



Standard Practice for Aluminum Alloy Extrusions Press Cooled from an Elevated Temperature Shaping Process for Production of T1, T2, T5 and T10–Type Tempers¹

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1. Scope

1.1 This practice establishes the controls necessary for production of extrusions cooled from an elevated temperature shaping (extrusion) process for the production of T1, T2, T5 and T10–type tempers (see ANSI H35.1).

1.2 This practice is for production of extruded product supplied in the alloys shown in [Table 1](#) in the T1, T2, T5 or T10–type tempers. It contains pertinent information to be used in establishing production practices and is descriptive rather than prescriptive.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase form a part of this standard to the extent referenced herein:

2.2 *ASTM Standards:*²

[B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products](#)

[B647 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage](#)

[E648 Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source](#)

[B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products](#)

[B918 Practice for Heat Treatment of Wrought Aluminum Alloys](#)

¹ This practice is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.03 on Aluminum Alloy Wrought Products.

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² 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.

[E10 Test Method for Brinell Hardness of Metallic Materials](#)
[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E2281 Practice for Process and Measurement Capability Indices](#)

2.3 *ANSI Standard:*

[H35.1 Alloy and Temper Designation Systems for Aluminum](#)³

3. Terminology

3.1 *Definitions*—Refer to Terminology [B881](#) for Definitions of Product terms used in this specification.

4. Equipment

NOTE 1—Equipment includes billet preheating, extruding and quenching.

4.1 Prior to being extruded, aluminum alloys are heated to a temperature not to exceed the temperatures shown in [Table 1](#). Usual heating methods include, but are not limited to, induction, flame impingement, or forced air. Controls shall be adequate to ensure that the equipment can be operated in a manner which precludes metal overheating or deleterious contamination of the metal by the furnace environment.

4.1.1 Temperature control and recording devices used to measure temperature shall be calibrated as specified in [5.2](#).

4.2 *Quenching*—Quenching methods may consist of, but are not limited to, air, water or water/glycol mixture in forced air, water spray, fog or mist, standing wave, a quench tank or another pressurized water device, or a combination thereof. The quench equipment shall be used in a manner such that the quench parameters can be controlled and recorded.

5. Quality Assurance, Calibration and Testing

5.1 *Process Documentation:*

5.1.1 Extrusion thermal practices shall be established, documented, controlled and monitored so that shipped product meets order requirements.

³ Available from the Aluminum Association, Inc., 1525 Wilson Blvd., Arlington, VA 22209, www.aluminum.org

TABLE 1 Extrusion Billet or Log Temperature High Limit^A

Alloy	Billet or Log Temperature Upper °F
6005, 6005A, 6105, 6061, 6162, 6351	1050
6060, 6063, 6101, 6463, 6560	1060
7005, 7116, 7129	1000

^A These upper limit temperatures avoid the possibility of eutectic melting due to overheating, and include a safety factor of approximately 25°F.

5.1.1.1 *Capability*—The producer’s process shall have been proven capable per Practice **E2281**, with documented evidence of statistically verified capability, to produce product in various product classes which conforms to required mechanical property minimums. Methods to establish capability are defined in Practice **E2281**. Appropriate models shall be used for representation of the data as well as the generation of control charts. For further information see ASTM MNL7A⁴.

5.1.2 Recommended time measurements:

5.1.2.1 Time interval between removal of the billet from the billet heating equipment and start of extrusion,

5.1.2.2 Time interval between the metal exiting from press and its entering the quench, and

5.1.2.3 Time interval between metal entry into and exit from the quench below the identified critical maximum temperature.

5.2 *Calibration*—Temperature control and recording devices used to measure temperature shall be calibrated in accordance with documented calibration practices.

5.2.1 *Temperature Measuring System Accuracy*—The accuracy of any temperature sensing system shall be within $\pm 1\%$.

5.3 *Records*—Records shall be maintained for each extrusion press/quench facility involved in the production of extrusions cooled from an elevated temperature shaping process to show compliance with this practice. The records shall include identification of the specific press involved (which includes metal heating and quenching equipment), the frequency and results of calibration of measurement equipment used for control, and the dates and description of equipment repairs or alteration and instances of disqualification and corrective action.

5.4 *Process Surveillance Tests:*

5.4.1 *Test Requirements:*

5.4.1.1 Surveillance tests of heating, extrusion, and quench facilities operated in accordance with documented procedures shall have a demonstrated capability for producing material meeting applicable material specification requirements for each type of product (shapes, tube, rod, hollow section, etc.), and alloy and temper produced. Surveillance tests should include tensile properties for all material and metallographic examination to confirm that the elevated temperature shaping process has not resulted in eutectic melting or subsurface porosity from hydrogen diffusion. (Eutectic Melting and Subsurface Porosity tests are applicable to 7xxx alloys only.)

