Experience from IEC type approval qualification

TÜVRheinland®
Precisely Right.

Dipl.-Ing. Christian Bauerdick
TÜV Immissionsschutz und Energiesysteme GmbH
TÜV Rheinland Group
Am Grauen Stein, 51105 Köln, Germany
Tel.: 0221/ 806 2082, Fax 0221/806 1350
E-Mail: christian.bauerdick@de.tuv.com,
Internet: www.umwelt-tuv.de

Introduction

- Requirements and standards
- Type approval testing for PV modules
- Quality control for PV modules
- Experience of TUV Rheinland
- Measurement of PV modules

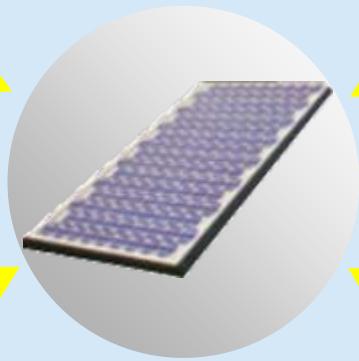
Requirements for PV modules

- Safe operation
- Long operating life, suitable for the application, little degradation
- Fulfilling of the guaranteed specifications, in particular in respect to the nominal power
- Small tolerances
- High energy yield
- Short energy payback times
- Long warranty, competitive

Influences on PV modules

Irradiance:
sun, sky

Temperature:
heat, frost,
night-day cycles



Humidity

Mechanical stress:
wind-,snow load
hail impacts

Moisture:
rain, dew, frost

Atmosphere:
Salt mist, dust,
sand, pollution

Important standards for PV modules

IEC 61215:2005 (EN 61215:2005)

Silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61646:2008 (EN 61646:2008)

Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61730:2004 (EN 61730:2007)

Photovoltaic (PV) module safety qualification –

- Part 1: Requirements for construction
- Part 2: Requirements for testing

IEC 62108:2007 (EN 62108:2008)

Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval

TÜVRheinland® Precisely Right.

Important standards for PV modules

IEC 60904 Series (EN 60904-1 to -10)
Photovoltaic Devices (measurement principles)

IEC 61701:1995 (EN 61701:2000)
Salt mist corrosion testing of photovoltaic (PV) modules

IEC 62446:2007 (Draft)
Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection

EN 50380:2003
Datasheet and nameplate information for photovoltaic modules

UL 1703:2003
Flat plate photovoltaic modules and panels

TÜVRheinland® Precisely Right.

Type approval testing for PV modules

After completion of all test sequences the following **pass criteria** have to be fulfilled:

➔ <u>For crystalline modules</u>:
maximum relative power degradation after each test is **< 5%**

➔ <u>For thin-film modules</u>:
Final output power after light-soaking shall be at least 90% of the minimum rated power **(0.9 x (P_N – tolerance))**

➔ Minimum requirements of the electric insulation have to be met (dry and wet)

➔ No major visual defects

TÜVRheinland® Precisely Right.

Type approval testing for PV modules

TÜVRheinland®
Precisely Right.

Quality control for PV modules

Quality assurance through certification

- Type approval through ISO 17025 accredited laboratories offers the possibility to confirm quality
- Test marks signal an independent quality check
- Certified components offer increased security for the module manufacturer
- Possible changes of the product are regulated in international guidelines
- Regular factory inspections are part of the type approval system with TÜV Rheinland

TÜVRheinland®
Precisely Right.

Quality control for PV modules

Quality assurance through certification

Laboratory test for a type family	ISO 17025 accredited laboratory
Factory inspection	Conducted by PV specialists
Certificate	Issued by the independent certification body
regular follow-up factory inspections	Annually performed to keep the license valid

Quality control for PV modules

Problems with the certification system

- For the type approval testing only few samples are taken (~10)
- A certificate does not offer a guarantee for quality, as every system can be imposed; absolute control is not possible
- Qualification tests require several months; in this time the manufacturer has no certified product but likely a running production
- Also institutions with little experience in PV are issuing PV certificates
- Fake and misleading certificates are circulating and surface regularly

Original TÜV Rheinland certificate and test mark

TÜV

Certificate

Registration No.: Q 9999999 Page 1 Report No.: 99999999

License Holder:
XXX

Product:
PV Modules
Type

Manufacturing Plant:
YYY

Basis:

IEC 61215: 04.1993
"Crystalline silicon terrestrial photovoltaic (PV) modules - De qualification and type approval"

Factory Inspection
To document the consistent qu the product factory inspections performed periodically.

