Designation: B830 – 11

Standard Specification for Uniform Test Methods and Frequency[1]

This standard is issued under the fixed designation B830; 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 specification covers a standard basis for uniform testing and frequency to determine physical and electrical compliance for aluminum and copper drawing stock, and aluminum and copper conductors.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.2.1 *Exception*—Resistivity is measured in SI units.

2. Referenced Documents

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

2.2 *ASTM Standards:*[2]

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.3 *National Bureau of Standards:*[3]

Handbook 100, Copper Wire Tables

2.4 *Canadian Standards Association:*[4]

CAN/CSA-ISO 9001-08 Quality Management Systems – Requirements

CAN/CSA Z299.3-85 (R2006) Quality Assurance Program - Category 3

2.5 *ANSI Standards:*[5]

ANSI/ISO/ASQ 3534-1-2006 Statistics-Vocabulary and Symbols Part 1-General Statistical Terms and Terms Used In Probability

ANSI/ISO/ASQ 3534-2-2006 Statistics-Vocabulary and Symbols Part 2-Applied Statistics

ANSI/ISO/ASQ Q9001-2008 Quality Management Systems - Requirements

ANSI/ISO/ASQ Q9004-1-2009 Managing for the Sustained Success of an Organization – A Quality Management Approach

ANSI/ASQC C1-1996 Specification of General Requirements for a Quality Program

ANSI/ASQC S1-1996 An Attribute Skip-Lot Sampling Program

ANSI/ASQ Z1.4-2008 Sampling Procedures and Tables for Inspection by Attributes

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *acceptable quality level (AQL)*—the maximum percent nonconforming (or the maximum number of nonconformities per hundred units) that, for purposes of sampling inspection, can be considered as a process average.

3.1.2 *average outgoing quality (AOQ)*—the average quality of outgoing product, including all accepted lots or batches, plus all lots or batches not accepted after such lots or batches have been effectively 100 % inspected and all nonconforming units replaced by conforming units.

3.1.3 *CPK*—Process Performance Index.

Discussion:

Capability in Relation to Spec Mean:

USL	=	5.0
LSL	=	1.0
MEAN	=	2.0
Standard deviation (σ)	=	0.5

CPK tells the capability of a process based upon the worst case view of the data.

The equation is:

CPK = the lesser of:

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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.

[3] Available from National Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, http://www.ntis.gov.

[4] Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, http://www.csa.ca.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

$$\frac{(USL - MEAN)}{3\sigma} \text{ or } \frac{(MEAN - LSL)}{3\sigma} \quad (1)$$

For example:

$$CPK = \frac{(5.0 - 2.0)}{1.5} \text{ or } \frac{(2.0 - 1.0)}{1.5} \quad (2)$$
$$= 2.0 \text{ or } 0.67$$
$$= 0.67$$

A negative value for CPK indicates that the mean is outside the specification limits. A CPK of zero indicates that the mean is equal to one of the specification limits. A CPK between 0 and 1.0 means that part of the 6 sigma limits falls outside the specification limits. A CPK of 1.0 means that one end of the 6 sigma limits falls on a specification limit. A CPK larger than 1.0 means that the 6 sigma limits fall completely within the specification limits. See Explanatory Note 1 for an example interpretation of CPK values and actions to follow.

Capability indices are useful tools in the analysis of capability data. The most useful index is CPK, since it formulates capability in a manner that relates to shifts in the mean of the distribution away from the midpoint.

3.1.4 *lot*—a group of production units of one type and size of wire, which were produced during the same time period under similar production conditions, and are presented for acceptance at the same time. The mass will be defined in the ASTM document for the specific product to be tested.

3.1.5 *process average*—the average percent nonconforming or average number of nonconformities per hundred units (whichever is applicable) of product submitted by the supplier for original inspection. Original inspection is the first inspection of a particular quantity of product as distinguished from the inspection of product that has been resubmitted after prior rejection. When double or multiple sampling is used, only the first sample results shall be included in the process average calculation.

