INTEGRATED SYSTEM FOR TRAINING OF OPERATING PERSONNEL FROM THERMAL POWER PLANTS EQUIPPED WITH GROUPS OF 50 MW

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Abstract: This paper presents the solutions adopted to achieve an integrated system for manoeuvres simulation related to operation in various load regimes of a central heating plant equipped with steam boilers of 420 t / h, 50 MW groups with condensation and controlled extractions and hot water boilers. Simulation system reproduces dynamic and stationary operation regimes of a central heating plant and complex mathematical models respects the real behaviour of the simulated installations for various manoeuvres such as start / stop / exploitation on load / emergency operations.It is mentioned the importance that is achieving such a system in analyzing the behaviour of the installations, as well as professional training of the speciality personnel.

Key words: integrated system, modelling, process and training

1. GENERAL DATA

The Integrated System is destined to training and coaching staff from heating plants with 50 MW groups (training young personnel and regular training of personnel with experience). It can also be used in the teaching process of higher education in specialties: energy, mechanical, automatic, [1].

The system is designed so the operator can maneuver and track stationary and dynamic processes in the same conditions as in real plants.

The achievement system was envisaged that the instructor can monitor and intervene in the deployment process, creating abnormal operating situations.

In order to use the system operating personnel, the system has an interface similar to those of existing plants.

The integrated system simulates real-time operation of a central heating steam generators equipped with 420 t / h, heating groups of 50 MW with condensing and controlled extractions and steam / hot water boilers. Heating power plant is equipped with two steam generators of 420 t / h, two groups of 50 MW, which supplies industrial consumers of steam and hot water for heating and domestic hot water preparation.

The system performance requires the development and implementation on software systems both of stationary and dynamic mathematical models of processes in the power plant and basic software and application software, [2, 3].

Integrated system with a high degree of scientific and technical complexity required the analysis and establishment of complementary solutions in areas such as: development of stationary and dynamic models, automated management systems, achievement of basic and application software, [4].

The intelligent engineering system consists of: 2 operator workstations destined to management of the boiler (1 post) respective of turbine and generator (1 post) and 1 instructor workstation for management and coordinating of the activity.

Operating regimes are: normal regimes in which the operator executes maneuvers and emergency regimes in which the instructor introduces defects and disturbances, and the operator executes maneuvers to the installations that have deficiencies.

It is noteworthy that the ampleness and complexity imposed training of more specialists collectives starting with heat-power, electrical, automation fields. By using the integrated system in exploitation of heating plants, the system will lead to operational safety increasing in power and heating supply to fuel economy and lowering emissions.

2. SIMULATED CIRCUITS AND TECHNOLOGICAL INSTALLATIONS

The Integrated System includes circuits and installations afferent to subsystems of the boiler, turbine, electrical generator, heating boiler, condenser, etc.

Modeling the technological processes correspondes to circuits and technological installations: heating turbine, condenser, cooling pumps, condensate pumps, low and high pressure pre-heaters, barrel exhausting pumps, 6 and 1.2 at deaerators, supply pumps, reducing cooling stations, boiler 2 simplified, turbine 2 simplified, the bus

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bars of the power plant, electrical generator simplified, simplified block transformer, transformers and simplified auxiliaries supplying bars, steam boiler and afferent annex circuits, [1, 3].

3. MATHEMATICAL MODELSLEVEL II HEADING

Mathematical models of stationary and dynamic processes for technological installation of the system correspond to the analogue and binary models (technological processes and algorithms of actuating, signalling, permission), [5, 6].

Realization of the models imposed throughness research of the technological installations processes carried out as follows:

- developing research of the stationary and dynamic processes of equipment, turbine, steam generator, internal services, etc.
- developing mathematical models of stationary and dynamic processes of these processes.

In developing models was followed on the one hand that they can reflect real processes taking place in mentioned installations and secondly the duration of the calculation is within the limits of real time operation.

To achieve the integrated system were established for the technological processes over 20 modules and were written the necessary mathematical relations: 50 MW turbine, the turbine oil installation, installation of condensing and condensed basic circuit, vacuum installation, installation of steam labyrinth, regenerative circuit of low pressure - low pressure preheater, the regenerative circuit of high pressure - high pressure preheater, deaerators, turbine control engineering, electric generator, electrical network model, peak-base heating boilers, water feed pump, coal steam boiler 420 t / h, models processes in systems management of the boiler of 420 t / h and regulators adjustment, binary part – module of actuating, signalling, protections.

Based on these models were developed: the basic software and graphical user interfaces and develops appropriate application software (for circuits and technological installations simulated).

In Figures 1 and 2 are two of thermodynamic diagrams that are displayed on the display.

