No. 19251

UNITED STATES OF AMERICA
and
SWITZERLAND

Agreement on research participation and technical exchange in the United States Nuclear Regulatory Commission (USNRC) Heavy Section Steel Technology Program and the research programme in fracture mechanics of the Swiss Federal Institute for reactor research (EIR) covering a four-year period (with appendices). Signed at Washington on 15 June 1979 and at Wurenlingen on 9 July 1979

Authentic text: English.

Registered by the United States of America on 7 November 1980.

AGREEMENT[1] ON RESEARCH PARTICIPATION AND TECHNICAL EXCHANGE BETWEEN THE UNITED STATES NUCLEAR REGULATORY COMMISSION (USNRC) AND THE SWISS FEDERAL OFFICE OF ENERGY (EAEW) FOR AND ON BEHALF OF THE GOVERNMENT OF SWITZERLAND IN THE USNRC HEAVY SECTION STEEL TECHNOLOGY PROGRAM AND THE RESEARCH PROGRAM IN FRACTURE MECHANICS OF THE SWISS FEDERAL INSTITUTE FOR REACTOR RESEARCH (EIR) COVERING A FOUR-YEAR PERIOD

The Contracting Parties,

Considering that the United States Nuclear Regulatory Commission (USNRC) and the Swiss Federal Office of Energy (EAEW)

(*a*) Have a mutual interest in cooperation in the field of reactor safety research, with the objective of improving and thus ensuring the safety of reactors on an international basis;

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

(*c*) Recognize that their respective countries are parties to the Implementing Agreement on the Technical Exchange of Information in the Field of Reactor Safety Research and Development of the International Energy Agency, signed on May 20, 1976, under which this Agreement is executed, and

(*d*) Have expressed their intention to participate cooperatively in the USNRC Heavy Section Steel Technology (HSST) program and in the Fracture Mechanics research program carried out by the Swiss Federal Institute for Reactor Research (EIR),

Have agreed as follows:

Article I. PROGRAM COOPERATION

The USNRC and the EAEW, in accordance with the provisions of this Agreement and subject to applicable laws and regulations in force in their respective countries, will join together for cooperative research in the USNRC-sponsored HSST program, as described in appendix 1 or as amended, and in the EIR Fracture Mechanics program, as described in appendix 2, or as amended.

Article II. SCOPE OF AGREEMENT

2.1. Both parties agree that the research programs which each has included for technical exchange under the terms of this Agreement and are described in appendices 1 and 2 are open for participation by the other party.

2.2. Subject to the availability of funds, each party agrees to provide the necessary personnel, materials, equipment and services for the performance of their respective programs, as described in appendix 1 or 2, or as amended.

2.3. Each party agrees to permit the other to assign a mutually agreed upon technical expert to participate in the program that the permitting party is sponsoring, as described in appendix 1 or 2, or as amended.

2.4. Further, each party agrees to permit the other to assign a technical expert to participate in any program review group that the permitting party may have established for periodic reviews of the status and future plans of the program it is sponsoring.

[1] Came into force on 9 July 1979 by signature, in accordance with section 6 (1).

2.5. Each party agrees to provide to the other party access to all experimental data and results of analyses it has obtained or derived from the USNRC and EIR programs included under this Agreement, as well as access to operational computer codes and data it has developed or used to analyze the results of these two programs, except for proprietary codes and data, which will not be made available unless authorized by the owner.

2.6. Each party agrees to bear the total costs of transportation, living expenses and any other costs arising from its participation under this Agreement, and for the transport and related costs for apparatus and other equipment furnished by it.

Article III. PATENTS

3.1. With respect to any invention or discovery made or conceived during the period of, or in the course of or under, this Agreement for SWISS participation in the USNRC HSST program described in appendix 1, or as amended, the USNRC as the recipient party and the EAEW as the assigning party, and for USNRC participation in the EIR Fracture Mechanics Program described in appendix 2, or as amended, the EAEW as the recipient party and the USNRC as the assigning party, hereby agree that:

3.1.1. 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 nonexclusive, 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 nonexclusive, 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.

3.1.2. If made or conceived other than by personnel in paragraph 3.1.1 above and while in attendance at meetings or when employing information which has been communicated under this Agreement 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, nonexclusive, 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.

3.2. 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 3.1.1 and 3.1.2 above.

3.3. Each party will assume the responsibility to pay awards or compensation required to be paid to its nationals according to the laws of its Country.

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

4.1. Subject to the other provisions of this article, the parties agree that information developed or transmitted under this Agreement may be given wide distribution. Except as may be noted hereinafter, such knowledge and information may be made available to

the public through customary channels and in accordance with normal procedures of the parties.

