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The impact of the year 2000 issue on electricity grid performance and nuclear power plant operation in Bulgaria, the Russian Federation and Slovakia

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THE IMPACT OF THE YEAR 2000 ISSUE ON ELECTRICITY GRID PERFORMANCE AND NUCLEAR POWER PLANT OPERATION IN BULGARIA, THE RUSSIAN FEDERATION AND SLOVAKIA
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FOREWORD

The Y2K date conversion is a potential source of problems to the operation of nuclear power plants through external events and interfaces with electrical power systems, telecommunication systems, and other supporting infrastructures, even if diagnostic and corrective actions within the plant itself, both planned or implemented, are successful.

At the end of 1998 there were 425 nuclear power plants in operation in 31 Member States. Most countries and regions are conducting intensive diagnostic and corrective activities to "find and fix" Y2K software (including embedded software) and equipment problems in their nuclear power plants. These efforts are supplemented by contingency plans. Other countries and regions have not been making comparable efforts and are relying mainly on contingency planning and preparedness.

Results of diagnostic and corrective activities can be of benefit to all Member States. Activities on "find and fix" Y2K problems in electricity grid control systems and computer related technology in national and regional dispatch centers could be of considerable benefit due to the widespread use of the same components, equipment, and software.

Consistent with the objectives of the International Atomic Energy Agency's Y2K program, an experts meeting was convened to collect information on Y2K activities related to grid operation in countries that operate nuclear power plants and also to identify specific actions to be taken and issues to be addressed in connection with expected grid disturbances. The countries of eastern Europe and the Russian Federation were considered to be a very important region due to delays in taking Y2K corrective actions but also due to the similarity of their electricity grid systems both in components and design but also in mode of operation. Most of these countries either operate their own nuclear power plants or are linked through their electricity grid interconnections to a neighboring country that operates nuclear power plants.

The purpose of the meeting was to address:

(1) The establishment and mode of implementation of methods and procedures for sharing information resulting from diagnostic and corrective activities conducted in the various Member States on grid instabilities and their respective influence on nuclear power plant operations.

(2) The scope of additional activities, also including countries other than those operating nuclear power plants, due to the existence of important grid interfaces. Examples are telecommunication systems and electrical grid connections with other countries that can be the source of grid disturbances impacting nuclear safety in neighboring States.

This publication includes this information in the form of simple to use suggestions to utilities and grid operators as well as to governmental organizations with responsibilities in this area.

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

"Year 2000 problems" result from the use of two digit fields to represent the year. In the less technically sophisticated times when computer storage was at a premium, such two byte year representation was a common convention to conserve space. The convention used two numeric or alphabetic characters to represent the year only to the decade level. In these cases, the century is assumed to be a "19". In some cases, the "19" may actually have been hard coded. Often, the two-digit year characters are embedded in a larger date field. In other cases, such embedded dates are more subtle. The change to the year 2000 will thus not be properly reflected in the equipment and software that uses this convention. The results are guaranteed to be incorrect date and day of the week representation in all instances of date information beyond the year-2000 transition. If such date information is used in calculations, the results of the calculation will be totally inaccurate.

The way information systems might react on 1 January 2000 and at other times to year 2000 (Y2K) problems varies considerably. Some systems may not be able to cope and will simply shut down, while others may continue to function, but produce erroneous results. The latter case is of particular concern, since the results of false calculations might not be detected until damage is done to other critical data. Due to the diverse nature of using dates in computer coding Y2K problems are already occurring in some systems, and maybe expected to occur after 1 January 2000.

Correcting year 2000 problems may be a very complex task. Programmers must be able to decipher programs possibly written years earlier by different individuals, who may not have documented their work. The testing procedures involve entry of a variety of test data to ensure that the program will work in any practical situation that can be encountered. Programs that pass date information from one program to another must be examined and tested. Data that are passed electronically from one computer from another must be verified as being year 2000 compliant.

