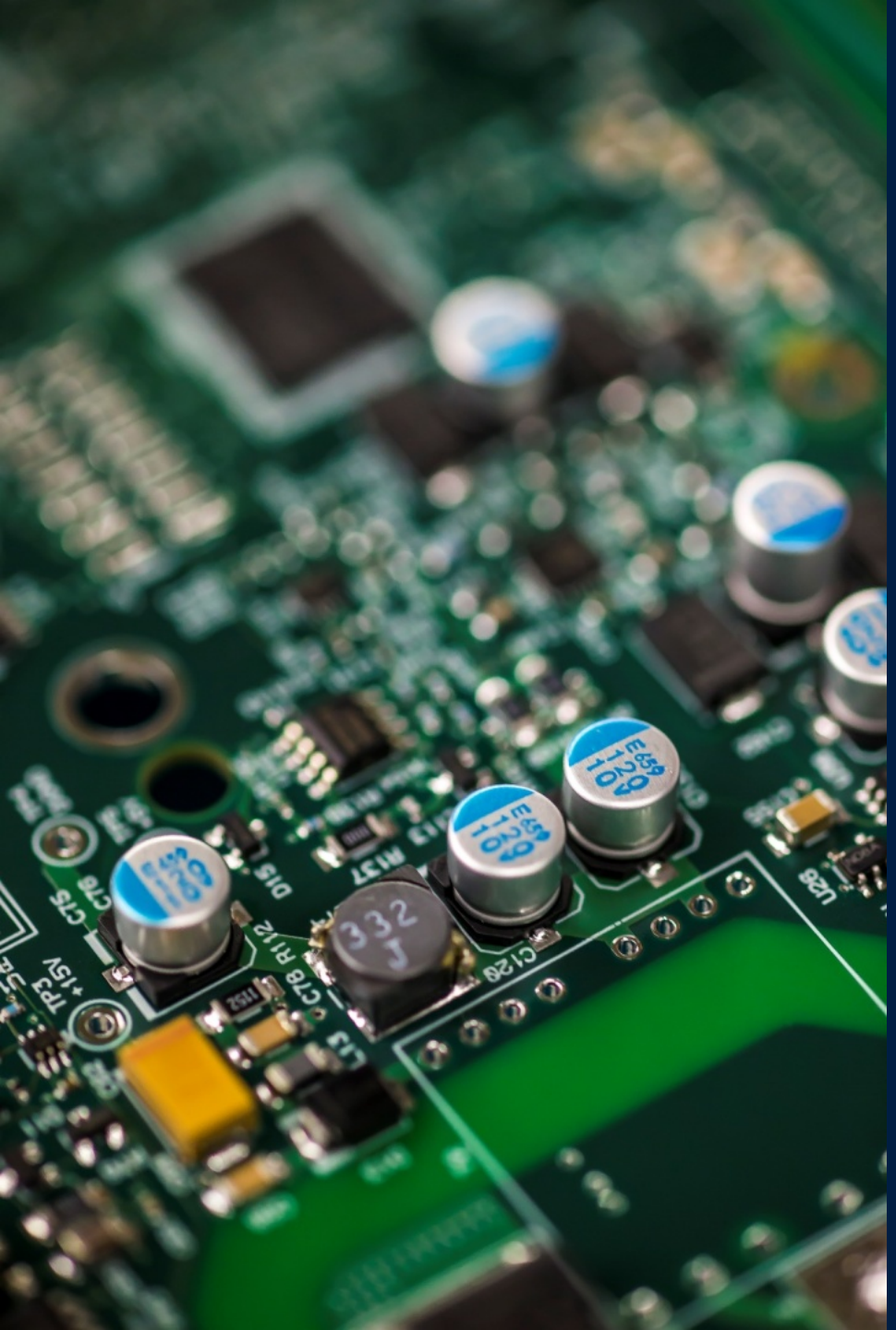
The Useful Life of Microprocessor-Based Relays: A Data-Driven Approach

Derrick Haas, Matt Leoni, Karl Zimmerman,
Adrian Genz, and Travis Mooney
Schweitzer Engineering Laboratories, Inc.



