No. 19839

UNITED STATES OF AMERICA
and
NORWAY

Agreement relating to the peaceful applications of atomic energy in the field of water reactor technology (with data sheet and the Agreement of 17 June 1975 on the Halden Reactor Project covering the period 1 January 1976 to 31 December 1978). Signed at Bethesda and Kjeller on 3 and 28 November 1975

Authentic text: English.
Registered by the United States of America on 10 June 1981.

ÉTATS-UNIS D'AMÉRIQUE
et
NORVÈGE

Accord relatif aux applications pacifiques de l'énergie atomique dans le domaine de la technologie des réacteurs refroidis par eau (avec feuille de données et Accord du 17 juin 1975 sur le projet relatif au réacteur de Halden couvrant la période du 1er janvier 1976 au 31 décembre 1978). Signé à Bethesda et à Kjeller les 3 et 28 novembre 1975

Texte authentique : anglais.
Enregistré par les États-Unis d'Amérique le 10 juin 1981.

AGREEMENT[1] BETWEEN INSTITUTT FOR ATOMENERGI AND THE UNITED STATES NUCLEAR REGULATORY COMMISSION

This Agreement, effective as of the 1st day of January, 1976, between the United States Nuclear Regulatory Commission (hereinafter called the "Commission"), acting for and on behalf of the Government of the United States of America and the Institutt for Atomenergi (hereinafter called "IFA"), acting for and on behalf of the Signatories to the Agreement on the OECD Halden Reactor Project covering the period from 1st January 1976 to 31st December 1978 (hereinafter called the "Halden Agreement").[2]

Witnesseth that:

Whereas, the Commission has proposed that it collaborate in the research and experimental program of the Halden Project (hereinafter called the "Program"), relating to the peaceful applications of atomic energy, involving the use of IFA's Halden Boiling Water Reactor in a program designed towards increasing knowledge in the field of water reactor technology, as described in the Halden Agreement; and

Whereas, the Program will be mainly devoted to fuel performance and reliability studies, irradiation of test assemblies for participating organizations, development of in-core fuel instrumentation in support of the fuel program, and studies on the application of process computers for on-line supervision and control of reactors; and

Whereas, the Commission is particularly interested in the information available through participation in the Program for the Commission's reactor safety research program and, desires to avail itself of the fuel irradiation services offered under the Program; and

Whereas the Parties deem it to be mutually advantageous for the Commission to collaborate in the Halden Project as an associated party, and to assign personnel to participate therein and to be participants in the meetings of both the Halden Program Group and the Halden Board of Management; and

Whereas, this Agreement is authorized by law, including the U.S. Atomic Energy Act of 1954, as amended, as concerns the Commission, and is authorized in article 8(*c*) of the Halden Agreement, as concerns IFA, and will be performed subject to and in accordance with the terms of the Agreement for Cooperation between the Government of the United States of America and the Government of Norway Concerning Civil Uses of Atomic Energy signed at Washington on 4 May 1967, as amended.[3]

Now therefore, the Parties hereto do mutually agree as follows:

Article I. INTERPRETATION

Any reference in this Agreement to the Halden Agreement shall be taken as reference to the Agreement on the OECD Halden Reactor Project covering the period from 1st January, 1976, to 31st December, 1978, and expressions such as "Signatories to the Halden Agreement", "OECD Halden Reactor Project", "Halden Board of Management", and "Halden Programme Group" shall be taken as

[1] Came into force on 1 January 1976, in accordance with its provisions.
[2] See p. 216 of this volume.
[3] United Nations, *Treaty Series*, vol. 685, p. 217, and vol. 740, p. 452.

reference to those terms as defined and used in the Halden Agreement, a copy of which has been furnished to the Commission as of the date of this Agreement. The term "Commission" shall mean the United States Nuclear Regulatory Commission or its duly authorized representative or representatives.

Article II. SCOPE OF AGREEMENT

This Agreement shall continue in full force and effect from 1st January, 1976, and up to 31st December, 1978.

A. *IFA Scope of responsibilities*

1. IFA shall ensure that the necessary personnel, materials, equipment, and services are provided in order that the participants in the Halden Project may perform to the best of their ability the program as set out in the Halden Agreement, which Agreement is incorporated herein by reference. The total expenditures in respect of the program are estimated to be seventy-three million (73,000,000) Norwegian kroner as set forth in the Halden Agreement as amended and including the contribution from the Commission as provided for in article II.B.1 below.

2. IFA agrees to grant the Commission and its assignees access to the Halden Reactor during the performance of the Program. The Commission shall further have the right to assign scientists, acceptable to IFA, to assist, advise and participate in the performance of the joint program, appropriate remuneration of one (1) such scientist as agreed between the parties to be paid by IFA. The Commission may also designate personnel to participate in the meetings of the Halden Board of Management and the Halden Program Group.

3. IFA agrees to inform the Commission of the results of the scientific research and of the information obtained from the operation of the Halden Reactor and the carrying out of the Program, including information furnished by Project participants according to article 6(*b*) of the Halden Agreement. The Commission may use such results and information for its research programs, including dissemination to its U.S. contractors for use in their work for the Commission on such research programs and on the understanding that no further dissemination of such results and information will be made by the contractors. Should the Commission be required by United States' law to disseminate further than to such contractors information from the Halden Project, the Commission will endeavor to consult in advance with IFA as to the acceptability of such dissemination in order to ensure that the interests of other Project participants in the use of such dissemination, secured under their agreements with IFA, are protected. Publication in the open literature may not take place without the prior written approval of IFA. It is understood, however, that no restriction will be applied to publication or dissemination of such information which is made public by IFA or by third parties.

