Evaluation of the XLPE MV lifetime

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Analysis of old cables

60kV cable with vapour crosslinking: 2 samples

	Production Cortaillod 1973 Graphite outer semicon	
Conductor	Copper	
Tan δ @ $1.5U_0$	$4.5\ 10^{-4}$	$1.8\ 10^{-4}$
Tan δ @ $2.0U_0$	$7.2\ 10^{-4}$	$3.5\ 10^{-4}$
Breakdown at 90kV	5 min	2 min
PD	10 pC	40 pC

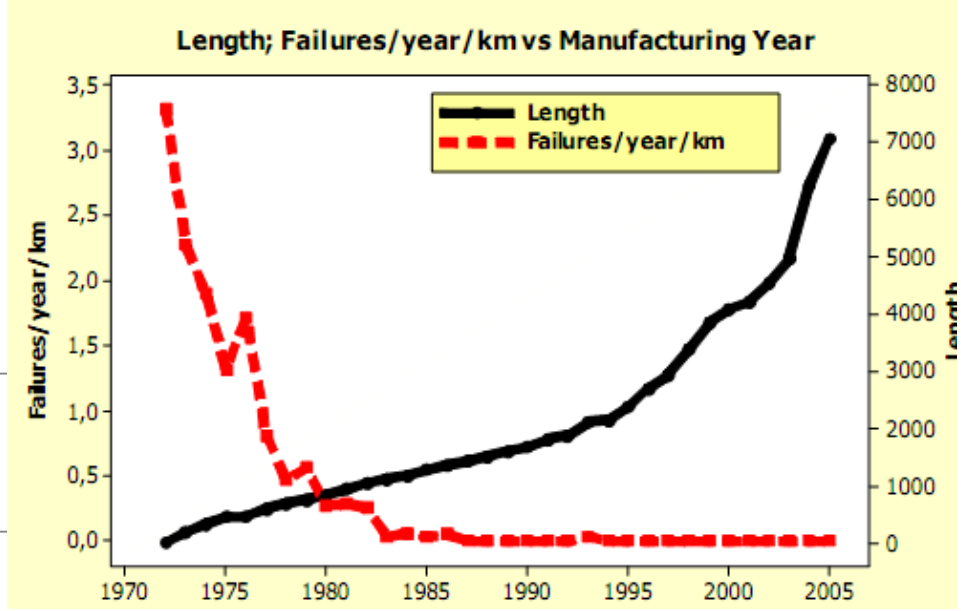
Analysis of old cables

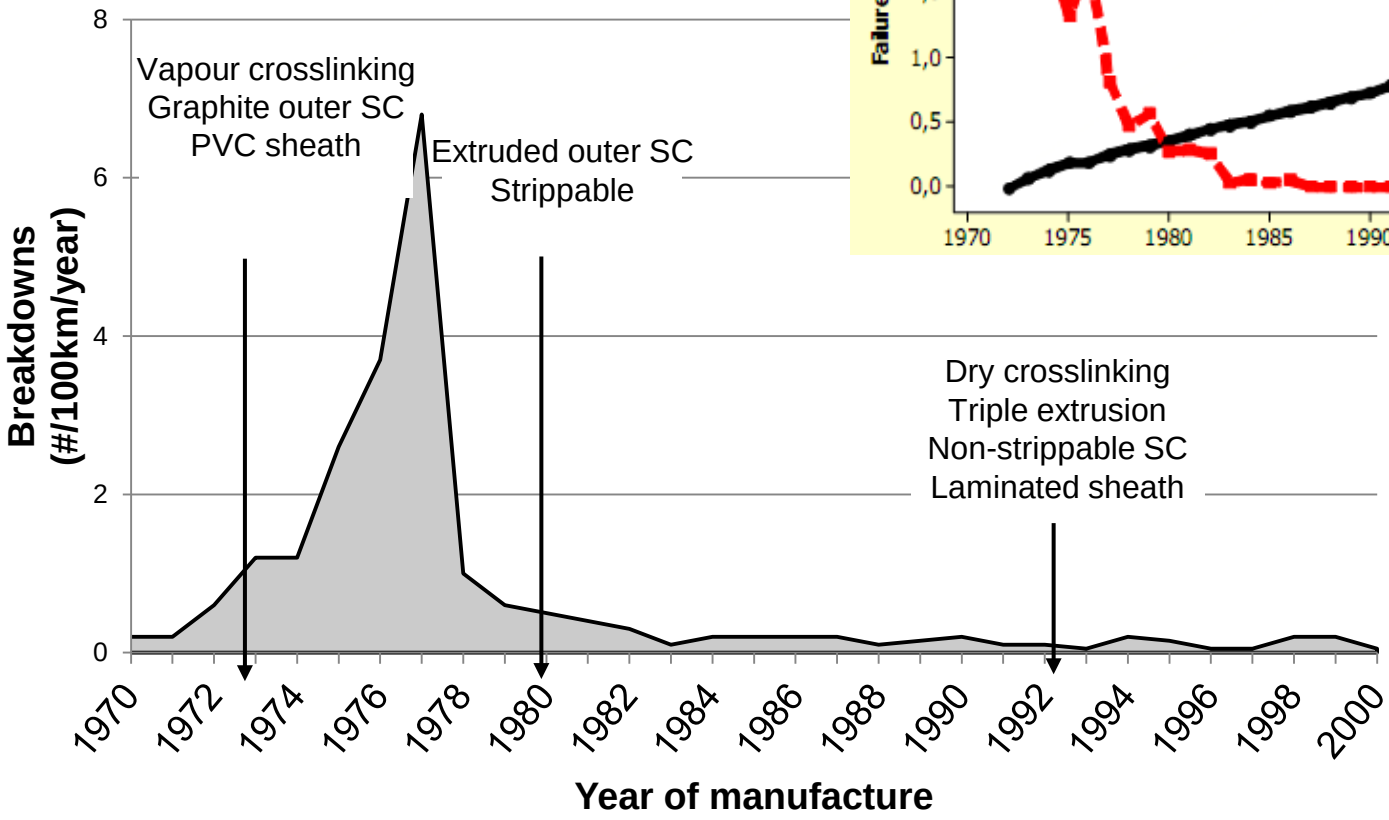
60kV cable with vapour crosslinking:

	Production Cortaillod 12/78	**Production Cossonay 1978?**
Conductor	Copper	Tinned copper
Tan δ @ $1.5U_0$	$4.9\ 10^{-4}$	$7.9\ 10^{-4}$
Tan δ @ $2.0U_0$	$6.2\ 10^{-4}$	$5.7\ 10^{-4}$
Breakdown at 90kV	10 min	12 min
PD	50pC	50pC

What about first synthetic cables?

Data in the litterature





Defects in insulation

3 types of defects can be present:

1. Point defects (inclusions/impurities) that lead to a rapid breakdown and determine the lifetime of the insulation
2. Voids that reduce the stress ageing resistance of the material.
3. Irregularities on the SC/insulation interface