1.2. THE INTERFACE ISSUE

The year 2000 problem is not limited to computer systems. Control systems often use computer chips, which utilize dates. All of these can be affected. The equipment and systems that are normally classified as safety related and that directly control the operation of the nuclear reactors do not pose a major challenge from a Y2K perspective, as most of these systems have no date or time dependent functions.

The Y2K problem may, however, directly impact the safety of nuclear power plants through interfaces with the electrical power systems and through the telecommunications/telemetry used to control these systems. A significant potential impact of the Y2K problem on the safety of the nuclear power plants is from interfaces with the electrical power grids, telecommunications, and from other external factors.

The major specific grid interface concern is that the Y2K problem can influence stability of electricity grid performance, thus creating an increase in the probability of tripping of nuclear units or loss of off-site power. In recent years, US NRC probabilistic risk assessments have made it clear that a 'station blackout' at a nuclear power station is a major contributor to core damage frequency. Station blackout refers to an event in which a loss of off-site power is coupled with the inability of the onsite emergency power supply, e.g. diesel generators, to provide vital power to plant safety equipment. On the other hand external grid instabilities, such as might result from the Y2K problem, may cause the nuclear power units to disconnect from the grid. Conversely, the nuclear power plant's protective system's response to grid instabilities could cause the grid to disconnect from the unit. Related concerns are potential infrastructure impacts on support systems required for the safe operation of these units.

1.3. OBJECTIVE

Consistent with the objectives of the International Atomic Energy Agency's Y2K program, as expressed in GC(42)/RES/11, Measures to Address the Year 2000 (Y2K) Issue, dated September 1998, this TECDOC presents information and suggestions related to nuclear power plants that identifies specific actions to be conducted and issues to be addressed in connection with expected Y2K induced power grid instabilities and interface problems with special focus on the countries of eastern Europe and the Russian Federation operating power grids and nuclear power plants of similar design.

1.4. SCOPE

Information was presented and examined by a team of experts, including results of diagnostic and corrective activities that are planned, or have been conducted. The experience gained from the activities that have been performed may be of benefit to all Member States, but in particular to those in the countries of eastern Europe and the former Soviet Union due to the widespread use of much of the same components, equipment, operating norms, and software.

Based on these presentations and examinations, the establishment and implementation of methods and procedures for sharing information resulting from such diagnostic and corrective activities on grid instabilities and their respective influence on nuclear power plant operations were considered. As directed, due to the existence of important interfaces, these considerations included countries other than those operating nuclear power plants.

The meeting prepared conclusions and suggestions concerning exchange of information on electrical power grid Y2K problems. In addition, some key potential problems were identified and suggested solutions presented to be considered by operators of electrical power systems and nuclear power plants.

1.5. STRUCTURE

This section provides information on the background, objective and scope of the report. It also describes the content of specific sections of the report.

Section 2 provides information concerning the current situation, action, and plans concerning preparations for Y2K in Bulgaria, the Russian Federation, and Slovakia and with interfaces with adjacent electrical power systems. Information on these countries' electrical power systems and organization is presented.

Section 3 provides the conclusions and suggestions for exchange of information.

2. SITUATION

All countries considered in this report have initiated actions to prepare for the Y2K problems in their electrical power systems. The extent of testing accomplished and status of planned actions varies among the countries.

2.1. BULGARIA

Bulgaria set up a special council of experts for the power sector and initiated actions to respond to the Y2K problem in accordance with the President of the Committee of Energy's Order Number 317/01.09.98. Actions required by this order include an inventory of the information and management systems of all elements. As of December 7, 1998 seventy-two of these organizations (from a total of 74 companies and 30 branches) have completed estimates of the problems and funds required.

The considerations involved in planning and implementing activities for coping with the Y2K problem included examination of internal and external interfaces, clarification of supplier related issues, preparing scenarios for critical systems, and for new orders requiring supplier warrantees related to Y2K compliance.