4. BASIC SOFTWARE AND APPLICATION SOFTWARE

Integrated System impose achievement of an integrating concept regarding the inclusion of the component modules, modelling of the technological processes in static and dynamic regimes, and software packages elaboration for simulating the operation of the boiler of 420 t / h and of the 50 MW turbo generator.

Implementation of the application is made on a configuration of 3 computers containing 2 workstations for operators from the boiler and turbo-generator group and an instructor workstation that allows him to monitor and coordinate activity developed within the application of the integrated system.

The application imposes the necessity to develop application software packages structured as follows:

- category of programs that form the basis for implementing the system and all its basic functions; this class is the system software (basic software);
- category of applicative programs, containing on the one hand processing of the actuating, signalling and protection algorithms, afferent to the schemes of automation and protection of the simulated installations and second processing modules of the analogue models afferent to the calculation of operating parameters of equipment and installations as a whole; this class is the application software;

System software and application software communicates directly and through the database of the integrated system.

System software implements the functions of a training system and allows viewing the operating technological schemes of the group of 50 MW, making and taking of manoeuvres, and interfacing with programs afferent to simulation mathematical models.

Graphic component is the basic module of visualization and interface software. Unlike other components, is essential component of any graphical interface software for such a system.

Graphical working interfaces breed specific process interfaces of a group of 50 MW based on a library of active graphical elements.

It is important the organization manner of the database afferent to the system, the database providing implementation of all the functions specific to the system. Resulting databases include a large volume of data.

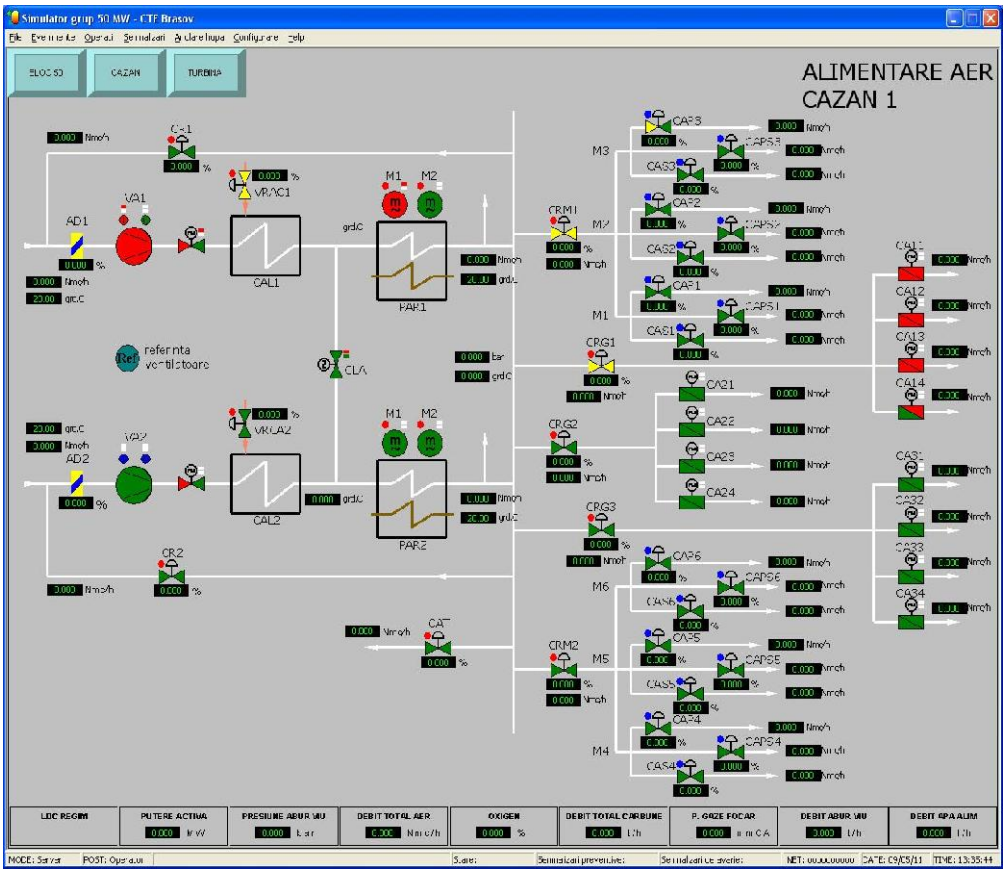

Fig.1. The air supply scheme of the 420 t/h boiler1.

