Select a chart from the data and sampling plan

Select a monitoring candidate from the observation type and sampling design, then identify the assumptions that still need review.

The word defect is not a data model

Fictional case: a monitoring workshop receives six records: individual widths, small width subgroups, rejected-unit fractions, fixed-size reject counts, fixed-area blemish counts and varying-area blemish rates. The core chooser retains six distinct routes. Engineer Sal must assign candidates without pretending that a chart name approves the collection plan.

Your role and the reference condition

Quality engineer and process record owner
Normal: The team knows what one observation means, its time order, subgroup or exposure basis and whether a unit can contribute more than one event.
Gap: Every record has been labelled defects. A proposed p chart would treat multiple blemishes on one sheet as though they were different rejected sheets.

Work within these conditions

1. These are introductory candidates; dependence, overdispersion and rare events can require other methods.

2. Control limits describe process behavior under a model, not product specifications.

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

See how the method works

Chart selection starts with how data are generated. Measurements taken individually differ from rational subgroups collected under comparable short-term conditions. Nonconforming units differ from nonconformities, because one unit can contain several faults. For attributes, record whether the inspected quantity or exposure changes. These distinctions guide the candidate family: individuals and moving range, subgroup charts, p or np, and c or u. Selection is not complete until independence and model assumptions are considered. Rare events, autocorrelation, changing opportunity and overdispersion may require specialist methods. Choose the sampling plan and interpretation rules before routine monitoring begins.

One measurement per observation

I-MR candidate; retain time order and assess dependence.

Small rational measurement subgroups

Xbar-R candidate; review spread before averages; choose constants by n.

Fraction of nonconforming units

p chart; retain each sample size and binomial assumptions.

Count of nonconforming units at fixed n

np chart; each unit classified once.

Nonconformities at fixed exposure

c chart; one unit may contain multiple faults.

Nonconformities per varying exposure

u chart; keep counts and exposure, check count-model assumptions.

These are candidates, not automatic approvals. Autocorrelation, overdispersion, rare events and unsuitable opportunity definitions may require other methods.

Follow the evidence and decisions

Inspect the supplied case inputs

Record	Collection design
A: width	One measurement per time point
B: width	Five consecutive units per subgroup
C: pass/fail units	Known sample sizes that vary
D: pass/fail units	Always 100 inspected per sample
E: blemishes	Same inspected area each time
F: blemishes	Different known areas each time

01 / Separate measurements from classifications

Sal marks A and B as measured variables. C and D classify each unit once. E and F can record several nonconformities within one inspection area.

Why: The number format alone is insufficient: both widths and defect counts are numbers. The observation definition determines the statistical question.

Evidence / check: Each record names its unit and whether multiple events can belong to it.

02 / Examine the sampling mechanism

For A he retains time order and considers I-MR. For B he examines whether five consecutive units are a rational subgroup under comparable conditions and considers Xbar-R.

Why: A subgroup is an intentional comparison structure, not any five values pooled for convenience. Serial dependence and measurement fitness can invalidate a simple chart choice.

Evidence / check: Candidate A is I-MR; B is Xbar-R subject to subgroup and measurement review.

03 / Handle unit fractions and fixed-size counts

C uses a p candidate because each sample has a known denominator that may change. D can use an np candidate for the count because its denominator remains 100.

Why: A raw count rises when more units are inspected even if the fraction is unchanged. Fixed-n and variable-n displays must retain their intended scale.

Evidence / check: The selection record preserves each sample size and binomial-model questions.

04 / Handle multiple events and exposure

E uses a c candidate only with comparable fixed exposure. F uses a u candidate with count divided by known exposure and exposure-dependent limits.

Why: Counting blemishes is not the same as classifying a sheet once. A larger area provides more opportunity, and count-model assumptions need scrutiny.

Evidence / check: The record defines the exposure unit and distinguishes multiple faults from affected items.

05 / Qualify the candidate before deployment

Sal records unresolved dependence, opportunity, measurement and response-plan questions. A chart owner must confirm baseline development and reaction rules before operational use.

Why: Choosing a plausible chart is a first decision. It does not establish stability, approve product release or authorize automatic adjustments.

