Test tailoring- from LCEP to test specification

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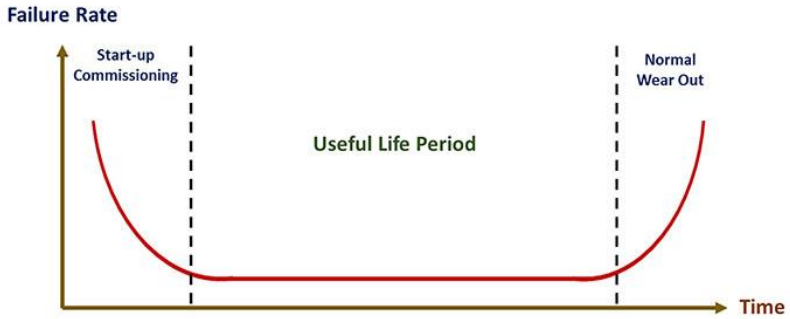
Specialist in reliability

Reliability of a system

Temperature, Vibration
Pressure, …



Lightning, Flight load
Bird strike, Hail and ice…

Corrosion (salt, chemical), Fungus
Mine blast, humidity, …

- Requirement management from whole system to a component level
- Model based systems engineering

Temperature,
Sun and dust, Rain, wind, …

Life Cycle Environmental Profile (LCEP)

- Main environmental phases
  - Production
  - System test
  - Transport A (transportation to customer)
  - Transport B (storage & logistic supply)
  - Storage
  - Installation
  - Operation
  - Transport D (transportation to destruction site)

- Environmental conditions

(Truck, flight, ship) Vibration, humid, temperature

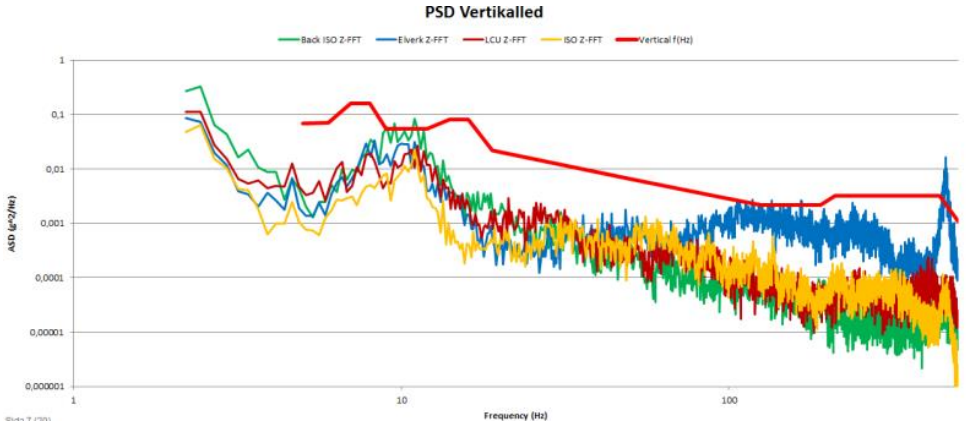
(Truck, flight, ship, animal,…)Vibration, shock, temperature cycling, humid, salt, ESD

Humid, temperature, ESD

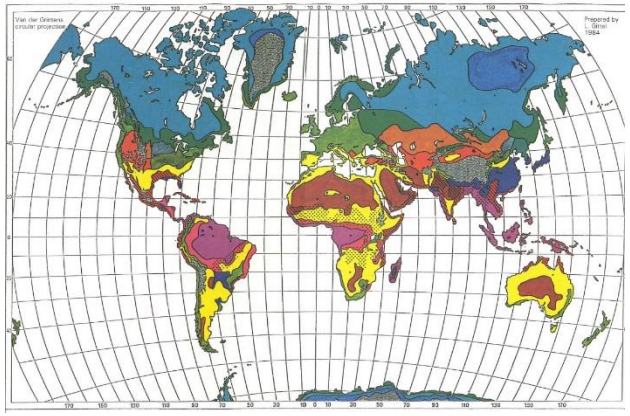
Vibration, shock, temperature cycling, lightning, bird strike, sand, wind