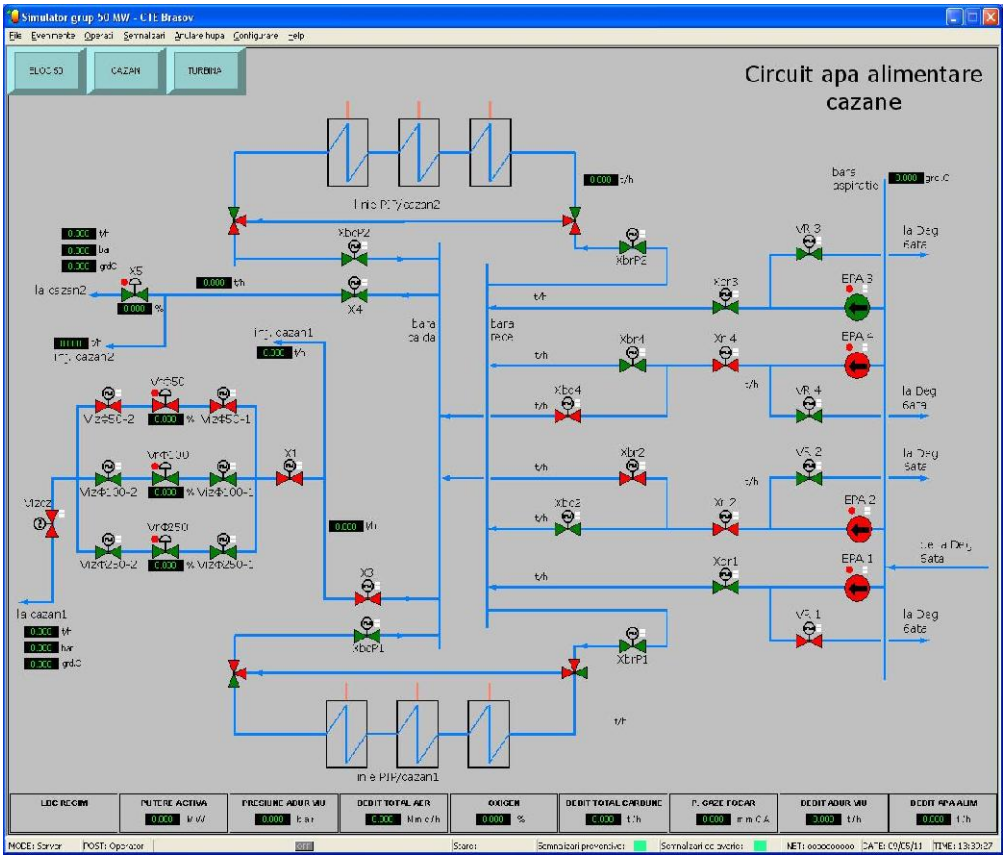

Fig. 2. The water supply circuit scheme of the 420t / h boiler.

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5. EVALUATION OF MANOEUVRES EXECUTED ON THE SIMULATOR

Simulation software system developed enables automatic evaluation of manoeuvres performed during a training session of the students.

The evaluation is conducted based on preliminary editing assessment criteria.

Each evaluation session is associated with a set of evaluation criteria.

When creating new session evaluation is necessary to establish new sets of criteria. T

he evaluation criteria are related to values evolution of a set of analogue amounts chosen by the user.

Figure 3 presents the editing window of the evaluation criteria including the left analogue amounts from the database, and the right the selected parameters, which constitutes the evaluation criteria.

A criterion is characterized by: analogue amount considered as an evaluation criterion, the weight of the criterion in the set of criteria (P) in [%], the correctly working domain of the analogue amount (L) in [%], the sanction domain of the analogue amount (D) in [%].

Modification of the value of specific parameters of a criterion is made adding criteria in the list or after it.

Can be changed for each selected parameter: the weights used, correct working domains, domains of sanction.

Edit evaluation sessions.

Having prepared the general rules under which the evaluation will be made, within the function "Edit evaluation sessions", the user reunite these elements and establishes the conditions of development of an evaluation session.

The evaluation report itself is completed by an evaluation report.

The report contains a comparison between a pre-registration of a standard lesson and the results obtained by the operator-student after the exercise achieved.

The student shall receive a note for each criterion in the set. Endnote is calculated by weighted sum of the marks obtained for each criterion.

Figure 3 is represented by the evaluation report window.

