S-18.3154 Electricity distribution and markets Exam 8.4.2015

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Q1. General

a) What are 3 main considerations regarding protection when planning an MV network?
b) Mention one of the savings that a new primary substation brings with it.
c) Mention one of the advantages for distribution networks that come with distributed generation.
d) Mention one of the disadvantages for distribution networks that come with distributed generation.

Answer briefly!

Q2. Markets

a) Why do the system and area prices sometimes differ in the ESLPOT market (Nordic electricity spot market)? (3p)
b) What is one thing the regulation of distribution networks try to keep up, and one thing it tries to keep down? (2p)
c) What is one method for regulation of the distribution network business? (1p)

Q3. Power quality

List 4 kinds of power quality problems that one can observe in the voltage of a distribution network?

What might you do if one substation is experiencing voltage disturbance from an industrial customer connected to the same point (i.e. the same PCC or point of common coupling)?

Distribution Network Analysis

Q4. Technical constraints

The figure below shows two feeders that feed large industrial loads (lumped to nodes 2-5)
The load growth is 0.12 % / year, the interest rate is 6 % and the network life is 40 years.
Are the feeders in Fig. 1 technically feasible? Justify your answer.

All cables (new and existing):

r (Ω/m)	x (Ω/m)	I_{max} (A)	$I_{sc,1s}$ (kA)
1.50E-04	1.10E-04	385	22.6

Substation circuit breakers operate within 400 ms

- Nodes 0 and 1 are primary substations
- Nodes 2 to 5 are lumped loads of 2350 kW each, $\cos\varphi = 1$

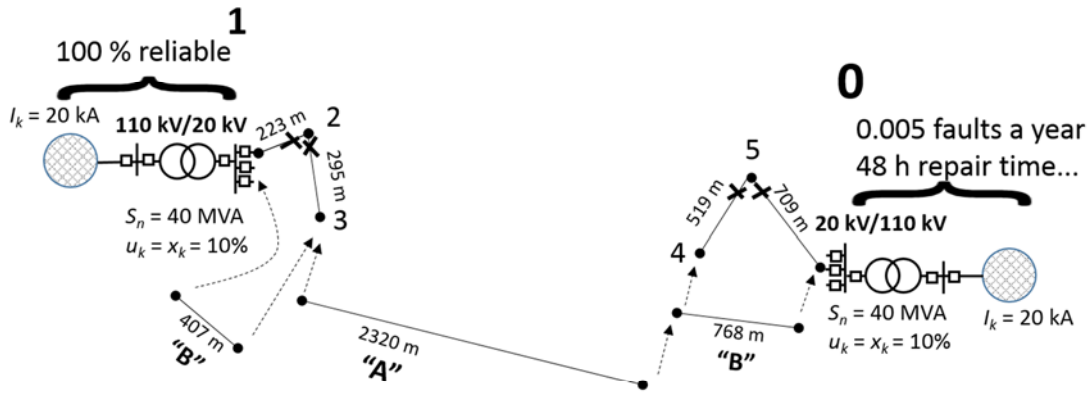
Q5. Reliability

All cables (new and existing):

r (Ω/m)	x (Ω/m)	I_{max} (A)	$I_{sc,1s}$ (kA)
1.50E-04	1.10E-04	385	22.6

Fault rate for both new and old lines is 2.0 faults / 100 km / year

Repair time is 10 h



- The primary substation at node 0 has, on average, 0.005 faults a year with an average repair time of 48h
- Node 1 is a fully reliable primary substation
- Nodes 2 to 5 are lumped loads of 2350 kW each, $\cos\varphi = 1$
- Interruption costs (CIC) are 1.1 €/kW/fault and 11 €/kWh for each load node
- All line sections have switches at both ends that are remote operated and operate in 5 minutes
- New line costs are 90 €/m
- New remote switches cost 3000€/switch station + 3500 €/switch

Backup connection(s) are needed! Which is the best alternative to provide backup, "A" (a new line from node 3 to node 4) or "B" (two shorter lines: from node 2 to node 3 and from node 4 to node 5)?

$$\kappa = \gamma \frac{\gamma^t - 1}{\gamma - 1} \qquad \gamma = \frac{(1+r)}{(1+p)}$$