat Treatment*:

5.2.1 All pipe shall be furnished in the heat—treated condition in accordance with the requirements of Table 2. The heat—treatment procedure, except for "H" grades, S30815, S31272, S31254, S32654, N08367, N08904, and N08926 shall consist of heating the pipe to a minimum temperature of 1900 °F [1040 °C] and quenching in water or rapidly cooling by other means.

## 6. Materials and Manufacture

6.1 *Manufacture*:

6.1.1 The pipe shall be manufactured by one of the following processes:

6.1.2 *Seamless (SML) pipe* shall be made by a process that does not involve welding at any stage of production.

6.1.3 *Welded (WLD) pipe* shall be made using an automatic welding process with no addition of filler metal during the welding process.

6.1.4 *Heavily cold-worked (HCW) pipe* shall be made by applying cold working of not less than 35 % reduction in thickness of both wall and weld to a welded pipe prior to the final anneal. No filler shall be used in making the weld. Prior to cold working, the weld shall be 100 % radiographically inspected in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest revision, Paragraph UW-51.

6.1.5 Welded pipe and HCW pipe of NPS 14 and smaller shall have a single longitudinal weld. Welded pipe and HCW pipe of a size larger than NPS 14 shall have a single longitudinal weld or shall be produced by forming and welding two longitudinal sections of flat stock when approved by the purchaser. All weld tests, examinations, inspections, or treatments shall be performed on each weld seam.

6.1.6 At the option of the manufacturer, pipe shall be either hot finished or cold finished.

6.1.7 The pipe shall be free of scale and contaminating exogenous iron particles. Pickling, blasting, or surface finishing is not mandatory when pipe is bright annealed. The purchaser is permitted to require that a passivating treatment be applied to the finished pipe.

[4] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

[5] Available from American Society for Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.

[6] Available from the American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33135.

[7] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

[8] Society for Nondestructive Testing, 1711 Arlingate Plaza, PO Box 28518, Columbus, OH, 43228-0518.



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**TABLE 1 Chemical Requirements**

