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PROGRESS IN PEACEFUL APPLICATIONS OF NUCLEAR ENERGY DURING THE YEAR 1967/1968

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CANADA

Progress in the peaceful applications of nuclear energy during 1967-68

1. There has been considerable progress and expansion in the Canadian nuclear and uranium mining industries during the past year. In the nuclear power programme, the most important development was the announcement by the Hydro Electric Power commission of Ontario (Ontario Hydro) that it expects to make a major new commitment in Canadian heavy water reactors before the year's end. This new development would involve some 3000 MW(e) of nuclear capacity and would envisage the use of generating units of 750 MW(e) each. Not only would this represent an important increase over the size of the four 540-MW(e) units chosen for their Pickering nuclear power station, but also a re-affirmation of this major utility's confidence in the natural uranium fuelled, heavy water moderated reactor system developed by Atomic Energy of Canada, Limited, (AECL) and known as the CANDU system. With Pickering, Ontario Hydro would have 5000 MW(e) of nuclear capacity within its system and would become one of the world's largest producers of electricity from nuclear energy.

2. Confidence in the CANDU system has sprung from the operation of both Douglas Point nuclear power station and the Nuclear Power Demonstration plant (NPD), both of which are being operated at full power. It will re recalled that Douglas Point began producing electricity in January 1967, and reached half-load operation shortly thereafter. Its operation was subsequently interrupted, primarily due to the need to replace a calandria tube which had been damaged by an adjacent control rod and to repair damage sustained in varying degrees by all of the ten primary coolant pumps. The station went back into service in December 1967, and was operated at 85% availability during the peak-demand winter season. The station was brought to full power operation early in March, and with the exception of short outages as part of the commissioning programme, has continued to operate at this level.

3. As Douglas Point has assumed the power demonstration role formerly occupied by NPD, the latter reactor will now be used in a more experimental capacity. To this end it was converted during recent months to operate with the heavy water coolant at boiling temperature, a mode of operation that is of particular interest in the Canadian nuclear power reactor development programme. Although the annual capacity factor is no longer a figure of merit, having regard to the experimental role now to be played by NPD, it is interesting to note that in the peak-load months during the past three winter seasons the station operated at capacity factors of 96.5, 97.9 and 99.96% respectively.

4. Ontario Hydro is making steady progress with the construction of the four 540-MW(e) units located at the Pickering nuclear power station. The four units will go into service during the period 1971/73 and will produce electricity at a lower unit energy cost than that produced by fossil fuel plants of comparable size in the Ontario Hydro system. It is noteworthy that fixed price tenders have been bid by Canadian industry for the fuel for the Pickering station which assure a maximum fuelling cost of 0.7 mills/kWh(e), which cost does not include any credit whatsoever for plutonium or spent fuel.

5. The construction of the 250-MW(e) Gentilly nuclear power station in the Province of Quebec, started in the fall of 1966, is progressing satisfactorily, and the original target date for having this station at full power by 1971 remains unchanged in spite of a lengthy construction strike. The reactor chosen for this station, CANDU BLW-250, is expected to demonstrate the practicability of using boiling light water as a coolant, the attainament of lower capital costs for heavy water reactors and a more efficient use of natural uranium. It is noteworthy that the walls of the reactor building - a structure 175 ft high and 120 ft in diameter, with walls 4 ft thick - were constructed in a period of only 18 calendar days through the use of the "slip-form" technique.

6. Construction of two 200-MW(e) CANDU stations at the Rajasthan Atomic Power Project in India is proceeding as scheduled, as is the construction of the 137-MW(e) heavy water moderated, natural uranium fuelled, nuclear power plant at Karachi.

7. The demand for heavy water, both present and foreseen, is such that the expected production from the two heavy water production plants currently under construction in Canada will be inadequate. The construction of a third Canadian plant is currently being considered and it is expected that plans for its contruction will be finalized by the year's end.

8. In July 1968 a contract was signed for the merger of the nuclear power plant engineering group of Canadian General Eelctric Company (CGE) with that of AECL. The objective of the merger, proposed by CGE, is to make the most effective and efficient use of Canadian nuclear design capability, both in meeting the demands of the domestic nuclear power programme and in competing for foreign orders. AECL has taken over the responsibility for the direction and support of the CGE systems group, which is now known as AECL Power Projects, Peterborough Division. The agreement is for a five-year period with appropriate termination arrangements.

