A TECHNICAL SYSTEM TO IMPROVE THE OPERATIONAL MONITORING OF THE UKRANIAN NUCLEAR POWER PLANT ZAPOROZH'YE (UNIT 5)

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Abstract

As part of the program implemented by the German Ministry of Environment, Nature Conservation and Reactor Safety to co-operate with the Central and Eastern European States and Commonwealth of Independent States in the area of nuclear safety, a technical system to improve operational monitoring was designed, specified and established as a pilot project by the Research Centre Rossendorf and the Technischer Überwachungsverein Rheinland with a significant contribution from the state scientific and technical centre of the Ukrainian supervisory authority in the Zaporozh'ye/Ukraine nuclear power plant.

As part of the program implemented by the German Ministry of Environment, Nature Conservation and Reactor Safety to co-operate with the Central and Eastern European States and Commonwealth of Independent States in the area of nuclear safety, a technical system to improve operational monitoring was designed, specified and established as a pilot project by the Research Centre Rossendorf and the Technischer Überwachungsverein Rheinland with a significant contribution from the state scientific and technical centre of the Ukrainian supervisory authority in the Zaporozh'ye/Ukraine nuclear power plant. [The Zaporozh'ye nuclear power plant is located about 500 km southeast of Kiev on the southern bank of the Dinner River, which is dammed-up to the Kachovska storage lake. It has six uniform units of the type VVER-1000/V-320. With an electric output of 6,000 MW this nuclear power plant is the largest nuclear power generator in Europe at present.]

The technical system complements existing operational checking and monitoring facilities by including modern means of information technology. It enables concentration on a continual monitoring of the state of unit 5 in normal operation and in cases of anomalies or incidents so that when recognisable deviations from the regular plant operation occur, the Ukrainian supervisory authority can immediately inquire and if necessary impose conditions on the operator. The radiological and meteorological parameters at the nuclear power plant location are monitored to the extent necessary to assess the current radiation situation and to implement effective emergency management measures.

The parameters to be monitored were selected on the basis of German and international experience using the criterion of being able to observe and evaluate the adherence to the following four protection aims:

S1 Assurance of reactor shutdown;

S2 Assurance of core cooling;

S3 Assurance of heat removal from the primary circuit and assurance of its integrity;

S4 Assurance of the integrity of the containment.

The advantage of these procedures is that monitoring the protection aims is self-redundant and complements the monitoring of limit values and conditions of safe operation which the operator has to carry out in accordance with the operating instructions.

On the basis of the protection aim concept

- 49 different safety-related operational parameters of the core and unit,
- 18 radiological parameters of the unit and the plant site, and
- 6 meteorological parameters

are permanently and automatically recorded, monitored and evaluated.

The technical system set up in the Zaporozh'ye nuclear power plant is hierarchically structured. The operational parameters are down-loaded by the Transfer Computer Unit 5 and the radiological and meteorological data by the Transfer Computer Auxiliary Building 2. There they are checked, condensed individually or in monitoring-specific links to logical data channels and transferred as data packages at one-minute intervals to the Server and to the On-site Computer in the laboratory building. In the On-site Computer the process and plant status is evaluated by comparing the current data with monitoring-specific limit values and limit value combinations at one-minute intervals.

The monitoring-specific limit values generally lie above the operational tolerance values to prevent any restrictions of the operator's room for manoeuvre but necessarily below the approved limit values set by the authorities and below the load limit values specified by the manufactures, respectively.

If no violation of the protection aims is found, the users receive an information data file every ten minutes, only. Excess of threshold values causes notice to be sent to the users in the Zaporoge Centre (authority) and in the administration building (on-site-inspector and operator). In view of the importance and possible effects of excess, there are three different information levels:

- *A Notice* is sent to the authority and the operator in the event of a breakdown in redundant measuring lines or safety systems if it reduces safety margins. The report consists of a short verbal communication on monitor and logging printer, the indication of the measuring point or the system and the repair deadline which must be complied with. The notice is automatically cancelled once the cause has been eliminated.

- *A Warning* is conveyed to the users in the event of a violation of at least one protection aim. It consists of verbal communication and signalling on the monitor, entry in a warning journal and the output of actual values and limit values for the monitored parameters which can be linked to the protection aim violation. This information should serve to give the trained specialist an overview of the process and plant status which emerged. The receipt of warning must be acknowledged by the users. A state of warning may only be cancelled when the authority gives its consent and no further protection aim violation has occurred for a fairly long period.

- *An Alarm* in the technical system is triggered if in case of a protection aim violation a process or plant status is reached which for safety reasons requires intensified monitoring. This is always necessary when incidents or accidents occur such as in the International Nuclear Event Scale (INES) for significant events in nuclear engineering installations. Whereas in all states from normal operation to warning the operational information is transmitted to the users at ten-minute intervals and the radiological-meteorological data at sixty-minute intervals, in the state of Alarm the intervals between two consecutive transmissions is shortened to one and ten minutes, respectively. Moreover, the conditions of the Warning state are valid, too.

Trial operation of the technical system to improve operational monitoring, installed with German support in the Zaporozh'ye nuclear power plant, was commenced at the end of 1995. Following the completion of the user software by the scientific and technical centre

of the Ukrainian supervisory authority and the operator, in which the German partners participated in a consultative capacity, and the establishment of evidence of reliability under nuclear power plant conditions, the industrial testing phase of the system was started in the middle of 1996. Since then, supervisory authority and operator have been able to fulfil their monitoring duties more efficiently than before.

The technical system is unique in terms of its effective monitoring of nuclear power plants with VVER-1000 reactors in the Central and Eastern European states and in the CIS. The modular and open structure of the system makes it possible to extend the monitoring to all six units and to connect more users.