Notation

$\bar{p}$ = estimate of the proportion of defective items in the process

$$= \frac{\text{total number of defects found among all items sampled}}{\text{total number of items sampled}}$$

$\bar{q}$ = estimate of the proportion of process items that are not defective

$= 1 - \bar{p}$

n = size of each sample or subgroup

Graph

Points plotted: Proportions from the individual samples of size n

Centerline: $\bar{p}$

Upper control limit: $\bar{p} + 3\sqrt{\frac{\bar{p}\bar{q}}{n}}$ (Use 1 if this result is greater than 1.)

Lower control limit: $\bar{p} - 3\sqrt{\frac{\bar{p}\bar{q}}{n}}$ (Use 0 if this result is less than 0.)

CAUTION Upper and lower control limits of a control chart for a proportion p are based on the *actual* behavior of the process, not the *desired* behavior. Upper and lower control limits are totally unrelated to any process *specifications* that may have been decreed by the manufacturer.

We use $\bar{p}$ for the centerline because it is the best estimate of the proportion of defects from the process. The expressions for the control limits correspond to 99.7% confidence interval limits as described in Section 7-2.

Example 1 Defective Quarters

Examples in Section 14-2 involved control charts for variation in the mean weight of quarters manufactured by the United States Mint. Let's now consider the proportion of defective quarters produced by the same new production method used to manufacture the weights listed in Table 14-1. A quarter is designed to weigh 5.670 g and have a diameter of 24.26 mm, a thickness of 1.75 mm, and it should be composed of 8.33% nickel and 91.67% copper, it should have 119 reeds on its edge, and it should be stamped correctly. Large deviations from any of those specifications results in a quarter considered to be defective. Listed below are the numbers of defects in batches of 10,000 quarters randomly selected on each of 20 consecutive days from a new manufacturing process that is being tested. Construct a control chart for the proportion p of defective quarters and determine whether the process is within statistical control. If not, identify which of the three out-of-control criteria apply.

Defects:	8	7	12	9	6	10	10	5	15	14
	12	14	9	6	16	18	20	19	18	24