Remarks:
1 The details of the factory inspec

Conditions:
The product test is voluntarily according to technical regulations. Any change of the design, materials, components or processing may require the repetition of some of the qualification tests in order to retain type approval.
The certificate has a validity of 5 years counting from date of issue.

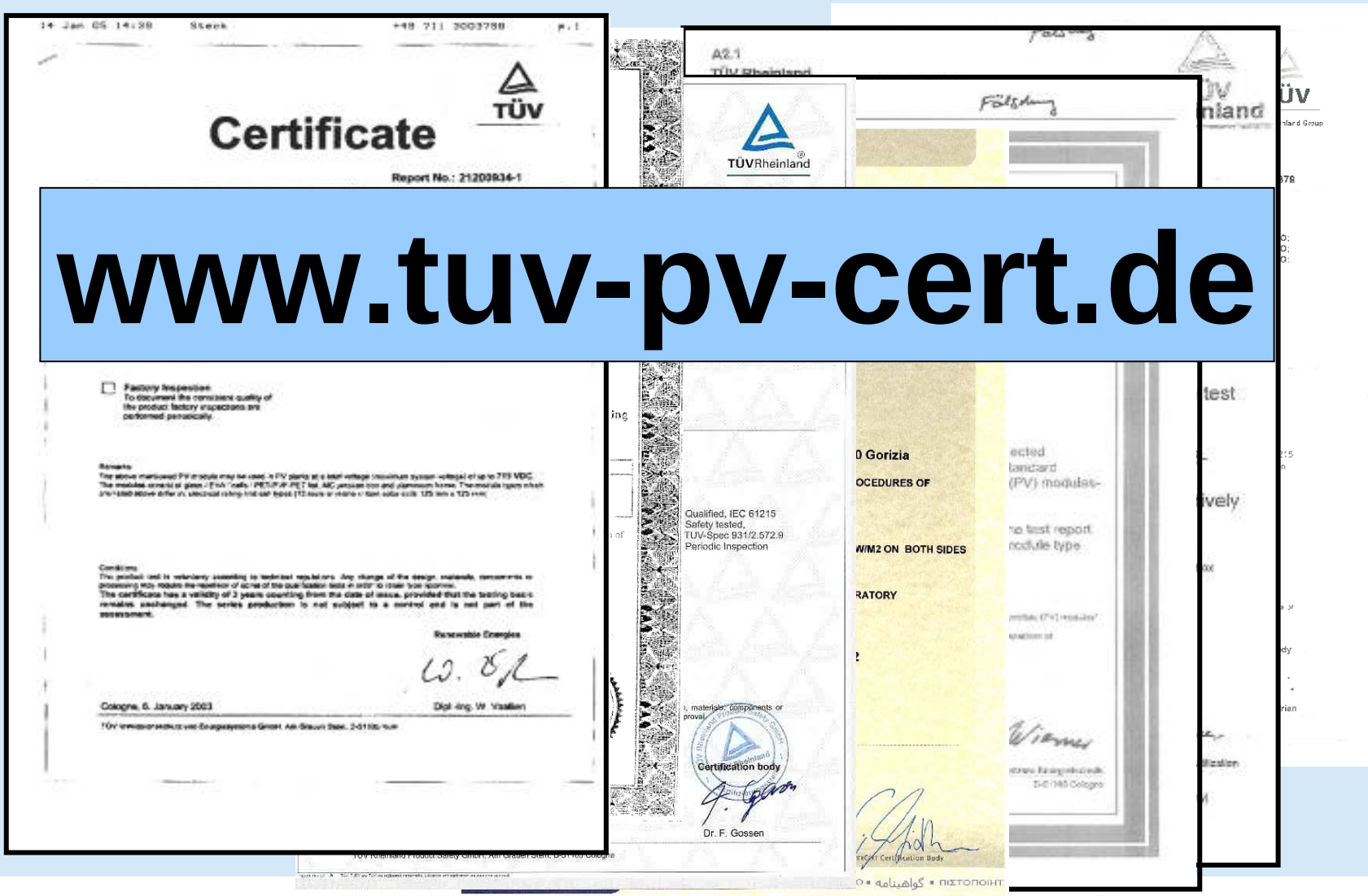
Certification body

Cologne, 18 January 2005 Dr. F. Grassen

TÜV Rheinland Product Safety GmbH, Am Grauen Stein, D-51105 Cologne

TÜVRheinland®
Precisely Right.

Fake and misleading certificates



TÜVRheinland®
Precisely Right.

Quality control for PV modules

Verification of output power

- If the power from production charges shall be verified, the sample size has to be determined.

- TÜV Rheinland has developed a software tool together RWTH Aachen that helps to do so.

- Result: if large numbers of module are to be verified (several 1000), a sample size > 100 module is required.

- For already installed smaller sized systems the conventional statistical models are not valid and case studies are required.

TÜVRheinland®
Precisely Right.

Quality control for PV modules

Problems with the power determination

- The current standards do not sufficiently take technology specific characteristics of the different thin-film technologies into account

