2008

Stage II: Achievement of execution documentation for experimental model

For carrying out the second stage, the following activities have been performed:

Activity II.1. Drawing up the technical specifications for experimental models of excitation systems

The following participated in performing the activities of this stage:

Project leader (CO) – INCD - ICMET Craiova cooperated in drawing up the technical execution documentation for the stand laboratory model and carried out the execution documentation for the industrial model of the hydrogenerator excitation system.

Partner I – UNI-Timisoara drew up the execution documentation for the laboratory model components.

Partner III - University of Craiova drew up the specific documentation regarding the excitation system automating and monitoring functions.

Activity II.2. Drawing up the execution documentation for experimental models of excitation systems

Project leader (CO) – INCD - ICMET Craiova drew up the execution documentation for the industrial model of the hydrogenerator excitation system.

Activity II.3. Information dissemination

Project leader (CO) – INCD - ICMET Craiova achieved the first knowledge dissemination as a conclusion on the present status and trends in developing the static excitation and voltage control systems, by participating in conferences.

Partner III - University of Craiova achieved the first knowledge dissemination as a conclusion on the present status and trends in developing the static excitation and voltage control systems, by participating in conferences.

1. Objectives of the execution phase

The main objectives of the second phase - Achievement of the execution documentation for the experimental model - are the following:

2.1 Drawing up the technical specifications for the experimental laboratory model of a hydrogenerator with digital excitation system, and purchasing the basic equipment

2.2 Drawing up the technical specifications for the industrial model of the digital excitation system for hydrogenerators;

The execution documentation for the laboratory model of the digital excitation system will be used for carrying out, within a future stage, a stand for didactic research at Polytechnical University – Timisoara, and also for achieving, with a view to endowing ICMET laboratories, a system (stand) for research and tests for certifying the digital excitation systems for hydrogenerators which will be achieved as a result of research activities.

2.3 Drawing up the execution documentation for the laboratory model of the stand for studying and testing the digital excitation systems of hydrogenerators.

2.4 Drawing up the execution documentation for the industrial model of the hydrogenerator excitation system;

2.5 Information dissemination.

2. Phase summary

The second stage of this project is focused on drawing up the documentation necessary for achieving an experimental model of an excitation system intended for research in the field.

Fundamental aspects on the excitation systems, characteristics, performances and tasks imposed to the excitation systems are taken into account.

On the basis of these considerations and drawn conclusions, the principle structure of an automatic excitation system can be set; this system should be flexible, modular and able to test many practical solutions and to fulfill many functions.

This experimental model of the excitation system should include modern hard and soft solutions and take into account the development trends of this field, which were outlined in the first stage of the research project, by bibliographic synthesis of recent papers.

In the documents issued as a result of performing the activities from project execution phase, functional aspects of the excitation control system are detailed; they have been mentioned in the general presentation made in the first stage of the project.

These present elements related to the theory of the excitations of synchronous hydrogenerators will be the basis for choosing the testing duties of the experimental excitation model, which represents one of the activities of the third stage of the research project. The third stage of the project provides achieving and testing the experimental excitation model.

In the final section of this project part (Stage II.1 *Technical specification for experimental model*) the principle diagram chosen for the experimental model is presented.

On the basis of this document, the concrete, detailed solution for the proposed experimental model was drawn up also in this project stage; this solution forms "execution documentation for the experimental model of the excitation system" (Stage II.2).

The experimental model will contain an automatic system for the supply and control of a DC motor, by means of which the hydraulic turbine is modeled, and an automatic system for controlling the excitation and for connecting a salient pole synchronous machine (coupled to Mcc), which represents the synchronous generator.

A power hydro-aggregate is a complex system of elements which carries out electricity generation on the basis of hydraulic energy. The structure of this system contains: control elements, devices for automatic control of the operation duties, automatic devices for protection when a failure occurs. The numerous elements of such power system are close connected one to another by the continuity of the process of electricity generation and consumption. This feature outlines the system complexity, which is determined not only by the high quantity of elements, but also by the numerous connections between them.

In such system, like in any other complex system, deep internal connections exist, which do not allow system splitting into separate autonomous components; when determining the system characteristics it is not allowed to modify the determinant factors, so as they should be considered as independent, one by one. A complex system as a whole has new features, which are not specific to its components.

The calculation methods of such systems become mathematically very complicated. For being able to perform practically these calculations, many approximations, which could generate significant errors, are necessary.

The attempts for improving the accuracy of the existing calculation methods and for simplifying them subsequently for practical purposes need an experimental verification. An experimental system allowing the reproduction of any operation duty of the considered system is necessary for making possible the verification of new theories or new methods and also the assessment of the approximations and premises of the existing methods. Obviously, such system can be only a physical model.

The physical model of a power hydro-aggregate is an achievement of a real physical system on reduced-scale, and contains in its structure the models of all the main elements of the original system. Before building the physical model of the power hydro-aggregate, a clear wording of the problems to be resolved by means of the given model is necessary. This will allow emphasizing those parts of the system which should be reproduced on the model. For instance, if the physical model is built for studying the transitory phenomenon which is developed in the electric part of the system, the hydraulic part of the system (hydraulic turbines) can be simulated approximately by means of mathematic models.

The models of power systems containing, besides the simulated elements, also the mathematic models of different elements of the power system, are sometimes called electrodynamic models. They became widely spread in practice. In electrodynamic models, only the main elements forming the power installations of the systems are simulated. All auxiliary elements, like relay protection, are introduced in models directly in their natural form, not-simulated. .

This project is focused on achieving an experimental model for a hydro-aggregate assembly, which outlines the complex problems which are the basis of an automatic system for controlling the excitation of synchronous generator. The experimental model is made of a unit containing a DC motor and a synchronous generator, mechanically coupled; for them, power and automating electric diagrams were designed.

For the constitutive elements of the force diagrams and automating diagrams, technical characteristics required by the high performances characterizing the modern systems for controlling and adjusting automatically the synchronous generator excitation became necessary.

It has to be specified that synchronous generator is a salient pole machine, allowing studying the operating duties for hydrogenerators.

For this purpose, in order to supply the excitation winding of the synchronous generator, a complex system based on a controlled rectifier module- latest generation - was designed.

The diagram adopted for the experimental model allows controlling the frequency and voltage of synchronous generator, manually or automatically. Thus, the synchronous generator can operate under different steady or transient states, specific to high power synchronous generators.

The results got from the tests which are going to be performed on the experimental model could lead to important conclusions on the improvement of the performances for high power synchronous generators in operation at present.