Chart nonconforming units with the right denominator

Keep nonconforming-unit counts linked to sample size, calculate the appropriate fraction or fixed-size count limits, and interpret a changed denominator.

Twice the count, the same fraction

Fictional case: an inspection desk classifies each item once as conforming or nonconforming. A supplied historical fraction is .10. The core p example uses sample sizes 100,200,100,200 and counts 8,24,11,17; the separate np example always inspects 100 and records 8,12,11,9. Analyst Pia explains why limits must reflect the observation design.

Your role and the reference condition

Quality analyst and inspection owner
Normal: Every sample records its actual inspected amount; one item contributes at most one nonconforming classification; model and baseline are suitable for the declared process.
Gap: A supervisor compares 24 failed items in 200 with 12 in 100 and declares the larger sample twice as bad. Both are 12%.

Work within these conditions

1. Historical pbar=.10 is supplied, not estimated from these four samples.

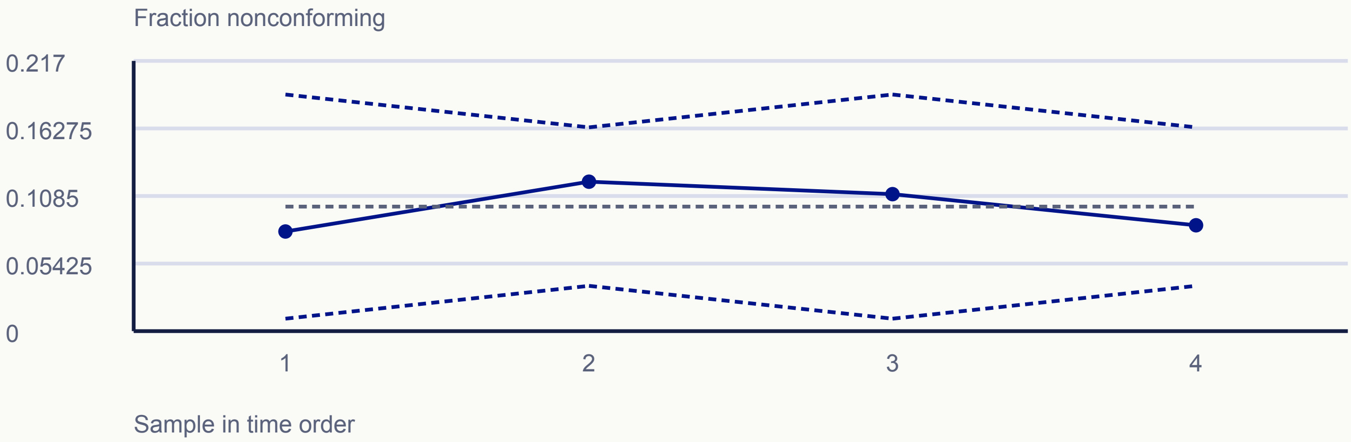
2. Dependence, overdispersion or changing risk can require another model; these are not acceptance-sampling limits.

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

See how the method works

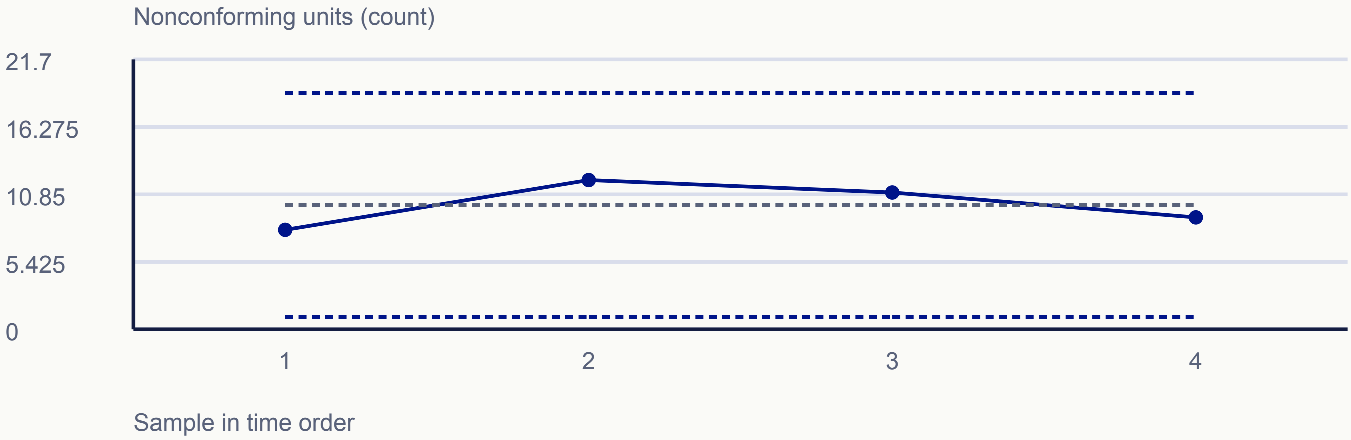
For nonconforming units, every inspected unit contributes at most one failure to the count. A p chart displays the fraction nonconforming and can accommodate different sample sizes with different limits. An np chart displays the count and assumes a constant sample size in this basic form. A larger sample narrows the p-chart limits because it changes the expected sampling variation; it does not change the customer specification. Estimate the baseline from appropriate totals and retain each denominator. The example uses a supplied baseline proportion. Dependence, changing product mix and unsuitable binomial assumptions require investigation rather than blind application of these formulas.

p: sample size may vary / n: 100, 200, 100, 200



Center: 0.1
LCL: 0.01 / 0.0363604
UCL: 0.19 / 0.16364

np: fixed sample size 100 / n: 100, 100, 100, 100



Center: 10
LCL: 1
UCL: 19

p limits = pbar ± 3 sqrt(pbar(1-pbar)/n)

np limits = n pbar ± 3 sqrt(n pbar(1-pbar))

Restrict displayed p limits to [0,1] and np limits to [0,n] when the basic formula exceeds possible values.