Overview

- Definitions
- Background and considerations
- Manufacturer perspective
- Utility-reported data
- Utility perspective
- Conclusions

Definitions

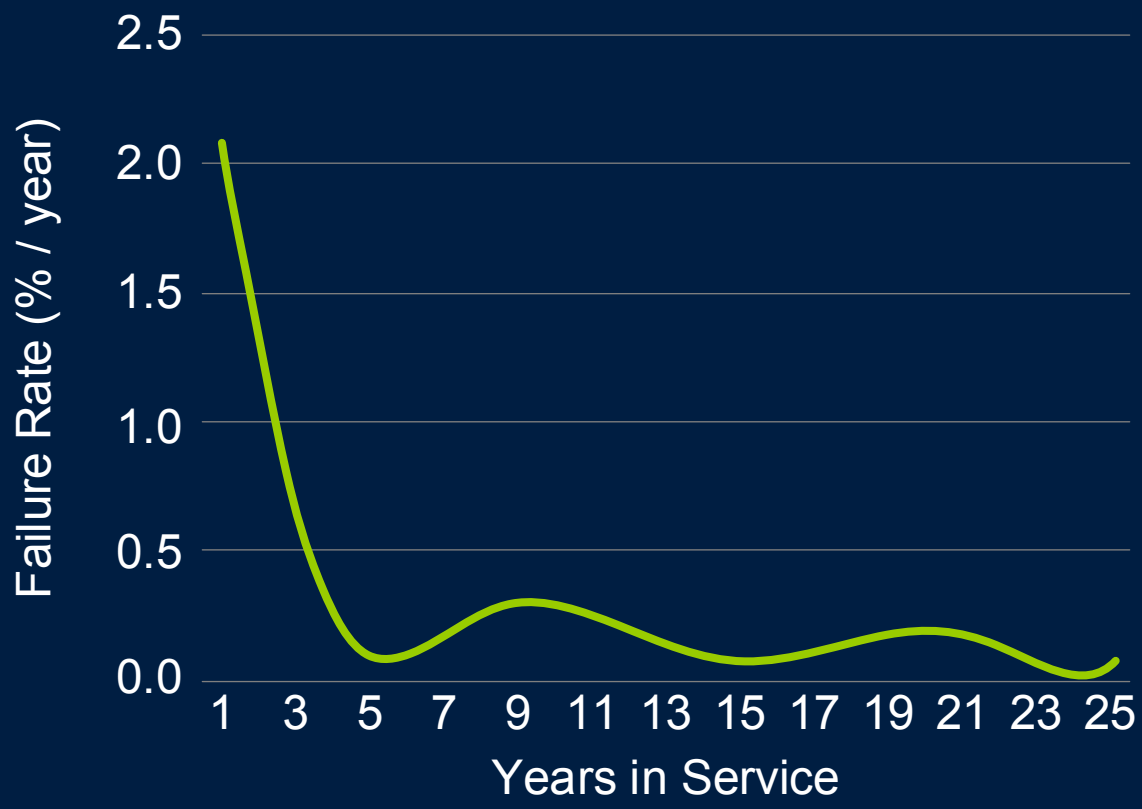
- *Reliability* – probability that product or system will perform specified function over a specified period in a defined environment
- *Latent defect* – defect that could not have been discovered by reasonably thorough tests or inspection before product was sold or placed in service

Definitions

- *Failure rate* – average number of failures over specified period, expressed in failures per year
- *Useful life or service life* – intended operational lifetime of device
- *End of useful life* – period following service life when device has an insupportable failure rate or experiences an unrepairable failure

Reliability Life Cycle

- Field-observed reliability life cycle for specific vintage
- Elevated failure rates at any time from latent defects
- Common mode failure after 5 years