3.1.6 *production unit*—a coil, reel, spool, or other package of drawing stock/wire that represents a single usable length.

3.1.7 *sample*—the production unit or units from which a test specimen or specimens have been removed and which are considered to have properties representative of the lot.

3.1.8 *specimen*—a length of drawing stock/wire removed for test purposes.

4. Methods for Ensuring Product Compliance

4.1 *Acceptance Sampling:*

4.1.1 When acceptance sampling is used, statistical sampling of each lot shall be presented for inspection in accordance with ANSI/ASQ Z1.4-2008. Sampling of each lot shall be presented for normal inspection in accordance with the sampling system described by ANSI/ASQ Z1.4-2008.

4.1.2 Diameter and tensile shall be tested using General Inspection Level 1 with an AQL (acceptable quality level) of 4.0 %. (See Table 1.)

4.1.3 Resistivity shall be tested using Special Inspection Level S-4 with an AQL of 4.0 %. (See Table 2.)

4.1.4 All other material properties shall be tested per the specific level and AQL in ANSI/ASQ Z1.4-2008 as required in the ASTM specification for the specific product.

4.1.5 Test records shall meet the requirements of ANSI/ASQ Q9001-2008, Section 4.16.

4.2 *Conformance Criteria:*

4.2.1 Failure of a specimen to conform to the applicable requirements of ASTM shall constitute failure of the production unit from which the specimen was taken. Sampling of each lot shall be switched according to the rules described in ANSI/ASQ Z1.4-2008. (See Fig. 1.)

4.2.2 Any lot of drawing stock/wire that has been sampled in accordance with 4.1.2, 4.1.3, or 4.1.4, and from which the number of specimens failing to comply with the requirements does not equal or exceed the appropriate reject number of the sampling Table 1 used, shall be considered as complying with the requirements of ASTM.

4.2.3 Rejected lots may be screened to remove nonconforming production units by testing one specimen from each production unit in the lot for the failing characteristic.

4.2.4 *Sample Size*—The sample size shall be the number of production units selected.

4.3 *Provisions for Skip-lot Inspection:*

4.3.1 When reduced inspection is in effect (see 4.2), skip-lot inspection shall be allowed when the preceding ten lots have been accepted in accordance with ANSI/ASQ Z1.4-2008. Skip-lot testing shall be in accordance with ANSI/ASQC S1-1996.

4.3.2 When skip-lot inspection is in effect, normal inspection (see 4.1) shall be instituted if any lot is found unacceptable.

TABLE 1 Sampling for Diameter and Tensile Properties Except Joints

NOTE 1—This sampling plan was taken from ANSI/ASQ Z1.4-2008. General Inspection Level I, normal sampling was used, with an AQL (Acceptance Quality Level) of 4.0 %.

Number of Units in Lot	Sample	Sample Size	Cumulative Sample Size	Acceptance Number	Reject Number
1 to 3	first[A]	all	all	0	1
4 to 90	first[A]	3	3	0	1
91 to 280	first	8	8	0	2
	second	8	16	1	2
281 to 500	first	13	13	0	3
	second	13	26	3	4
501 to 1200	first	20	20	1	4
	second	20	40	4	5

[A] Single sampling only.

TABLE 2 Sampling for Resistivity Properties

NOTE 1—This sampling plan was taken from ANSI/ASQ Z1.4-2008. Special Inspection Level S-4, normal sampling was used, with an AQL (Acceptance Quality Level) of 4.0 %.

Number of Units in Lot	Sample	Sample Size	Cumulative Sample Size	Acceptance Number	Reject Number
1 to 3	first[A]	all	all	0	1
4 to 90	first[A]	3	3	0	1
91 to 500	first	8	8	0	2
	second	8	16	1	2
501 to 1200	first	13	13	0	3
	second	13	26	3	4

[A] Single sampling only.

