The normal practices of dividing the areas into fire zones, incorporation of adequate fire barriers, segregation cables from power cables, use of covered cable trays etc. are all being constantly reviewed and implemented in our nuclear installations. The thrust from C & I point of view would be to reduce cable density by resorting to multiplexing and interconnected microcomputer systems, use of fire survival and low smoke fire resistant cables and installation of more number of different types of fire detectors. In our new plants, we will be using linear thermal detectors in cable trays in addition to infrared, flame and smoke detectors and also a comprehensive microprocessor based addressible detector system for fire alarm for quick identification of incipient fire areas.

6.0 **Policies in Implementation**

With simultaneous work going on a large number of reactor projects problems are bound to arise due to limited trained technical manpower available. The strategy being conceived is to encourage a greater industrial participation and in greater role of consultants to handle specific, defined, noncritical portion of the systems. In the critical areas of C&I systems a policy of liberalized imports from recognized international sources would be pursued as a temporary measure.

7.0 **Conclusion**

It is fortunate that we have supporting organisations both for research and development and also for fabrication for our required power programme to face the demands of the growth. The Bhabha Atomic Research Centre provides the necessary R & D efforts while the Electronics Corporation of India Ltd. has the capacity to build most of the C & I systems required for our future power programme

SUMMARY OF DEVELOPMENTS AND FUTURE PROJECTS IN NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION IN THE NETHERLANDS

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Abstract

A general view is given of the developments and trends due to instrumentation and control of the two nuclear power plants in the Netherlands around the year 1989.

Several projects, under which for classification of systems and components and for emergency operating procedures are executed in both plants. An OSART mission initiated a project to make possible the periodic test of safety commands during operation. An other large project concerned the replacement of the process presentation system in Nuclear Power Plant Borssele.

In the article several other developments due to the application of I&C in existing plants are outlined generally.

Since 1974 no new nuclear power plants have been constructed in the Netherlands.

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1. Introduction

In the Netherlands are two nuclear power plants and three reactors for research and education.
Approximately 7% of the electrical power in the country is delivered by nuclear energy. Most of the electricity is generated using natural gas and coal. Some electricity is bought from surrounding countries. With respect to the protection of the environment, shifting is expected from the utilisation of coal to natural gas.
Although the Netherlands played a relatively progressive role at the introduction of electric power generation with nuclear energy twenty years ago, there has never been an extension of the nuclear energy program because of political reasons. After the Tsjernobyl accident the decision to build new nuclear power plants was again postponed.

The NPP-Dodewaard Supplies 54 MWe nett and started operation in 1968 to gain experience with nuclear energy. It is a boiling water reactor with natural circulation over the core, designed by General Electric.

The principle is again of interest because of the latest developments in simplified boiling water reactors. Several tests, based on the principle of natural circulation are in preparation these days.
Over the years several backfitting projects have been completed. However the reactor protection system is based on well known relay technics and modifications are always carried out in that way if necessary.

The NPP-Borssele is a pressurized water reactor of 450 MWe nett. Operation started in 1973. The plant has been built by KWU and is clearly from an earlier generation than for example Biblis A in the FRG.
During the life of the plant several safety systems extensions have taken place, one of the most important being a completely independant and redundant feed water system (RS).

The reactor protection system is constructed out of hard-wired logics from Siemens. In the so-called dynamic part which is based on the magnetic core principle, process inputs are worked up to commands which are passed on to a static part of the reactor protection system in the shape of the so-called YZ-signals. Each YZ-signal activates a more or less complex safety function. The static part generates 2 up to 4 process redundancies for each YZ-signal. Process redundancies are built up by 2-out-of-3-voting systems. See fig. 1.

2. Nuclear power plant Borssele developments

2.1. Periodic test of YZ-signals

The OSAR-team recommended a few years ago to modify the static part of the reactor protection system in such a way that periodic testing is possible, also during full operation of the plant. The recommendation did not apply to the dynamic part, because the pulse logic automatically reports defects.

NPP-Borssele therefore started a project in 1987, with design and construction work by Siemens/KWU. Meanwhile this system has been in operation for more than one cycle. Experience is largely positive. Tests take place four-weekly.
The system is based on YT-test equipment, which is coupled to the YZ-system at each testcycle.
Each YZ-process redundancy is sequentially tested. It costs a few hours to pass all YZ-signals.
In the Uo-testmode the canals between the dynamic logic and the static 2-out-of-3-voting systems are tested (including the RAG-relais). In the U1-testmode the voting systems are tested. See fig. 2. The YT-test equipment generates for each voting system 7 configurations of zeros and unities and checks the reaction of the tested partial system. For those combinations, which lead to an activation of a component, the respective command module is also taken up into the testloop.

