No. 16579

UNITED STATES OF AMERICA
and
JAPAN

Agreement on research participation and technical exchange in the United States Nuclear Regulatory Commission Power Burst Facility (PBF) Research and the Japan Atomic Energy Research Institute Nuclear Safety Research Reactor (NSRR) Program covering a four-year period (with appendices). Signed at Tokyo on 9 March 1976

Authentic text: English.
Registered by the United States of America on 27 April 1978.

ÉTATS-UNIS D'AMÉRIQUE
et
JAPON

Accord quadriennal relatif à la participation à la recherche et à des échanges techniques dans le cadre du Programme de recherche sur les essais de rupture de gaines en régime de puissance de la Commission de réglementation nucléaire des Etats-Unis et du Programme du réacteur de recherche sur la sûreté nucléaire de l'Institut de recherche sur l'énergie atomique du Japon (avec appendices). Signé à Tokyo le 9 mars 1976

Texte authentique : anglais.
Enregistré par les États-Unis d'Amérique le 27 avril 1978.

AGREEMENT[1] ON RESEARCH PARTICIPATION AND TECHNICAL EXCHANGE BETWEEN THE UNITED STATES NUCLEAR REGULATORY COMMISSION (USNRC) AND THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE (JAERI) IN THE USNRC POWER BURST FACILITY (PBF) RESEARCH AND THE JAERI NUCLEAR SAFETY RESEARCH REACTOR (NSRR) PROGRAM COVERING A FOUR-YEAR PERIOD

WHEREAS, the United States Nuclear Regulatory Commission (USNRC) and the Japan Atomic Energy Research Institute (JAERI)

(*a*) Have a mutual interest in cooperation in the field of reactor safety research, and

(*b*) Have as a mutual objective improving and thus ensuring the safety of reactors on an international basis, and

(*c*) Have as a mutual objective the achievement of full reciprocity in the exchange of technical information in the field of reactor safety research, and

(*d*) Recognize their status either as a successor to, or an authorized participant for, an agreement between the United States Atomic Energy Commission and the Japanese Atomic Energy Bureau for the exchange of technical information in the field of research and development in reactor safety, dated the fifth day of March 1973, and

(*e*) Recognize that they are participants in the cooperative programs on reactor safety research of the International Energy Agency (IEA), as defined in the Article IV of the Guiding Principle for Cooperation in the field of Energy Research and Development, agreed upon by the IEA Governing Board, and

(*f*) Have expressed their intention to participate cooperatively in the USNRC funded Power Burst Facility (PBF) research program at the Idaho National Engineering Laboratory owned by the United States Government and operated under contractual arrangement between the Aerojet Nuclear Company and the U.S. Energy Research and Development Administration (USERDA) and the Nuclear Safety Research Reactor (NSRR) program at the Tokai Research Establishment of the JAERI.

NOW, THEREFORE, the USNRC and the JAERI do hereby mutually agree as follows:

Article I. PROGRAM COOPERATION

1. The USNRC and the JAERI will join together, in accordance with the provisions of this agreement, for cooperative research in the USNRC Power Burst Facility (PBF) program as described in Appendix A incorporated herein by reference and the JAERI Nuclear Safety Research Reactor (NSRR) program as described in Appendix B, incorporated herein by reference, for a period of four years beginning upon execution of this agreement.

[1] Came into force on 9 March 1976 by signature.

Article II. SCOPE OF AGREEMENT

A. Scope of Responsibility — USNRC

1. The USNRC, in consideration for the technical benefits received by its participation in the NSRR program and receipt of information under this agreement, agrees to permit the JAERI to participate in the PBF program.

2. The USNRC agrees to provide the necessary personnel, materials, equipment and services in order that the PBF program may be carried out as described in Appendix A, as amended, subject to the availability of funds.

3. The USNRC agrees to permit the JAERI to assign one mutually agreed upon technical expert to the PBF program for participation in the conduct and analysis of program experiments.

4. In addition, the USNRC agrees to permit the JAERI to assign one technical expert as a consultant to the PBF programs review group which will periodically review the status of the present program and future program planning.

