

Gage R&R Study

How-to guide: what the workbook does, how to use it and what every number means.

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Gage R&R Study

Enter a crossed gage study (parts x appraisers x trials) and get repeatability, reproducibility, % GRR of study variation and tolerance, and ndc.

For: Quality and metrology engineers, supplier quality engineers and inspection leads qualifying a gage for PPAP, a control plan or a customer audit.

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Quick start

1. On Setup, name the gage and characteristic, set the trials (2 or 3), parts (2 to 10), tolerance and your acceptance limits, and list the appraisers (2 or 3).
2. Measure the parts in random order, blind to part number where you can. On Study, enter one row per appraiser per part with the trials in order.
3. Fix anything the Check column names; Range above UCL means re-measure that part.
4. Read the Dashboard: % GRR of study variation and of tolerance, ndc, and which source dominates (equipment or appraisers).

What is in the workbook

Start Here	Read this first: what the workbook does and how to use it.
Setup	The gage, the study design, the tolerance, your acceptance limits and the appraisers.
Study	One row per appraiser per part. Enter the trials in the order measured.
Dashboard	Is the gage good enough? % GRR of study variation and tolerance, ndc, and where the measurement error comes from.
Method	How every number is calculated, with assumptions, limits and sources.
Verify	Self-check: the workbook's formulas recomputed on fixed inputs against an independent reference.

What each number means

Quantity	How it is calculated	Units
Mean and range (per row)	Average and largest minus smallest of one appraiser's trials on one part.	unit
R-double-bar	Average of every row's range.	unit
Range control limit	D4 x R-double-bar (D4 = 2.574 for 3 trials, 3.267 for 2). A row above it is flagged for re-measurement.	unit
X-diff	Largest minus smallest appraiser average.	unit

Quantity	How it is calculated	Units
Rp	Largest minus smallest part average (over all appraisers and trials).	unit
Repeatability (EV)	$R\text{-double-bar} \times K1$; $K1 = 1 / d2^* = 0.5908$ for 3 trials, 0.8862 for 2.	unit
Reproducibility (AV)	$\sqrt{(X\text{-diff} \times K2)^2 - EV^2 / (\text{parts} \times \text{trials})}$, set to 0 when negative; $K2 = 0.5231$ for 3 appraisers, 0.7071 for 2.	unit
Gage R&R (GRR)	$\sqrt{EV^2 + AV^2}$.	unit
Part variation (PV)	$Rp \times K3$; $K3$ depends on the number of parts (0.3146 for 10).	unit
Total variation (TV)	$\sqrt{GRR^2 + PV^2}$.	unit
% study variation	Component / TV. % contribution is the square of it (variance share).	%
% tolerance	Spread multiplier (6 by default) $\times$ component / tolerance.	%
ndc	$1.41 \times PV / GRR$, truncated to a whole number.	categories
Status words	% GRR: OK below the acceptable limit, Check between the limits, FAIL above the unacceptable limit (Setup). ndc: On target at or above the minimum.	words

Assumptions, limitations, sources and the self-check (the Verify sheet, which recomputes the workbook's formulas on fixed test inputs) are in the workbook. The last page shows the Dashboard with the example data for Northgate Precision, a fictional business.

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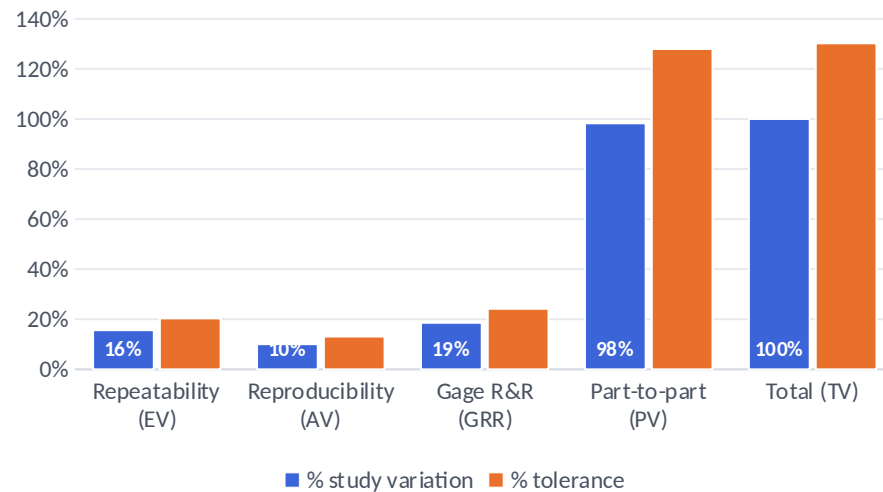
Is the gage good enough? % GRR of study variation and tolerance, ndc, and where the measurement error comes from.

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Digital micrometer 0-25 mm, GA-114 (example) | Plunger OD 6.350 +/- 0.025 mm (example) | 10 parts x 3 appraisers x 3 trials

% GRR OF STUDY VARIATION	% GRR OF TOLERANCE	DISTINCT CATEGORIES (NDC)	LARGER SOURCE OF GAGE ERROR
18.6%	24.2%	7	Repeatability (equipment)
Limit 10.0%	Limit 10.0%	Target 5	Compare EV with AV below
Check	Check	On target	

Components of variation



Average by part, each appraiser