4. IFA shall provide four (4) core positions in the Halden Reactor for Commission supplied test fuel assemblies throughout the period of experimental operation agreed upon in the Halden Agreement, and shall ensure that irradiation of the Commission's test fuel is carried out in accordance with the conditions laid down in annex II of the Halden Agreement and in accordance with the reactor program laid down in the said annex II and as may be modified by the Halden Board of Management.

5. IFA shall be responsible for the following experimental services on the Commission's test fuel as part of the work provided for under the Halden Project's joint program and budget.

a. Loading into the core, in-pile calibrations of the instruments, unloading from the core and transfer to the fuel pond.

b. Shearing and disposal of all instrument lines and other top and bottom equipment, and visual inspection in the pond.

c. Storage of the irradiated fuel up to five (5) months following final discharge from the reactor, loading of the irradiated fuel into the cask to be used for transport from the reactor site, and placement of casks containing fuel on bed vehicle.

B. *Commission scope of responsibility*

1. In full consideration for those rights and services provided in article II.A, the Commission will contribute to IFA for use in the Program a total sum of 5 million Norwegian kroner, payable in advance in equal quarterly sums commencing on 1st January, 1976. IFA will submit invoices for such contributions at least thirty (30) days prior to date of payment. This payment is the only one to be made by the Commission to IFA to carry out the scope of this Agreement. The payment shall be made at a mutually acceptable bank in Norway.

2. The Commission shall be responsible for supplying the test fuel rods and associated equipment and for satisfying that the proposed testing may be carried out with safety. IFA has the right to refuse in a timely manner any experiment proposed by the Commission if the safety and reliability of the Halden Reactor is endangered.

3. The Commission shall provide data and information on the test fuel in compliance with the Halden Project's standard data sheet, an example of which is annexed hereto, for use by IFA to obtain the approval of the Halden Board of Management to perform the planned irradiations.

4. The Commission shall communicate to IFA reports on the post-irradiation examinations that are performed on the test fuel by the Commission, it being understood that these reports will be made available to the other parties to the OECD Halden Reactor Project, in accordance with article 6(*b*) of the Halden Agreement, and that the Commission otherwise may dispose of such information as it deems fit.

5. It is understood that a supplemental agreement between the parties may be entered into, such agreement covering services in addition to those specified in article II.A. above to be rendered by IFA in connection with irradiation of the Commission's test fuel assemblies and special rods. Separate payments to be agreed upon between the Commission and IFA will be made by the Commission to IFA in consideration of such services.

Article III. Reduction of Program

If for any reason a major part of the OECD Halden Reactor Project Program is substantially reduced or eliminated, and in particular if the expected fuel irradiation conditions are not achieved, without substitution of work determined by the Commission to be of equivalent and programmatic interest to the Commission, the Commission shall have its contribution under this Agreement suitably adjusted downward to reflect such reduction.

In the event of failure of the parties to agree as to any such adjustment, the matter shall after notice of thirty (30) days by either party to the other be referred to an arbitration board for determination. Each party shall promptly appoint one arbitrator and the two shall elect a third. The decision of the majority of the three arbitrators shall be final and binding. Allocation of the cost of arbitration shall be as determined by the board of arbitrators; provided, however, that neither party shall be obliged to pay the cost of the other party's arbitrator.

Article IV. PATENTS

A. The parties agree that, with respect to all right, title, and interest in and to any invention or discovery made or conceived by Commission personnel while in Norway and assigned to the Halden Project, or any patent application or patent thereon:

1. IFA shall be entitled to all such right, title and interest in all countries other than the United States of America, subject to a royalty-free, non-exclusive, irrevocable license, with the right to grant sub-licenses, to the Commission for use in the production or utilization of atomic energy or special nuclear material.
2. The Commission shall be entitled to all such right, title and interest in the United States of America, subject to a royalty-free, non-exclusive, irrevocable license, with the right to grant sub-licenses, to the Signatories of the Halden Agreement for use in the production or utilization of atomic energy or special nuclear material.

B. The parties agree that, with respect to all rights, title, and interest in and to any invention or discovery made or conceived by personnel, other than Commission personnel, while conducting work related to the carrying through of fuel irradiation experiments for the Commission, or any patent application or patent thereon:

1. IFA shall be entitled to all such right, title and interest in all countries other than the United States of America, subject to a royalty-free, non-exclusive, irrevocable license, with the right to grant sub-licenses, to the Commission for use in the production or utilization of atomic energy or special nuclear material.
2. The Commission shall be entitled to all such right, title and interest in the United States of America, subject to a royalty-free, non-exclusive, irrevocable license, with the right to grant sub-licenses, to the Signatories of the Halden Agreement for use in the production or utilization of atomic energy or special nuclear material.

C. Each party agrees to waive, and does hereby waive, any and all claims against the other party for compensation, royalty and award as regards the use of any such invention, discovery, patent application or patent in the production or utilization of atomic energy or special nuclear material, and agrees to release, and does hereby release, the other party with respect to any and all such claims.

D. As to inventions and patents under paragraph A, neither party shall discriminate in the granting of any license or sub-license for the reason that the proposed licensee is a national of the United States of America or of any country or countries represented by the Signatories of the Halden Agreement.

