

# **AGREEMENT**

## **ON THE OECD MCCI PROJECT**

**A PROJECT TO INVESTIGATE EX-VESSEL  
MELT COOLABILITY AND CONCRETE INTERACTION  
DURING A SEVERE ACCIDENT**

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### **A PROJECT TO INVESTIGATE EX-VESSEL MELT COOLABILITY AND CONCRETE INTERACTION DURING A SEVERE ACCIDENT**

The United States Nuclear Regulatory Commission, The Tractebel Energy Engineering, Belgium, The Nuclear Research Institute of the Czech Republic, The Valtion Teknillinen Tutkimuskeskus, Finland, also representing other Finnish Parties, The French Institut de Protection et de Sûreté Nucléaire, jointly with the Commissariat à l'Énergie Atomique and Electricité de France, The Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH., Germany, The Hungarian Atomic Energy Authority jointly with VAEKI, Hungary, The Nuclear Power Engineering Corporation, Japan, The Korea Atomic Energy Research Institute, The Institute for Energy Technology, Norway, The Consejo de Seguridad Nuclear, Spain, The Statens Kärnkraft-Inspektion, Sweden, The Swiss Federal Nuclear Safety Inspectorate

CONSIDERING that the United States Nuclear Regulatory Commission (USNRC) has set up an international programme called the "MCCI PROJECT", to conduct experiments at the Argonne National Laboratories (ANL) using prototypical materials and simulating severe accident conditions:

CONSIDERING that complete quench of the molten masses by water flooding from the top and the long-term interaction of the melt with the containment concrete structure are outstanding safety issues that need to be experimentally addressed:

CONSIDERING that the experiments conducted so far at the ANL have been very valuable in identifying possible mechanisms for cooling of the molten debris by flooding from above and that specific tests are needed to prove that such mechanisms would lead to complete quench:

CONSIDERING that prior to melt quench or for the case in which the containment cavity remains dry, melt-concrete interaction may undermine containment structures and that a characterisation of two-dimensional melt-concrete interaction phenomena is needed in order to evaluate viable accident management measures;

CONSIDERING that the OECD Nuclear Energy Agency (OECD/NEA) is entrusted with promoting the creation of international co-operation projects between its Member countries in the field of the peaceful uses of nuclear energy;

CONSIDERING that the USNRC has proposed to OECD/NEA Member countries that they participate in a series of experiments on ex-vessel melt coolability and concrete interaction to be conducted in the ANL Reactor Analysis and Engineering facilities;

CONSIDERING that this proposal is of interest to the Signatories and that they are willing to provide financial and other support to such a joint project for a period of four years;

CONSIDERING that the development, construction and operation of the necessary experimental facilities will be carried out under the USNRC responsibility and in accordance with all relevant laws and agreements;

AGREE to participate in an OECD Project Programme to investigate ex-vessel melt coolability and concrete interaction that constitutes the MCCI Experimental Programme (hereinafter referred to as "the Project"), on the terms and conditions stated herein:

#### *Article 1*

### **OBJECTIVES**

The Signatories, in accordance with this Agreement, shall jointly with the USNRC define an experimental test matrix, experimental conditions, and parameters to be investigated in the MCCI Project, according to the programme outline described in Appendix A hereto. The programme is to provide experimental data on relevant severe accident phenomena and to resolve two important accident management issues. The first one concerns the mechanisms by which the molten debris that has spread on the base of the cavity, can be stabilised and cooled by water flooding from the top. The second issue concerns the two-dimensional, long-term interaction of the molten mass with the concrete structure of the containment, as the kinetics of such interaction is essential for assessment of the consequences of a severe accident. To achieve these basic objectives, supporting experiments and analyses will be performed, with a view to providing an understanding of the phenomena of interest, and to producing a consistent interpretation of the results relevant for accident management.

