

W.K. BROWN

RISØ

The Danish Atomic Energy Commission
Research Establishment Risø



THE DANISH ATOMIC ENERGY COMMISSION

The DR 2 reactor core with its Cerenkov radiation seen from the top of the reactor. Some of the horizontal beam tubes are seen just outside the core.

After the Second World War it was realized that nuclear energy would have a decisive influence in future on a number of branches of science and technology. Therefore it was desirable that Denmark should join as early as possible in the work on the peaceful uses of atomic energy. After careful preparations with the aim, among others, of ensuring that the enriched uranium required for the research reactors would be available, the DANISH ATOMIC ENERGY COMMISSION was established by Statute in December 1955. The purpose of the Commission is to **promote the peaceful utilization of nuclear energy for the benefit of the community**, and with a view to the diversity of tasks to be discharged the Commission was so composed that a direct influence on the organization of the work was secured for science as well as for the most important relevant interests of industry and the public.

THE RESEARCH ESTABLISHMENT RISØ

From the outset, the activities of the Commission were established as part of the international effort concerning the peaceful uses of nuclear energy through agreements entered into in June 1955 with the United Kingdom and the United States. In the building of the necessary facilities it was thus possible to obtain assistance from the two most advanced countries in this field. On the eastern side of Roskilde Fjord, only 25 miles from Copenhagen and its institutions of science and technology, the peninsula of **Risø** with an adjoining area to the east was acquired. Building operations were commenced in July 1956, and in June 1958 the establishment was inaugurated. The research facilities include three reactors, which are employed for teaching and training purposes, for the production of radioactive isotopes, physics experiments, and materials tests connected with Risø's own development work as well as with investigations carried out in co-operation with other countries. A hot-cell facility has been built for post-irradiation examination of materials. In addition to departments of physics, chemistry, metallurgy, electronics, reactor studies, and health physics, Risø has a department of agricultural research.



Professor Niels Bohr, Chairman of the Commission until his death on November 18th, 1962. Drawing by Homi Bhabha, Head of the Indian Department of Atomic Energy.

Outside view of the airtight steel containment surrounding the DR 2 reactor. The reactor is a light-water cooled and moderated tank type with a 5,000 kw thermal power, operated with a highly enriched uranium core.



Aerial view of Risø from the east. In the left foreground is seen the accelerator department of the Institute for Theoretical Physics, University of Copenhagen; to the right, staff dwellings. In the centre, the laboratory group, and in the background, on the peninsula, the two largest research reactors, DR 2 and DR 3, the metallurgy hall and laboratory, and the hot-cells.

The reactor DR 1 viewed from above. At its top is seen a facility for exponential experiments using DR 1 as a neutron source. DR 1 is a homogeneous research reactor with a thermal power of 2 kw.

THE ACTIVITIES OF RISØ

The use of nuclear energy for peaceful purposes confronts a country with many problems which can only be solved by specialized engineers and scientists who have at their disposal the necessary equipment for experiments, measurements, etc.

The said problems are related to the use of nuclear energy as a source of power for the generation of electricity, the utilization of radiation effects in industrial processes, for treatment of manufactured articles (e.g. sterilization of plastic equipment for hospitals) and for preservation of food products, the use of radioactive isotopes for industrial and scientific purposes, etc. To this must be added fundamental research in fields such as physics and chemistry, including the characteristics and effects of ionizing radiation, to the extent that such research is of importance for the use of nuclear energy.