The systems analysis task performed included:

(1) identification of critical time periods;

(2) analyses of software upgrades to be made based on by software suppliers information;

(3) fixing probable disturbance sources in systems software;

(4) preparation of needed corrections;

(5) evaluation of test configurations to simulate possible operational schemes;

(6) implementation and testing of necessary modifications;

(7) system upgrades with Y2K compatible versions;

(8) fixing necessary hardware upgrades using new versions.

The control systems within the power plants are also being evaluated. In the Bulgarian power system there are 2820 MW of thermal and 1590 MW of hydroelectric generation capacity with 14 thermal and 26 hydroelectric units that can be involved in direct load frequency control from national dispatching center. The units control systems had different suppliers: ABB, Siemens, Toshiba and control system produced in Bulgaria — MICROSYST.

The new SCADA/EMS (supervisory control and data acquisition) system at the Bulgarian national control center are scheduled to be in regular operation by April 1999. The hardware, the UNIX 4.0 D operating system, and the application software are Y2K ready.

Telecom equipment (type Telegyr 065, 709, 709s, 803, 809) installed in power plants, substations and control centers is Y2K ready. The systems at the regional dispatching centers and at control center of the city of Sofia, a distribution control center, are also being upgraded. Y2K is also a reason for the hardware upgrades. These upgrades will be completed by September 1999.

Following preliminary analyses, Y2K simulation tests were conducted. These tests of the Bulgarian power system were completed on 8 October 1998. All systems operated normally except for problems with archive searches for the time period 1999 and 2000. Additional activities are planned. Action is in progress on telecommunications. The general conclusion is that the problem is under control.

Testing showed no problem with automatic generator control or real time power application programs.

Work to evaluate interfaces with neighbors systems, telecommunications, etc. is reasonably established and is in progress.

The conclusion, presented by Bulgaria, based on these tests, was that performing such tests of systems and documenting these tests may prove useful exercise for everybody in the region. The procedure used by Bulgaria of analyzing the situation (initial assessment), contacting suppliers (vendor evaluation), and proceeding on this basis provides a few simple initial steps. Power plants, regional control centers, and then national centers should be checked. An assessment could then be made of these systems. Then, after completion of the preliminary steps, Y2K simulation tests could be done by changing dates.

2.2. THE RUSSIAN FEDERATION

The management of the Russian Federation's integrated power system (IPS) is performed by dispatching centers which are organized into a hierarchic system of dispatching management and control that has four levels. The central dispatch board is at the top of this system. The central dispatch board is over the seven territorial dispatching boards, as well as dispatch to, and co-ordination of activities and data exchange with, dispatch centers in Ukraine, Belarus, the Republic of Moldova, the Baltic Association, the Transcaucasian Association, and Kazakhstan. Under the regional dispatch boards there are 72 regional power systems and hundreds of local power distribution grids

The IPS's seven territorial power systems are for northwest Russia, central Russia, the north Caucasus, the middle Volga, the Urals, Siberia, and the Far East. The IPS's regional power systems are interconnected through a transmission network with lines rated at 330 kV or higher. The IPS has more than 220 000 miles of transmission lines with a capacity of 110 kV and higher, including about 275 miles of 1150 kV lines and about 1500 miles of 750 kV lines. It covers about 5000 miles from east to west and is in six time zones. The Russian IPS has an extremely robust grid, the operational methods that sometime require load and generation shedding are used to preserve the overall integrity of the grid. Manual operation and shedding have allowed the Russian Federation (and the former Soviet Union) to respond to many severe challenges without loss of the grid for over 50 years. The operational priority is to protect the grid, accepting the local blackouts that result from manual or automatic disconnects.

All of the dispatch boards use similar equipment, with similar functions. While originally they had standard software and equipment, there have now been three or four modernizations. The current situation is that several different systems are in use. IBM RS/6000 and Motorola UNIX-servers and local PC networks were installed in the central Russia, northwest Russia, and Northern Caucasus dispatch centers in 1996 through 1998. RTP, INTEL 8080 CPU, microcomputers and local PC networks were installed in the Urals, Siberia, and the Far East in 1985 through 1989. RTP, INTEL 8080 CPU, microcomputers (CM-1420, analogous to PDP-11), EC-1011, and local PC networks were also installed in this same time period in dispatch center in middle Volga, in most of the Russian Federation's regional power systems, and in what are now the national dispatch centers of Belarus, Ukraine, and the Baltic Region.