⁴ *Manual on Presentation of Data and Control Chart Analysis*, Seventh Edition, ASTM MNL7A, ASTM International, 2002.

5.4.1.2 *Frequency of Tests*—Material property tests shall be carried out at the frequency required by the applicable material specification. When no material specification is applicable, the number of samples tested shall be not less than one per 1000 lb of product weighing less than 1 lb per ft or not less than one per 1000 ft of product for material weighing 1 lb or more per ft. Product is meant to include the alloy in the form being extruded, such as tube, pipe, or shape. For 7xxx alloys only, examination to confirm the absence of elevated temperature shaping induced eutectic melting or subsurface porosity from hydrogen diffusion shall be performed at a minimum rate of one sample per alloy every three months for each press/quench facility producing that alloy.

5.4.1.3 *Use of Production Test Results*—The results of tests to determine process conformance of material cooled from an elevated temperature shaping process can use the results of tests for requirements of the respective material specification as evidence of process surveillance of the equipment and procedure employed.

5.4.2 *Test Methods:*

5.4.2.1 Mechanical properties shall be determined in accordance with Test Method **B557**.

5.4.2.2 *Eutectic Melting*—Specimens from at least one of the processed samples in 5.4.1.1 shall be sectioned in the plane perpendicular to the direction of the extrusion, polished to an appropriate fineness, mildly etched with an etchant such as Keller’s reagent to reveal any evidence of eutectic melting, and examined at a magnification of 500 \times .

5.4.2.3 *Hardness Testing*—May be used in conjunction with tensile testing for surveillance and process control. The recommended testing procedure should be Brinell Test Method **E10**, Rockwell Test Method **E18**, Barcol Test Method **E648**, Test Method **B647**, or any other ASTM approved hardness testing procedure. Each producer using hardness testing shall establish their relationship for hardness values to tensile properties and set limits such that minimum hardness values will correlate to the specified minimum tensile properties required.

5.5 *Interpretation of Results:*

5.5.1 *Mechanical Properties*—Tensile properties determined in accordance with 5.4.2.1 shall conform to the requirements of the applicable material specification(s).

5.5.2 *Eutectic Melting and Subsurface Porosity* (applicable to 7xxx alloys only)—There shall be no evidence of subsurface porosity from hydrogen diffusion or eutectic melting.

5.5.3 *Process Disqualification*—Inability to conform to 5.5.1 or 5.5.2 shall result in process disqualification. The process shall remain disqualified until corrective action is taken and its effectiveness substantiated through conformance to 5.5.1 and 5.5.2.

5.5.4 Statistical significance of material property data through different statistical techniques may be found useful in the analysis of mechanical property data. Sufficient mechanical property test data should be accumulated to determine statistical characteristics of the process using accepted conventions.

5.5.5 *Equipment Re-qualification*—Whenever any qualified equipment is modified, replaced or reconditioned, it shall be

re-qualified unless it is known the change or reconditioning will not have a detrimental effect upon the properties of products.

6. Extrusion Press Procedure

6.1 Extrusion parameters should be controlled as follows:

6.1.1 During the extrusion process, the following temperature measuring points should be monitored and controlled as per the producer's internal procedures. The measuring points include but are not limited to:

6.1.1.1 Billet or log temperature in the heating equipment.

6.1.1.2 Billet or log temperature after heating and before charging into the extrusion press.

6.1.1.3 Temperature of the extrudate at the press exit.

6.1.1.4 Temperature of the extrudate at quench entry.

6.1.1.5 Temperature of the extrudate at the completion of quench.

6.1.2 Billet temperature shall not exceed the maximum temperature for the alloy as listed in **Table 1**.

NOTE 2—The surface temperature of a billet or log may differ significantly from its interior temperature. Temperature sensing devices may give instantaneous values at a specific point, or give average values over time or over an area. Note that gradients differ between induction and gas-fired billet heaters.

6.2 Heated billets should be loaded into the extrusion press in a reasonably short period of time. If the billet temperature falls below the producer's minimum allowed billet temperature as used to qualify the process, or if the time between heating and extruding exceeds the producer's internal limit, that billet shall be rejected or reprocessed (for example, by reheating).

7. Aging

7.1 Artificial aging shall be accomplished using times and temperatures as necessary to achieve required properties. Practice **B918** aging practices may be used as a guide.

8. Keywords

8.1 aluminum alloys; cooled from an elevated temperature shaping process; press quenched

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