QUESTIONNAIRE ON FAULT LOCATION SYSTEMS

For

WG B5.52

Analysis and comparison of fault location systems in substation automation systems

The objective of this questionnaire is to obtain information of nowadays fault location systems used by the electric utilities.

November 2014

QUESTIONS

1. *Electric Utility Information*

Name of the Utility – Country			
Address- Contact person information			
What departments of your company are involved in fault location?			
How many people involved in fault location?		Calculation/Estimation	
		Line crew	
Transmission and/or sub-transmission network data (owned and/or operated)	Number of substations and voltage levels	Transmission	
		Sub-transmission	
	Total length of overhead lines		(km)
			(miles)
	Total length of underground cables		(km)
			(miles)
	Total length of mixed overhead and underground lines		(km)
			(miles)
	Cumulative annual energy transferred in 2013		
Distribution network data - exclude low voltage. (owned and/or operated)	Number of substations and voltage levels		
	Total length of overhead lines		(km)
			(miles)
	Total length of underground cables		(km)
			(miles)
	Mixed overhead and underground lines		(km)
			(miles)
	Cumulative annual energy supplied in 2013		
	Number of customer / consumers connected to the Distribution System Grid		
	Earthing methods used at different voltage levels		

2. *Please indicate what kind of methods are used for the different topologies (answer Yes or only check mark)*

Fault Location method	Topology				
	Two terminals	Mutually-coupled/Parallel circuits	Multi-terminal circuits	Series-compensated circuits	Mixed circuits
Single-ended impedance					
Double-ended impedance					
Multi-ended impedance					
Single-ended travelling wave					
Double-ended travelling wave					
Multi-ended travelling wave					
Current measurement					
Fault passage indicators					
Voltage drop					
Customer feedback					
Line crew					
Other (*)					

Fault Location method (cont'd)	Topology (cont'd)			
	Radial distribution circuits	Meshed distribution circuits	Loop/ring distribution circuits	Others (*)
Single-ended impedance				
Double-ended impedance				
Multi-ended impedance				
Single-ended travelling wave				
Double-ended travelling wave				
Multi-ended travelling wave				
Current measurement				
Fault passage indicators				
Voltage drop				
Customer feedback				
Line crew				
Other (*)				

(*) Please specify if any.

3. *In what fault scenarios do you perform a fault location analysis? (answer Yes or No)*

Fault type	Fault location analysis is performed	Comments
Incipient faults (*)		
Temporary faults		
Permanent faults		

(*) Faults not resulting in line protection pickup/trip (e.g. large partial discharge or induced lightning)

4. *What accuracy requirements (maximum allowable error) for fault location does your company have? Note: if you have different requirements for overhead or cables, please specify.*

Length (km/miles)	Relative accuracy (%)	Absolute accuracy		Comments
L < 10			km	
			miles	
10 < L < 20			km	
			miles	
20 < L < 100			km	
			miles	
L > 100			km	
			miles	

5. *What reporting time requirements for fault location does your company have, if any?*
Note: leave blank if you don't have any requirements

Fault type	Time	Comments
Incipient faults (*)		
Temporary faults		
Permanent faults		

(*) Faults not resulting in line protection pickup/trip (e.g. large partial discharge or induced lightning)

6. How is your fault location system implemented? (answer Yes or only check mark)

Fault Location system	Stand-alone fault locator	Integrated in the protection relay	Back office post-processing of oscillographs	Do you require dedicated sensor(s)?
Impedance based				
Travelling wave				
Current measurement				
Line fault indicators				
Voltage drop				
Other (*)				

(*) Please specify if any.

7. Please indicate the approximate number of lines with fault location systems?

Fault Location system	Stand-alone fault locator	Integrated in the protection relay	Post-processing of oscillographs	Comments
Impedance based				
Travelling wave				
Current measurement				
Line fault indicators				
Voltage drop				
Other (*)				

(*) Please specify if any.

8. What is your average error in your fault locator systems? (absolute, relative or both)

Fault Location method	Topology				
	Two terminals	Mutually-coupled/Parallel circuits	Multi-terminal circuits	Series-compensated circuits	Mixed circuits
Single-ended impedance					
Double-ended impedance					
Multi-ended impedance					
Single-ended travelling wave					
Double-ended travelling wave					
Multi-ended travelling wave					
Current measurement					
Line fault indicators					
Voltage drop					
Customer feedback					
Other (*)					

Fault Location method (cont'd)	Topology (cont'd)			
	Radial distribution circuits	Meshed distribution circuits	Loop/ring distribution circuits	Others (*)
Single-ended impedance				
Double-ended impedance				
Multi-ended impedance				
Single-ended travelling wave				
Double-ended travelling wave				
Multi-ended travelling wave				
Current measurement				
Line fault indicators				
Voltage drop				
Customer feedback				
Other (*)				

(*) Please specify if any.

9. *What are the main sources of problems you have in your fault location systems? Please weight the following items from 1 (a minor problem) to 10 (a major problem) or NA if not applicable*

Fault Location method	**Source of problem**							
	Communication problems	Synchronization problems	Network changes	Wrong settings	Lack of expertise	Distributed generation	Sensors (e.g. frequency response and saturation)	Other (e.g. challenging fault type, vendors reliability)
Single-ended impedance								
Double-ended impedance								
Multi-ended impedance								
Single-ended travelling wave								
Double-ended travelling wave								
Multi-ended travelling wave								
Current measurement								
Line fault indicators								
Voltage drop								
Other (*)								

(*) Please specify if any.

10. Please describe the procedure used in your company for determining a fault location by answering the following questions.

10.1. What means of communication do you use for collecting disturbance information from the substation control and protection equipment?

10.2. If performing manual fault location calculation, is it done by the field service crew or by the dispatcher center personnel or is it a back office activity?

10.3. In case of manual fault location calculation, what kind of software tools or methods do you use for analysis and calculation?

10.4. Do you do any additional actions to improve the reliability of the results (e.g. integrate data from weather stations, lightning location systems, etc.)?

10.5. How the results of your fault location system are distributed (please specify per stakeholder if possible)?

10.6. When you need to distribute the results of your fault location system, do you use a special representation method for the different stakeholders (e.g. visualization of a fault in a graphical way for dispatcher)?

10.7. In case of high-impedance earthed networks (ungrounded or Petersen coil), please describe the procedure used in your company for determining location of earth-faults.

11. Do you have any particular issues for a given topology regarding fault location? Please elaborate.

12. Please answer the following cost related questions.

12.1. Has the fault location method helped reduce the cost associated to line inspection? What type of cost and time reduction have your company experienced?

12.2. Are there any maintenance costs associated to your fault location method? Please elaborate.

12.3. Has the fault location system assisted in reducing the social cost of market constraints or in achieving financial incentives for your company though a market constraint mechanism?

ADDITIONAL COMMENTS