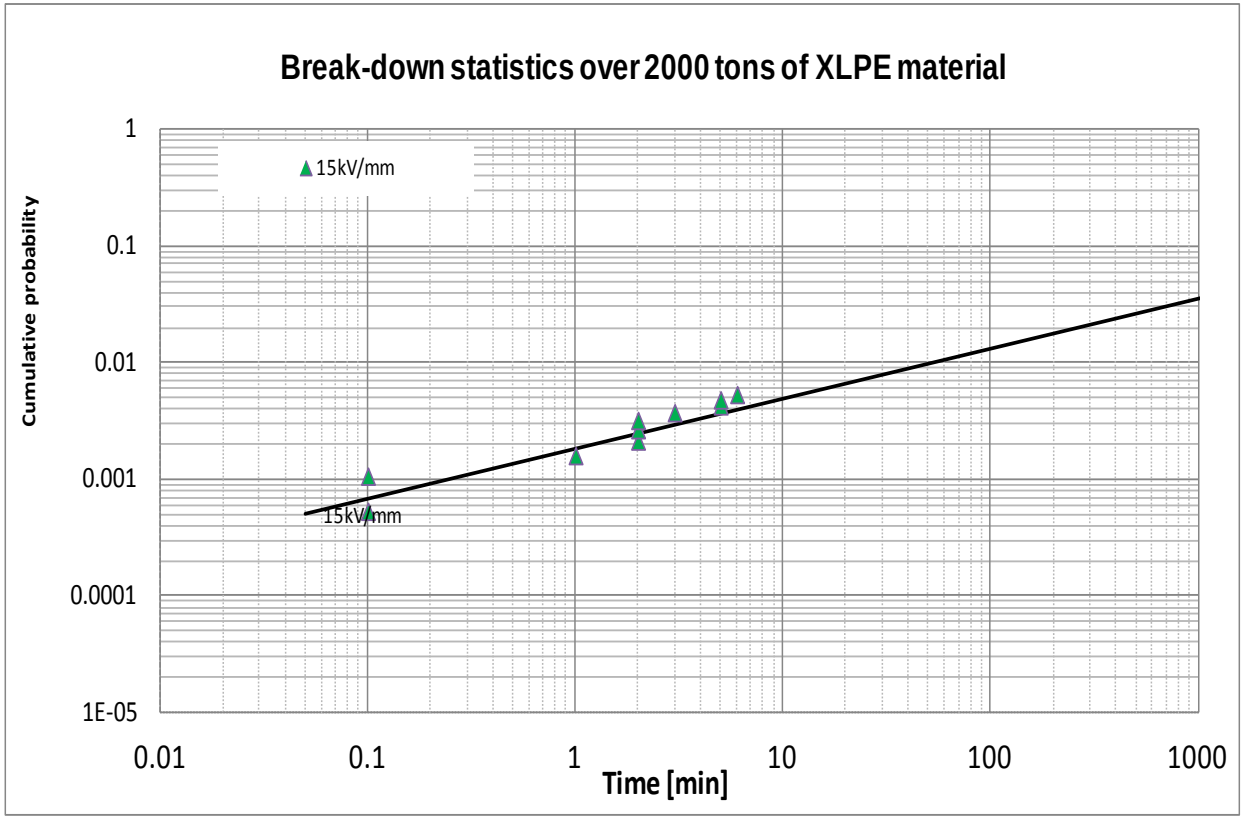
Selection criteria for routine test

15 kV/mm voltage test during 30 minutes

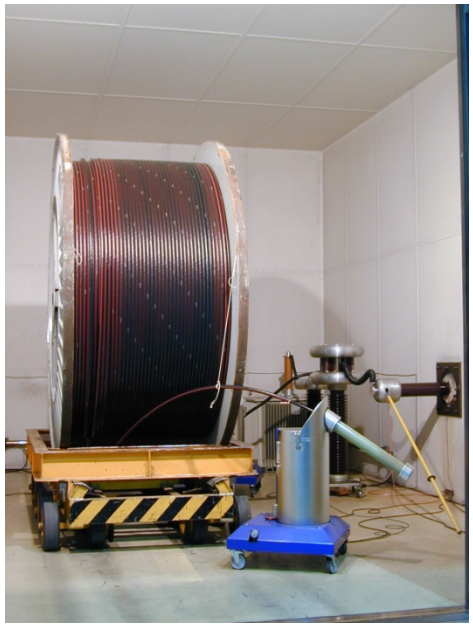
- No partial discharges
- Breakdowns as well as PD are localized and analyzed for corrective action

Elimination of point defects

A voltage test is done at a high stress and, if a breakdown occurs, the time to breakdown is recorded (routine test).