Environmental requirements

- **Standard**
  - STANAG 2895
  - MIL-STD 810G
  - MIL-STD-167-1A
  - DEF-STAN 00-35
  - MIL-STD-901D
  - AECTP-230
  - IEC 60721
  - RTCA
  - …



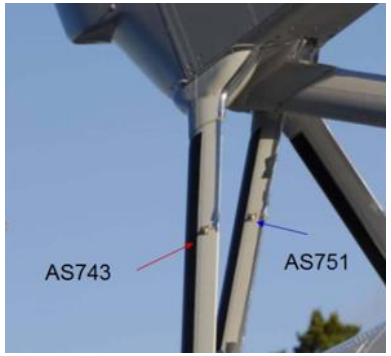
Vibration levels



Climate zones

- **Customer defined**

- **Field measurement**

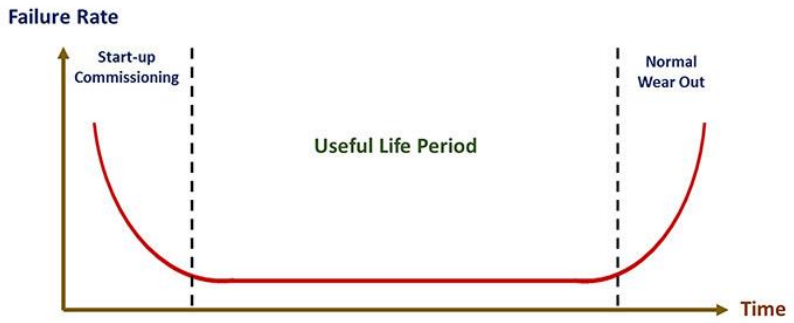


Environmental test of modules and electronic

LCEP

Requirement allocation

Accelerated test for modules



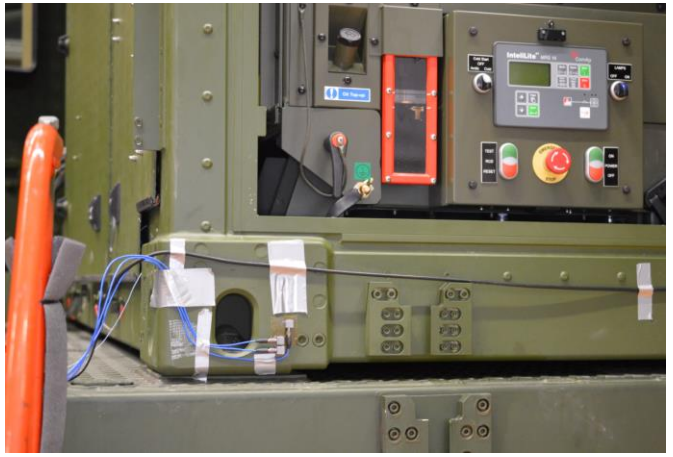
