Designation: B 807 – 02

Standard Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys[1]

This standard is issued under the fixed designation B 807; 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.

1. Scope *

1.1 This practice is intended to cover the controls necessary to press solution heat treat some 6xxx and 7xxx series aluminum alloys at extrusion facilities when the alloy design permits them to be so treated; specific alloys are shown in Table 1. For the alloys listed in Table 1, this practice is an alternate process to solution heat treatment in a furnace, such as specified in Practice B 918 for the attainment of T3, T4, T6, T7, T8 and T9-type tempers (See ANSI H35.1).

2. Referenced Documents

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

2.2 *ASTM Standards:*

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products[2]

B 918 Practice for Heat Treatment of Wrought Aluminum Alloys[2]

2.3 *ANSI Standard:*

H35.1 Alloy and Temper Designation Systems for Aluminum[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *extrusion billet*—the starting stock for the extrusion operation. Extrusion billet is a solid or hollow form, commonly cylindrical, that is usually a cast product, but may be a wrought product or manufactured from sintered powder. Extrusion billet is termed as the final length of material charge used in the extrusion process.

3.1.2 *extrusion ingot*—a cast form that is solid or hollow, usually cylindrical, suitable for extruding.

3.1.3 *extrusion log*—the starting stock for extrusion billet. Extrusion log is usually produced in long lengths from which the shorter length extrusion billets are cut.

TABLE 1 Extrusion Billet or Log Temperature[A,B]

Alloy	Billet or Log Temperature	
	Upper °F	Lower °F
6005, 6005A, 6105	1025	800
6061, 6262	1035	850
6060, 6063, 6101, 6463	1025	800
6351	1010	875
7004, 7005	950	710
7029, 7046, 7116, 7129, 7146	1000	850

[A] The range shown may require appreciable narrowing, depending upon reduction ratio, section configuration, and other extrusion parameters.

[B] These temperatures may be altered when statistical analysis of tensile test data substantiates that the material will meet the tensile property requirements of 5.3.1 and other required material characteristics.

3.1.4 *solution heat treatment*—heating an alloy at a suitable temperature for sufficient time to cause one or more soluble constituents to enter into solid solution, and then cooling the material rapidly enough to retain the constituents in solution. (Note 1)

NOTE 1—Metallurgical structure of the alloy is influenced by the heating equipment used. Some heating equipment achieves very rapid temperature rise and may require the metal to be soaked for a period within the temperature range noted in Table 1 to ensure that sufficient applicable alloying elements are taken into solid solution. This soaking stage may be eliminated if the alloying elements are substantially in solid solution prior to charging the metal to the heating equipment.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *potentiometer measuring system*—a means of temperature measurement which compares thermoelectric electromotive force (emf) with a reference emf (also known as a null-balance indicator).

3.2.2 *remote temperature sensing system*—a system of temperature measurement of a non-contact type usually including either a single or multi-wave length radiation sensing device.

3.2.3 *statistical significance of material property data*—though different statistical techniques may be found useful in the analysis of mechanical property data, sufficient mechanical property test data should be accumulated to adequately determine the form of the frequency distribution curve and to provide a reliable estimate of the population mean and standard deviation. In most instances, the distribution is normal in form, and properties are based on the results of a minimum of 100 tests from at least 10 different lots of material. There should be

[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] *Annual Book of ASTM Standards*, Vol 02.02.

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

a 95 % confidence that at least 99 % of the distribution conforms to material specifications.

4. Apparatus

4.1 Prior to being extruded, aluminum alloys are heated to the temperature range 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. (Note 2)

NOTE 2—Induction equipment requires measurement of thermal gradients along the billet. Flame impingement devices require assessment of thermocouple placement relative to burner location because of the possibility of nonuniform surface temperature.

4.1.1 Metal temperature shall be monitored and controlled to the extent that the entire metal charge (Note 2) is within the required range prior to extrusion.

4.1.2 Automatic control and recording devices used to measure temperature at pertinent points in the heating equipment shall be calibrated as specified in 5.1.1.