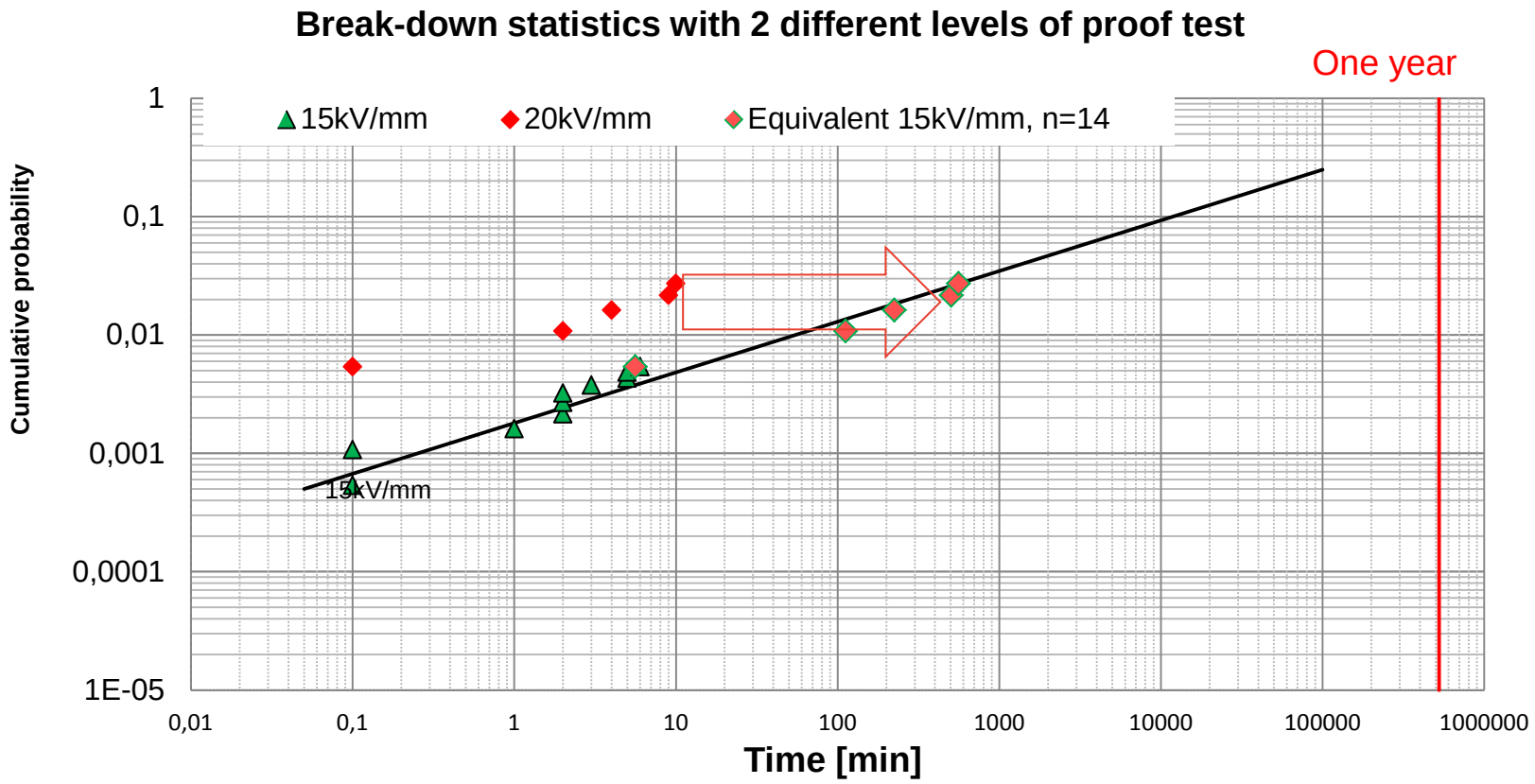
Routine test at15 kV/mm (4 to 6 U_0 depending on insulation thickness).
The mean length per breakdown is 320km single phase (1 ton approx. corresponds to 1km - phase cable)