9. The Commercial Products Group of AECL, responsible for the processing and marketing of radioisotopes and for the designing and marketing of associated equipment, has now installed more than 600 cancer teletherapy units in clinics and hospitals in 48 countries. Radioisotopes totalling more than 1.5 million curies were shipped during 1967-68, so that the cumulative total of isotope shipments by the Group now exceeds 8 million curies. A highlight of the year was the installation, in the Federal Republic of Germany, of Europe's largest medical products sterilization plant. It is loaded with 90 000 curies of cobalt-60 but has an ultimate capacity of 1.5 million curies. Another important development was the initiation of design work on a large-scale cobalt-60 sterilization unit for hospital use. The facility is to be built in the University Hospital at the University of Western Ontario. It will be used to study the effects of radiation sterilization of bulky articles such as hospital beds and medical machines, as well as surgical instruments, bedding and clothing.

10. Canada is also an important country as a source of nuclear fuel, and both the Government and the uranium industry are interested in promoting the export of uranium, subject to the conclusion of suitable agreements, providing for appropriate verification and control, to ensure that the uranium will be used for peaceful purposes only.

11. Production from the four operating uranium mines during 1967 was maintained at the 1966 level of approximately 4000 tons of U_3O_8. Meanwhile, mine development increased significantly in anticipation of additional demand over the next few years. Contracts providing for exports in excess of 17 000 tons of U_3O_8 were negotiated during the past year by the three major producers.

12. Exploration for Canadian uranium, essentially dormant since 1957, has increased significantly during the past year. The main centres of activity are focused around the three uranium producing areas of Elliot Lake, the Bancroft districts in Ontario and the Beaverlodge district in Saskatchewan. Although it is much too early in the programme to expect conrete results, reports to date have not indicated any new discoveries of significance. It is clearly evident, however, that foreign countries place considerable faith in the potential for discovering additional deposits of Canadian uranium, as indicated by their increasing participation in and financing of exploration throughout the country. Canada welcomes this participation in the development of its uranium mining industry as a means of furthering international co-operation in the development of nuclear energy.

13. Developments have also been taking place in basic nuclear research in Canada. Ever since the early years of the century, when Rutherford's work in Montreal brought the first glimpse of understanding of nuclear rays, Canadian scientists have pursued the quest for knowledge in fundamental nuclear science. Particle accelerators are the most effective tool in research into the basic properties of the atomic nucleus, and the number of these devices has increased in Canada as its basic research programme has expanded. There are now 45 particle accelerators scattered across Canada in 23 different government, university and private research laboratories. Beam energies of 10 to 100 million electron volts can be achieved in 13 of these machines and energies in excess of 100 million electron volts in two machines.

14. Funds have recently been allocated to begin construction of the Can.$19 million tri-university meson facility to be known as TRIUMF, an H-minus cyclotron of unique capabilities which, in addition to its applications in nuclear physics, will provide Canadian scientists with an entry to the major field of intermediate energy physics. The beam characteristics, a maximum energy of 500 million electron volts and a maximum current of 100 micro-amperes will allow the production of large quantities of mesons for use as nuclear probes, and the study of the interaction of mesons with other elementary particles.

JAMAICA

Summary of activities in the peaceful uses of atomic energy

1. Functional studies of various organs in rats using ^{131}I.
2. Studies on insulin secretion from isolated rabbit pancreas.
3. Study of the insulin secretion capacity in malnourished infants.
4. Attempt to set up a radio-immunoassay for glucagon.
5. Attempt to prepare purified insulin-secreting tissue from mammalian pancreas.
6. Assay of hexokinase enzyme in normal and diabetic human red blood cells using radioglucose.
7. Studies of biosynthesis of natural products using radioisotopes.
8. Study of fatty liver formation using ^{14}C-acetate.
9. Study of muscle catabolism using ^{14}C-carbonate and ^{14}C-arginine
10. Study of turnover of amino-acids and protein synthesis using ^{14}C-lysine.
11. Study of protein metabolism in humans using ^{75}Se-methionine.
12. Study of iron absorption using ^{59}Fe. Study of albumin metabolism using ^{125}I and ^{131}I.
13. Study of mineral nutrition in plants.
14. Therapy studies (Kingston Public Hospital) using ^{60}Co source.

JAPAN

Progress in the peaceful application of atomic energy during the 1967-68 period

GENERAL

1. The long-range programme for the development and utilization of atomic energy was published by the Atomic Energy Commission in April 1967. The 1967-68 period was the first fiscal year[1/] in the implementation of the programme. With a budget of $58 million, which is 38% higher than in the preceding year, the Government has stepped forward to a new stage. More than three thousand people are now working in governmental or quasi-governmental organizations concerned with nuclear energy.