Evidence / check: Every row has a candidate and at least one explicit qualification check.

Completed chart-selection record

Record	Candidate	First qualification
A: individual width	I-MR	Time order, dependence and measurement
B: five-unit width subgroup	Xbar-R	Rational subgroup and matching constants
C: pass/fail, varying n	p	Unit classification and sample-specific limits
D: pass/fail, fixed n = 100	np	Constant inspected sample size
E: blemishes, fixed area	c	Comparable fixed opportunity
F: blemishes, varying area	u	Known varying exposure and count-model fit

The denominator is missing

Record C gives rejected units but omits how many were inspected on two days.

Decision

Retrieve the actual denominators before calculating fractions or limits. Mark the missing observations explicitly; do not assume 100 because another row uses 100.

Reasoning

A plausible-looking graph based on invented exposure would communicate false evidence. Another process's denominator is not a substitute.

What would change the decision?

The record identifies the two missing sample sizes and their owner.

Practise with a changed case

Classify four new records

New fictional records contain one service duration per completed case, six measurements collected across different machines, multiple faults over varying inspected cable lengths, and pass/fail counts from a fixed 50-unit sample.

Record	Design issue
Service duration	One observation at each completion
Six measurements	Mixed machines in one proposed subgroup
Cable faults	Known varying length
Pass/fail	Fixed n=50

Your task

1. Choose a candidate or explain why the sampling design must be repaired first.
2. State the relevant denominator or subgroup rationale.
3. Name a conclusion that choosing the chart does not establish.

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

Your practice worksheet

Classify four new records

Data definition

Time/subgroup/exposure

Candidate

Assumption gap

Response owner

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

Check your reasoning and transfer it

1. I-MR is a candidate for individual duration, subject to distribution/dependence and measurement review. The six mixed-machine readings are not automatically a rational subgroup; preserve source identity and design the grouping first.

2. Use u as a candidate for multiple faults per varying cable length, and np for nonconforming-unit count at fixed 50. A p display of the same fixed-size unit fractions is also defensible if its scale is clear.

Suggested completed record

Record	Candidate or action	Boundary
Duration	I-MR candidate	Assess dependence and distribution
Mixed measurements	Repair subgroup design	Do not pool unlike conditions casually
Cable faults	u candidate	Known comparable opportunity per length
Fixed 50 pass/fail	np or clearly labelled p	One classification per unit

Plausible wrong turns

1. A tool choice is not a stability finding.

2. A u rate counts multiple faults; a p fraction classifies units.

Evidence of a sound answer

1. Keep unit and event counts distinct.

2. Identify the invalid mixed subgroup.

3. Accept justified alternatives with explicit assumptions.

Take the learning back to work

Commitment	Agreed follow-through
Owner	SPC owner and process measurement lead
Record	Chart-selection, sampling and response-plan record
Review	Before baseline collection and after process/sampling changes
Verification evidence	A defined observation, defensible model and reviewed reaction plan
If unresolved	Redesign sampling or seek a suitable specialist method instead of forcing a familiar chart.

Help someone else apply the method

Prepare

1. Six source-record cards
2. Blank chooser table
3. Changed four-record exercise

Minutes	Activity and coaching prompt
5	Define the observation Can one item contribute more than one count?
8	Explain each route What changes when n or exposure changes?
10	Challenge the mixed subgroup What variation would pooling hide?
5	Debrief implementation Who approves the baseline and response?

Debrief

1. Do not mark a justified fixed-n p alternative wrong.
2. Require an assumption check even for a correctly named chart.

Individual or remote practice

Annotate the sampling mechanism before looking up any chart name.

Connect the method and check its boundaries

Before application

1. Defined data type and opportunity
2. A rational sampling plan

Outside this lesson

1. Every specialist chart family
2. Automatic treatment of autocorrelation or overdispersion

NIST: Control chart families

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Chart selection distinguishes measured variables, attributes and multivariate statistics.

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

NIST: Attributes charts

NIST: Attributes charts

Nonconforming units differ from counts of nonconformities; p, c and u charts address different data definitions.

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Open this lesson and its visual aids