4.2. It is recognized by both parties that in the process of exchanging information, or in the process of other cooperation, the parties may provide to each other "industrial property of a proprietary nature." Such property, including trade secrets, inventions, patent information, and know-how, made available hereunder and which bears an appropriate restrictive legend clearly indicating that the property is of proprietary commercial value, shall be respected by the receiving party and shall not be used for commercial purposes or made public without the prior consent of the transmitting party. Such property is defined as that which:

(*a*) Has been held in confidence by its owner; and

(*b*) Is of a type which is customarily held in confidence by its owner; and

(*c*) Has not been transmitted by the transmitting party to other entities (including the receiving party) except on the basis that it be held in confidence; and

(*d*) Is not otherwise available to the receiving party from another source without restriction on its further dissemination.

4.3. Recognizing that "industrial property of a proprietary nature," as defined above, may be necessary for the conduct of specific programs included under this Agreement, or may be included in an exchange of information, such property shall be used only in the furtherance of nuclear safety programs in the receiving country. Its dissemination will, unless otherwise mutually agreed to in writing, be limited as follows:

(*a*) To persons within or employed by the receiving party, and to other concerned government agencies of the receiving party, and

(*b*) To prime or subcontractors of the receiving party for use only within the country of the receiving party and within the framework of its contract(s) with the respective party engaged in work relating to the subject matter or the information so disseminated, and

(*c*) On an as-needed, case-by-case basis, to organizations licensed by the receiving party to construct or operate nuclear production or utilization facilities, provided that such information is used only within the terms of the license and in work relating to the subject matter of the information so disseminated, and

(*d*) To contractors of licensed organizations in subparagraph (*c*) receiving such information, for use only in work within the scope of the license,

provided that the information disseminated to any person under subparagraphs (*b*), (*c*) and (*d*) above shall be pursuant to an agreement of confidentiality.

4.4. The application or use of any information exchanged or transferred between the parties under this Agreement 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.

Article V. DISPUTES

5.1. Any dispute between the parties concerning the interpretation or application of this Agreement which is not settled by negotiation or other agreed mode of settlement shall be referred to a tribunal of three arbitrators to be chosen by the parties, and who shall also choose the chairman of tribunal. Should the parties fail to agree upon the composition of the tribunal or the selection of the chairman, the President of the International Court of Justice shall, at the request of the parties, exercise those responsibilities. The tribunal shall decide any such dispute by reference to the terms of this Agreement and any applicable laws and regulations, and its decision on all questions of facts shall be final and binding on the parties.

Article VI. FINAL PROVISIONS

6.1. This Agreement shall enter into force upon signature of the parties and shall remain in force for a period of 4 years.

6.2. Either party may withdraw from the present Agreement after providing the other party written notice 6 months prior to its intended date of withdrawal.

6.3. If either of the research programs described in appendices 1 and 2 is substantially reduced or eliminated, other research work of equivalent programmatic interest may be substituted upon mutual agreement of the parties.

6.4. Either party may at its option participate in a continuation of the other party's program beyond the 4-year period of this Agreement under mutually acceptable terms and conditions.

For the United States
Nuclear Regulatory Commission:
By: [*Signed — Signé*][1]
Title: Executive Director for Operations
Date: June 15, 1979

For the Swiss Federal
Office of Energy:
By: [*Signed — Signé*][2]
Title: Deputy Director
Date: July 9, 1979

APPENDIX 1

THE HEAVY SECTION STEEL TECHNOLOGY (HSST) PROGRAM

The Program

The Heavy-Section Steel Technology (HSST) Program is a major Nuclear Regulatory Commission (NRC) sponsored safety engineering research activity devoted to development of a quantitative basis for assuring adequate margins of safety against fracture of the primary coolant pressure boundaries of water-cooled nuclear power reactors. The principal objects of study are the thick-walled pressure vessels of these reactor systems. All relevant aspects of the technology of the steels and weldments commonly used in reactor pressure vessels are being investigated. Another important part of the program is to establish quantitative relationships between the characteristics of materials and loading conditions under which fracture would occur in a flawed structure.

The specific objectives of the program are to provide a thorough quantitative assessment of heavy-section reactor vessel steel fracture characteristics including a realistic assessment of fracture potential and development of fracture prevention criteria. The program will include the effects of irradiation, flaw growth mechanisms, and the effects of thermal shock, with crack propagation and arrest characteristics under both stress and toughness gradients.

Table 1 describes the general test program capabilities.

The program has been underway since 1967 and over 70 technical reports or progress reports have been produced. The program is extending into studies of thermal shock, weld heat affected zones and failure under pneumatic loads.