## Article 2

### MANAGEMENT BOARD

- (a) Control of the Project shall be vested in a Management Board constituted under this Article.
- (b) The Management Board shall consist of one member designated by each Signatory, provided that, in the case of Signatories participating jointly in the Project, the members of the Management Board designated by them shall be considered as a single member for the purpose of the execution of this Agreement. Signatories shall also designate alternate members to represent them in the event of members being unable to do so. Signatories shall notify the NEA of the members designated to represent them on the Management Board.
- (c) The Management Board shall:
- (1) approve each year the annual programme of work and budget, including the allocation of tasks amongst Signatories, in accordance with the outline of the Programme set down in Appendix A hereto;
  - (2) approve each year the financial report covering the previous year;
  - (3) make such rules of procedure, directives and regulations, consistent with the objectives and provisions of this Agreement, as may be required for the sound management of the Project;
  - (4) consider any matters brought before it by the Programme Review Group, the Operating Agent or any Signatory;
  - (5) carry out the other functions conferred upon it by this Agreement.
- (d) The Management Board shall elect each year a Chairperson and a Vice-Chairperson from amongst its members. It shall meet at least once a year and shall be convened by its Chairperson. A special meeting shall be convened by the Chairperson within a reasonable time after receiving a written request from members of the Board representing a majority of the voting strength or from the USNRC acting as the Operating Agent. A representative of the OECD/NEA may attend the meetings of the Management Board in an advisory capacity.
- (e) The Management Board shall operate and reach its decisions to the greatest extent possible on a mutually agreed basis. However, when formal voting is requested, decisions of the Management Board shall be taken by a two-thirds majority of the votes cast, unless unanimity is expressly required by this Agreement. Unanimity requires the agreement of each member voting. All members of the Management Board shall each have one vote. Notwithstanding the above, the agreement of the USNRC shall be required for decisions which might affect the safety of tests, operations and personnel, or concerning insurance. The quorum for transaction of business in meetings of the Management Board shall be two-thirds of the voting strength.

(f) If necessary, decisions of the Management Board may also be reached by mail, telefax, telex or cable communication in which case unanimity shall be required. The Chairperson shall be responsible for ensuring that all members are informed of each decision made pursuant to this paragraph.

(g) At least thirty days before each regular meeting, notice of the time, place and agenda of the meeting shall be given by the Chairperson to each member and to other persons entitled to attend the meeting.

(h) The Management Board Chairperson shall, after each meeting, send to all the members of the Management Board and the Operating Agent a letter that contains the Minutes of the meeting including any decisions of the Management Board.

(i) The Management Board shall conduct its business in the English language. Reports and other documents to be submitted to the Management Board under this Agreement shall also be in English.

### Article 3

#### PROGRAMME REVIEW GROUP

(a) There shall be a Programme Review Group (hereinafter referred to as "the Review Group"), that shall act as a technical adviser to the Management Board.

(b) The Review Group shall consist of one member designated by each Signatory. Signatories shall notify the NEA of the members designated to represent them in the Programme Review Group. Members may be accompanied by advisors, provided that the NEA and the Chairperson of the Review Group are notified at least two weeks in advance.

(c) The Review Group shall:

(1) advise the Management Board concerning the annual programme of work and budget;

(2) provide technical advice and recommendations to the USNRC acting as Operating Agent concerning the carrying out of the programme of work;

(3) review the technical reports of the Project, assess the results of experiments performed and provide guidance for future work.

(d) The Review Group shall elect each year a Chairperson and Vice-Chairperson. It shall meet as it deems necessary, and shall be convened by its Chairperson. A representative of the OECD/NEA may attend the meetings of the Review Group in an advisory capacity. At least thirty days before each meeting, notice of the time, place and agenda of the meeting shall be given by the Chairperson to each member and to other persons entitled to attend. Special meetings shall be

convened by the Chairperson upon receiving a written request from members representing a majority of the Management Board voting strength or from the Operating Agent.

(e) If necessary, recommendations of the Review Group may be agreed upon by mail, telefax, telex or cable communication. The Chairperson shall be responsible for ensuring that all members are informed of each recommendation made pursuant to this paragraph.

(f) The Review Group Chairperson shall, after each meeting, send to all the members of the Review Group, the Management Board and the Operating Agent a letter that contains the Minutes of the meeting, including any advice and recommendations of the Review Group.

(g) The Review Group shall conduct its business in the English language. Reports and other documents to be submitted to the Review Group under this Agreement shall also be in English.