- Some young module manufacturers unfortunately have considerable deficiencies regarding the power determination under standard test criteria.

- Accordingly the power ratings in some cases can be questioned and should be verified.

TÜVRheinland®
Precisely Right.

Experience from the product certification

Experience of TÜV Rheinland

- Gathered experience in PV module qualification since 1996
- Thin-film module qualification since 1999
- Participation in national and international standardization work
- Research and development in the area of PV, especially questions regarding power determination
- 45 specialists in Cologne (partly with 25+ years PV experience)
- Global PV-Network with locations in Cologne, Arizona, Shanghai Taipei and Yokohama

TÜVRheinland® Precisely Right.

Experience from the product certification

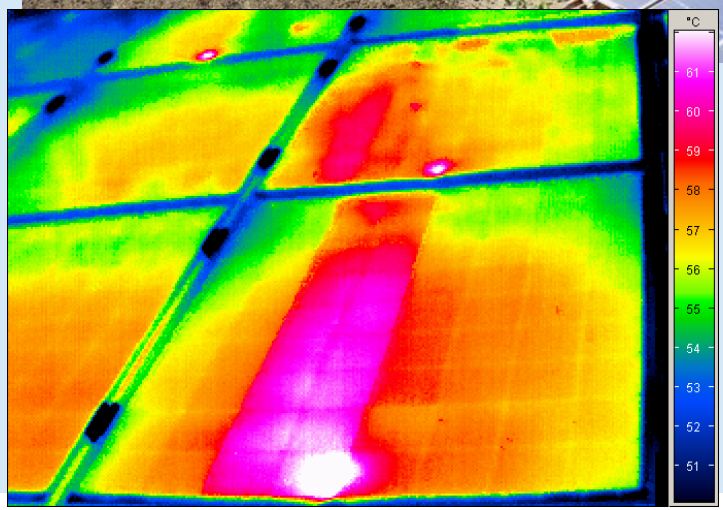
Experience of TÜV Rheinland

- Current failure rates for PV modules are at 30%
- The last 1-2 years showed failure rates of up to 50%
- Thin-film failure rates were higher than crystalline failure rates, however after the start-up problems of some new manufacturers are overcome, failure rates are similar
- Laboratory experience can be verified by field experience through the final acceptance testing for MW systems, pre-shipment inspections as well a STC calibration services

