Outline

- Test Planning
- Data Acquisition
- Data Validation
- Data Reduction Modes
Why Do We Collect Data?

- Assess product performance
- Estimate product durability
- Establish customer usage
- Model Verification
- Put Out Fires
- Other
Data Collection Equipment

- Analog Tape Recorders
- Digital Tape Recorders
- Solid State Digital Devices
  - Data Loggers
  - Time History Recorders
  - Field Computers
Data Collection Equipment
Field Data Collection

- Field tests are expensive
- Do it in one trip
  - Do I have the right data?
  - Do I have enough to be representative?
  - Is it of sufficient quality and accuracy?
- Good data acquisition equipment
  - Rugged
  - Easy to use
  - Flexible
Huge Investment
Durability Testing

Test Article

Data Collector

Strain Gages
What Is Data Validation?

- Process of verifying that the data collected meets the objectives set forth during test planning
- Data quality is sufficiently high
- Data quantity is enough to ensure statistical relevancy
- Data can sometimes be corrected
What Kind of Effort Is Validation?

- Most laborious, least interesting form of data analysis
- Time consuming - 20% to 50% of total data analysis effort
- Critically important - bad data begats bad analysis
Data Validation Steps

- Visual Inspection
- Quality Tests
- Sufficiency Tests
- Corrective Action
- Data Transfer
Relationship of Modes

- **FFT**
- **Time History**
- **Peak-Valley**
- **Burst History**
- **Time at Level**
- **Rainflow/Peak-Valley Matrix**
- **Range Only**
- **Range - Mean**
- **To - From**
Data Mode Uses

Time History - everything
Burst History - finding rare events
Sequential Peak Valley - durability analysis
Time @ Level Histogram - usage and performance determination
Peak Valley Matrix - statistical history characterization
Rainflow - durability analysis and statistical history characterization
FFT – everything like a time history but in the frequency domain
Time History

- Maintains amplitude
- Maintains sequence
- Maintains phase between multiple channels
- Maintains frequency content
Burst History (Triggered)

- Maintains amplitude
- Maintains sequence
- Maintains phase between multiple channels
- Maintains frequency content
Peak Valley Extraction

- Maintains amplitude
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content
Time At Level Histogram

- Maintains statistics
- Destroys sequence
- Destroys phase between multiple channels
- Destroys frequency content

Counts the total number of samples in each input signal category.
1D Time At Level

Counts the total number of samples in each input signal category.
2D Time At Level

Counts the total number of samples in each unique combination of input signal categories

- Maintains statistics
- Destroys sequence
- Maintains time between multiple channels
- Destroys frequency content
2D Time At Level

Counts the total number of samples in each unique combination of input signal categories
Peak Valley Matrix

\[ \text{RANGE} = |A - B| \quad \text{MEAN} = \frac{(A + B)}{2} \]

PEAK VALLEY PAIRS = AB, BC, CD, DE, EF, FG, GH, HI, IJ, ……
Peak Valley Matrix (Range Only)

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content
Peak Valley Matrix (Range-Mean)

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content

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Peak Valley Matrix (To-From)

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content
Rainflow Counting

- Maintains amplitudes
- Maintains sequence
- Destroys phase between multiple channels
- Destroys frequency content
Rainflow Counting

PEAK VALLEY PAIRS = AB, BC, CD, DE, EF, FG, GH, HI, IJ, …...

RAINFLOW PAIRS = AB, CD, EF, GH, IJ, ……
FFT (How’s Fourier Work?)

**Time Domain**

- Stress
- Time

**Frequency Domain**

- Fourier Transform
- FFT Stress
- Frequency

**Inverse Fourier Transform**
How’s Fourier Work?

(Theory of Fourier, 1768-1830)