E. The parties agree that all situations not specifically covered shall be settled by mutual agreement governed by the basic principle of equivalent benefits to both parties.

Article V. TRANSFER OF FISSILE MATERIAL

Any fuel assemblies or components thereof containing special nuclear material desired by the Commission to be submitted for testing pursuant to article II.B of this Agreement shall be transferred subject to, and in accordance with, the terms and conditions of the Agreement for Cooperation Between the Government of the United States of America and the Government of Norway Concerning Civil Uses of Atomic Energy signed at Washington on 4th May, 1967, as amended. The specific provisions governing such transfers are as follows:

A. Each transfer of fuel assemblies or components thereof containing special nuclear material shall be on a loan basis; title to such assemblies, components and material shall at all times be and remain in the Commission. Detailed terms governing each transfer shall be agreed upon in advance.

B. Following storage of the fuel assemblies, components and material as contemplated in article II.A.5.*c*, IFA will deliver the assemblies, components and material to the Commission at the Halden Reactor Plant.

Article VI. LIABILITY, INSURANCE AND INDEMNITY

A. IFA hereby agrees to indemnify and hold the United States, the Commission, its contractors and assigned personnel harmless against any and all actions, claims, liabilities, costs and expenses by or of third parties for personal injury, including death, and property damage resulting from the performance of this Agreement. This indemnity shall apply to any liability arising out of, resulting from, or in any way related directly or indirectly to a nuclear incident involving special nuclear material supplied by the Commission pursuant to article V occurring at the Halden Reactor, or occurring during transportation within Norway from port-of-entry after the fuel rods and associated equipment have passed ships rail (or equivalent), or occurring during transportation within Norway to the port-of-exit before the fuel rods and associated equipment have passed ships rail (or equivalent). It is recognized that IFA, pursuant to the Norwegian Nuclear Energy Act of 12th of May 1972, is absolutely liable for any such injury or property damage as described in the preceding sentence, and IFA agrees to maintain, without cost to the Commission, insurance in an amount of NKr 70,000,000 to cover any such liability. IFA further waives any rights of recourse it may have against the Commission with respect to any such injury or property damage.

B. Neither the Commission nor its suppliers shall have any liability to IFA or its insurers for any nuclear damage to any property located at the Halden site whether owned by IFA or others, and IFA agrees to indemnify and hold the Commission and its suppliers harmless against any liability for any such damage.

C. As used in this article, (1) "liability" means liability of any kind at any time whether in contract or tort, regardless of fault or degree thereof, including negligence; (2) "nuclear damage" means any loss, damage or loss of use which in whole or in part is caused by, arises out of, results from, or is in any way related directly or indirectly to the hazardous properties of source, special nuclear or byproduct material as these terms are defined in the Norwegian Nuclear Act of 12th May, 1972; and (3) "supplier" means any sub-contractor, vendor, or other person, regardless of tier, who furnishes information, materials or equipment to the Commission.

D. Except as provided in article III, in no event, whether as a result of breach of contract, negligence or otherwise, shall either party be liable to the other for loss of anticipated profit, loss of use, loss of revenue, inventory or use charges, cost of capital, claims of customers, damages caused by reason of unavailability of the Halden Reactor or its shutdown or any special or consequential damages of any nature.

Article VII. OFFICIALS NOT TO BENEFIT

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise

therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

Article VIII. COVENANT AGAINST CONTINGENT FEES

IFA warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by IFA for the purpose of securing business. For breach or violation of this warranty, the Commission shall have the right to annul this Agreement without liability, or in its discretion to deduct from the consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

Article IX. Disputes

Any dispute between the parties concerning the application or interpretation of this Agreement, that are not settled through consultation, or, if so agreed upon between the parties, through arbitration as provided for in article III, shall be submitted to Norwegian court. This Agreement shall be construed in accordance with the internal federal law applicable in U.S. District Courts, to agreements to which the Government of the United States is a party.

Article X. ENTIRE AGREEMENT

This Agreement contains the entire and only agreement between the parties affecting the rights and obligations of the Signatories to the Halden Agreement and requiring the approval of the Halden Board of Management, and prior negotiations, commitments, and writings with respect thereto are superseded hereby. No waiver, alteration or modification of any of the provisions hereof shall be binding unless incorporated in a duly executed amendment of this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this document as of the day and year first above written.

Institutt for Atomenergi of Norway:

By: VIKING OLOV ERICKSEN
Title: Managing Director

United States of America,
By United States Nuclear
Regulatory Commission:

By: LEE V. GOSSICK
Title: Executive Director for Operations

DATA SHEET

SIGN: E.K.	DATE: 26/2-73

IFA-

TEST ASSEMBLY DATA

Description							
Fuel Form	Sintered UO_2 pellets						
Rod No.	1	2	3	4	5	6	Total
Fuel Weight kg	0.56	0.56	0.56	0.52	0.52	0.52	3.24
% of T.D.		96			93		
Fuel Density g/cm³		10.5			10.2		
Fuel Diameter mm	9.56					Actual date to be listed	
Enrichment	12-15 w/o U-235						
Diam. Clearance mm	0.203						
Pellet Length mm	16						
Dishing	Dished						
Dishing Depth mm	Actual data to be listed						
Land Width mm	Actual data to be listed						
Cladding	Zircaloy-4						
Cladding State	Actual data for heat treatment and resulting mechanical properties to be listed						
Welding							
Fill pressure	17	35	35	17	17	35	
Filler Gas	Helium and air						
Clad. Int. Diam. mm	9.86						
Clad. Thickness mm	1.0						
No. Pins/Cluster	6						
Pitch Distance mm	46 (P.C.D.)						
Spacers	No						
Fuel Length/Pin mm[1]	750 Active fuel length						
Plenum	Plenum and clearance/fuel volume = 0.098						
Shroud Material	A1 × 8001						
Shroud Int. Diam. mm	71						
No. Of Clusters	1						

