CONCLUSION

Using models to optimize the management of transboundary rivers, energy and irrigation systems can lead to difficult and labor-intensive work, requiring knowledge of the programming language and processes in the system itself. During the design of models, it is important to analyze deeply the principles and organization of systems, to consider many facts, requirements and restrictions in natural, technological, technical and political aspects, which can influence the work. Later, the designed models have to be tested under industrial conditions, step-by-step checking the adequacy and correctness of forms and optimized solutions, making proper corrections. These require sufficient time, intellectual efforts, and means.

It is important to emphasize, that the designers of the models reported here solved the task for the first stage of work, which was mentioned above (see Introduction and Chapter 3). The BVO Syrdarya is using the "River" component of the model in their everyday activity. The UDC Energia updated its old "OPTIMUM" complex of operational planning of water-energy regimes with a new computation program written in the GAMS language.

It is important to continue the work, because time, efforts and means were not sufficient for creating the complete programming product for each component. Analyses and evaluation of the completed work and requirements for the programming complexes from the point of view of optimization and automation of managed processes shows the following:

"River" Component

1. The activity reported here on elaborating the model of optimal regulation of transboundary water resources of the Syrdarya basin at the BVO Syrdarya completely confirmed the ability and expediency of using the GAMS language in solving such complicated optimization tasks;

2. During the current (2000) vegetation season complete testing of the "River" component will be conducted, and some changes and corrections will be made; and

3. The Syrdarya river has a very high level of regulation; the guaranteed water supply for the brunches of economy in the Republics of the basin greatly depend on the optimal management of the reservoir operation, especially in the upper basin, including multi-year regulation, and forecasting water availability for some years ahead. Because of this, the operation plans for the water cascade are very important for the basin as a whole. The next phase of work will include the elaboration of a multiyear regulation model. Now, a good scientific and practical base exists for this work.

"Energy" Component

1. Certain time is required to complete testing of the modified OPTIMUM complex, analyses of results, and some additions to the algorithm and to the complex in general. Besides these, in the process of working with this model there are some additional ideas for further development of the optimization model in the following aspects:

- Modeling the electric regime;
- Modification of objective functions; and
- Implementing additional technological constraints.

1. The activity reported here on elaborating the complex of water-energy operating planning regimes at the EPP CA completely confirmed the ability and expediency of using the GAMS language in solving such complicated optimization tasks. The ability and perspective of this system is in elaboration of the following program complexes, which are important for UDC Energia:

   - Modeling of HPP cascades on the Syrdarya and Amudarya rivers for the complex of operative and seasonal planning of water-energy regimes;
   - Operative correction and optimization of regimes of the EPP CA on the basis of telemetric data and evaluation of conditions; and
   - Optimization of electric regimes based on the losses of active capacity.

3. Cascade models will allow, in important cases, provision of operative and complex correction of water consumption at the HPPs of the Naryn-Syrdarya cascade. Operative correction and optimization of regimes of the EPP CA on the basis of telemetric data and evaluation of conditions will allow dispatchers and calculation groups at the dispatcher service to do the following:

   - Provide calculations of balanced electric regimes in active time with minimal deviations from calculated parameters of regimes in all telemetric measurements for each period of time; and
   - Make calculations of variants based on the balanced regime:
     - in connecting and disconnecting equipment at the stations (HPPs and TPPs);
     - in connecting and disconnecting electric transmission lines;
     - increasing or decreasing consumption, and implementing contracts for energy supply; and
     - changing conditions at the stations to provide electric energy and energy consumption.

3. Optimization of electric regimes of the losses of active capacity in the EPP CA will allow:

   - Minimizing active capacity losses in the network of the EPP CA;
   - Determination of optimal coefficients of transformation at the main transformers of the sub-stations;
   - Determination of optimal loads at the reactive capacity sources in the main distribution network in the EPP CA; and
   - Elaboration of proposals for installation of additional reactive capacity sources for energy systems in the EPP CA.

5. In the future, UDC Energia considers the elaboration of industrial variants of the complex programs of operation and seasonal planning of water-energy regimes to be expedient for the three complexes mentioned above. The complexes should work in Windows environment and be oriented toward the following:

   - Using a modern data base management system for organizing a unified data base and facilities with access for Explorer and SQL-servers;
   - Using modern information technologies (WEB-technology, ...), to organize the information interaction of the mentioned complexes for the UDC Energia, EPP CA, BVO Syrdarya and other external organizations;
   - Using a modern user interface for the entrance, correction and reflection of information;
   - Using graphic means for the entrance information; and
   - Providing access to complex data by a unified system of reflected information and technological tasks in UDC Energia.

Further development of modeling activity, from our point of view, can be directed to the elaborating a mutually connected complex to support creation of a Long-term Intergovernmental Basin Agreement in regulating the main questions of efficient water and energy resources management in the region for a long term period. Such a complex is important in choosing efficient solutions for future planning in distribution and use of water and energy resources, reviewing possible conflict situations between States and economical branches (hydraulic-energy, irrigated agriculture), preventing breaks in Agreements and obligations.

Improvement of existing management models can be made in four main directions:

- Developing and adapting methods of long-term water flow forecasts for local conditions;
- Elaborating and improving methods for finding compromise solutions and consensus in integrated management of water and energy resources, methods of evaluating benefits and damages as a consequence of management decisions, mechanisms of compensation and payments between states;
- Modernizing and implementing computer complexes in the BVO Syrdarya and the UDC Energia to improve their opportunities in operational water and energy resources management in the transition to multiyear management of the water and energy complex; and
- Modeling the multiyear functioning of planning zones;

The aim of these works is to increase the efficiency of using water and energy resources on the base of economic consumption of water and energy resources and decreasing losses. One of the components, which will help to achieve this goal is computer models, the first versions of which, as this report documents, have been created and are now being used in the BVO Syrdarya and the UDC Energia. The elaborated complex must be a model available for any organization as well as for the main users.