#### *Article 4*

### **OPERATING AGENT**

(a) The Project shall be operated by the USNRC as the Operating Agent. The Operating Agent shall be responsible for taking all steps and performing all legal acts required to operate the Project in accordance with this Agreement and with the decisions of the Management Board.

(b) The Operating Agent shall in particular:

(1) ensure that the Project is administered in accordance with the outline of the Programme and within the limits of funds as set forth in Appendices A and B hereto;

(2) secure the maximum protection and safety of the ANL-RAE facility and related staff and ensure that the programme of work is carried out according to acceptable standards of quality, budget and schedule;

(3) ensure that the scientific and administrative staff necessary to perform the Programme as outlined in Appendix A hereto is made available to the Project;

(4) prepare, in accordance with a format agreed by the Management Board, the draft annual programme of work and budget not later than three months before the beginning of the financial year in question as defined in Article 5;

(5) submit reports on the progress of the Project to the Management Board twice a year or at such other intervals as the Management Board shall determine.

(c) The Operating Agent shall have the power to enter into contracts for the procurement of equipment or materials and for the general interest of the Project provided that such contracts are allowed for in an approved budget, by the provisions of this Agreement or by authorisation of the Management Board.

(d) An USNRC representative shall be designated by the Operating Agent as Programme Manager with the approval of the Management Board. He shall attend meetings of the Management Board in an advisory capacity and shall also take part in meetings of the Review Group. He shall supply all information that is requested of him concerning the carrying out of the Project.

#### Article 5

#### FINANCE

(a) Each Signatory hereby agrees to commit to the Project the amount set forth in Appendix B hereto. The schedule for payment of contributions shall be determined by the Management Board on the basis of a proposal by the Operating Agent. Contributions from Signatories due under the schedule shall be paid in full, on the dates specified, in United States dollars to an account designated by the Operating Agent.

(b) The Management Board shall approve the annual budget before the beginning of the financial year in question. The financial year shall be from 1 January to 31 December. The Management Board shall approve the first budget at its first meeting.

(c) A financial report covering the previous year shall be submitted by the Operating Agent to the Management Board in a format agreed by the latter, not later than two months after the end of each financial year.

(d) The Operating Agent shall provide the Management Board with semi-annual financial records in a format agreed by it. The financial records maintained by the Operating Agent shall clearly account for all funds of the Project. These records shall be kept by the Operating Agent for three years from the date of termination of the Project.

(f) Each Signatory shall bear all costs of its participation in the Project other than common costs funded by the budget of the Project.

(g) The Operating Agent shall pay all taxes and similar obligations imposed by national or local governments and incurred by it in connection with the Project, as expenditure incurred in the operation of the Project, within the budget.

(h) Each Signatory shall have the right, at its sole cost, to request the Operating Agent to furnish copies of all original records relative to the accounts of the Project. The requested copies shall be provided to the Signatory.

## *Article 6*

### **INFORMATION AND INTELLECTUAL PROPERTY**

(a) This Article sets forth the provisions applicable to the publication, distribution, handling, protection and ownership of information and intellectual property relevant to and arising from the Project. Additional rules and procedures related thereto, where necessary, shall be adopted by the Management Board acting by unanimity and in conformity with this Agreement.

(b) Subject to prior approval by the Management Board and to restrictions applying to patents and copyrights, the Signatories shall have the right to publish information arising from the Project and information provided to the Project, except proprietary information. The Management Board will review technical reports of individual participants prior to their publication.

(c) For the purposes of this Article, proprietary information shall mean information acquired prior to or outside the Project of a confidential nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical composition of materials or manufacturing methods, processes or treatments) which is appropriately marked, provided such information:

- (1) is not generally known or publicly available from other sources;
- (2) has not previously been made available by the owner to others without obligation concerning its confidentiality; and
- (3) is not already in the possession of the recipient Signatory without obligation concerning its confidentiality.

The Operating Agent and the other Signatories shall take all necessary measures in accordance with this Article, the laws of their respective countries and international law to protect proprietary information provided to the Project. It shall be the responsibility of the Signatory supplying proprietary information to identify the information as such and to ensure that it is appropriately marked.