[1] In addition, a 0.25 inch thick Al_2O_3 insulating disc will be provided at each end of the fuel stack

DATA SHEET

OECD HALDEN REACTOR PROJECT

Sign: E.K.	Date: 26/2-73

IFA-

Supplier:

OPERATIONAL DATA

Objectives

Measurements of fuel stack length changes, fuel rod gas pressures and fuel centre temperatures

Description	*Predicted*	*Actual*	*Remarks*
Loading Date	-		
Unloading Date	-		
Burn-Up MWd/lUO_2	-		
Reactor Position	-		
Rel. Flux Position	-		
Channel Power kW	190		
Avg. Lin. Heat Rating W/cm	420		
Max. Lin. Heat Rating W/cm	500		
Peak Surf. Heat Flux W/cm^2	143		
Peak $\int kd\theta$ W/cm	36		
Peak Spec. Heat Rating W/gUO_2	69		
Max. Centre Temp. °C	2100		
Cooling Condition	Natural circulation		
Inlet Velocity m/sec	-		
Inlet Throttling $v^2/2g$	-		
Hydraulic Diam. mm	-		
Flow area mm^2	-		
Assembly Dwg.	-		Parts List Dwg.
Cable Data Sheet	-		
Experim. Procedure	-		

INSTRUMENTATION

1 Inlet turbine $D=40$, $\mu=32$
2 Inlet thermocouples
1 Calibration valve
4 Neutron detectors
2 Fuel stack elongation detectors
6 Fission gas pressure transducers
4 T/C control oxide thermocouples

1 Outlet turbine $D=55$, $\mu=32$
2 Outlet thermocouples

1 Fuel failure detector

AGREEMENT ON THE OECD HALDEN REACTOR PROJECT COVERING THE PERIOD 1ST JANUARY 1976 TO 31ST DECEMBER 1978

The Norwegian Institutt for Atomenergi (hereinafter referred to as the "Institute"), Aktiebolaget Atomenergi, Sweden, the Danish Atomic Energy Commission, the Electric Power Research Institute, USA, the Finnish Ministry of Trade and Industry, the Italian Comitato Nazionale per l'Energia Nucleare, the Japan Atomic Energy Research Institute, Kernforschungsanlage Jülich GmbH, representing a German group of companies working in agreement with the German Federal Ministry for Research and Technology, and Reactor Centrum Nederland (hereinafter referred to as the "Signatories");

Considering that since 1st July 1958, pursuant to the Agreement of 11th June 1958 on the Joint Operation of the Halden Boiling Water Reactor, to the Agreement of 14th June 1960 Prolonging and Amending that Agreement, to the Agreement on the OECD Halden Reactor Project covering the period from 1st January 1964 to 31st December 1966, to the Agreement on the OECD Halden Reactor Project covering the period from 1st January 1967 to 31st December 1969, to the Agreement on the OECD Halden Reactor Project covering the period from 1st January 1970 to 31st December 1972, and to the Agreement on the OECD Halden Reactor Project covering the period from 1st January 1973 to 31st December 1975 as amended by the Protocol of 11th June 1974, the Halden Heavy Water Boiling Reactor has been operated as a joint undertaking of the OECD Nuclear Energy Agency;

Considering that in execution of these Agreements, programmes have been carried out in reactor physics, water chemistry, the development of in-core instrumentation, long-term fuel element testing, including thorium fuel studies, control methods and computer applications, and fuel performance and reliability studies;

Considering that the Institute has invited the other Signatories to participate for a period of three years using the Halden Reactor in a joint programme covering research and development in the fields of fuel rod performance studies in steady state and transient operating conditions, process supervision and control, modelling and simulations, and fuel element testing;

Considering that the Signatories have expressed their intention to participate technically and financially in such programme;

Considering that the total expenditure in respect of this programme has been estimated at 73,000,000 Norwegian kroner (the tentative breakdown of this amount is shown in annex I to the present Agreement);

Considering that the operation of the Halden Reactor, of which the Institute remains the owner, will be carried out under the Institute's responsibility and in accordance with the relative laws and agreements;

Have agreed as follows:

Article 1. The Signatories will sponsor, in accordance with the provisions of the present Agreement, a joint programme with the Halden Reactor for a period of three years beginning 1st January 1976 on the basis of the draft programme and the reactor operating conditions as set out in annex II hereto.

Article 2. (*a*) A Board (hereinafter referred to as the "Halden Board of Management") composed of one member designated by each of the Signatories shall:

(i) Approve each year the joint programme of research and experiments;

(ii) Approve each year the budget of expenditure relating to the joint programme;

(iii) Decide upon rules relating to patents resulting from the carrying out of the joint programme and in particular the conditions under which the Signatories shall be entitled to acquire non-exclusive licences under such patents;

(iv) Deal with any other matter brought before it by the Institute or by the Halden Programme Group.