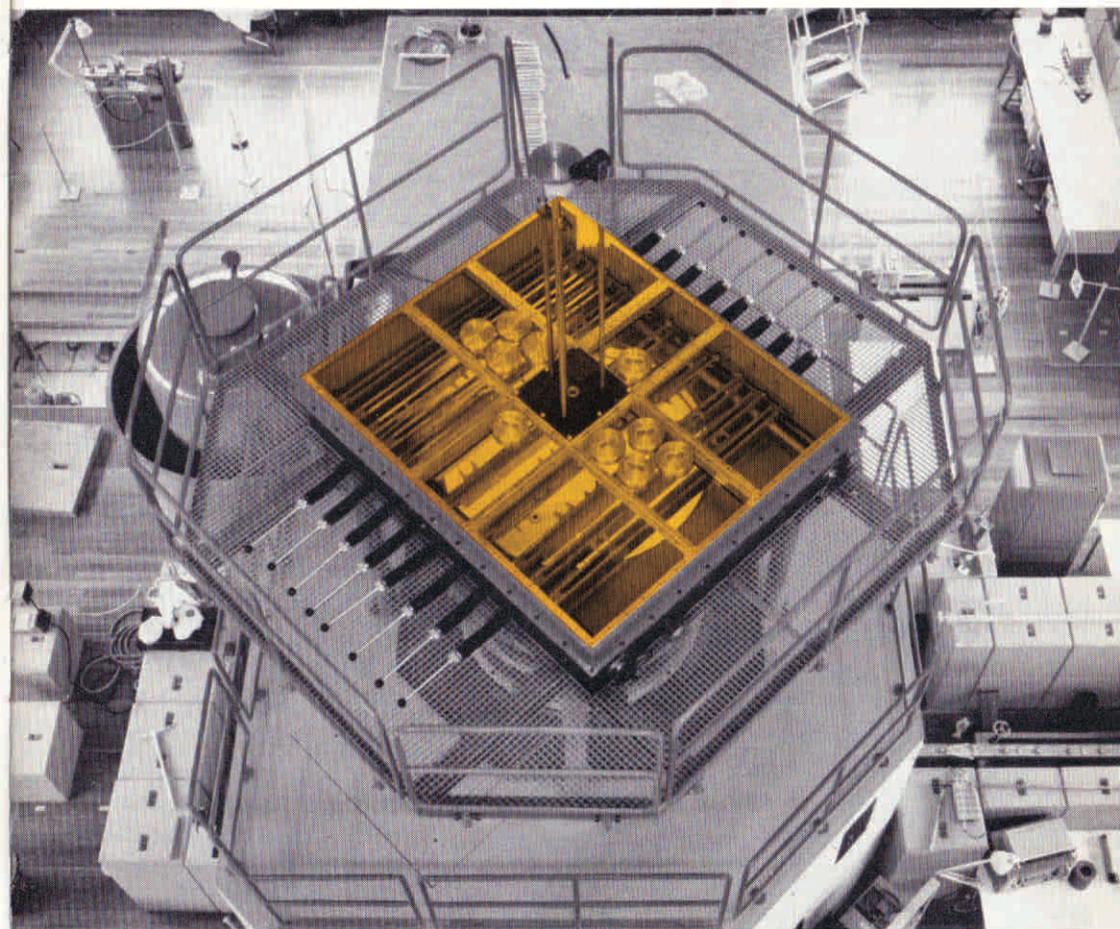
In a small country like Denmark, whose total contribution is bound to be modest as compared with that of larger countries, it has been considered most expedient from a technical and economic point of



view to concentrate the greater part of the work within the framework of a single institution, in which the different departments and groups, each with its special duties, may inspire and stimulate each other and, through collaboration with similar institutions abroad, may utilize to the highest degree the results obtained in other countries.

The research work proper covers on the one hand fundamental physical and chemical studies in the nuclear field and on the other investigations of a more technological character directly connected with the practical application of nuclear energy. To this must be added the work done in the Agricultural Research Department.

