WETS D’15 Workshop

Organization: Jicable and Prospective 21OO

Palais des Congrès de Versailles, France

Thursday, 25 June 2015

Part 3 - Diagnosis for ageing of and residual life assessment

ERDF DT – Pôle réseau et EDF R&D - LME

ÉLECTRICITÉ RÉSEAU DISTRIBUTION FRANCE

THE 4 TOPICS OF WETS D'15

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➢ General data of the network

Roger TAMBRUN + Guillaume PELTON : **ERDF** & Yves BRUMENT : **R&D**

➢ Technologies

Roger TAMBRUN : **ERDF** & Yves BRUMENT + Christophe TOURCHER : **R&D**

1 – Câbles

2 – Accessories

➢ Diagnosis of ageing and estimation of the residual life

Roger TAMBRUN : **ERDF** + Thierry ESPILIT + H. DIGARD : **R&D**

➢ Renewal of the distribution networks

Gauthier BEAUZEMONT : **ERDF &** Emanuela BUCCAFURRI + Adrien RESMOND : **R&D**

3-1 -1 Diagnosis of ageing and estimation of the residual life

What diagnosis methods, off line : by T.ESPILIT

Deployed since early 2007 for ERDF

- 21 test vans for 23 geographical areas

▼ CALCULÉ ▼		▼ REPORT RÉSULTATS DE MESURES ▼						▼ CALCULÉ ▼		
Mesures										
			6 KV	12 KV	18 KV	.. KV	tension de claquage	Δtgδ%/ΔU	Ecart type%	Risque électrique
Tangente Delta	Tg sain	Tg XIE-3	17,2	18	18,6			0,68%	0,47%	Risque faible
	2,69	Ph1	C(nF) à 12 KV		écart type (XIE-3) à 18 KV					
			263 nF		0,087					
	Tg critique	Tg XIE-3	19	20,8	21,3			1,01%	0,04%	Risque faible
	19,2	Ph2	C(nF) à 12 KV		écart type à 18 KV					
			261 nF		0,008					
		Tg XIE-3	20,2	21,6	23			1,16%	0,28%	Risque modéré
		Ph3	C(nF) à 12 KV		écart type à 18 KV					
			265 nF		0,065					

	Phase	Localisation		câble/ accessoire	U apparition	Niveau Max à 12 KV	Niveau Max à 18 KV	Nombre de DP		Risque
Décharges Partielles	Ph 1	115 m.	145 m.	Câble papier	6 KV	2100 pC	6100 pC	Elevé		Risque élevé
	Ph 1	420 m.		Câble papier	12 KV	2100 pC	3000 pC	Faible		Risque modéré
	Ph 1	40 m.	440 m.	Câble papier	18 KV		2100 pC	Elevé		Risque modéré
	Ph 2	420 m.		Câble papier	6 KV	2800 pC	2800 pC	Elevé		Risque élevé
	Ph 2	110 m.	160 m.	Câble papier	12 KV	3000 pC	3400 pC	Elevé		Risque élevé
	Ph 2	50 m.	590 m.	Câble papier	12 KV	2000 pC	2200 pC	Faible		Risque faible
	Ph 3	420 m.		Câble papier	6 KV	2200 pC	2200 pC	Elevé		Risque élevé
	Ph 3	105 m.	160 m.	Câble papier	12 KV	3200 pC	3400 pC	Elevé		Risque élevé
	Ph 3	588 m.		accessoire	18 KV		2700 pC	Faible		Risque faible
	Ph 3	40 m.	680 m.	Câble papier	18 KV	950 pC	950 pC	Elevé		Risque modéré

Automatic calculation criteria

- 3 levels risk evaluation : low, moderate, high
- Tan delta criteria:
  - Mean Tan delta @ 0.5 Uo
  - Voltage dependence of Tan delta
  - Time stability of Tan delta @ 1.5 Uo (std dev)
  - Set to identify weak joint problems (water penetration)
  - Adapted for paper insulation and XLPE (except very degraded cables)
- Criteria for PD :
  - Inception at nominal voltage or lower
  - Inception under 1.5 Uo and remaining at Uo
  - PD distribution along cable length (PD Map)
  - Mainly for ranking
  - Evolution vs time (Off-line measurements)
  - According to the actual knowledge rules in complex distribution systems