(*b*) The Halden Board of Management shall designate each year a Chairman and Vice-Chairman and settle its own Rules of Procedure. It will meet at least twice a year, and shall be convened by its Chairman, in principle at the Headquarters of the OECD Nuclear Energy Agency. The Chairman must convene a meeting of the Halden Board of Management within two weeks of receiving a written request from members representing 50 per cent of the votes. A representative of the OECD Nuclear Energy Agency may attend meetings of the Halden Board of Management in an advisory capacity.

(*c*) The Halden Board of Management shall keep the Steering Committee of the OECD Nuclear Energy Agency informed as to the general progress of the work.

(*d*) Decisions of the Halden Board of Management shall be taken by a two-thirds majority of the votes cast. Each member shall have one vote, provided, however, that the member designated by the Institute shall have two votes and provided that his agreement shall be required for decisions concerning insurance and decisions which may involve safety risks or which might prejudice the utilization of the reactor and ancillary installations after the termination of the present Agreement.

Article 3. (*a*) A Committee (hereinafter referred to as the "Halden Programme Group") composed of one senior technical specialist designated by each of the Signatories shall assist the Halden Board of Management in the execution of its tasks, in particular in formulating the joint programme, and will supervise the carrying out by the Institute of the joint programme.

(*b*) The Halden Programme Group shall in particular:

(i) Approve contracts above 400,000 Norwegian kroner which may be concluded by the Institute for carrying out the joint programme;

(ii) Approve the conditions for the scientific and technical personnel working on the joint programme and paid from the common budget.

(*c*) The Halden Programme Group shall designate each year a Chairman and Vice-Chairman. It will meet as often as it deems necessary and at least four times a year, in principle at Halden, and shall be convened by its Chairman. The Chairman must convene a meeting of the Halden Programme Group within two weeks of receiving a written request from members representing 50 per cent of the votes. A representative of the OECD Nuclear Energy Agency may attend meetings of the Halden Programme Group in an advisory capacity.

(*d*) Decisions of the Halden Programme Group shall be taken by a two-thirds majority of the votes cast. Each member shall have one vote, provided, however, that the member designated by the Institute shall have two votes.

Article 4. (*a*) The Institute shall, in consultation with the Halden Programme Group, ensure the technical and administrative conduct of the work within the programme and budget approved by the Halden Board of Management.

(*b*) The Project Manager, appointed by the Institute and approved by the Halden Board of Management, shall attend meetings of the Halden Board of Management in an advisory capacity and shall also attend meetings of the Halden Programme Group. He shall supply all information which is requested of him concerning the carrying out of the joint programme.

(*c*) The scientific and technical personnel shall be appointed by the Institute in agreement with the Signatories placing them at the disposal of the Institute. The Institute shall be responsible in every way for all acts or omissions of all personnel in the course of or arising out of the performance of their work.

(*d*) The Signatories may send trainees to the reactor and ancillary installations; the Signatories shall be responsible for the remuneration of trainees. The Institute shall prepare rules for the admission of trainees, including the number of trainees, for the approval of the Halden Board of Management.

Article 5. (*a*) Within the limits of 60,000,000 Norwegian kroner for the period of three years, expenditure relating to the carrying out of the joint programme shall be borne by the Signatories, and shall be apportioned as set out in annex III to the present Agreement and, subject to article 6, the contribution of each of the Signatories to the execution of the programme shall be limited to the amount as set out in such apportionment.

(*b*) The Institute shall each year prepare a draft programme and budget as well as a report, including accounts, covering the previous year which shall be submitted, with the comments of the Halden Programme Group, for the approval of the Halden Board of Management. The Institute shall submit for the approval of the Halden Board of Management the format for the budget and accounts reflecting expenditure relating to the carrying out of the joint programme. The draft programme and budget shall be so submitted not later than two months before the beginning of the year in question. The report shall be so submitted not later than three months after the end of the year in question. The financial year shall be from 1st January to 31st December.

(*c*) The Halden Board of Management shall approve the annual budget not later than thirty days before the beginning of the financial year in question. The Board of Management shall approve the first annual budget not later than 1st February 1976.

(*d*) Contributions due from the Signatories shall, following such approval be paid at such times as the Board of Management shall determine, to the Institute and assigned for the carrying out of the joint programme.

(*e*) The Institute shall be solely liable in respect of all actions, claims, costs and expenses whatsoever arising out of the operation of the Halden Reactor and the ancillary installations, and shall indemnify the other Signatories in respect of any such actions, claims, costs and expenses, which may involve the other Signatories.

(*f*) Except as otherwise agreed between the Halden Board of Management and the Institute, all assets acquired by the Institute under the joint programme and budget shall remain the property of the Institute at the termination of the present Agreement.

Article 6. (*a*) Any Signatory desiring to submit fuel elements for testing under the present Agreement shall be responsible:

(i) For satisfying the Institute that the proposed testing may be carried out with safety;

(ii) For supplying the fuel and for selecting and manufacturing of the elements, including, where appropriate, any instrumentation, and their delivery to the Project;

(iii) For the transport of the elements after testing to the place where the post-irradiation examination is to be carried out and for the post-irradiation examination.

(*b*) Such Signatory shall communicate to the Project the results of the post-irradiation examination, and any information which may be necessary for a proper understanding of the results of that examination.

(*c*) Such Signatory shall bear all expenses and charges incurred in connection with paragraphs (*a*) and (*b*) of this article without cost to the funds of the joint programme.

