5.3 Cables for high temperature radiation detectors

For many years the production and exploitation of high temperature radiation detectors has been limited by difficulties in the manufacture of mineral insulated cable. However, these have been overcome and it is now routine to produce such cable which, at 550°C, has an insulation resistance of better than 10^{-11} mho.m^{-1} and no pulse breakdown exceeding 10^{-13} coulombs at 1kV. Recent production includes more than 100 lengths of copper/copper/stainless steel triaxial cable, of which 98% have met the above performance specification. Of a recently examined batch of 27 lengths of the special colaminax cable for current fluctuation channels, 26 have an insulation resistance at 550°C of better than 5×10^{-11} mho.m^{-1} whilst six are better than 5×10^{-12} mho.m^{-1}. All will work at 1kV with no small-pulse breakdown.

5.4 Digital techniques applied to neutron flux measurement

Instrumentation employing analogue techniques is becoming increasingly costly to manufacture, set up and maintain. Studies have begun at AEE Winfrith into the potential applications of digital circuit techniques and microprocessors in neutron flux reactor control and safety channels. Although there are many avenues still to be explored, some new techniques have been identified and laboratory models of the more critical elements of pulse counting and wide-range mean current measurement channels have been built and tested. Results of measurements on laboratory models have demonstrated the ability to measure ionisation chamber mean currents over the range 10^{-12} to 10^{-2} amperes with an accuracy and consistency that are significantly better than can be achieved with purely analogue circuits. Methods have also been demonstrated for controlling the operating parameters of pulse counting channels, such as channel gain, that are necessary for microprocessor control.

VIEWS ON NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION ACTIVITIES IN SWEDEN

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About 50 per cent of the electricity generation in Sweden now comes from the twelve nuclear power plants in operation. Commercial power production begun during 1985 in the two last nuclear power plants in Sweden, Oskarshamn 3 (1050 MW BWR) and Forsmark 3 (1050 MW BWR). Permission to operate the reactors is limited to the year 2010 when nuclear power shall be phased out in Sweden.

During the last three years the increase of electric power consumption in Sweden has in average annually been close to 10 per cent. Some of the nuclear power plants have received permission to increase their power rating by 6 to 8 per cent. The application of load follow operation with the BWRs, daily and weekends, is experienced without detrimental fuel behaviour. Load follow operation has been extensive with 25 to 50 load swings of greater than 30 per cent reactor power, per year and reactor. Coast down operation is also sometimes applied.

The availability of the Swedish designed nuclear reactors show an excellent record, recently noticed in public records.

Human errors in test and maintenance in nuclear power plants.

A recent report by NKA, the Nordic Liason Committee for Atomic Energy, includes a summary of the NKA/LIT-1 project, performed during the period 1981-1985. The report summarizes work on human error influence in test and calibration activities in nuclear power plants, reviews problems regarding optimization of test intervals, organisation of test and maintenance activities and the analysis of human error contribution to the overall risk in test and maintenance tasks.

The assumption that the testing itself may increase the risk, both because the tested system will be inoperable during the test and because the test itself may introduce errors, was investigated in the project by comparison with actual experience of such tests in some nuclear power stations. It was found that in the model for calculating optimum test intervals a number of specific factors had to be taken into consideration.

Since human errors are liable to occur during maintenance activities, an analytical attempt was made to identify those parts of the process in which the risk for human error is highest. Reported errors in Nordic and American nuclear power plants were used to develop a search strategy for finding error-prone maintenance tasks. This search strategy was found to be useful both for evaluating existing procedures for test and calibration activities, and for designing new ones.

Details of this project part is found in a report:

"Assessment of a search strategy for human risk contribution in test and calibration work in nuclear power plants," by P-G Sjolin, Studsvik Technical Report NR-85/26.

References to all the LIT final reports:

LIT final reports:

LIT(85)1 The human component in the safety of complex systems.

LIT(85)2 Human errors in test and maintenance of nuclear power plants - Nordic project work.

LIT(85)3 Organization for safety.

LIT(85)4 The design process and the use of computerized tools in control room design.

LIT(85)5 Computer aided operation of complex systems.

LIT(85)6 Training in diagnostic skills for nuclear power plants.

These reports are available at the following organizations:

Technical Research Center of Finland, VTT/INF Vuorimiehentie 5 SF-02150 Espoo 15	LIT(85)1 & 4
Studsvik Energiteknik AB S-611 82 Nyköping	LIT(85)2
Statens Vattenfallsverk Fack S-162 87 Vällingby	LIT(85)3
Risø National Laboratory Postbox 49 DK-4000 Roskilde	LIT(85)5 & 6

Handling charge USD 10,- per report to be forwarded with order.

