

Selection: The most critical part of maintenance

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- Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Department of Energy.

Outline

- Motivation
- SAGE
- Selection
 - Choice of when to start
 - Choice of location
 - Choice of action
 - Choice of diagnostic
- Impact of Selection on Benefits / Value

Motivation

- The goal of proactive maintenance is to prevent future service failures
 - Wholesale Replacement
 - Targeted Maintenance
- A Targeted Maintenance program uses diagnostic test(s) to identify the “weak” circuits.
- Program carries upfront costs that must be offset by program benefits.
- The economics of diagnostics are difficult to model and even more difficult to quantify. Must be used to quantify the benefits.

SAGE

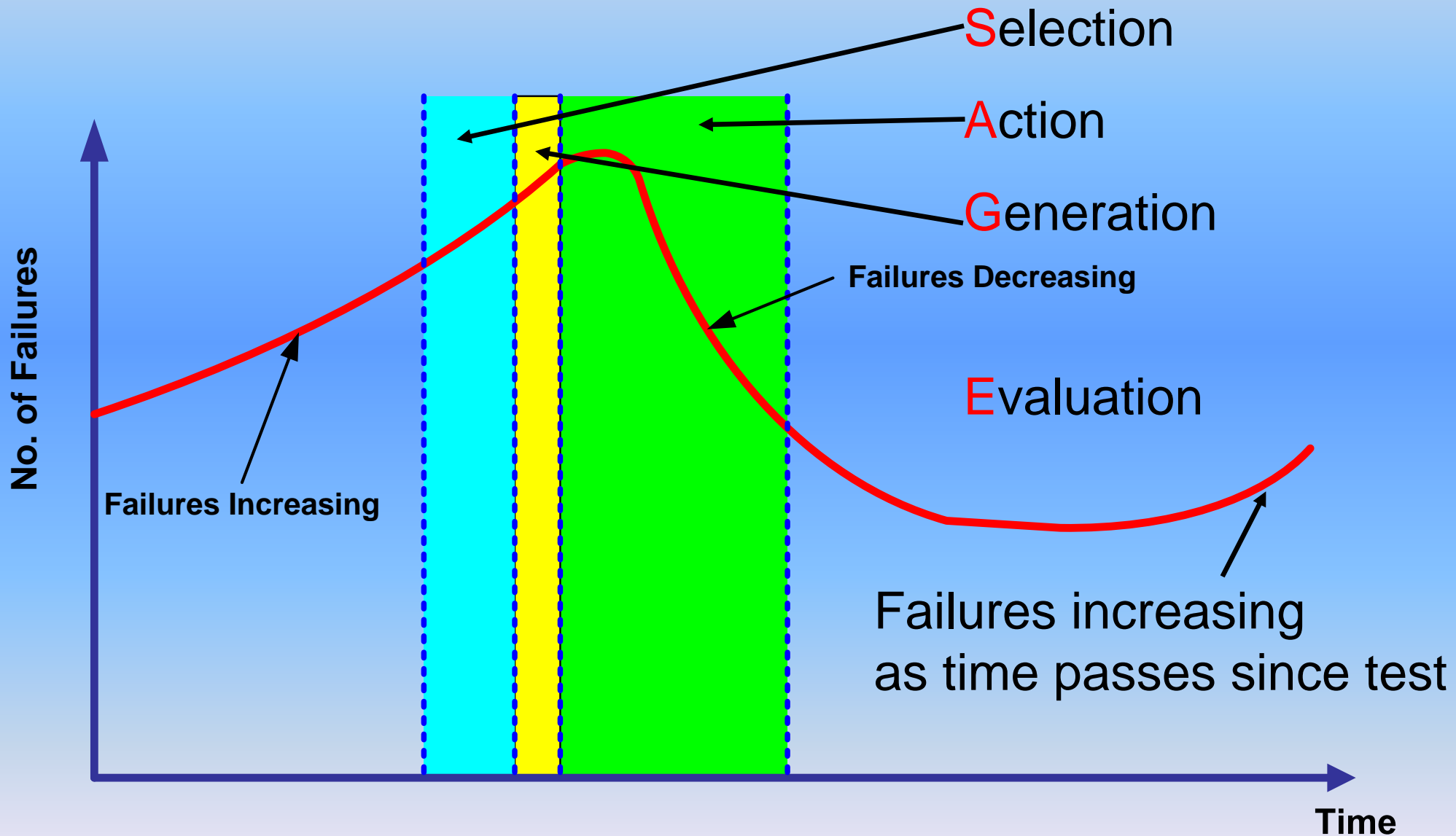
A Useful Way to Visualize this

SAGE

- **S**election of circuits
- **A**ctions that might be taken
- **G**eneration of data – including Diagnostics
- **E**valuation of the outcome

The name of the herb Sage comes from the Latin salvere or salvation meaning 'to be in good health, to cure, to save.'

Expectations



Selection

Choice of when to start

Choice of location

Choice of action

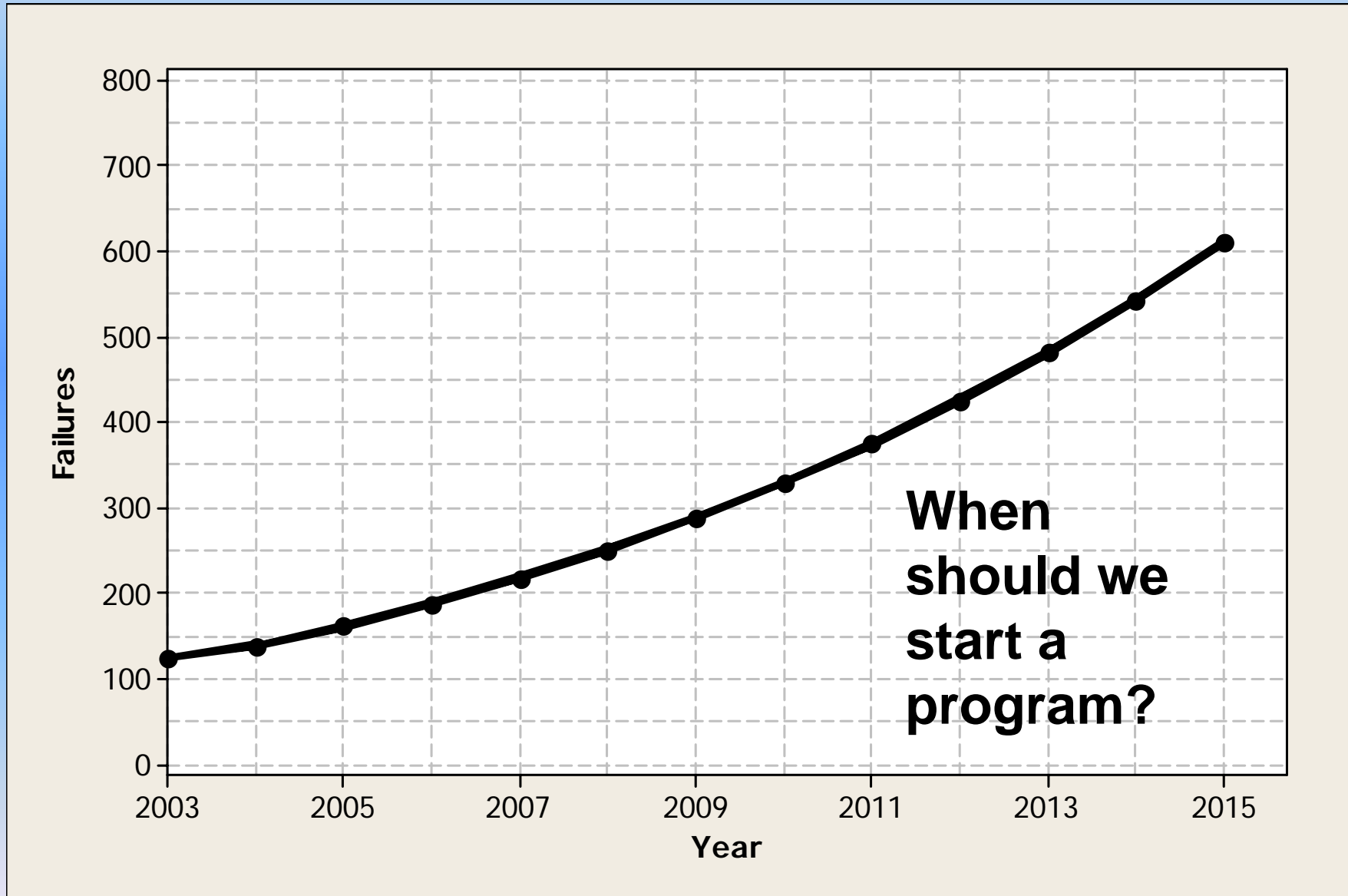
Choice of diagnostic

When to start?