Article 7. (*a*) The Signatories shall be informed of the results of the scientific research and of the information obtained from the operation of the Halden Reactor and the carrying out of the joint programme, including information furnished by a Signatory in accordance with article 6(*b*).

(*b*) The results of the research and of the information so obtained shall be circulated, in accordance with the directives of the Halden Board of Management, by means of reports to the Signatories.

Article 8. (*a*) The present Agreement shall be concluded for a period of three years from 1st January 1976. If at any time during this period it becomes doubtful whether the programme outlined in annex II could be carried out, the Signatories shall consult together to consider the position and, in particular, to examine to what extent and under what conditions its completion might be possible.

(*b*) Other parties may accede to the present Agreement with the unanimous assent of the Signatories and subject to any conditions which they may determine.

(*c*) The Institute may, with the approval of the Halden Board of Management, enter into agreements for collaboration in furtherance of the joint programme. Such agreements may, in particular, cover exchange of information, scientific and technical personnel, and association in the work of the Halden Programme Group.

DONE in Halden, 17th June 1975.

ANNEX I

TENTATIVE BREAKDOWN OF TOTAL EXPENDITURE FOR THE JOINT PROGRAMME OF THE OECD HALDEN REACTOR PROJECT COVERING THE PERIOD 1st JANUARY 1976 TO 31st DECEMBER 1978

Item	*1976*	*1977*	*1978*		*Total*
			1st half	*2nd half*	
Salaries	15.8	17.5	9.7	6.0	49.0
Reactor operations including insurance	3.4	2.5	1.3	1.0	8.2
Experiments and development	3.2	2.3	0.6	1.0	7.1
Overheads	1.9	2.0	1.0	0.8	5.7
Reserve	0.7	0.7	0.7	0.9	3.9
TOTAL	25.0	25.0	13.3	9.7	73.0

All amounts in million Norwegian Kroner.

ANNEX II

SUMMARY OF RESEARCH AND EXPERIMENTAL PROGRAMME

INTRODUCTION

This annex outlines the programme for the three-year period 1976-1978 on the basis of the programme proposal of August 1974. Further, it deals with the reactor operations schedule and special conditions for the fuel testing programme.

The aim of the programme is to improve the operational safety and reliability of water-cooled reactor systems. The programme is based on operating the HBWR in the period 1st January 1976 - 31st July 1978, i.e., a total of 31 months of reactor operation including down-time necessary for maintenance, fuel handling operations, etc.

The programme items to be executed during this period cover three main research areas: fuel performance studies, process supervision and control, and mathematical modelling and simulation of reactor and fuel behaviour. The fuel performance studies, including continued fuel irradiation experiments for participating organizations, comprise experiments under normal and transient operating conditions aimed at improving the understanding of performance-limiting characteristics and defect mechanisms. The work on process supervision and control will be concentrated on developing methods and high reliability computer structures and in-core instrumentation, which will enable practical implementation of computer-based control systems. The efforts in mathematical modelling and simulations will serve as an aid in the planning of, and interpretation of results from, the fuel performance and process control programmes.

The programmes on fuel performance and test fuel irradiation for participants impose particular requirements on mode and length of reactor operation periods and length of shutdowns for plant maintenance, fuel handling and inspection. Therefore shutdowns and operating cycles will be determined primarily by the requirements of the fuel programme. Experiments on process computer applications will be carried out intermittently throughout the operating periods, and will in general not interfere with the requirements of the fuel programme on reactor operation.

PROGRAMME SUMMARY

Reactor operation

The reactor will be operated at coolant pressures up to 33 kp/cm^2 which corresponds to a saturation temperature of 240°C. The reactor core will consist of a combination of test fuel assemblies and base charge assemblies from the HBWR third fuel charge. Sufficient base charge assemblies will be available to provide reactivity for operation of the reactor at 15 MW through the 31 month period with a load factor of more than 65%. It is anticipated that participants' test fuel assemblies individually will have a reactivity contribution at least equivalent to that of a third charge assembly.

Generally, the reactor operation periods will be of three to four months' duration with shutdowns in between for maintenance and loading/unloading of experimental rigs and test fuel assemblies. Additional shutdowns for loading/unloading of special experiments may be required.

The overall characteristics of the reactor core will be similar to those pertaining during the 1973-1975 period. The first shutdown in 1976 is expected to include plant inspections in addition to a routine shutdown period for maintenance and test fuel handling operations, and preparatory work for future experimental fuel rig operation. Reactor operation will end on 31st July 1978, allowing for a five month rounding-off period. The actual operations schedule will be decided on a yearly basis by the Halden Programme Group.

Process supervision and control

A research and development programme on control methods and on-line computer applications has been carried out since 1967 with the main purpose of investigating the use of advanced control and supervision techniques in nuclear reactors. Extensive work has been done on development of software and hardware systems for passive functions such as monitoring, logging and reporting, interactive functions such as operator-process communication and active functions such as feedback control of the core power distribution and of the reactor plant processes. Several computer systems have been installed for execution of this programme. The general objective for the 1976-1978 programme will be to explore further the potentials of modern computer technology and control methods for improving the control and protection systems for commercial power reactors.

