South Ukraine Nuclear Power Plant
(SU NPP)

Advanced Computer Information System Project
(CIS)

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INTRODUCTION

There is much debate today with respect to the safety of nuclear power plants in the former Soviet Union. In an effort to bring plant safety up to western standards, many programs for the installation of modern instrumentation and control equipment have been discussed. However, one such program has actually been implemented which combined the efforts the South Ukraine Nuclear Power Plant, Westron (a Ukrainian joint venture company), and Westinghouse Electric Corporation.

The South Ukraine Nuclear Power Plant Unit 1 became the first VVER 1000 unit to be back-fitted with an advanced digital Computer Information System (CIS). This new system enhances plant safety and performance by providing operators with detailed, high resolution displays of operating conditions. The system was designed, and installed by Westron, a joint venture of the Ukrainian company Hartron and Westinghouse Electric Corporation of the United States. The VVER 1000 plant is a pressurized light water reactor, and is very similar in design to nuclear plants in the U.S., Western Europe, and Asia.

The South Ukraine plant is the first operating VVER to install an advanced plant Computer Information System. This is significant since there are a large number of operating VVER type plants that will need upgrades in the future. Listed below are some of these VVER plants:

1. Ukraine (13 operating plants)
    - South Ukraine NPP (3 Units)
    - Zaporozhye NPP (6 Units)
    - Khmelnitskiy NPP (1 Unit)
    - Rovno NPP (3 Units)
2. Russia (13 operating plants)
    - Balakovo NPP (4 Units)
    - Kalinin NPP (2 Units)
    - Kola NPP (4 Units)
    - Novovoronezhskiy NPP (3 Units)
3. Bulgaria (6 operating plants)
    - Kozloduy NPP (6 Units)
4. Czech Republic (4 operating plants)
    - Dukovany (4 Units)
5. Slovak Republic (4 operating plants)
    - Bohunice (4 Units)

The new CIS system utilizes the Westinghouse Distributed Processing Family (WDPF II™) Control and Information System technology. There are more than 3000 such Computer Information Systems in operation around the world in nuclear and fossil power stations, steel mills, water treatment facilities, and many other industries utilizing process control and information monitoring systems.

PROJECT HISTORY

After Ukraine declared its independence, Westinghouse Electric Corporation spent several years exploring the nuclear power plant upgrade market in Ukraine. During this time Westinghouse concluded that in order to effectively participate in this market it would be necessary to establish a joint venture in Ukraine. In 1994 Westinghouse was awarded a grant by the US Department of Defense for the first defense conversion project in Ukraine under the Nunn-Lugar program for the newly independent states of the former Soviet Union. This Program was the result of an agreement between the US and Ukraine to assist in the conversion of military-industrial enterprises to commercial activities.

Westinghouse evaluated several possible partners and eventually teamed with Hartron a Ukrainian company that formerly developed, produced and installed control and monitoring systems for missiles and space systems. Westinghouse and Hartron agreed to form Westron as a Ukraine Joint Venture company to design, engineer, manufacture, install, and service instrumentation and control (I&C) systems in Ukraine.

In July 1994, Westinghouse and Westron made their first combined visit to the South Ukraine Nuclear Power Plant (SU NPP). In the course of discussing the problems of I&C operations at power units, SU NPP specialists introduced their visitors to the status of the installed CM-2M CIS (URAN-B2) hardware. This system provides data acquisition from process point sensors, data processing, storage and presentation of information to operators at the Main Control Room (MCR). By 1994, the system had exhausted its service life, become obsolete and needed to be upgraded or replaced. At that time, the SU NPP specialists were investigating and comparing various possible options of CIS refurbishment/replacement:

- by IMPULS SPA (Ukraine),
- by Siemens (Germany), and
- other companies.

Westinghouse provided a presentation on their experience in the development, manufacture and supply of computer information systems on Nuclear Power Plants throughout the world. The Westinghouse systems utilize the WDPF II™ distributed control and information systems technology that feature a number of advantages as compared to similar systems supplied by other companies. The Westinghouse WDPF II™ technology provides high-speed notification to operators of changes in plant conditions. This digital system is a fully distributed, open architecture system that is easily expandable to support future upgrades. The system is designed to be fully redundant so that failure of any single component in the system will not impact its operation.

Over the next several months Westinghouse and Westron specialists introduced SU NPP personnel to the features and capabilities of the Westinghouse WDPF I&C technology and how it might be used to replace the existing CIS.

After having studied the joint Westinghouse/Westron proposal, SU NPP decided to replace the CIS at SU NPP Unit 1 with the CIS designed and supplied by Westron using Westinghouse technology. SU NPPs critical decision was based on the fact that Westron, a Ukrainian-American Joint Venture, manufactures WDPF-based hardware and relevant spare parts. Additionally, the joint SU NPP, Westron, and Westinghouse CIS specification insured the design of a system that meets the latest western safety and performance standards for nuclear power plants.