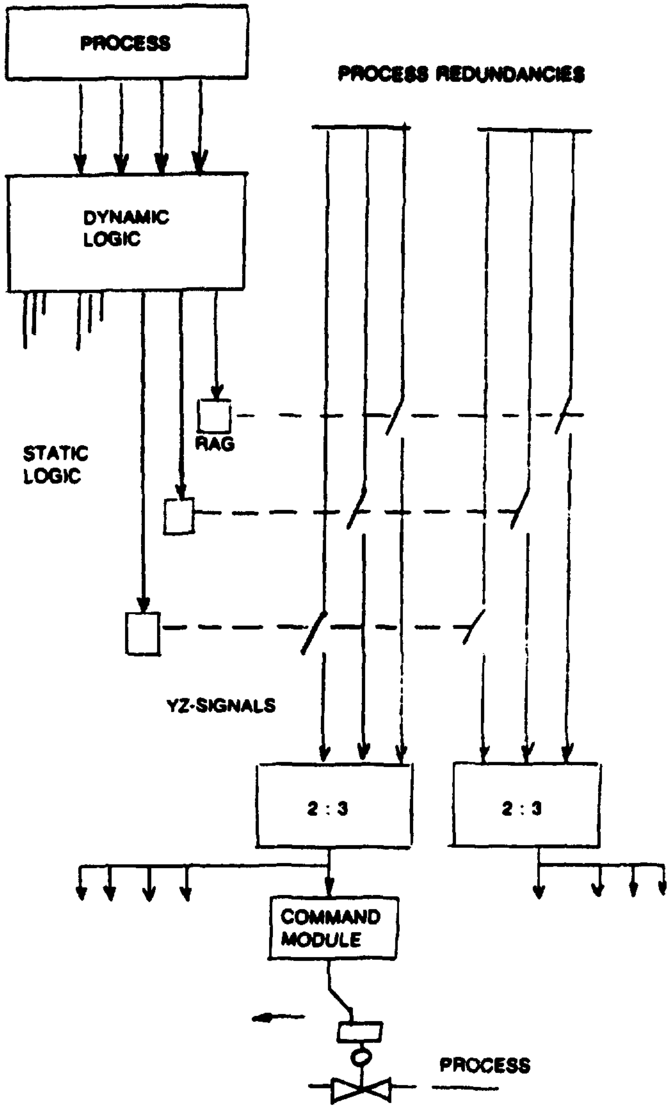

FIG. 1. Reactor protection system (Borssele NPP).

