Selection:
The most critical part of maintenance

N. Hampton & J. Perkel

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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

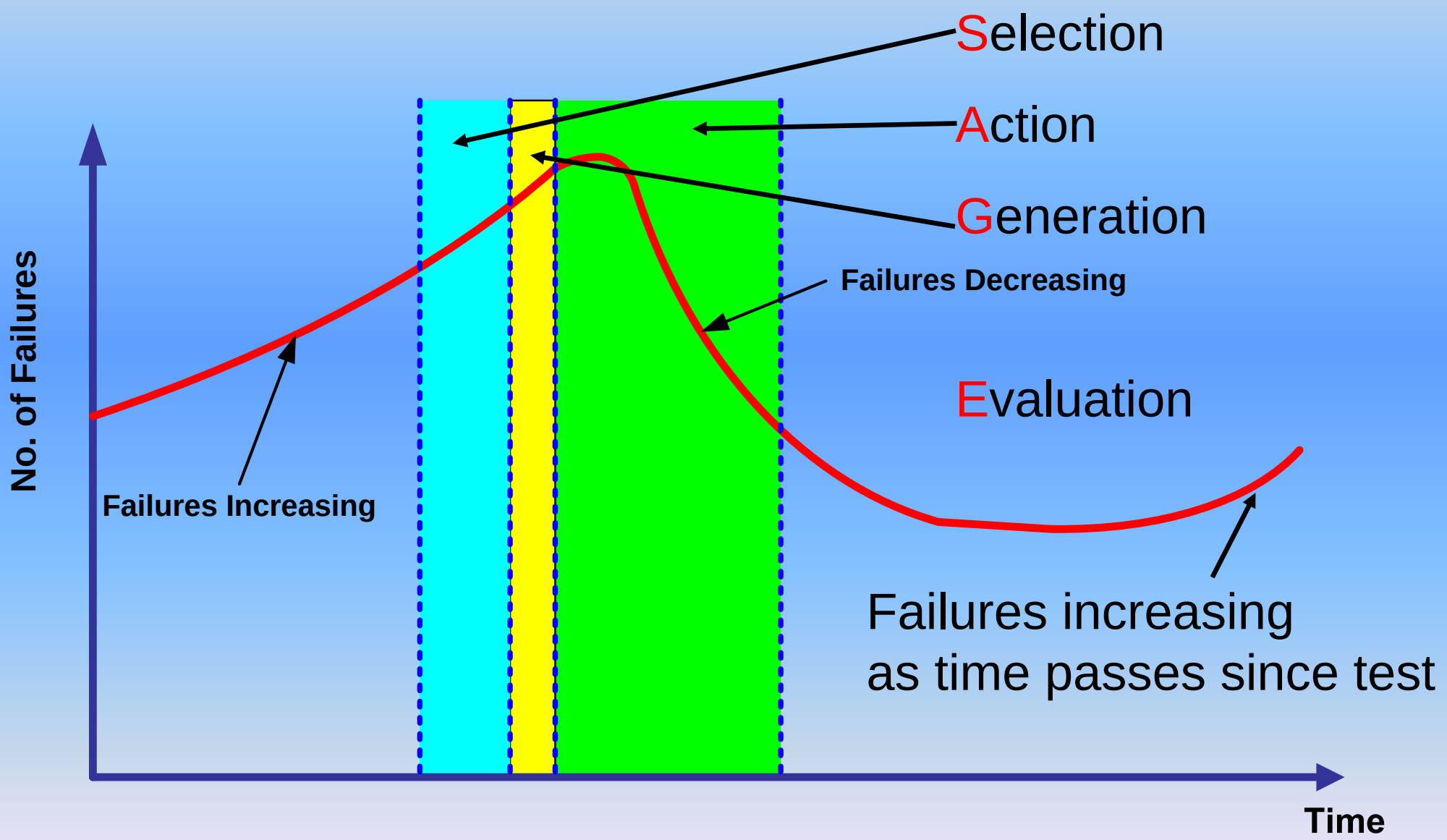
A Useful Way to Visualize this

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

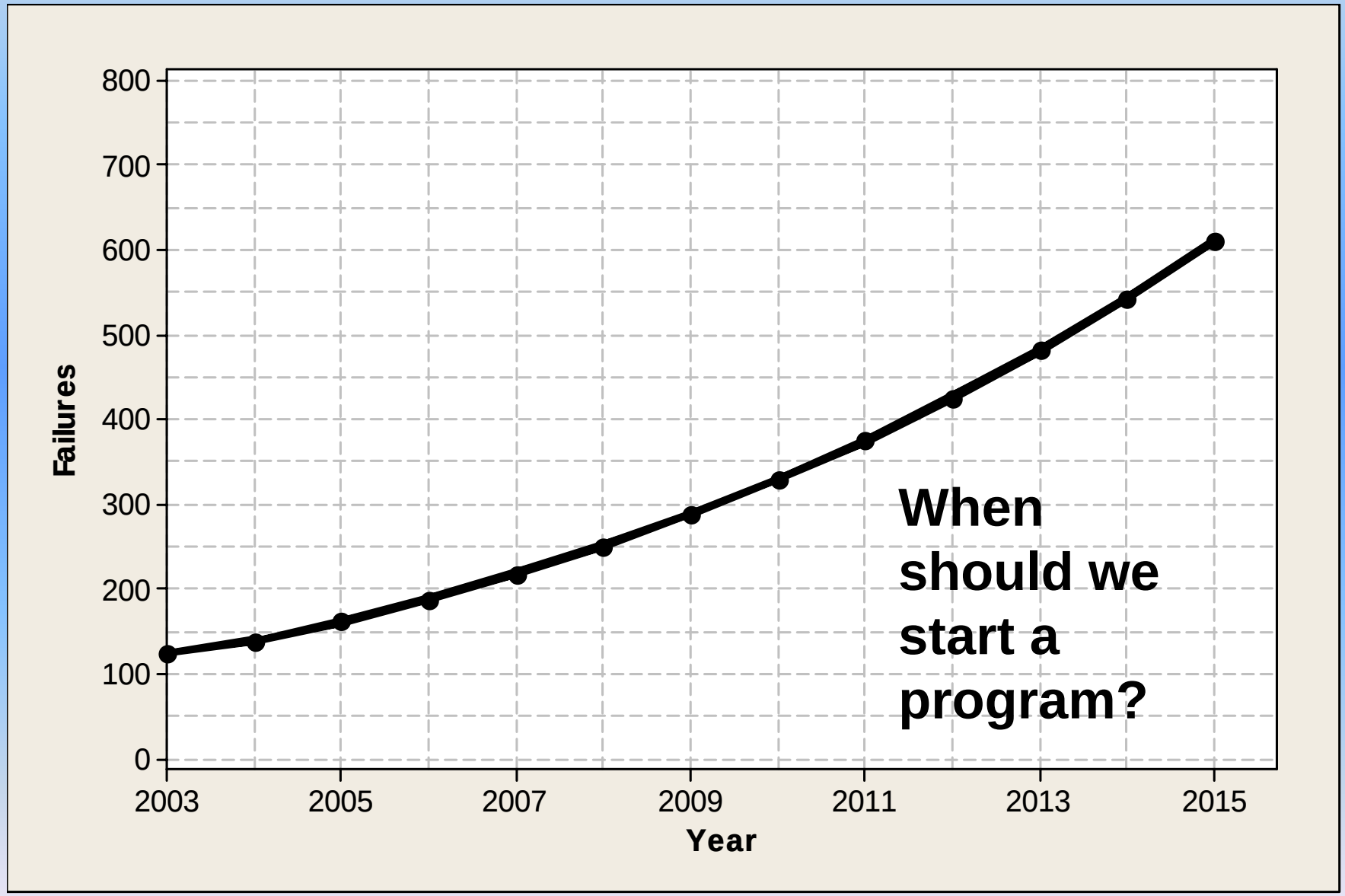
Choice of diagnostic

When to start?

