

Comparison of reported data from multiple data sources

**DATA USED IN
QUANTIFIED RELIABILITY
MODELS**

Objective

- Describe sources, practices and protocols that may be used to compare reported failure rates available to support the quantification of early design risk and reliability models

Areas of Discussion

- Sources:
 - Where do we find data?
 - Source selection
- Practices & Protocols:
 - Data Collection Protocols Data
 - Comparing Reliability Measures
- Example

Data Sources

- National Technical Reports Library
- Defense Technical Information Center –
- US Department of Energy
- Office of Science and Technical Information
- Department of Energy (DOE) Technical Server
- Department of Transportation (DOT) National Transportation Library
- Federal Aviation Authority (FAA) Technical References and Research Library
- Nuclear Energy Commission Technical Server
- **NRC - Industry Average Parameter Estimates**
- **Defense Systems Information Analysis Center – Formerly RIAC**
- **Electronic Power Research Institute (EPRI)**
- **North American Electric Reliability Corporation (NERC)**
- **IEEE Reliability Society**
- Barringer & Associates, Inc
- **Del Norske Veritas**
- **European Safety and Reliability Association**
- **European Safety, Reliability and Data Association**
- **International Atomic Energy Agency**
- **International Association of Oil and Gas Producers**

Source Selection should be based on availability of datasets or source, viability of reported data, and applicability to intend use.

RELIABILITY PERFORMANCE MEASURE SOURCE SELECTION



Commercial Data Sets

European Industry Reliability Data - EiReDA
 Failure Rate Data In Perspective – FARADiP
 Component Reliability Data for use in Probabilistic Safety Assessment - IAEA TECDOC-478
 Generic Component Reliability Data for Research Reactor PSA - IAEA-TECDOC-930
 Centralized Reliability and Events Database – ZEDB
 Risk Assessment Data Directory - OGP 434-A1
 Generic Component Failure Data Base for Light Water and Liquid Sodium Reactor PRA – EGG-SSRE-8875
 Failure Rate and Event Data for use within Land Use Planning Risk Assessments - HSE PCAG 6K
 Centralized Reliability and Events Database, ZEDB
 Idaho Chemical Processing Plant Failure rate database, INEL-95/0422
 Vacuum Bellow, Vacuum Piping, Cryogenic Break, and Copper Joint failure Rate Estimates for ITER design use, INL/EXT-10-18973
 A Summary and Assessment of Historical Reliability and Maintainability Data for Active Solar Hot Water and Space Conditioning Systems, SERI/TR-253-2120



Industry and Vendor Technical Reports

Guidelines for Process Equipment Reliability Data with Data Tables, Center for Chemical Process Safety
 Design of Reliable Industrial and Commercial Power Systems - IEEE STD 493-2007
 IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear-Power Generating Stations - IEEE STD 500
 Historic Reliability Data for IEEE 3006 Standards: Power System Reliability - IEEE 3006
 Fairchild Semiconductor Reliability Report
 A Summary and Assessment of Historical Reliability and Maintainability Data for Active Solar Hot Water and Space Conditioning Systems – SERI TR-253-2120
 Component Failure and Repair Data for Coal-Fired Power Units, EPRI AP-2071
 Reliability and Availability Assessment of Selected Domestic Combined-Cycle Power Generating Plants, EPRI AP-2536
 Availability Analysis of Gasification-based Systems, EPRI-AP-4216
 Risk Assessment Data Directory, OGP 434-A1



Design Details



Military Handbooks

Reliability Prediction of Electronic Equipment, Mil-Hdk-217
 Handbook of Reliability Prediction Procedures for Mechanical Equipment, MechRel



National Consortia Standards

Failure Rate Estimating, GEIA SSB-1.004
 American National Standard for Reliability Prediction, ANSI/VITA 51.0-2008



International Standards

Reliability Data Handbook-Universal model for reliability prediction of electronics components, PCBs and equipment, IEC TR-62380
 Reliability - Reference conditions for failure rates and stress models for conversion, IEC-61709
 Reliability Data Handbook, RDF2000 (UTE C 80-800)
 Reliability Methodology for Electronic Systems, FIDES Guide
 Reliability Prediction Model for Electronic Equipment, GJB/z 299B



Commercial Practice

Reliability Prediction Procedure for Electronic Equipment, Telcordia SR-332
 Next Generation Reliability Prediction, 217Plus
 PRISM System Reliability Assessment Software Tool
 Reliability and Maintainability Predictions, Frontis Corp

Generic Data



Web Based Data Sources

Industry Average Parameter Estimates, U.S. NRC
 Failure Rates, Ility #Engineering
 Weibull Database, Barringer & Associates, Inc