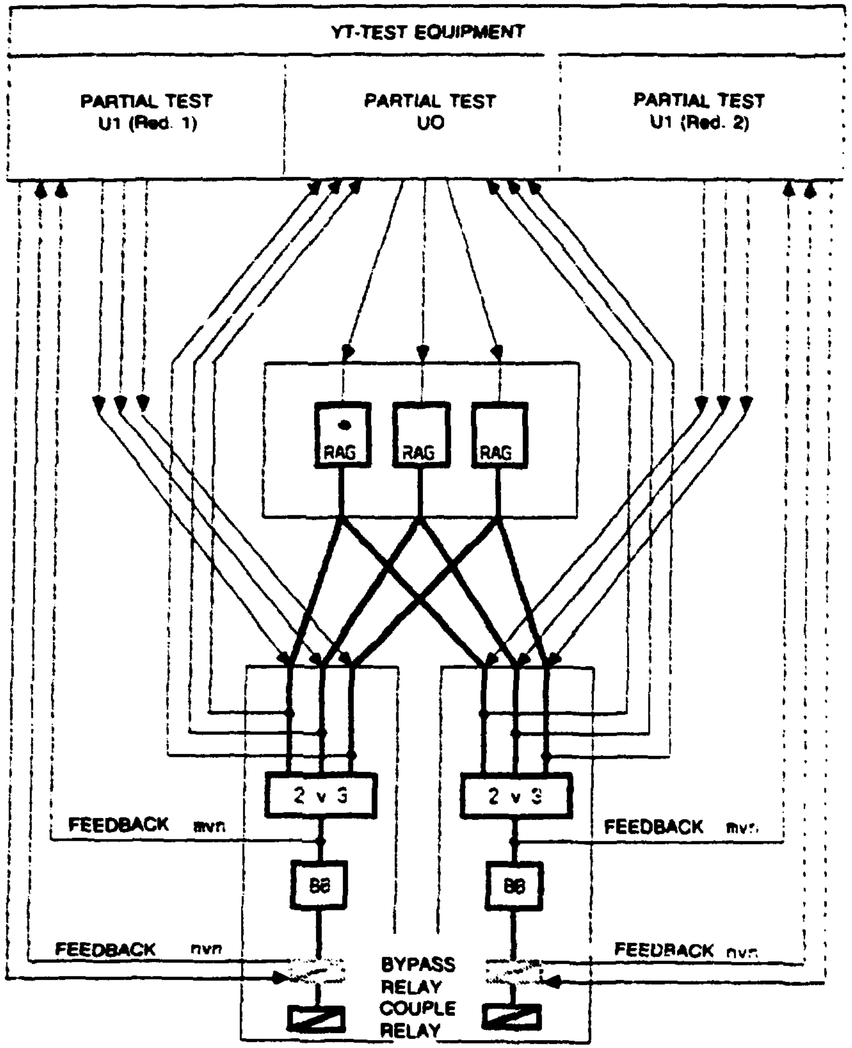

FIG. 2. Periodic testing of RPS signals (YZ-system).

Although activation of some components during operation of the plant is not forbidden, actuating is systematically prevented by newly installed by-pass contacts in the lines between the command modules and the components. This means that during the Ul-testmode the appropriate component is not available.
The test is automatically terminated when a YZ-signal is generated. The by-pass relay is put back and the component is available again.
After the YT-test a functional test follows of the components activated by YZ follows, as far this is possible during operation of the plant. After such a test certainty is obtained about the return of the by-pass contact to the normal position.

The test of several YZ-signals requires a more complex architecture. Many command modules are only to be activated when certain process- or system conditions are met. Many of these conditions are to be simulated by the YT-equipment. This forms an important checkpoint at design modifications later on and is acknowledged as a disadvantage.
NPP-Borssele is still working on making testable those safety relevant signals, which do not strictly suit in the YZ-system. (Category 3.)
Corrective actions have to be stipulated in case defects in YZ-canals are shown by the YT-test. These measures shall be included in the Technical Specifications of the plant.

2.2. Process presentation system (2 PR project)

The old processcomputer has been replaced by a new computer system, which has led to a flexible data presentation in the control room, better storage of historical data, better presentation of process conditions during emergencies and a higher reliability of the computer system. The software is to be devided in monitoring programs, calculation programs and historical data facilities.
The system contains several safety relevant program packages.
The Critical Function Monitoring System (CFMS) reflects six critical parameters known as subcriticality, core cooling,heat sink, integrity, containment and inventory, and also the topics radioactivity, defect diagnostics and bypassed systems (BISI).

Important devations from the normal situation are presented to the operator with priority. By using decision trees, which are shown on the CRT's in the control room, the way is found to the emergency operating procedures (EOP's). The program package BISI gives an indication of the bypassed and inoperable process systems.
The computer system is connected to a hard mimic panel, the IPSO, on which the most important process conditions can be presented from any point in the control room.

The operator is served by a number of CRT-mimics, which can also be generated as (hard) print copies.
All process flow diagrams are available, supported by colour symbols, The existing process conditions and the limits are also presented. It is possible to zoom in for more details.
Alarms are presented by a hierarchical structure.
All operational diagrams are included in the system. They are connected to existing operating points. Examples are: DNB margin, part load diagram, spray-heating diagrams for the pressuriser.

The whole computer system has a hierarchical structure and shows automatic fail-over features for hard- and software.
Signals from the plant are decoupled; the computer system cannot affect the process.

The system is installed by a consortium of CE and CGEE-Alsthom. The connection to the process took place in summer 1988 during full operation of the plant. The conversion went smoothly, each signal could be converted and checked seperately, sufficient decoupling was available and all wiring had already been done during the previous outage.
Several auxiliary needs, like uninterrupted power supply and airconditioning were provided in the ZPR-project. Also the control room lay out and furniture were improved.

2.3. Emergency Operating Procedures (EOP's)

EOP's are developed, based on the Westinghouse principles. The aforementioned CFMS provides information to the operator to find the suitable procedure.

2.4. Classification of I&C

NPP-Borssele has started to classify all I&C systems. A relatively simple principle is employed which shows links with the classification according IEEE. As preliminary classes are chosen 1E, 1A and 0E.
Design and maintenance requirements based on the classification are not yet available. The fact that Borssele is an existing plant has to be taken into consideration.
The dividing in categories, mentioned in IAEA-safety guide D8 is not applied, mainly because of the large number of factors which are mentioned to establish a category.