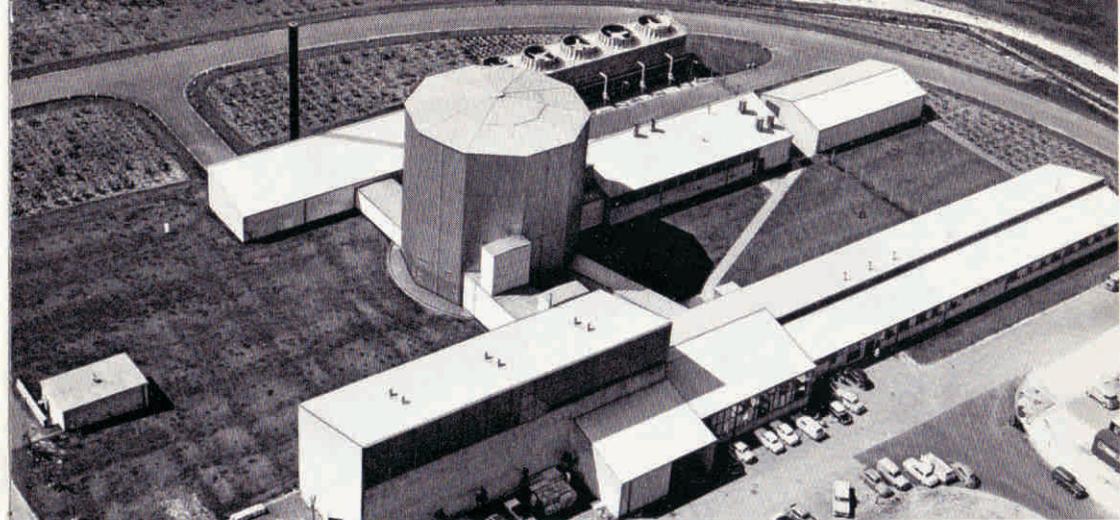
The fundamental research at Risø comprises in particular plasma physics, nuclear data, solid-state physics, radio-chemistry, nuclear chemistry, radiation chemistry, and experiments performed at the meteorological station. Thus Risø contributes to the development of atomic science and creates the basis on which Denmark may utilize the possibilities opened up by the world-wide research in this field.



The control room of DR 2, from which the reactor is operated. The room is situated outside the containment, but an internal television system gives the operator a view of the entire reactor hall and the core.

General view of the DR 2 reactor hall, showing the top of the tank shielding, where the control-rod actuators are situated. An experimental set-up with its concrete shielding is seen in the lower left part of the picture.

Aerial view of the reactor DR 3 and adjacent buildings. DR 3 is a heavy-water research reactor similar to the PLUTO reactor at Harwell and has a thermal power of 10,000 kilowatt.



Among the research projects with a more direct bearing on the practical applicability of nuclear energy, the following may be mentioned in particular: irradiation experiments with materials that may be of importance in the construction of nuclear plants, production of fuel elements for reactors, investigation of uranium- and thorium-bearing Greenland ores, and production of radioactive isotopes and labelled compounds.

As regards the development of power reactors, Risø conducts a study programme of its own concerning a heavy-water reactor and moreover takes part in the European study projects relating to the high-temperature reactor Dragon in England and the boiling heavy-water reactor at Halden, Norway. Through the joint European enterprise Eurochemic, in which Denmark participates, insight is gained into the technological aspects of the reprocessing of spent fuel elements.

A number of experiments are performed in co-operation with similar establishments in other countries such as England, France and Sweden.

In its research activities, Risø also collaborates with Danish industrial concerns and institutes of higher education. These contacts are in themselves of educational value, and in addition studies in preparation for masters' theses as well as post-graduate studies are carried out at Risø, and training courses are given at DR 1 for certain categories of students from Copenhagen and Århus.

THE DEPARTMENTS OF RISØ

Fundamental research in the nuclear field chiefly comes within the provinces of the **Physics Department** and the **Chemistry Department**. To the latter belong the **isotope laboratory** and the **processing plant for radioactive waste**, etc. The **Reactor Department** comprises a reactor study group and a group that designs irradiation experiments for DR 2 and DR 3. The **Reactor Physics Section** performs calculations and experiments concerning reactor-core design, employing for this purpose the GIER computer of Risø and the small reactor DR 1, which serves as a neutron source for exponential experiments. With