5. The USNRC agrees to grant the JAERI access, to the maximum extent authorized by the law of the United States, to all experimental data and results of analyses generated by the PBF program during the period of this agreement.

6. The USNRC agrees to provide the JAERI access to operational computer codes developed to analyze experimental data generated by the PBF program to the maximum extent permitted by the law of the United States, except for proprietary codes and data, unless authorized by the owner.

7. The USNRC agrees to provide the JAERI access to all results obtained from USNRC's analysis of information and experimentation developed for the NSRR program during the period of this agreement, including computer codes used in such analyses.

8. The USNRC agrees to bear the total costs of transportation, living expenses and any other costs arising from its participation in the NSRR program under this agreement and the transport and related costs for apparatuses and other equipment furnished by the USNRC.

B. Scope of Responsibility — JAERI

1. The JAERI, in consideration for the technical benefits received by its participation in the PBF program and receipt of information under this agreement, agrees to permit the USNRC to participate in the NSRR program.

2. The JAERI agrees to provide the necessary personnel, materials, equipment and services in order that the NSRR program may be carried out as described in Appendix B, as amended, subject to the availability of funds.

3. The JAERI agrees to permit the USNRC to assign one mutually agreed upon technical expert to the NSRR program for participation in the conduct and analysis of program experiments.

4. In addition, the JAERI agrees to permit the USNRC to assign one technical expert as a consultant to an NSRR program review group which would periodically review the status of the present program and future program planning.

5. The JAERI agrees to grant the USNRC access, to the maximum extent authorized by the law of Japan, to all experimental data and results of the analyses generated by the NSRR program during the period of this agreement.

6. The JAERI agrees to provide the USNRC access to operational computer codes developed to analyze experimental data generated by the NSRR program to the maximum extent permitted by the law of Japan, except for proprietary codes and data, unless authorized by the owner.

7. The JAERI agrees to provide the USNRC access to all results obtained from JAERI's analyses of information and experimentation developed for the PBF program during the period of this agreement, including computer codes used in such analyses.

8. The JAERI agrees to bear the total costs of transportation, living expenses and any other costs arising from its participation in the PBF program under this agreement, and the transport and related costs for apparatuses and other equipment furnished by the JAERI.

Article III. PATENTS

A. With respect to any invention or discovery made or conceived during the period of, and in the course of and under, this agreement for JAERI participation in the PBF program, the USNRC on behalf of the United States Government, as recipient party, and the JAERI as assigning party, and for USNRC participation in the NSRR program, the JAERI as recipient party, and the USNRC as assigning party, hereby agree that:

1. If made or conceived by personnel of one party (the assigning party) or its contractors while assigned to the other party (recipient party) or its contractors:
   (*a*) The recipient party shall acquire all right, title and interest in and to any such invention, discovery, patent application or patent in its own country and in third countries, subject to a non-exclusive, irrevocable, royalty-free license to the assigning party, with the right to grant sublicenses, under any such invention, discovery, patent application or patent for use in the production or utilization of special nuclear material or atomic energy; and
   (*b*) The assigning party shall acquire all right, title, and interest in and to any such invention, discovery, patent application, or patent in its own country, subject to a non-exclusive, irrevocable, royalty-free license to the recipient party, with the right to grant sublicenses, under any such invention, discovery, patent application or patent, for use in the production or utilization of special nuclear material or atomic energy.
2. If made or conceived while in attendance at meetings or when employing information which has been communicated under this exchange arrangement by one party or its contractors to the other party or its contractors, the party making the invention shall acquire all right, title, and interest in and to any such invention, discovery, patent application or patent in all countries, subject to the grant to the other party of a royalty-free non-exclusive, irrevocable license, with the right to grant sublicenses, in and to any such invention, discovery, patent application, or patent, in all countries, for use in the production or utilization of special nuclear material or atomic energy.

B. Neither party shall discriminate against citizens of the country of the other party with respect to granting any license or sublicense under any invention pursuant to subparagraphs A.1 and A.2 above.