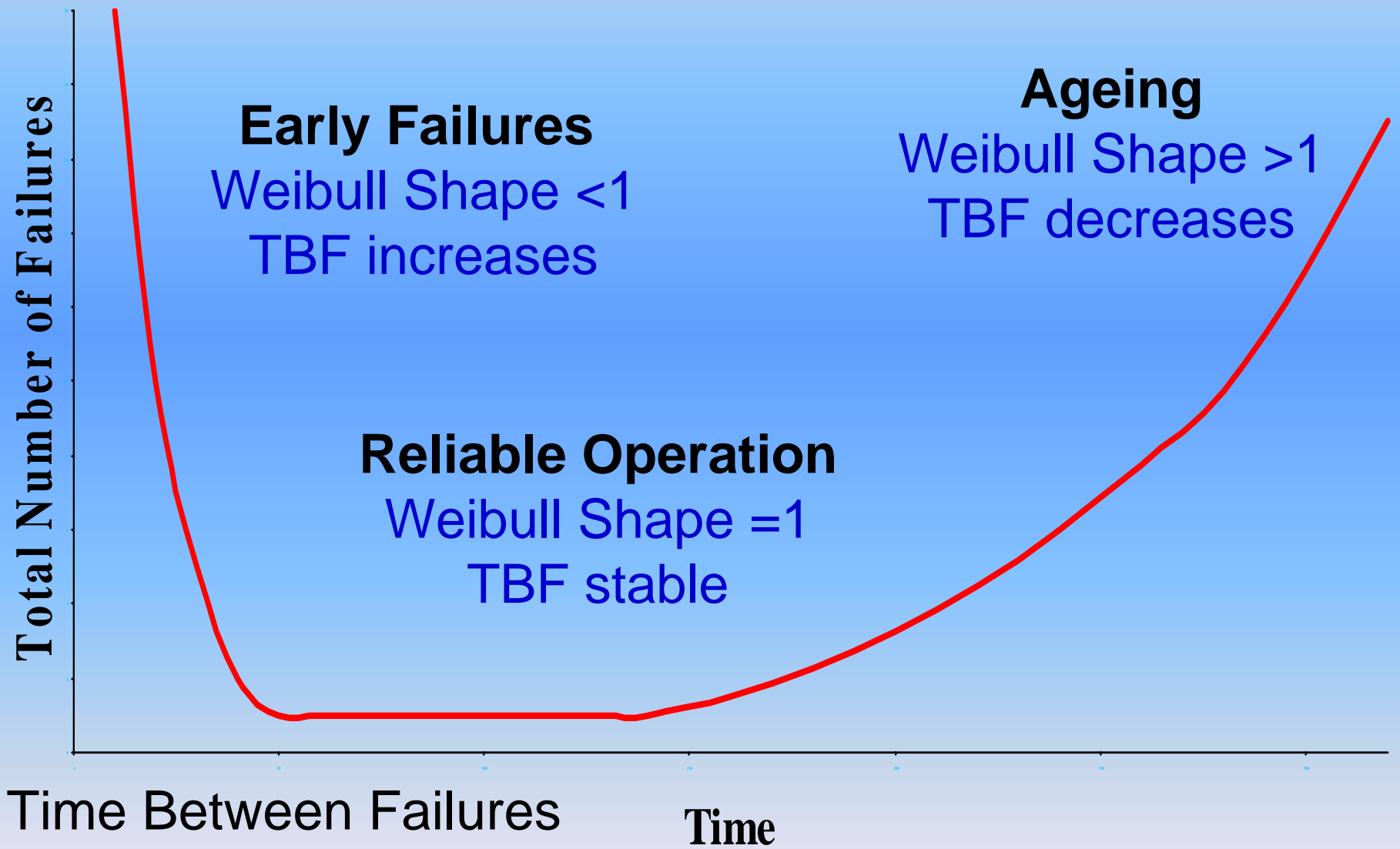
How to spot the trend

How late can you leave it before it is too late

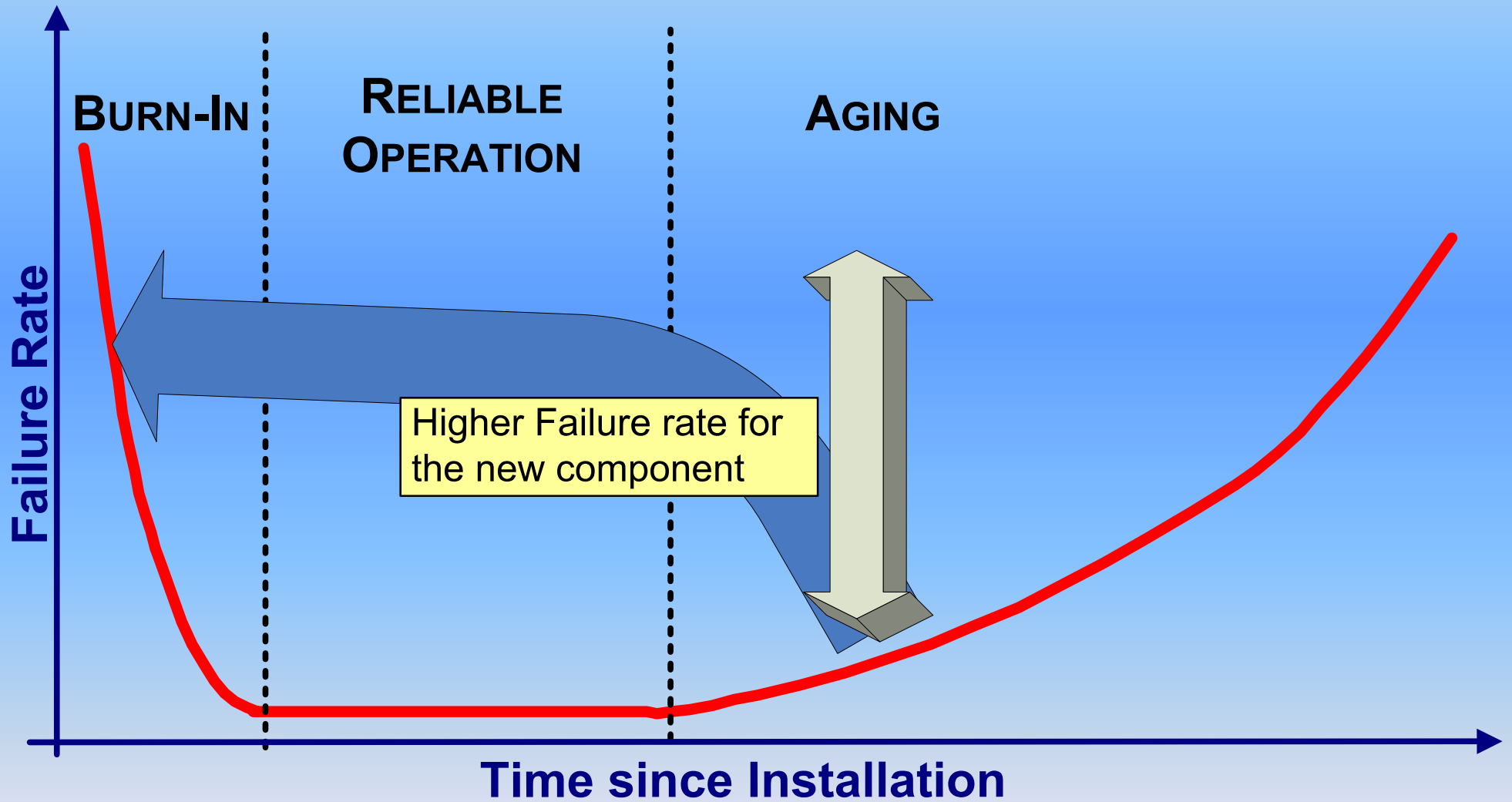