Manufacturer Perspective

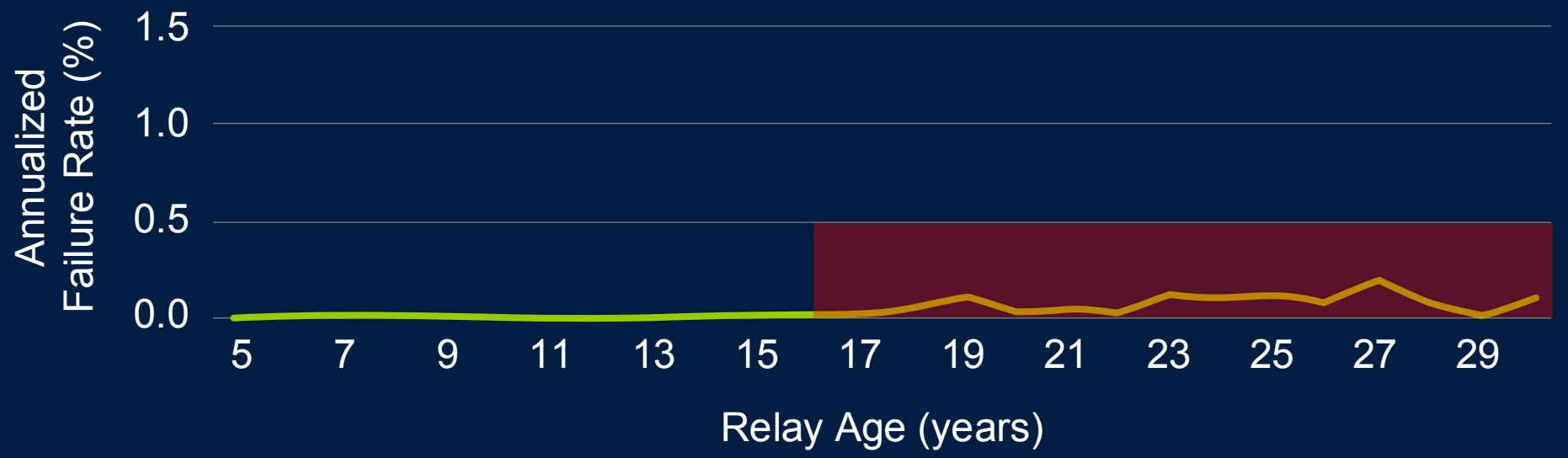
- Accurate product return data
- Communication between manufacturers and end users
- Analysis of effects of aging on electronics