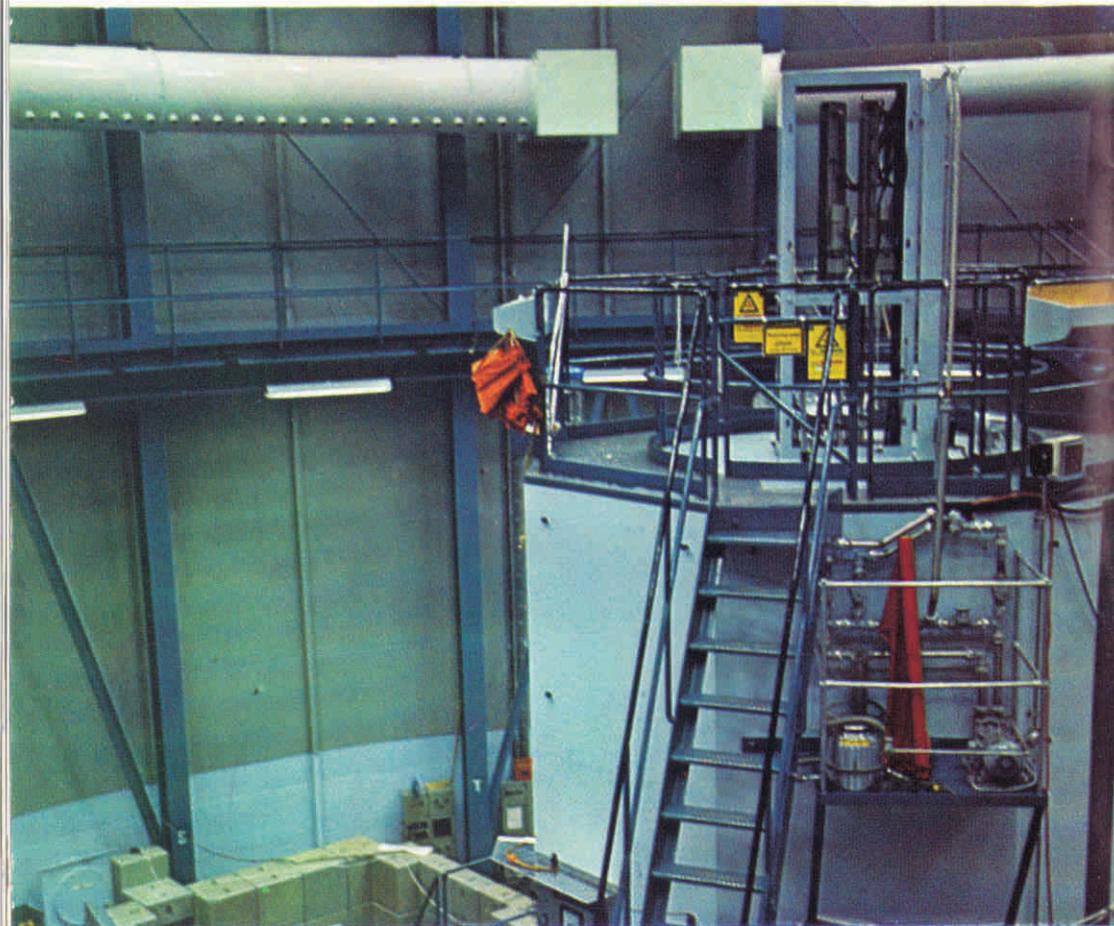
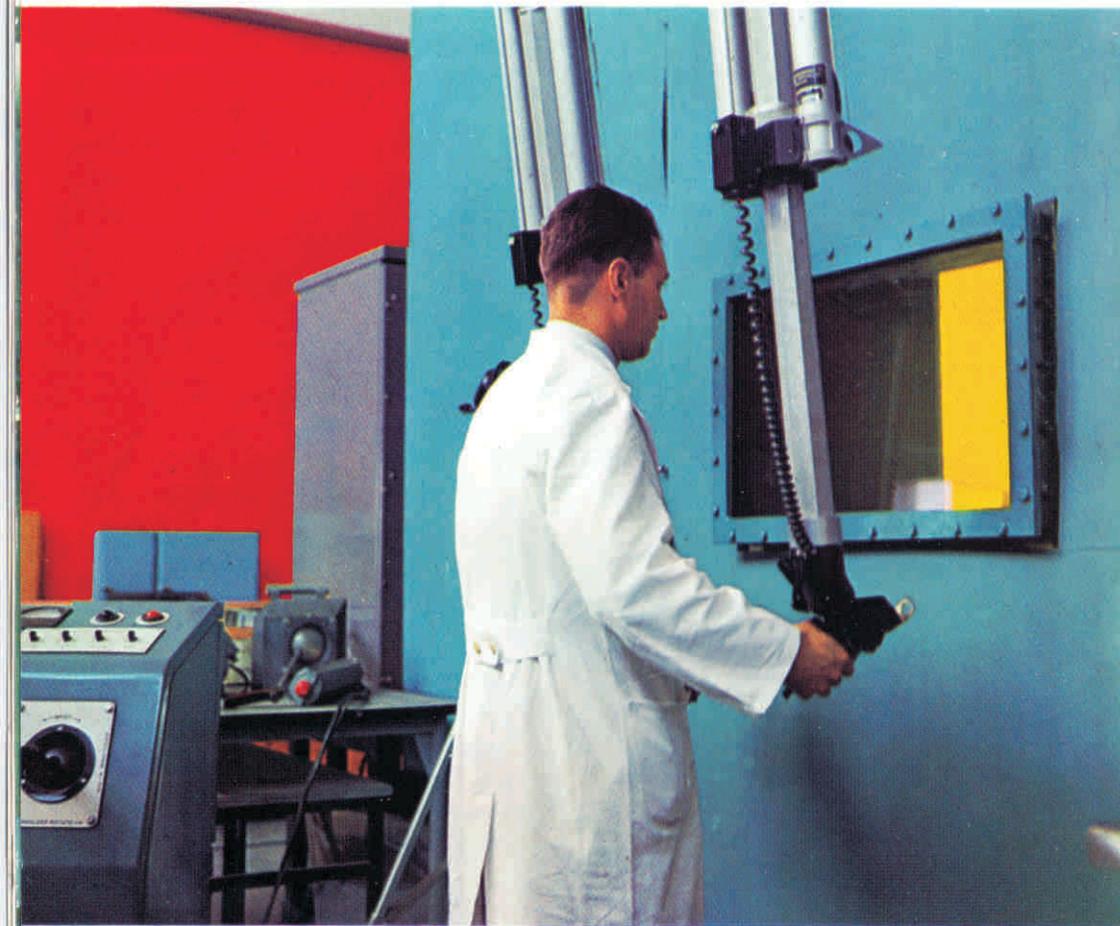
