How to recognize the key indicators of quality

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Quality is not everything, but everything without quality is NOTHING
Agenda

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   - Fire/arking/grounding issues
   - UV resistance of color cables

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Low quality in the PV industry - examples
Wrong installations – high filling in the tubes

**Cables are heaters**
Every cable has a loss because the resistance is always more than zero

\[ P = I^2 \times R \]

Example: 16 A and 4 mm\(^2\) (100m = 0.5 Ohm)

\[ \Rightarrow 16^2 \times 0.5 = 128 \text{ W} \]

20 cables in this duct are loosing 2560 W (!)

2000 W is enough to heat up a room with 30m\(^2\)

What is wrong? \(\Rightarrow\) Too many cables in the duct. There is no space for circulation of cooling air.

**Result \(\Rightarrow\) FIRE**
Low quality in the PV industry - examples
Fire/arking/grounding issues

Corona Effect

› Typically on large PV plants with central inverters (harmonics up to 10MHz are generating partial discharges)
› Affected in hot & humid areas
› Insufficient care of cable management (sharp edges, wrongly designed cable ducts, etc...
UV is a killer of plastics

› Sunlight contains a significant amount of ultraviolet radiation. The ultraviolet radiation that is absorbed by a polymer material will result in its degradation.

› Incorporating carbon black in polyolefines greatly increases their weather resistance. Carbon black acts as a UV absorbent and screens the polyolefine from damaging ultraviolet radiation.

› All known test results acc. Standards cannot be extrapolated based on a mathematical formula. Out of this tests we can only get comparable results, but no real statement about the real lifetime.

› As has been demonstrated through over five decades of outdoor experience with polyethylene jacketed communication cables the addition of finely dispersed carbon black results in more than 25 years of protection against sunlight.

› It is possible to pass the weathering tests with red or blue cables but it is also a fact that this results cannot tell us the lifetime!
Today´s main highlight:
DIRECT BURIAL CABLES
Direct burial of cables
Current standards vs. reality

**Standards**

› According to the IEC 62930 – Electric cables for PV Systems, Annex A „Guide to use“, it is mandatory to use the IEC 62440 (Guide to Use for low voltage cables)

„General guidance information given in IEC 62440 (Guide to use for low voltage cables) must be used“

› In the IEC 62440 „4. Safety“ it is clearly defined:

„Cables shall not be buried directly in the ground“

**Reality**

› PV cables have traditionally quite low thicknesses (costs !!!)

› These thicknesses make the cable relatively „fragile“ for directly buried installations
Direct burial of cables
Moist penetration of the polymer materials

› Water, which is almost always present at 100% relative humidity at the typical 1 meter burial depth moves very quickly through any polymeric layer.

› It is important to recognize that because underground air does not freely circulate with atmospheric air below the to few centimeters of soil, the cables are permanently exposed to water.

› Generally all polymeric compounds are not humidity proof. It is only a question of time. This is the reason that all sea cables are having a metal barrier below the sheath. Only a closed metal barrier can guarantee a constant insulation resistance for decades of use. Wire or tape armoring is NOT a closed metal barrier.

› Because standards are requiring halogen free materials which are also flame retardant, the used compounds are filled with anorganic mineral flame retardant additives. This kind of additives are stimulating the absorbtion of humidity in a long term use of this materials in humid areas.
Direct burial of cables
Underground fauna

› By locating the PV plants out of the urban areas brings an exposure of the systems with various animals.
› Rats, squirrels, or termites are able to cause severe damages on various parts of the installation.
› Cables are one of the most exposed and its design shall consider such exposure.
› Chemical solutions are questionable/not sustainable and not always the friendliest for human/environmental issues.
› **Mechanical barriers have been considered as the most effective ones**
Direct burial of cables
Chemical contamination of the ground

› There are many old landfills where the ground contamination is unknown.
› Many of them are used for PV Installations.
› Here is an extreme case to show what can happen:
› In this case there must be a high sulfuric acid content in the ground. Copper in contact to sulfuric acid generates copper sulphate which is toxic and corrosive.
› **Corrosion of contacts results in high resistance and can cause fire**
Solution?
New standard as a guideline for the PV market
Need for a new standard
Initiation & reasoning

› Because of the high cost pressure in the pv industry, all of main cables, typically 240 or 300 mm² are direct buried in the ground.

› We have seen in this presentation that cables needs a protection against humidity.

› The available PV cable standards are not optimal for this cable application.

› Cables in ground do not need fire resistance

› Cables in ground with 90°C rating is recommended
No more questionmarks.
The 2PfG2642 is here!
Standard 2PfG2642/11.17

Background

What is the meaning of a 2 PfG?

Example: 2 PfG 2642/11.17

2 : Identification number for TUV Rheinland (historic)

P : “Prüfgrundsatz” (Testing principle)

f : “für” (for)

G : “Gerätesicherheit” (Product safety)

2642 : Consecutive Number

11.17: Month/Year of listing (application date)
Standard 2PfG2642/11.17

Background

How important are 2 PfG standards?

