مركـز المستشـار الوطنـي للتدريـب
National Consultant Centre For Training

3-Day Intensive Training Course
In

Automated Fault Analysis for HV Transmission Power System

Dubai, 21 – 23 April 2014

In Collaboration with Systems Europe CO. – France

Course Outlines & Daily Agenda:

Day one

1. **Fundamentals and value Chain**

1.1 What are the Goals of the Fault Analysis?

The training will first introduce the notion of fault analysis, in three different aspects.

- Is there a fault? Where is the fault? How critical is it? Is the fault cleared and/or can I put the line(s) back to operation?
- Did the protection system react as expected? What caused the fault? Are there any hidden causes?
- How many faults did we have over a year? How many faults were cleared automatically? What is the average downtime? How many downtimes were caused by malfunctions and/or maloperations? Which viable strategy can we apply to reduce the costs?

1.2 Qualifying a fault

We will give the definition of a fault, and summarize its main characteristics.
We will then explore the most common fault causes (lightning, insulator pollution, trees, cranes, birds,), as well as the types of faults (mono-, two-, three-phase, evolving).
We will then tackle the fault location algorithms, their uses, advantages and disadvantages, and requirements: single-ended, double-ended, overhead lines vs cables.

1.3 The protection system

Those Components are:

- The protection relays
- The sensors, such as PTs/VTs and CTs
- The circuit breakers and/or switches
- The interconnection

We will explore their functions (protective, monitoring, reclosing …), and which values they need to operate. We will then explore the main types of relays: Distance, Line differential, Earth Fault/ Ground, Overcurrent, Wattmetric, Directional.
The training will describe how each type works, and why they are used, and in which conditions.

This will also lead to another concept: the zones of protection. We will explain what are the different main zones (1, 2, 3+, reverse), how the relays work together using this concept, and then delve deeper into the teleprotection systems, focusing on the permissive and blocking schemes.

1.4 Auto-reclose automats

– What is their purpose?
– Basic auto-reclose process
– More complex auto-reclose phases

1.5 Asymmetrical components

Analyzing the asymmetrical components of the input values (voltages and currents) is one of the keys to a successful fault identification.
This section will explore the sequence components, and how they can give an indication of the type (phase) and direction of the faults.

1.6 Use cases

– Case 1: AT2
– Case 2: Bareilly-Moradabad

Day Two

2. Capturing the data

2.1 Where do the data come from?

This section will focus on the sensors, i.e. the devices from which the data is measured to get meaningful information.
We will present the Potential/Voltage Transformers (PTs/VTs), and the Current Transformers (CTs).
This part will also cover which signals should be captured (currents, voltages, protection relays' outputs, circuit breakers' outputs, …), and which data format should be used. It will emphasize the use of standard formats, such as COMTRADE.

2.2 How is the data captured?

Different types of IEDs populate the grids:

– Digital protection relays
– Digital fault recorders
– Sequence of Event Recorders

2.3 How is the data communicated?

The data are communicated using different channels:

– Legacy channels: often-proprietary channels (RTC), or proprietary formats on standard protocols (MODBUS, DNP …).

This part will explain the advantage of using standard formats and protocols over proprietary ones. It will focus more specifically on the IEC 61850 substations, but also on the CIM standard, which is emerging.

2.4 Remote Acquisition System (RAS)

The data will be available through the RAS, which allows to decouple the communication process, and the data processing.

The RAS locally handles the periodic data retrieving of the devices in its area. At user-defined, periodic intervals, it checks the devices for new records, retrieves the data, and convert them in COMTRADE format if needed.

The RAS stores the COMTRADE files on the Data Concentrator, in a separate directory per device, from where the data collection module reads and processes them.

2.5 Architecturing the data collection

Multiple instances of the data collector may be remotely installed on dedicated PC in regional centers. The communication with the main application server runs over the utility Intranet configured as a permanent and reliable communication TCP/IP link.

In the scope of automated substations, the RAS can also be located inside the substation to directly get information from IEC61850 or other compatible device.

Ultimately, the architecture depends on how the grid is configured, and how it is managed.

2.6 Data format: COMTRADE

The standard input format is COMTRADE files according to IEC 60255-24 (ANSI C37.111- 1991 or 1999), in BINARY or ASCII formats, or IEC 60255-24:2013, including the cff format.

Any conversion between another standard or proprietary format shall take place in a vendor-specific module attached to the data collector, or to the RAS supplier. The RAS will therefore ultimately provide files in the format described here.

This section will describe the COMTRADE format in details.

2.7 Use cases:

Fault analysis on long lines

Day three

3. <u>Advanced Processes</u>

3.1 Analysis rules

3.2 What are they?

The AFAS shall offer a set of default rules, controllable and configurable for each of these categories: rules for fault analysis, rules for protection analysis, and settings for circuit breakers analysis.

