# Read spread before the subgroup average

**Apply supplied subgroup baseline constants, interpret spread before the mean, and record a signal response without confusing limits with specifications.**

## A quiet average can hide an abnormal range

Fictional case: a width process samples five consecutive units per subgroup. A prior reviewed baseline is supplied as grand mean 20.00 mm and average range 0.50 mm. The core charts show six illustrative subgroup means and ranges; those six points are not used to estimate the baseline. Technician Imani checks the calculations and prepares a response record.

## Your role and the reference condition

SPC technician with the process owner
Normal: Subgroup size is five; measurement and subgroup rationale remain appropriate; historical limits are clearly identified and applied to later observations.
Gap: The draft report recomputes limits from the six demonstration points and reads the mean chart first. That changes the stated evidence and can hide a spread problem.

## Work within these conditions

1. Supplied baseline adequacy is an exercise assumption, not newly demonstrated by these six points.

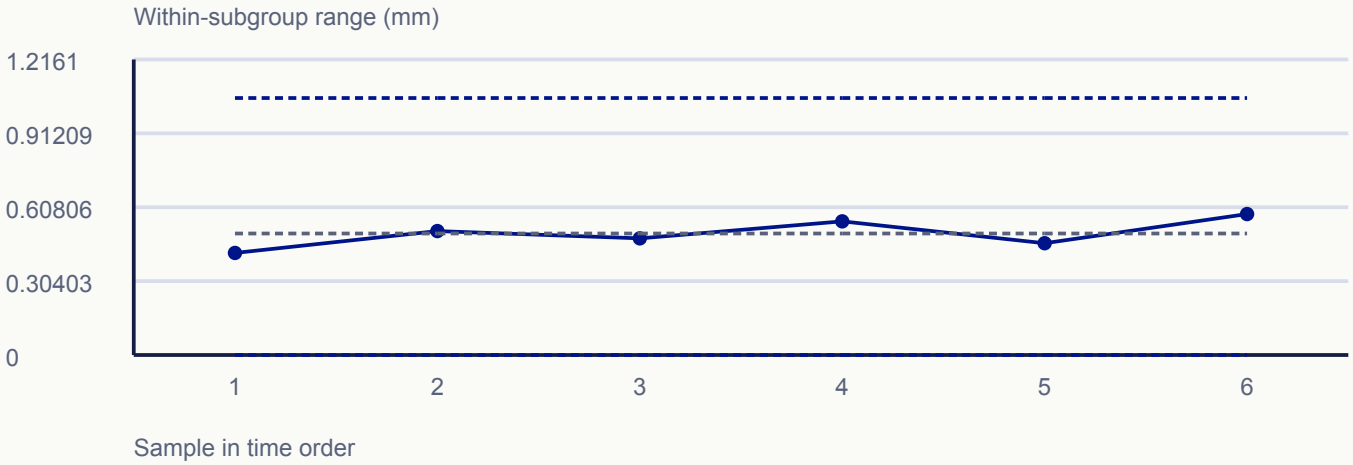
2. No product specifications or automatic release criteria are supplied.

Fictional teaching case. Supplied observations support the exercise; proposed actions are not verified customer results.

# See how the method works

A rational subgroup is intended to expose short-term variation while preserving meaningful changes between samples. For this example each subgroup contains five readings taken under comparable conditions. The range chart helps assess whether that within-subgroup spread is behaving consistently. Review it before interpreting the average chart, whose limits depend on that variation estimate. Constants must match the subgroup size and the chosen method. The displayed points illustrate reading the charts; they do not establish the historical baseline. Do not delete awkward samples merely to obtain attractive limits. Document investigations and use an authorized approach when the underlying process changes.

