**Pulley engineering**

Pulley Engineering manufactures needle bearings for use in high-tech machinery. The target diameter for one particular bearing is 0.125 inches. The quality control staff has taken 15 samples of five observations each with the manufacturing processes under control and has measured the diameter. The results are as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| one | two | three | four | five | X-bar | Range |
| 0.1253 | 0.1262 | 0.1254 | 0.124 | 0.123 | 0.12478 | 0.0032 |
| 0.1242 | 0.1247 | 0.1251 | 0.1238 | 0.1241 | 0.12438 | 0.0013 |
| 0.1225 | 0.1258 | 0.1229 | 0.1242 | 0.1255 | 0.12418 | 0.0033 |
| 0.1249 | 0.1259 | 0.1249 | 0.124 | 0.1257 | 0.12508 | 0.0019 |
| 0.1245 | 0.1252 | 0.1261 | 0.1238 | 0.1225 | 0.12442 | 0.0036 |
| 0.1273 | 0.1234 | 0.1248 | 0.1241 | 0.126 | 0.12512 | 0.0039 |
| 0.1226 | 0.1239 | 0.1227 | 0.1252 | 0.1259 | 0.12406 | 0.0033 |
| 0.1244 | 0.1238 | 0.1254 | 0.1261 | 0.126 | 0.12514 | 0.0023 |
| 0.1236 | 0.1262 | 0.125 | 0.1247 | 0.125 | 0.1249 | 0.0026 |
| 0.1251 | 0.1264 | 0.1233 | 0.1233 | 0.1246 | 0.12454 | 0.0031 |
| 0.1253 | 0.1248 | 0.1237 | 0.1252 | 0.1226 | 0.12432 | 0.0027 |
| X0.1232 | 0.1251 | 0.1259 | 0.1263 | 0.1257 | 0.12524 | 0.0031 |
| 0.1231 | 0.1242 | 0.1256 | 0.1252 | 0.1257 | 0.12476 | 0.0026 |
| 0.1256 | 0.124 | 0.1246 | 0.125 | 0.1252 | 0.12488 | 0.0016 |
| 0.1243 | 0.124 | 0.1239 | 0.1262 | 0.1246 | 0.1246 | 0.0023 |

1. Use this data to develop control limits for X and R charts.
2. In addition, suppose that engineering has established upper and lower tolerance limits of 0.129 inches 0.121 inches, respectively. Calculate the process capability ratio and interpolate the results.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| X2-bar | 0.124693 | R-Bar |  |  |  | X-Bar |  |  |
| R2-bar | 0.00272 | UCLx | CLr | LCLr |  | UCLx | CLx | LCLx |
| A2 | 0.58 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
|  |  | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| UCLx | 0.126271 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| CLx | 0.124693 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| LCLx | 0.123116 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
|  |  | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| UCLr | 0.005739 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| CLr | 0.00272 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| LCLr | 0 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| D4 | 2.11 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
| D3 | 0 | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
|  |  | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
|  |  | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |
|  |  | 0.005739 | 0.00272 | 0 |  | 0.126271 | 0.124693 | 0.123116 |

|  |  |  |
| --- | --- | --- |
| Process Control | | |
| stdev | 0.0011 | |
| UTL | 0.129 | |
| LTL | 0.121 | |
| Cp | 1.211941 | |
| Cp(1.211941) > | | 1, thus, |

The process is capable