(d) The Signatories shall notify the Operating Agent of, and contribute to the Project, all pre-existing information and information developed independently of the Project which is or may potentially be relevant to the Project and the transfer of which is not subject to any contractual or legal limitation. To the extent that the provision of such information entails costs of any significance, the Management Board acting by unanimity shall determine whether and on what terms to acquire the information.

(e) The Management Board will be responsible for the production and publication of periodic reports and a final report on this Project. All reports of work performed under this Agreement and the results thereof, including studies, assessments, analyses, evaluations, and other documentation shall be produced and compiled in the manner and format decided by the

Management Board. Such reports shall be provided by the Operating Agent to the other Signatories.

(f) The Signatories agree with respect to the inventions made or conceived in the course of or under the Project that each Signatory shall, in its own country, own such inventions, subject to a non-exclusive, royalty-free licence for the other Signatories with the right to grant sub-licences in such inventions. In determining ownership of such inventions in third countries, the Management Board shall, acting by unanimity, equitably apportion the rights to the Signatories taking into account the obligations, contributions, and rights and benefits of all the Signatories.

(g) All material generated under the Project may be copyrighted in the name of the Operating Agent for the benefit of the Signatories in proportion to their respective contributions to the Project, provided that each Signatory shall be free to reproduce and distribute such material. The Management Board will decide on the transfer of know-how from the Project to Signatories.

(h) Each Signatory shall, without prejudice to any rights of authors and inventors under its national laws, take the necessary steps to secure such co-operation or assignment of rights as are required to implement the provisions of this Article. Each Signatory shall assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

#### *Article 7*

### **ASSIGNMENTS OF PERSONNEL AND VISITS**

(a) Any Signatory may, subject to the approval of the Operating Agent, send technical experts for participation in the Project. The person to be delegated and the purpose and term of such delegation shall be agreed in writing by the Operating Agent and the Signatory sending the expert, in advance of each delegation of personnel. In addition, these parties shall sign a separate personnel assignment agreement. The personnel shall be integrated into the scientific and technical work of the Project. In this context, and to the extent permitted by such separate personnel assignment agreements, the assigned personnel shall have appropriate access to information concerning the Project and to participation in technical discussions. A Signatory sending an expert is responsible for all associated salary, transportation, living, communication, insurance and other costs. The Operating Agent shall provide suitable office space and computer access for approved tasks.

(b) Similar arrangements may also be made between Signatories in relation to any work under the Project carried out by the Signatories themselves.

(c) It is further agreed that, to the extent reasonable, visits of a Signatory's experts to the facilities where work is being performed for the Project shall be facilitated. Such visits shall be arranged with the consent of the Operating Agent or relevant Signatory, as the case may be, following receipt of adequate notice given by the Signatory requesting the visit.

## *Article 8*

### **OECD NUCLEAR ENERGY AGENCY**

- (a) In accordance with its Statute, the OECD/NEA shall encourage the broadest possible participation in the Project by its Member countries, and shall endeavour to co-ordinate the Project's work with its other activities in this field.
- (b) The Management Board shall make an annual report to the Steering Committee for Nuclear Energy on the progress of the Project.
- (c) The OECD/NEA is invited to provide secretarial services to the Management Board and to the Programme Review Group.
- (d) The Secretariat of the OECD/NEA or, as appropriate, of the OECD, may be invited by the Management Board to take on some administrative or financial responsibilities for the implementation of the Project.

## *Article 9*

### **LEGAL RESPONSIBILITY AND INSURANCE**

- (a) The Operating Agent shall use all reasonable skill and care in carrying out its duties under this Agreement and shall be responsible for ensuring that its work under the Project is carried out in accordance with all applicable laws and regulations.
- (b) The Operating Agent shall propose to the Management Board all necessary liability, fire and other insurance for its work under the Project and, subject to availability, shall procure such insurance as the Management Board may direct. The cost of obtaining and maintaining such insurance shall be charged to the budget of the Project.
- (c) The Operating Agent shall, subject to applicable federal laws, be solely liable in respect of all actions, claims, costs and expenses whatsoever arising out of the execution of the Project.
- (d) In so far as any work under the Project is carried out by a Signatory itself, all legal liabilities and any related costs for that work rest with that Signatory.