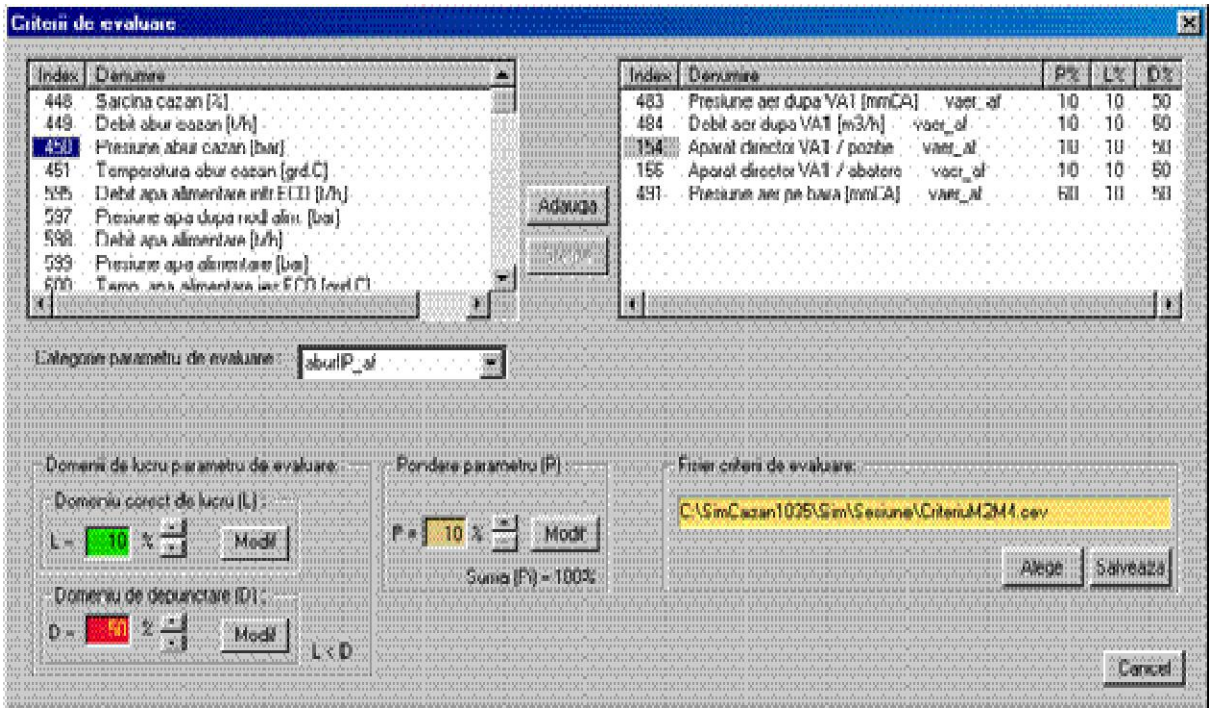

Fig. 3. The configuration window of the evaluation criteria.

Visualisation of the evaluation report or of the variation graphic of the criterion in the list can be made both on the display and the printer.

In Figure 4 is presented the editing / modifying window of an evaluation session, and the figure 5 prezent the windows with the evaluation report.

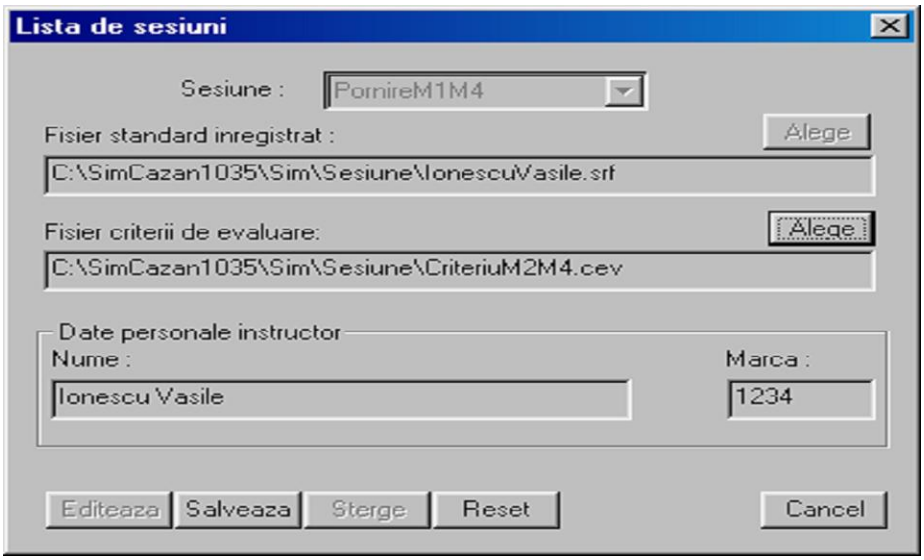

Fig.4. The editing/modifying window of an evaluation session.