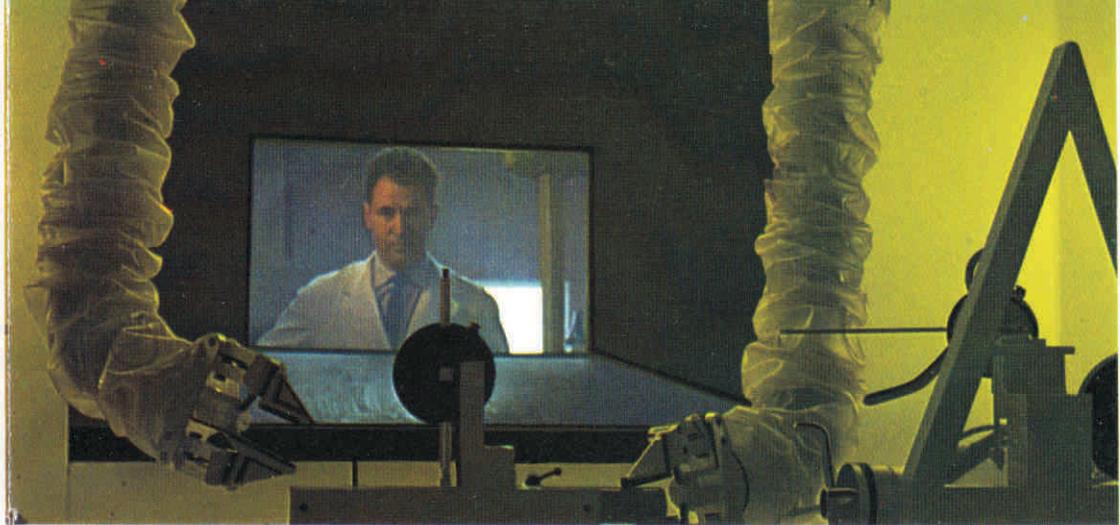