C. Each party waives any and all claims against the other party for compensation, royalty or award as regards any such inventions or discovery, patent application, or patent, and releases the other party with respect to any and all such claims, including any claims under the provisions of the U.S. Atomic Energy Act of 1954, as amended, and the Japanese Laws concerning Industrial Property Rights.

Article IV. WITHDRAWAL FROM AGREEMENT

A. Upon a decision by either USNRC or JAERI to withdraw from this agreement, the withdrawing party shall notify the other party of the intent to withdraw at least six months prior to the date of the withdrawal.

Article V. EXCHANGE OF SCIENTIFIC INFORMATION AND USE OF RESULTS OF PROGRAM

A. The USNRC and the JAERI agree that until approval is granted by the transmitting party for publication, the information, once transmitted, will be freely available to government authorities and organizations cooperating with the USNRC and the JAERI for their own use but not for publication. When required by administrative procedure in its own country, the USNRC and the JAERI may on its own responsibility disseminate or otherwise make use of information received.

B. The USNRC and the JAERI agree that the application or use of any information exchanged or transferred among them shall be the responsibility of the party receiving the information, and the transmitting party does not warrant the suitability of the information for any particular use or application.

For the United States Nuclear Regulatory Commission:		For the Japan Atomic Energy Research Institute:	
By:	[*Signed — Signé*][1]	*By:*	[*Signed — Signé*][2]
Title:	Commissioner	*Title:*	President JAERI
Date:	March 9, 1976	*Date:*	March 9th 1976

APPENDIX A

THE POWER BURST FACILITY (PBF)

IDAHO FALLS, USA

The Facility:

The Power Burst Facility is a water cooled and moderated reactor contained in an open top steel vessel. The PBF is operated for the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC) by the Aerojet Nuclear Company (ANC).

[1] Signed by Edward A. Mason — Signé par Edward A. Mason.
[2] Signed by Eiji Munakata — Signé par Eiji Munakata.

The present reactor core is designed for both steady state operation (to 40 MW) and pulsed mode operation (to 1500 MWsec). A new reactor core interchangeable with the original core should be available sometime after late 1977. The new core is designed for steady state operation for testing large assemblies (clusters) of low enrichment irradiated or unirradiated fuel elements at high power densities.

Table 1 describes the general facility characteristics and compares the test capabilities of the first and second PBF cores.

The PBF currently operates on a two shift basis, but 3 or 4 shift operation during the next few years is probable. At present, reactor tests are scheduled at 7 day to 30 day intervals, with 7 to 16 tests scheduled per 8-month operating year. Four months are allowed each year for reactor modification and maintenance.

The Test Train:

Fuel elements and fuel element assemblies to be tested, one to 25 fuel rods in the first core and one to 64 rods in the second core, are fitted into a test train, together with necessary test instrumentation. The assembled test train is then fitted into a heavy walled vertical pressurizable cylindrical metal tube (the IPT) mounted concentric to the vertical axis of the reactor core and the containing vessel.

The in-pile tube head has six openings, permitting the active use of up to 100 pairs of instrumentation test leads. Typical test instrumentation includes inlet and/or exit flow meters (up to 5 per test), absolute and differential pressure transducers for monitoring fluid and fuel element plenum pressures, surface and internal thermocouples for monitoring fuel, clad, plenum and coolant temperatures, ultrasonic thermometers, linear variable differential transformer (deflection indicators), radiation flux monitor wires and foils and self-powered neutron detectors. Suitable instrumentation, signal conditioning equipment, and data accumulation and reduction equipment and services are available.

The Program:

The program for the four-year period, June 1975-June 1979, encompasses tests in each of the following areas: (*a*) Power-cooling mismatch (PCM), 9 reactor tests (FY76, early FY77), (*b*) Irradiation effects, 14 reactor tests (FY76, FY77), (*c*) Loss of Coolant Accident (LOCA), 11 to 18 reactor tests, (late FY77, 78, 79), (*d*) Inlet Flow Blockage, 5 reactor tests (late FY77, 78), (*e*) Reactivity Initiated Accident (RIA), 7 to 18 reactor tests, (FY77-79), (*f*) Gap Conductance and PCM Parameters, 17 to 23 reactor tests (FY76-79).

