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CArbon-14 Source Term
CAST

General Assembly Meeting 1 Minutes (D1.1)

25th – 26th November 2013
London, United Kingdom

Author(s):
E. Scourse, S. Williams

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RE	Restricted to the partners of the CAST project	
CO	Confidential, only for specific distribution list defined on this document	

EURATOM

CAST – Project Overview

The CAST project (CArbon-14 Source Term) aims to develop understanding of the potential release mechanisms of carbon-14 from radioactive waste materials under conditions relevant to waste packaging and disposal to underground geological disposal facilities. The project focuses on the release of carbon-14 as dissolved and gaseous species from irradiated metals (steels, Zircaloys), irradiated graphite and from ion-exchange materials as dissolved and gaseous species.

The CAST consortium brings together 33 partners with a range of skills and competencies in the management of radioactive wastes containing carbon-14, geological disposal research, safety case development and experimental work on gas generation. The consortium consists of national waste management organisations, research institutes, universities and commercial organisations.

The objectives of the CAST project are to gain new scientific understanding of the rate of release of carbon-14 from the corrosion of irradiated steels and Zircaloys and from the leaching of ion-exchange resins and irradiated graphites under geological disposal conditions, its speciation and how these relate to carbon-14 inventory and aqueous conditions. These results will be evaluated in the context of national safety assessments and disseminated to interested stakeholders. The new understanding should be of relevance to national safety assessment stakeholders and will also provide an opportunity for training for early career researchers.

For more information, please visit the CAST website at:
http://www.projectcast.eu

CAST		
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General Assembly Meeting 1 Minutes (25th – 26th November 2013)

Executive Summary

The kick-off meeting was the first General Assembly Meeting for the CAST Project. The meeting was held on 25th – 26th November 2013 in London, UK.

These minutes record the main points discussed at the meeting and serve to meet the objective of Deliverable 1.1 for the CAST Project.

Contents

1 Introduction

1.1 Welcome

The CAST kick-off General Assembly Meeting 1 was opened by Steve Williams from NDA. He welcomed the participants to London and invited participants to give a short introduction to themselves and their organisation's involvement with CAST.

The purpose of the meeting was to:

1. Introduce all participants to the details for each work package in CAST.
2. Discuss coordination, working arrangements and dissemination activities with all the Consortia participants present.
3. Allow each Work Package Manager to meet with the participants for their Work Package and discuss the working arrangements and timescales for meeting project deliverables and milestones.

1.2 Attendees

The attendees for the kick-off meeting were:

Table 1: CAST participant attendees at the kick-off meeting

Name	Organisation
Steve Williams	NDA
Simon Norris	NDA
Jens Mibus	Nagra
Stéphan Schumacher	Andra
Pascal Reiller	CEA
Manuel Capouet	Ondraf/Niras
Erika Neeft	Covra
Crina Bucar	INR
André Rübel	GRS
Erich Wieland	PSI
Frank Druyts	SCK.CEN
Bernhard Kienzler	KIT
Alfredo Luce	ENEA
Hiromi Tanabe	RWMC
Werner von Lensa	Juelich
Corrado Rizzato	Juelich
David Bottomley	ITU
Petr Vecernik	UJV
Jose Luis Leganés Nieto	Enresa
Tiina Heikola	VTT
Jari Tuunanen	Fortum
Ernestas Narkunas	LEI
Tomo Suzuki-Muresan	Armines
Johannes Fachinger	FNAG
Hans Meeussen	NRG
Viorel Fugaru	IFIN-HH
Antonín Vokál	Surao
Klas Källström	SKB
Nelly Toulhoat	CNRS/IN2P3

Nathalie Moncoffre	CNRS/IN2P3
Steve Swanton	Amec
Marina Rodríguez Alcalá	Ciemat
Florence Cochin	Areva
Laurent Petit	EdF
Ellie Scourse	MCM
Nikitas Diomidis	Nagra
Christine Lamouroux	CEA
Laurent Veiller	CEA

Each participant introduced their organisation, and which Work Package they are involved in:

Table 2: Outline of CAST participants and Work Packages

Participant no.	**Participant organisation name**	WP1	WP2	WP3	WP4	WP5	WP6	WP7
1. (Coordinator)	NDA	x				x	x	
2	Nagra		x				x	
3	Andra			x		x	x	
4	CEA			x	x			
5	Ondraf/Niras						x	
6	Covra							x
7	INR			x	x	x	x	
8	GRS						x	
9	PSI		x					
10	SCK.CEN		x	x				
11	KIT		x	x				x
12	ENEA				x	x	x	
13	RWMC		x	x			x	
14	FZJ				x	x		
15	ITU		x	x				x
16	UJV				x			
17	Enresa		x			x	x	
18	VTT		x					
19	Fortum						x	
20	LEI					x	x	x
21	SI IEG NASU					x		
22	Armines		x	x				
23	FNAG					x		
24	NRG		x				x	
25	IFIN-HH					x		
26	Surao						x	
27	SKB				x		x	
28	CNRS/IN2P3					x		
29	Amec		x					

30	Ciemat		x			x		
31	Areva			x				
32	EdF			x	x	x		
33	MCM	x						

2 Presentations – Day One

On the first day of the kick-off meeting each of the Work Package Leaders was allocated fifteen minutes to give a brief overview of their Work Package aims, objectives, participants and deliverables. This allowed all CAST participants to learn about the content of each Work Package. An introduction to CAST and WP1 was also given, along with discussions on working arrangements, the CAST website, and the dissemination plans.

2.1 'An Introduction to CAST: WP1 Management and WP7 Dissemination' by Steve Williams (NDA) and Erika Neeft (Covra).

Steve Williams gave an overview of WP1: Coordination. The presentation gave an overview of:

- the objectives of the CAST project, which are to:
  - gain a scientific understanding of the rate of release of ^{14}C from the corrosion of irradiated steels and Zircaloys, and from the leaching of ion-exchange resins and irradiated graphites, under geological disposal conditions, its speciation and how these relate to ^{14}C inventory and aqueous conditions;
  - evaluate this understanding in the context of national safety assessments; and
  - disseminate this understanding and its relevance to safety assessments to a range of interested stakeholders and provide an opportunity for training of early career researchers.
- The CAST Work Packages:
  - WP1 – Coordination (led by NDA RWMD)
  - WP2 – Steels (led by Nagra)
  - WP3 – Zircaloy (led by Andra)
  - WP4 – Ion-Exchange Resins (led by CEA)
  - WP5 – Graphite (led by NDA RWMD)
  - WP6 – Relevance of results in national contexts and safety assessments (led by Ondraf/Niras)
  - WP7 – Dissemination (led by Covra)
- WPs 2, 3, 4 and 5 focus on the fundamental science for CAST, while WP6 focuses on the end-users and the relevance of the results in the Waste Management Organisation's safety cases. WP1 manages the coordination of CAST and WP7 manages dissemination and education and training for the project.
- The CAST project began on 1st October 2013, and consists of a Consortium of 33 members from various countries. The total EC contribution is ~4.5 Million Euros. The pre-financing for the project has been distributed to almost all of the participants. There are a few outstanding and the Coordinators are working with these participants to arrange fund transfers.
- The CAST Consortium Agreement has been circulated for comment once, updated and a new version distributed for final comments. Comments on the new version are

requested from the participants no later than 20th December 2013.
The Coordinators will then finalise the consortium agreement in January 2014.

- The Coordinators are currently working on various organisational topics for the project, including:
  - Contracting the Expert Advisory Group;
  - Putting in place the working arrangements;
  - Organising the next General Assembly Meeting.
- The WP1 Deliverables and Milestones for the first year of the project are:
  - D1.1 General Assembly (kick-off) meeting and minutes (this record);
  - D1.2 Project plan including risk management plan;
  - D1.3 Advisory Group review of WP2, 3, 4 and 5 and kick-off meeting minutes;
  - MS1 First General Assembly meeting held (this kick-off meeting);
  - MS2 CAST Project Plan available;
  - MS4 CAST Advisory Group set up;
- The Coordinator discussed the risk management plan, highlighting that the main risk may be ensuring the availability of samples for the project on the required timescales. The risk management plan will be a 'live' document, which will be updated periodically throughout the course of the project.