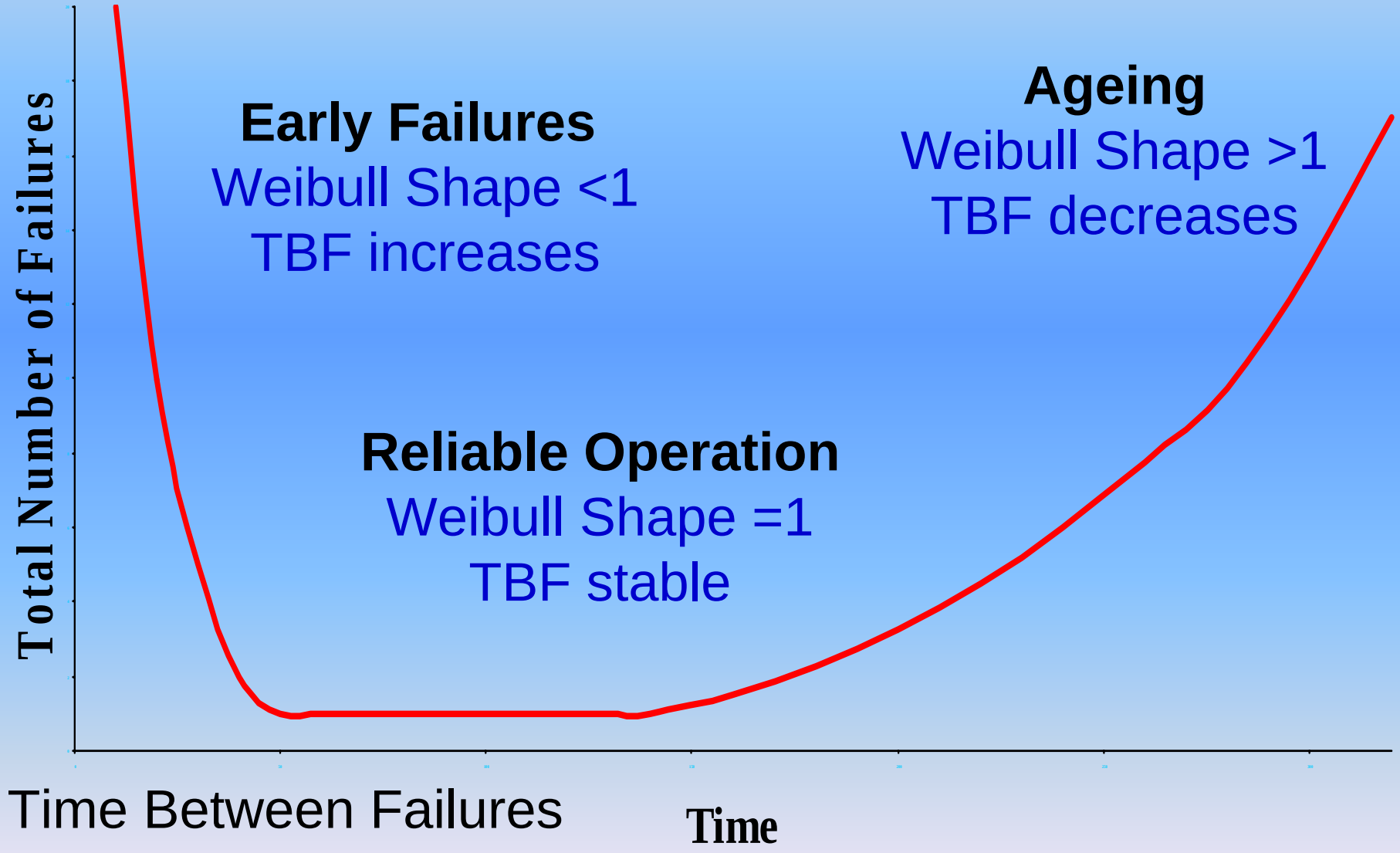
How to spot the trend

How late can you leave it before it is too late

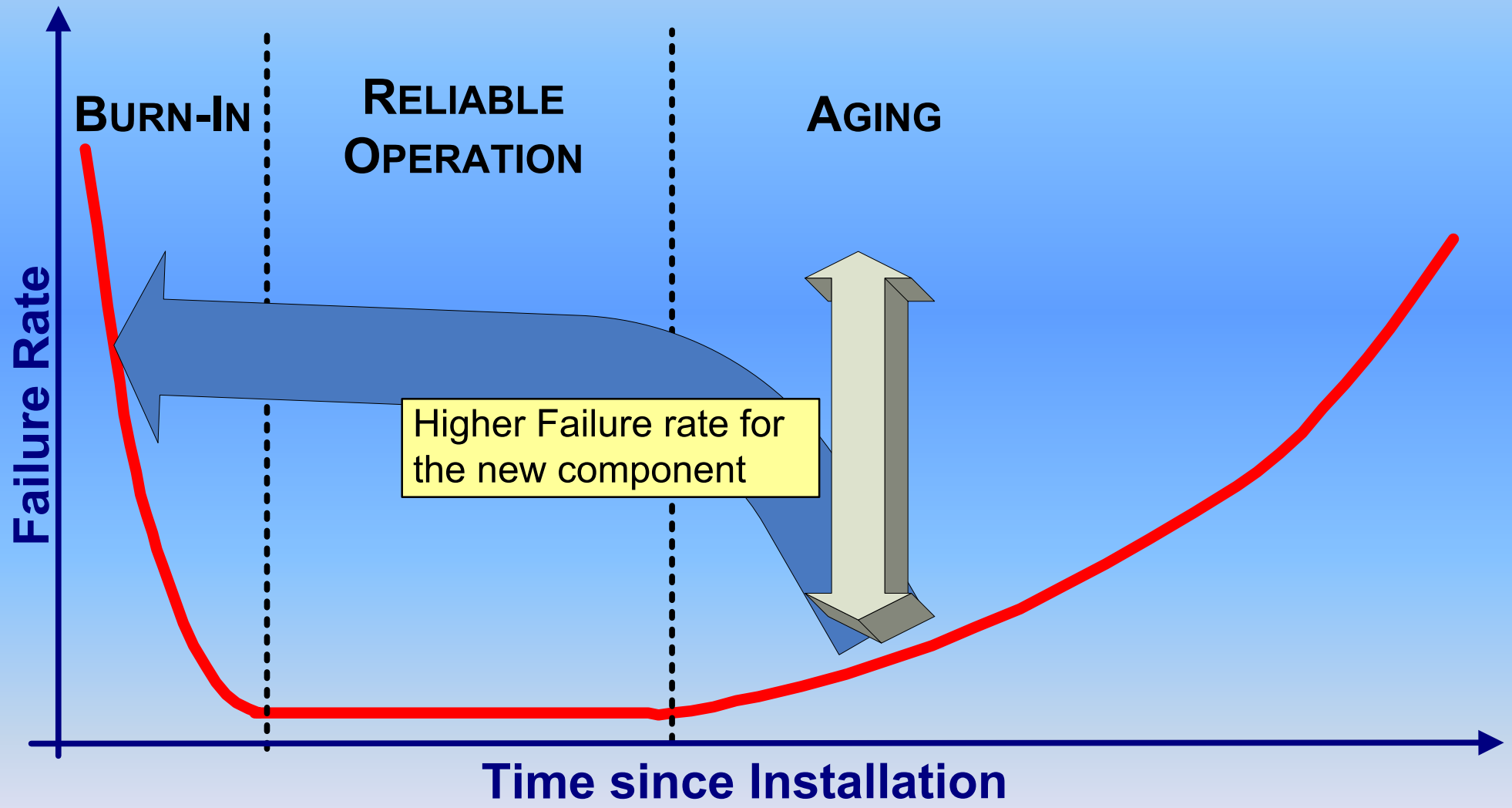
Falling Reliability



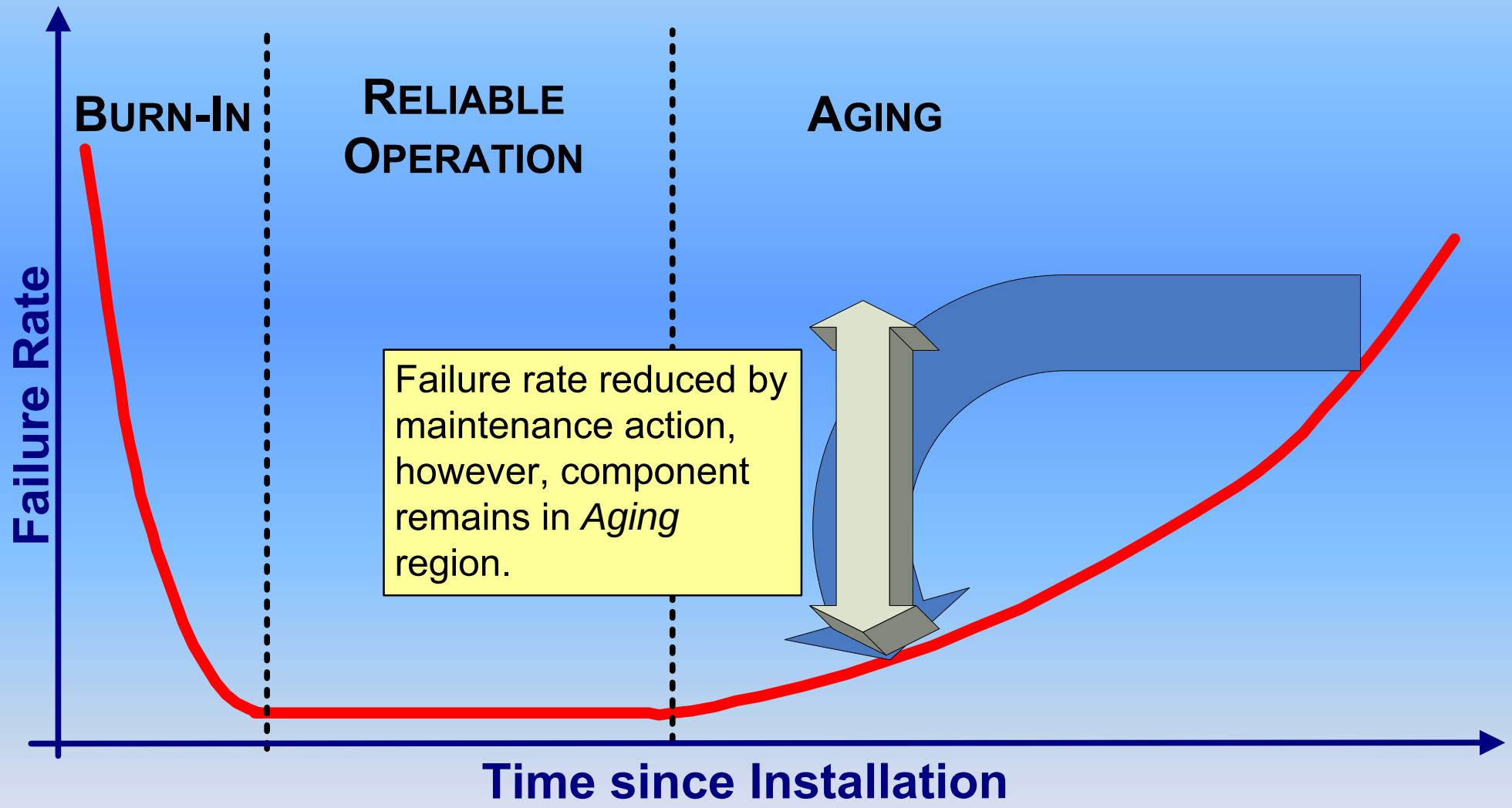
Bathtub Curve for Failures



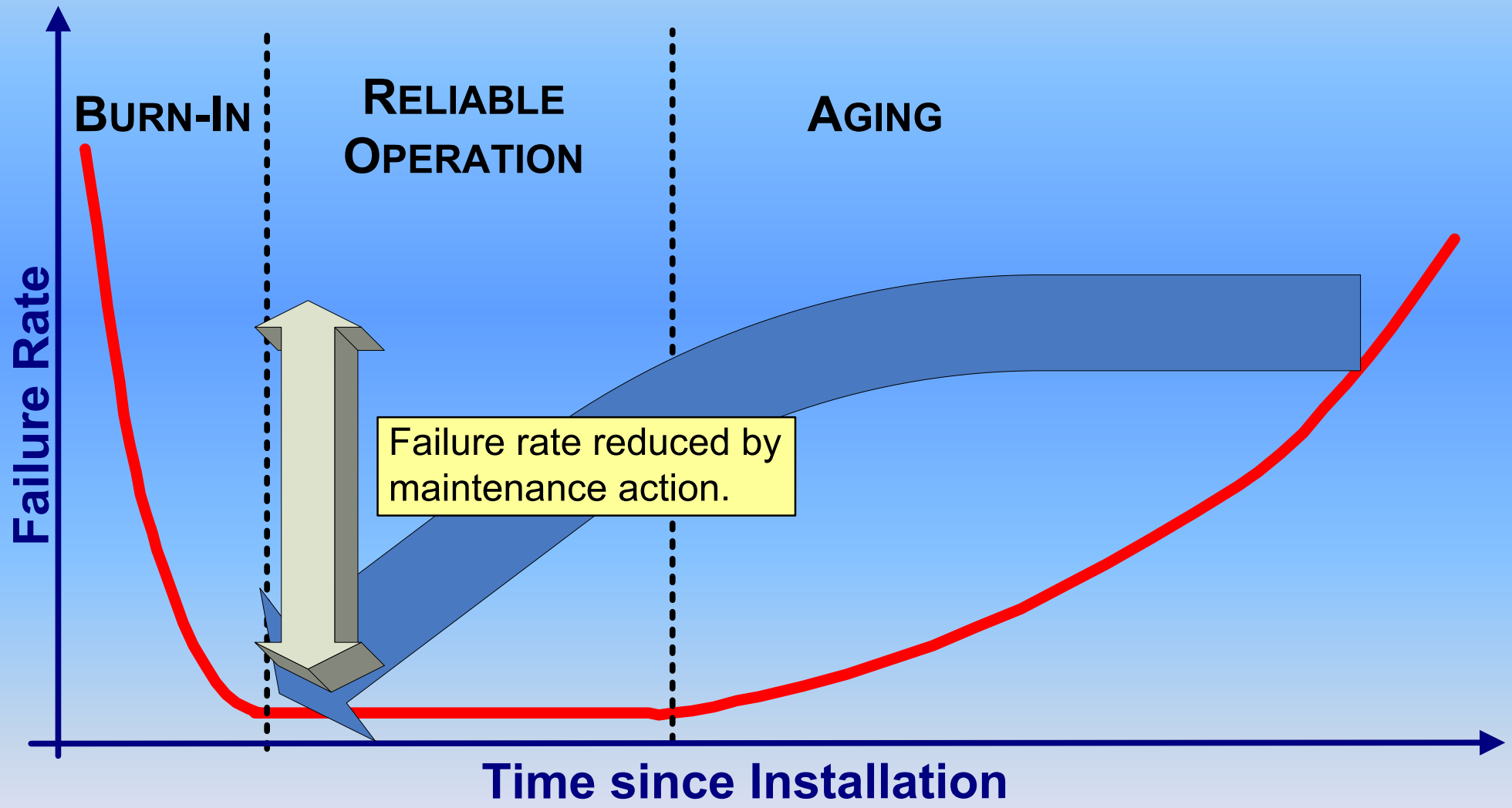
Too Soon


BURN-IN