4.1.2.1 Pertinent measuring points include, but are not limited to: (Note 3)

(1) Metal temperature in the heating equipment, and

(2) Metal temperature after heating, and before charging to the extrusion press.

NOTE 3—The intent is to minimize the time period between discharge of the metal, at the desired temperature, from the heating equipment and the initiation of the extrusion process. Some of these time or temperature measurements may be omitted if it has been demonstrated that they are not essential to achieving an appropriate degree of process control.

4.2 During extrusion, pertinent temperature measuring points include, but are not limited to (Notes 3 and 4):

4.2.1 Metal temperature at quench entry, and

4.2.2 Metal temperature at completion of quench.

NOTE 4—When the design of the quench equipment does not permit measuring the extrudate temperature at the entry to the quench zone, the quench portion of the facility may be approved if all other requirements of this practice are met when the facility is operated according to the documented procedure.

4.3 The following time measurements are pertinent (Note 3):

4.3.1 Time interval between measurement of metal temperature immediately prior to charging to the extrusion press and start of extrusion,

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

4.3.3 Time interval between metal entry to and exit from, the quench.

4.4 *Quenching*—Quenching methods may consist of, but are not limited to, water or water/glycol mixture in a standing wave, a quench tank, a spray, or a pressurized water device, or a fog or an air blast, or a combination thereof. The quench equipment shall be used in a manner such that the quench parameters can be controlled, are recorded, and meet the requirements of Tables 2 and 3.

TABLE 2 Maximum Time Interval Between Extrusion Emergence From the Extrusion Die and Entry to the Quench Zone[A]

Element Thickness Range, in.[B]	Time Interval, s[C]
Up through 0.062	45
Over 0.062 through 0.150	50
Over 0.150 through 0.250	60
Over 0.250	90

[A] The boundaries of the quench zone are the extremities over which the minimum cooling rate in Table 3 applies.

[B] The thinnest element of the extruded profile generally governs the thickness range for the maximum permitted time interval. If the thinnest element is not a main feature of the extrusion, it generally may be disregarded unless it represents the fastest cooling portion of the profile.

[C] Longer time intervals may be used only when complete extrusion press solution heat treatment documentation, including statistically supporting mechanical properties, substantiate that the increased time interval will not have a deleterious effect.

TABLE 3 Minimum Cooling Rate in the Quench Zone[A]

Alloy	Cooling Rate, °F/s[BC]
6005, 6005A, 6105	4
6061, 6262, 6351	15
6060, 6063, 6101, 6463, 7004, 7005	2
7029, 7046, 7116, 7129, 7146	10

[A] The cooling rate is defined as the average temperature drop when subjected to a constant cooling system from initial extrudate temperature, down to 400°F.

[B] Cooling with still air from 400°F to ambient temperature is permissible.

[C] A lower quench rate may be used when supported by a documented process and statistical confirmation that the material specification requirements are met.

5. Calibration and Standardization

5.1 *Calibration of Equipment*:

5.1.1 *Temperature Measuring System Accuracy Test for Remote Sensing Systems*—The accuracy of remote sensing systems shall be within ±6°F of true temperature, and calibrations shall be traceable to a National Institute of Standards and Technology reference standard. This test shall be performed under operating conditions at least once during each week that the facility is used. When the measured temperature of the system differs by more than ±2°F from that of the NIST standard, the system may be used, provided that the adjustments of 6.1 are used.

5.1.2 *Temperature Measuring System Accuracy Test for Contact Systems* (systems other than remote sensing systems)—The accuracy of temperature measuring system(s) shall be tested under operating conditions at least once during each week that the facility is used. The test should be made by inserting a calibrated test temperature sensing element to contact the surface being measured to within 3 in. of the system's sensing element and reading the test temperature sensing element with a calibrated test potentiometer. (**Warning**—Advice should be sought from the equipment manufacturer to determine precautions necessary when inserting sensing elements to avoid incurring any safety hazards.) When the system is equipped with dual potentiometer measuring systems which are checked daily against each other, the above checks shall be conducted at least once every three months. Test temperature sensing element, test instrument, and cold junction compensation combination shall have been calibrated and traceable to National Institute of Standards and