Illustration of the working principle of the hot-cell facility. The operator standing by a full-size model cell operates the master-end of the master-slave manipulators. The picture to the right shows the slave-end of the manipulators inside the cell. The operator is seen through an imitation of the four feet thick lead-glass windows used in the hot-cells.



the computer, the section also makes calculations for other divisions of the establishment. The **Metallurgy Section** is responsible for the work on reactor fuel elements and besides carries out a number of tasks directly for Danish industrial concerns. The **Electronics Department** constructs and maintains instrument systems for the various experimental set-ups and does research and development work in this field; an analogue computer has been made by the department for the use of Risø and industry. The **Construction Department** designs and constructs apparatus and experimental set-ups and performs technological experiments. To this department belong the **drawing office** and the **workshop**.

The **Health Physics Department** is in charge of safety measures against radiation in the entire establishment and sees that no staff member is exposed to danger in his work. In co-operation with the National Health Service investigations are made with a view to protecting the population against the radiation risk in general; in this connection the department develops

special equipment for the measurement and registration of radiation.

The **main research facilities** are the reactors DR 1, DR 2 and DR 3, which are employed for irradiation experiments, isotope production and physics experiments, a 10 MeV linear electron accelerator, used for radiation-damage experiments and irradiation of hospital equipment such as disposable hypodermic syringes, oxygenators, catgut, etc., and a gas-tight, 1 megacurie hot-cell facility for the handling of α -, β - and γ -active materials. This plant, which was completed in 1964, consists of six concrete-shielded examination cells and a number of lead cells. On a site adjoining the Risø area the **Institute for Theoretical Physics of the University of Copenhagen**, which collaborates with the establishment, has built a tandem Van de Graaff accelerator of 10 MeV.

The **Library** of the Atomic Energy Commission is part of the public technical and scientific library system in Denmark and renders its services to borrowers inside as well as outside Risø.

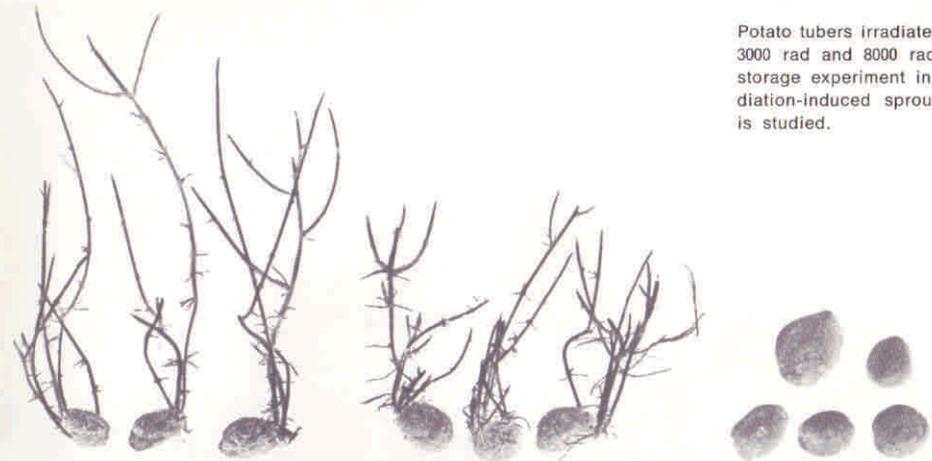


From left to right: lecture theatre, canteen, library, health physics department, and administration department.