Determination of n

200 tons were tested at 20 kV/mm

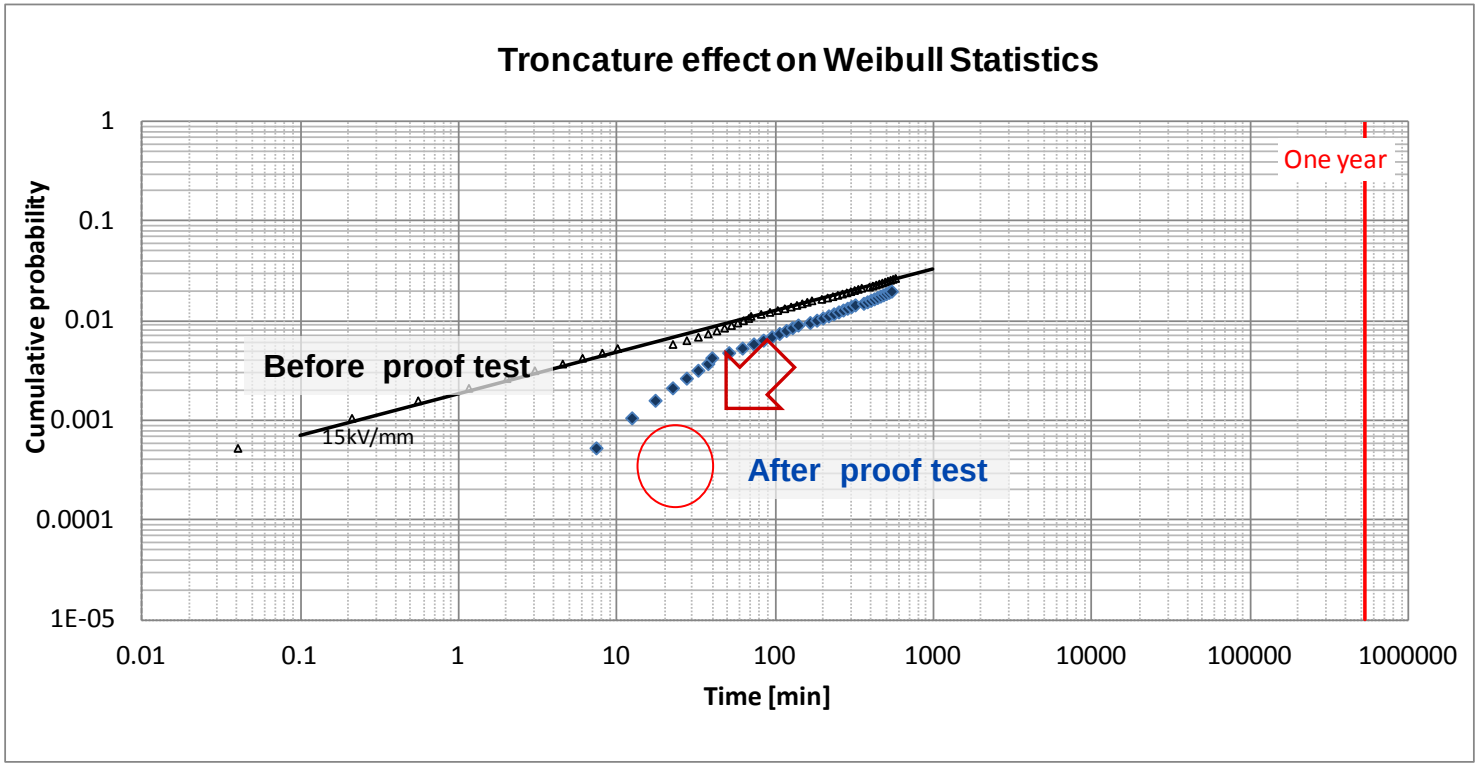
$E \cdot t^{1/n} = \text{constant}$



In the present case n is estimated to be around 14

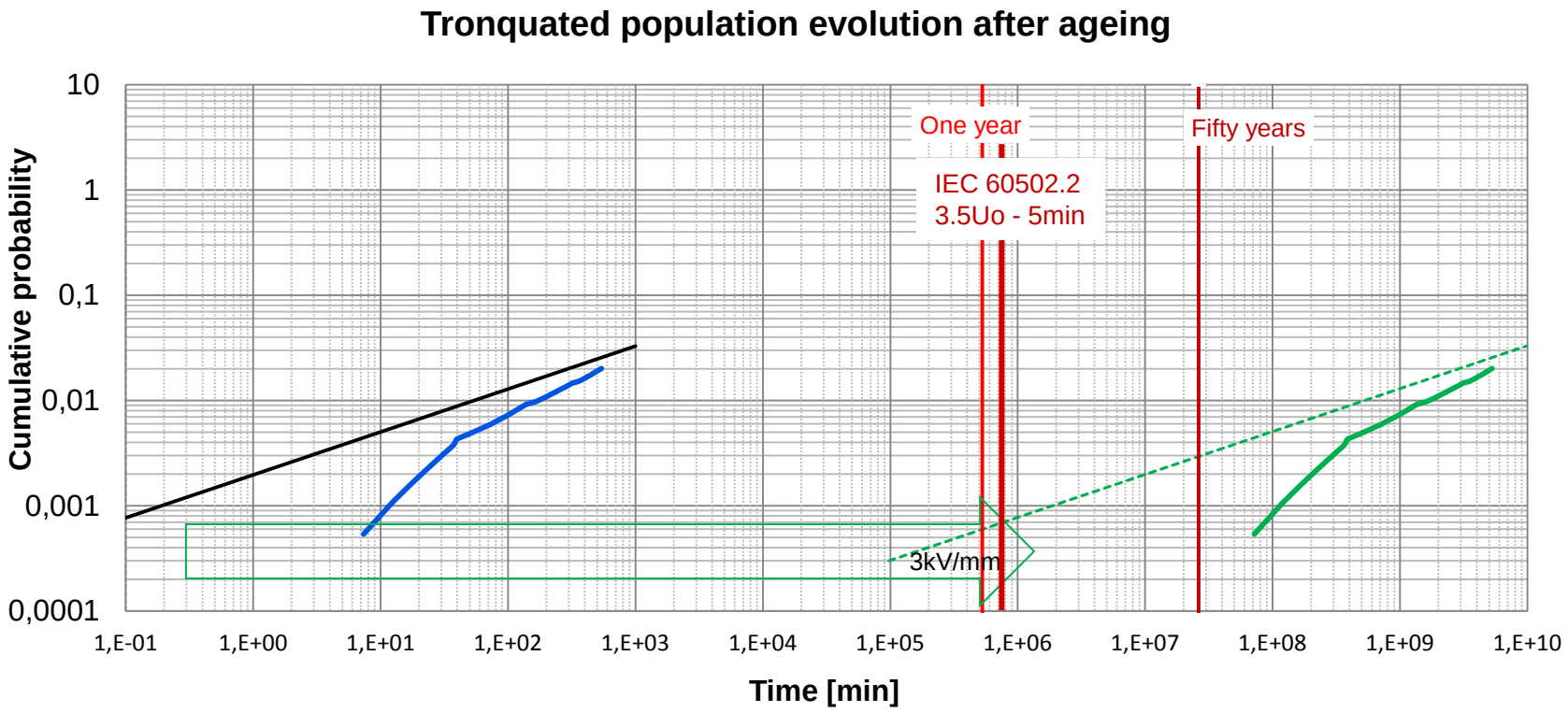
Defect distribution after the proof test

- The largest defects are removed by the proof-test
- The residual defects could be detected if the voltage application was 30 minutes or more
- These are quite rare and will define the cable lifetime.



Ageing of residual defects

- If we suppose an n value of 10 to take into account the service conditions (higher temperature), then the extrapolated lifetime at 3kV/mm of the routine tested cable is far above 50 years …