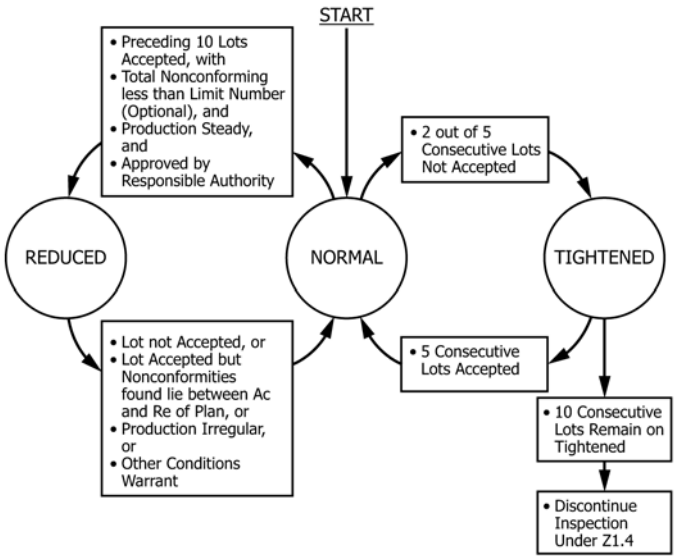

FIG. 1 Switching Rules for ANSI/ASQ Z1.4-2008 System

4.4 When skip-lot inspection (see 4.3) is in effect, and the preceding ten inspected lots have been accepted, audit inspection shall be instituted by the manufacturer in accordance with the following statistical process control (SPC) program requirements.

4.4.1 CPK >1.0 for 10 lots in control with less than 2 out-of-control indications.

5. Statistical Process Control

5.1 When statistical process control (SPC) is used, the manufacturer shall comply with CSA Standard Z299.3, Section 3.5, ANSI/ASQ Q9004-1-2009, Sections 10 and 20.

5.1.1 Basic inspection and testing system requirements shall conform to ANSI/ASQ Q9001-2008, Section 4.10.

5.2 *Statistical Techniques:*

5.2.1 Identify and classify product, process, and service characteristics for which statistical techniques will be used as basis for the assurance and control of quality and acceptance or rejection of lots.

5.2.2 When statistical techniques are used, the property being evaluated shall comply with the requirements of the applicable ASTM standard. The process performance index (CPK) shall not be less than 1.0. A process performance index (CPK) of 1.3 should be considered a goal.

5.2.3 Other physical or electrical properties shall have statistical techniques applied at the supplier's option or if specified in the applicable ASTM standard.

5.2.4 Select appropriate statistical techniques and confidence levels for process control and product acceptance and indicate the basis for selection. Control charts and statistical data shall follow ASTM Manual 7[6] for form, style, and data presentation.

5.2.5 Apply the statistical techniques selected, review them for adequacy, and monitor their application to ensure the specified ASTM requirements are met.

5.2.6 Include or reference the selected statistical techniques used for product or service acceptance or special process monitoring specified in the inspection and test plan(s), ANSI/ASQ Q9001-2008, Sections 4.10 and 4.20.

5.3 *Quality Audits:*

5.3.1 Control charts following the form and style of ASTM Manual 7[6] shall be provided, if requested, to the customer with each order that is representative of the processes used in the manufacture of the product.

5.3.2 Records shall be kept in accordance with ANSI/ASQ Q9001-2008, Section 4.16.

6. Keywords

6.1 acceptable quality level (AQL); average outgoing quality (AOQ); control chart; lot; lower specification limit (LSL); process average; process control ratio (CPK); skip-lot inspection; statistical process control (SPC); upper specification limit (USL)

[6] *Manual on Presentation of Data and Control Chart Analysis, ASTM Manual 7*, ASTM, 1992.

EXPLANATORY NOTES

NOTE 1—The following is an example of how one might interpret the CPK results and determine the frequency of monitoring a specific test:

Between 0 and 1.0 CPK	=	Inspection required as process unstable, failures will occur.
Between 1.0 and 1.33 CPK	=	Monthly Audit required to prevent process drift
Between 1.33 and 1.5 CPK	=	Process Capability Audit at least every 6 months
More than 1.5	=	Capability Audit annually.