Erika Neeft gave an overview of WP7: Dissemination:

- Covra, KIT, ITU and LEI are involved in WP7, which aims to:
  - Set up the internal (private) and external (public) websites for CAST;
  - Organise two workshops targeting different groups;
  - Organise two training courses;
  - Other dissemination activities.
- The WP7 deliverables for the first year are:
  - D7.1 Set-up the CAST websites;
  - D7.2 Produce a project presentation (flyer);
  - D7.3 Produce a Dissemination plan;
  - D7.4 Produce the first CAST newsletter.

2.2 'WP2: Steels' by Jens Mibus (Nagra)

Jens Mibus gave an overview presentation for WP2. Nagra, PSI, SCK.CEN, KIT, RWMC, ITU, Enresa, VTT, Armines, NRG, Amec and Ciemat all participate in WP2. The objectives of this WP are to:

- Advance our understanding of the speciation of ^{14}C released during corrosion of irradiated steels under conditions relevant to cement-based repositories;
- Provide techniques for analyzing ^{14}C species in aqueous and gaseous phases at extremely low concentrations;
- Measure the release rate and speciation of ^{14}C in corrosion experiments under various conditions;
- Validate activation models by measuring ^{14}C inventories in irradiated steel.

The objectives will be met by the following tasks:

- Literature survey (Lead: AMEC with contributions from all partners);
- Analytical development (PSI and Armines, cooperation with WP3);
- Corrosion experiments and subsequent ^{14}C speciation measurements (all other WP2 partners);

- Synthesis and reporting (Lead: Nagra with contributions from all WP2 partners).

The WP2 deliverables for the first year are:

- D2.1 State of the art review of steel corrosion and ^{14}C release;
- D2.2 Annual progress report year 1.

It was noted that there are many similarities and overlap between WP2 and WP3, including similar requirements in analytical approaches. It would be beneficial for a meeting between these two WPs to be organised by the WP2 and WP3 work package leaders (possibly in May 2014) to establish points of common interest before the main experiments begin. It was also noted that the advanced analytical development was focused on WP2 and WP3.

2.3 'WP3: Zircaloy' by Stéphan Schumacher (Andra) in place of Sophia Necib (Andra - currently on maternity leave).

Stéphan Schumacher gave an overview presentation for WP3. Andra, CEA, INR, SCK.CEN, KIT, RWMC, ITU, Armines, Areva and EdF all participate in WP3. The objectives of this WP are to:

- Obtain a better understanding of ^{14}C behaviour in zirconium alloy fuel claddings under disposal conditions with regard to:
  - Inventory – origin, location and distribution of ^{14}C and its precursors in zirconium alloys and in inner/outer oxide layers; influence of several parameters: burn up, BWR/PWR, zirconium alloys; comparison between modelling and experiments;
  - Release from waste packages – corrosion of irradiated zirconium alloys (short term/ long term experiments, high/low-temperature, water chemistry, effect of burn up, irradiation, and radiolysis); solubility of zirconium oxide and ^{14}C migration in zirconium oxide;
  - Speciation – volatile/dissolved species; organic/inorganic species; identification of organic compounds.

The objectives will be achieved by:

- Assessing ^{14}C inventories in zirconium alloy metals and oxides;
- Characterizing ^{14}C release from zirconium alloy corrosion and oxide dissolution;
- Determining ^{14}C speciation under simulated disposal conditions.

The samples and experimental conditions will be:

- Samples: Zircaloy 2, Zircaloy 4 and M5 from different reactors: PWR (UOx and MOx), BWR, Candu;
- Leaching conditions: cementitious / argillaceous water (deep geological disposal conditions) or acid dissolution (inventory).

There are 4 tasks in WP3:

- Task 3.1 - will review the current status of knowledge of ^{14}C release from zirconium alloy fuel claddings;
- Task 3.2 - will develop analytical methods for the characterization of ^{14}C organic and inorganic molecules. This task will strongly interact with Task 2.2 of WP2 to share analytical developments;

- Task 3.3 - will characterize ^{14}C inventory and ^{14}C release from irradiated zirconium alloy fuel claddings sampled from different BWRs and PWRs. This will be determined from corrosion of activated materials (Zircaloy 2, Zircaloy 4 and M5) in experiments under conditions relevant to deep geological disposal (cementitious/argillaceous media, aerobic/anaerobic). Acid dissolution of irradiated hulls will be used to measure total amounts of ^{14}C;
- Task 3.4 - will summarize and synthesize in a final report the work undertaken in the previous tasks to develop an interpretation of ^{14}C behaviour in zirconium alloy fuel claddings (^{14}C inventories, release rates and speciation of released ^{14}C) under disposal conditions.