Falling Reliability



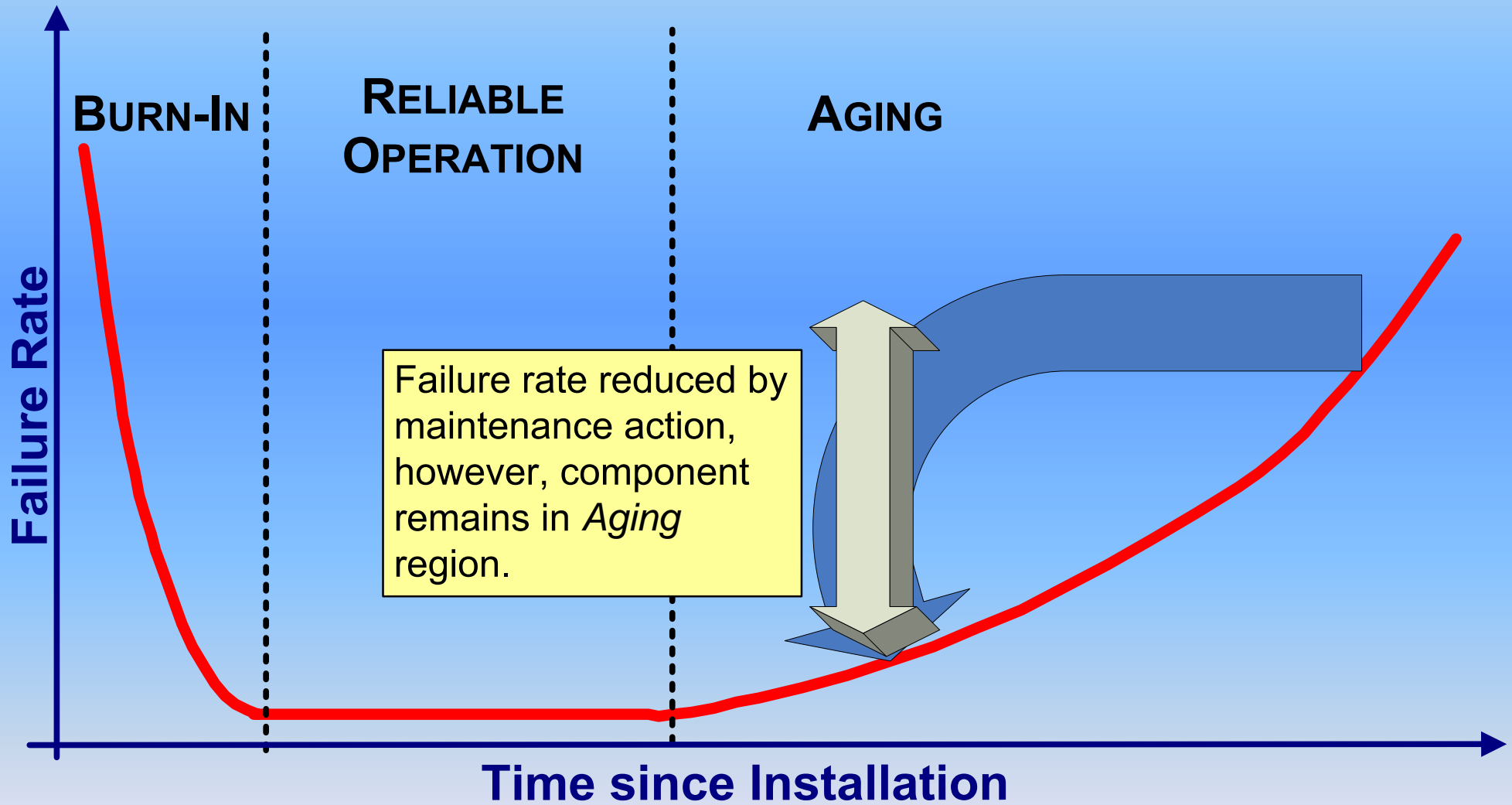
Bathtub Curve for Failures



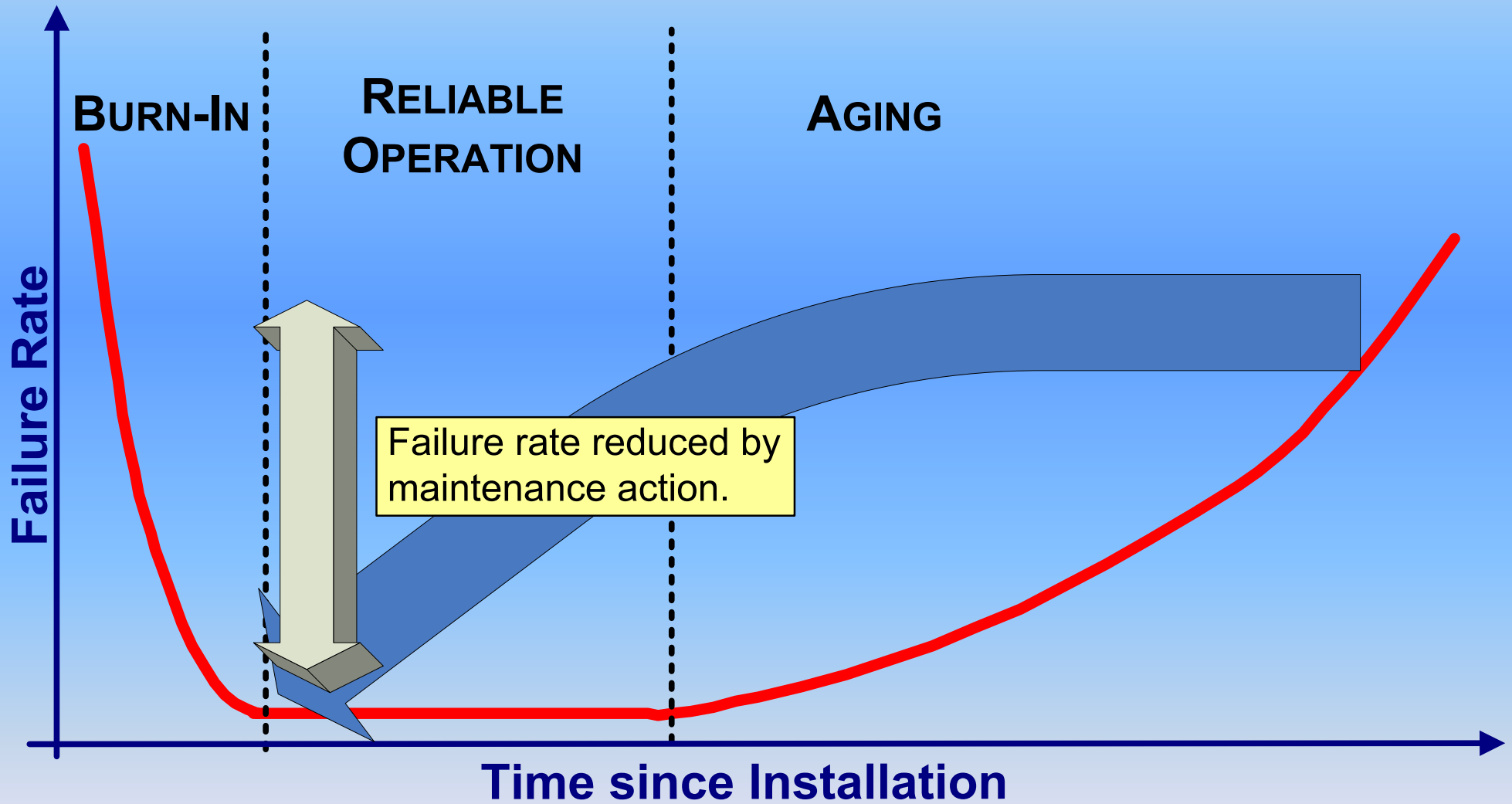