3-1 -1 Diagnosis of ageing and estimation of the residual life

What diagnosis methods, off line : by T.ESPILIT

Experience Feedback Main Results

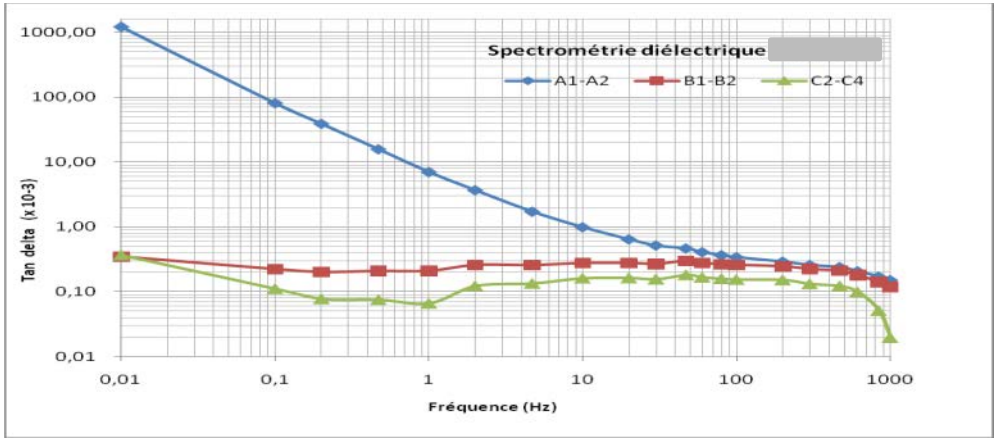
- Automatic calculation
  - Good for **low risk** and **high risk** situations
  - **Intermediate risk** situations are problematic
    - Threshold effect (e.g. values close to red level)
    - Too many cases in same population (“rather good” to “rather bad”)
    - Need for better discrimination for accurate ranking
  - Need for better precision for extruded cables
- Organisation
  - Need to provide appropriate training (PD measurement interpretation)
  - Need to facilitate measurement data input for automatic calculation
  - Need to encourage systematical PD measurement in order to improve overall assessment
- Equipment
  - Need to improve automatic PD location/detection

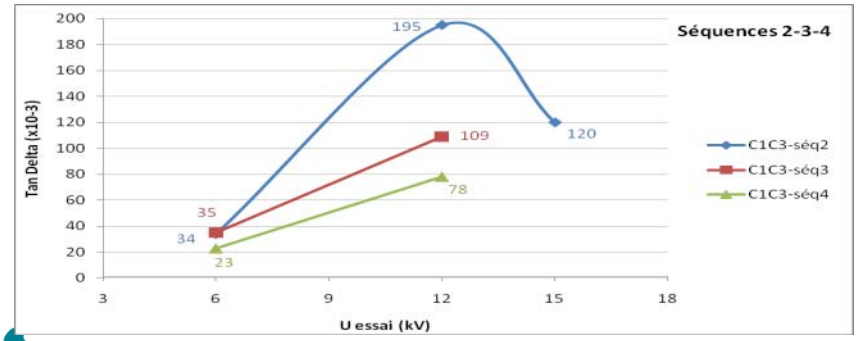
3-1 -1 Diagnosis of ageing and estimation of the residual life

What diagnosis methods, off line : by T.ESPILIT

Better characterization of degraded cables,
e.g. by using enhanced diagnostic features

- Dielectric spectroscopy
  - Low frequency : off-line criteria
    - water penetration
    - temperature sensibility
  - High frequency : more accurate PD propagation features:
    - Off-line PD measurement
    - On-line location
- Tan delta @ 0,1 Hz
  - Voltage dependence
  - Time stability



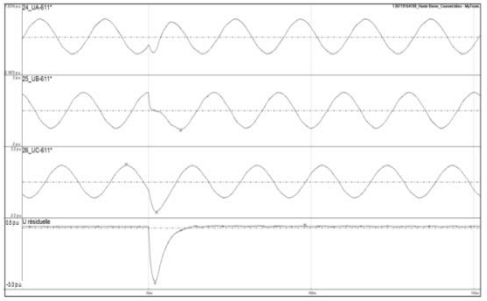


3-1- 2 Diagnosis of ageing and estimation of the residual life

What diagnosis methods, on line : by T ESPILIT - H. DIGARD

❑ Diagnosis methods

- Partial Discharges
- Transient : self extinguishing faults
- Faults location



❑ Difficulties - Main challenges

- Identify specific knowledge rules for trend and behavior before failure versus time
- **Accurate location in a complex network** with limited number of measurement points (typically one at the substation) :