NUCLEAR POWER

2. At present one commercial nuclear power plant is in operation and five are under construction. The status of these plants is indicated below:

Name		Type	Location	Power (MW(e))	Date of entry into operation
Japan Atomic Power Co.:					
The Tokai Power Station		Calder Hall	Tokai	166	July 1966
The Tsuruga Power Station		Boiling water reactor (BWR)	Tsuruga	322	December 1969
Tokyo Electric Power Co., Fukushima Nuclear Power Station,	No.1	BWR	Fukushima	400	December 1970
	No.2	BWR	Fukushima	784	May 1973
The Kansai Electric Power Co., Mihama Power Station,	No.1	Pressurized water reactor (PWR)	Mihama	340	December 1970
	No.2	PWR	Mihama	500	June 1972

1/ The fiscal year in Japan starts on 1 April.

3. According to the long-range programme it is foreseen that 6000 MW(e) of nuclear power plants will be built by 1975 and 30 000 to 40 000 MW(e) by 1985. Private electric utilities are active in nuclear power programmes, and steady progress has been made towards the target envisaged in the long-range programme.

4. Side by side with the nuclear power programmes of private electric utilities, the Government intends to play an active role in developing the fast breeder reactor on the one hand, and the heavy water reactor on the other, by designating their development as "national projects". In October 1967 the Power Reactor and Nuclear Fuel Development Corporation (PNC) was set up, incorporating the former Atomic Fuel Corporation as its nuclear fuel division. PNC has been entrusted with the design and construction of prototypes of a fast breeder reactor and an advanced thermal reactor, in addition to the functions taken over from the Atomic Fuel Corporation.

5. According to the power reactor development programme decided on by the Government in March 1968:

(a) Research and development on the fast breeder reactor, with mixed oxide fuel, will be carried out anticipating that an experimental reactor of 100 MW(e) will become critical in 1972, and subsequently a prototype reactor of 200-300 MW(e) by 1976; and

(b) Development of the heavy-water moderated, boiling-water cooled reactor is expected to lead to the building of a prototype reactor of 200 MW(e) by 1974. The fuel to be used for the reactor will be slightly enriched uranium or plutonium-enriched uranium at the initial stage, and natural uranium at a later stage.

6. Progress has been made with respect to the development of both types of power reactors:

(a) In August 1967 the Japan Atomic Energy Research Institute (JAERI) had made the first conceptual design of the fast breeder reactor and PNC, taking over the work done by JAERI in this specific field, completed the second conceptual design in May 1968. Research on reactor physics has been done be making use of a fast critical assembly built at JAERI in April 1968. Also, research and development on sodium technology, major equipment and components, mixed oxide fuel, safety, etc. in relation to the fast breeder reactor have been carried out jointly by PNC and JAERI; and

(b) As to the advanced thermal reactor PNC, through contracts with private industry, is making the detailed design of the prototype reactor which is to be based on the conceptual design already made by JAERI. In addition, the existing thermal loop has been improved in order to facilitate experiments on heat transfer, and work on making test fuel elements has made progress. In order to make the design more precise, PNC concluded a contract with the United Kingdom Atomic Energy Authority in February 1968 to obtain information on the enriched uranium steam-generating heavy water reactor.

7. Besides the development of these kinds of reactors, research and development on light water type reactors have also been carried out in order to accelerate manufacturing of these reactors by our own industry, and also to contribute to the improvement of this type of reactor. The materials testing reactor of 50 MW(th) which was completed in February 1968 at the Oarai Establishment of JAERI, will be used mainly for test irradiation of nuclear fuel and material for light water reactors.

NUCLEAR FUEL

8. The total amount of uranium required for nuclear power plants by 1985 will reach approximately 90 000 tons in terms of U_3O_8. In spite of the extensive exploration made by the Geological Survey of Japan and PNC, the total uranium ore reserve in Japan was estimated at about 10 million tons (only 5 300 tons in terms of U_3O_8) as of 1 April 1968. It is, therefore, of supreme importance for our nuclear fuel policy to secure a stable supply of uranium from abroad on the one hand, and on the other to make the maximum use of uranium by establishing the appropriate nuclear fuel cycle within this country.

9. In December 1967 and January 1968 electric power companies concluded long-term contracts to purchase 15 500 short tons of uranium, in terms of U_3O_8, from Canadian mines.