Too Soon



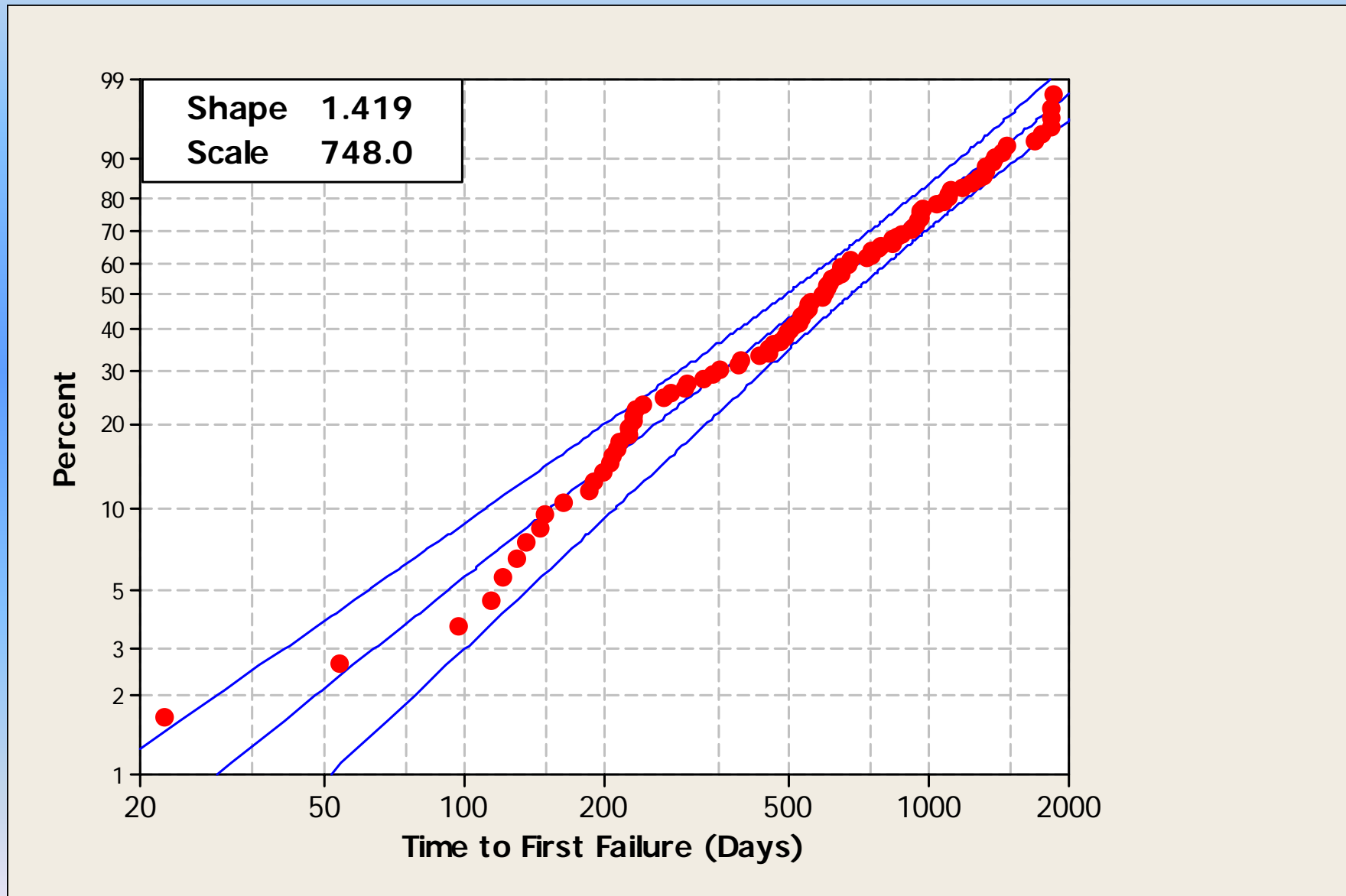
Too Late



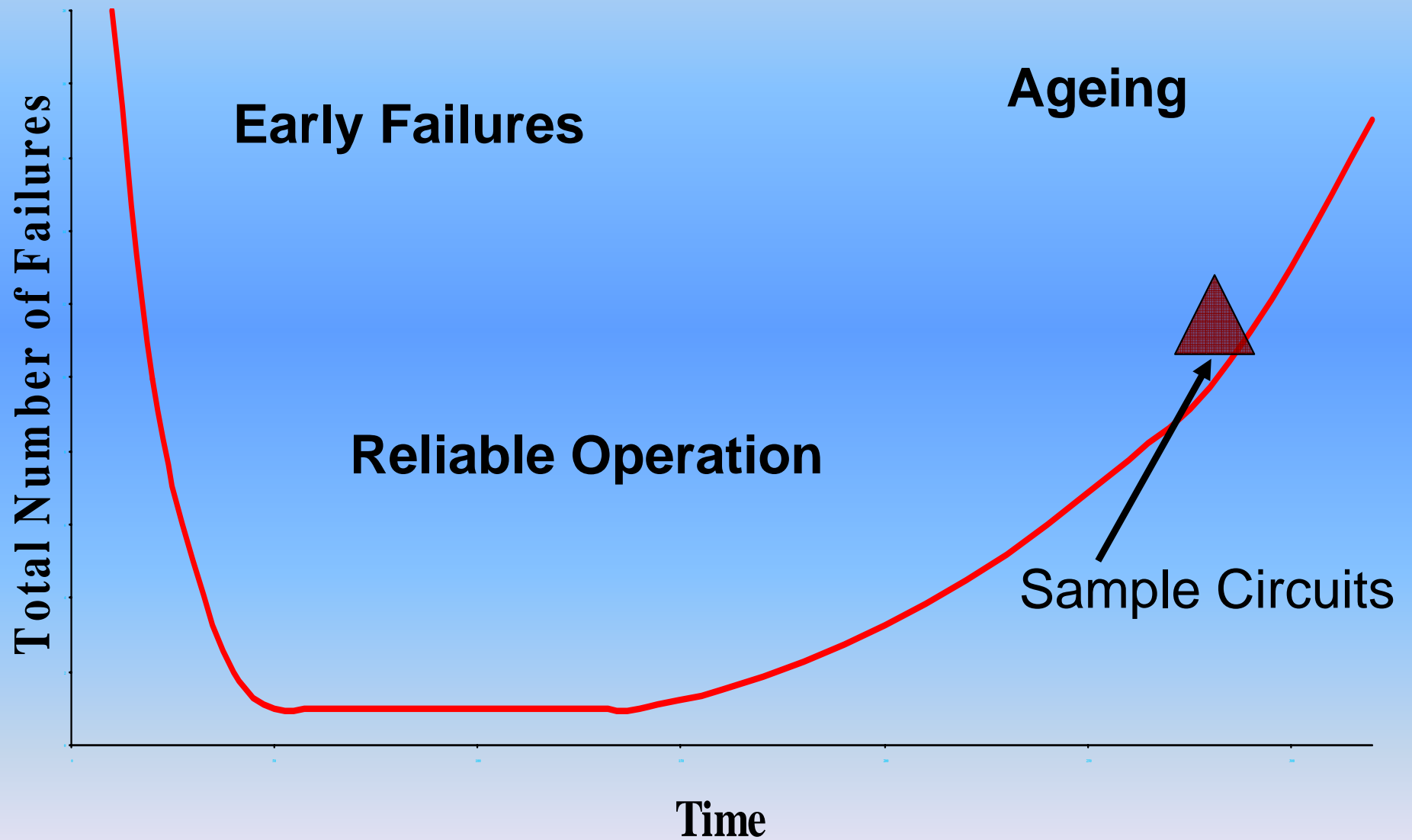
Just Right...



