Constructing the "Best" Reliability Data for the Job

Developing Generic Reliability Data from alternative sources when observed data is not an alternative

Objective

- Describe sources, practices and protocols that may be used to derive a composite generic failure rate supporting the quantification of early design risk and reliability models.

Areas of Discussion

- Sources: Where do we find data?
- Practices & Protocols:
  - Source Selection
  - Data set taxonomies
  - Data Development Protocols
  - Development of Generic Datasets
  - Use of generic data composites to influence design and operations

Data Sources: Where do we find data?

Generic Data

Commercial Data Sets

Reliability Automated Databook – RIAC RAD (NPRD,EPRD,FMD)
System and Part Integrated Data Resource - SPIDR
Offshore Reliability Data Handbook – OREDA
Reliability Data for Control and Safety Systems - PDS Data Handbook
Safety Equipment Reliability Handbook - PDS Data Handbook
Reliability of Well Completion Equipment - Wellmaster
Subsea Reliability Data – SubseaMaster

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
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

Industry Data

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

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

Design Details

Engineering Data

Predictive Methodologies

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

Source Selection

- Industry, corporate, and discipline best practice influence source selections.
- Consider the following when assessing the availability of data:
  - Specific product or system field data
  - Similar product or system field data or test data
  - Data
    - Relevance
    - Sufficient quantity
    - Sufficient quality

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

Data Set Taxonomies & Architecture

- Detail available and represented as part of the internal data collection and aggregation protocol.
  - Minimum details include:
    - Define the boundary
    - Observed operating time or demands
    - Observed failures
      - Mode and mechanism
      - Number of failures
  - Traceability criteria to original data source.
  - Performance parameter generated
    - failure rate (time, cycle, mileage)
    - failure mode and distribution (percentile of failure rate by failure mode)
    - uncertainty
      - upper and lower boundary (5^{th} and 95^{th} percentile)
      - error factor

The dataset taxonomy will determine viability of the dataset.

Data Development Protocols

Data development protocols represent the methods influencing the data collection and aggregation effort.

- 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
  - Tailoring Data
- Reporting criteria – Rate (time or demand based)

Establish protocols early in the process and then implement them consistently

Development of data Aggregation Composites

- The development of composite analog data:
  - Summing all failures and dividing by the sum of all hours
  - Using statistical methods to identify and exclude outliers
  - Deriving the arithmetic mean and modifying the resulting value as needed
  - Using a mean failure rate.
  - Deriving the geometric and multiplying the derived failure rates by the proportion
- Account for environment and quality factors

The development of composite analog data requires the identification of the dataset taxonomy as influenced by the data analysis protocols to derive an aggregated reliability performance parameter based on similar equipment types and failure modes from multiple data sources

Development of Generic Datasets

- The generic data aggregation provides an initial reliability estimation of a reported equipment type, assembly, part or component.
- Data included in the generic dataset:
  - Equipment item, part or component description and boundary
  - Observed operating time or other performance measure (miles, cycle, flow, etc)
  - Observed failures
  - Rate of failure in time or other performance measures
  - Uncertainty (error factor, upper limit, lower limit)
  - Failure mode and percent of overall failure rate

The development of composite analog data will only be as good as the consistent implementation of the data processing protocols.

Data Composites Used To Influence Design and Operations

- The generic data aggregation provides an initial reliability estimation of a reported equipment type, assembly, part or component.
- Project specific data sets include additional details:
  - Industry data
  - Internal Technical Reports
  - Design Details
  - Engineering Data
  - Environmental conditions

During preliminary design or when observed data is limited or non-existent, the composite failure rate may be used as an analog in quantifying reliability models.

Take Away

Reliability performance measures are not easy to find, but details exist. Industry datasets, technical documents and maintenance records are a viable source to develop quantitative reliability factors that are effective measures for risk and reliability modeling. These also support the quantitative logistics parameters associated with maintenance planning for spares and provisioning.

What is needed, is the desire and time to capture the records.