RELIABLE OPERATION
AGING
Failure Rate
Higher Failure rate for the new component
Time since Installation

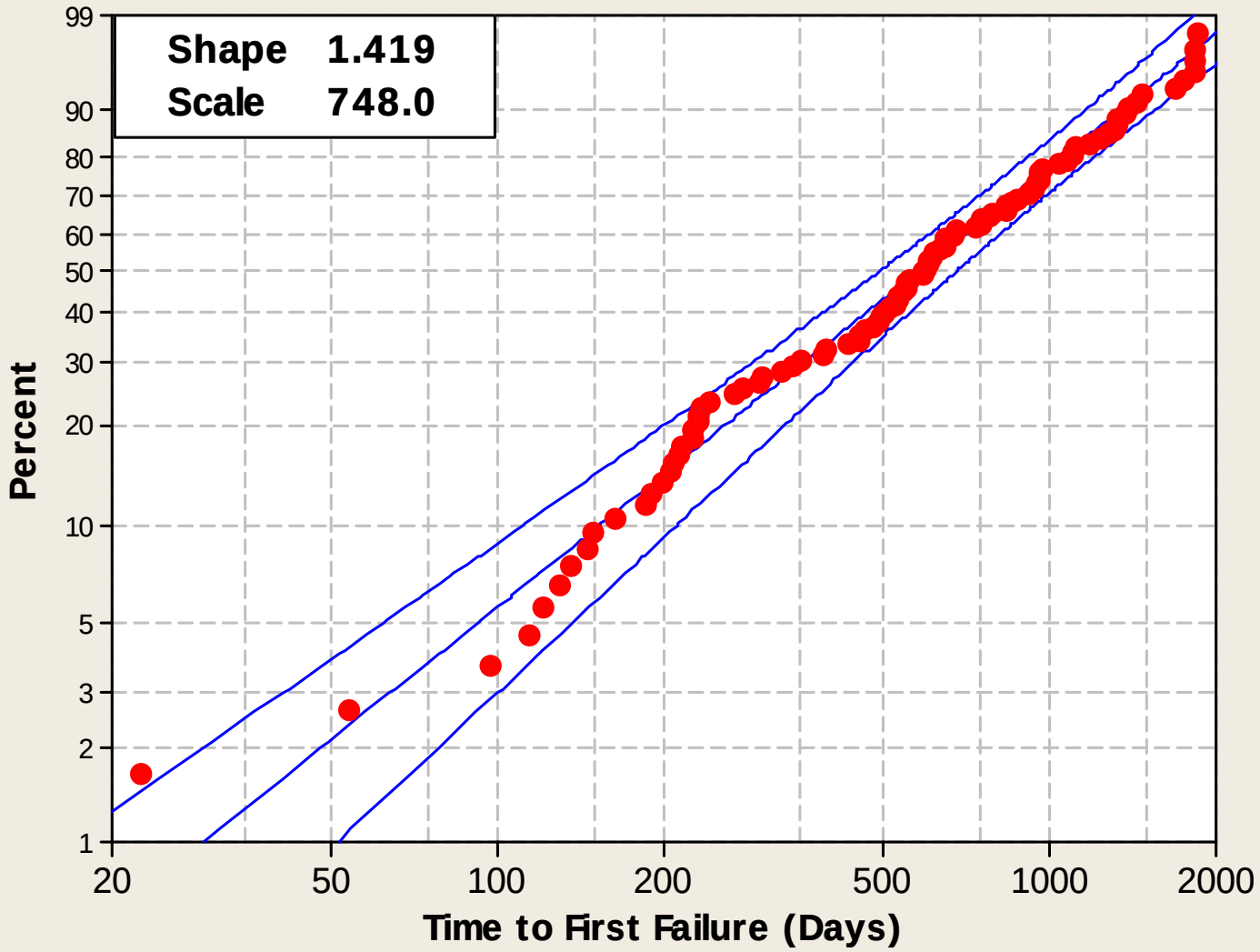
Too Late


BURN-IN
RELIABLE OPERATION
AGING
Failure Rate
Failure rate reduced by maintenance action, however, component remains in *Aging* region.
Time since Installation

