Risk analysis on IC in Schneider Electric

Presented by: Claire Garden / EME lab / Schneider Electric

Summary

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1. Schneider Electric / EME laboratory
2. Mission Profile: Customer expectation
3. Risk analysis on IC
4. Difficulties / Concerns

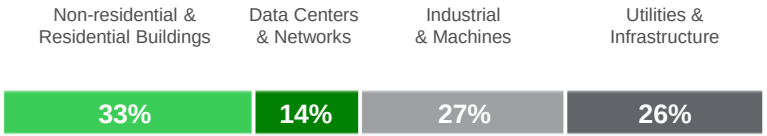
Schneider Electric,
the global specialist in energy management and automation

€25 billion
FY 2014 revenues

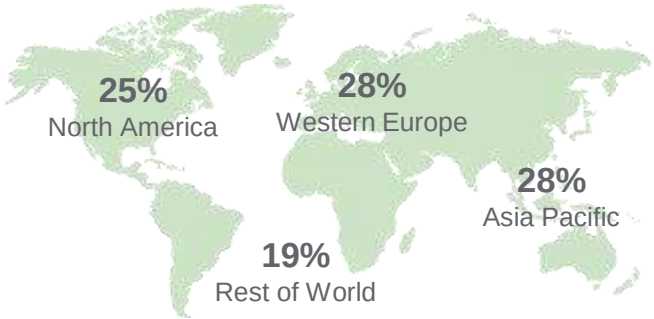
~5%
of revenues devoted to R&D

~170,000
people in 100+ countries

Diversified end markets – FY 2014 revenues[1]



Balanced geographies – FY 2014 revenues[1]



Life Is On Schneider Electric

Energy is the base of life.

Life Is On

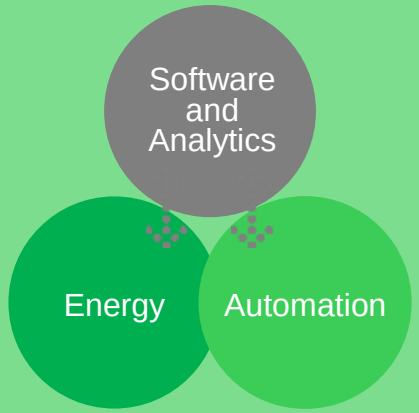
when energy is on……

We ensure energy is on by making it

- Safe
- Reliable
- Efficient
- Connected
- Sustainable

Life Is On | Schneider Electric

At Schneider Electric , we combine **Energy Management, Automation** and **Software** serving 4 markets, i.e. 70% of the world energy consumption



% are calculated on final energy

Buildings + Residential

> 30%

Industry & Infrastructure

> 30%

~2%

Data centres & networks

Source: IEA Explore 2015

Life is On with Schneider Electric Building Solutions:

From **grid to floor space**, we ensure **safety, comfort, reliability, efficiency and sustainability**


