



Designation: D4583 – 95 (Reapproved 2019)

# Standard Practice for Carbon Black—Calculation of Process Indexes From an Analysis of Process Control Data<sup>1</sup>

This standard is issued under the fixed designation D4583; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers (1) a statistical procedure for analyzing the test data generated in the statistical process control of a carbon black manufacturing process; (2) a format for reporting process capability determined from the analysis of control chart data of an individual production run, and (3) a format for reporting process performance determined from the analysis of control chart data of an individual production run.

1.2 This practice specifically applies to the analysis of pelleted carbon black samples taken during the manufacturing process prior to storage. This practice does not apply to shipment samples taken from hopper cars or other containers or packages.

1.3 This practice is specifically designed to be used for those test methods given in Classification D1765 which specify target values. However, these techniques are applicable to other test methods on carbon black.

1.4 This practice describes the calculation for two methods of determining capability factors from an analysis of process control data.

1.4.1 Process capability ( $C_p$ ) is a measurement of variation calculated from the process control chart data with the use of an estimated standard deviation ( $\hat{\sigma}$ ) from the mean value of the moving range ( $R$ ) chart. The calculation of the process capability ( $C_p$  and  $C_{pk}$ ) indexes can be used as historical information or to predict future performance of the process, but are only valid when the process is in a state of statistical control.

1.4.2 Process performance ( $P_p$ ) is a measurement of variation calculated from the process control chart data using sample standard deviation(s). The calculation of the process performance ( $P_p$  and  $P_{pk}$ ) indexes are used for a historical reference of a process' performance and does not require a state of statistical control.

1.5 *This international standard was developed in accordance with internationally recognized principles on standard-*

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D24 on Carbon Black and is the direct responsibility of Subcommittee D24.61 on Carbon Black Sampling and Statistical Analysis.

Current edition approved Nov. 1, 2019. Published December 2019. Originally approved in 1986. Last previous edition approved in 2015 as D4583 – 95 (2015). DOI: 10.1520/D4583-95R19.

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

D1765 Classification System for Carbon Blacks Used in Rubber Products

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*<sup>4</sup>

3.1.1 *average moving range ( $\bar{R}$ )*—the arithmetic mean of  $n$  moving ranges,  $\bar{R} = \sum R/n$ .

3.1.2 *Cpk index*—an index that indicates how well the common cause process variability is actually contained within the specifications. (See 6.4.)

3.1.3 *moving range (R)*—the absolute difference between consecutive, individual test values.

3.1.4 *Ppk index*—indicates how well the common and special cause process variability is actually contained within the specifications. (See 6.6.)

3.1.5 *process capability index (Cp)*—an index that compares the magnitude of common cause process variability to the range of upper and lower specification limits ( $USL$  and  $LSL$ ) without regard to where the process is centered;  $C_p$  index =  $(USL - LSL)/(6\hat{\sigma})$ . (See 6.3.)

3.1.6 *process performance index (Pp)*—an index that compares the magnitude of common and special cause process variability to the range of the upper and lower specification limits ( $USL$  and  $LSL$ ) without regard to where the process is centered;  $P_p$  index =  $(USL - LSL)/(6s)$ . (See 6.5.)

<sup>2</sup> 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.

<sup>3</sup> *Manual on Presentation of Data and Control Chart Analysis, STP 15D*, ASTM International, 1976.

<sup>4</sup> *Ford Motor Company Manual on "Process Capability and Continuing Process Control,"* Publication No. 80-01-251. Available in packs of five from Ford Motor Company, Statistical Methods Publications, P.O. Box 1000, Plymouth, MI 48170.