The development of improved systems for core surveillance and control will be continued. The properties of alternative in-core instrumentation systems will be investigated, and improved systems for on-line digestion and presentation to the operator of the data from the in-core sensors will be developed. The work with power distribution control in large cores will be carried further to a stage where methods and systems applicable to large water-cooled reactors will be established. Evaluations of computer system structures with high reliability for use in core surveillance and control, utilizing dedicated mini- and micro-computers, and meeting envisaged licensing requirements, will be made.

Further, the development of systems for handling of plant disturbances will be pursued. An advanced operator communication system will be developed, taking advantage of the experience gained through several years of research on this subject. Methods for prime cause determination and operator guidance in disturbance situations will be developed. These methods will be implemented on and developed through the operator communication system. The use of computers in reactor protection systems will be studied. In this area, the emphasis will be on development of methods for producing reliable software, in order to meet the special licensing requirements.

Fuel performance

Previous Project programmes and fuel testing work have included studies of fuel and channel limitations such as burn-out, instability, fuel temperature and fission gas pressure. Since 1967 a major effort has been devoted to in-pile investigations of mechanical interaction between fuel and cladding. These studies are based on measurements of fuel stack and cladding elongation by means of a differential transformer sensor. Differential transformers have furthermore been successfully applied in rigs for in-pile diameter measurements along the entire length of fuel rods. Thus, both axial and diametral cladding strains can be analyzed as a function of design parameters and operating conditions. A newly developed pressure rig enables the same type of measurements under PWR conditions.

Unpredicted fuel problems have appeared in power reactors under normal operating conditions, e. g., those caused by hydriding, pellet-clad mechanical interaction (PCMI), clad collapse due to fuel densification. Phenomena-oriented fuel tests assist in reducing fuel defect rates normally achieved through improved quality control and design feedbacks from experience in nuclear power plants.

To an increasing extent, the fuel designer must rely on analytical tools, i.e., mathematical models and correlations, and must be able to apply these tools with a confidence based more on testing and measurement and less on assumption. One of the aims of the 1976-1978 programme will be to provide data for experimental verification of models. Assurance of the reliability of predictive models must rest upon a data base obtained both from statistical analysis of production-fuel performance and from phenomena-oriented experiments over a range of burn-ups, designs and operational parameters. It is generally acknowledged that the fuel design procedure will become a technical/economic optimization of gradually increasing complexity, which can be accomplished only with proven and validated models of fuel behaviour.

The proposed experimental programme is mainly an extension of the current programme. Thus, investigations of the influence of design parameters, operating mode and burn-up on PCMI will be continued, with special emphasis on conditioning procedures and load-follow operation. These experiments will also include studies of material properties of fuel and cladding.

A comparison of the performance of mixed oxide fuel with that of UO_2 is envisaged.

A major effort will be devoted to investigations of fuel rod thermal behaviour through fuel temperature and gap conductance measurements, including evaluation of new measuring and analysis techniques. These experiments are aimed at an improved characterization of the thermal conditions during normal operation to define more accurate starting conditions for LOCA related simulations, including determination of stored heat.

Experiments are planned for further studying the mechanisms related to fission products release from defect fuel.

Experimental studies of the behaviour of fuel rods during transients/accidents may be conducted in a special rig permitting adverse cooling conditions. Of particular interest are studies of fuel and clad temperatures and defect mechanisms, including ballooning of pre-pressurized fuel, during such transients.

Test fuel irradiation

The Halden Reactor has demonstrated its attractiveness as a fuel testing facility through successful irradiations of about 180 test assemblies by the end of 1975. The reactor permits great flexibility in the assembly design, so that assemblies with wide variations in fuel material, fuel form, rod dimensions and cluster configuration can be tested. Test assemblies are individually instrumented, and their power density adjusted through enrichment variations.

The continued fuel testing by Project participants is expected to have its emphasis on the following:

- Investigations on mechanical interaction and fuel relocation;
- Investigations on fuel rod thermal characteristics;
- Investigations on fission gas behaviour;
- Demonstration of manufacturing capability.

Part of these investigations will be carried out by continued irradiation of instrumented fuel assemblies installed during previous Project periods.

It is expected that a typical core will consist of about 60 assemblies of which up to 45 will be instrumented test assemblies. The number of lattice positions available for fuel testing is limited by such considerations as core power distribution, excess reactivity, test assembly ratings, fuel handling, signal handling capacities, and safety considerations.

With a U-235 enrichment of 10% it is estimated that an average specific power of up to 60 W/g for a single rod assembly and about 23 W/g for a nine rod cluster can be achieved. The axial power form factor over the core length is about 1.25.

Modelling and simulation

The fuel and process control programmes at Halden have in common the need for developing and validating fuel, core and plant models over a variety of steady state and transient conditions.

The fuel modelling work at the Project has been concentrated on interpretations of the phenomena observed in different fuel experiments and has aimed at correlating the effects of fuel design and operating parameters. Work towards advanced PCMI-models is in progress, and increased efforts on fuel performance modelling for normal and transient operating conditions will be undertaken in the 1976-1978 period.

Core and plant modelling is a prerequisite for the development of computer control systems at the Project. Consequently, considerable emphasis will be put on the development of adequate reactor core and plant models, describing the transient behaviour of the core as well as of critical plant variables. The inclusion of performance limitations for the fuel into the core models is desirable for the development of core control systems.

A possible integration of the models arrived at through the fuel and the control methods programmes will be considered. Such integration would permit more extensive and relevant analyses and would contribute to the optimization of the performance and reliability of nuclear plants.