SU NPP personnel provided information on the functionality of the CM-2M system and together, with Westron and Westinghouse experts, a system architecture based on WDPF was developed along with a Technical Specification document. Based upon this information, a detailed technical proposal was prepared in October, 1994. A contract for the SU NPP Unit 1 CIS replacement was signed in February, 1995. Westron, as a Ukrainian company, was the lead organization for the project.

SYSTEM CONFIGURATION

The reconstruction process was split into two phases so that the work effort could be divided into two refueling outage cycles. The Phase I CIS system (shown in Figure 1.),

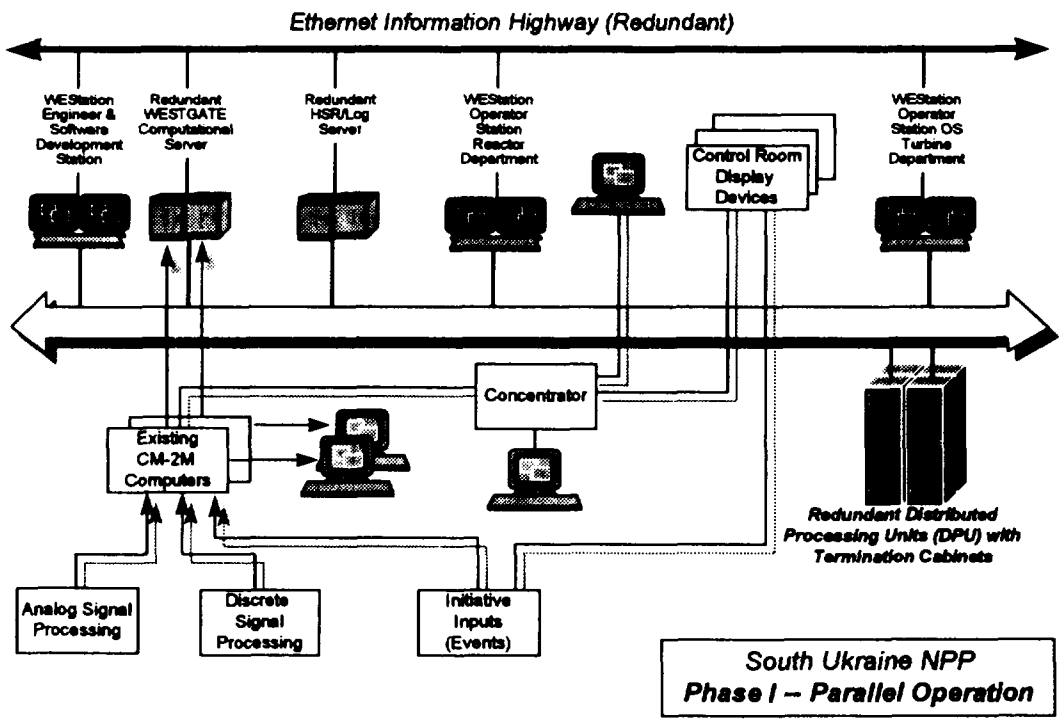

Figure 1.

which was installed during the 1996 summer refueling outage, now provides operators with the ability to plot trends against each other on any desired time-scale or measurement parameter. This simplifies the process of making correlation's so that operators can better

understand the process. Safety is improved since parameters like temperature, pressure, or flows can be easily seen in graphical form.

The Phase I CIS now on line was designed to operate in parallel with the existing CM-2M. All plant parameters are transferred from the CM-2M to the new CIS via a custom datalink called WESgate. The WESgate's function during Phase I operation is data acquisition of all plant parameters. The Phase I hardware includes two redundant WDPF distributed processing units (DPUs), the WESgate datalink, a WEStation Engineers/Software Server, two WEStation operator stations, redundant computational servers, and redundant Historical Storage & Retrieval units and Loggers (HSR/Log).

Below is a more detailed description of the CIS components:

- ***Operators workstation*** - WEStations are based on the Sun Microsystems Sparc hardware. These stations provide a high resolution, multi-window environment for the man-machine interface (MMI) to the I&C systems via color graphics video displays. One operator WEStation is dedicated to the reactor monitoring system and the other WEStation is dedicated to the turbine generator monitoring system.
- ***Computational servers*** - carry out most of the specialized calculations associated with the nuclear plant systems. All programs run on the Sun Microsystems computers which use the UNIX operating system.
- ***Data link server*** - provides the interface required to communicate with the CM-2M during Phase I, and after Phase II will provide the interface for other systems such as radiation monitoring.
- ***Historical storage and retrieval*** - supports the collection, storage, and archiving of the plant data. This subsystem collects and stores the real-time data including pre-trip and post-trip data and the sequence of events during the trip occurrence.
- ***Log Servers*** - redundant log servers provide the ability to present data in a report format, either manually requested or event driven. The ability to capture hard copies of display screens is also provided.
- ***Engineer's station and software server*** - gives the software engineer the capability to perform software and system maintenance.
- ***WDPF DPU cabinet*** - provides hardware and software necessary for direct data acquisition from plant sensors.

All of the WDPF devices or Drops reside on a redundant Westnet II™ real-time data highway. All of the drops with the exception of the DPUs, are connected to an Ethernet information highway for passing of files and non real-time data between WEStations.