Sample Circuit Population



Bathtub Curve

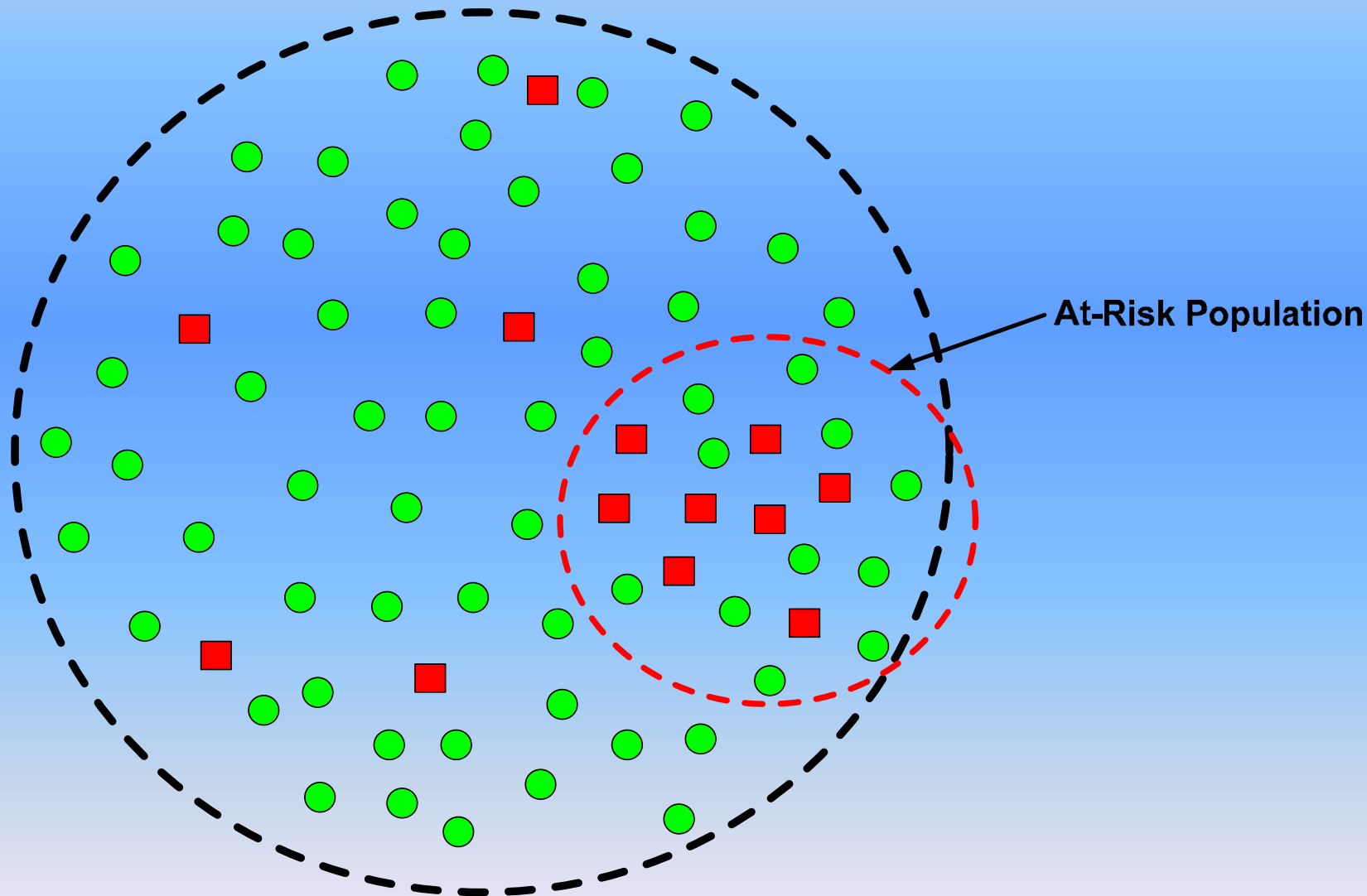


Location

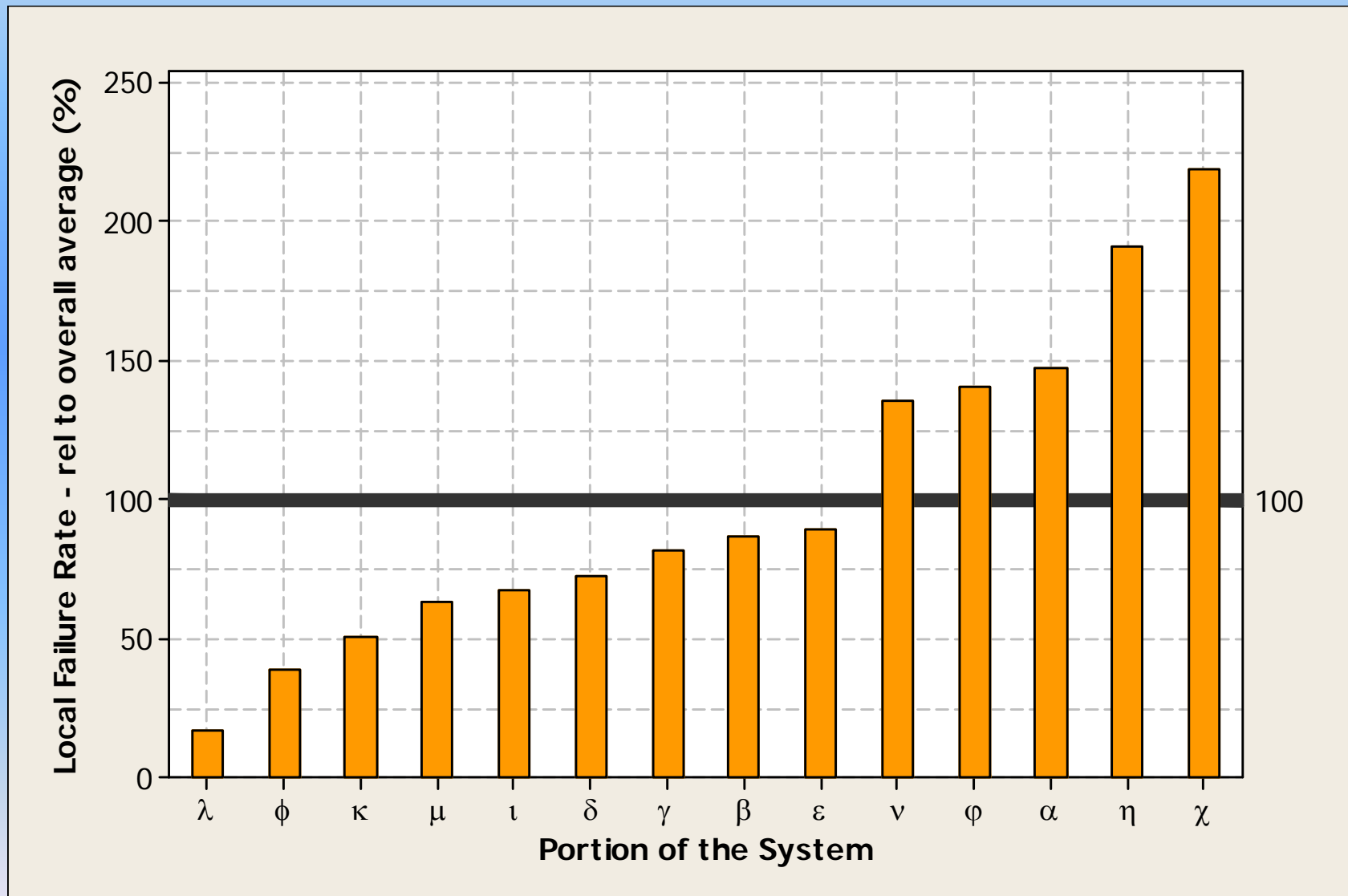
The failure rate is not the same everywhere