Security Management


Building Management


Power Management


Circuit Breaker


Power factor correction
Power meters


Busways


Cable Management Systems


Switches and Sockets


HVAC Controllers, Sensors, valves and actuators


Life Space Controls


Voice Data Image


Cameras

Key Buildings Sub-Segments


Hotel


Hospital


Retail


Office

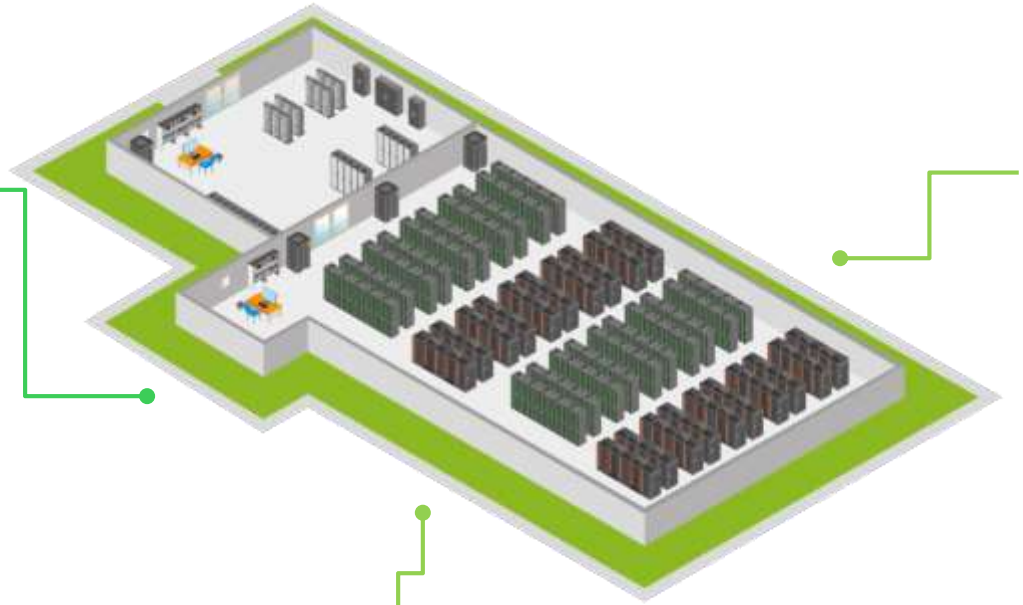

Life Science

Software & Analytics
Energy
Automation
EcoStruxure

Life Is On Schneider Electric

Life is On with Schneider Datacenter Solutions:

From **rack to cyber space**, we **optimize performance, speed and cost**



HV/MV & MV/LV Transformers

MV and LV Switchboards & Switchgears

Modular UPS

Sensors & Meters

Busway

Network connectivity & Cable management

Floors, Rack systems

Flexible Air Containment

Room/Row/Rack precision cooling

Indirect Free Cooling

Chillers

Cooling VSD & Control

Row Modular UPS & PDU

Lighting Control

Access Control, CCTV

Software & Analytics

Energy

Automation

EcoStruxure

Life Is On Schneider Electric

Life is On with Schneider Electric Smart City Solutions:

From **downtown** to **suburb** , we deliver **urban efficiency today**

Smart Water

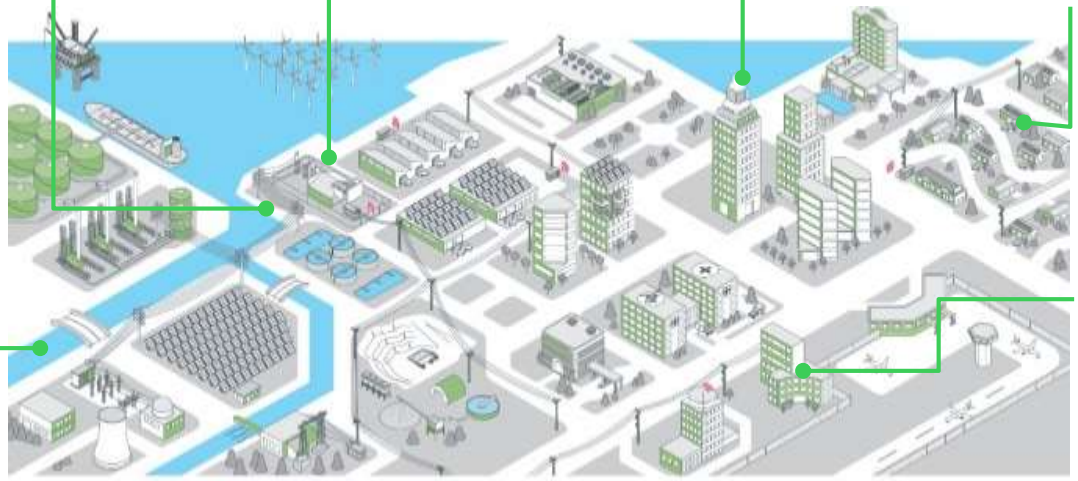
- Plant & Network Energy Performance
- Water Distribution Optimization & Loss Mgt
- Stormwater management and Urban Flooding
- Irrigation Management

