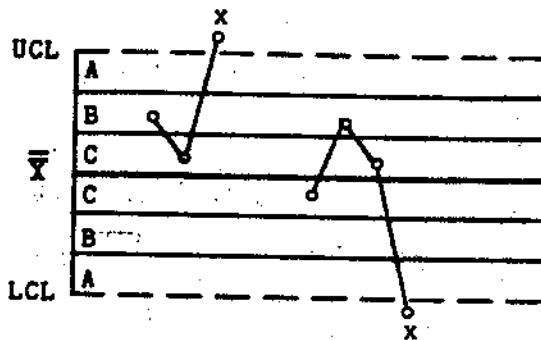
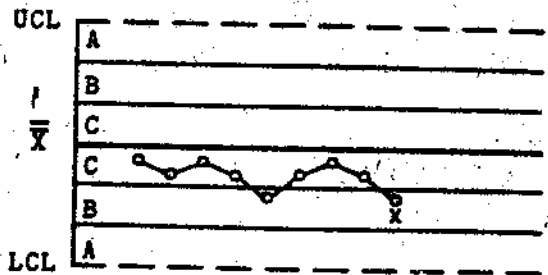


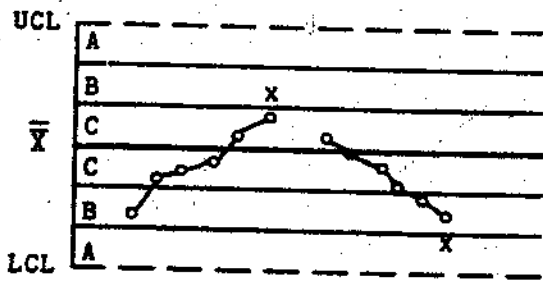
Test 1. One point beyond Zone A



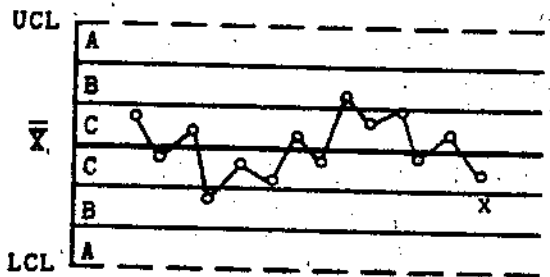
Test 2. Nine points in a row in Zone C or beyond



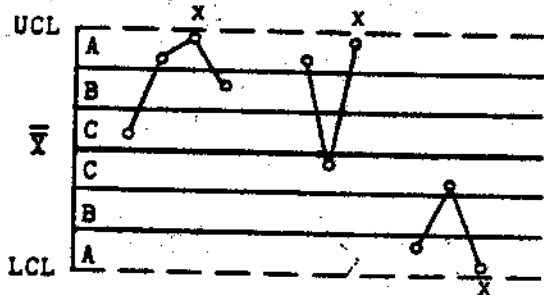
Test 3. Six points in a row steadily increasing or decreasing



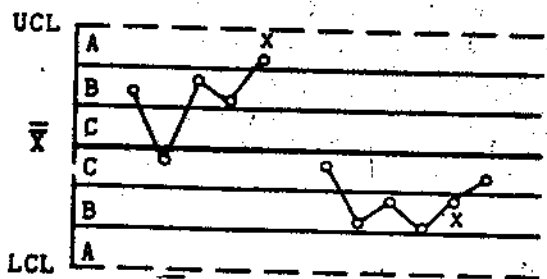
Test 4. Fourteen points in a row alternating up and down



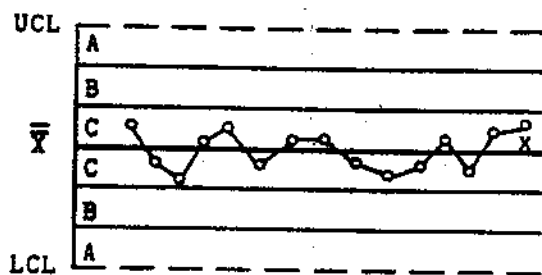
Test 5. Two out of three points in a row in Zone A or beyond



Test 6. Four out of five points in a row in Zone B or beyond



Test 7. Fifteen points in a row in Zone C (above and below centerline)



Test 8. Eight points in a row on both sides of centerline with none in Zones C

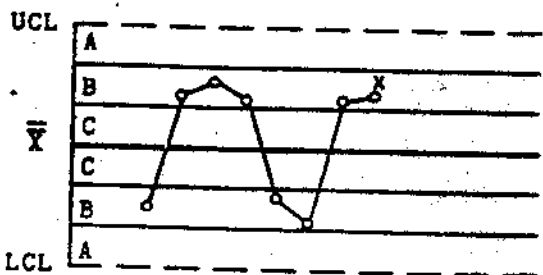


FIGURE 1. Illustrations of Tests for Special Causes Applied to Shewhart Control Charts

## SHEWHART CONTROL CHARTS

### Notes on Tests for Special Causes

1. These tests are applicable to  $\bar{X}$  charts and to individuals ( $X$ ) charts. A normal distribution is assumed. Tests 1, 2, 5, and 6 are to be applied to the upper and lower halves of the chart separately. Tests 3, 4, 7 and 8 are to be applied to the whole chart.
2. The upper control limit and the lower control limit are set at three sigma above the centerline and three sigma below the centerline. For the purpose of applying the tests, the control chart is equally divided into six zones, each zone being one sigma wide. The upper half of the chart is referred to as A (outer third), B (middle third) and C (inner third). The lower half is taken as the mirror image.
3. When a process is in a state of statistical control, the chance of (incorrectly) getting a signal for the presence of a special cause is less than five in a thousand for each of these tests.
4. It is suggested that Tests 1, 2, 3 and 4 be applied routinely by the person plotting the chart. The overall probability of getting a false signal from one or more of these is about one in a hundred.
5. It is suggested that the first four tests be augmented by Tests 5 and 6 when it becomes economically desirable to have earlier warning. This will raise the probability of a false signal to about two in a hundred.
6. Tests 7 and 8 are diagnostic tests for stratification. They are very useful in setting up a control chart. These tests show when the observations in a subgroup have been taken from two (or more) sources with different means. Test 7 reacts when the observations in the subgroup always come from both sources. Test 8 reacts when the subgroups are taken from one source at a time.
7. Whenever the existence of a special cause is signaled by a test, this should be indicated by placing a cross just above the last point if that point lies above the centerline, or just below it if it lies below the centerline.
8. Points can contribute to more than one test. However, no point is ever marked with more than one cross.
9. The presence of a cross indicates that the process is not in statistical control. It means that the point is the last one of a sequence of points (a single point in Test 1) that is very unlikely to occur if the process is in statistical control.
10. Although this can be taken as a basic set of tests, analysts should be alert to any patterns of points that might indicate the influences of special causes in their process.

FIGURE 2. Comments on Tests for Special Causes