## *Article 10*

### **LEGISLATIVE PROVISIONS**

- (a) Activities under this Agreement shall be subject to the laws and regulations applicable to the Signatories. Such laws and regulations shall be those of the State on whose territory the activities in question are carried out.
- (b) It shall be the responsibility of each Signatory concerned to facilitate the accomplishment of the formalities involved in the movement of persons, the importation of materials and equipment and the transfer of currency which shall be required to operate the Project.

## *Article 11*

### **SETTLEMENT OF DISPUTES**

- (a) Any dispute among the Signatories concerning the interpretation or application of this Agreement that 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 Signatories concerned, who shall also choose the Chairperson of the tribunal. Should the Signatories concerned fail to agree upon the composition of the tribunal or the selection of its Chairperson, the President of the International Court of Justice shall, at the request of any of the Signatories concerned, exercise those responsibilities. The tribunal shall decide any such dispute by reference to the terms and conditions of this Agreement and any applicable laws and regulations, and its decision shall be final and binding on the Signatories concerned.
- (b) Unless otherwise agreed by the disputing parties, this Agreement shall be governed by the law of the USA and arbitral proceedings initiated to settle any dispute shall take place in Washington DC and shall be conducted in English languages.

## *Article 12*

### **ACCESSION AND WITHDRAWAL OF SIGNATORIES**

- (a) This Agreement shall be open to accession by Governments of other OECD Member countries or bodies designated by such Governments with the unanimous assent of the Management Board and subject to any conditions that it might determine.
- (b) With the agreement of the Management Board, and upon the request of a Government, a Signatory proposed by that Government may be replaced by another party. The latter shall sign this Agreement and assume the rights and obligations of a Signatory.

(c) A Signatory may withdraw from this Agreement upon written notice six months prior to the beginning of the financial year. The withdrawal of a Signatory under this paragraph shall not affect the rights and obligations of the other Signatories, including the amount which each of the other Signatories is required to commit to the Project, unless otherwise unanimously agreed by the Management Board.

(d) Any Signatory that fails to fulfil its obligations under this Agreement within sixty days after its receipt of notice invoking this paragraph and specifying the nature of those obligations shall be considered to have withdrawn from this Agreement.

(e) The Operating Agent, with the approval of the Management Board, may enter into agreements with non-Signatory entities for collaboration in furtherance of the Project. Such entities shall be Associate Members. Such agreements may, in particular, cover exchange of information, patent rights, assignment of scientific and technical personnel and association with the work of the Project. The provisions of such agreements shall be consistent with the requirements of this Agreement.

### *Article 13*

#### **FINAL PROVISIONS**

(a) Unless otherwise agreed in writing between the Operating Agent and the Management Board, all assets acquired by the Operating Agent under the Project shall remain its property at the termination of this Agreement.

(b) This Agreement shall remain in force until 31 December 2005 and may be continued in force thereafter on the written unanimous agreement of the Signatories that desire to continue this Agreement.

(c) This Agreement may be amended at any time by the agreement in writing of all the Signatories.

(d) The original of this Agreement shall be deposited with the Director General of the ECD/NEA and a certified copy thereof shall be furnished to each Signatory.

## *Appendix A*

### **THE OECD-MCCI PROGRAM**

#### **EXPERIMENTS AND ANALYSIS TO ADDRESS EX-VESSEL DEBRIS COOLABILITY AND 2-D MOLTEN CORE/CONCRETE INTERACTION ISSUES IN LIGHT WATER REACTOR SYSTEMS**

##### **A.1 BACKGROUND AND OBJECTIVES**

In a postulated core melt accident, if the molten core is not retained in-vessel despite taking severe accident mitigation actions, the core debris will relocate in the reactor cavity region and will interact with structural concrete resulting potentially in basemat failure by erosion or overpressurization and consequent fission product release to the environment. Though this is a late release event, the radiological consequences in terms of land and groundwater contamination as well as latent cancer risk could be substantial to warrant an effective mitigation strategy for preventing such release. The severe accident management guidance (SAMG) for operating light water reactor plants includes, as one of several strategies, flooding the reactor cavity in the event of an ex-vessel core melt release.