Selecting from the Whole Population

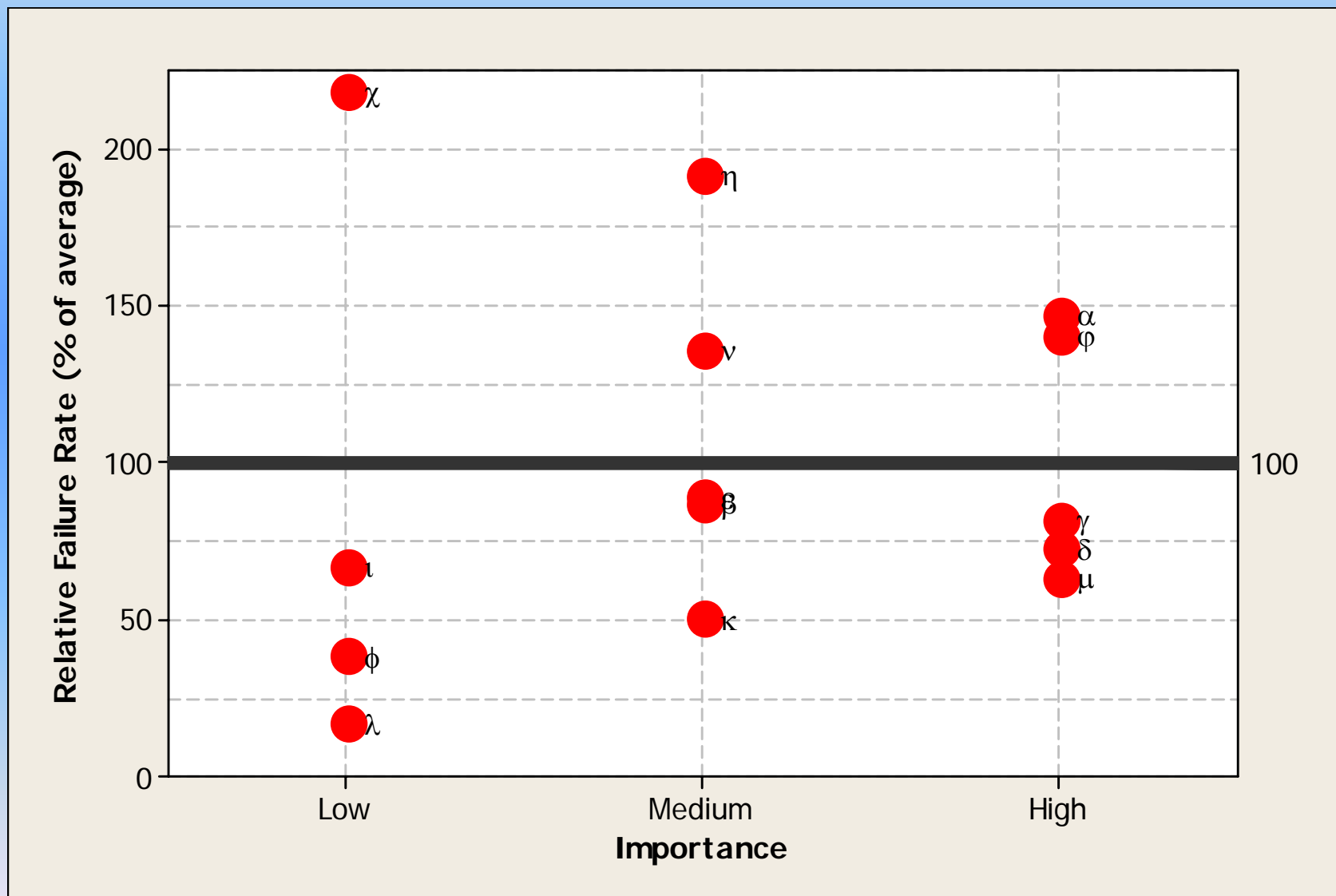
Total Component Population



Local Failure Rates



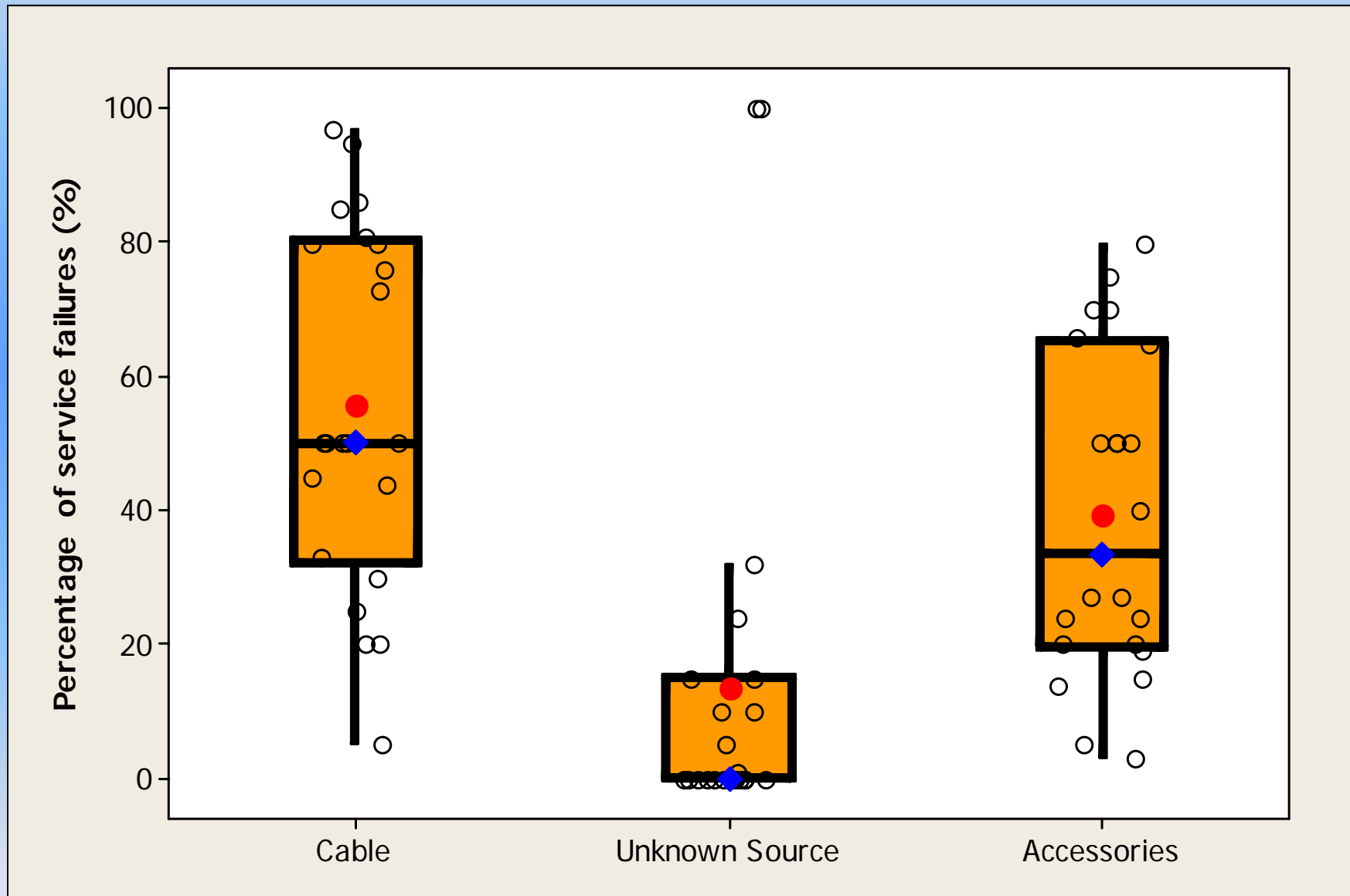
Local Failure Rates - Importance



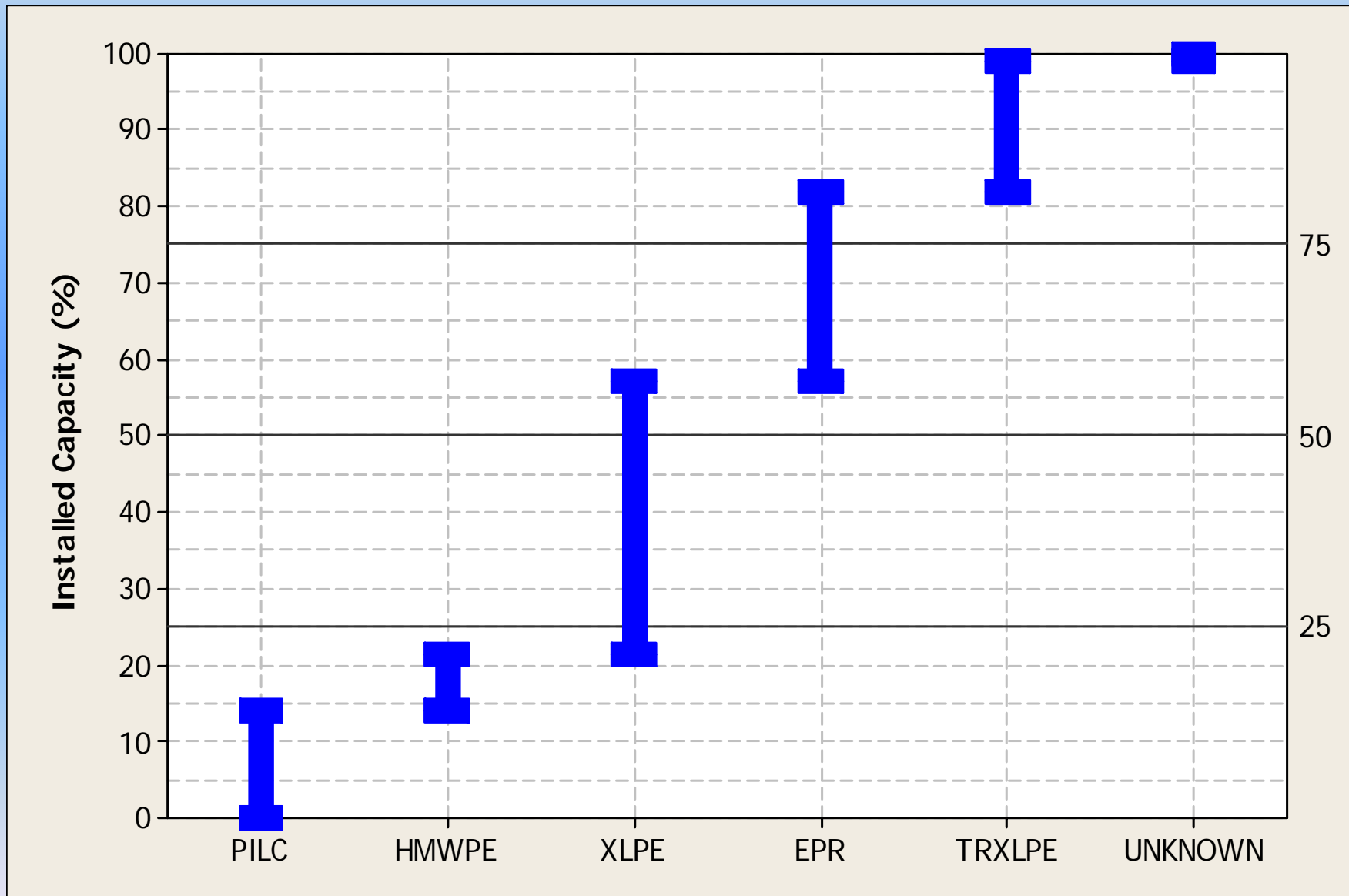
Action

How the circuits fail will determine how they are fixed
Age and Type will also determine actions