Thus the sensitivity to the Y2K problem differs from region to region in the Russian Federation and with different interconnections outside of the Russian Federation. It is anticipated that the more modern equipment that is sensitive to the Y2K problem can be fixed relatively easy. The older systems that have outdated hardware and software will require considerable effort to fix. No testing has been done.

Telemetry equipment in power plants and transformer substations that provide data and information to the relevant dispatch centers have no Y2K sensitive equipment.

Actions are being taken by two Russian ministries to respond to Y2K concerns. The Ministry of Electricity, operating through RAO ESS the Russian Federation, is addressing the transmission and distribution system. MINATOM, directly and through Rosenergoatom, is addressing concerns at nuclear units. Activities are being coordinated both at the working level and the ministerial level.

An executive order addressing the Y2K problem was issued by the Government of the Russian Federation in June 1998. The State Committee for Communications and Information Support was named the lead organization for Y2K actions. This State Committee formulated and issued the Methodological Guidelines to resolve the Y2K Problem.

The IPS's Central Control Board has provided methodological guidelines to resolve the Y2K problem to all territorial and regional dispatching centers. This requires performing an inventory of all computer hardware and software in use to get precise data on the scale of the Y2K problem in the various level of the IPS dispatch system hierarchy. A requirement is to obtain information identifying which computers and software should be replaced, and which software should be modified. This task is facilitated by use of information from Internet web sites and through contacts with hardware and software suppliers.

The following methodology is being used for this inventory.

- A list is compiled of all information systems used in a dispatching center, categorized as follows:
  - (1) micro and mini computers;
  - (2) PC and UNIX servers;
  - (3) PCs;
  - (4) active network hardware;
  - (5) system software (operating systems and systems application);
  - (6) application software.
- Testing of systems is then conducted for clock function correctness at the main time transition points, checking installation and display of specific dates of concern, and checking processing of date dependent data before and after 1 January 2000 for different time settings.

- Testing PCs and servers, the most widely used system components, that includes checking the date setting after 2000, checking for automatic clock setting to 2000 with power on, and also with power off.

- Retrieval of data required for assessment of Y2K readiness of information systems hardware and software for each architectural group.

- Assessment of applications software is to be performed by of Y2K certified hardware and software at specialized test benches.

- Testing of PCs and servers in the central dispatch board has been performed using a specialized testing program, TEST2000.EXE, developed by RighTime (USA). Most generators do not use computers. Those that do use computers normally work in parallel with other systems. These are also being tested using TEST2000.EXE.

Full scale testing of dispatch systems was not regarded as being possible due to the non-stop nature of dispatch systems operation. Specialized bench tests are to be used to imitate the rollover to the year 2000.

The dispatch centers will each have to develop an action plan to resolve the Y2K problem upon completion of the inventory.

The data obtained by late 1998 were provided to the central dispatch board to provide IPS senior management generalized information.

On conclusion of the inventory, in the first quarter of 1999, a report was provided to the Russian Parliament – The Duma and all other authorities. It is hoped that additional financial resources will be allocated in order to obtain specialized hardware. The current Russian economic situation and the economic situation in the Russian power industry makes it practically impossible to obtain the needed funding, required to replace hardware and upgrade software. Thus, the IPS is focusing on upgrading efforts on the most critical systems and applications where failure or malfunction may have severe consequences. In addition to the upgrading of these top priority systems an emergency preparedness plan is being prepared to cope with possible accidents, failures, and malfunctions.