## Read range first

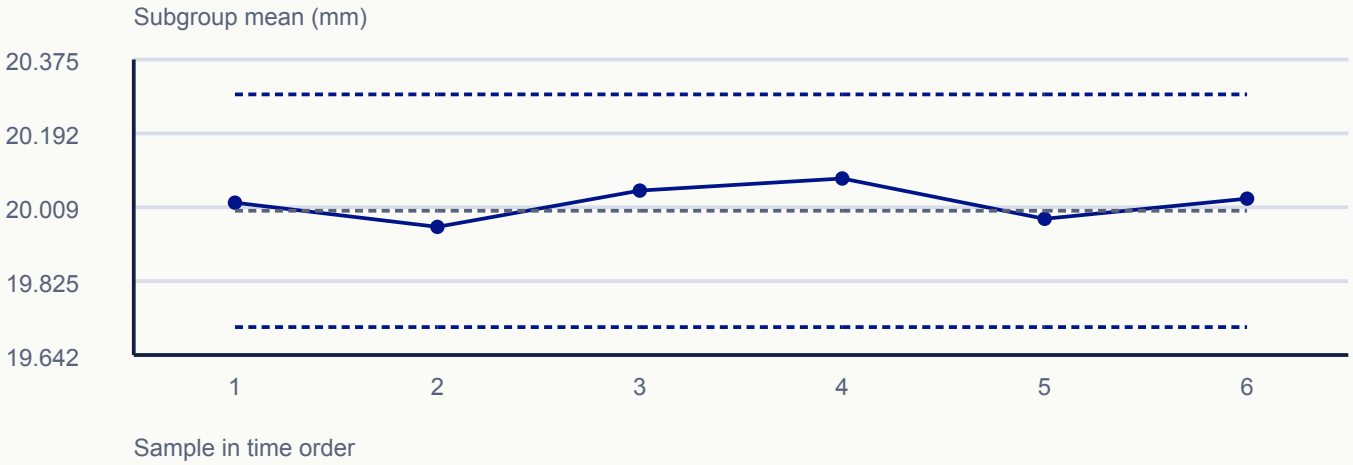



Center: 0.5

LCL: 0

UCL: 1.0575

## Then subgroup average




Center: 20

LCL: 19.7115

UCL: 20.2885

Xbar limits = 20 ± 0.577 x 0.5

R limits = 0 x 0.5 and 2.115 x 0.5

Given historical grand mean 20 mm and Rbar 0.5 mm; n=5. The six plotted subgroups are illustrations, not the baseline estimate.

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# Follow the evidence and decisions

## Inspect the supplied case inputs

| Input | Supplied value |
|---|---|
| Subgroup size | n=5 |
| Historical grand mean / average range | 20.00 mm /0.50 mm |
| Constants for n=5 | A2=.577; D3=0; D4=2.115 |
| Illustrative ranges | 0.42,0.51,0.48,0.55,0.46,0.58 mm |
| Illustrative means | 20.02,19.96,20.05,20.08,19.98,20.03 mm |

## 01 / Confirm the subgroup meaning

Imani verifies that each point summarizes five consecutive units under the stated collection design and that units are millimetres. She keeps subgroup identity and raw readings available.

Why: Five values collected across unrelated conditions are not automatically a useful subgroup. The collection design is part of the interpretation, not a chart-format preference.

Evidence / check: n=5 and the source of each subgroup are explicit.

## 02 / Calculate limits from the supplied baseline

She uses 20 ± .577x.50 for mean limits 19.7115 and 20.2885 mm. Range limits are 0x.50=0 and 2.115x.50=1.0575 mm.

Why: The constants correspond to subgroup size five. Replacing the historical averages with the six plotted examples would silently answer a different question.

Evidence / check: Calculation record identifies the historical baseline and constants.

## 03 / Review the range chart first

She compares each displayed range with 0 and 1.0575 mm. The six supplied ranges show no point beyond these limits under the stated point rule.

Why: The mean-chart interpretation depends on a suitable within-subgroup spread estimate. An abnormal spread should not be ignored because the means look quiet.

Evidence / check: The record describes the observed range comparison without claiming a new baseline study.

## 04 / Then examine subgroup means

The six displayed means lie between 19.7115 and 20.2885 mm. Imani records the rule examined and avoids claiming that six points establish control or capability.

Why: Absence of an observed signal is weaker than proof of future stability. A mean within control limits also says nothing by itself about individual product conformance.

Evidence / check: No beyond-limit mean point in the illustrative sequence; product limits not supplied.

### 05 / Plan the signal response

She prepares a record for subgroup identity, raw values, measurement checks, relevant changes and authorized containment/investigation. Limits stay frozen unless a justified baseline review approves a change.

Why: Widening a limit to absorb a signal would conceal the condition. Investigation must preserve the original signal and distinguish correction from learning about its cause.