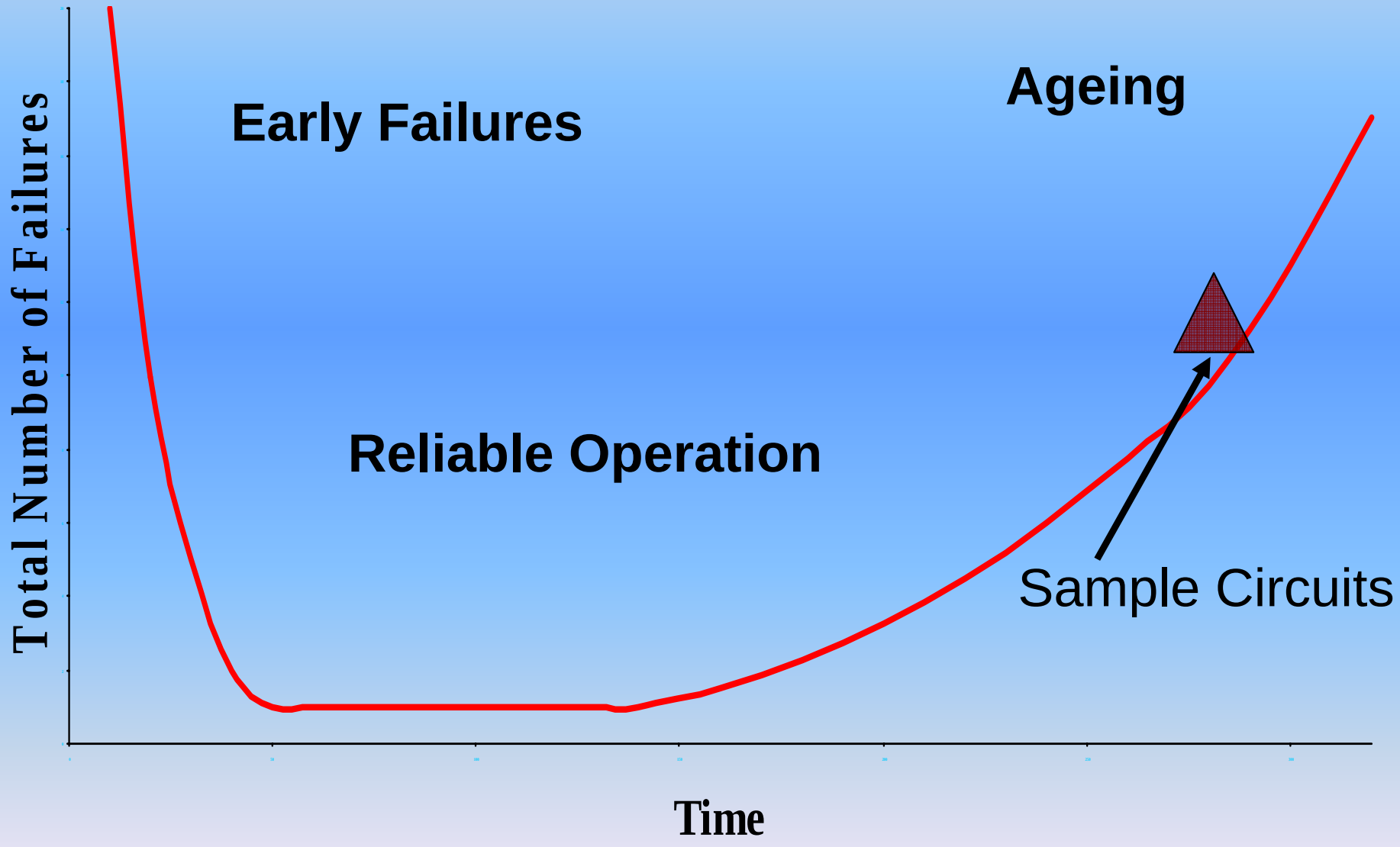
Just Right...


BURN-IN
RELIABLE OPERATION
AGING
Failure Rate
Failure rate reduced by maintenance action.
Time since Installation