MTBF system requirement

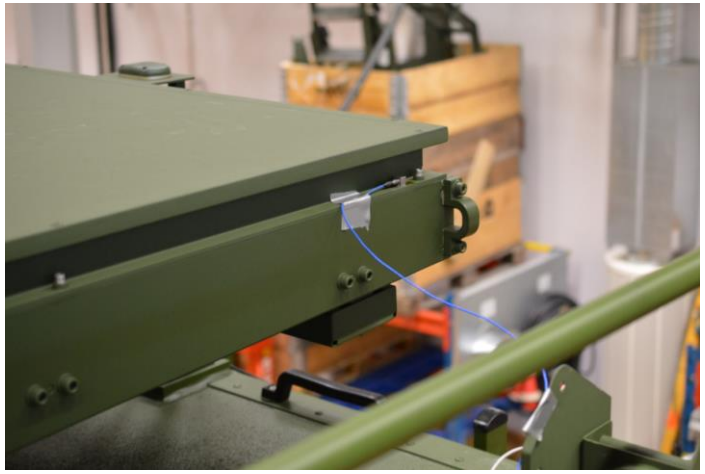
MTBF requirement allocation

$MTBF_{module}$

$MTBF_{test} > MTBF_{module}$

Field measurement of a land system





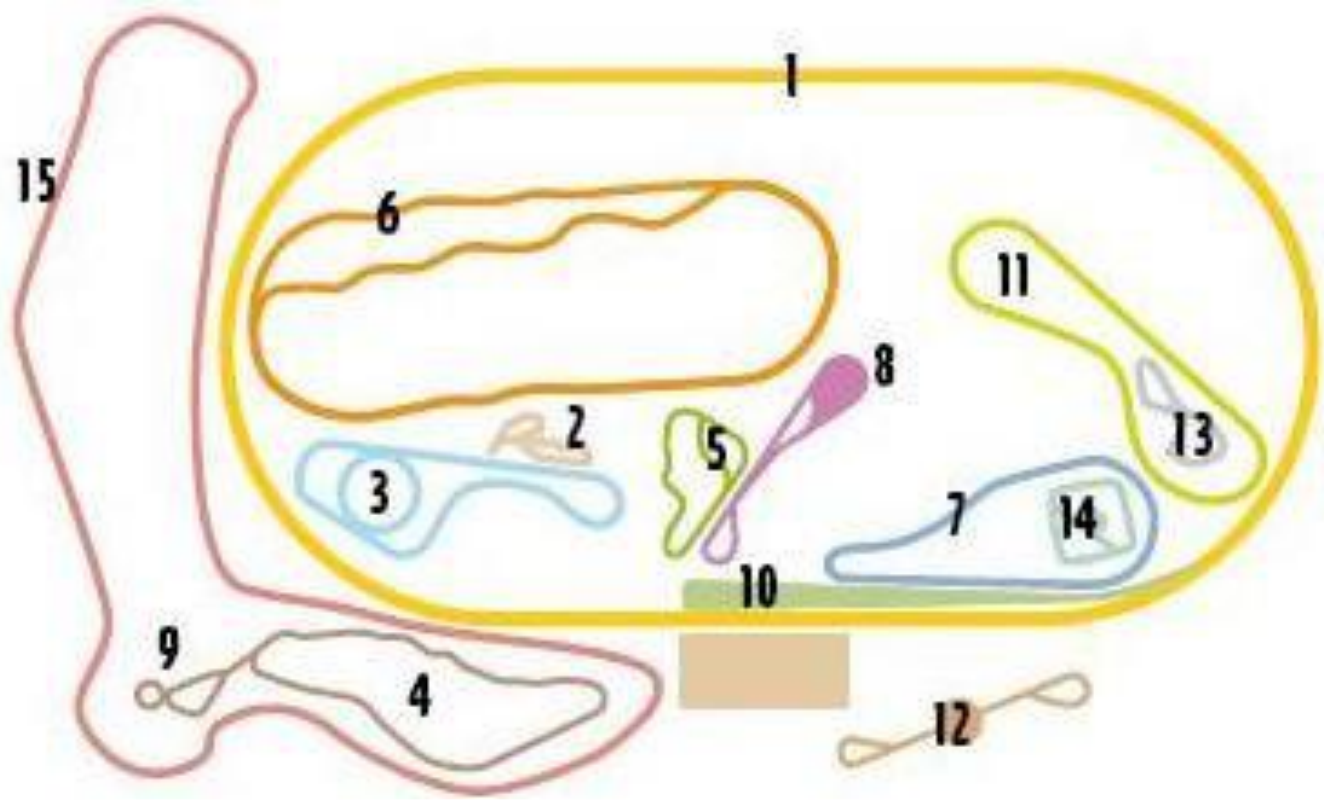
TEST TRACK IN HÄLLERED

2 – Construction site track
- Större hinder för anläggningsmaskiner och terrängfordon
- 750m lång

3 – Durability Track
- Gropar, kantsten, tvättbrädor och kullersten
- 2600m lång

4 – Gravel Road Track
- Underhållen för att efterlikna typisk grusväg
- 1500m lång