Experience from field inspections

Experience of TÜV Rheinland

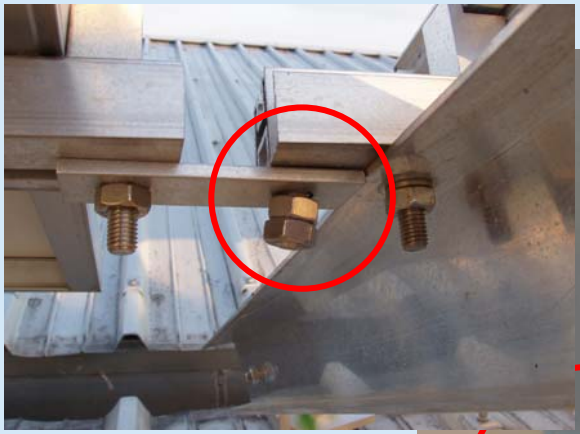
- Many MW installations have been inspected by TÜV experts
- The inspection includes safety checks, power verification, installation check and verification of existing certificates for components and modules
- Power measurement in the field and on selected samples in the laboratory; IR-imaging in the field to detect hot-spots and weak connections

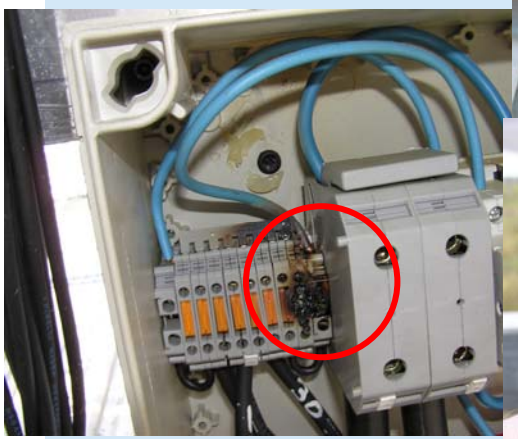


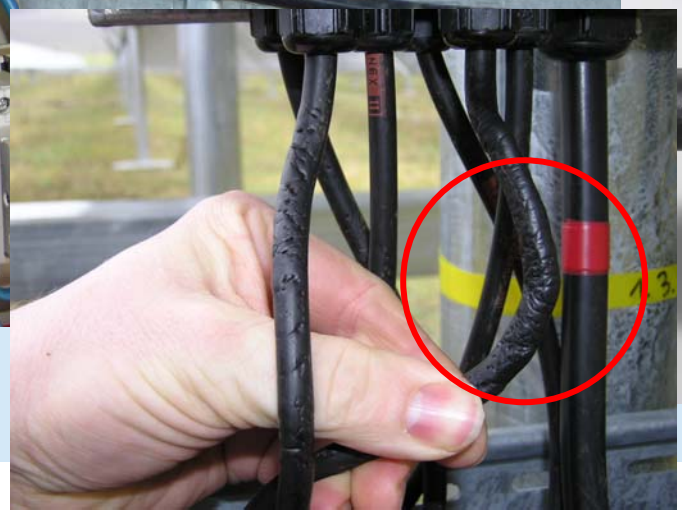
Experience from field inspections

TÜVRheinland®
Precisely Right.

Experience from field inspections







TÜVRheinland®
Precisely Right.

Summary

- Although PV-modules have reached a sophisticated level of technology, a lot of different test-failures occur in laboratory testing (failure rate > 30%)
- Failure mechanisms for crystalline modules differ from those for thin-film modules. The high failure rates for thin-film modules are regressive.
- Many failures are avoidable through sufficient quality control.
- Existing standards do not consider all technology specific behavior of PV modules sufficiently.
- Especially for accurate power determination additional research and development efforts are needed.
- Final acceptance checks in the field are inevitabel to find installation problems and verify that certified components are used.

It is not always what it seems

TÜVRheinland®
Precisely Right.

It is not always TÜV Rheinland when it says TÜV

TÜVRheinland®
Precisely Right.