Given baseline pbar=0.10. Each unit classified once. Per-point p limits vary with n; np example uses constant n.

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Follow the evidence and decisions

Inspect the supplied case inputs

Sample	Inspected / nonconforming	Fraction
1	100 /8	.08
2	200 /24	.12
3	100 /11	.11
4	200 /17	.085

01 / Confirm what is counted

Pia checks that an item with several faults is still classified once in this unit-count record. She retains fault-category details separately if needed.

Why: A p or np chart describes affected units, not the number of faults within them. Mixing those numerators would break the interpretation.

Evidence / check: Each count is bounded by its inspected sample size.

02 / Calculate fractions and preserve n

She divides each sample count by its actual n and retains n beside the plotted point. Sample 2 is 24/200=.12, not 24/100.

Why: Different sample sizes can produce different counts with the same fraction. The denominator also determines the expected sampling variation.

Evidence / check: The sequence is .08,.12,.11,.085 with its four actual sample sizes.

03 / Apply the supplied p baseline

Using $.10 \pm 3\sqrt{(.10 \times .90/n)}$, n100 gives .01-.19; n200 gives approximately .03636-.16364. The center stays .10.

Why: The larger sample has narrower fraction limits under this model. Reusing fixed limits for all denominators would discard relevant information.

Evidence / check: Each point receives limits matching its own n; limits remain within possible fraction values.

04 / Explain the fixed-size count view

For the separate fixed-n100 illustration, np center is 10 and limits are 1-19 nonconforming units. Pia labels counts and does not mix this axis with fractions.

Why: A count view is interpretable when the inspected amount is fixed. A p view can also be used with fixed n if it is clearly labelled.

Evidence / check: The np sequence 8,12,11,9 uses n100 throughout.

05 / Record a response rather than a verdict

Pia documents any signal against the supplied baseline and checks measurement, sampling and process context. Product containment and release follow the applicable quality procedure.

Why: A point within statistical limits is not proof that the defect level is acceptable. A signal identifies changed behavior worth responding to, not its cause.

Evidence / check: The record separates chart evidence, product decisions and investigation ownership.

Completed denominator-to-limit record

Display	Baseline / limits	Meaning
p at n100	Center .10; .01-.19	Fraction of inspected units
p at n200	Center .10; .03636-.16364	Narrower fraction limits
np at fixed n100	Center 10;1-19	Count of nonconforming units
Interpretation	No cause or acceptance verdict	Use the declared response plan

Inspection amount changes on the np record

A busy shift inspects 200 instead of 100 and enters 20 in the count chart.

Decision

Retain 20/200=.10 and handle the sampling-design change through the chart owner; do not compare 20 directly with the old fixed-n100 upper limit 19.

Reasoning

The change in denominator alone can explain the count increase. The original chart was designed for fixed n.

What would change the decision?

The observation is preserved with n200 and a documented display/design decision.

Practise with a changed case

A signal at the larger sample size

New observation under the supplied pbar=.10 baseline:36 nonconforming units among 200 inspected. A colleague proposes dividing by 100 because that was yesterday's amount.

Given	Value
Nonconforming	36
Inspected	200
Historical pbar	.10

Your task

1. Calculate the fraction and applicable limits.
2. Identify whether the point exceeds the stated upper limit.
3. Explain why this is neither 36% nor an automatic product-disposition instruction.

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

Your practice worksheet

A signal at the larger sample size

Actual n

Fraction

Sample-specific limits

Signal statement

Response and missing authority

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

Check your reasoning and transfer it

1. 36/200=.18. For n200, the supplied-baseline limits are approximately .03636-.16364; .18 exceeds the upper limit.

2. Report an upward signal and follow the approved response. Dividing by 100 invents a denominator; the chart itself does not decide the disposition of particular units.

Suggested completed record

Calculation	Result	Decision
36/200	.18	18% observed
Upper limit	.16364	.18 is above UCL
Product status	Separate applicable criteria	No automatic release or scrap

Plausible wrong turns

1. A point within limits can still represent an unacceptable defect level.

2. Multiple faults on one item do not create multiple affected units.

Evidence of a sound answer

1. Use n200 consistently.

2. Distinguish fraction and count scales.

3. Preserve signal and response authority.

Take the learning back to work

Commitment	Agreed follow-through
Owner	SPC and inspection owners
Record	Count, denominator, baseline and sample-specific response record
Review	At each sampling interval and whenever sampling changes
Verification evidence	One classification per unit, correct n and verified response
If unresolved	Resolve denominator/model changes before applying a fixed-n interpretation.

Help someone else apply the method

Prepare

1. Sample-size/count cards
2. Calculator
3. Blank response record

Minutes	Activity and coaching prompt
5	Define affected units Can one item contribute three here?
8	Compare n100 and n200 Why do fraction limits narrow?
10	Evaluate 36 of 200 What denominator and limit apply?
5	Debrief Why does a chart not authorize product release?

Debrief

1. Ask learners to explain why 12/100 and 24/200 are equal.
2. Challenge the unsupported 36% calculation by tracing the inspected population.

Individual or remote practice

Write n next to each numerator before choosing a plotting scale.

Connect the method and check its boundaries

Before application

1. Each unit classified once
2. Known sample sizes and suitable binomial assumptions

Outside this lesson

1. Multiple nonconformities per unit
2. Universal fixed limits for varying sample sizes

NIST: Proportions charts

NIST: Proportions charts

The binomial model underlies fraction-nonconforming charts; limits depend on the sample denominator.

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

Open this lesson and its visual aids