Failures by Equipment Type



Length adjusted MV system



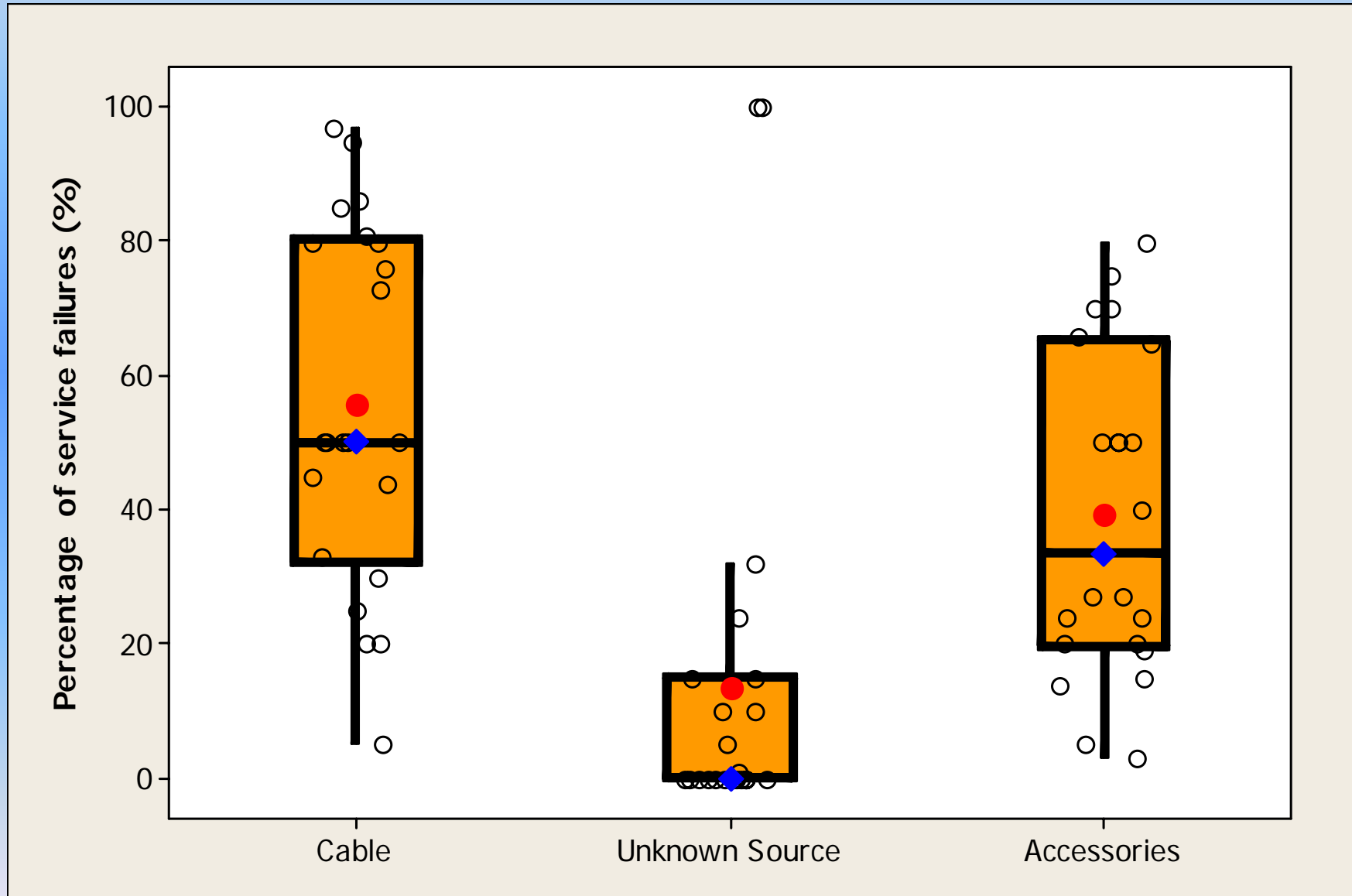
Diagnostic

What diagnostic to use for which actions and
equipment

Selection of Diagnostic

- Diagnostic technologies are available that provide either localized or global assessments of circuits.
- These techniques should fit with the actions that will be taken.
- Diagnostic should be sensitive to the prevalent failure mechanism.

Failure by Equipment Type



Economic Benefit

Data for Economics Calculations

Different data are needed before one can begin to compute the economics for diagnostic programs

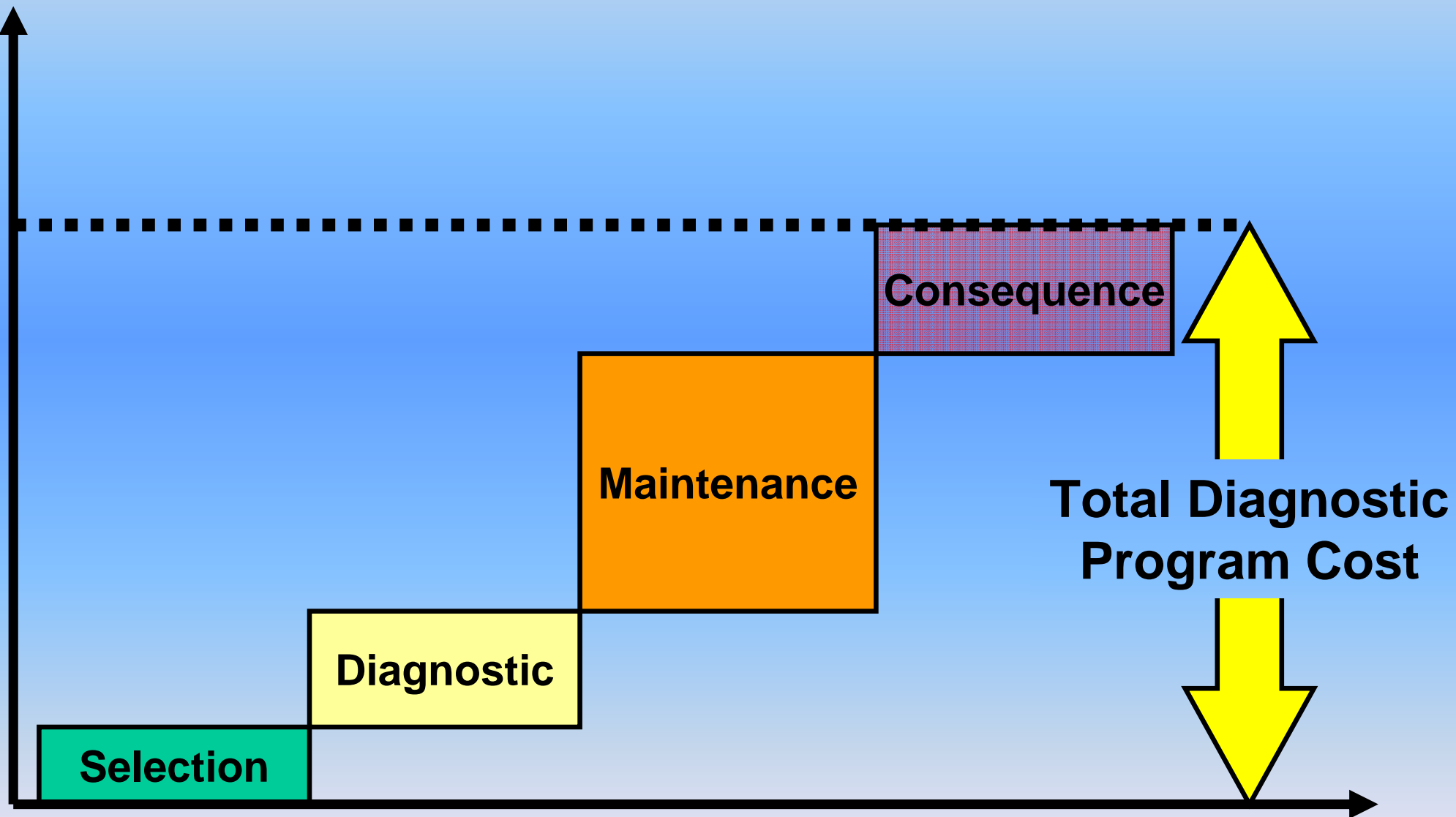


System

Diagnostic

Diagnostic Program Costs

Cost [\$]



System Data

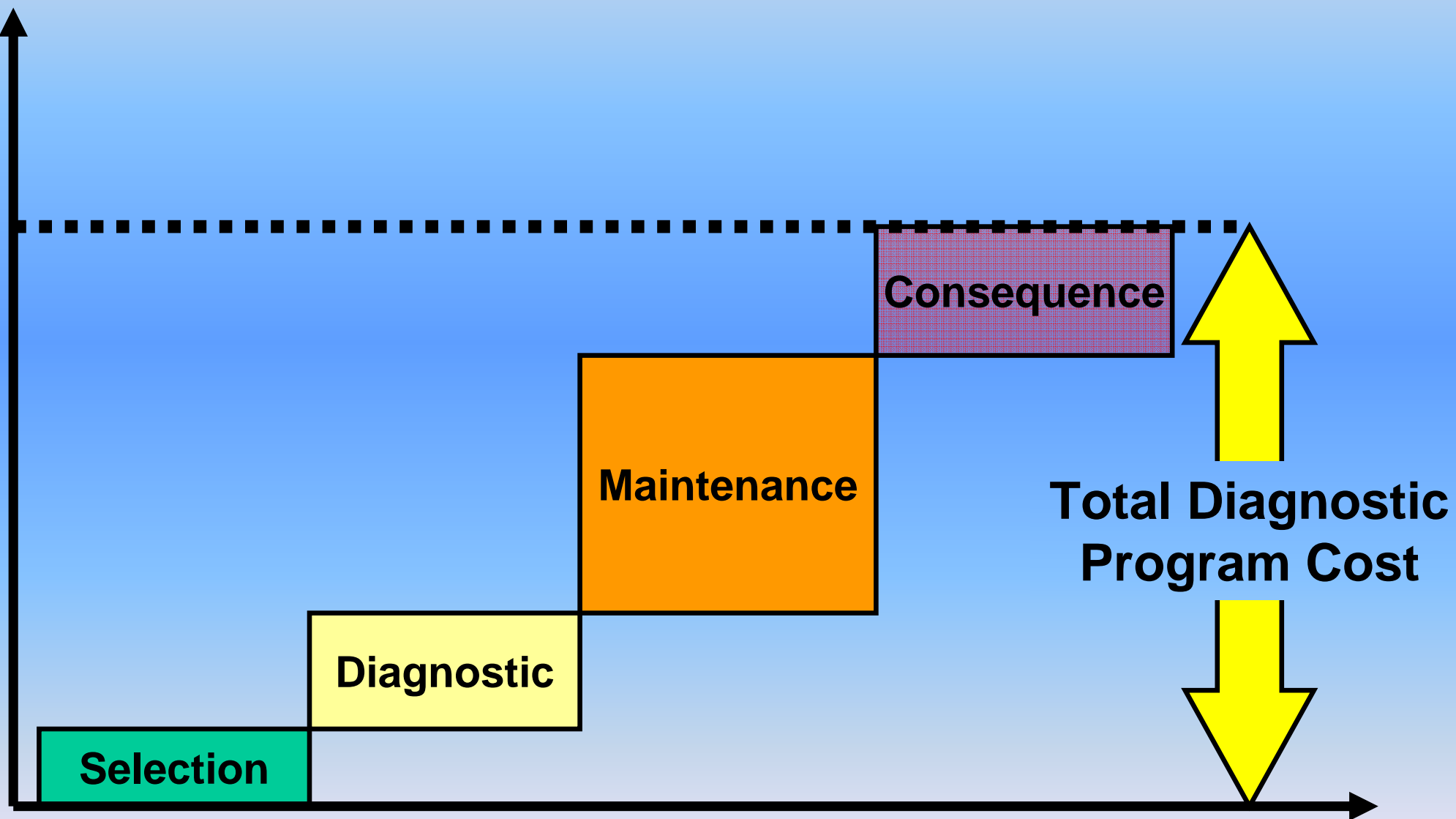
- Failure Rate
 - Global
 - Local
- Maintenance/Replacement costs
 - repair
 - rejuvenation
 - replacement
- Cost of Poor Reliability
 - Reliability indices
 - Customer, regulator, or media intervention
 - Emergency restoration cost

