

# Plant performance: Reducing downtime

by Milan Podest

As investment costs now constitute up to 80% of nuclear-generated electricity's total costs compared to oil-fired plants, the technical and economic performance of nuclear power plants has drawn more concern. Accordingly, nuclear power plant reliability and high operating availability – in addition to standardization of licensing procedures and reduction of construction times – are being emphasized from the viewpoint of ensuring nuclear power's long-term competitiveness.

Toward this end, the IAEA recently arranged a symposium to provide an international forum for exchanging technical information on ways to minimize nuclear plant outage time and on major lessons to be drawn from past outage experience.\*

Through 1983, the world's total installed nuclear power generating capacity was 191 gigawatts, with 313 reactors in operation. These nuclear units represented about 8% of worldwide electrical generating capacity, but since nuclear plants generally are used for baseload operation, they contributed about 12% of the world's electricity generation. In seven countries, nuclear plants are producing more than 25% of the electricity and, in some of them, the nuclear share at times of low demand often exceeds 50%. Nuclear power still remains generally competitive with coal-fired plants and has much lower generating costs.

## Load factors up in several nations

Nuclear power's past operating record already is a solid basis for improved operation, maintenance, inspection, and repair schemes. All told, about 3200 reactor-years of operating experience have accumulated worldwide, which also corresponds to some 1100 reactor-years of outage. A feedback of past experiences into the design and layout of new plants and equipment also has generated improvements to plant availability. Thus, past load factors averaging between 60 to 65% have been brought up to over 80% in several countries.

According to a Swiss participant who referred to experiences with four Swiss nuclear power plants (without respect of plant origin or type), cumulative unavailabilities of only 15 to 20% were achieved by the end of 1982. This was said to stem mainly from very good plant management, operation and maintenance; highly quali-

fied, trained and motivated personnel; and special design criteria. Keeping in mind that a one-day outage of a 1000-megawatt nuclear power plant causes losses of about US\$500 000, a higher availability of just 1% a year compensates the extra costs for management, operation, and maintenance.

## Major influence: planned outages

Summarizing presentations from several countries – Canada, France, German Democratic Republic, Federal Republic of Germany, Hungary, Italy, Sweden, and the USA – it can be concluded that availability is mainly influenced by planned, rather than unplanned, outages by a factor of about 75% to 25%. Further reduction of planned outage times for refuelling, inspection, maintenance, and repair is, therefore, the most important challenge. A target of 30 days planned outage per reactor cycle, already achieved by some utilities (without considering major in-service inspections required by regulatory authorities), seemed to be about the optimum.

Improved availability has become more and more a problem of software rather than hardware development, and suppliers now offer well-developed and experienced service for inspection, maintenance, and repair. In several papers, it was shown that further improvements require intensive preparatory work, exact planning, use of mock-ups for repair work (such as steam generator mock-ups) and systematic training of personnel. Computerization of planning and control, as well as actual work performance in all activities, also are used or under development already.

Unplanned outages, most not safety-related, are more generic in nature. As indicated in a comprehensive analysis by Electricité de France on all 900-megawatt French pressurized-water reactors, about 77% of unplanned outages were of technical origin, whereas 23% were due to human errors. In this respect, several papers stressed better quality assurance and control in manufacture, construction, and operation.

## Operations training stressed

At the same time, the importance of systematic education, training, and retraining of operating personnel was discussed in many papers. It was recognized that good results in assuring a plant's high availability only can be obtained with highly qualified, skilled, and motivated plant operation personnel. Improved operator education and training (from station managers to control-room operators) is, therefore, playing an important role. Papers surveyed a variety of different training methods

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\* The meeting was officially entitled "International Symposium on Nuclear Power Plant Outage Experience" and held in Karlsruhe, Federal Republic of Germany, 18–21 June 1984.