Computer Assisted Training Tools Used to Increase Staff Performance

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Abstract: - This paper presents two of the new training opportunities offered by the “Bridge Grant” projects to increase the partner staff performance, training tools to exercise in risk free conditions. The training tools system consists of a Safety Training simulator – Java Script aplication that allows the study of various dangerous regimes to humans’, regimes that may occur in electrical installations, when a fault occurs, and a training system - SCADA application which is linked to a dynamic power system simulator, which calculates and presents economic indicators to qualify the economic state of the power system. Engineers can follow the indicators during online operation and see the safety and economic result of all operations in terms of being most secure / profitable or not.

Key-Words: - knowledge transfer, training tools, risk free, energy efficiency, power system

1 Introduction

The current global trend towards improving the power distribution and security service is undoubtedly the most serious concerns of the parties involved in the process, and significant efforts are being made to increase the reliability and stability of power systems.
On the other hand, the current operating philosophy of free energy markets imposed, after a period of increasing the quality level, a reduction in the costs related to the electricity distribution process by increasing productivity. Under these circumstances, serious pressure has been generated to reduce global costs. Against this backdrop, it is clear that only well-trained staff from all points of view can guarantee the maintenance of high standards in this area.
Taking into account the opening of energy markets and the current tendency to legally assume responsibilities, it is particularly important to use specialized tools to highlight efforts to increase the performance of the power distribution system by training staff.
An option for these tools is control and computer assisted training, capable of providing competent staff training [1]. The computer-assisted technique was initially used in universities for the students' training activity, subsequently proving an efficient tool in the process of continuous training of the specialized personnel in the energy field - the employees of the distribution companies.
Staff training can be achieved by initially identifying training needs, then planning, organizing, conducting and evaluating it [2].
The evaluation may identify the potential needs for reviewing the training program.

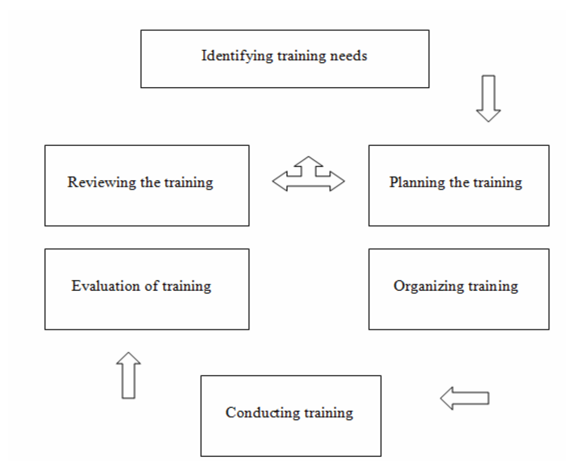

Fig.1. Specific actions to the training cycle

This paper aims to present the training opportunities (specific instruments) available at the University of Craiova in this field, which can benefit the partners involved in direct co-operation through the national development program - increasing the competitiveness of the local economy - "Bridge Grant", in this case the local distributor "Oltenia Energy Distribution" [3].

2 “Bridge Grant” knowledge transfer &training tools

Knowledge transfer known in literature as the movement of know-how or technical knowledge from one organization to another, is considered to be one of the most important components of the strategic plan of the INCESA research institute /University of Craiova.

INCESA (Research Hub of Applied Sciences, University of Craiova) is a young organization; it already counts an important number of collaborations with the local and regional business environment. Consequently, it is developing a management strategy that approaches the knowledge transfer (KT) to the industry as a recurrent event [4].

Two of the INCESA’s projects financed by national grants and based on a partnership with the regional power distribution company – Oltenia Energy Distribution - have as one of the main object training periods for increasing the personnel skills.

The regional power distribution operator delivers power energy for 7 counties in the Oltenia region, being committed to supplying all of it’s over 1,400,000 clients with high quality electricity. The rapid expansion of Oltenia Energy Distribution (referred to as DEO) activities and units, doubled by the permanent objective of network reliability improvement and smart concept implementation shape its policy regarding the staff professional development and expertise. Following these trends, DEO is perfectly aware of the importance of having highly qualified employees. One of the strategies used by DEO is the development and integration to partnerships with the local academic and research environment.

