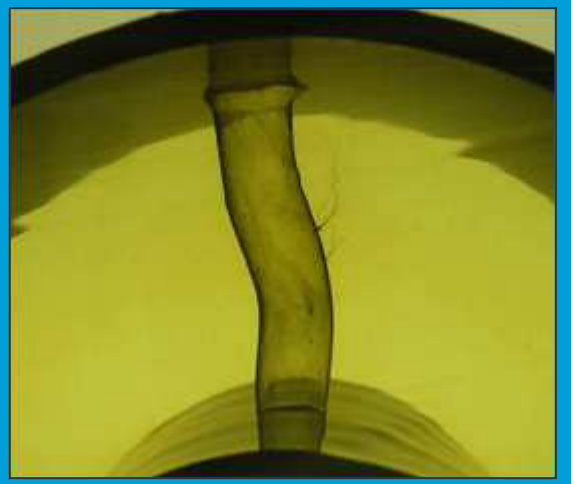
DNV·GL

ENERGY

Failures in underground power cables

return of experience



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Fred Steennis

In case of failure

- Sometimes cause for failure immediately known

In case of failure

- Sometimes cause for failure immediately known
- Usually it is not…

Analysis of the root cause for failure because of:

1. Technical reasons
2. Economical / political
3. Insurance claim
4. Safety

Power failure investigations

Large number of steakholders involved in the investigation:

-Owner of the connection

-Manufacturer

-Installation company

-Insurer

DNV GL fullfills the role of independent and impartial party to lead the investigation

Power failure investigations

- Approx. 170 individual cases investigated in period 1997-2014
- Cable failures that occurred in the field (not laboratory)
- Strong rise in the number of cases over time

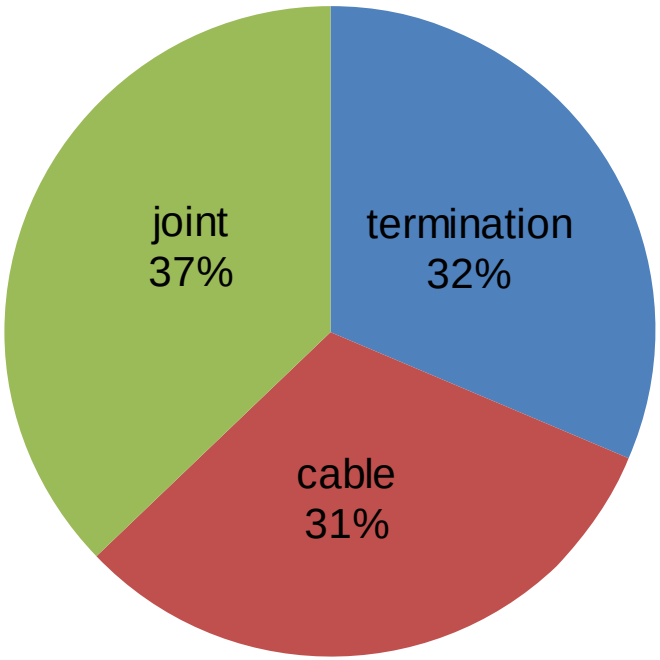
Power failure investigations

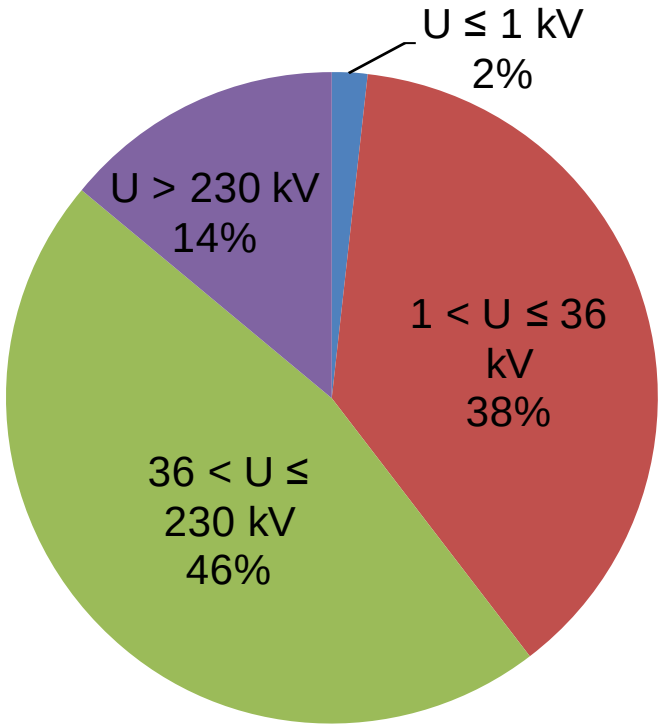
- Majority of the information is (and needs to be!) classified to protect our customers

- What we can share is:
  - Type of components
  - Type of cables
  - Voltage class
  - When was the root cause incurred?