Smart Energy

- Smart Grid Asset Management, Smart Generation, Demand Side Management, Utility Services
- Renewables Integration & Micro Grid
- District Heating/Cooling Management
- Gas Distribution Management
- Shore Connection

Smart Buildings & Homes

- Multiple Disparate Buildings Management
- High Performance Buildings
- Flexible Buildings
- Efficient Homes



Smart Public Services

- Public Safety: Video Surveillance
- Smart Street Lighting Management

Smart Mobility

- EV Charging Infrastructure & Supervision Services
- Traffic Management
- Tunnel Management
- Tolling Management
- Railway Management
- Airport Solutions

Smart Data Center

- Efficient Data Centers
- Prefabricated Data Centers
- Infrastructure Enabled Management Services

Smart Integration

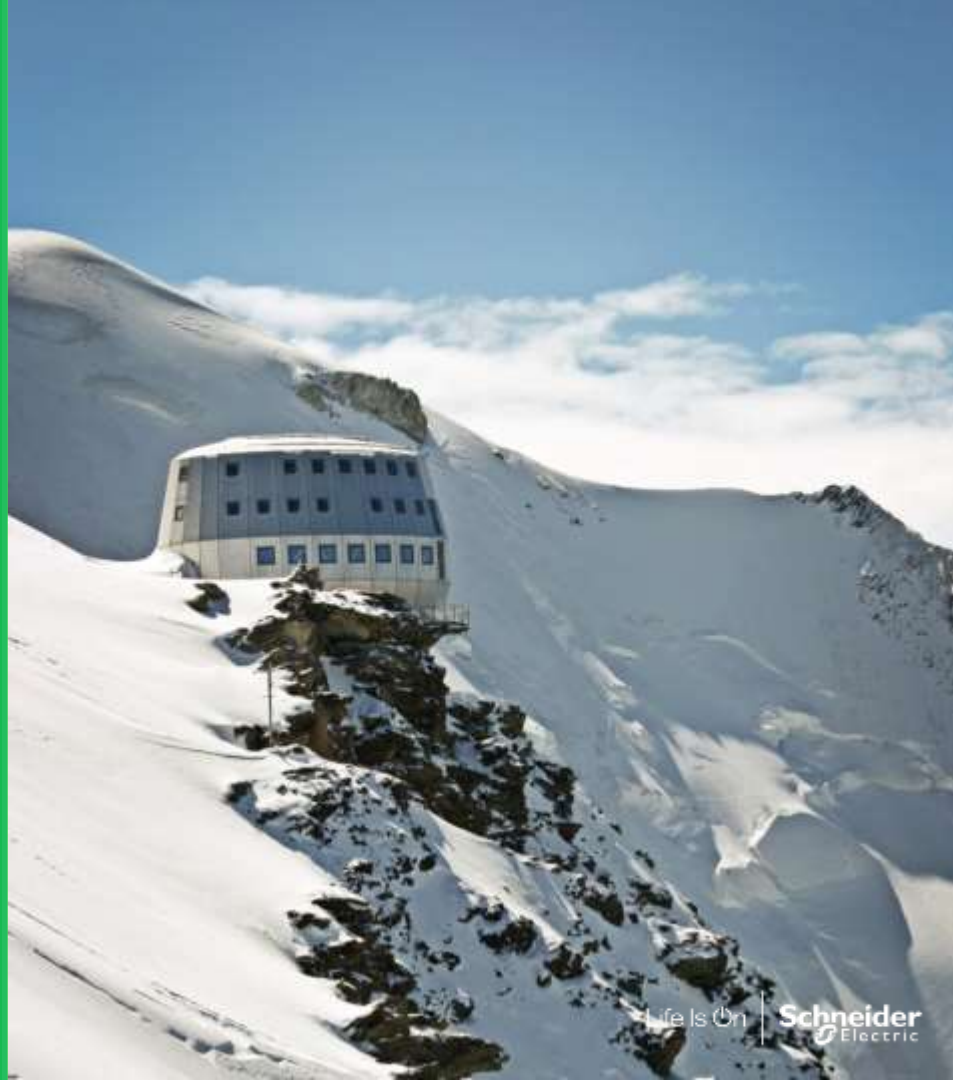
- City-wide Platforms
- Energy & Sustainability Resource Management
- Urban Efficiency Platform
- District Energy Management Information System