An internationally sponsored program at Argonne National Laboratory (ANL), which is nearing completion, has been investigating, by means of integral experiments and associated analysis, the ability and the effectiveness of an overlying water pool to thermally stabilize a molten core/concrete interaction and to cool ex-vessel core debris. In this program, large-scale reactor material tests were conducted with core melt masses ranging from over 100 kg to about 2000 kg, and with simulated decay heat that is representative of a PWR core. In all tests, an efficient bulk cooling was observed initially; however, a stable and anchored crust formed eventually impeding further bulk cooling of the molten debris underneath, and only little additional cooling was observed by means of water ingress through cracks in the crust or by melt eruption. This additional cooling is not sufficient to extract the decay heat unless bulk cooling can be re-established through a macroscopic crust breach. It is believed that in the reactor scale, an anchored crust cannot be sustained and a breached crust will promote efficient cooling by one or more of the several mechanisms mentioned above. This provides the impetus for conducting separate effects tests which is the focus of the proposed OECD-MCCI Program with the following technical objectives:

1. Provide both confirmatory evidence and test data for the individual coolability mechanisms identified in previous ANL (MACE) integral effect tests; resolve the ex-vessel debris coolability issue through an understanding of the synergistic effects of these coolability mechanisms and through development of analytical models.

2. Address remaining uncertainties related to long-term two-dimensional melt-concrete interaction under dry as well as flooded cavity conditions.

Achievement of these two program objectives will provide a sound technical basis for determining the efficacy of severe accident management guidance for existing plants involving flooding of the cavity. The program will also provide useful data for improved containment designs for future plants. A long range objective of the program is maintenance of an experimental facility for addressing plant-specific ex-vessel accident issues that may arise in the future.

## **A.2 EXPERIMENT FACILITIES**

Experimental work in the OECD-MCCI Program will be performed in the Reactor Analysis and Engineering (RAE) Division's Large Scale Test Facility located in Bldg. 315 of the ANL-East site. During the course of the ongoing work at ANL, unique expertise and infrastructure have been developed insofar as conducting large scale, high temperature reactor materials experiments. The current proposal, under the sponsorship of the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD-NEA), takes full advantage of continued utilization of the ANL facilities and expertise.

## **A.3 PROGRAM ELEMENTS**

The OECD-MCCI Program consists of the following two key elements:

### ***Coolability and Interaction Tests***

Using reactor prototypic materials (also simulant as appropriate), experiments will be conducted to provide confirmatory evidence for various ex-vessel debris coolability mechanisms which have been identified in integral experiments under the ongoing MACE program. In particular, separate effect tests will be carried out to investigate water ingress mechanism and to provide data on the melt eruption heat transfer mechanism. Also, crust mechanical failure tests will be carried out to provide information on crust strength and permeability.

With regard to the molten core-concrete interactions (MCCI) issue, tests will be carried out over a relatively long duration at low power to obtain data on long-term 2-D cavity erosion behavior, initially under dry conditions and at a late stage, with water addition.

### ***Data Analysis and Examination***

Coolability test data will be analyzed in detail to understand the effectiveness of various cooling mechanisms. The analysis will be supplemented with the results of post-test debris examination. Data from these tests will support model development and assessment activities for various coolability mechanisms.

#### A.4 SCOPE OF WORK

Separate effect tests, focusing on individual coolability mechanisms identified in integral experiments under the ongoing MACE program, will be carried out to provide data on water ingress, melt eruption, and crust mechanical failure.

Water ingress tests will be carried out using prototypic oxidic melt on an inert basemat and without any sustained heating to determine water ingress mechanism and rate through a solidified debris layer. The effect of concrete decomposition products on crust formation and water ingress will also be investigated in some tests by adding concrete products in melt composition or by changing the basemat to an ablative type. An ablative basemat will simulate the effects of concrete products on melt viscosity and solidus-liquidus, and in turn, the effects of the latter on crust formation, porosity, and water ingress. Finally, tests will be carried out at different geometric scales to determine the effect of melt depth or span length on the effectiveness of water ingress mechanism. Given the number of parameters involved, it is estimated, for the purpose of cost determination, that a minimum of six tests, possibly at two different scales, will be necessary.