Research Areas

The HSST program is comprised of the major research areas listed below:

—*Elastic Plastic Fracture Analysis Development and Evaluation:* This part of the program has been set up to develop new methods of elastic-plastic fracture analysis and to evaluate existing methods. J-R curve test development for upper shelf toughness characterization is an important

[1] Signed by Lee V. Gossick — Signé par Lee V. Gossick.
[2] Signed by C. Zangger — Signé par C. Zangger.

task in FY 77-78. Photoelastic measurements and analysis of nozzle corner cracks are conducted in model vessels. The required fracture toughness testing is performed in this area. Also this research area provides the analytical support for the thermal shock and the intermediate test vessel (ITV) programs.

—*Cyclic Crack Growth and LWR Crack Growth Analyses:* In this research area, the investigators are to continue to develop cyclic crack growth rate data including the effects of material, LWR water chemistry, temperature, R-ratio, cyclic rate, hold time, loading rate, etc., and to determine a realistic upper bound relationship between da/dN and delta K. From these data, the investigator will update the crack growth analyses for LWR pressure vessels.

—*Irradiation Effects:* The purpose of this research area is to determine the static and dynamic toughness of the ductile upper shelf of irradiated reactor vessel materials. Included among the FY 1977 tasks are completion of a 4T-CT program on low shelf weld metals and initiation of a third irradiation of this material.

—*Intermediate Vessel Testing:* Tests are planned to evaluate structural integrity of repair welds both on the upper shelf and in the transition region. A crack arrest test is also planned.

—*Thermal Shock:* The aim of this research area is to verify the method of analysis that is used to predict crack propagation in a reactor vessel subjected to emergency core cooling system (ECCS) operation following a postulated loss-of-coolant accident (LOCA). Thermal shock tests on 21-inch OD test cylinders have been completed, and studies are underway to design a "warm prestressing" test using liquid N_2 on large cylinders.

Table 1. HEAVY SECTION STEEL TEST PROGRAM CAPABILITIES

Test Phase	*Capabilities*
1. Intermediate Test Vessel (ITV) Testing	Temperature from ambient to ~200°F (~93°C) Pressures from ambient to ~35 ksi (~241MPa)
2. Pneumatic Load Testing of Vessels	Vessel sizes up to ~39 in. (99 cm) O.D. by 54 in. (137 cm) high
3. Thermal Shock Testing	Temperatures from −10°F (−23°C) to 550°F (288°C) Ambient pressure Specimen sizes: straight cylinders 21 in (53 cm) O.D. and 39 in (99 cm) O.D.
4. Irradiation Effects	Hot cells for studying highly irradiated Charpy, tensile and 1T CT specimens Irradiation facilities: —Temperature control up to 550°F —Fluences up to ~2×10^{19} n/cm^2 —Specimen up to 4 in. CS.

APPENDIX 2

THE EIR RESEARCH PROGRAM IN FRACTURE MECHANICS

The Program

The EIR Research Program in Fracture Mechanics was initiated in 1972 with the aim to review and improve the existing methods for analyzing fracture phenomena in the light of their application to nuclear power reactor structures in Switzerland. In particular the program aims at improving the basis for a prediction of fracture behavior in case of ductile materials and relatively thin walled structures, like, for instance, containment shells or primary pipe systems.

The specific objective of the program is a quantitative evaluation of the safety margin against fracture for nuclear reactor components under both monotonic and alternating loading conditions. Theoretical and experimental work is done on selected topics within this frame.

So far, about 25 technical reports have been produced and 13 papers have been published in the open literature or presented at related groups. The program is sponsored by the Swiss Licensing Authority. Contributions to three Swiss regulatory guides have been made in this context.

Research Areas

Fatigue Growth Mechanics of Planar Cracks

Fatigue growth of realistically shaped cracks in wide plate specimens made of nuclear reactor steels is investigated experimentally. A theoretical model is sought for prediction of growth rate and change of shape of fatigue cracks in vessel walls with particular emphasis to low cycle—high loading conditions. Use in the model of elastic-plastic fracture parameters to describe crack growth is envisaged. The results will be applied to the "leak before break" question.

Another typical application is the realistic prediction of crack growth in noninspectable areas of nuclear pressure vessels in order to assess the requirements for inservice inspection.

Elastic-Plastic Fracture Mechanics

The development of elastic-plastic methods is continuously followed up. Potentially useful methods are studied with a view to prediction of high load fatigue crack growth in connection with the research area described above. Especially the crack opening displacement and the J-Integral technique are applied to the testing of materials for nuclear components, in order to obtain a more realistic estimate on the safety against fracture at these operational conditions, under which ductile fracture is expected. The degree of conservatism of the various methods is evaluated for specific examples.

Effect of Dimensions on Fracture Behavior

A theoretical model was developed for prediction of the thickness dependent transition from a plane stress to a plane strain condition in front of a crack in fracture mechanics specimens. Measurements of the state of stress and the state of strain in front of deep notches are made for both elastic and plastic material behavior. These measurements are extended to specimens with very sharp notches, representing cracks. Plans exist to further improve the model and to make it suitable for application to more complex geometries.