This partnership has been accelerated by the availability of national funding to research, innovation and knowledge transfer. Bridge Grant is one of the Romanian financing schemes designed to sustain KT. Last year there were registered 11 applications of INCESA’s laboratories for the Bridge grants, out of which 64% were successful.

Two of these applications were submitted by the Laboratory of Innovative Processes and Technologies in the field of Electrical Smart Grids of INCESA [5], [6]. Both projects will run for two years.

An outline of these two projects is given bellow.

A. Project - SITNSE-EESS

The project “Intelligent solutions for neutral grounding in 110/MV distribution substations for increasing of the energy efficiency, personnel security and reliability of power users’ supply” is one of the application of the INCESA’s Smart Grid Laboratory within the Bridge Grants projects [5].

This project has as main objectives the development of studies for specific solutions to improve the quality of energy supply services to MV and LV network users, to increase the energy efficiency and personnel safety in order to comply with future regulations regarding continuity in power supply.

The project proposes solutions that will enhance the performance of the power distribution operator DEO by both increasing the level of safety in the electricity supply (by reducing the specific indicators SAIFI, SAIDI) improving so the energy efficiency, and the level of personnel one.

The project implementation ensures the KT to DEO, pursuing concrete and lasting benefits of scientific and technical nature, and also from the economic and work safety perspectives. Consequently, the further development of the technical skills of the staff directly or indirectly involved in the project is estimated, as well as the training of future specialists regarding the issue of the neutral grounding in modern distribution networks, and their own safety.

The project implementation underpins the expertise of a total of nine academic researchers, accompanied by the technical staff of DEO.

B.Project - SYMMPQI

The project “Intelligent system for monitoring and management of power quality at the interface between the electricity distribution network and its users (SYMMPQI)” aims at the replication and customization of a package of knowledge dedicated to Oltenia Distribution Company. The envisaged field is monitoring and management of power quality (PQ). These ones are customized to the specificity of the interaction power distribution grid-users, seen as a product (software) and a set of procedures for training, application and utilization of PQ instruments dedicated to the company’s operating staff. The project is designed to increase the level of expertise of the power distribution operator and its organizational skills development. More effective policies will be identified so as to increase the technical-economic competitiveness and the quality of the distribution service, in the context of preparing for moving on to the Smart Grid [6].

The grid operator is expected to have competitive advantages such as: accurate information, increased predictability for monitored phenomena, adaptive flexibility. The project brings added value in the field of information protocols of power consumers and their "smart" versions. Its maximum economic impact will be achieved by extending the partnership between INCESA and one of the most important national power companies.

3 Training tools to increase the personnel safety and skills

The first project SITNSE-EESS has as objectives not only the development of studies for specific solutions to improve the quality of energy supply, but also increasing the energy efficiency and personnel safety in order to comply with future regulations regarding continuity in power supply. The project team is able to use two computer assisted simulator applications, one of them used to study the implications of possible defects in the security of the personnel serving the electric installations developed by the team leader of the project toghether with a specialized company in safety field (Miso SRL [7]), and the another one that helps to train the personnel regarding the command and control of the power energy systems developed by former Repas AEG company toghether with Hochschule Darmstadt.

3.1. Safety training simulator ▪ STS

Training simulator is available on-line as a Java Script application and it was created to perform a complete training and analysis with dangerous situations that may occur in the operation of electrical installations [8], [9].

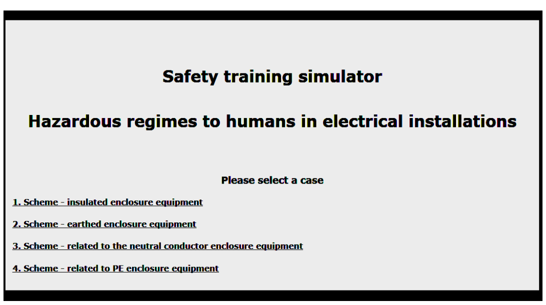

Fig.2. Safety training simalator/start page display

For it is deemed a general electric scheme was implemented into the simulator shown in Fig.3., scheme based on which the application will allow to train and study several specific cases concerning the mode protective influence on the current and voltage values undergone by the human operators when a failure occur (Fig.2.).