Melt eruption tests will be carried out, also using prototypic oxidic melt on an inert basemat, but with sustained heating and with gas sparging to mock-up concrete decomposition gases. The use of inert basemat will ensure melt-crust contact while gas sparging will promote melt eruption. The tests will produce melt entrainment data for use in modeling. Gas sparging rate is the primary variable in these tests and, as such, a small number of tests is anticipated in this category. Again, for the purpose of cost determination, two tests at a reasonable geometric scale may be considered adequate.

As part of the post-test examination activity, crusts produced in the water ingress tests will be tested at room temperature as well as at some elevated temperatures for strength and brittleness. Note the water ingress tests will be performed at relatively small-scale. To extrapolate small-scale crust failure data to larger scale and prototypic temperature regime, additional crust strength tests will be needed. It is anticipated that up to six larger scale crust failure tests may be necessary to investigate crust strength in the right temperature regime. The data will be used for temperature scaling of crust strength as well as for mass scaling, if necessary.

With respect to the long-term 2-D MCCI issue, intermediate scale tests will be carried out, initially in a dry cavity condition to investigate long term cavity erosion profile. Decay heat will be simulated in these tests with sustained heating of the melt, and water will be added at a later stage of the experiments to investigate coolability. The thrust of these experiments will be to generate 2-D MCCI data for two basemat types, limestone common-sand and siliceous, which are used in the operating plants. Additional data need will be evaluated at the conclusion of these two experiments.

A tentative test matrix for the OECD-MCCI Program is shown below. The number of tests in each category is to be regarded as tentative, only to serve as a preliminary guidance for the purpose of cost estimation. The exact number of tests and the details of test conditions in each category will be proposed by the Operating Agent (OA), reviewed by the Program Review Group

(PRG) and approved by the Management Board (MB). Within the confinement of the overall program cost, the test program may be modified based upon the results of completed tests and analysis following the same procedure as in other OECD-sponsored programs. Additional tests may be necessary to adequately understand and quantify a particular phenomenon. Expert reviews may be initiated by the MB and the PRG to assist in making key decisions and to evaluate results.

### **Tentative Test Matrix for the OECD-MCCI Experimental Program**

Test Type	No. of Tests	Objective
Melt eruption	2	investigate coolability by melt eruption under controlled test conditions; determine melt entrainment coefficient from the experimental data for use in calculating entrainment rate and its effect on melt dispersal and coolable bed formation
Water ingress	up to 6	investigate coolability by water ingress; obtain dryout heat flux data and determine the effectiveness of water ingress mechanism for debris bed coolability; determine the effect of concrete decomposition products on crust formation and water ingress; investigate composition and scale effect
Crust failure	up to 6	investigate crust strength in right temperature regimes; measure temperature-dependent crust strength properties; investigate composition and geometric scale effects on crust failure
Long term 2D MCCI	2	investigate long term 2-D cavity erosion behavior and use the data to reduce uncertainties in the prediction of such behavior by MCCI codes; initial stage will be dry cavity; late addition of water to investigate coolability in an integral manner

#### **A.5 SCHEDULE**

Project start date: 01 January 2002  
 Project end date: 31 December 2005

#### **A.6 DELIVERABLES**

The main deliverables are Quick-look Data Reports providing preliminary test data, Final Data Reports providing qualified results from all OECD-MCCI experimental activities, and a Project Integration Report. The Quick-look Data Reports will be delivered within one month of the completion of each test, and the Final Data Reports will be delivered within three months of the completion of each individual test. The Project Integration Report will be delivered on or before completion of the Project. All reports will be written in English.

**TENTATIVE BREAKDOWN OF TOTAL EXPENDITURE AND OF CONTRIBUTIONS TO THE MCCI PROJECT**

**B.1. FUNDS REQUIRED TO EXECUTE THE PROJECT**

This Appendix sets the tentative breakdown of total expenditure for the execution of the programme of the Project, as shown in the table below (in 1000 US Dollars).

