No. 21018

UNITED STATES OF AMERICA
and
FRANCE

Agreement on research participation and technical exchange in the United States Nuclear Regulatory Commission Loss of Fluid Test (LOFT) research programme (with appendix). Signed at Paris on 30 July 1980 and at Washington on 12 September 1980

Authentic texts: English and French.

Registered by the United States of America on 15 April 1982.

ÉTATS-UNIS D'AMÉRIQUE
et
FRANCE

Accord de participation à la recherche et d'échange technique sur le programme de recherche sur les installations d'essai de perte de fluide (LOFT) du Commissariat à l'énergie atomique des États-Unis (avec annexe). Signé à Paris le 30 juillet 1980 et à Washington le 12 septembre 1980

Textes authentiques : anglais et français.

Enregistré par les États-Unis d'Amérique le 15 avril 1982.

AGREEMENT[1] ON RESEARCH PARTICIPATION AND TECHNICAL EXCHANGE BETWEEN THE UNITED STATES NUCLEAR REGULATORY COMMISSION (USNRC) AND THE COMMISSARIAT À L'ÉNERGIE ATOMIQUE (CEA) IN THE USNRC LOFT RESEARCH PROGRAM

The Contracting Parties,

Considering that the United States Nuclear Regulatory Commission (USNRC) and the Commissariat à l'énergie atomique (CEA)

(*a*) Have a mutual interest in cooperation in the field of light water reactor (LWR) safety research conducted in special facilities such as the Loss of Fluid Test (LOFT) facility;

(*b*) Have cooperated in the field of LWR safety research under the terms of a 5-year Technical Exchange Arrangement, originally signed on October 16, 1974,[2] between the United States Atomic Energy Commission (USAEC) and the CEA, but continued after January 19, 1975, as between the USNRC and the CEA;

(*c*) Have indicated their mutual wish to continue the cooperation established under the aforementioned Arrangement by the execution of a new technical exchange arrangement in the field of LWR safety (hereinafter referred to as the NRC-CEA LWR Arrangement); and

(*d*) Have expressed their intention to participate cooperatively in the USNRC-funded LOFT research program at the Idaho National Engineering Laboratory (INEL), which is operated under contractual arrangement between the US Department of Energy and EG&G, Idaho;

(*e*) Have noted that the CEA, Electricité de France (EdF) and FRAMATOME cooperate closely in the field of LWR safety research and that such cooperation will extend to include the scope of participation by the CEA in the LOFT program as provided for under the terms of this Agreement, including the provisions for exchange and use of information and for assignment of personnel;

Now, therefore, do agree as follows:

Article 1. OBJECTIVE

The USNRC and the CEA, in accordance with the provisions of this Agreement and subject to applicable laws, regulations and national policy in force in their respective countries, will join together for cooperative research in the USNRC LOFT program, as described in appendix 1, or as amended.

Article 2. SCOPE OF AGREEMENT

2.1. The USNRC will provide the necessary personnel, materials, equipment and services in order that the LOFT research program may be carried out as described in appendix 1, or as amended, subject to the availability of funds.

[1] Came into force on 12 September 1980 by signature, in accordance with article 6 (1).
[2] United Nations, *Treaty Series*, vol. 1066, p. 305.

2.2. The CEA may assign up to three mutually agreed upon technical experts to the LOFT program for participation in the conduct and analysis of program experiments.

Each such assignment will be the subject of a separate attachment-of-staff agreement between representatives of the Contracting Parties.

2.3. In addition, the CEA may assign one technical expert as a consultant to the LOFT program review group which will periodically review the status of the present program and future program planning.

2.4. The USNRC agrees to provide the CEA and its assignees access to all experimental data and results of analyses generated by the LOFT program during the period of this Agreement.

2.5. The USNRC agrees to provide the CEA access to USNRC operational computer codes and input data used to analyse LOFT experimental data; access to codes and data not developed by the USNRC will not be provided except by written authorization of the owner.

2.6. The CEA, as a contribution for participation in the USNRC LOFT research program, agrees to pay into a specified US Government account the amount of $ 1 million annually for the period of this Agreement, the initial payment to be made within 1 month after execution of this Agreement, with subsequent payments made on each of the remaining anniversary dates of the execution of this Agreement.

2.7. The CEA agrees to provide the USNRC access to all results obtained from CEA's analyses of LOFT information and experimentation developed under and during the period of this Agreement.

2.8. The CEA agrees to provide the USNRC access to CEA operational codes and input data used in the analysis of LOFT experimental data, being understood that some codes may be considered as proprietary and consequently shall be handled as proprietary information in pursuance with the provisions set forth in article 5 of the CEA-NRC LWR Arrangement. Access to codes and data not developed by the CEA will not be provided except by written authorization of the owner.