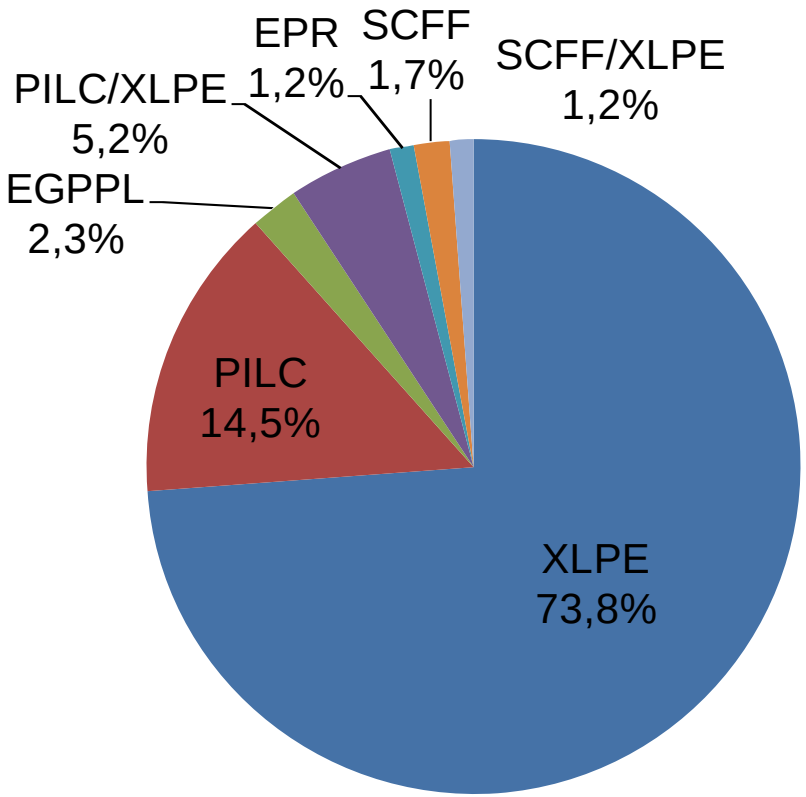
- Information based on the investigations performed by DNV GL only not as a way to determine overall statistics in general without further consideration

Type of components and operating voltage





Type of cables



Failure causes

The root cause of failure is finally categorized in:

1. Ageing (natural)
2. Design
3. External damage
4. Installation
5. Production
6. Unknown

Failure causes - cables

Failure causes - cables

More than 50% incurred before installation is completed

Production:

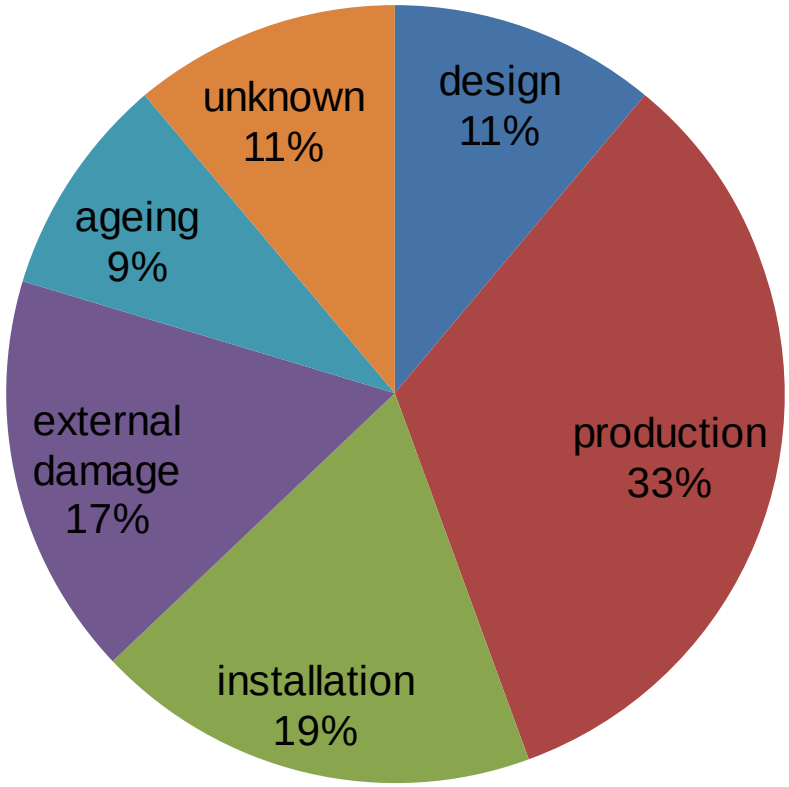
-damages

-inclusions

Installation:

-damages

-bad technique



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Failure causes - accessories

Failure causes - accessories

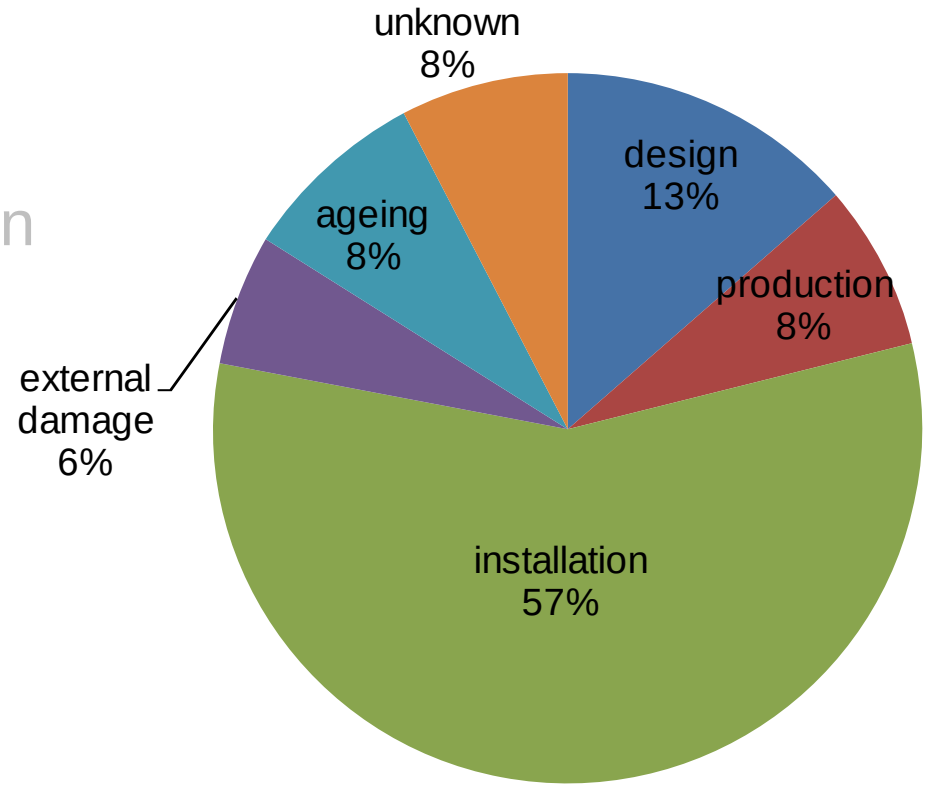
57% of failures related to the installation

Installation:

-insulation surface preparation

-interface pressure

- needs to be retained
- inclusions
- damages



Failure causes - accessories

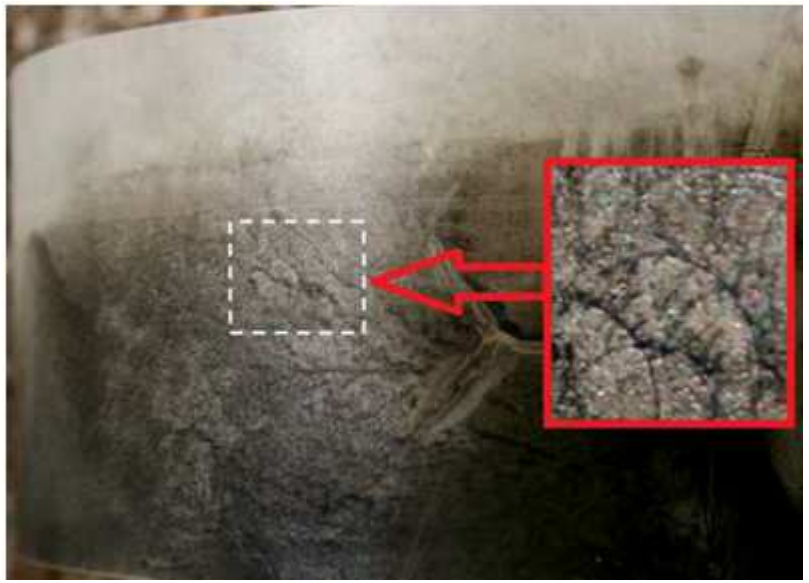
57% of failures related to the installation