The Agricultural Research Department

is affiliated to the Royal Veterinary and Agricultural College with respect to its work, much of which is done in co-operation with plant-breeding stations and state experimental institutions for agriculture, horticulture and forestry. The research deals with plant-breeding techniques and methods, including the utilization in plant breeding of mutations (genetic changes) induced by chemicals or radiation. Experi-

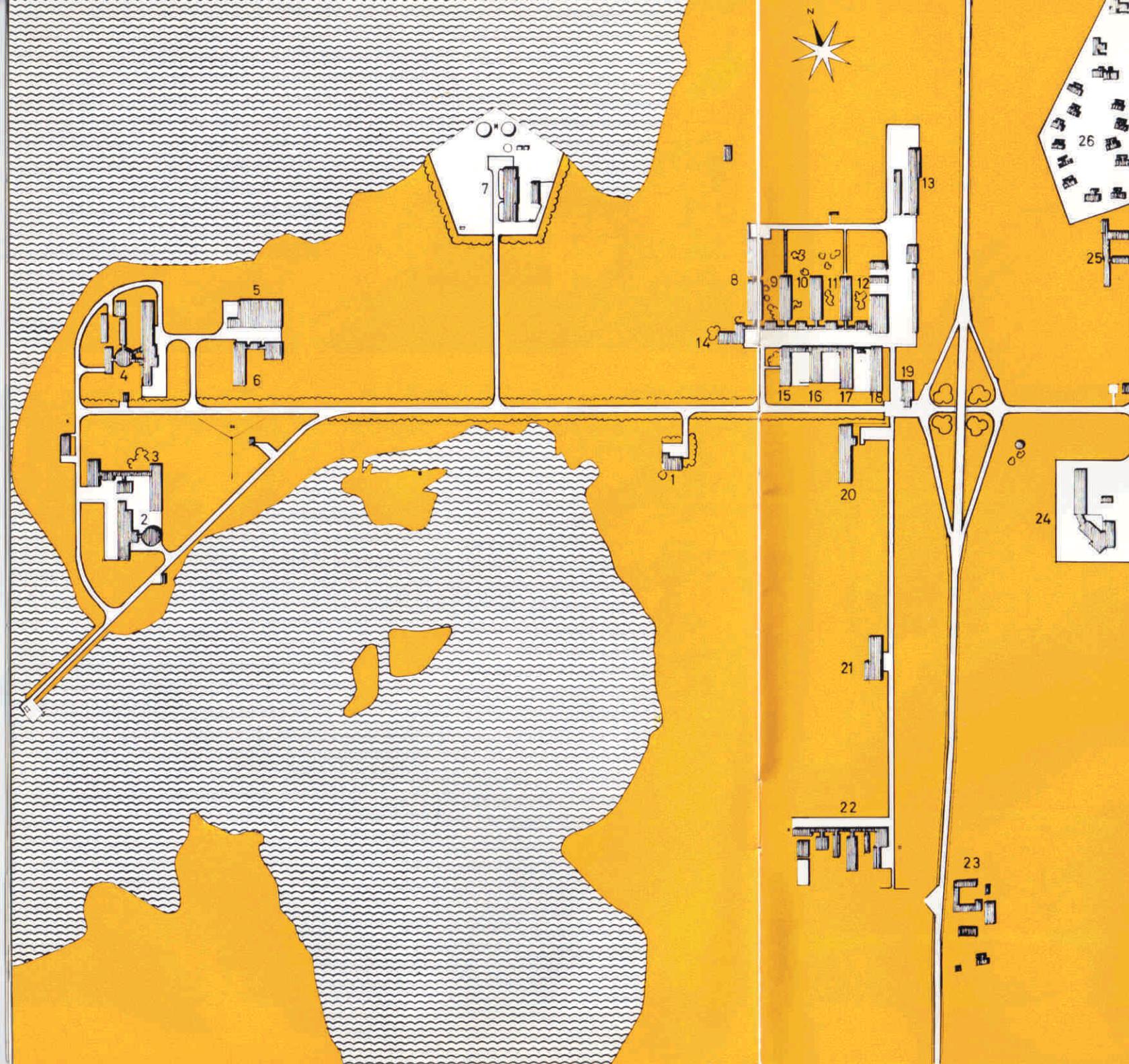
ments relating to soil chemistry and plant nutrition are performed; these investigations, often carried out with the help of radioactive isotopes, concern among other things the uptake by plants of the radioactive strontium and caesium isotopes occurring in fall-out. Moreover, the use of γ -radiation as a means of prolonging the storage life of potatoes and carrots is investigated.