Conclusions

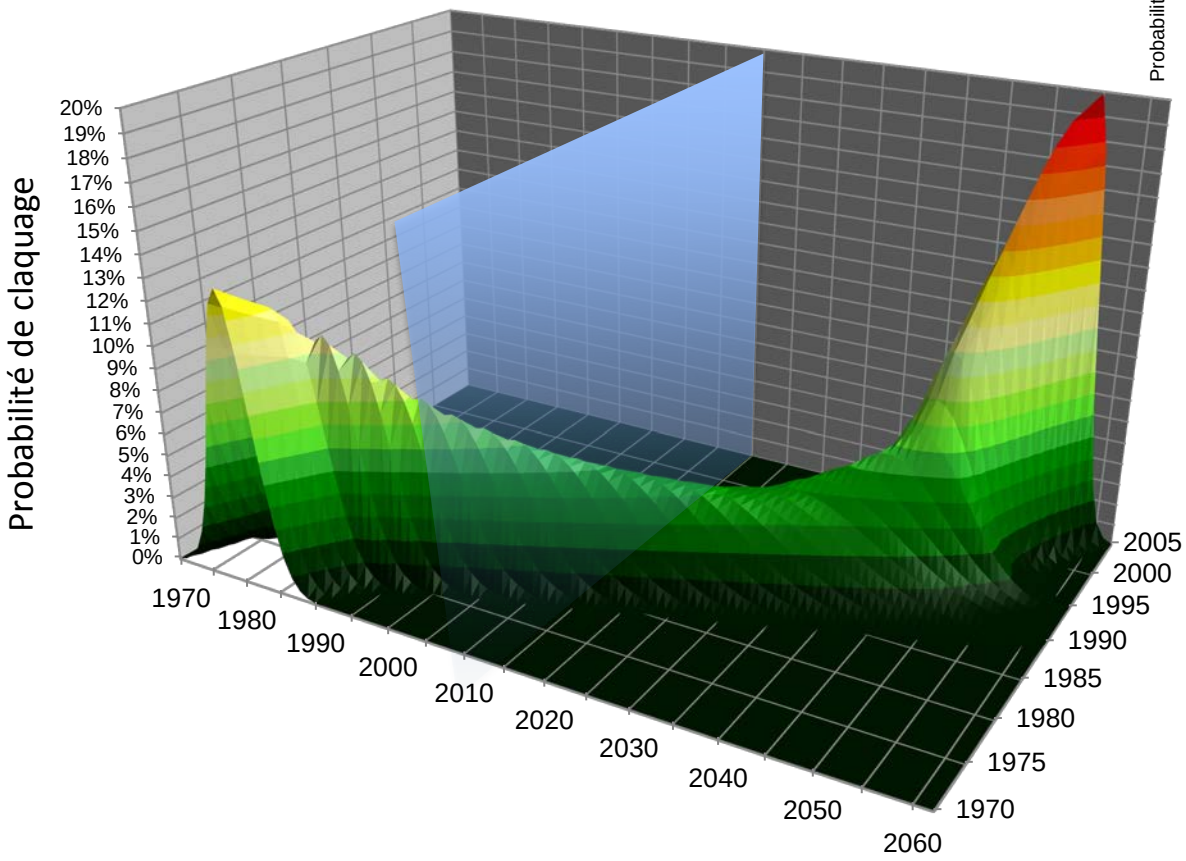
Since the 90's, actions have been taken to warrant a lifetime of the cable over 50 years.

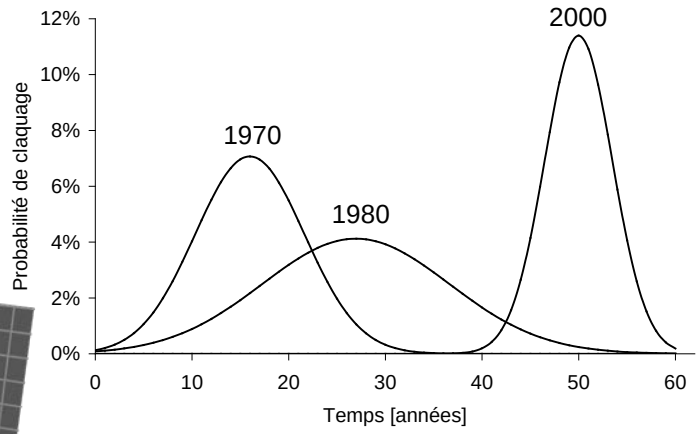
- Material selection
- Processing
- Testing

At the conditions that the laying and the accessories installation are done properly, that the accessories are of good quality and that the maintenance are done properly.

For cables that are more than 30 years old, we will learn progressively about the existing problematic. A good evaluation of the characteristics (original values, service conditions, …) of the cables that are replaced is then necessary and will require a strong collaboration between the manufacturers and the operators.

What can be expected





Nexans

Thank you for your attention