| Grade | UNS Designation[A] | Composition, %[B] | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon | Manganese | Phosphorus | Sulfur | Silicon | Chromium | Nickel | Molybdenum | Titanium | Columbium | Tantalum, max | Nitrogen[C] | Vanadium | Copper | Cerium | Boron | Aluminum |
| . . . | S20400 | 0.030 | 7.0-9.0 | 0.045 | 0.030 | 1.00 | 15.0-17.0 | 1.50-3.00 | . . . | . . . | . . . | . . . | 0.15-0.30 | . . . | . . . | . . . | . . . | . . . |
| TPXM-19 | S20910 | 0.06 | 4.0-6.0 | 0.045 | 0.030 | 1.00 | 20.5–23.5 | 11.5–13.5 | 1.50–3.00 | . . . | 0.10–0.30 | . . . | 0.20–0.40 | 0.10–0.30 | . . . | . . . | | |
| TPXM-10 | S21900 | 0.08 | 8.0–10.0 | 0.045 | 0.030 | 1.00 | 19.0–21.5 | 5.5–7.5 | . . . | . . . | . . . | . . . | 0.15–0.40 | . . . | . . . | . . . | | |
| TPXM-11 | S21904 | 0.04 | 8.0–10.0 | 0.045 | 0.030 | 1.00 | 19.0–21.5 | 5.5–7.5 | . . . | . . . | . . . | . . . | 0.15–0.40 | . . . | . . . | . . . | | |
| TPXM-29 | S24000 | 0.08 | 11.5–14.5 | 0.060 | 0.030 | 1.00 | 17.0–19.0 | 2.3–3.7 | . . . | . . . | . . . | . . . | 0.20–0.40 | . . . | . . . | . . . | | |
| TP304 | S30400 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| TP304L | S30403 | 0.035[D] | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–13.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| TP304H | S30409 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| . . . | S30415 | 0.04-0.06 | 0.80 | 0.045 | 0.030 | 1.00–2.00 | 18.0–19.0 | 9.0–10.0 | . . . | . . . | . . . | . . . | 0.12–0.18 | . . . | . . . | 0.03–0.08 | | |
| TP304N | S30451 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–18.0 | . . . | . . . | . . . | . . . | 0.10–0.16 | . . . | . . . | . . . | | |
| TP304LN | S30453 | 0.035 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–12.0 | . . . | . . . | . . . | . . . | 0.10–0.16 | . . . | . . . | . . . | | |
| . . . | S30600 | 0.018 | 2.00 | 0.02 | 0.02 | 3.7–4.3 | 17.0–18.5 | 14.0–15.5 | 0.20 | . . . | . . . | . . . | . . . | . . . | 0.50 max | . . . | | |
| . . . | S30615 | 0.16–0.24 | 2.00 | 0.030 | 0.03 | 3.2-4.0 | 17.0–19.5 | 13.5–16.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.80–1.50 |
| . . . | S30815 | 0.05–0.10 | 0.80 | 0.040 | 0.030 | 1.40–2.00 | 20.0–22.0 | 10.0–12.0 | . . . | . . . | . . . | . . . | 0.14–0.20 | . . . | . . . | 0.03–0.08 | | |
| TP309S | S30908 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | 0.75 | . . . | . . . | . . . | . . . | . . . | | . . . | | |
| TP309H | S30909 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | | |
| TP309Cb | S30940 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–16.0 | 0.75 | . . . | 10 × C min, 1.10 max | . . . | . . . | . . . | | . . . | | |
| TP309HCb | S30941 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–16.0 | 0.75 | . . . | 10 × C min, 1.10 max | . . . | . . . | . . . | | | | |
| | S31002 | 0.015 | 2.00 | 0.020 | 0.015 | 0.15 | 24.0–26.0 | 19.0–22.0 | 0.10 | . . . | . . . | . . . | 0.10 | . . . | | | | |
| TP310S | S31008 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | 0.75 | . . . | . . . | . . . | . . . | . . . | | . . . | | |
| TP310H | S31009 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | | |
| TP310Cb | S31040 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | 0.75 | . . . | 10 × C min, 1.10 max | . . . | . . . | . . . | | . . . | | |
| TP310HCb | S31041 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | 0.75 | . . . | 10 × C min, 1.10 max | . . . | . . . | . . . | | | | |
| . . . | S31050 | 0.025 | 2.00 | 0.020 | 0.015 | 0.4 | 24.0–26.0 | 20.5–23.5 | 1.6–2.6 | . . . | . . . | . . . | 0.09–0.15 | . . . | . . . | . . . | | |
| . . . | S31254 | 0.020 | 1.00 | 0.030 | 0.010 | 0.80 | 19.5–20.5 | 17.5–18.5 | 6.0–6.5 | . . . | . . . | . . . | 0.18–0.22 | . . . | 0.50–1.00 | . . . | | |
| | S31272 | 0.08–012 | 1.5–2.00 | 0.030 | 0.015 | 0.25–0.75 | 14.0–16.0 | 14.0–16.0 | 1.00–1.40 | 0.30–0.60 | | | | | | | 0.004–0.008 | |
| | S31277 | 0.020 | 3.00 | 0.030 | 0.010 | 0.50 | 20.5–23.0 | 26.0–28.0 | 6.5–8.0 | | | | 0.30–0.40 | | 0.50–1.50 | | | |
| TP316 | S31600 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 11.0–14.0[E] | 2.00–3.00 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| TP316L | S31603 | 0.035[D] | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 2.00–3.00 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| TP316H | S31609 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 11.0–14.0[E] | 2.00–3.00 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| . . . | S31635 | 0.08 | 2.00 | 0.045 | 0.030 | 0.75 | 16.0-18.0 | 10.0-12.0 | 2.00-3.00 | 5× (C+N) min, 0.70 | . . . | . . . | 0.10 | . . . | . . . | . . . | . . . | . . . |
| TP316N | S31651 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 11.0–14.0[E] | 2.00–3.00 | | | | 0.10–0.16 | . . . | . . . | . . . | | |
| TP316LN | S31653 | 0.035 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 11.0–14.0[E] | 2.00–3.00 | . . . | . . . | . . . | 0.10–0.16 | . . . | . . . | . . . | | |
| TP317 | S31700 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 11.0–14.0 | 3.0–4.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| TP317L | S31703 | 0.035 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 11.0–15.0 | 3.0–4.0 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| . . | S31725 | 0.03 | 2.00 | 0.040[F] | 0.030 | 1.00 | 18.0–20.0 | 13.5–17.5 | 4.0–5.0 | . . . | . . . | . . . | 0.10 | . . . | 0.75 | . . . | | |
| . . | S31726 | 0.03 | 2.00 | 0.040[F] | 0.030 | 1.00 | 17.0–20.0 | 14.5–17.5 | 4.0–5.0 | . . . | . . . | . . . | 0.10–0.20 | . . . | 0.75 | . . . | | |
| TP321 | S32100 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | . . . | [G] | . . . | . . . | 0.10 | . . . | . . . | . . . | | |