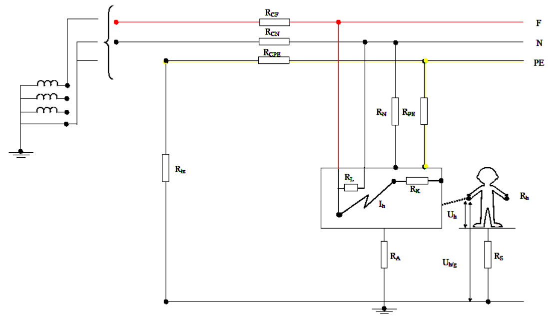

Fig.3. Training simulator general electric scheme

All the possible cases will be trained and studied together with a variation of the certain parameters considered important in evaluating and limitation of the current I_h and voltage U_h through the human body, so basically to be avoid the possibility of electric shock appearance.

The corresponding values for certain network parameters (system) and for the local equipment analyzed subjected to defect, and also those relating to particular cases which can be analyzed, are considered to be constant, namely:

► operating voltage installation U = 230V;

► internal system reactance X_{System}= 0.16Ω;

► resistance of the phase conductor R_{CF}=0.50Ω respectively neutral conductor R_{CN}= 0.50Ω;

► protective conductor resistance R_{CPE}=0.25Ω.

The value of the fault resistance that occurs, it was considered constant also, in all cases to be analyzed, being equal to R_K = 5 Ω.

For other parameters: electrical resistance of the human body R_h, resistance grounding circuit R_{is}, additional electrical resistance to the human body R_S, resistances conductors of binding to the neutral conductor R_N, to protective conductor R_{PE} and to the earth R_A, values that are considered fixed or automatically predefined values in a certain interval, or variable with a certain step.

Thus, for R_h were defined more eloquent values within the range considered 1000Ω - 3000Ω with a step of 500Ω (Fig.7.a), values that will be used automatically in charts to determine the variation of electrical current I_h (Fig.4.) and voltage U_h (Fig.5.) to all four general cases which can be studied – Fig.2, [10]:

#Case 1: Scheme – insulated enclosure equipement;
#Case 2: Scheme – earthed enclosure equipement;
#Case 3: Scheme – related to the neutral conductor enclosure equipement;
#Case 4: Scheme – related to the PE conductor enclosure equipement.

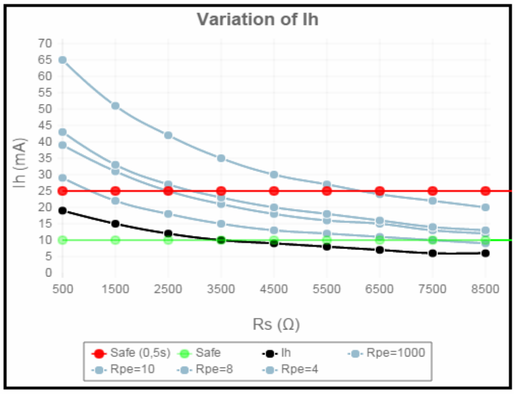

Fig.4. Electrical current I_h variation

The red line from the upper display shows a certain safety level only when the protection system works faster than 0,5seconds. The green one means a good security no matter what, and the black line presents the variation of the current thru the human body in this case (as an example).

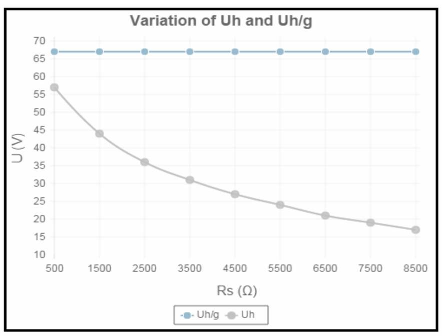

Fig.5. Variation of electrical voltages

Similar in this display – we have human body voltage to ground with blue colour and voltage thru human body with grey.
Results can be also dispayed as numerical values calculate results – as Fig. 6 shows.