Sample Circuit Population



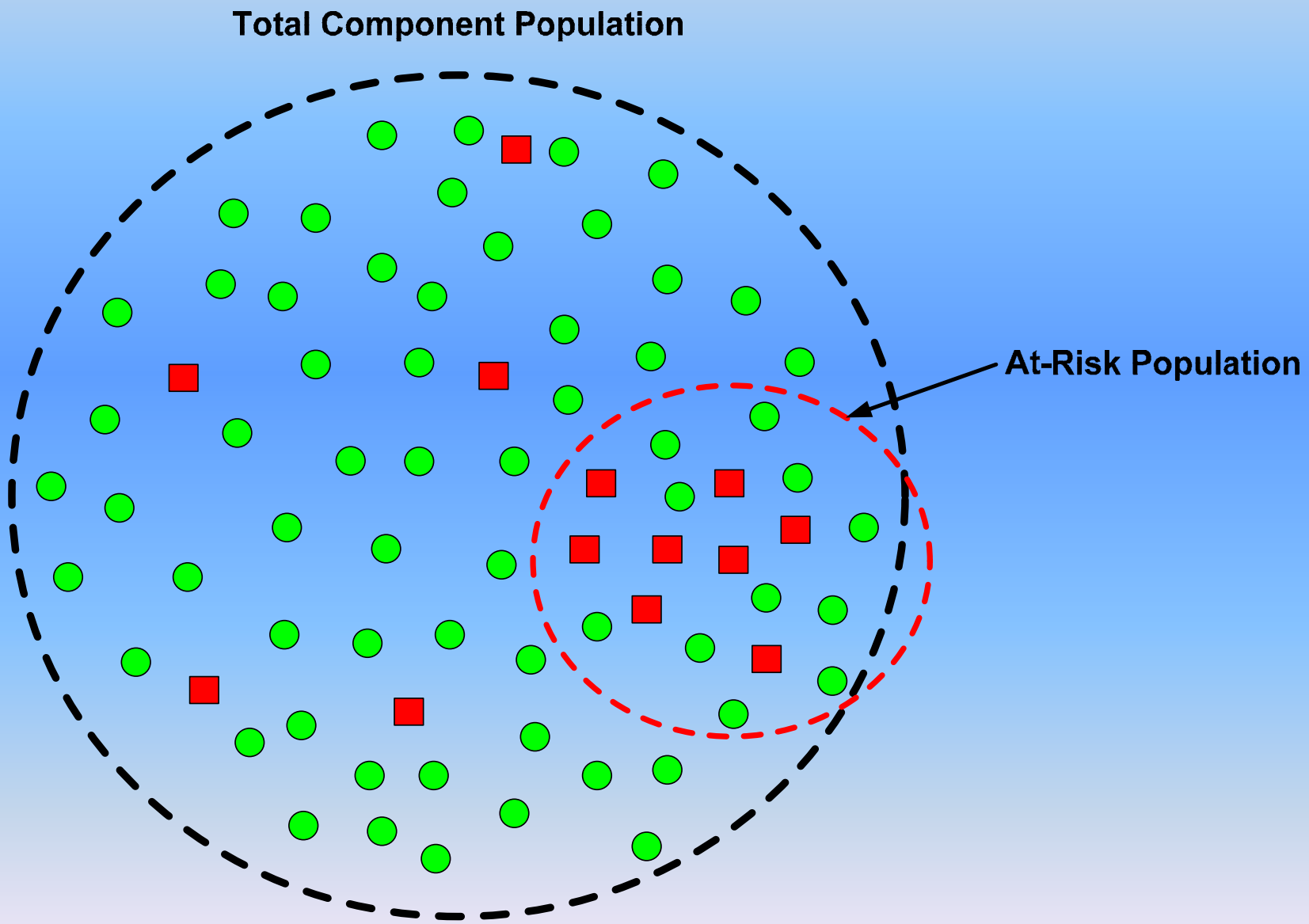
Bathtub Curve



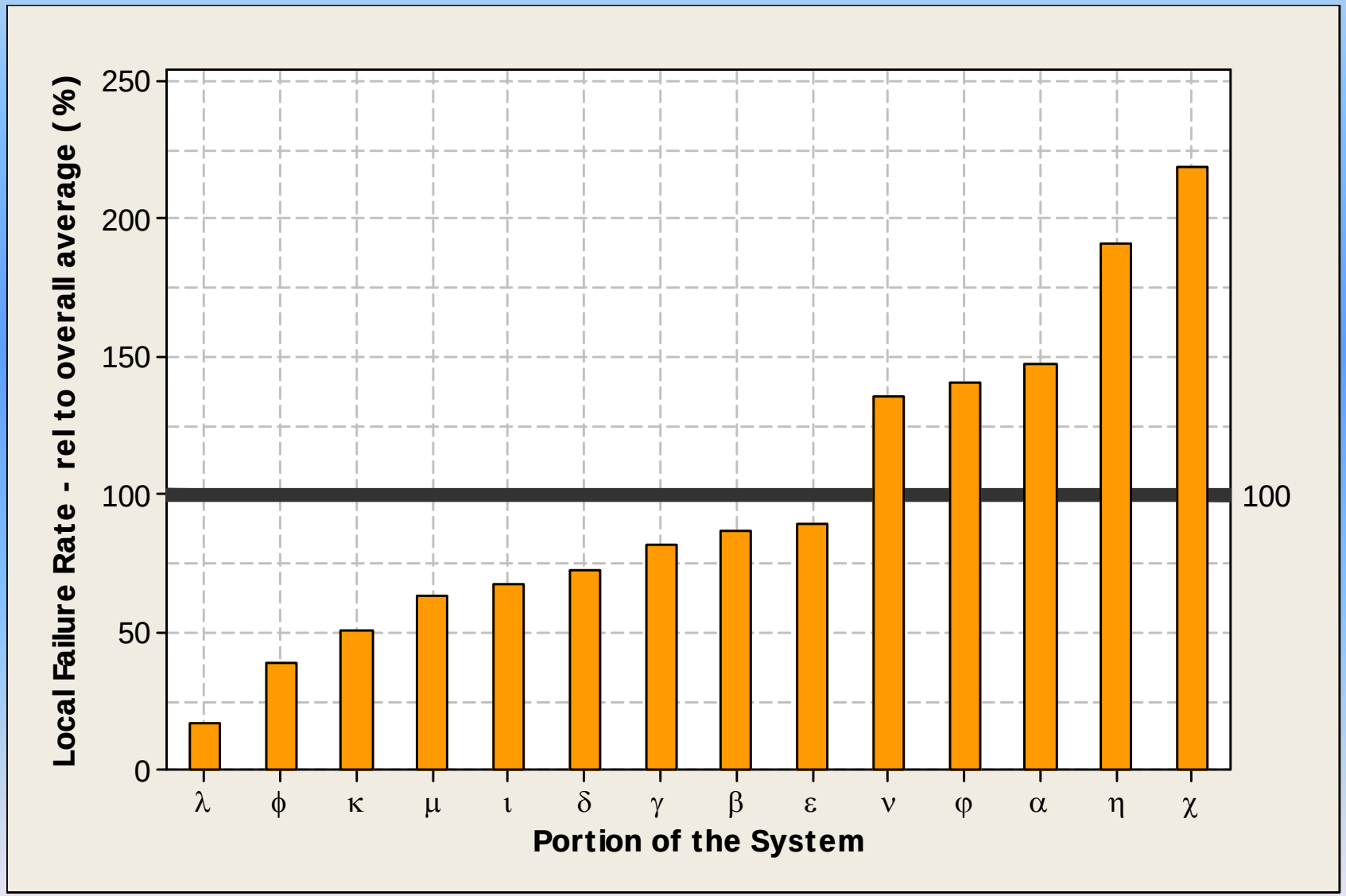
Location

The failure rate is not the same everywhere

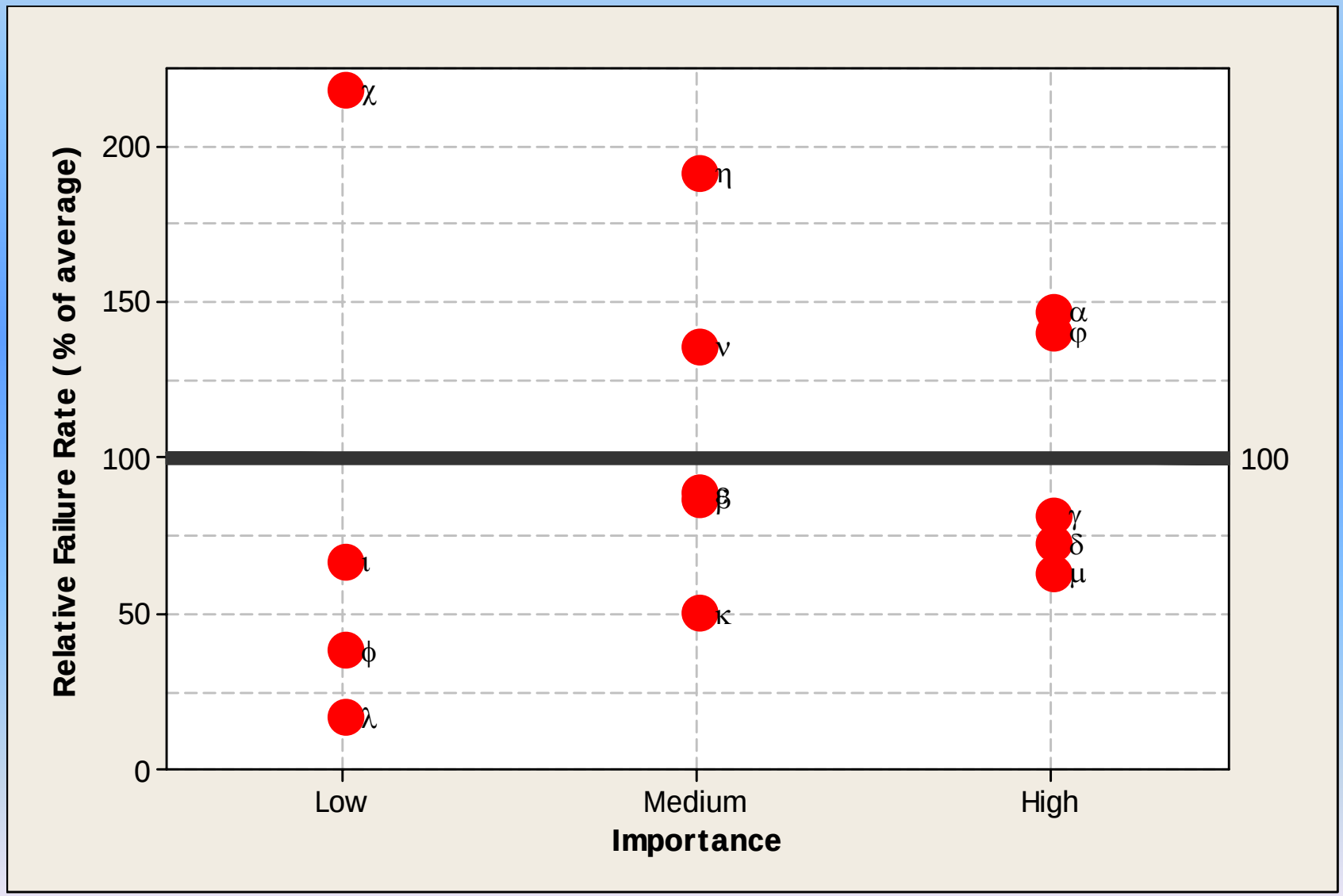
Selecting from the Whole Population



Local Failure Rates



Local Failure Rates - Importance