Published Data Sources

European Industry Reliability Data - EiReDA
 Failure Rate Data In Perspective – FARADiP
 Component Reliability Data for use in Probabilistic Safety Assessment - IAEA TECDOC-478
 Generic Component Reliability Data for Research Reactor PSA - IAEA-TECDOC-930
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Industry Data



Problem reporting and corrective actions

Dependability Management – Part 3-2.Application Guide – Collection of dependability data from the field, IEC 60300-3-2
 Nuclear Power Plants – Reliability Data Exchange – General Guidelines, ISO 6527
 Nuclear Power Plants – Guidelines to assure quality of collected data on Reliability, ISO 7385
 Petroleum, petrochemical and natural gas industries Collection and exchange of reliability and maintenance data for equipment, ISO 14224
 Petroleum, petrochemical and natural gas industries — Production assurance and reliability management, ISO 20815
 Collection and Exchange of Reliability and Maintenance Data for Equipment, API STD 689
 Performance-Based Failure Reporting, Analysis & Corrective Action System (FRACAS) Requirements, AIAA S-102.1.4
 Standard Classification for Hierarchy of Equipment Identifiers and Boundaries for Reliability, Availability, and Maintainability (RAM) Performance Data Exchange, ASTM F2446
 Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear-Power Generating Stations, IEEE 500
 Recommended Practice for Reporting Field Failure Data for Power Circuit Breakers, IEEE 1325



Engineering Data

Data Collection Protocols

Data collection protocols represent the methods used.

- Management criteria:
 - Traceability of records to originating source
 - Configuration control of data taxonomy and resulting data record
- Processing criteria:
 - Data required (item name/description, observed hours, number of failures, environment, quality level, etc.)
 - Use of math models and methods
 - Inclusion and Exclusion criteria
- Reporting criteria – Comparison of industry observed performance measures

Establish protocols early in the process and then implement them consistently

Comparing Reliability Measures

- Develop Reliability Record for each assembly, subassembly, part and/or component
 - Individual by equipment type
 - Reported data from originating source
 - Includes traceability
- Comparison data
 - Equipment type/description
 - Reliability Measures
 - Time To Failure
 - Mean-Time-To-Failure
 - Mean Expected Life
 - Failure Rate
 - Probability of Failure

Comparing the reported performance measures from multiple data sources allows the determination of “in-family” or “out of expected range”.

An example

- Sources used:
 - RIAC's Reliability Automated Databook
 - NRC's Industry Average
 - Idaho Chemical Processing Plant Failure rate database, INEL-95/0422
 - IAEA's Generic Component Reliability Data for Research Reactor PSA