Considerations for Relay Replacement

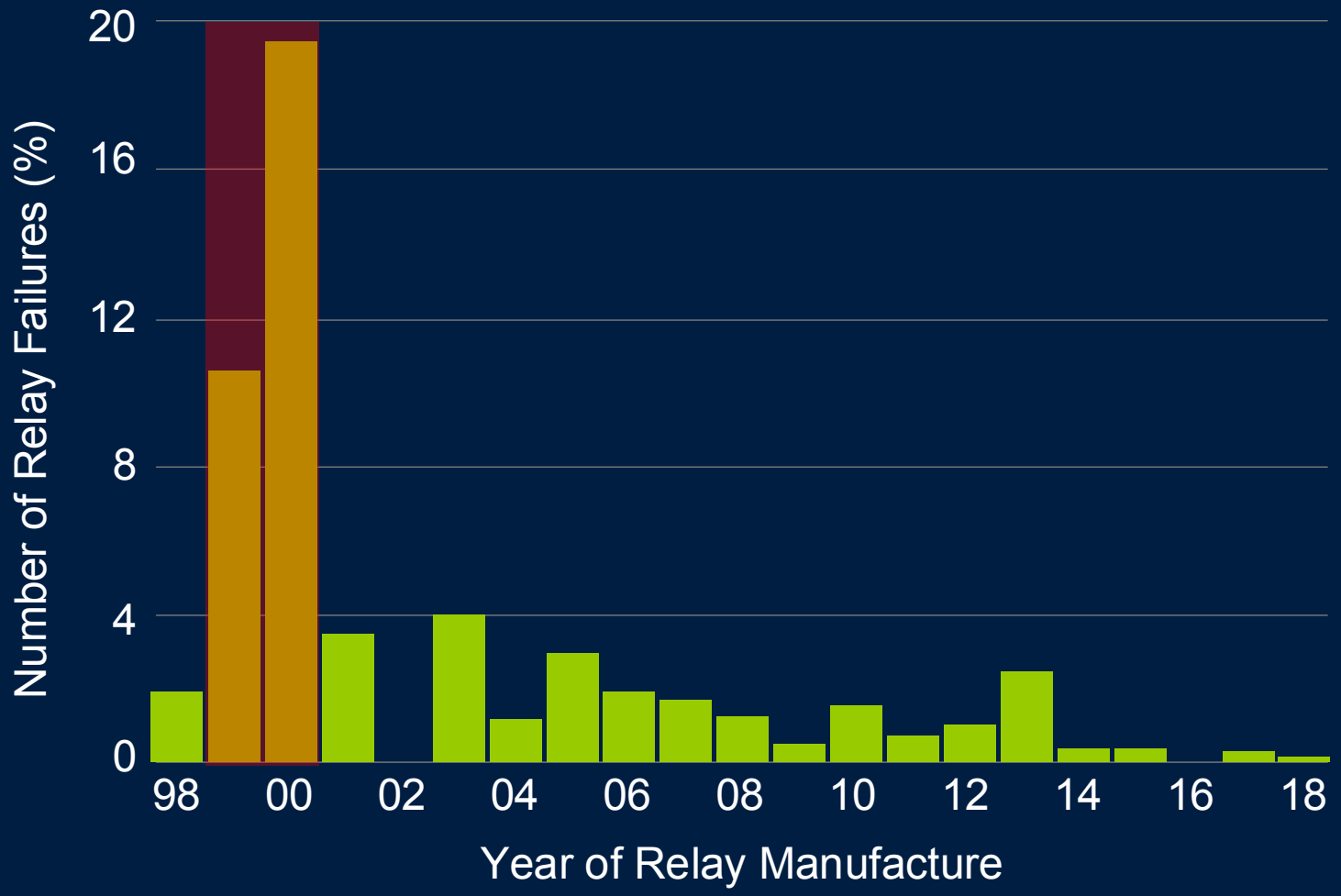
- New technology
- Safety
- Compliance
- Obsolescence and form factor
- New primary equipment
- Budgeting for replacement
- Training and process

Accurate Product Return Data

- Relay return data from 2018
- Increased failure rates after 16 years
- Many failures caused by latent defects



