and techniques currently used – classroom lectures, handling of equipment, use of mock-ups and simulators, and on-the-job training – and emphasized that training always should be related towards improving motivation for efficient work performance.

Somewhat different views were expressed on the role of standardization to improve availability. Standardization presently is a major effort for suppliers to further improve plant economy; it should, however, positively influence planned outage times and, therefore, availability.

Information sharing

Also reported during the symposium was the use of several information systems – most of them computerized – at the national, regional, and even international level for extensive exchange of operating experience.

Some discrepancies in definitions of data, factors, and experiences still exist. It is obvious that load factors or time availability are no longer sufficient for an exchange of experience, since nuclear power plants increasingly are used on load following mode. Energy availability is, therefore, a better indicator for comparing availability of nuclear power plants.

Better co-operation and co-ordination should solve these existing problems. IAEA's Power Reactor Information System (PRIS) could be a good basis for better definitions worldwide.

Plant safety: Improving diagnosis & response

by Vitaly Osmachkin

As everyone knows, the prevention of serious illnesses by early diagnosis of minor deficiencies in the body is one prerequisite for a long and happy life.

Similarly, early diagnosis of failure in reactor internals and in primary circuit components to avoid abnormal events at nuclear power plants provides conditions for their successful operation.

The IAEA constantly pays great attention to the enhancement of operational safety. Among the Agency's manifold efforts in this sector are meetings to discuss methods to prevent reactor incidents.

One such meeting was the International Seminar on Diagnosis of and Response to Abnormal Occurrences at Nuclear Power Plants held in Dresden, German Democratic Republic, from 12 to 15 June 1984. It was convened by the IAEA in co-operation with the Central Institute for Nuclear Research, Rossendorf, and the Staatliches Amt für Atomsicherheit und Strahlenschutz, DDR. Highly experienced experts, scientists, designers and operators met to discuss modern technology in the prevention and control of incidents, to exchange ideas, and to evaluate results of research in such areas of immediate interest.

A total of 68 participants from 19 countries presented 35 progress reports covering various topics important to operational safety. Subjects addressed included the diagnosis of abnormal events at nuclear power plants; computerized operator support systems; early diagnosis of failures in core parts and primary circuit components; on-site emergency actions and response to abnormal events; and feedback of operating experience.

On-line monitoring stressed

It was underlined that on-line monitoring and diagnosis systems have been proposed, developed, and are currently installed at some nuclear power plants. The on-line reactor monitoring system for the Borsele power plant in The Netherlands was described in detail.

Methods such as neutron noise analysis have been found appropriate for on-line monitoring of the vibrations of reactor internals, while acoustic methods have proved effective for loose parts and leakage detection.

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Computerized decision-aids for control-room operator support was one area drawing considerable interest at the international seminar on operational safety.

Progress in operator support

Trends in computerized operator support – currently undergoing rapid evolution – were discussed intensively. The accident at Three Mile Island in March 1979 spotlighted the need to develop appropriate emergency management responses and support for decision-making. Since then, considerable progress has been made.

Process computers and micro-processors are now in wide use at nuclear power plants. Computer activities such as data logging, print switching logs, calculations of burn-up and margins to burn-out, and control rod movement optimizations are well known. More sophisticated undertakings, such as operator manuals, core surveillance and control, as well as disturbance analysis and incident simulation, are being implemented. It was underlined that substantial upgrading of computer hardware will allow new and more sophisticated applications to be developed for operator support. Artificial intelligence in the form of expert systems for the storage and retrieval of extensive information content appears promising for operator support functions.

An impressive presentation at the seminar was a lecture describing a new approach, based on the concept of fuzzy sets, to fault-tree analysis and diagnosis of failure at nuclear power plants. Ideas about the uses of the concept "possibility" instead of "probability" in performing fault-tree analysis were described. An approach along these lines appears to be uniform in dealing with component failures, human factors, environmental effects and common mode failure.

Emergency preparedness

Other important topics addressed emergency actions and the feedback of operating experience.

Reporters have described emergency preparedness as an important aspect of activities to mitigate the consequences of potential accidents. Feedback of operating experience based on functioning national and international incident reporting systems, evaluation of abnormal events, and implementation of corrective actions are considered to be significant contributions to the enhancement of the operational safety of nuclear power plants.

Overall, the seminar proved to be a successful means for exchanging ideas and data and correlating experience beneficial to all participants.