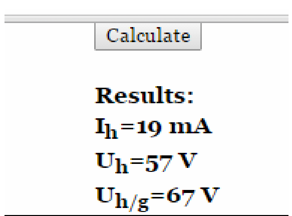

Fig.6. Display of the calculate values results

Regarding resistance R_{is} it varies from case to case starting from 2Ω / 4Ω (fixed value) to 100 kΩ (fixed value) depending on the analyzed case (Fig.7. b).
Similar parameters for connection to the neutral line and PE, R_N resistance respectively R_{PE} resistance, have fixed values that can be chosen above from the menu (Fig.7.c) beetwen 2Ω and 10000Ω.
The corresponding value for the strength of binding additional grounded enclosure R_A it is also possible to be selected in the same range. The only value that will be introduced from the operator console and depending on changes to be carried out and graphs, is the appropriate additional human resistance (R_S) represented by insulation resistance of various protective equipment, and which can vary from 0 the 100000Ω.

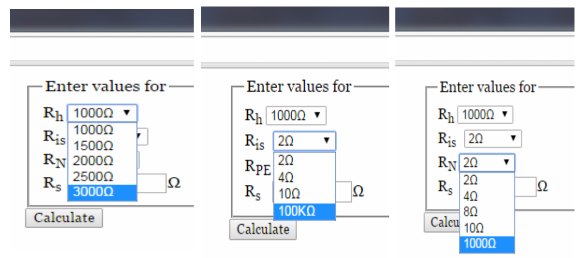

Fig.7. Resistances values: a) R_h , b) R_{is} , c) R_N

The computing relations for determining the current I_h, voltage U_h and respectively voltage $U_{h/g}$ are valid only for each individual study case.

#Case 1: Scheme – insulated enclosure equipement
Total current in the circuit is:

$$I_T = \frac{U}{\sqrt{X_S^2 + (R_{CF} + R_K + R_h + R_S + R_{is})^2}} \tag{1}$$

In this case the electrical current I_h is:

$$I_h = I_T \tag{2}$$

#Case 2: Scheme – earthed enclosure equipement
Total current in the circuit is:

$$I_T = \frac{U}{\sqrt{X_S^2 + \left(R_{CF} + R_K + \frac{R_A \cdot (R_h + R_S)}{R_A + R_h + R_S} + R_{is}\right)^2}} \tag{3}$$

In this case the electrical current I_h is:

$$I_h = I_T \cdot \frac{R_A}{R_A + R_h + R_S} \tag{4}$$

#Case 3: Scheme – related to the neutral conductor enclosure equipement
Total current in the circuit is:

$$I_T = \frac{U}{\sqrt{X_S^2 + \left(R_{CF} + R_k + \frac{(R_N + R_{CN}) \cdot (R_h + R_S + R_{is})}{R_h + R_N + R_{CN} + R_S + R_{is}}\right)^2}} \tag{5}$$

In this case the electrical current I_h is:

$$I_h = I_T \cdot \frac{(R_N + R_{CN})}{R_h + R_N + R_{CN} + R_S + R_{is}} \tag{6}$$

#Case 4: Scheme – related to the PE conductor enclosure equipement
Total current in the circuit is:

$$I_T = \frac{U}{\sqrt{X_S^2 + \left(R_{CF} + R_k + \frac{(R_{PE}+R_{CPE})\cdot(R_h+R_S+R_{is})}{Rh+R_{PE}+R_{CPE}+Rs+Ris}\right)^2}} \quad (7)$$

In this case the electrical current I_h is:

$$I_h = I_T \cdot \frac{(R_{PE}+R_{CPE})}{R_h+R_{PE}+R_{CPE}+R_s+R_{is}} \quad (8)$$

For all cases voltages are:

$$U_h = I_h \cdot R_h \quad (9)$$

$$U_{h/g} = I_h \cdot (R_h + R_S) \quad (10)$$

All that will be used in order to obtain appropriate variations electricity I_h, respectively U_h and $U_{h/g}$ voltage (Fig.9.) variations that may assist in the assessment regime, dangerous or not category based on prescribed standards values for current I_h and voltage U_h [11],[12].
It should be also noted that the numerical values obtained (fig.6.) are presented as whole numbers (rounded to the nearest unit), which leads to, for certain sets of values, to an overlap in terms of graphics because the numerical values on which they are made, are very close[8].
Training with this simulator leads to knowing the implications of certain parameters or network elements on human operator security, eg the use of additional protection means - through a larger R_S or the implications of the existence or not of additional R_A resistance.