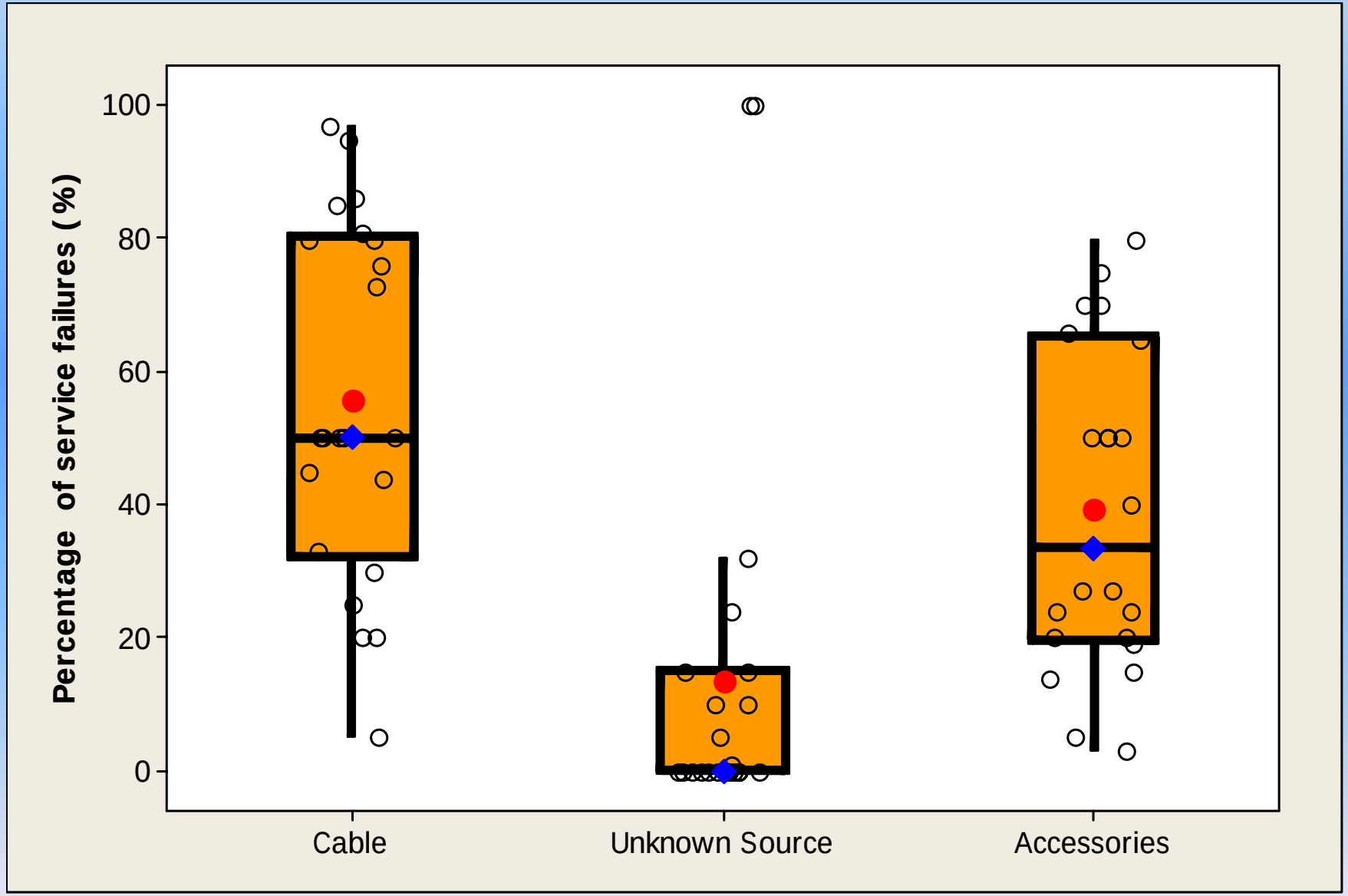


Action

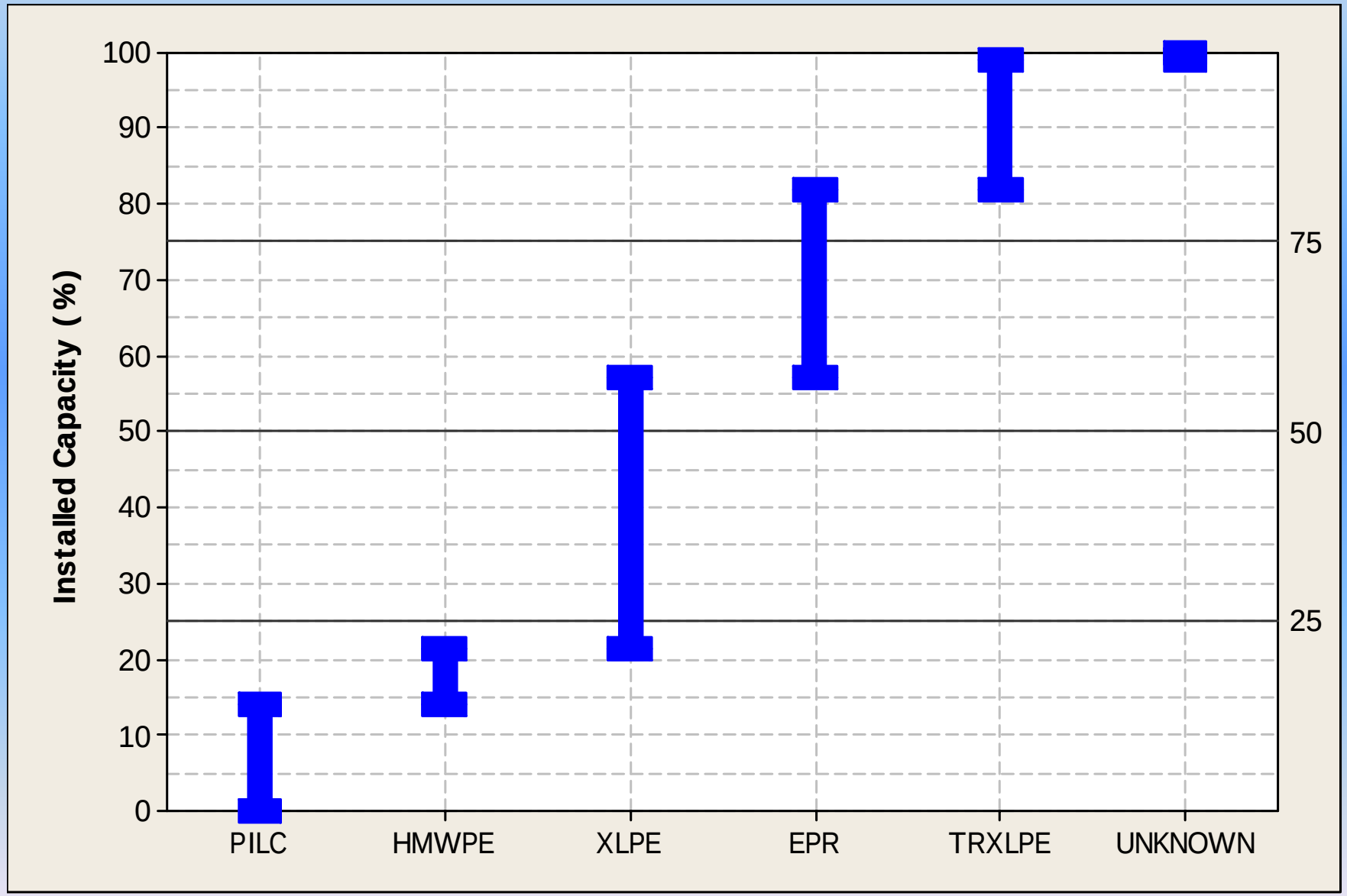
How the circuits fail will determine how they are fixed

Age and Type will also determine actions

Failures by Equipment Type



Length adjusted MV system



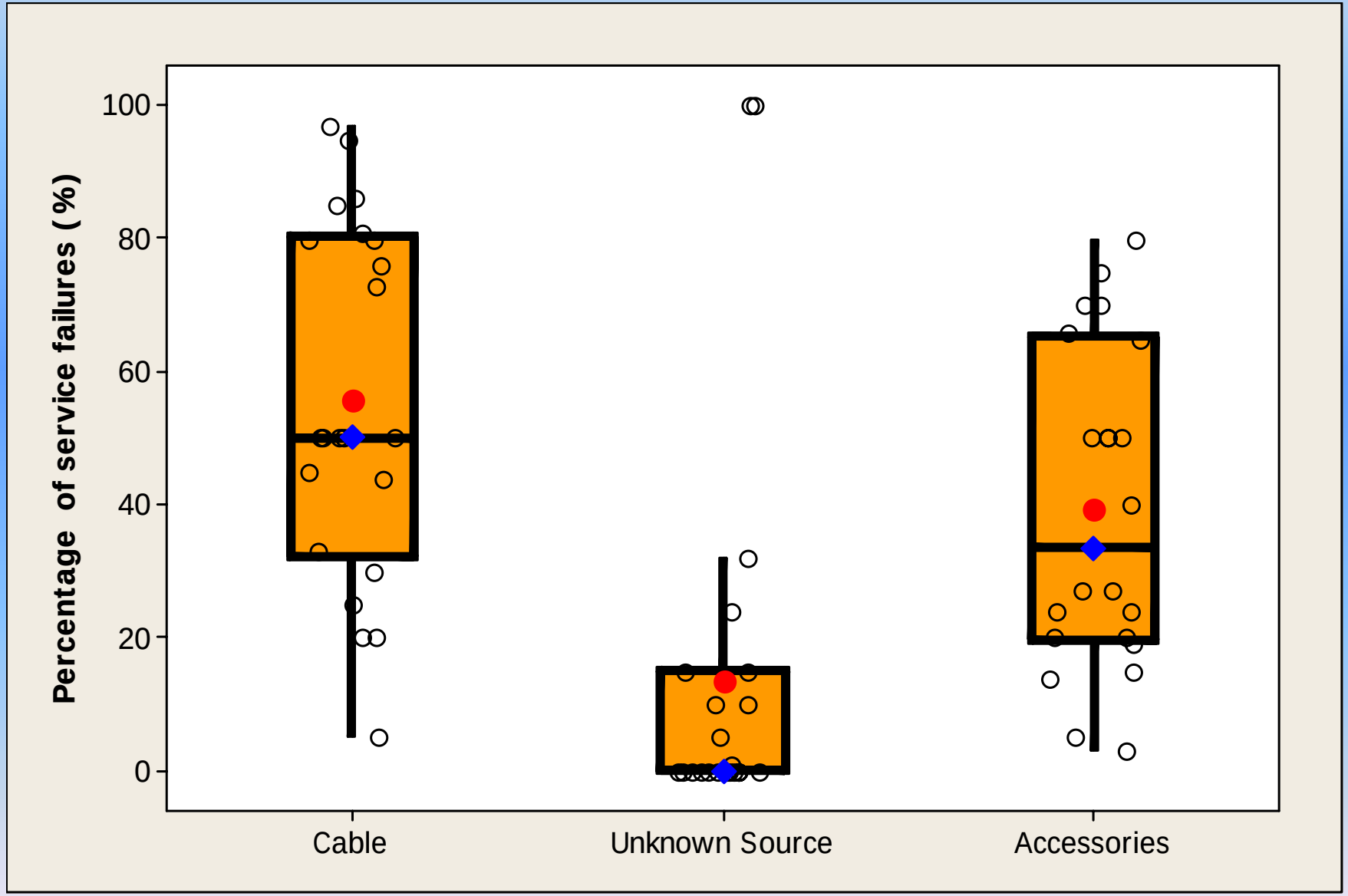
Diagnostic

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.