› International acceptance
› Basis for several IEC standards
› In some countries better known than IEC standards

When are 2 PfG standards applicable?

› If no or no national nor international standard is existing for a device or component
› If – for several reasons – the requirements of an existing standard are not sufficient.
Standard 2PfG2642/11.17
Extract of the Standard

Scope

› 2 PfG 2642/11.17 applies to single-core cables (wires) having a solid or stranded aluminium conductor for fixed installations in PV-systems with a rated voltage up to and including $U_0$ DC 1,5 kV.

› This specification covers cables having aluminium conductors (of classes 1 or 2 acc. to IEC 60228) and for installation in ground.
Construction

- The cable shall exist of a conductor (class 1 or class 2), of an insulation layer, and of an outer sheath. In case of direct burial installation an inner sheath and protection layer against migration of humidity are required, the insulation and inner sheath can be combined as reinforced insulation.
- Cables for direct burying covered in this standard shall have a metallic layer for humidity protection and as screen.
Standard 2PfG2642/11.17
Relation to the EN50618

General
› This document based on EN 50618. Most of the requirements are equal or similar. So even weathering resistance is required since parts of the cable usually are not protected against direct sunlight. Nevertheless, there are some differences…

Differences between 2 PfG 2642/11.17 and EN 50618
› Construction (if intended for DB)
› Application
› Also non-halogen-free materials considered
› Maximum conductor temperature
› No fire performance needed
Introducing
SOLARpower
Alu-ATA XS
Solution – SOLARpower Alu-ATA XS

General Info

Features
- Direct burial water resistant cable
- Halogen – free
- XLPE insulation and termigon jacket
- Termite & rodent protected
- UV resistant
- Transversal watertight by metal barrier
- Simple feed, low friction on the jacket
- Aluminium shield, suitable as grounding and protective earth and for EMC shielding
Solution – SOLARpower Alu-ATA XS

Facts, figures & sizes

**Construction**
- **Conductor**: Aluminium stranded wire, compacted. class 2
- **Insulation**: XLPE, halogen free
- **Armouring**: Aluminium tube / extra hard compound
- **Jacket**: Copolymer, halogen free
termite and rodent protection
- **Jacket colour**: Black
- **Bending radius**: Fixed installation > 12 × Ø

**Thermal characteristics**
- **Operating temperature**: –40 °C up to +90 °C
- **Ambient temperature**: –40 °F up to +194 °F
- **Min. permissible installation temperature**: -10 °C
- **Max. short circuit temp.**: +250 °C, +482 °F / 5 s

**Electrical characteristics**
- **Max. Voltage**: Um = 1800 V DC
- **Rated voltage**: U0/U = 1500 V / 1500 V DC
  U0/U = 1000 V / 1000 V AC, 50Hz
- **Test voltage**: 6500 V, 50 Hz, 5 min.
  (Conductor / Shielding)
Solution – SOLARpower Alu-ATA XS
Rodent & termite testing report

Thanks to a robust termigon jacket combined with the aluminium layer, the cable offers a high rodent / termite protection as well as a transversal water tightness.

Independent laboratory results:
› According to the test method and the evaluation criteria DIN EN 117* all tested material variations were resistant against the attack by the most aggressive termite species – Australian Darwin termites* or Formosan Subterranean termites**. There was either no attack (rating 0) or only attempted attack (rating 1).
› The test samples showed no toxic effect against termites.

* - The DIN EN117 testing is not part of the 2PfG2642 standard, and was done as an additional testing.
* - Mastotermes Darwiniensis
** - Coptotermes Formosanus
Solution – SOLARpower Alu-ATA XS

Accessories

- Centering sleeves
- Roll springs
- Cable lug
- Heat-shrink tube
- 2 x sealing strip
- Assembled grounding wire with water blocking

- Includes all materials for the installation
- Reliable and harmonized connection and grounding concept
- With accurate use, acc. to the instruction manual, no contact corrosion due to durable sealing
- Consistently safe contact with the aluminium conductor and the earthing screen
- Grounding wire in tinned copper braid with water blocking
Solution – SOLARpower Alu-ATA XS

References

Some of the projects finalized:

› Shotwick Solar Park (UK)
› Bradenstoke RAF Lyneham (UK)
› Wroughton Airfield Solar Park (UK)
› Owls Hatch Solar Park (UK)
› PLB Terang (MY)
› Bentley & Jaguar Works (UK)
› Southwick Solar Park (UK)
› Marriott & Sheraton Hotel (JOR)
› Fixborough Solar Park (UK)
› Bidor Solar Park, Perak (MY)
› MOD Lyneham (UK)
› Gading Kencana (MY)
› Proconics Mutoko, (ZW)
› Crowdown Lane (UK)
› Greenviro Solutions (MY)
CLOSING

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Thank you
Vielen Dank
Merci
Merci
Gracias
謝
Terima kasih
σας ευχαριστώ
धन्यवाद
Dank je
شكرا لكم
Teşekkür Ederim
תודה
Grazie
ありがとう
ขอบคุณ
cảm ơn bạn
고맙습니다
Obrigado