10. As to the reprocessing of irradiated fuel, PNC is planning to build a reprocessing plant with a capacity of 700 kg per day, and is reviewing the second detailed design. The plant is expected to start operation by 1971. In order to refine our technology in this field JAERI has established the Fuel Reprocessing Development Laboratory which, in May 1968, succeeded in extracting 18 grams of high-grade plutonium-239 from the fuel irradiated in the JRR-3 (natural uranium - heavy water reactor of 10 MW(th)).

11. Taking into consideration the prospect that accumulated plutonium from our nuclear power plants will amount to around 15 tons by 1980, and about 42 tons by 1985, development of the effective use of plutonium is also a major part of our nuclear fuel policy. In addition to the research facility at JAERI to develop plutonium fuel, PNC completed the Plutonium Fuel Development Laboratory in 1965 and is doing research and development on mixed oxide fuel. JAERI, in co-operation with private industry, is also undertaking research on plutonium carbide and plutonium nitride fuel.

12. As to the enrichment of uranium, PNC is carrying out research and development on the centrifugal separation method, and the Institute of Physical and Chemical Research, together with private industry, is doing research on the diffusion separation method. Basic research on the chemical separation method is also being done in the universities.

13. Fabrication of nuclear fuel is also one of the essential parts of the nuclear fuel cycle. Anticipating the rapid growth of nuclear power plants, five private companies have filed applications with the Government to obtain licences for nuclear fuel fabrication. The Atomic Energy Commission is working on safety criteria of fuel fabrication facilities, which will serve as a basis for safety review of these facilities.

14. As to the nuclear fuel policy, the Atomic Energy Commission has already laid down the basic policies in its long-range programme and, in order to elaborate the nuclear fuel programmes in more concrete form, has set up a Special Committee on Nuclear Fuel. The Committee produced its report in March 1968 after ten months' study of the subject.

NUCLEAR SHIP

15. The Japan Nuclear Ship Development Agency, the government corporation in charge of building our first nuclear ship, placed an order for the ship with private industry in November 1967.

16. The Agency also decided in November 1967 to set up an anchorage for the nuclear ship in Mutsu City, Aomori Prefecture. The Atomic Energy Commission has completed the safety review of the reactor to be installed in the nuclear ship.

17. The major characteristics of the nuclear ship are as follows:

Gross tonnage	8 350 tons (23 000 m^3)
Displacement	10 400 tons
Service speed	16.5 knots
Complement	79 persons
Type of reactor	PWR
Thermal output	36 MW

USE OF RADIATION

18. Use of radiation has steadily spread in the fields of medicine, agriculture and industry. The number of installations using radiation increased from 1425 in March 1967 to 1540 in March 1968.

19. Development in this field during the 1967-8 period includes the development of an isotope-battery using strontium-90. The Takasaki Establishment of JAERI has promoted development in radiation chemistry, and in May 1968 succeeded in the trial production on an industrial basis by radiation of polimerized trioxan.

20. In the field of food irradiation the Atomic Energy Commission decided in September 1967 to carry out a co-ordinated project on food irradiation. The foods being treated in the project are potatoes and onions for inhibition of sprouting, and rice for insect eradication and disinfestation.

NUCLEAR FUSION

21. The Atomic Energy Commission set up the Committee on Nuclear Fusion to study the precise programme for the development of nuclear fusion. Based on the report of the Committee, the Atomic Energy Commission decided in July 1968 to start a co-ordinated project on nuclear fusion.

INTERNATIONAL CO-OPERATION

22. In 1968 bilateral agreements were concluded with the United States of America and the United Kingdom of Great Britain and Northern Ireland. According to the Japan-USA Agreement, enrichment services for 161 tons of uranium-235 will be provided by the USA.

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Advances in nuclear energy: 1967/68

INTRODUCTION

1. Nuclear power has become part of the British industrial scene - accepted by the public, fully competitive and contributing a significant and increasing proportion of electricity output. With its wide experience in the design, construction and operation of power reactors gained since the nuclear power programme began in the 1950's, UK industry is able to supply gas-cooled and water reactors for commercial power stations, together with complete fuel cycle services and a comprehensive range of nuclear components and equipment. To meet later needs, the United Kingdom Atomic Energy Authority (UKAEA) continues to press forward rapidly with the fast reactor.

2. This stage of development is being matched by plans for the future of the British nuclear industry. To equip the industry to meet the increasing demands that will be made upon it at home and from abroad, it is planned to concentrate the nuclear design resources of the various industrial organizations and UKAEA into two new companies. Thus, effective competition within the UK will be retained along with a more economical and efficient alignment of technological and industrial resources. It is also planned to create an independent nuclear fuel company from UKAEA's fuel production organization. The Government looks to the new arrangements to facilitate the forging of industrial links abroad, to which they attach great importance.