- Cross-domain Application
  - Weather
  - GIS
  - Asset Management

- City Strategy Services
  - Sustainability Services
  - Smart Cities Advisory Services
  - Energy Performance Contracting

Life Is On Schneider Electric

Our capabilities allow us to deliver tangible results for customers, wherever they might be.



Electronics and Materials Expertise Lab. (EME)

Provide technological expertise support to all Schneider Electric Businesses for product quality mastery

- **Qualification**
- **Failure analysis**
- **Consulting**

In the field of

- **Electronics**
- **Materials**
- **Metals**
- **Assembly**

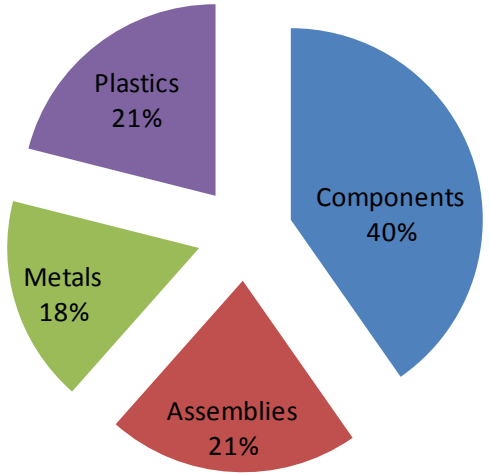
EME lab in few figures

19 experts

550 m² lab

5 M€ equipment

+ a wide external laboratory network



750 analyses performed / year
(2014 figures)

7500 expertise reports accessible in our iExpert database

Life Is On Schneider Electric

Mission Profile: Customer Expectation

Electronics to be safe, reliable, connected, green, in our customer environment during the expected lifetime.....




Varieties of environmental constraints in our final customers applications require high reliability & requirements levels where failures cannot be tolerated!

Our Customers expect the “legendary reliability of Schneider Electric products “!

For each life phase of the product, the mission profile …

1. **describes the environmental conditions of the product and its components**
2. **describes the usage conditions**
3. **fixes the expected time duration and cycles numbers**

Manufacturing:
component storage,
assembling,
sub-assembly storage

Shipping

Storage:
distribution center,
distributor,
final customer

Installation / Commissioning

Operation

Maintenance

Product Mission Profile Example

Storage

Temperature (close to the component)	Humidity (close to the component)	Duration
30°C	80%RH	6 months

10 years

Operation

Temperature (close to the component)	Humidity (close to the component)	Duration
90°C	7%	61320 h
105°C	5%	26280h

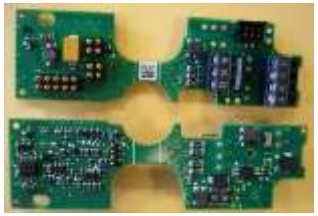
20 years

Temperature (close to the component)	Humidity (close to the component)	Duration
50°C	15%	157680h
60°C	10%	8760h

Standard components market gets lower level requirements than Schneider industrial products

Risk analysis on IC

Risk analysis



Quality and Reliability data from the component manufacturer are compared to the need of the project (mission profile), in order to identify the risks related to the technology and its use in the final product

1rst step: Gathering component data by CIR
2nd step: Analysis and calculation
3rd step: Risk assessment plan

Risk analysis

1rst step

- Gathering all the data concerning the component: A CIR is sent to the supplier

- Check obsolescence or shrink status of the component,

- Technological node used,

- Wafer plant names and locations,

- Assembly plants/subcontractors names and locations

- All test results (wafer, die and package levels)