MINATOM issued an order on the Prevention of Adverse Consequences to the Computer and Information Systems in Operation in the (Nuclear) Industry due to the coming Y2K. As a result all parts of MINATOM were required to perform analyses of all information and computer systems (including embedded software), and software to identify potential problems, develop required response measures, and report back to the ministry.

To implement this order Rosenergoatom has recommended to all NPPs to take high priority actions to respond to the problem, including:

(1) identifying systems and equipment, that might contain any type of computers and software;

(2) determining which of these are date dependent;

(3) assessing the importance of these system to safety;

(4) assessing the Y2K readiness of these systems;

(5) establishing priorities;

(6) either correcting problems or providing feasible alternatives;

(7) preparing relevant emergency work plans.

The majority of NPPs completed an interim inventory and reported results to MINATOM and Rosenergoatom in November 1998. Rosenergoatom is currently preparing schedules to resolve Y2K problems, with work to be completed by September 1999. At that time all NPPs must provide written confirmations of readiness to Rosenergoatom.

Testing of PCs and servers within the MINATOM system of enterprises is being done using TEST2000.EXE developed by RighTime. The methodology established provides a well conceived approach to finding and fixing problems and upon completion of an inventory all dispatch centers will have to develop an action plan to resolve the Y2K problem.

2.3. SLOVAKIA

The Information Technology Department of the Slovak National Electricity Company analyzed the Y2K problem and presented a report in May 1998. This report pointed out that at that moment the national electricity utility had still not completed the necessary actions to fully address the Y2K issue. A program was prepared and activities were initiated to aggressively identify all equipment with potential Y2K problems. These involved identification, testing, and remediation and readiness for auditing. The head office is responsible for co-ordination and taking action if something is not on schedule.

There is one overall project manager, one project manager at each nuclear power plant. Each power plant has a special group to inventory systems and equipment. Responsible people have checklists with defined milestones.

Based upon the IAEA Y2K guidance for Member States, a revised approach was prepared to have equipment ready for audit, whether date sensitive or not. The work is performed to make sure systems are or are not date sensitive, to inventory compliance, to assure statements concerning Y2K compliance are available from suppliers, to check contingency plans, and identification and verification.

The Bohunice nuclear power plant has inventoried all computer system software, etc. and is now working on actions. Several actions are underway to update based on safety considerations.

The NPP is connected to the west European system, which has good grid stability and control so no problems are expected in this area. Bohunice Unit 1 and 2 (model V230s) reactor protection systems are being replaced with Siemens ESX systems, which were developed when the Y2K problem was recognized. These systems are still in the process of replacement.

The capability to manage loss of load is believed to be good — the last event happened at unit 4 on October 1998. The 1E power supplies of the first and second categories have been upgraded. A special connection (upgraded) has been made to a nearby hydroelectric plant to obtain a power supply after a station blackout. Batteries and diesel generators are being upgraded. In mid-1999 all parts of the system will be reassessed.

Slovakia has developed its own procedures for all safety systems. Established systems provide feedback.

Tests of a more global nature have not been done yet.

3. CONCLUSIONS

(1) Activities to prepare national electricity grids for Y2K have been reported for Bulgaria, the Russian Federation, and Slovakia.

(2) Information and experience obtained by each country can benefit the others if appropriately shared. Due to the similarity of equipment, operating methods, and norms this information is of greater mutual benefit than that from countries with dissimilar equipment, etc. The information contained in this report can be also beneficial to other neighboring countries, which do not operate nuclear power plants but have important electricity grid interfaces with Bulgaria, the Russian Federation and Slovakia.

(3) The potential loss of nuclear power plant generation capacity is a significant risk to the electrical power grids. On the other hand, loss of the electrical power grid increases the probability of a nuclear power plant having a station blackout. The US NRC and others have found through probabilistic safety assessments (PSAs) that station blackouts are major contributors to the probability of initiation of a severe accident.

(4) The relevant organizations have the required specialized knowledge and expertise. Sharing of information and experience with other countries in eastern Europe and the CIS will allow activities to be performed in a more efficient manner.

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