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ANSI/ASQC A1-1987

AMERICAN NATIONAL STANDARD

Definitions, Symbols, Formulas, and Tables for Control Charts



AMERICAN SOCIETY FOR QUALITY CONTROL
310 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

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Sponsor: American Society for Quality Control

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Abstract

AMERICAN NATIONAL STANDARD: An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review and users are cautioned to obtain the latest editions.

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Foreword

(This Foreword is not a part of the American National Standard *Definitions, Symbols, Formulas, and Tables for Control Charts*.)

The Standards Committee of the American Society for Quality Control was formed in 1947, being "authorized to study and select symbols, concepts, terms, procedures, and other matters which it feels the Society might standardize to advantage and to make recommendations to the Board of Directors regarding such standardization."

The revision of ANSI/ASQC A1 includes several minor changes from the 1978 standard which contained major changes from earlier revisions. The original standard was restricted to the Shewhart Control Chart, whereas the 1978 revision expanded coverage to include many other types of charts. The style of presentation was expanded in 1978 to include extensive comments both to provide more complete explanations and to permit comparison of the various techniques. The 1987 revision adds a section on terms related to process capability. It includes some changes and additions so as to be in agreement with ISO 3534 and ISO 8402 whenever possible.

Scope

The scope of this document is intended to cover the major forms of statistical control charts which are in general use in United States industry.

Writing Committee

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DEFINITIONS, SYMBOLS, FORMULAS, AND TABLES FOR CONTROL CHARTS

I. TYPES OF CONTROL CHARTS

A. GENERAL

1.0 CONTROL CHART: A graphical method for evaluating whether a process is or is not in a "state of statistical control."

NOTE: The determinations are made through comparison of the values of some statistical measure(s) for an ordered series of samples, or subgroups, with control limits or other prescribed criteria.

COMMENT: A control chart is used to make decisions about a process. There are a variety of specific charts, each designed for the type of decisions to be made, the nature of the data, and the type of statistical measure used. The term *control chart* was for many years synonymous with *Shewhart Control Chart* (see 4.0) being based on the original work by Shewhart, (W. A. Shewhart, "Economic Control of Quality of Manufactured Product," C. Van Nostrand Company, Inc., 1931, republished, 1980 and available from the American Society for Quality Control). There are now several other distinct types or major variations in use.

The emphasis of the *control chart*, as contrasted to the *acceptance control chart*, is on the process being "in control" rather than a direct evaluation of whether the measure of the product or service satisfies tolerance requirements. (See comments under 2.0 and 4.0.) The *control chart*, however, is sometimes used in an acceptance sense calling for action or investigation when a process is deemed to have shifted from its standard level.

Criteria other than control limits, e.g., runs, are also used to determine if a process is in control.

1.1 Control Chart — No Standard Given: A control chart whose control limits are based on the sample or subgroup data plotted on the chart.

COMMENT: This type of control chart is used to determine whether observed values of $\bar{X}$, R , p , etc., for a series of samples vary among themselves by an amount greater than should be attributed to chance. Control charts based entirely on the data from the samples being evaluated are used for detecting lack of constancy of the cause system. This type of chart is particularly useful in research and development stages to determine whether a new process or product is reproducible and whether test methods are repeatable.

1.2 Control Chart — Standard Given: A control chart whose control limits are based on adopted standard values applicable to the statistical measures plotted on the chart.

COMMENT: This type of control chart is used to discover whether currently observed values of $\bar{X}$, c , p , etc., for samples differ from standard values $\bar{X}_0$, c_0 , p_0 , etc., by an amount greater than should be attributed to chance. The standard value may be based on representative prior data, or an economic value based on consideration of needs of service and cost of production, or a desired or aimed-at value designated by a specification. The standard value of the standard deviation should almost invariably be based on representative prior data. It is assumed that the process is capable of being, and intended to be, operated at the designated standard values. Any prior data being used to set limits should be checked to assure that it is "in control."

The use of the subscript zero (e.g., $\bar{X}_0$, c_0 , p_0) to designate standard levels is recommended to avoid confusion with exponents. There has been a long tradition of using the prime notation (e.g., $\bar{X}'$, c' , p') for this purpose and this will continue to be an accepted alternative along with a combination of both (e.g., $\bar{X}'_0$, c'_0 , p'_0). Generally, the use of a prime notation is an indication that the standard value is to be treated as if it were the population value, although Greek letters are sometimes used to indicate this (e.g., μ , σ , θ , etc.).

2.0 ACCEPTANCE CONTROL CHART: A graphical method for the dual purposes of evaluating a process in terms of (a) whether or not it can be expected to satisfy product or service requirements for the characteristic(s) being measured and (b) whether or not it is in a "state of statistical control" with respect to within sample, or subgroup, variability.

NOTE: The determinations are made through comparison of values of some statistical measure(s) for an ordered series of samples, or subgroups, with acceptance control limits.

COMMENT: The emphasis of the *acceptance control chart*, as contrasted to the *control chart* as defined in 1.0, is that the process usually does not need to remain in control about some single standard process level, but that as long as the within-subgroup variability remains in control, it can run at any level or levels within some zone of process levels which would be acceptable in terms of requirements. It is assumed that some assignable causes will create shifts in the process