Risk analysis

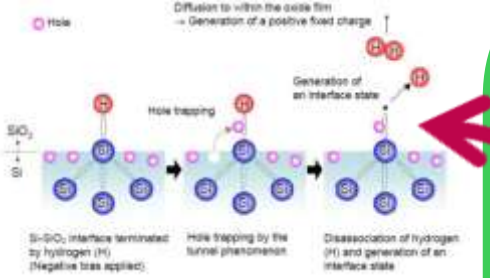
2nd step

- Analysis of the CIR form

Risk analysis

Reliability tests results at wafer level

WEAR OUT

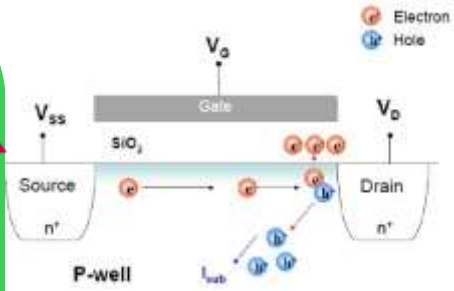


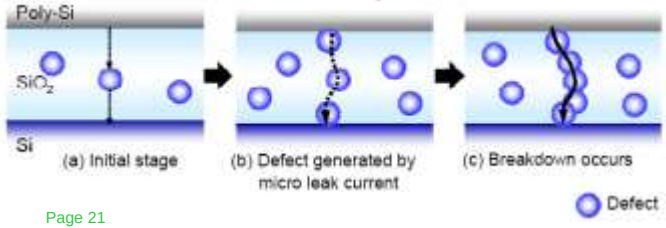
Hot Carrier Injection (HCI)

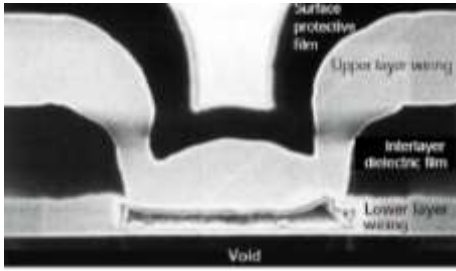
Time Dependent Dielectric Breakdown (TDDB)

Electromigration (EM)

Negative Bias Thermal Instability (NBTI)

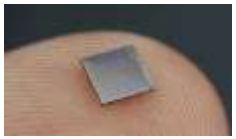






Source: Semiconductor Device Reliability Verification (SONY)

Risk analysis

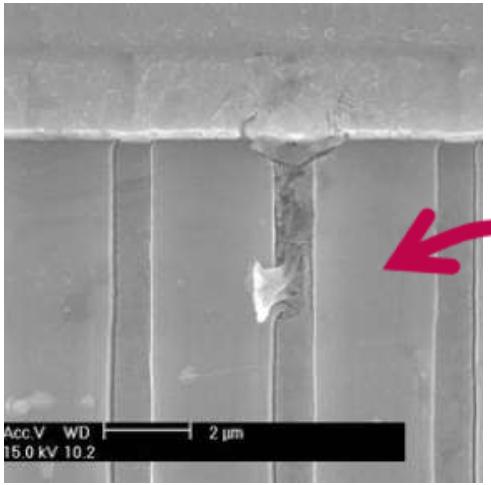


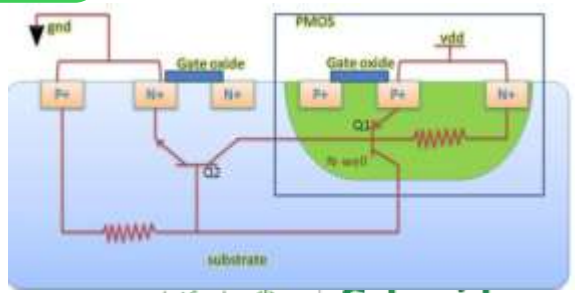
Reliability tests results at device level

High Temperature Operating Life (HTOL)