9 – Slopes
- Varierande backar mellan 8% och 60%



Durability track can be considered correspond to severe off-road in MIL-STD 810

Vibration transport endurance test

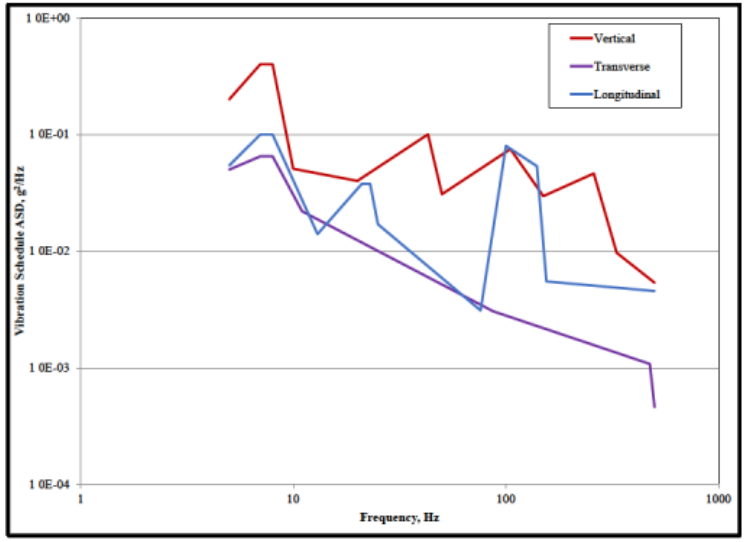
- Analysis data from field measurement
- Identify real time vibration level
- Design the endurance test using acceleration formula

$$\frac{t_2}{t_1} = \left[\frac{w_1}{w_2}\right]^{m/2}$$

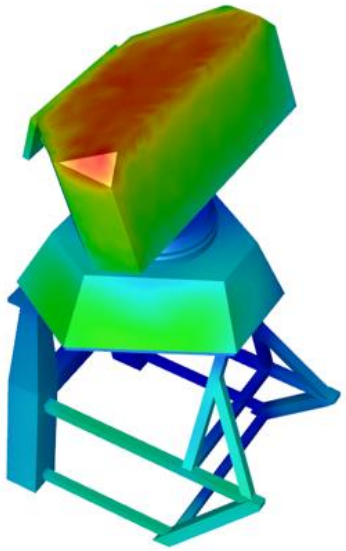
Where:

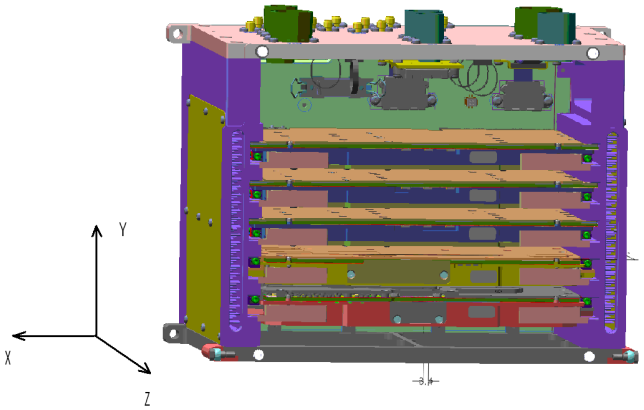
t_1	equivalent test duration
t_2	real time
w_1	ASD at test condition, g^2/Hz
w_2	ASD at real time, g^2/Hz
m	a value based on the slope of the S-N curve for the material, usually between 5 to 8.

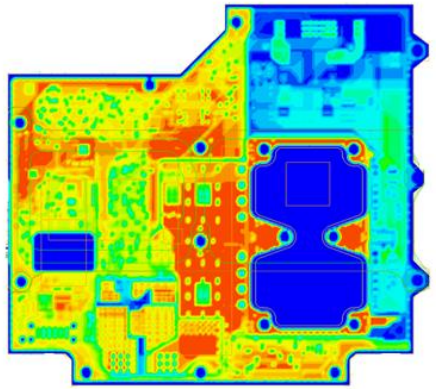
Usually a value of m=7.5 has been used for random environment.