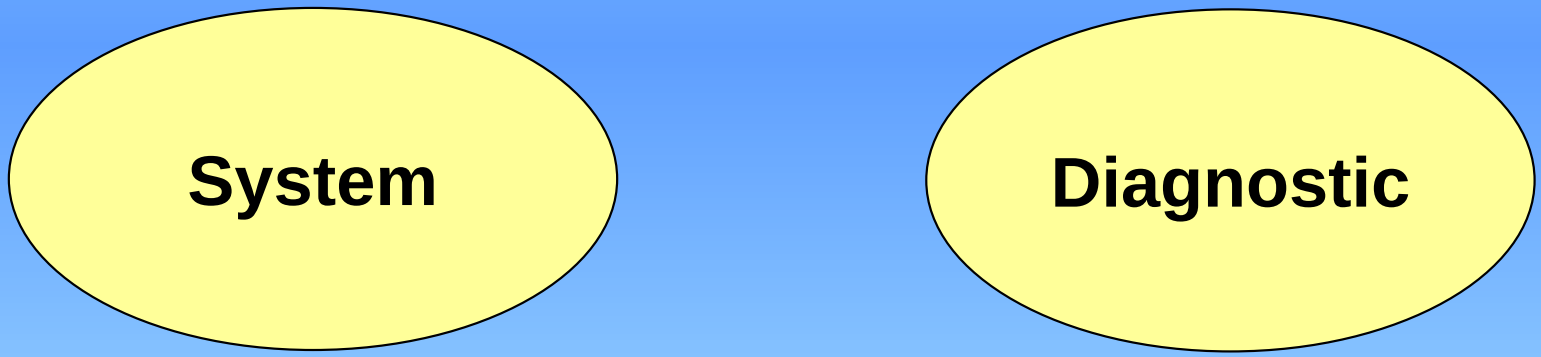
Failure by Equipment Type



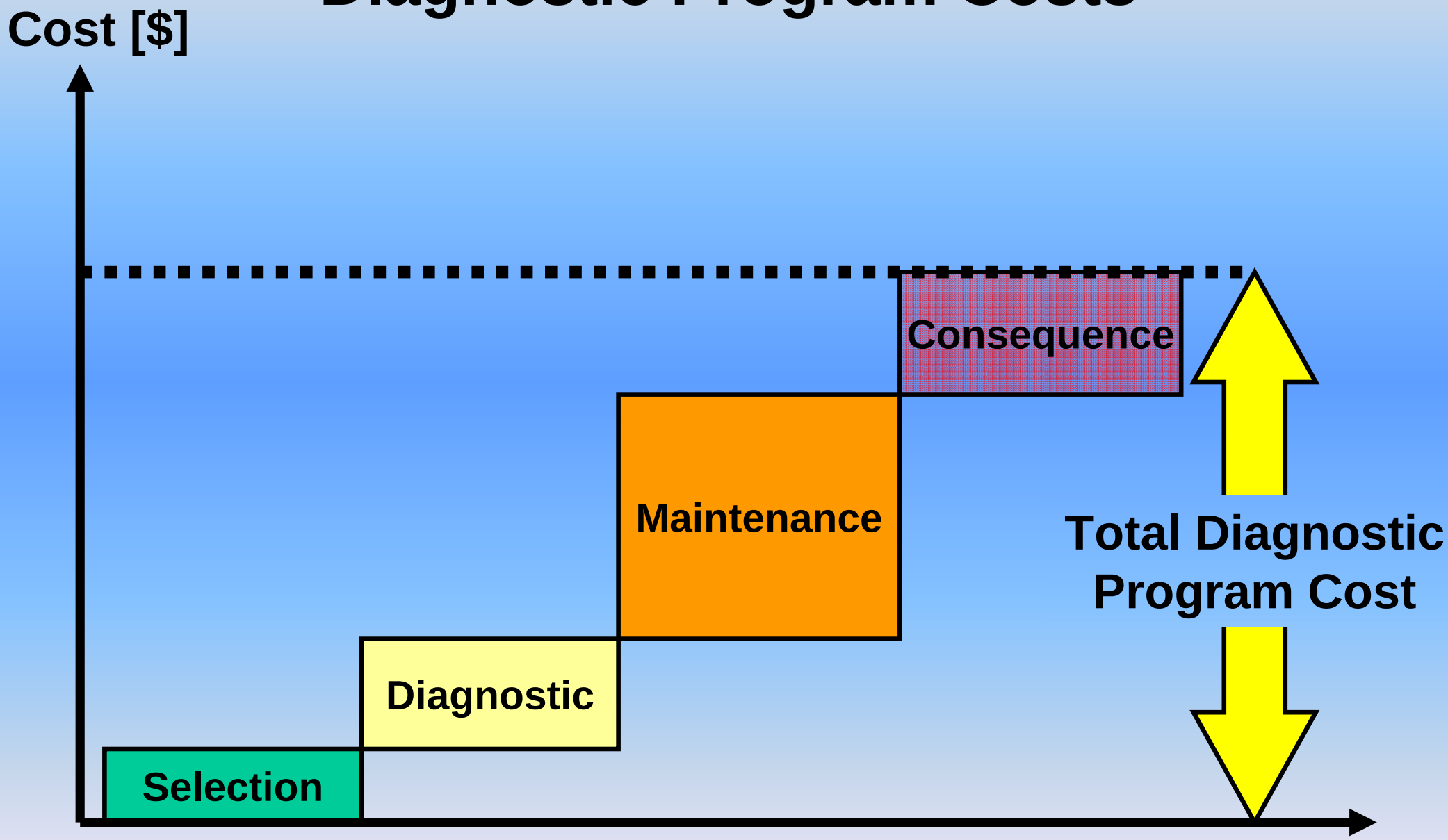
Economic Benefit

Data for Economics Calculations

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



Diagnostic Program Costs



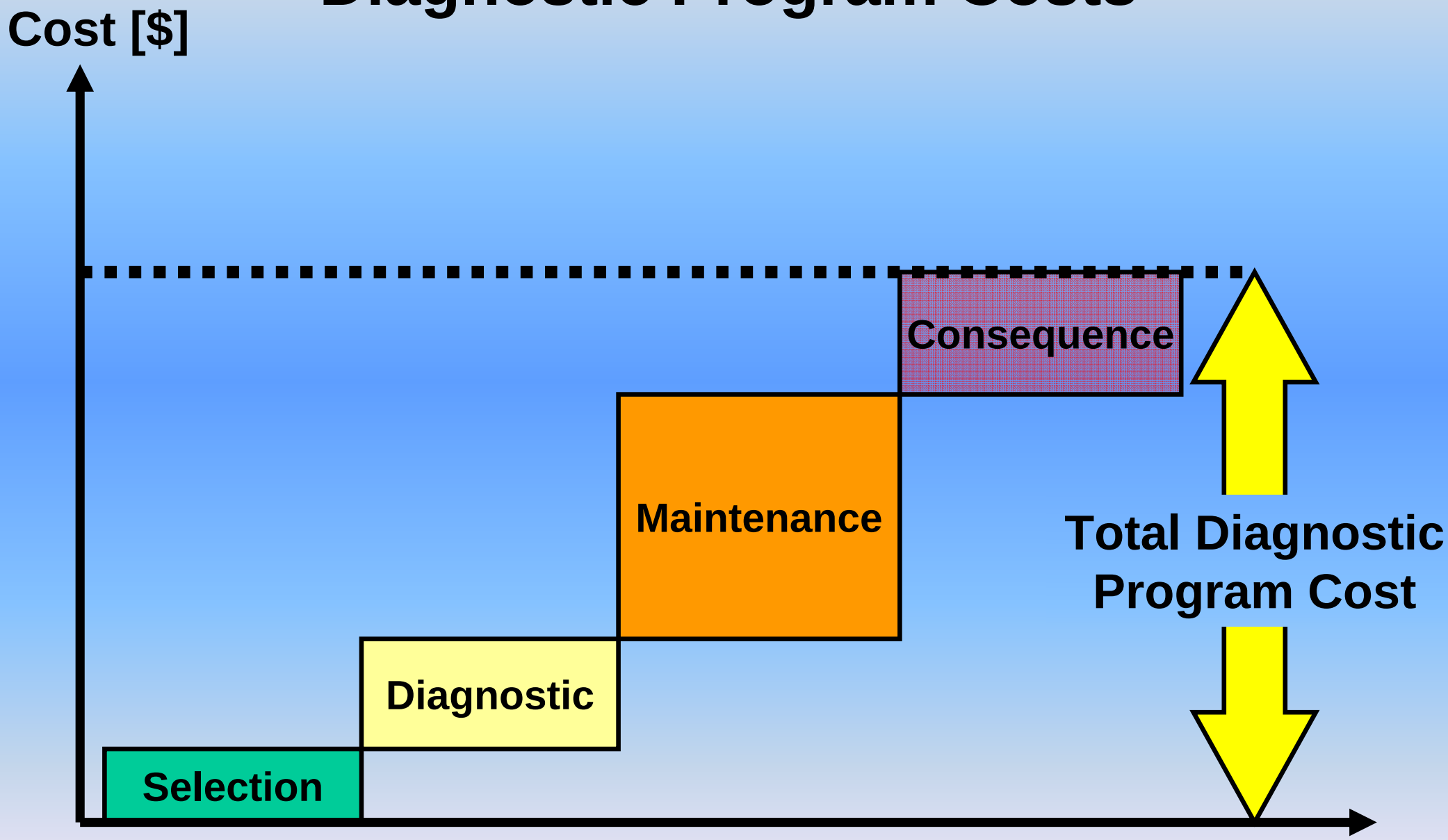
System Data