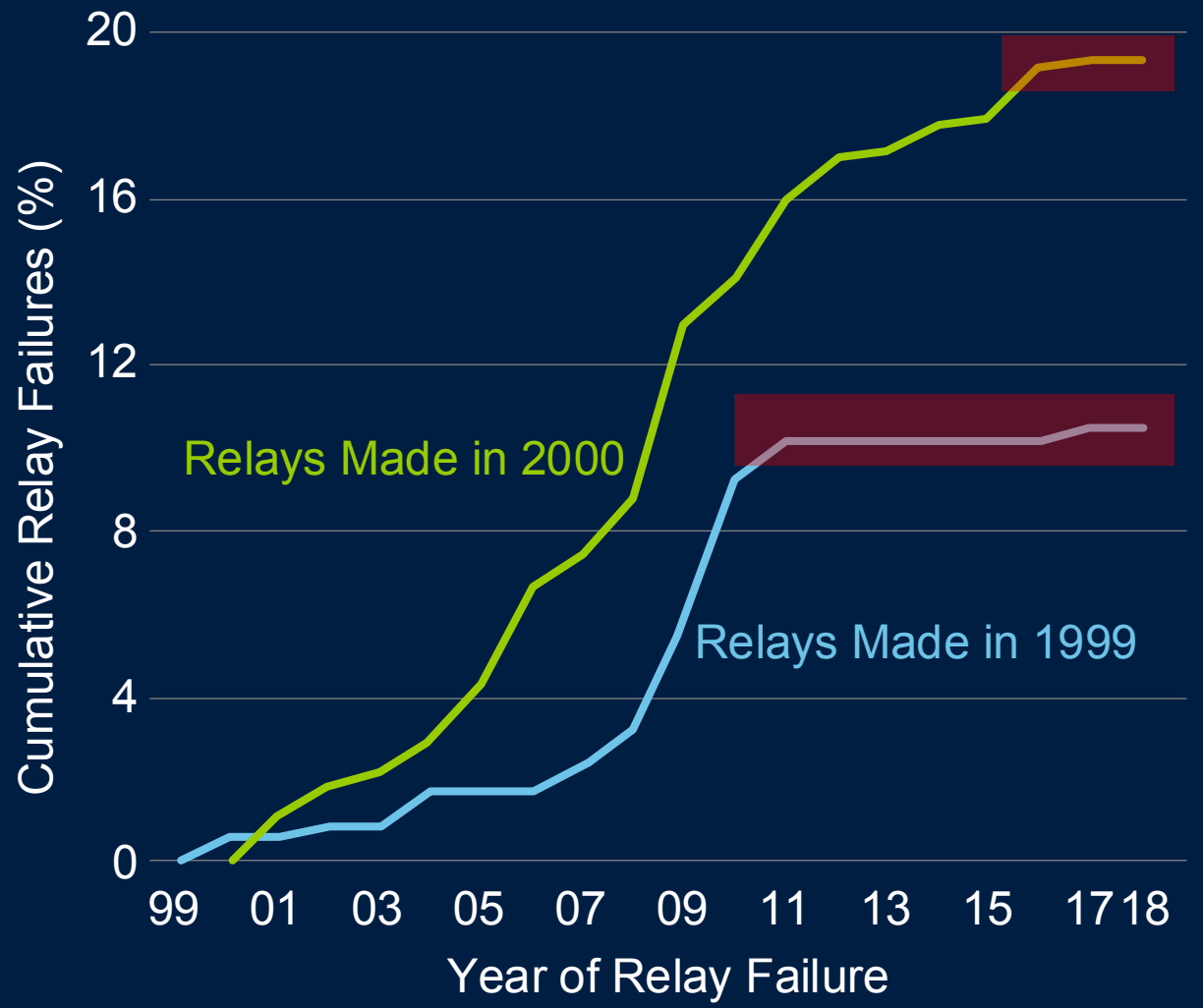
Communication Between Manufacturers and End Users



- Utility A observed higher failures in 1999 and 2000
- Service bulletin was issued in 2006
- Most devices were proactively replaced in 2007–2010