This program is subject to continuous review and selective modification as test results are evaluated and further behavior demonstration and model verification needs are identified. The overall PBF test program is based on balanced support of the following Fuel Behavior Branch, RES:RSR, NRC objectives:

1. In-reactor study of fuel properties
2. In-reactor study of fuel rod and fuel rod assembly properties
3. In-reactor study of fuel rod and fuel rod assembly behavior under accident conditions
4. Support of fuel element behavior model development
5. Support of fuel element behavior model evaluation

The several PBF test series are described in the Small Cluster Program Requirements Section of the WRSR Fuel Behavior Program Description prepared by the Systems Safety Research Division, Aerojet Nuclear Company. The test series descriptions may be summarized as follows:

(*a*) Power-Cooling Mismatch Tests: These tests will study CHF and post-CHF fuel behavior of single rods (4 at a time) and 9 rod clusters under a variety of power and cooling

conditions. Coolant flow, stored energy, and test termination temperatures will be measured.

(*b*) Irradiation Effects Tests: These tests will study the effects of irradiation and burnup on the thermal-mechanical properties of cladding materials and single fuel rods and the behavior of fuel rods at high power ratings. Post CHF cladding deformation will be one of the dependent test variables measured.

(*c*) Loss of Coolant Tests: These tests will study fuel rod behavior, e.g., clad deformation and oxidation of multiple rod assemblies, under PWR loss of coolant conditions. Results will be correlated with ex-reactor tests. Parameters to be varied include irradiation history and cold internal pressures. Test loop modifications will provide heatup and blowdown capability late in the 4-year test period.

(*d*) Inlet Flow Blockage Tests: These tests will study fuel rod behavior, e.g., clad temperature profiles of multiple rod assemblies under inlet flow blockage conditions. Blockages of 80% and greater will be investigated. Test loop modifications will be required for these tests.

(*e*) Reactivity Initiated Accident Tests: These tests will study irradiated and unirradiated fuel rod behavior under rod drop and rod ejection conditions. Independent rod tests, cluster tests and model development/evaluation tests will be performed. The effects of irradiation, cluster size, coolant flow, and initial power level will be suited.

(*f*) Gap Conductance and PCM Parameter Tests: These tests will study gap conductance and fuel rod behavior of irradiated and unirradiated rods. Parameters to be varied include irradiation history, gap size, fill gas and pressure and pellet densities. Power oscillation (transfer function technique) and integral k-dt methods will be compared.

Table 1. PBF TEST CAPABILITIES

	*Core 1**	*Core 2**
Test Space Size:		21.6 cm, target
Diameter	15.5 cm	15.5 cm, minimum
Active length	91 cm	91 m (nominal)
Test Coolant Flow Rate:	0-3000 l/min	0-3000 l/min
Coolant Pressure:	0.3-15.6 MPa (154 atm, std)	0.3-15.6 MPa (154 atm, std)
Coolant Temperature:	Ambient-343° (650°)	Ambient-343 °C (650°F)
Test Power Density (max):	*a*) 18 kw/ft in a 16 rod array of highly enriched 17 x 17 type PWR fuel rods	*b*) 21 kw/ft in a 36 rod array of irradiated (to 40,000 MWD/MIM) 17 × 17 type PWR fuel rods with maximum initial enrichments of 3.1 w/o ^{235}U.
	b) 18 kw/ft in a 25 rod array of highly enriched BWR-6 type fuel rods	*b*) 21 kw/ft in a 25 rod array of irradiated (to 40,000 MWD/MIM) BWR-6 type fuel rods with maximum initial enrichments of 2.0 w/o ^{235}U.
Test Power Rate of Change:		
Steady State	100%/min power increase 15%/sec power decrease	100%/min power increase 15%/sec power decrease
Pulse Mode	Periods as short as 1.3 msec-natural burst (to 1 500 mw sec sloped burst)	

*Cores can be interchanged during annual shutdown period (60-120 days).