2.9. The CEA agrees to bear the total costs of transportation living expenses and any other costs arising from its participation under this Agreement, including the transport and related costs for apparatus and other equipment furnished by the CEA, except, as authorized by the USNRC, for office and travel expenses of CEA assignees at the INEL incurred in connection with their work in the LOFT program.

Article 3. EXCHANGE AND USE OF INFORMATION

The parties agree that the provisions on exchange and use of information set forth in article 5 of the above-referenced NRC-CEA LWR arrangement shall apply for this Agreement.

Article 4. PATENTS

The parties agree that the provisions on patents set forth in article 6 of the above-referenced NRC-CEA LWR arrangement shall apply for this Agreement.

Article 5. DISPUTES

Any dispute between the USNRC and the CEA concerning the application or interpretation of this Agreement that is not settled through consultation shall be submitted to the jurisdiction of the United States Federal courts. This Agreement shall be construed in accordance with the internal Federal law applicable in the appropriate United States Courts, to agreements to which the Government of the United States is a party.

Article 6. FINAL PROVISIONS

6.1. This Agreement shall enter into force upon signature of the parties and shall remain in force for a period of three years.

6.2. Either party may withdraw from the present Agreement after providing the other party written notice six months prior to its intended date of withdrawal.

6.3. The CEA may at its option participate in a continuation of the USNRC LOFT program beyond the three-year period of this Agreement under mutually acceptable terms and conditions which are formally documented and executed.

6.4. If the USNRC LOFT technical program is substantially increased by mutual agreement, the USNRC and CEA agree to consider equitable adjustments in the CEA contribution.

6.5. If the LOFT research program is substantially reduced or eliminated, equitable work determined by the USNRC and CEA to be of equivalent programmatic interest may be substituted as may be mutually agreed.

6.6. If the LOFT research program is significantly delayed, the payments provided for in § 2.6 hereabove may be postponed for an equivalent period of time and the effectiveness of this Agreement will be extended accordingly, as mutually agreed.

DONE in duplicate in the English and French languages, each equally authentic.

The Commissariat à l'énergie atomique (CEA):	U.S. Nuclear Regulatory Commission (USNRC):
[*Signed*]	[*Signed*]
Name: PIERRE TANGUY	*Name:* WILLIAM J. DIRCKS
Title: Délégué à la protection et à la sûreté nucléaire	*Title:* Acting Executive, Director for Operations
Date: 30 juillet 1980	*Date:* September 12, 1980

APPENDIX

LOFT TEST RESULTS AND PROGRAM PLANS

Results to date

In the four years of testing at the LOFT facility four distinct types of tests have yielded results of use to the licensing process. First, large pipe break loss-of-coolant experiments without nuclear power, second, large pipe break loss-of-coolant experiments with nuclear power, third, small pipe break loss-of-coolant experiments with nuclear power, and fourth, an operational transient initiated at full power.

The large break non-nuclear tests were initiated at approximately full reactor coolant pressure and temperature. They were designed to study the effectiveness of the emergency core cooling (ECC) systems in delivering coolant to the core and thus confirm certain conservatisms in the NRC's ECC rule. The results showed that the ECC water is delivered more quickly to the core, more reactor coolant remains in the core region and less ECC water flows from the break than is predicted by codes based on the ECC rule. These tests also demonstrated that the ECC systems which are identical to those in commercial reactors work as expected, and they provided invaluable experience in handling a nuclear reactor under accident conditions.

The subsequent large break nuclear tests showed that early in the accident, even before the ECC system is actuated, the core receives a flow of water which significantly lowers the temperature of the fuel leaving it more readily coolable than expected when the ECC water arrives. When the physics of the predictive procedures was corrected to agree with the observed thermal hydraulics, this unexpected behavior was then predicted. Computer codes which were so modified then predicted that the same cooling phenomenon would occur in a commercial reactor subjected to the same large break accident. Additional large break tests, which were postponed to 1982 in order to permit small break and anomalous transient tests, will study the effect of higher core power, the loss of off-site power and the effect of using pre-pressurized fuel.

The small break tests series is designed to study the behavior of a plant subjected to various pressure transients, the effectiveness of different possible decay heat sinks (the break, the steam generator, ECC injection and the primary make-up system) and the effect of different break locations. The first test was done only two months after the TMI-2 accident. It was initiated at full pressure and temperature, but in order to obtain much needed data as early as possible, the core was not generating power. This test was a study of a stuck open PORV and therefore demonstrated some of the events which occurred early in the TMI-2 accident. The second test, simulating a 4-inch break, caused a slow continuous depressurization and eventual activation of the ECC systems to refill the plant before core uncovery. The third test, simulating a 1-inch break caused a very slow pressure reduction with stabilization at an intermediate value. Operator intervention then brought the pressure down sufficiently to actuate the ECC systems and the plant was recovered without uncovering the core. Of special interest to NRC was the indication that the steam generator transitioned from liquid natural circulation to liquid-vapor natural circulation, and possibly to reflux boiling (or condensate fall-back) and then back again, with no evidence of instability. Another important discovery was the realization that flow paths which bypass the core and which exist in all PWRs can have an important influence over the course of a small break accident.