3.2. Power system training simulator ▪ RESY

The Dynamic Power System Simulator software application from the RESY family developed by the former Repas AEG Company allows the real-time simulation of processes in the implemented test system and its responses to users' actions [13].
The test network implemented on the simulator is optimally controlled by complex tools, which allow continuous monitoring of the considered energy system, in normal operation mode or by simulation of defects, of planned operations or with the aim of optimizing the network configuration, followed by an analysis of their effects, including of an economic nature [14].
The personnel can be trained to perform operations at the level of generation nodes, voltage level optimization and power transitions, short-circuiting or change of economic indicators (sale, purchase, imports).

The simulator was designed to meet the new requirements for increasing electricity consumption and developing the electricity market, with modules and functions for training in:
- monitoring and control of the implemented system in order to maximize available transfer capacity and reduce the likelihood of disturbances;
- calculating and controlling the movement of powers or tensions in real time;
- real-time security evaluation;
- assessing the operating conditions of the system, both in a permanent and stable way, but for new software variants and in the presence of distributed generation and active consumers.

The hardware configuration for network study is shown below [13]:

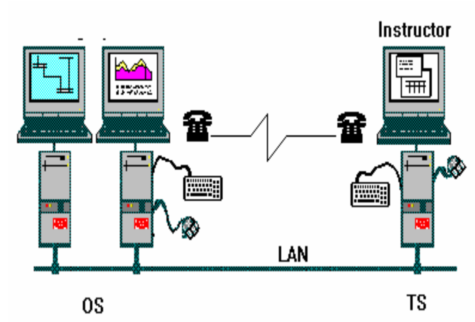

Fig.8. Hardware configuration of the simulator

The training system is a stand-alone system, not connected to any real energy process. SCADA, EMS, and MMI software are deployed on a single operating system OS.
The system implemented by the simulator is a relatively small size (13 nodes), all of its components belonging to a fictitious company, FHD-AEG (Fig.9.) [13], [15].
It includes all types of conventional power sources and voltage levels of 400, 110 and 20 kV, plus the low voltage distribution network.
In addition, there is a voltage level of 15.5 kV at which a hydroelectric power plant with accumulation and pumping flows.
Economic indicators are analyzed using specialized applications such as Ertrag and CENS.
The first application, Ertrag, is to determine permanently the cost associated with the exploitation of the test network considered (transport and distribution).
The second one, CENS - Compensation for Energy not Supplied, is being developed as a module for the calculation of penalty indicators for energy not supplied to consumers, it being necessary to specify that specific regulations have been used in the countries of the European Union [16].

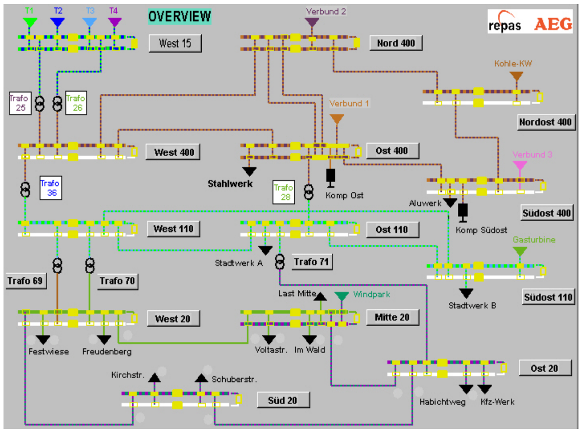

Fig.9. Test network overview

The trained operators do not feel a significant difference between online operation and operational training because the simulation parameter sets are power system snap shots and the calculations are performed in real time manner. Beginners and experienced operators staff can increase their skills by operating and solving power system emergency situations.
Staff qualification used to be achieved by studies of network theory, electrical behaviour of all grid components. It should also be noted that the application complies with all applicable standards for communication protocols [17].

4 Conclusion

Experienced and well trained personnel can achieve a reliable optimum under consideration of all safety and economic demands and technical constraints.
The safety application allows operator awareness (students or operating staff) about the danger to which is subjected in the current activity and especially are highlighted the limits of parameters from the scheme, so that the conditions of security to be respected.
Using the training the technical and economic effects of different operational strategies can be traced and trained.
The training activity leads to increasing of the operating staff's professionalism and prevents expensive errors.This training will result in countable profit increase of the company by less accidents and expensive errors.

Acknowledgment
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