DATA COLLECTION

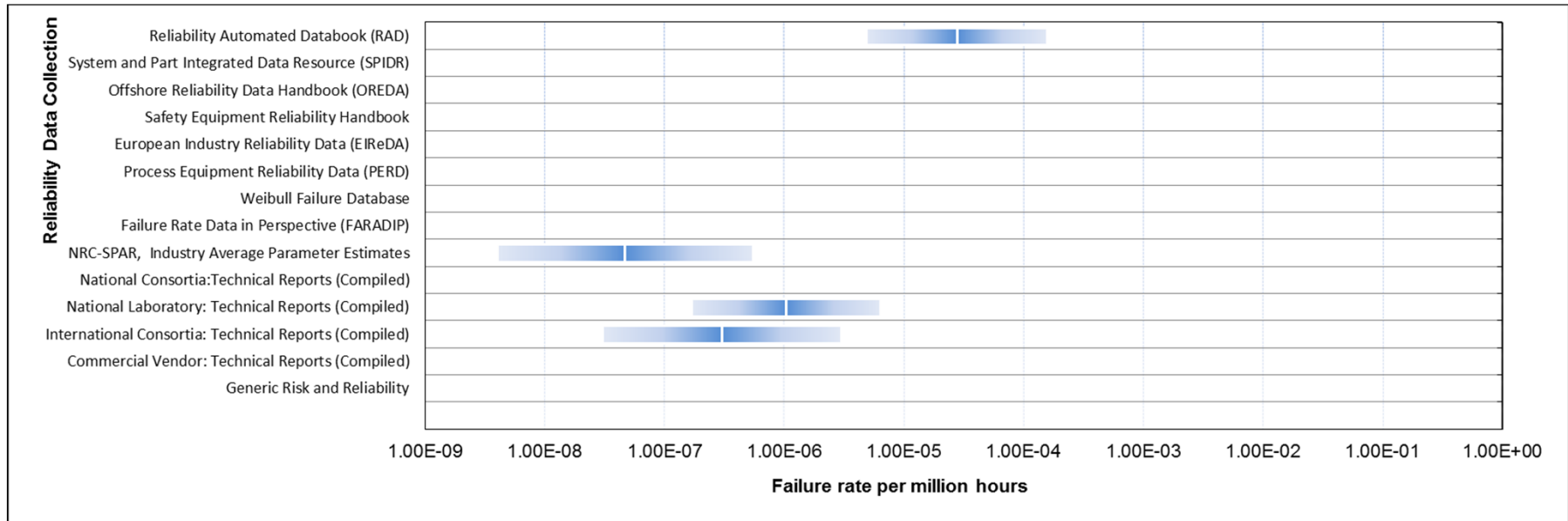
ALTERNATIVE FAILURE RATE DATA:					
RegtBot					
Dataset 1:					
λ	Variance	EF	Source	Equivalent Component	Comment
2.76E-05	1.57E-09	5.70	Summary composite Reliability Analysis Information Center's Reliability Auto	Valve,Manual	
Dataset 2:					
λ	Variance	EF	Source	Equivalent Component	Comment
4.66E-08	1.80E-14	11.67	Summary composite based on total hours and total failures	Valve,Manual	Observed operational time: 100961448; Observed Failures: 47
2.62E-07		1.34		Valve,Manual, External Leak Small	Observed operational time: 100961448; Observed Failures:26
1.34E-07		1.49		Valve,Manual, Internal Leak Small	Observed operational time: 100961448; Observed Failures: 13
8.42E-08		1.63		Valve,Manual, Spurious Operation	Observed operational time: 100961448; Observed Failures: 8
Dataset 3:					
λ	Variance	EF	Source	Equivalent Component	Comment
1.03E-06	3.63E-06	6.18	Idaho Chemical Processing Plant Failure rate database, INEL-95/0422	Valve, All	
2.52E-07	1.79E-06	12.80		Valve, Leak	
6.58E-08	9.17E-07	28.22		Valve, Plug	
7.53E-07	3.10E-06	7.24		Valve, Other	
Dataset 4:					
λ	Variance	EF	Source	Equivalent Component	Comment
3.00E-07			Generic Component Reliability Data for Research Reactor PSA, IAEA TECDOC	Valve, manual, Failure to function	Uper Control Limit: 1.0E-06 Lower Control Limit:
4.60E-06				Valve, manual, Degraded	Uper Control Limit: 6.2E-06 Lower Control Limit: 7.0E-07
5.50E-06				Valve, manual, Degraded	Uper Control Limit: 1.31E-05 Lower Control Limit: 1.10E-06
1.35E-05				Valve, manual, Failure to function	Uper Control Limit: 3.2E-05 Lower Control Limit: 2.40E-06
1.35E-05				Valve, manual, Leakage	Uper Control Limit: 3.2E-05 Lower Control Limit: 2.40E-06

COMPARISON OF DATA VALUES

Component Type Name:						
Failure rate per million hours						
Dataset Source	Original Qlty Level	Original Environment	Mean	95%	5%	EF
Reliability Automated Databook (RAD)	Military	Aviation	2.76E-05	1.57E-04	4.85E-06	5.70
System and Part Integrated Data Resource (SPIDR)						
Offshore Reliability Data Handbook (OREDA)						
Safety Equipment Reliability Handbook						
European Industry Reliability Data (EIReDA)						
Process Equipment Reliability Data (PERD)						
Weibull Failure Database						
Failure Rate Data in Perspective (FARADIP)						
NRC-SPAR, Industry Average Parameter Estimates	Commercial	Ground Fixed	4.66E-08	5.43E-07	3.99E-09	11.67
National Consortia: Technical Reports (Compiled)						
National Laboratory: Technical Reports (Compiled)	Commercial	Ground Fixed	1.03E-06	6.37E-06	1.67E-07	6.18
International Consortia: Technical Reports (Compiled)	Commercial	Ground Fixed	3.00E-07	3.00E-06	3.00E-08	10.00
Commercial Vendor: Technical Reports (Compiled)						
Generic Risk and Reliability						
Selected Failure Rate						

COMPARISON OF DATA VALUES

Chart 1: Failure Rate per Million Hours



Take Away

The reliability analyst is often tasked to determine the probability of failure or success of a system based on a new or incomplete design using state of the art equipment with little or no failure history.

And, someone will disagree with the results. But, by using available data sets and comparing the observed operational reliability the analyst can determine if the recommended performance parameters used to quantify the model make sense. The analyst can address the question of whether the data used to quantify a model is “in family” or “out of expected range” based on observed operational times and failures of similar equipment.

Sounds simple?

BACK-UP MATERIALS