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**TABLE 1** *Continued*

| Grade | UNS Designation[A] | Composition, %[B] | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon | Manganese | Phosphorus | Sulfur | Silicon | Chromium | Nickel | Molybdenum | Titanium | Columbium | Tantalum, max | Nitrogen[C] | Vanadium | Copper | Cerium | Boron | Aluminum |
| TP321H | S32109 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | . . . | [H] | . . . | . . . | . . . | . . . | . . . | . . . | | |
| . . . | S32615 | 0.07 | 2.00 | 0.045 | 0.030 | 4.8–6.0 | 16.5–19.5 | 19.0–22.0 | 0.30–1.50 | . . . | . . . | . . . | . . . | . . . | 1.50–2.50 | . . . | | |
| . . . | S32654 | 0.020 | 2.0–4.0 | 0.030 | 0.005 | 0.50 | 24.0–25.0 | 21.0–23.0 | 7.0–8.0 | . . . | . . . | . . . | 0.45–0.55 | . . . | 0.30–0.60 | . . . | | |
| . . . | S33228 | 0.04–0.08 | 1.00 | 0.020 | 0.015 | 0.30 | 26.0–28.0 | 31.0–33.0 | . . . | . . . | 0.60–1.00 | . . . | . . . | . . . | . . . | 0.05–0.10 | . . . | 0.025 |
| . . . | S34565 | 0.03 | 5.0–7.0 | 0.030 | 0.010 | 1.00 | 23.0–25.0 | 16.0–18.0 | 4.0–5.0 | . . . | 0.10 | | 0.40–0.60 | . . . | . . . | . . . | . . . | |
| TP347 | S34700 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–13.0 | . . . | . . . | [I] | . . . | . . . | . . . | . . . | . . . | | |
| TP347H | S34709 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–13.0 | . . . | . . . | [J] | . . . | . . . | . . . | . . . | . . . | | |
| TP347LN | S34751 | 0.005–0.020 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–13.0 | . . . | . . . | 0.20–0.50[F,K] | . . . | 0.06–0.10 | . . . | . . . | . . . | . . . | . . . |
| TP348 | S34800 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–13.0 | . . . | . . . | [I] | 0.10 | . . . | . . . | . . . | . . . | | |
| TP348H | S34809 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–13.0 | . . . | . . . | [J] | 0.10 | . . . | . . . | . . . | . . . | | |
| . . . | S35045 | 0.06-0.10 | 1.50 | . . . | 0.015 | 1.00 | 25.0-29.0 | 32.0-37.0 | . . . | 0.15-0.60 | . . . | . . . | . . . | . . . | 0.75 | . . . | . . . | 0.15-0.60 |
| . . . | S35315 | 0.04–0.08 | 2.00 | 0.040 | 0.030 | 1.20–2.00 | 24.0–26.0 | 34.0–36.0 | . . . | . . . | . . . | . . . | 0.12–0.18 | . . . | . . . | 0.03–0.08 | . . . | . . . |
| TPXM-15 | S38100 | 0.08 | 2.00 | 0.030 | 0.030 | 1.50–2.50 | 17.0–19.0 | 17.5–18.5 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | |
| . . . | S38815 | 0.030 | 2.00 | 0.040 | 0.020 | 5.5–6.5 | 13.0–15.0 | 15.0–17.0 | 0.75–1.50 | . . . | . . . | . . . | . . . | . . . | 0.75–1.50 | . . . | . . . | 0.30 |
| . . . | N08367 | 0.030 | 2.00 | 0.040 | 0.030 | 1.00 | 20.0–22.0 | 23.5–25.5 | 6.0–7.0 | . . . | . . . | . . . | 0.18–0.25 | . . . | 0.75 | . . . | . . . | . . . |
| . . . | N08904 | 0.020 | 2.00 | 0.040 | 0.030 | 1.00 | 19.0–23.0 | 23.0–28.0 | 4.0–5.0 | . . . | . . . | . . . | 0.10 | . . . | 1.00–2.00 | . . . | . . . | . . . |
| . . . | N08926 | 0.020 | 2.00 | 0.030 | 0.010 | 0.50 | 24.0–26.0 | 19.0–21.0 | 6.0–7.0 | . . . | . . . | . . . | 0.15–0.25 | . . . | 0.50–1.50 | . . . | . . . | . . . |

[A] New designation established in accordance with Practice E 527 and SAE J1086.
[B] Maximum, unless otherwise indicated.
[C] The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.
[D] For small diameter or thin walls or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).
[E] For welded TP316, TP316N, TP316LN, and TP316H pipe, the nickel range shall be 10.0–14.0 %.
[F] For welded pipe, the phosphorus maximum shall be 0.045 %.
[G] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[H] The titanium content shall be not less than four times the carbon content and not more than 0.60 %.
[I] The columbium content shall be not less than ten times the carbon content and not more than 1.00 %.
[J] The columbium content shall be not less than eight times the carbon content and not more than 1.0 %.
[K] Grade S34751 shall have a columbium (niobium) plus tantalum content of not less than 15 times the carbon content.



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