Diagnostic Data

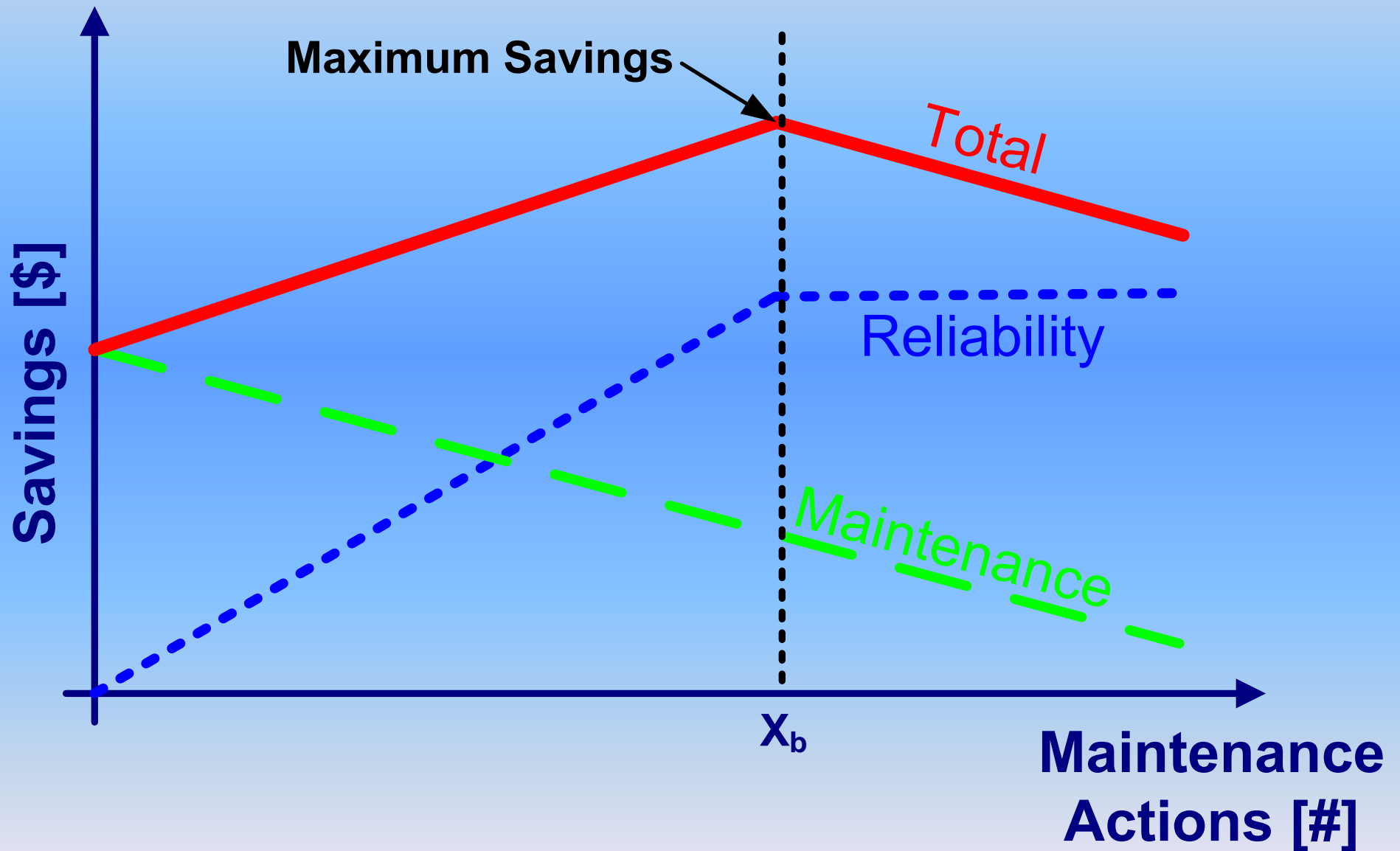
- Selection
- Testing
 - Diagnostic vender or equipment
 - Switching crew
- Pilot Study data from testing in other areas
 - Percent of tested population requiring each level of maintenance (i.e. percent of segments that needed to be replaced according to diagnostic)
- Percent of tested segments failing on test
- Accuracy (i.e. how often do segments perform as diagnosed?)

Diagnostic Program Costs

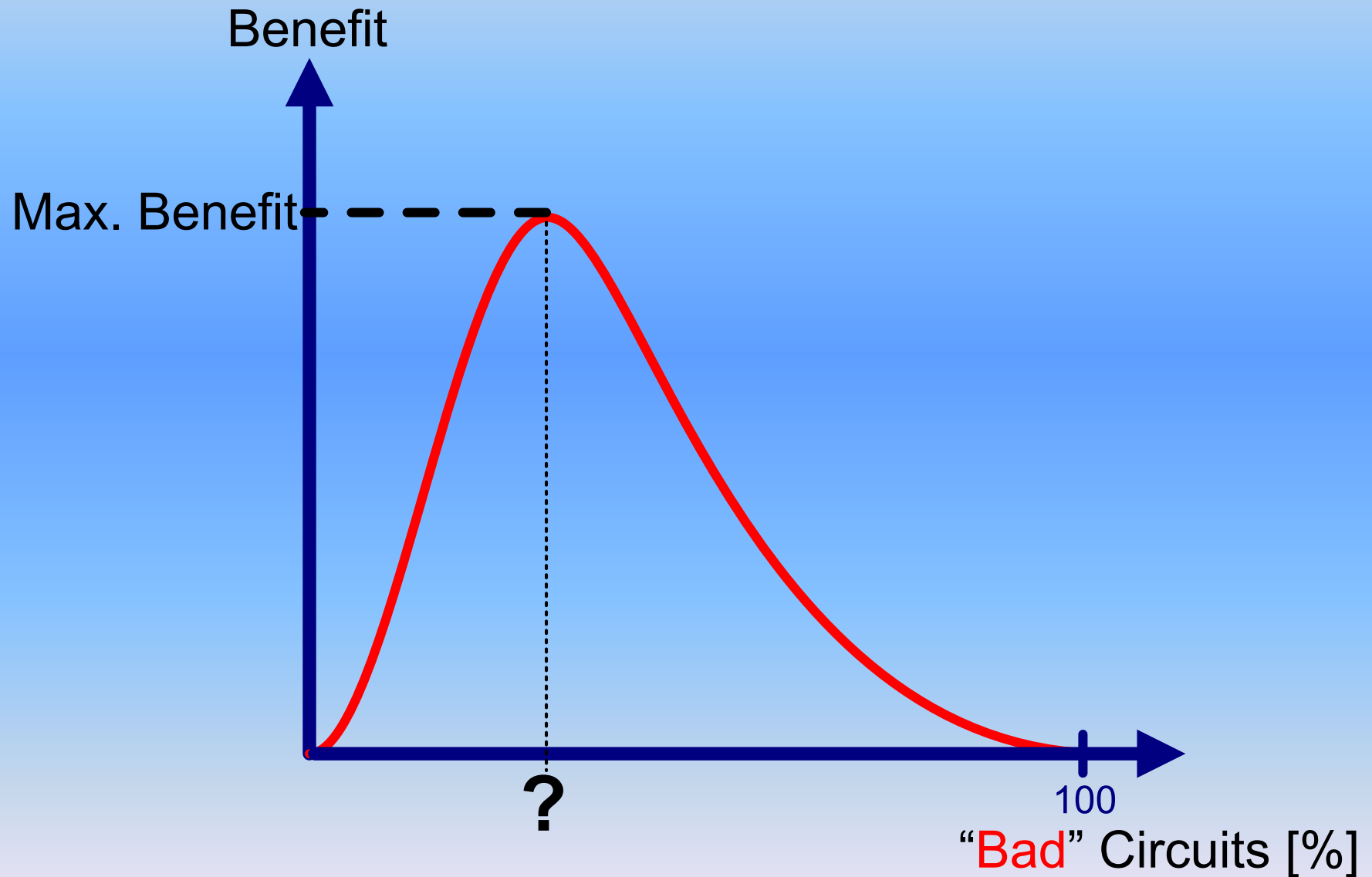
Cost [\$]



Program Savings



Population Composition



Summary

- Selecting the right segments to test is key to achieving good performance from the diagnostic program
- Selection should focus on failure rates and importance of circuits.
 - System cannot be either “too good” or “too bad”.
- Chosen diagnostic technique should match the system characteristics (i.e. failure mechanism) and possible maintenance actions
- A diagnostic program requires substantial planning to be effective.