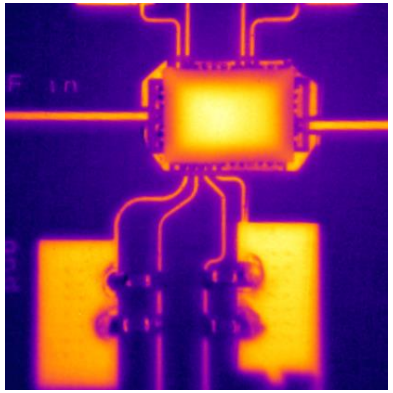


Temperature test









Climate environment define surrounding temperature → Electronic equipment → PCB board → chip

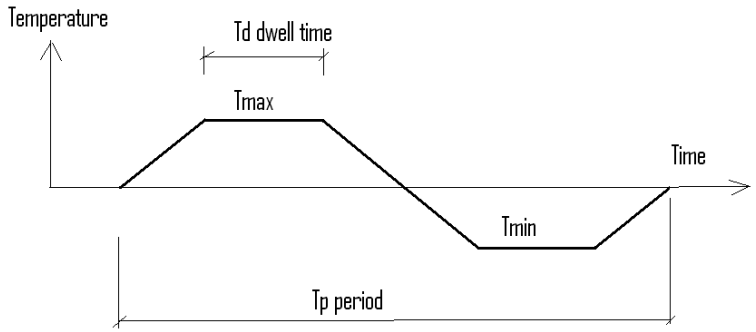
Temperature endurance test

- Operational profiles define climate environment and deployment
- Number of cycles for different temperature intervals from operational profiles
- Define a temperature cycle using acceleration formula
- For solder joints, the Norris & Landzberg can be used:

$$AF = n_2 / n_1 = (\Delta T_1 / \Delta T_2)^{\alpha} (f_2 / f_1)^{\beta} \exp [1414 \{ 1/T_{max2} - 1/T_{max1}\}]$$

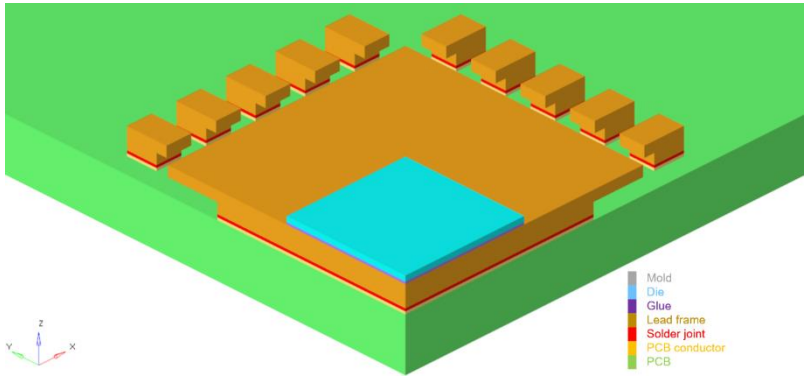
Where AF = acceleration factor

- ΔT = temperature variation in one cykel (°K)
- n = number of cycles
- f = frequency, number of cycles per 24 hours.
- T_{max} = max temperature in the solder (°K)
- index 1 = accelererat test in lab
- index 2 = environment in field



Reliability of electronic

- Methodology and tools for analysis of reliability of electronic
  - Finite element method and DOE (design optimization)
  - Sherlock – Software for life predictions for electronics components
- Temperature cycling test



Summary

- LCEP with a list of all events with duration and chronological order is essential for a proper test tailoring
- Search for real environmental data representative for each identified event
- Synopsis of data to deduce a specification with realistic duration
- Establishment of the test program, have a balace between saving test time and a representative test
- Standards require test tailoring: MIL-STD 810, GAM.EG 13 and the NATO (STANAG 430)