The WP3 deliverables for the first year are:

- D3.1 State of the art of ^{14}C in Zircaloy and zirconium alloy;
- D3.2 Definition of operating conditions and presentation of the leaching experiments;
- D3.3 Description of the analytical procedure for gaseous and dissolved ^{14}C species quantification;
- D3.4 Progress report on corrosion tests in the hot cell – experiment set up;
- D3.5 Annual progress report – Year 1.

2.4 'WP4: Ion-Exchange Resins' by Pascal Reiller (CEA).

Pascal Reiller gave an overview presentation for WP4. CEA, INR, ENEA, FZJ, UJV, SKB and EdF all participate in WP4. The objective of this WP is to:

- Obtain a better understanding of the ^{14}C source term from Spent Ion Exchange Resins (SIERs) of different origins (BWR or PWR) under different storage strategies and its likely release and chemical species under geological disposal conditions.

This objective will be achieved by reviewing the current status of understanding, characterising the ^{14}C inventory and speciation, and undertaking experiments to measure ^{14}C release to gas and solution and its speciation. There are 4 tasks:

- Task 4.1 – Current status review of ^{14}C and its release from SIERs (CEA/All WP4 Participants);
- Task 4.2 – ^{14}C Inventory and speciation in SIERs (BWR – FZJ/SKB, PWR – CEA-EdF/SKB/INR/ENEA);
- Task 4.3 – ^{14}C Release from SIERs and its speciation (INR/CEA/FZJ/UJV);
- Task 4.4 – Synthesis of experimental data and interpretation – final report (lead by CEA-FZJ with all WP4 Participants).

The WP4 deliverables for the first year are:

- D4.1 state of the art review on sample choice, analytical techniques and current knowledge of release from SIERs;
- D4.2 Annual progress report on WP4 – Year 1.

2.5 'WP5: Graphite' by Simon Norris (NDA).

Simon Norris gave an overview presentation for WP5. NDA RWMD, Andra, INR, ENEA, FZJ, Enresa, LEI, IGNS, FNAG, IFIN-HH, CNRS, Ciemat and EdF all participate in WP5. The objectives of this WP are to:

- Understand the factors determining release of ^{14}C from irradiated-graphite under geological disposal conditions through:
  - determining the ^{14}C inventory and concentration distribution in i-graphites and controlling factors;
  - measuring the rate and speciation of ^{14}C release to solution and gas from i-graphites in contact with aqueous solutions;
  - determining the impact of selected waste treatment options on ^{14}C release and relating this to the nature of ^{14}C in i-graphite.

There are 5 main tasks:

- Task 5.1 Review of CARBOWASTE and other relevant R&D activities to establish the current understanding of inventory and release of ^{14}C from i-graphites (FZJ, IFIN-HH, LEI, Ciemat, CNRS/IN2P3, ENRESA, INR, FNAG, Andra, EdF, IGNS, ENEA, NDA RWMD);
- Task 5.2 Characterisation of the ^{14}C inventory in i-graphites (FZJ, IFIN-HH, LEI, CNRS/IN2P3, EdF);
- Task 5.3 Measurement of release of ^{14}C inventory from i-graphites (FZJ, IFIN-HH, Ciemat, ENRESA, INR, Andra, EdF, IGNS, NDA RWMD);
- Task 5.4 New waste forms and ^{14}C decontamination techniques for i-graphites (Ciemat, ENRESA, FNAG, ENEA);
- Task 5.5 Data interpretation and synthesis – final report (FZJ, IFIN-HH, LEI, Ciemat, CNRS/IN2P3, ENRESA, INR, FNAG, Andra, EdF, IGNS, ENEA, NDA RWMD).

There are 19 deliverables for this WP over the course of the project. The WP5 deliverables for the first year are:

- D5.1 Review on leaching of French i-graphite (PP);
- D5.2 WP5 Annual progress report – Year 1;
- D5.3 Report on graphite categories in the RBMK reactor;
- D5.4 Definition of the scientific scope of leaching experiments and definition of harmonised leaching parameters.