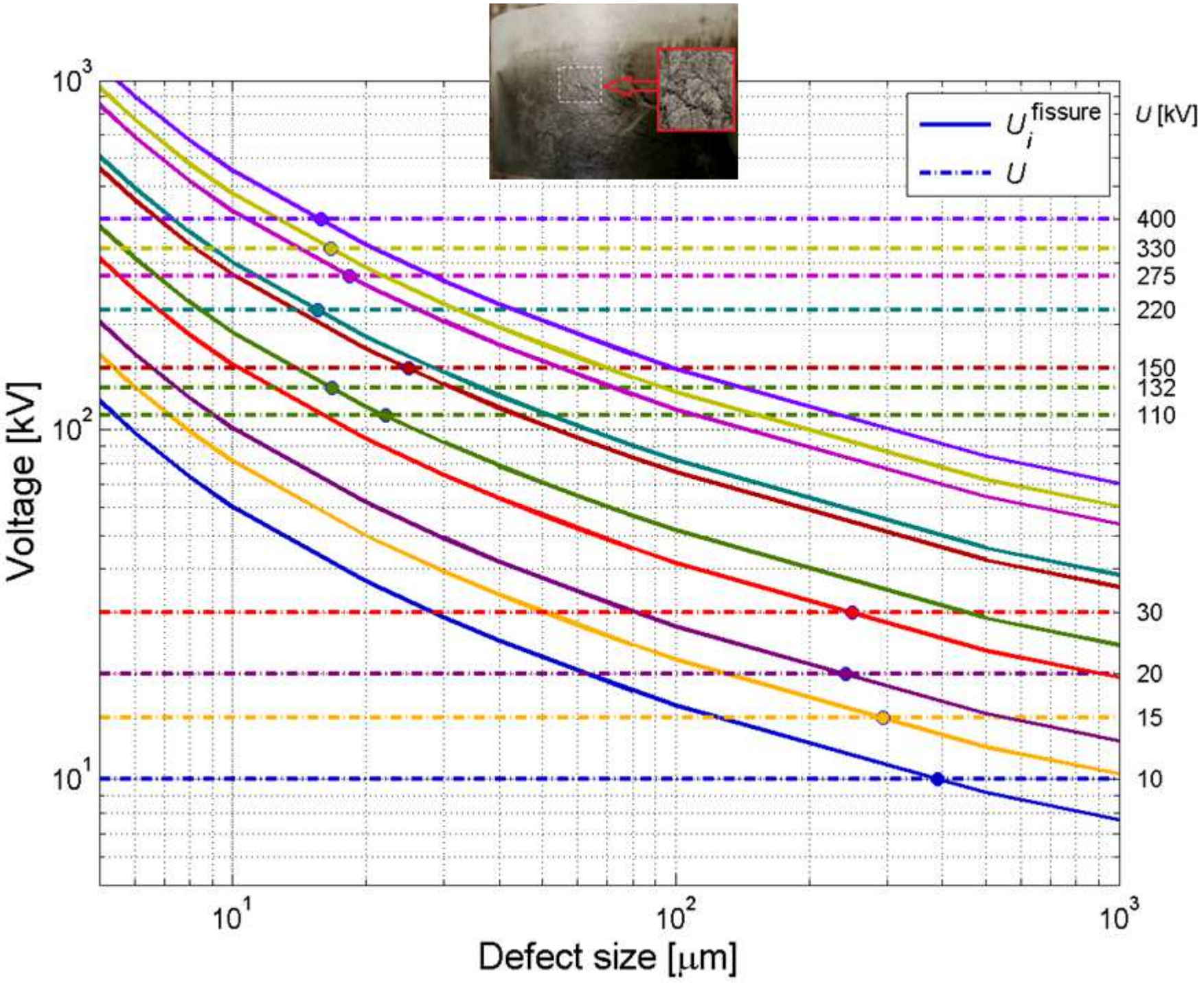
Installation:

-insulation surface preparation

-interface pressure

- needs to be retained
- potential damages
- grease




10^3
10^2
10^1
Voltage [kV]
10^1
10^2
10^3
Defect size [μm]
$U_i^{fissure}$
U
U [kV]
400
330
275
220
150
132
110
30
20
15
10

Failure causes - accessories

57% of failures related to the installation

Installation:

-insulation surface preparation

-interface pressure

- needs to be retained
- potential damages
- grease

Conclusions

- 170 failure investigations in the period 1997-2014
- Strong increase in the number of investigations over time

- Though each case is unique, trends can be seen in the statistics for cable and accessory failures

Thank you