The fourth small break test, run June 20, 1980, examined the effectiveness of various heat sinks available to PWRs. Preliminary study of these results suggests that for larger small breaks (4″ pipe and above) the break flow is sufficient to carry away all decay heat while for smaller breaks (1″ pipe) the steam generator is the dominant heat sink and its pressure leads the primary system pressure very closely. Other conclusions regarding reflux cooling as a mechanism of decay heat removal and the effect of accumulator nitrogen on the effectiveness of the steam generator are now being studied.

Future tests FY 1980-1981

During this period all planned small breaks (L3 series), most operational transients (L6 series), and the first intermediate sized break (L5 series) will be done. These include:

Test	*Target Date*	*Comment*
L3-5	Oct. 1980	Small (4-in) break, pumps off, to be used as reference for next test.
L3-6	Dec. 1980	Small (4-in) break, pumps on. NRR has requested these two test with the utmost urgency.

Test	*Target Date*	*Comment*
L6-7 L3-3	Mar. 1981	Loss of feedwater initiating a small (1-in) break. Requested specifically by NRR to complete range of conditions to be expected in small breaks.
L6-2	Oct. 1980	Operational transient; loss of primary flow.
L6-3	July 1981	Operational transient; steam line break.
L5-1	Aug. 1981	Intermediate break

Each operational transient has been selected as the most severe in its chap. 15 group. Each requires very little time to perform yet provides needed data for transient code assessment and for direct comparison to commercial PWR behavior. The data from this series will also be used in planning a series of Anticipated Transients Without Scram for FY 1983.

The intermediate break has been scheduled in anticipation that once the large and small LOCA results are analyzed, some intermediate break size(s) will be identified as representing a safety concern.

FY 1982

During this year, the program returns to complete unfinished work in the large break LOCA area (L2 series):

Test	*Date*	*Comment*
L2-5	Nov. 1981	Large break at 12 Kw/ft peak rating, loss of offsite power. Expect fuel damage and need to replace center fuel module. Uncertainty in result together with specific reference by Appendix K underline need for this test.
L6-4	May 1981	Operational transient; control rod withdrawal.
L5-2	June	Intermediate break.
L2-4	Sept. 1982	Large break at 16 Kw/ft peak rating, perhaps loss of offsite power. Recognizes need to test at highest allowed powers. Will then require a complete core change.

Out years FY 1983 and FY 1984

During this period the program will complete the large break series and the alternate ECCS series, and will study ATWS and other phenomena:

Test	*Date*	*Comment*
L2-6	Mar. 1983	Large break, prepressurized fuel. Until this test only unpressurized fuel will be used. This test will identify the effect of the LOCA on clad ballooning and the subsequent deterioration of the core. NRC's fuel engineers have a strong interest in this test. At least the center fuel will then have to be replaced.
L6-8	July 1983	Anticipated transient without scram.
L7-1	July 1983	Large break, simultaneous steam generator tube rupture.
L6-9	Sept. 1983	Anticipated transient without scram.
L7-2	Oct. 1983	Large break, simultaneous steam generator tube rupture.
L4-1	Dec. 1983	Large break with ECC injection into downcomer.
L4-2	March 1984	Large break with ECC injection into upper plennum.
L4-3	May 1984	Large break with combined hot and cold leg injection of the ECC.

In addition to these transient and loss-of-coolant accident experiments, the LOFT program is yielding research results in other areas important to NRC.

Plant instrumentation

LOFT is serving as a test bed for instruments to monitor the reactor coolant behavior during accidents. For example, instruments proposed for commercial plants to meet NRC's post-TMI requirements for measuring liquid level in the reactor vessel will be tested in LOFT.

Improved control room display and diagnostic equipment

LOFT has installed visual display equipment in the control room to monitor important safety parameters during transients and accidents. This equipment has been demonstrated in recent tests and may prove to be the prototypes for safety parameter display and onsite technical support center requirements in commercial plants.

Severe fuel damage tests

One of the lessons from the TMI accident is that much more work must be done to study the behavior of severely damaged fuel during accidents. We are currently examining the merits of conducting some severe core damage tests in LOFT at the end of the currently planned test program.

Reference: J. D. Burtt, *LOFT Experimental Program Document* (Draft: January 15, 1980).