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

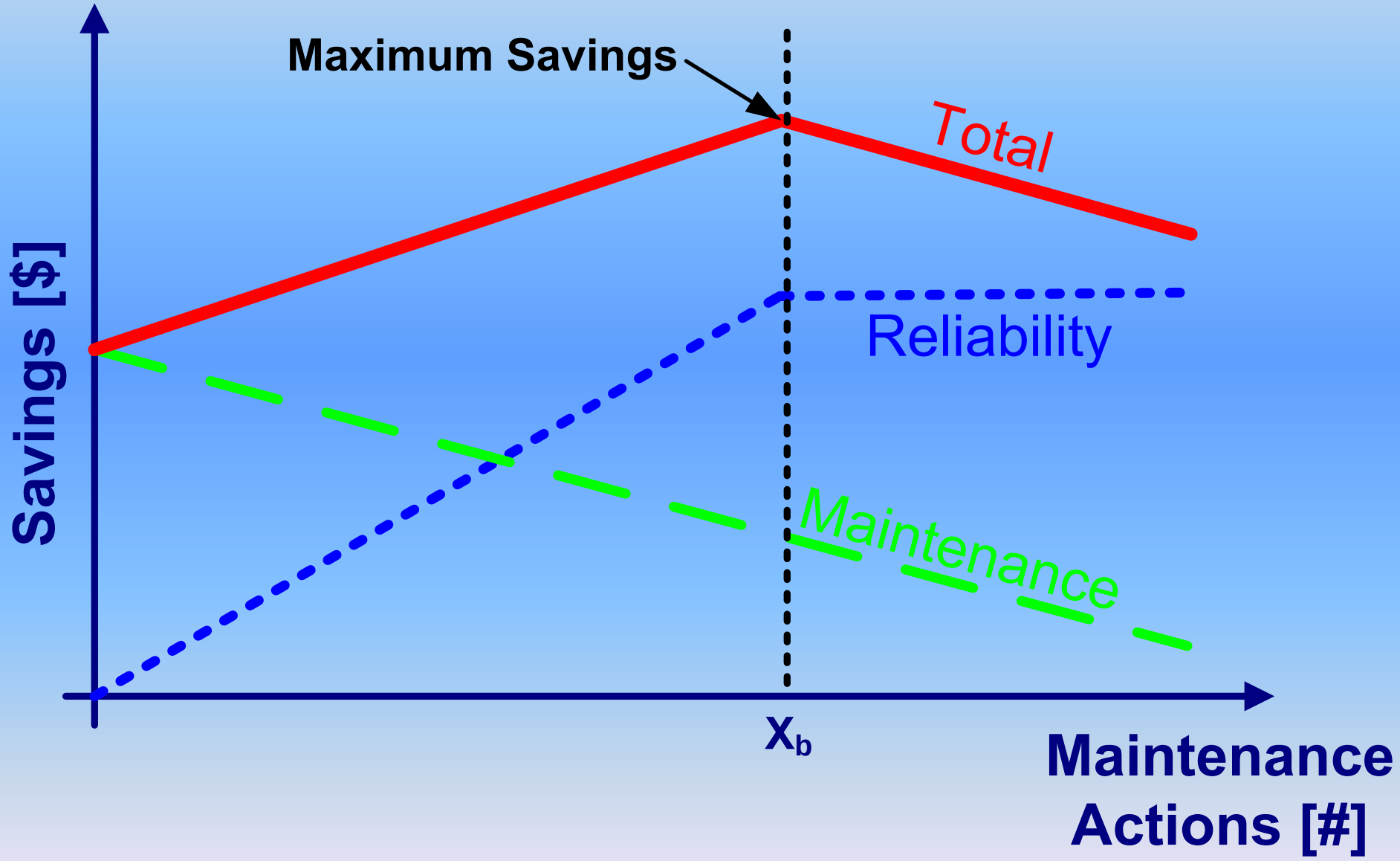
Diagnostic Data

- 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?)

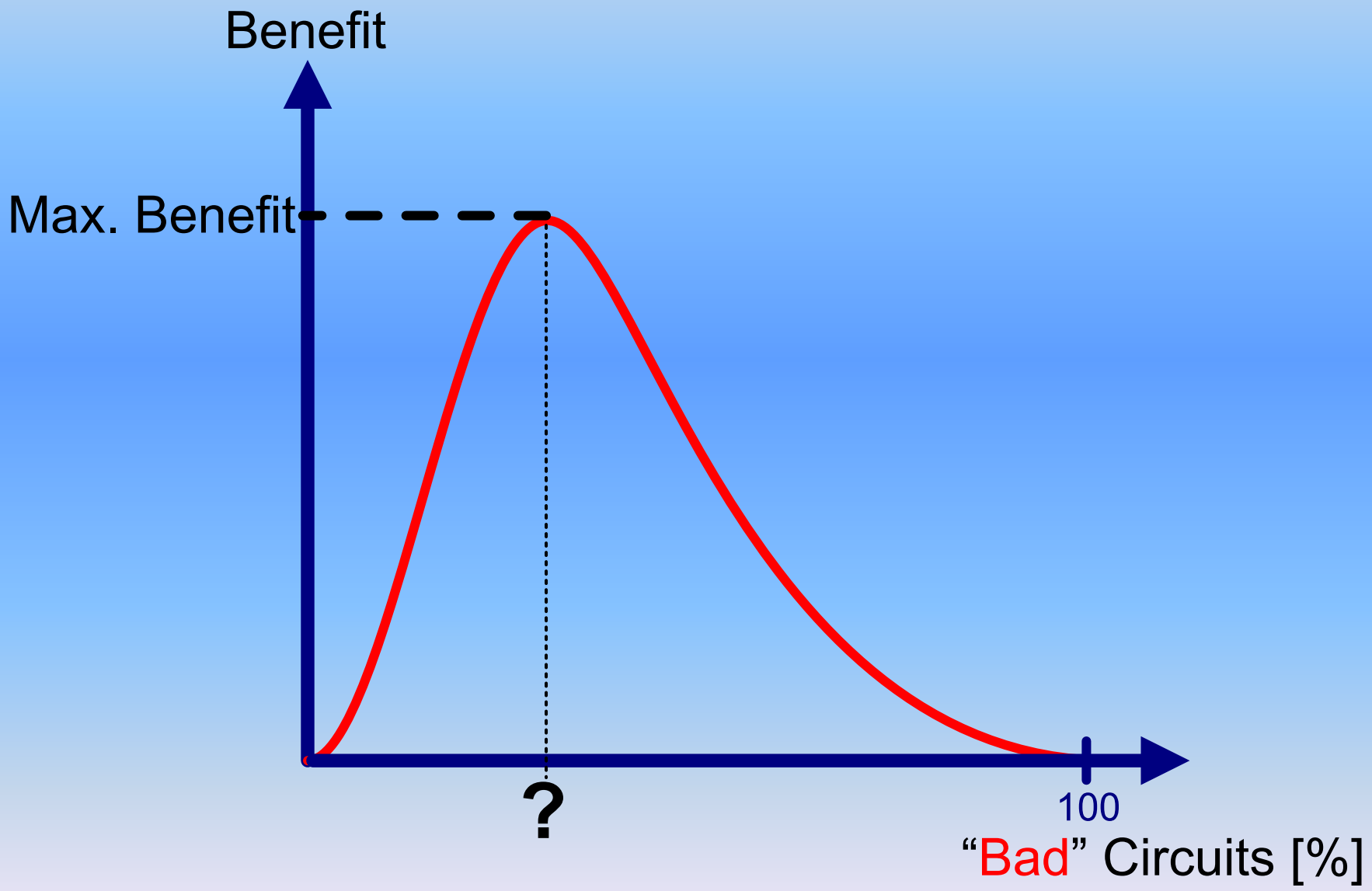
Diagnostic Program Costs



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.