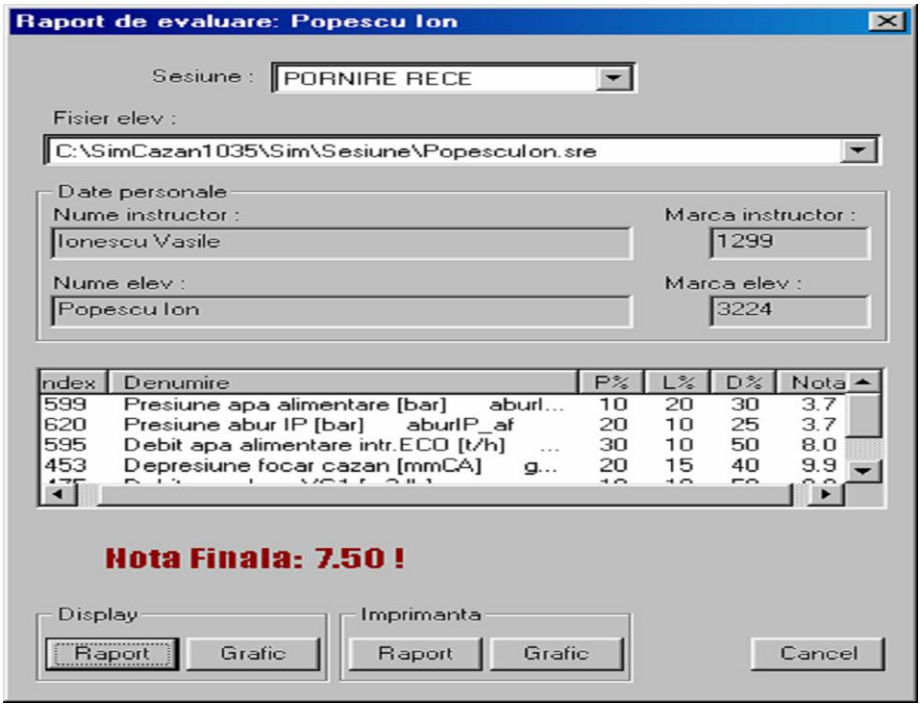

Fig. 5. The window with the evaluation report.

6. INPUT DATA AND OUTPUT DATA

Modelling and implementation of mathematical calculations in application programs assumes existing of a database of the implemented system, which contain coded and in full at least momentary name and value of all binary and analogue signals.

The database corresponding to the integrated system contains two main categories of data, namely:

- binary data - corresponding to the binary signals
- analogue data - corresponding to the analogue quantities.

The value of a binary signal contains, among other information, the momentary value of the respective amount.

The value of an analogue amount displays real numbers.

In turn each data category can be divided into:

- input data
- output data
- auxiliary data
- instructor data

Input data of the Integrated System correspond to the following categories of signals:

- control signals given by the user on graphical operating interface for equipment and installations actuating and are binary input data (eg engine control on / off or valve engine opening / closing);

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- signals corresponding to certain external parameters to determine the operating conditions, and are analogue input data (eg outdoor air temperature or cooling water temperature).

The binary output data corresponding to the equipment that compose the simulated installations, eg engine on / off or valve open / closed / intermediate position.

The analogue output data are represented by the parameters calculated by computer analogue programs that are displayed on and interface graphic of the simulator.

Auxiliary data are amounts not necessary to be displayed on the graphical interface. These amounts are amounts internal to the calculation programs. Information contained in these amounts is necessary both during development and testing programs for the programmer and the implementation of programs, but they are virtually invisible to the user.

7. CONCLUSIONS

Users of the integrated system are the exploitation operators from the control rooms from CET Brasov, with the possibility to use this product to the other heating groups of 50 MW.

Power plants is highly complex, their operation and management requires a well-trained technical staff, both theoretically and practically, that can provide a utilization with high security and achieving high economic indicators.

Meeting these requirements requires operating staffs that has thorough knowledge of the technological process of the operation of energy installations. Implications are taken into account that various manoeuvres performed on installations, manoeuvres that must intervene in case of disturbance or damage and the consequences of some manoeuvres on the operation economy of the plant.

Integrated system is a complex software application composed of two main categories, namely:

• basic software - system tasks that allow the application to run;

• application software - sequences and routines that implement the analogue mathematical models and the processing software of the actuating-signalling-protection schemes.

The programs are corresponding to the developed mathematical models. Computer programs are referring to the circuits operation represented on the visualization interfaces. Referenced circuits and installations were grouped in 28 modules – where through are implemented the mathematical models.

Programs can be successfully used in simulation of the manoeuvres related to operation in various load regimes of central heating plant equipped with steam boilers of 420 t / h, condensing groups and controlled extractions of 50 MW and hot water boilers.

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