Item	Year 1	Year 2	Year 3	Year 4	Total
Preparation of facilities, acquisition of parts, design of experiments including safety assessments	400	350	350	270	1,370
Set up and execution of melt eruption tests, post-test examinations and analyses	600	130	0	0	730
Set up and execution of water ingestion tests, post test examinations and analyses	195	400	335	0	930
Set up and execution of crust failure tests, including measurements of crust strength properties and analyses	0	315	400	105	820
Set up and execution of long term 2D molten core-concrete interaction, post-test examination and analyses	0	0	110	600	710
Reporting to Project steering bodies and to Signatories, final report preparation	5	5	5	225	240
<b>Total (4,800)</b>	<b>1,200</b>	<b>1,200</b>	<b>1,200</b>	<b>1,200</b>	<b>4,800</b>

**B.2.**

**CONTRIBUTIONS FROM SIGNATORIES**

The Signatories agree to assign funds to the Project apportioned as follows

Contribution from Signatories	US Dollars
The Tractebel Energy Engineering, Belgium	48,000
The Nuclear Research Institute of the Czech Republic	28,000
The Valtion Teknillinen Tutkimuskeskus and Other Finnish Parties, Finland	28,000
The Institut de Protection et de Sûreté Nucléaire, France, jointly with the Commissariat à l'Énergie Atomique and Electricité De France	268,000
The Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH, Germany	416,000
The Hungarian Atomic Energy Authority jointly with VAEKI, Hungary	28,000
The Nuclear Power Engineering Corporation, Japan	856,000
The Korea Atomic Energy Research Institute	76,000
The Norwegian Institute for Energy Technology	48,000
The Consejo de Seguridad Nuclear, Spain	108,000
The Statens Kärnkraftinspektion, Sweden	48,000
The Swiss Federal Nuclear Safety Inspectorate, Switzerland	60,000
Other income	388,000
The United States Nuclear Regulatory Commission	2,400,000
<b>Total budget</b>	<b>4,800,000</b>

The table below sets contributions necessary to execute the programme, divided between the US Participants and the other Signatories (all amounts in thousands of United States dollars).

Contributions	Year 1	Year 2	Year 3	Year 4	Total
US Participants	600	600	600	600	2,400
Other Signatories	600	600	600	600	2400
<b>Total</b>	<b>1,200</b>	<b>1,200</b>	<b>1,200</b>	<b>1,200</b>	<b>4,800</b>

**For the UNITED STATES NUCLEAR REGULATORY COMMISSION:**

**For the TRACTEBEL ENERGY ENGINEERING. BELGIUM:**

**For the NUCLEAR RESEARCH INSTITUTE OF THE CZECH REPUBLIC:**

**For the VALTION TEKNILLINEN TUTKIMUSKESKUS, representing also other  
Finnish Parties, FINLAND:**

**For the INSTITUT DE PROTECTION ET DE SÛRETÉ NUCLÉAIRE, FRANCE, jointly  
with the COMMISSARIAT À L'ÉNERGIE ATOMIQUE and ELECTRICITÉ DE  
FRANCE:**

**For the GESELLSCHAFT FÜR ANLAGEN- UND REAKTORISCHERHEIT (GRS) mbH,  
GERMANY:**

**For the HUNGARIAN ATOMIC ENERGY AUTHORITY, jointly with VAEKI,  
HUNGARY: .**

**For the NUCLEAR POWER ENGINEERING CORPORATION, JAPAN:**

**For the KOREA ATOMIC ENERGY RESEARCH INSTITUTE**

**For the INSTITUTE FOR ENERGY TECHNOLOGY, NORWAY**

**For the CONSEJO DE SEGURIDAD NUCLEAR, SPAIN:**

**For the STATENS KÄRNKRAFTINSPEKTION, SWEDEN:**

**For the SWISS FEDERAL NUCLEAR SAFETY INSPECTORATE, SWITZERLAND:**

Paris,

The HEAD OF LEGAL AFFAIRS

PATRICK REYNERS