Latch Up (LU) at max. operating temperature

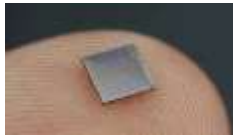
Electro-Static Discharge (ESD)





Source: http://vlsiuniverse.blogspot.fr/2013/03/latchup-condition-in-cmos-devices.html
Failure Signature of electrical overstress on power MOSFETs

Risk analysis



<u>Reliability tests results at die level</u> (applying to non volatile memories and IC's with flash or non volatile memories embedded)

Non-volatile Memory Uncycled High Temperature Data Retention (UCHTDR)

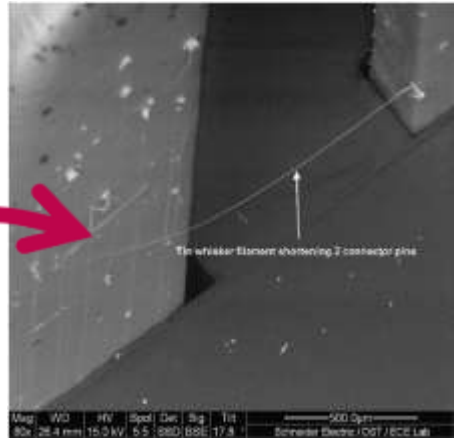
Non-volatile Memory Cycling Endurance (NVCE)

Non-volatile Memory Post Cycling High Temperature Data Retention (PCHTDR)

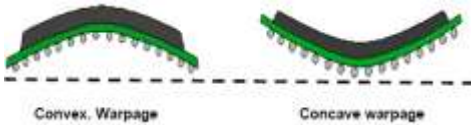
Risk analysis

Reliability tests results at package level

High Temperature Storage (HTS)
Temperature Humidity Bias (THB) or Highly Accelerated Stress test (HAST)
Thermal Cycling (TC)
Bond Pull Strength (BPS)
Bond Shear (BS)
Solderability (SD)
Tin whisker's tests excepted to BGA package



Qualification tests applying only to BGA packages:



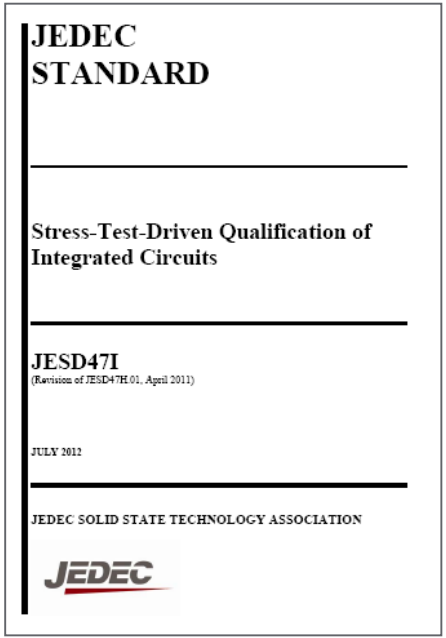
Solder Ball Shear (SBS)
Thermal warpage characterization test

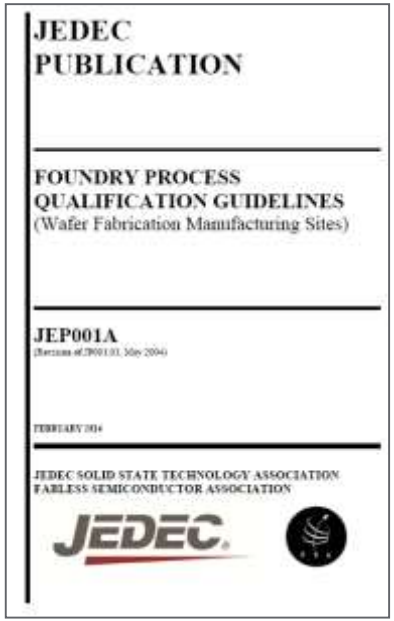
Source: http://www.tpt-wirebonder.com/en/accessories/add-ons/h53-pull-tester.html
JESD22 B112