2.5. Probabilistic risk analysis of electrical provisions

During the refueling outage in 1986 an incident took place (NEA IRS report no   ) in the emergency generating system, which led to a number of other incidents, including loss of cooling for the dieselgenerators. This was an occasion for a PRA for the complete internal electrical supply of the NPP-Borssele.

The analysis is carried out by KEMA. Recommendations are among others:

- increase of the testfrequency of elements which provide the switch over of the supply from the main generator to the external grid,
- feed back of the open position of a switch between the two main emergency rails,
- automatic activation of two emergency cooling water pumps instead of one,
- improvement of the procedure to change over from the main generator to the external grid and back,
- utilisation of a spare gasturbine set.

Several modifications have already been executed.
An additional study about the common cause failures has just been finished. Although there is a certain lack of spatial separation, the influence of these failures seems not to be dramatic.

2.6. Probabilistic safety analysis

NPP-Borssele is preparing itself for a level 2 probabilistic risk analysis. The project is expected to be finished in 1991.

2.7. Accident resistant equipment and accident instrumentation

This project, started several years ago, was finished during the last outage.

2.8. Component versus system protection

According to a presently accepted point of view, safety actuations which lead to stopping of active safety equipment have to be bypassed during upset conditions. During the last outage tripping logic for injection pumps, reactor cooling pumps and emergency cooling water pumps has been modified.
Apart from that, the philosophy of KWU is a more progressive one.

2.9. Plan 2003

NPP-Borsele is already in operation for more than 15 years. The operating company PZEM is preparing an approach to meet the technical and organisational requirements for a next period of 15 years.

3. NPP-Dodewaard developments

3.1. Emergency operating procedures

Emergency operating procedures are developed based on the US BWROG Guidelines. In deviation of the system employed by NPP-Borssele, there is no explicit utilisation of a critical function monitoring system. Procedures are read off and checked from paper. In aid of the procedures it will be possible to bypass several input signals to the reactor protection system. The regulatory authority requires that this does not harm the original design safety in any way.
Verification and validation of the EOP's will take place by computer simulation.

3.2. Classification of I&C systems

NPP-Dodewaard is preparing the classification of I&C systems and components. The philosophy is identical to the NPP-Borssele philosophy described in section 2.4.

3.3. Stability monitor

Up till today the periodically calculated void percentage is used as a measure for the hydraulic stability inside the core. The license contains a limit of 70% void. Processing of data is a batchwise human action requiring a considerable time lag.
A test is planned with a newly developed stability monitor, with the purpose to replace the 70%-void criterion by a so-called RMS-ratio. This figure reflects the ratio between spectral densities of natural neutron flux signals in two frequency areas. At the assumption that the process behaves itself as a third order system with one real and two complex poles, a relation can be found between the RMS-ratio and the so-called decay ratio. (DR.) The decay ratio is a damping factor, which is to be found in the time domain and is derived from the impulse respons.
The regulatory authority has under certain conditions agreed with the test.

4. Other points of interest

Other points of interest for the Nuclear Safety Department relating to I&C are:
- position indication of safety relevant valves in the control room,
- containment isolation to comply with IAEA SG-D12,
- failure diagnosis and analysis,
- backfitting,
- design of national guidelines (also non-nuclear) for programmable safety relevant equipment.

RAPPORT SUR LE CONTROLE-COMMANDE ET L'INSTRUMENTATION DES CENTRALES NUCLEAIRES EN SUISSE

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Abstract

Five NPPs are in operation in Switzerland. There are no new plants under construction at present or planned in the near future.

In the field of I&C, efforts are essentially directed to maintaining high performance and to improving the safety of the plants in operation. Three of these plants are about 20 years old and a significant part of their I&C equipment has to be replaced. This is an ongoing process which is carried out stage by stage during the annual shutdown.

Measures to avoid or mitigate severe accidents, including core melting, have been taken or are planned.

1. Introduction

Cinq centrales électro-nucléaires sont actuellement en fonctionnement, soit:

Centrale	Puissance nette	Type	Fournisseurs	En service depuis
Beznau I	350 MW	PWR	W/BBC	1969
Beznau II	350 MW	PWR	W/BBC	1971
Mühleberg	320 MW	BWR/Mark I	GE/BBC	1972
Gösgen	930 MW	PWR	KWU	1979
Leibstadt	990 MW	BWR/Mark III	GE/BBC	1984