Y2K & NUCLEAR FUEL CYCLE FACILITIES

ASSESSING VULNERABILITIES

BY RON SHANI

The nuclear fuel cycle may be broadly defined as the set of processes and operations needed to manufacture nuclear fuels, to irradiate them in nuclear reactors and to treat and store them, temporarily or permanently, after irradiation. Several types of nuclear fuel cycles exist, depending on the type of reactor and the type of fuel used and whether or not the irradiated fuel will be reprocessed.

As at other large-scale industrial operations, computer-based systems are widely used in nuclear fuel cycle facilities, for example, during operations and data processing and storage. Nuclear fuel cycle facilities and activities can be very diverse. They may range from the refining of uranium ore to the reprocessing of spent fuel discharged from nuclear power plants. The need for and the use of computers in various nuclear fuel cycle facilities and activities is also very diverse. It may range from fully computerized processes to the total lack of computer applications, in particular in simple nuclear fuel cycle processes or steps.

The problem may affect nuclear fuel cycle facilities in a number of ways because embedded systems are used in routine operation and control systems. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. All embedded systems are or include computers or microprocessors. Such systems can be found in all nuclear fuel cycle facilities, dealing with hazardous or radioactive materials, from milling to conversion and enrichment, from fuel fabrication to reprocessing and spent fuel storage.

As part of the IAEA's Y2K activities, specialists were convened in Vienna 24-26 March 1999 to examine potential vulnerabilities of nuclear fuel cycle cacilities to the millennium bug. Governments were invited to designate participants who are experts in Y2K issues, particularly where these related to digital equipment at nuclear fuel cycle facilities. Experts from Belgium, Canada, France, Germany, Japan, and the United Kingdom attended. The meeting resulted in a report -- *Potential Vulnerabilites of Nuclear Fuel Cycle Facilities to the Year 2000 Issue and Measures to Address Them* -- that has since been issued by the IAEA as a technical document (TECDOC-1087). The report is based on the strategy for Y2K readiness outlined in the IAEA's technical document entitled *Achieving Year 2000 Readiness: Basic Processes* (TECDOC-1072) that was issued to address nuclear safety and related aspects of the problem.

International Survey. In efforts to determine the overall scope of problems and to develop a database on the subject, the IAEA is surveying nuclear fuel cycle facilities in its Member States. This information will supplement data already on hand in the Agency's established Nuclear Fuel Cycle Information System (NFCIS). This database contains information on over 500 facilities in 51 countries, from which over 280 facilities are in operation.

The potential impact of the Y2K problem at nuclear fuel cycle facilities depends upon their type and operations. The specialists' report classifies impacts into safety, environmental, and operational categories. "Safety" means failures that could affect people on or off site. "Environmental" means failures that could affect people off-site or the environment; and "operational" means failures that could affect operations and products. The highest priority should be given to items which are critical to safety. The lowest priority should be given to

Mr. Shani is a staff member in the IAEA Division of Nuclear Fuel Cycle and Waste Technology.

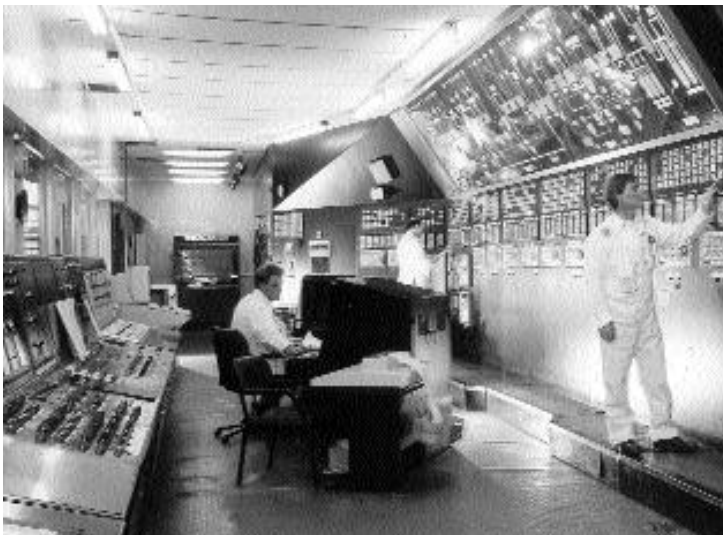
items which are desirable to the operation of the facility.

Several types of systems are potentially vulnerable.

- systems involving "open" radionuclides and active components, where an off-gas treatment failure could cause radionuclide releases into the environment;
- systems involving computerized process control, where a failure could lead to an unsafe condition, such as incorrect dosages resulting in a criticality situation; failure to retrieve and store spent fuel assemblies; damage to fuel assemblies which may lead to a critical situation; and overflow of radioactive material in containers.
- data processing systems, where, for example, an unnoticed incorrect calculation may have direct safety implications if clearance or discharge operations depend on computerized decay calculations, done by specific computer codes or spreadsheets.

More specifically, problems could arise at:

- uranium enrichment facilities, where priority should be given to all process steps in which uranium hexafluoride is heated up and brought into the liquid or gas phase, as failure of the pressure and temperature control may lead to its release;
- uranium fuel fabrication facilities, where priority should be given to computer-based systems controlling the chemical processes in order to avoid formation of hazardous products;
- mixed-oxide (MOX) fuel fabrication facilities, where priority should be given to those computer-based systems controlling plutonium-contained processes to avoid criticality and dispersion of plutonium; and
- reprocessing facilities, where priority should be given to the remotely controlled sheering device and dissolver, and those computer-based systems which drive cooling systems, ventilation and off-gas treatment systems and air-dilution of hydrogen. Attention should also be given to radiation monitoring systems, fire detection systems and power supply.



In the IAEA specialists' report on potential vulnerabilities, national authorities and facility operators -- who carry the main responsibility for safe operations and Y2K readiness -- are urged to ensure that systematic actions are taken to identify, assess, and correct problems.

In particular, facility licensees are urged to take a number of points into consideration. They include stopping production, if technically possible, before the Year 2000 rollover date, at at other critical Y2K dates, depending on the facility's state of Y2K readiness. Safety functions should remain operational. When operations are restarted, the procedure should be controlled and all necessary checks should be made to ensure that all safety conditions are met. Additionally, when investigating and testing in-service equipment, the report points out that care is required, since faults could be introduced and cause unexpected hazardous events.

Overall, the report emphasizes that a systematic approach, commensurate with the hazards involved, is essential to ensure that Y2K compliance is carried out, and that remedial measures are taken to ensure the safety of nuclear fuel cycle facilities.

As part of ongoing activities, the IAEA is drawing the report to the attention of national authorities responsible for nuclear fuel cycle facilities, in efforts to continue the global exchange of information and experience on Y2K issues. ❑

Photo: Control room at a plant for reprocessing spent fuel from nuclear plants. *(Credit: BNFL)*