<u>Advanced information technology</u>

The Nordic collaboration within the frame of NKA sponsorship is continued in a new 4 year project, 1985-1989, aiming at the development and the integration of methods, techniques and principles, necessary to establish more efficient aids for the decision making in severe situation. The principles and techniques for tools and aids in the form of expert systems, where expert knowledge and other important information for decisionmaking is stored in easy accessible data-bases, should be made applicable for use in nuclear power plants and other industrial processes with high demands on safety.

A number of tasks are identified and projected, and grouped in two half-time phases. The first phase aims at identifying and analysing the typical situation for decisionmaking and at developing tools and methods, while at the second phase two different prototype systems are to be designed, build and evaluated.

Expanded use of on-site conceptual plant simulators.

Conceptual plant simulators, tailored to the specific nuclear plant units, developed and build by STUDSVIK, have been installed on-site and used since more than six years back. The original purpose of these where to enable training of operators on basic concepts of plant dynamics and operation. However, the experience on the use of this type of a simulator, the continuous expansion of the simulators by adding system models and increasing the degree of detailness, the implementation of advanced graphic systems and advancing the instructor capabilities have all contributed to a substantial expansion of the application of the simulators.

The continued development of the simulators allow them to represent essentially a functionally complete simulation. The advanced graphic system permits a transparency of the plant system and component functional behavior, not available in the actual control room. The exploitation of the added capabilities of this tool comprises presently applications as pictured in Figure 1. These are:

- Staff training, including other trainee categories than just operators, e.g. maintenance staff, technicians, etc.
- New control room equipment development and testing.
- Validation of new operator support systems, including the necessary training of the potential users.
- Process analysis and prediction.
- Emergency exercises

All these employments are in process, but some in wait for the finalisation of an on-going project, linking the plant and the simulator computers by a data interface system.

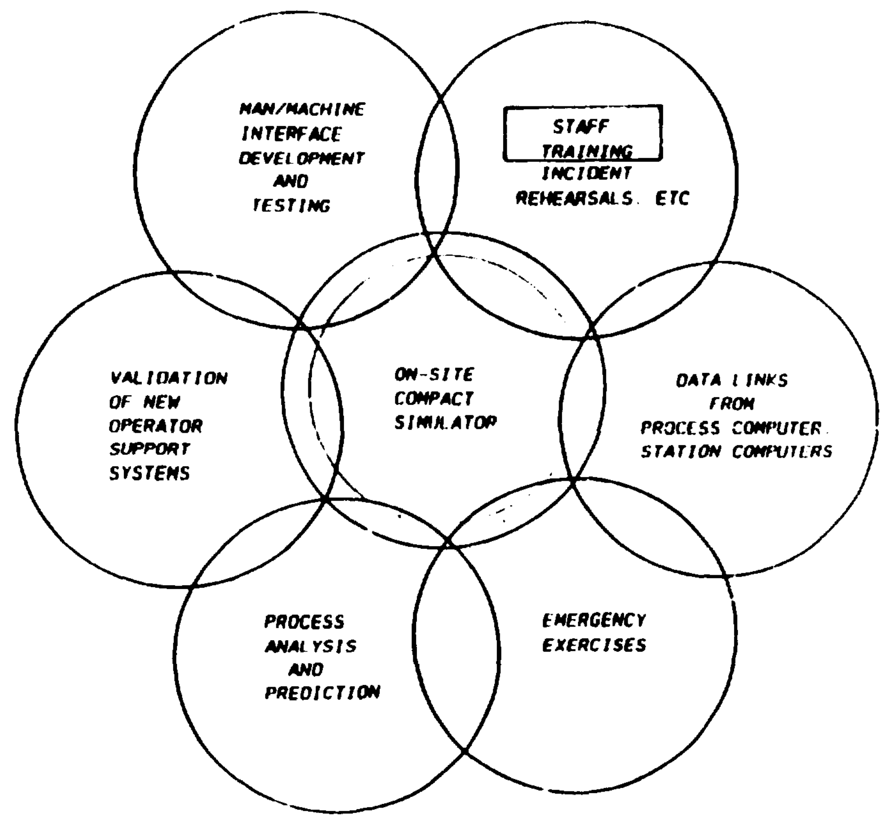

FIG 1. EMPLOYMENT OF THE ON-SITE COMPACT SIMULATOR AT A NUCLEAR POWER STATION.