Potato tubers irradiated with 0 rad, 3000 rad and 8000 rad; from a storage experiment in which radiation-induced sprout inhibition is studied.



Pot experiments with barley and oats in which the nutrient uptake by the plants is investigated by means of radioactive isotopes.



- KEY**
1. Research reactor DR 1
 2. Research reactor DR 2
 3. Isotope laboratory
 4. Research reactor DR 3
 5. Hot-cells
 6. Metallurgy laboratory
 7. Processing plant for radioactive waste
 8. Chemical laboratory
 9. Reactor-engineering laboratory
 10. Electronics laboratory
 11. Physics laboratory
 12. Workshops
 13. Service and maintenance divisions
 14. Lecture theatre
 15. Canteen
 16. Library
 17. Health physics laboratory
 18. Construction department and drawing offices
 19. Gate-house and fire-station
 20. Office building
 21. Linear accelerator
 22. Agricultural research department
 23. "Svaleholm" farmhouse
 24. Risø division, Institute for Theoretical Physics, University of Copenhagen
 25. Guest-house
 26. Staff dwellings

As a health precaution, meals are banned in the laboratories and are taken in the canteen of the establishment. The staff always includes a number of foreign research workers, and through the International Atomic Energy Agency (IAEA) Risø receives fellows, mainly from the develop-

ing countries, who stay for short or long periods to join in the work. For the accommodation of visitors from abroad, a guest-house has been built near the houses of those staff members who have to live at Risø to ensure the operation and safety of the establishment.

The lounge in the canteen building.



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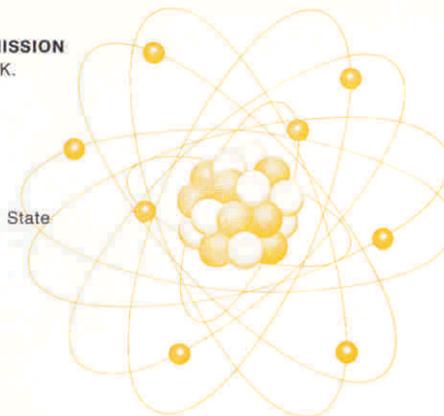
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Chairman:
H. H. Koch, Permanent Under-Secretary of State

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RISØ GUIDE

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Niels Bundgård

Agricultural Research Department
Jens Sandfær, M.Sc. (agric.)

Canteen and guest-house
E. Thingstrup

Chemistry Department
C. F. Jacobsen, Ph.D.

Construction Department
J. Marstrand, D.Eng.

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DR 2
B. Møller Jensen, M.Sc. (eng.)

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Jens Rasmussen, M.Sc. (eng.)

Health Physics Department
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Medical adviser
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Patent specialist
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Professor O. Kofoed-Hansen, Ph.D.

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Ib Larsen, M.Sc. (eng.)

Reactor Department
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Reactor Physics Section
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Safety section
D. Germann, Engineer

Service Department
K. K. Pedersen, M.Sc. (eng.)

Workshop
Poul Pedersen, M.Sc. (eng.)



The supervision of the Risø buildings is entrusted to Mr. Preben Hansen, architect, M.A.A., who was in charge of the building operations together with Steensen & Varming and Mogens Balslev, consulting engineers, Professor C. Th. Sørensen and Ole Nørgård, architect, M.A.A.

Granite sculpture by Poul Vandborg, presented by the State Art Foundation.