Risk analysis

2nd step

- Check if all the tests have been performed in accordance with JEDEC Standards (or AEC-Q100): JESD47I / JEP122G / JEP001A

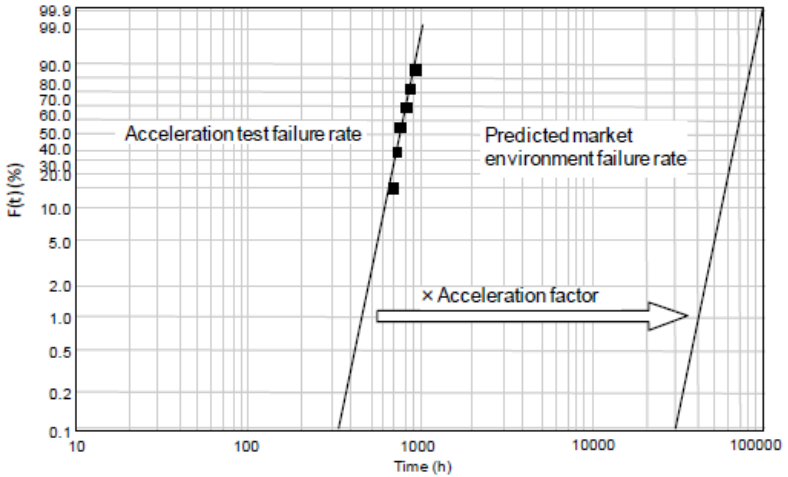




Risk analysis

2nd step

- Use acceleration factors and JEDEC models in order to validate the coverage of the mission profile by the reliability tests performed by the supplier



Arrhenius

$$AF = e^{\frac{E_a}{k}\left(\frac{1}{T_{use}} - \frac{1}{T_{Test}}\right)}$$

Black Model

$$AF = \left(\frac{Juse}{Jtest}\right)^{-n} * e^{\frac{E_a}{k}\left(\frac{1}{T_{use}} - \frac{1}{T_{Test}}\right)}$$

Hallberg-Peck Model

$$AF = \left(\frac{RH_{Test}}{RH_{use}}\right)^{m}$$

Source: Semiconductor Device Reliability Verification (SONY)

Risk analysis

3rd step

- Identify the risks
- Propose a risk assessment plan

Risk n°	Description of risk (describe risks of use in Schneider products that are not covered by Manufacturer's qualification)	Risk Assessment Proposal (describe proposed assessment works necessary for the use of the component in targeted Schneider products)
1	**Risk of poor quality of assembly of BGA package on electronic boards for ASET assembly site:** The supplier did not provide the SBS, SD and warpage tests	Ask the supplier to provide SBS, SD and warpage test results.
2	**Risk of poor quality of assembly of BGA package on electronic boards for CML assembly site:** BGA thermal warpage characterization test results are missing.	Ask the supplier to provide BGA thermal warpage characterization results.

Risk analysis

Gap coverage following risk analysis

- **Reliability tests missing: ask the supplier to provide the missing test**
  ➔Example: missing HTS test

- **Reliability tests not covering the mission profile: ask the supplier to perform the test with the conditions to cover the mission profile or perform the test in our laboratory**
  ➔Example: data retention test

- **Technological analyses (verification of the process quality, wafer fab unknown, new technology…)**

Difficulties / Concerns

Difficulties / Concerns

- **Difficulties in getting the relevant data from supplier (especially for wear out test results) as companies buy only small quantities of components.**

- **Difficulties in getting the activation energy value for certain test (data retention, HCI…)**

  ➔"Secret" values for component companies (can reveal the maturity of the process…)

- **Models used are getting obsolete (combination of failures mechanisms….) and in some points the JEDEC has reached its limit.**

- **Use multisource to avoid obsolescence: merging of several companies reduce the choice of component supplier (NXP/Freescale, Cypress/Spansion….)**


THANK YOU.
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Schneider Electric

Questions?

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