The Phase II CIS system (shown in Figure 2.), which will be installed during the 1997 summer refueling outage, will expand the system with three additional operator stations and 21 additional DPUs for data acquisition. The CM-2M will be completely removed during this outage.

In the course of Phase I equipment operation, SU NPP operations personnel provided some comments and requests, namely:

- considering features of Main Control Room (MCR) layout, to replace initially installed 20" monitors with 27" monitors;
- to develop and implement a functional keyboard intended for selecting and providing selection of alarms for display (similar to their existing keyboard);
- to arrange a synchronized time system in all of the CIS adjacent systems. The CIS uses the Global Positioning Satellite (GPS) network to synchronize its system. Other systems at SU NPP will be tied into the CIS GPS system.

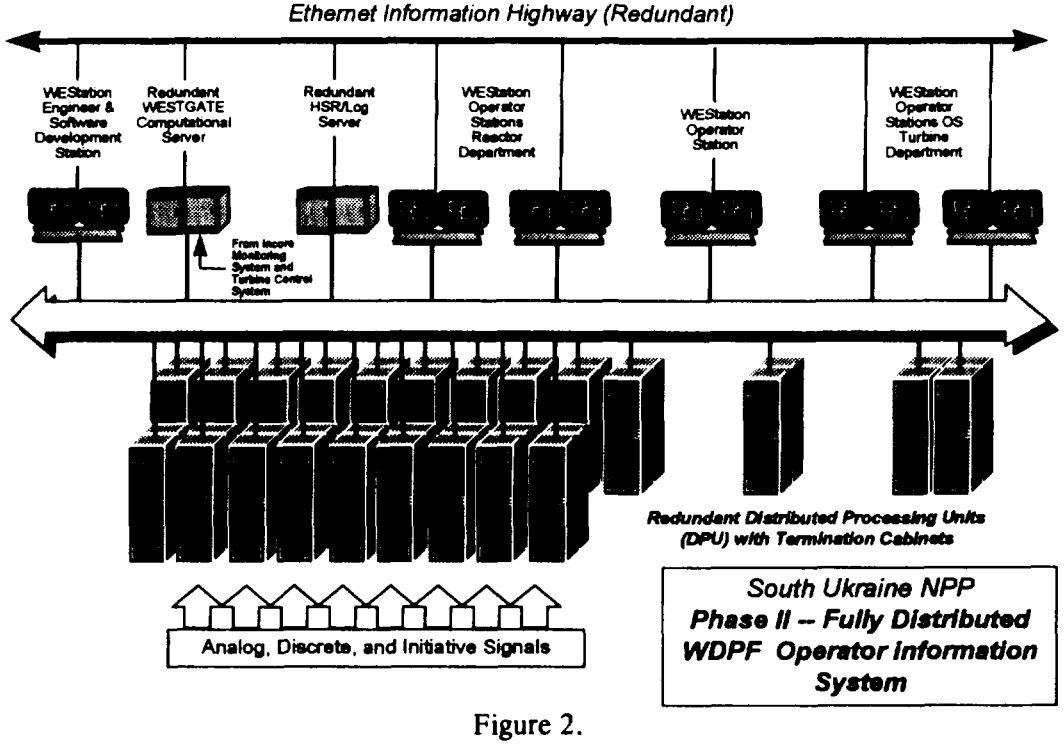

Figure 2.

In addition to the standard operating system software included with WDPF, several additional plant specific application programs will be installed. These include:

- ***Time averaging*** - A routine that continually averages operating parameters over various time intervals.
- ***Redundant measurements*** - A program that monitors redundant sensor readings and makes comparisons of actual readings versus expected readings and inferential data from other measurements to ascertain the validity or accuracy of key process instruments.
- ***Flow and level corrections*** - This program supplies operators with corrections for tank level measurements based on actual pressures and temperatures that compensate for "shrink and swell " effects.
- ***Plant and system status*** - Provides automatic adjustments to computer system parameters and notification routines based on actual plant status (i.e. full power, shut down, hot standby, refueling, etc.).

Other programs include the "Technical and Economic Parameters" program and a "Water Chemical Treatment" program which coordinate actual plant status or mode with the plant technical specifications, efficiency models and water treatment requirements for a particular plant status.

PROJECT SCOPE SPLIT

The contract provided the following scope split:

- Westron, as the lead organization, is responsible for all software engineering, software/hardware integration and testing, installation and commissioning along with training of SU NPP operations and maintenance personnel.
- Westinghouse supplied WDPF technology, hardware, training of Westron engineers, technical support and joint support for over all project management.
- SU NPP supplied all required plant information including all input/output data identification, initial data for plant application programs, and participated in the development of plant specific specification databases.
- SU NPP personnel participated with Westron specialists in the development of all MMI plant information graphical displays.

SUMMARY

The South Ukraine upgrade is the first of many that will take place in the former eastern bloc countries over the next several years. Westron is currently developing a similar system for the Zaporozhye nuclear power plant. In addition, there are eleven other VVER type units in operation in Ukraine, as well as twenty seven others in operation throughout Eastern & Central Europe and Russia - all potential upgrade projects.