NUCLEAR POWER PROGRAMME

3. Nuclear power stations are making a significant contribution to the country's publicly-owned electricity generating systems. Oldbury, the eighth Mark I gas-cooled (MAGNOX) station in the first nuclear power programme, was to come on power in August. The performance of Hunterston 'A', which started operation in 1964, indicates the reliability of these stations. During the four winter months from November 1967 to February 1968 the average load factor was 102.8% of the designed output capacity. Over the year the load factor was 85.9% and the cumulative load factor since the station began operating has been 83%

4. The second nuclear power programme based on the Mark II (AGR) gas-cooled system is making good progress, with three stations totalling 3700 MW(e) currently under construction at Dungeness 'B', Hinkley Point 'B' and Hunterston 'B', and others at the planning stage. The Minister of Power and the Secretary of State for Scotland have accepted the advice of the Nuclear Safety Advisory Committee that the safety of a gas-cooled reactor in a prestressed concrete pressure vessel is such that it may be constructed and operated much nearer built-up areas than hitherto permitted in the UK. Thus, nearly 200 000 people are living within five miles of the site approved for construction of a Mark II reactor station at Seaton Carew near Hartlepool.

NUCLEAR FUEL SERVICES

5. The nuclear fuel services offered by UKAEA are available both to home generating boards and to customers overseas. A major current production effort at Springfields is the manufacture of Mark I gas-cooled reactor (GCR) fuel elements. A plant for the production of UF_6 for enrichment plant feed is now operating there and large new plants for the production of oxide fuel will be commissioned in the near future. At Capenhurst separative work capacity is being expanded to meet the needs of the commercial Mark II gas-cooled reactors (AGR). The completion of the head-end plant at Windscale will add the capacity for reprocessing all types of low enriched uranium oxide fuel from home and overseas to the existing large capacity for reprocessing natural uranium metal fuel.

6. These developments enhance UKAEA's capability to provide a complete fuel service, which is already extensively used by a number of countries, and should lead to an expansion in its international trading in enriched uranium oxide, natural uranium fuel (including its reprocessing) and plutonium.

REACTOR DEVELOPMENT

7. The reactor development programme of UKAEA covers three main areas - gas-cooled reactors, the steam-generating heavy water reactor (SGHWR) and the fast reactor. In the gas-cooled field the immediate application arises for the Mark II reactor stations being built as part of the nuclear power programme. The development of a Mark III gas-cooled reactor is being studied. A number of designs are being reviewed, all based on graphite-coated fuel particules of of uranium dioxide or dicarbide, at a low enrichment.

8. One of the highlights of the year was the completion, on time and within the funds allocated, of the 100-MW(e) prototype enriched uranium SGHWR at Winfrith, which began generating electricity at the end of 1967. Measurements made during the commissioning of the reactor demonstrated that at full power the initial reactivity, nuclear power distribution, flow distribution and the influence of steam voids on reactivity were close to the predicted values. This light-water cooled, direct cycle, pressure tube reactor is one of the most advanced water reactors, providing at low capital cost an easily constructed reactor, simple to operate and maintain, and available in a wide range of commercial sizes. Development work on the enriched uranium version is continuing and is also going on, in collaboration with Australia and New Zealand, on a natural uranium SGHWR.

9. Construction of the 250-MW(e) prototype fast reactor (PFR) and the related development work has proceeded generally according to programme. Design work is in hand on a 1300-MW(e) fast reactor for large commercial generating stations, using a fuel sub-assembly almost identical to that of the prototype. The prototype itself will be used for irradiation experiments to produce the best possible fuel suitable for the first series of commercial fast reactors as well as to explore more advanced concepts.

10. The design of PFR if based on experience gained from the smaller Dounreay Fast Reactor (DFR) operated by UKAEA for several years. DFR was shut down at the end of July 1967 after a leak was found in its primary circuit, but went back on power in June 1968. The leak was due to a very small hole in some sub-standard welding which had, nevertheless, withstood many years of almost continuous operation of the reactor.

NUCLEAR DESALTING

11. UKAEA has published the results of extensive studies of large dual-purpose nuclear power desalination plants, with a detailed breakdown of their costs. The reactor systems chosen were AGR and SGHWR. The desalination plant designs were jointly developed for these studies with Weir Westgarth Limited.