APPENDIX B

THE NUCLEAR SAFETY RESEARCH REACTOR (NSRR)

TOKAI, JAPAN

1. The Facility:

The Nuclear Safety Research Reactor (NSRR) is a UZrH fueled, zirconium hydride and water moderated and water cooled annular core pulse reactor contained in an open top swimming pool, owned by the Japan Atomic Energy Research Institute (JAERI). The NSRR has a 23 cm diameter experimental hole in the center of the core, where the experiment (a capsule or a loop) can be accommodated. The maximum pulsing capability is described in Table 1. The maximum steady state power level is 300 KW.

2. The Experiment:

Test fuel elements, one to several rods, are fitted into a capsule or a loop, together with necessary test instrumentation.

The assembled experiment is then fitted into the aluminum and stainless steel walled experimental hole at the core center. The signals from the test instrumentation are recorded on a data acquisition and processing system which consists of an analogue data recorder and an electric computer.

There are two types of capsules. One is a so-called 'atmospheric pressure capsule,' whose inside pressure and water temperature are an atmospheric pressure and ambient temperature.

Capsules of this type have been served for in-pile experiments since October 1975.

The other one is a "high pressure capsule," whose internal pressure and water temperature are variable up to 150 kg/cm and 320°C respectively.

The loop is being so designed that the internal pressure, water temperature and water flow rate may be raised up to 150 kg/cm, 320 °C and 5 m/sec respectively. The high pressure capsule and loop will be available for in-pile experiments in late 1976.

3. The Program:

The program for four year period from 1976 to 1979 will be devoted to the reactivity initiated accident (RIA) experiments, and consists of the following major three test items:

(1) Preliminary Tests: These tests are intended to roughly survey the fuel rod behavior as a function of energy insertion and confirm the feasibility of test instrumentation as well as the reliability of capsules and loops. (Approximately 20 tests in 1976 and 1977).

(2) Fundamental Tests: These tests are intended to study the fuel rod behavior before failure, threshold energy and mechanism of either fuel failure or loss of integrity of fuel elements, fuel-coolant interaction, pressure generation mechanism, its mechanical effect and so forth.

These tests will be performed simulating, as closely as possible, the RIA conditions mainly from cold start-up and hot stand-by states in power reactors.

Hundreds of unirradiated BWR and PWR fuel rods will be used for these tests from 1976 to 1979. Furthermore, the experimental data will be utilized for verifying computer codes.

(3) Parametric Tests: These tests are intended to study the sensitivity of various parameters pertaining to fuel elements to the fuel failure threshold energy, failure mechanism and post-failure phenomena.

The main parameters presently being considered are: clad material, heat treatment of the clad, hydrogen content in the clad, plenum gas composition, plenum gas pressure, fuel-clad gap width, pellet density, pellet shape and so forth.

Study on the failure threshold and post-failure behavior of water-logged fuel elements and of irradiated fuel elements will also be a significant item in these test series. Fuel burn-up will be simulated by using irradiated clad with unirradiated fuel pellets together with plenum gas having appropriate composition and pressure. Furthermore, the feasibility of applying actually irradiated fuel elements to the NSRR experiments is being examined. (Approximately 400 tests from 1976 to 1979.)

Table 1. MAXIMUM PULSING CAPABILITY OF NSRR

Maximum reactivity insertion	$4.70 (3.43% Δk)
Peak reactor power	22,000 MW
Prompt energy release	106 MW-sec
Shortest reactor period	1.12 msec
Pulse width at half maximum power	4.3 msec

Example of estimated heat deposition in a test fuel rod by the maximum pulse:
—210 cal/g·UO_2 for 2.6% enriched fuel
—340 cal/g·UO_2 for 5.0% enriched fuel
—450 cal/g·UO_2 for 10% enriched fuel
—550 cal/g·UO_2 for 20% enriched fuel