International coordination of safety research

One of the main aims of the 1976-1978 Halden Programme will be to obtain data, experimental verification of models, and demonstrations that can provide a basis for reductions of the restrictions being applied in licensing and operation of LWR's. Considering the demand from regulatory organizations for extensive verification of systems developed and models employed, the Project will aim for the closest possible cooperation with Project member organizations in establishing the data base needed to verify the validity of the models.

During the discussions of the new programme with Project participants, the proposal has been made that the Project should aim for a broader role in pursuing international cooperation in areas of reactor safety research.

The need for increased safety related research which has developed over the last years has resulted in stepped-up programmes in this area in most of the countries participating in the Project. In view of the common problems with regard to improving LWR safety even further, it would seem desirable to improve the coordination of efforts in the safety research field, with the aim of:

- Identifying and pursuing investigations promising maximum short-term benefits;
- Avoiding unnecessary duplication of efforts;
- Promoting information exchange and interpretation efforts to establish an accepted data base, accessible to the whole community.

The Halden Project, with its background in execution of internationally sponsored technical programmes and its extensive work contacts to a majority of the most prominent nuclear research and industry organizations in the participating countries, is an already existing and potentially very useful cooperative tool that could be utilized for such coordination efforts.

SPECIAL CONDITIONS FOR THE FUEL TESTING PROGRAMME

Positions for insertion of test fuel assemblies

For the fuel testing programme, the disparity of reactivities resulting from differences in initial enrichment and time of insertion of the test fuel will require a continuous review of the allocation of reactor positions as the characteristics of each test element become known. The intention is that the Halden Programme Group shall evaluate the core loadings throughout the irradiation period.

Test assembly specifications

The intent is that HBWR shall continue to be available as a flexible fuel testing facility for experiments conceived by the participants. Therefore, it is not considered desirable to introduce specifications which limit or prohibit fuel experiments different from those at present being anticipated. The large number of open lattice positions and their corresponding lid penetrations provide capacity for new experiments. The independent subcooling system of HBWR provides the possibility for forced circulation to boiling or non-boiling experiments in limited numbers. There should be no requirement that test pieces conform exactly to HBWR rod bundle geometry.

It is required that a standard HBWR fuel hole closure, or an acceptable modification thereof, should be employed. The full length test assemblies should be supported from the top plate and restrained vertically by the lower plate.

Responsibility of fuel suppliers

The responsibility for providing the complete test assemblies, including fabrication of instruments, handling, insurance, transport, and post-irradiation examination, rests with the individual suppliers. Assistance from the Project can be provided on a cost basis for such items as manufacture of the final assembly. The Project also supplies on a rental basis read-out instruments and data logging facilities. Post-irradiation handling and inspection facilities are available. Partial disassembly and visual inspection can be done at Halden, while detailed inspections can be carried out in the high-level caves of the Kjeller Research Centre. A transport flask is available for transport of active fuel to Kjeller. Transport of active fuel out of Norway must be arranged by the fuel suppliers.

Procedures for fuel testing

The Project has a tested system for the proposing, detailed formulation, and final approval of experiments to be conducted in HBWR. The experimental proposal for fuel testing will be formulated by the fuel supplier in cooperation with Project staff according to existing procedures. Upon approval of the proposal, the supplier will produce a detailed fuel test and design description. The Project staff will be responsible for the final preparation and execution of the experimental procedure. Detailed requirements for the above described documents and the formalities of their execution will be supplied to Project participants on request.

The Project will review each proposed experiment to ensure that it does not compromise the successful completion of the total programme. Institutt for Atomenergi, having overall safety responsibilities, must reserve the right to reject any proposed experiment that could compromise personnel or public safety.

ANNEX III

CONTRIBUTIONS

Contributions from Signatories	*Amounts*
The Norwegian Institutt for Atomenergi	25,200,000
Aktiebolaget Atomenergi, Sweden	5,100,000
Electric Power Research Institute, Inc., USA	4,500,000
The Italian Comitato Nazionale per l'Energia Nucleare	4,700,000
Japan Atomic Energy Research Institute	4,800,000
Kernforschungsanlage Jülich GmbH, Germany	6,700,000
Reactor Centrum Nederland	3,400,000
The Finnish Ministry of Trade and Industry	2,800,000
The Danish Atomic Energy Commission	2,800,000
Total Contributions from Signatories	60,000,000
Contributions from Associated Parties, etc.	13,000,000
TOTAL CONTRIBUTIONS	73,000,000

All amounts in Norwegian Kroner.

For the Norwegian Institutt for Atomenergi:

[*Signed — Signé*][1]

For Aktiebolaget Atomenergi, Sweden:

[*Illegible*]

Subject to parliamentary approval of budgetary provisions

For the Electric Power Research Institute Inc., USA:

[*Illegible*]

For the Italian Comitato Nazionale per L'Energia Nucleare:

[*Illegible*]

For the Japan Atomic Energy Research Institute:

[*Illegible*]

For Kernforschungsanlage Jülich, GmbH representing a German group of companies working in agreement with the German Federal Ministry for Research and Technology:

[*Illegible*]

[*Illegible*]

For Reactor Centrum Nederland:

[*Illegible*]

For the Finnish Ministry of Trade and Industry:

[*Illegible*]

Subject to annual approval of the budget by the Parliament

For the Danish Atomic Energy Commission:

[*Illegible*]

[1] Signed by Viking Olov Ericksen — Signé par Viking Olov Ericksen.