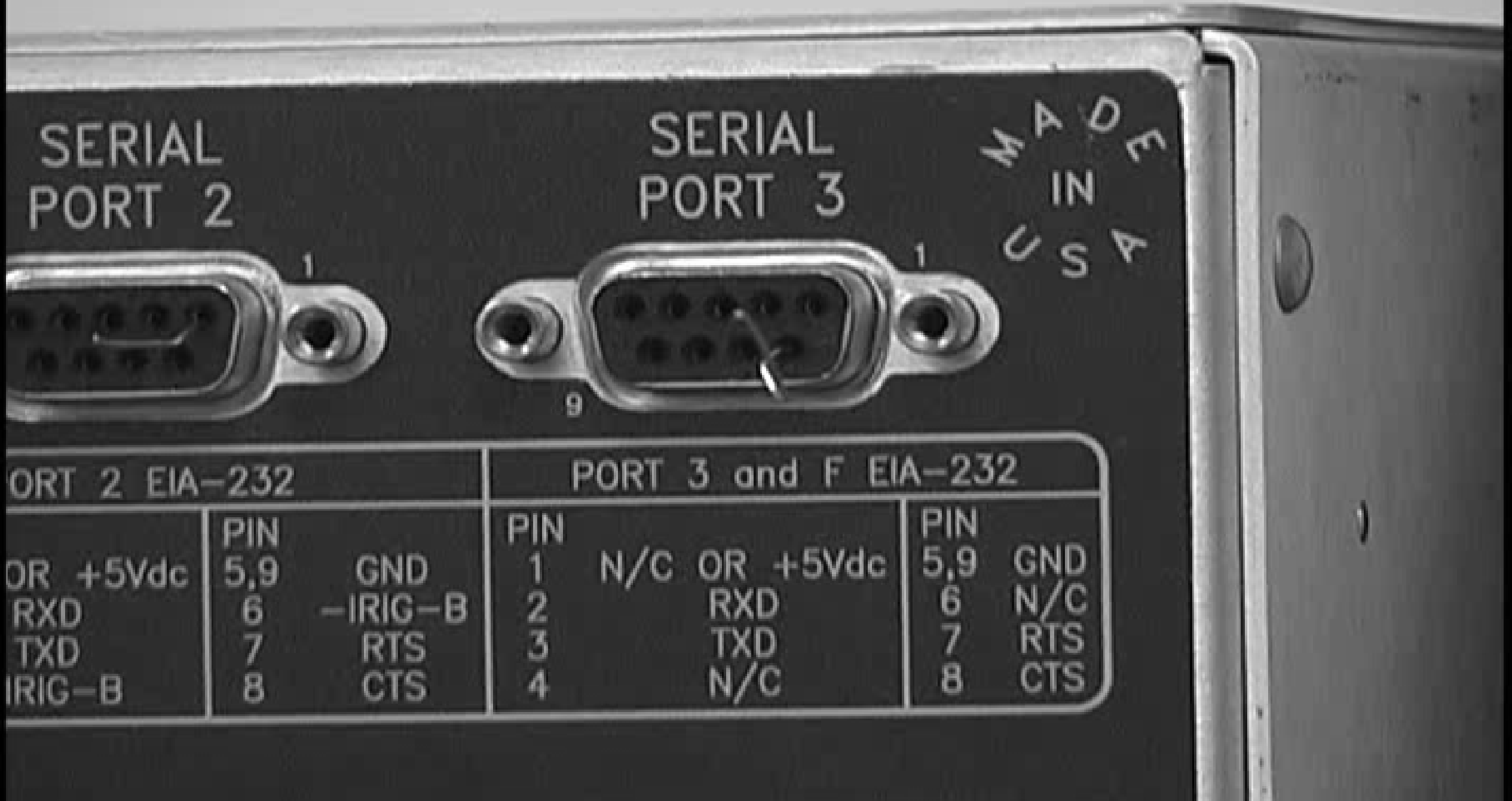
Cumulative Failure Rate for Utility A

- Cumulative failure rate for relays made in 1999 and 2000
- Most devices proactively replaced in 2007–2010



Analysis of Effects of Aging on Electronics

- 11 relays examined from 11 utilities across U.S.
- Service lives ranged from 19–25 years
- Relay functions were tested and verified
- Various components were measured and verified
- Reliability of safety insulation systems was tested
- Solder joint integrity was tested


SERIAL
PORT 2
SERIAL
PORT 3
MADE
IN
USA
1
1
9
ORT 2 EIA-232
PORT 3 and F EIA-232
PIN
PIN
PIN
OR +5Vdc
RXD
TXD
IRIG-B
5,9 GND
6 -IRIG-B
7 RTS
8 CTS
1 N/C OR +5Vdc
2 RXD
3 TXD
4 N/C
5,9 GND
6 N/C
7 RTS
8 CTS

Utility-Reported Data

Utility	In-Service Relays More Than 20 Years Old
X	1,844
Y	194
Z	294

About 70% of relays older than 20 years are still in active service

Utility Perspectives

- Replace only after relay failure
- Base on specific time or relay age
- Use more sophisticated approaches

Example of Time-Based Approach

Timeline	Planned Action
Initial install (0 years)	Perform commission testing and put into service
12 years	Perform periodic maintenance NERC requirements
24 years	Replace / upgrade protection or perform periodic maintenance per NERC requirements and put on a list to replace before next maintenance interval

Utility B matched replacement time with required maintenance intervals

Conclusions

- Microprocessor-based relays can reliably perform during and beyond intended service life of 20 years
- Measurements confirm relays in service for greater than 20 years showed no signs of wearing out
- Utilities are keeping relays in service beyond manufacturer warranty and beyond service life expectations

Conclusions

- Manufacturers and end users should collect and maintain data on relays
- Manufacturers should have proactive and robust process for communicating service bulletins to end users
- End users should have robust process for evaluating and acting on service bulletins

Conclusions

Manufacturers and end users should partner to make best data-driven decisions on useful life of microprocessor-based relays


Questions?