Those rules and settings shall be organized in structured sets, which can ben setup, used, and modified easily, and easily expandable, to meet future needs.

3.3 Defining the rules

This section will explain how the analysis rules should be created and applied. In particular, it will demonstrate why an AFAS should concentrate on the Protection Plan level, rather than each protection relay and its multiple settings.

Also, it will show why it is better to use standard rules whenever possible, rather than specific rules.

3.4 Use cases

Use case with missing data, and with wrong cabling (hidden failure)

3.5 Gap analysis for deployment

This section is devoted to implementation issues that are important for successful development and deployment of an automated analysis system. Issues such as implementation constraints, the deployment strategy and the role of standards will be tackled.

3.6 Monitoring strategy

We will describe how the data collection chain may be improved to enable an efficient AFAS.

3.7 Network coverage

In order to find out where data are missing, or, more exactly, which areas of the network may not be covered for the fault analysis (blind spots), it is essential that an thorough inventory is done prior to the installation, but also following the first weeks.

That means identifying substations without recorders, or with no means to retrieve the recorded data.

3.8 Enhancing the accuracy

The accuracy of the analysis depends on several factors.

One of the most crucial is the data synchronization between the IEDs. With synchronized data, the global analysis becomes easier. In addition, in terms of fault location, it makes the use of more advanced algorithms possible. Fault location, and therefore analysis, will always be better when using a double end algorithm vs single end computation.

3.9 Picking the right signals

Recording data is all and good, but recording the right data is even better. This section will cover the list of signals, which should be recorded in order to perform an efficient fault analysis: 3-phase currents, 3-phase voltages, protection relays per functions (pickup, trip), teleprotection signals (Rx, Tx), auto-reclose signals, circuit breakers statuses.

3.10 Planning the RAS

When the data is recorded, it needs be retrieved for the AFAS, as covered in the previous days. That means several items:

- A complete network and IED inventory: lines, grid structure, and recorders, but also sensors
- Checking on the data availability: the data should not only be recorded, but available for retrieval
- Formatting the data: data should be formatted in a standard form, i.e. COMTRADE files
- Centralizing the data: the communication infrastructure has to be efficient and reliable
- Interface: we will cover how the AFAS interface should be clear and efficient enough

3.11 Reporting

An AFAS should allow reporting on three different axis:

- Operational (short-term) fault analysis: the operator in the control room usually conducts this type of analysis. The purpose of this analysis is to decide what was a fault scenario
- Tactical (medium term) analysis: this is what one usually refers to as "fault analysis". Protection engineers typically perform this analysis, and the purpose is to decide if primary and control equipment behavior related to a given event was correct

Course Instructor:

Stephane Moyen
(CV Attached)

Stephane Moyen

Main skills

- Mr S. Moyen has a 13-year experience in hardware and software linked to the supervision of high voltage networks.
- He has developed, from the very beginning of his career, an expertise in project management, training, and technical and sales management aimed at measurement and data acquisition devices for the electrical networks.

Education

- 1999 APAVE Certification "Safety" to manage projects in the French nuclear power plants
- 1997 Bachelor in European Engineering Studies, Coventry University (United Kingdom)
- 1996 Diplôme Universitaire de Technologie (DUT) i.e. University Diploma in Technology, Electrical Engineering and Industrial Computing, Automation, Poitiers (France)

Professional experience

2012 - till now:

SYSTEMS EUROPE SA, Brussels, Belgium
Senior Project Manager for the FACES system

2006 – 2012:

Vision IT Group / EZOS
Training department manager
IT trainings in Belgium, Luxembourg, and north of France

1997 – 2006:

Danaher (Qualitrol) / LEM Instruments / Electronic Instruments International
(2005 – 2006) Product Manager
Market and competition analysis, internal and external promotion, and sales support for the digital fault recorders product range.

(2001 – 2005) Analyst-developer
Development of the embedded software for the new digital fault recorder generation.

(1999 – 2001) Sales and technical support
Project management for the highly technical cases. Technical quotations. Customer training. ISO 9001 procedures writing.

(1997 – 1998) Test technician
Digital fault recorder testing

Professional experience in the following countries/areas:

Most of Europe, North America, Malaysia, Morocco, Tunisia, Lebanon

Main projects:

2012 – 2013 Project management for the expert system FACES. Automated Fault Analysis system for the electrical transmission networks. Fault location, prioritization, root cause analysis, protection system analysis.

2006 – 2012 Catalog and custom, on-demand training projects for the IT departments and end-users of many private and public customers in Belgium and Luxembourg mainly. Training team management.

1998 – 2000 Project management for the data acquisition from the French nuclear power plants' generators (EDF)

1999 – 2002 Project management for the data acquisition in English power plants (National Grid)