12. Both reactor systems have two characteristics of special importance to dual-plant operation. The first is that they have high availability, leading to reliable supplies of low-cost water and electricity. The second is their inherent safety which is vital, particularly as the plant will have to be sited near population centres.

13. Within the current UK programme of research and development into methods of desalination of salt water for civil use, to be carried out at a cost of several million pounds by UKAEA, provision has been made for the continuing study of dual-purpose plant, including the updating of the commercial designs already prepared.

RADIOISOTOPES

14. The Radiochemical Centre has produced the important tracer isotope carbon-14 at isotopic abundances up to 99.5%, compared with levels hitherto available of 50 to 70%. Many labelled organic compounds have been prepared at these abundances, some by growing the green alga Chlorella with more than 90% of all its carbon substituted with carbon-14 2/. This advance has materially increased the usefulness of these compounds. Examples are in research into the mechanism of protein synthesis, the development of ultra-sensitive methods of assay for enzymes and the accuracy of analysis for steroid hormones in urine and plasma, using a double tracer method.

NUCLEAR RESEARCH

15. With the advent of economic nuclear power, and pressure on the country's deployment of resources of skilled manpower and money in areas of advanced technology, some rationalisation is under way in nuclear research. UKAEA's underlying research, which provides background information and broad support to applied research and development, is to be reduced over the next two or three years to not more than 10% of UKAEA's total civil research and development effort. Expenditure on plasma physics and fusion research at Culham is expected to fall by 10% each year up to 1972. A rationalization of materials testing facilities will enable two research reactors to be closed down - BEPO later this year and the Dounreay Materials Testing Reactor (DMTR) in 1969.

2/ The possibilities of this were first reported last year - see document GC(XI)/INF/97/Rev.1, Statement K, penultimate paragraph.

16. A vigorous research programme will, however, remain, both in underlying areas and in the applied field where the emphasis will be on industrial applications of nuclear processes. Many of the major research facilities built at Harwell in the early days of the British atomic energy programme are now used to a significant extent by universities and other organizations.

17. During the year much new information has been gained on the properties of materials, including the effects of irradiation upon them and in consequence their use in reactors. The availability of modified and new equipment, including the Variable Energy Cyclotron and the Harwell "refrigerator" producing temperature down to 0.1°K, has greatly extended the range of these studies.

18. In the industrial application of nuclear processes, the Activitation Analysis Service run by Wantage has been extended. Another four gamma-irradiation plants were built by UKAEA licensees to meet overseas orders and are now in operation for treating medical equipment or food. Gamma radiation from cobalt-60 is being used for the commercial production of wood-plastic composites. Advances in electron-beam curing of paints have led to the construction at Wantage of a pilot commercial installation for the ultra-rapid cold-curing of industrial paints.

19. The isotope-heated thermoelectric generators, RIPPLE I and II, have operated continuously and completely unattended since first put into operation in navigational beacons in 1965.

20. Measuring techniques involving the use of radiactive isotopes as tracers have been developed and are being used for research into hydrological and ground water problems of national importance. Isotope measuring techniques have proved extremely accurate for measuring large turbulent flows, as in the cooling water systems of power stations.

21. Work has continued on plasma physics and fusion at Culham Laboratory. Theoretical methods have been advanced for investigating the stability of plasma confinement in practical configurations. The present generation of confinement experiments has provided valuable data which are being used in the design of the new series of stellerator and multipole experiments now being commissioned.

INTERNATIONAL COLLABORATION

22. The UK has continued to collaborate internationally in the development of the peaceful uses of atomic energy, both through the various multilateral agencies and under bilateral agreements with other countries. In general, these intergovernmental agreements provide for exchange of information and for the supply of nuclear material, equipment and facilities under safeguards. The UK has signed new agreements with Finland and Japan during the year, and is ready to negotiate agreements with other countries, where this is considered necessary to facilitate collaboration in the peaceful uses of atomic energy.

23. UKAEA has remained in contact with Atomic Energy Commissions, public utilities and industrial concerns in many parts of the world and now has formal collaborative agreements with organizations in 15 countries.

TRANSPORT REGULATIONS

24. All movements of nuclear material within the UK and from the UK to overseas countries are made in full conformity with the Agency's Regulations for the Safe Transport of Radioactive Materials. The codification in the latest edition of the Regulations 3/ of the requirements for "large source" traffic has made a valuable practical contribution towards facilitating the movements of irradiated fuel from overseas to the UK.

3/ Safety Series No. 6, 1967 Edition (STI/PUB/148).