Evidence / check: The reaction record names the process and quality owners and the next verification.

# Completed baseline-to-observation record

| Calculation or review | Result | Meaning |
|---|---|---|
| Mean limits | 19.7115 to 20.2885 mm | From supplied historical parameters |
| Range limits | 0 to 1.0575 mm | n=5 constants |
| Six range points | All within displayed limits | No beyond-limit point in this illustration |
| Six mean points | All within displayed limits | Not proof of capability or a new stable baseline |

### Range signals while mean stays near center

A later fictional subgroup has mean 20.02 mm and range 1.20 mm.

### Decision

Record the range signal because 1.20 exceeds 1.0575; preserve the subgroup data and follow the authorized response before treating the near-center mean as reassuring.

### Reasoning

A normal-looking average can hide increased within-group spread. The mean does not cancel the range signal.

### What would change the decision?

The signal record includes the 1.20 mm range and original historical limit.

# Practise with a changed case

## Recalculate from a different supplied baseline

New fictional process uses n=5, historical grand mean 30.00 mm and Rbar 0.40 mm. A later subgroup has mean 30.30 mm and range 0.70 mm. Use the same n=5 constants.

| Given | Value |
|---|---|
| Grand mean | 30.00 mm |
| Rbar | 0.40 mm |
| Later mean / range | 30.30 mm /0.70 mm |

## Your task

1. Calculate both sets of limits.
2. Read range before mean and identify any beyond-limit signal.
3. Explain whether individual parts may be released from this chart alone.

Use the next page to record your reasoning before reading the answer.

# Your practice worksheet

## Recalculate from a different supplied baseline

### Constants and baseline source

### Range calculation

### Mean calculation

### Signal record

### Missing release authority

Complete your reasoning before turning to the answer. Use the separate learner workbook for group practice.

# Check your reasoning and transfer it

1. Mean limits are 30 ± .577x.40=29.7692 and 30.2308 mm. Range limits are 0 and 2.115x.40=.846 mm.

2. Range .70 is within the displayed range limits; mean 30.30 exceeds 30.2308 and signals under the stated point rule. Product release still requires the actual specification and applicable decision process.

## Suggested completed record

| Chart | Limits | Later point |
|---|---|---|
| R | 0 to .846 mm | .70: within |
| Xbar | 29.7692 to 30.2308 mm | 30.30: above UCL |

## Plausible wrong turns

1. Control limits are not product limits.

2. The six original illustration points do not estimate the supplied historical baseline.

## Evidence of a sound answer

1. Use constants for n=5.

2. Identify the mean signal after checking spread.

3. Avoid automatic release or limit recalculation.

## Take the learning back to work

| Commitment | Agreed follow-through |
|---|---|
| Owner | SPC owner with station quality lead |
| Record | Baseline revision, subgroup record and signal investigation |
| Review | At each defined subgroup and after reviewed process changes |
| Verification evidence | Traceable data and verified response with unchanged justified limits |
| If unresolved | Investigate measurement/process conditions; revise the baseline only through the authorized evidence review. |

# Help someone else apply the method

## Prepare

1. Baseline card
2. Calculator
3. Blank signal record

| Minutes | Activity and coaching prompt |
|---|---|
| 5 | Identify the source of limits<br>Which numbers are supplied rather than estimated here? |
| 8 | Calculate and read spread<br>What can a near-center average hide? |
| 10 | Complete the 30 mm case<br>Which point signals and under what rule? |
| 5 | Debrief response<br>What would be wrong with widening the limit? |

## Debrief

1. Ask for units on every limit.
2. Distinguish no observed point signal from demonstrated long-run control.

## Individual or remote practice

Work both charts on paper and write the reaction before revealing the answer.

# Connect the method and check its boundaries

## Before application

1. Comparable rational subgroups of five
2. A justified baseline for mean and range

## Outside this lesson

1. Subgroup-size-independent constants
2. An Xbar-S implementation

## NIST: X-bar, R and S charts

NIST: X-bar, R and S charts

Mean and dispersion charts answer different questions; subgroup size determines constants. Range charts suit relatively small subgroups.

Public primary-source summary; underlying paid standards/forms are not reproduced.

Open this lesson and its visual aids