2.6 'WP6: Safety Assessments' by Manuel Capouet (Ondraf/Niras).

Manuel Capouet gave an overview presentation for WP6. Ondraf/Niras, NDA RWMD, Nagra, Andra, INR, GRS, ENEA, RWMC, Enresa, Fortum, LEI, NRG, Surao and SKB all participant in WP5. The objectives of this WP are to:

- Integrate the CAST results at the level of WMOs safety cases;
- Consider the experimental results at the space and time scale of the geological concept (phenomenological perspective);
- Assess the knowledge progress brought by CAST on the long term safety through safety assessment calculations and sensitivity analysis;
- Establish the multiple lines of arguments regarding ^{14}C safety issues;
- Prioritize the future challenges at the national level and also at the international level by identifying commonalities & differences.

There are 3 main tasks:

- Task 6.1 - Handling of ^{14}C in current safety assessments;

- Task 6.2 - Knowledge supporting safety assessment of ^{14}C;
- Task 6.3 - Integration of CAST results.

There are 4 deliverables for this WP. No deliverables from WP6 fall within the first year.

2.7 'CAST Working Arrangements' by Ellie Scourse (MCM)

The following main points were discussed:

- EC Reporting Periods – there are 3 reporting periods specified: Month 1 – Month 17 (October 2013 – February 2015); Month 18 – Month 36 (March 2015 – September 2016); Month 37 – Month 54 (October 2016 – March 2018). There are specific forms that must be used for this reporting.
- Interim Progress Reporting – interim progress reporting between the formal EC reporting periods was discussed. The Coordinator would like updates from all participants as rough estimate of overall spend and progress. These will be for internal use within CAST. The coordinator will consider the views expressed and will email all participants with the suggestion for internal reporting.
- Risk Register and Project Plan – the CAST Project Plan and Risk Register are currently being produced. The Risk Register is likely to include the availability of samples. All participants should consider if their required samples are available, and if they are not, this should be highlighted to the Coordinator at the earliest possible opportunity.
- Report reviews and approval – The Coordinator will contract an Expert Advisory Group to review key deliverables including: the General Assembly Meeting minutes, WP Annual Reports, WP Final Report and the Final Overview of CAST. All reports to be published on the CAST website must be approved by the Coordinator first. All reports should have undergone formal review and approval from the originating organisation and have been reviewed by the WP lead. Guidelines for the formal review process will be produced and circulated by the Coordinator.
- Security Aspects – all participants should identify any information used in CAST that needs to be protected (as per their national security procedures). No protected material shall be placed on the public part of the CAST website. Protected information on the private part of the CAST website should be kept to a minimum.
- The next General Assembly Meeting will be held in the week commencing 20th October 2014. The Coordinators requested a volunteer organisation to host this meeting. If no organisations can volunteer, the Coordinator will approach the WP Leaders to host the meeting.

2.8 'WP7: Dissemination' by Erika Neeft (Covra)

Erika Neeft gave an overview of the CAST website.

- The public website is: http://www.projectcast.eu
- CAST WP Leaders confirmed that they are willing to have their email addresses available on the website. All participants should check that their organisation's logo (at the bottom of the public website) has sufficient resolution. If not, they should send a higher resolution version to E. Neeft within two weeks. Photos for the public website can be uploaded during the whole period of CAST.
- The logo for CAST was discussed and on Day 2 a number of possible logos were presented and the participants voted on their preference.
- The private, internal project website was also discussed and some of the working arrangements were agreed:

- CAST WP Leaders will decide on the file structure on the private part of the website. All WP participants will be able to upload files but must follow the structure set by the WP Leader.
- Erika will check whether it is possible to automatically inform relevant people when material is uploaded on the private website.
- Back-ups of the internal website will be undertaken regularly – E. Neeft will check when.

2.9 WP5 Graphite – Kick-Off Meeting

All WP5 Participants (bar IGNS who could not attend) were involved in a detailed overview of WP5. Each participant presented an overview of the work that will be carried out for this WP and the deliverables they are responsible for. The presentations were:

- **Stéphan Schumacher/Laurent Petit (Andra/EdF)** – Andra and EdF contribution to D5.5 – an overview of the available data and applied methodology for leaching of ^{14}C from French i-graphite; origins of ^{14}C remaining in i-graphite from EdF UNGG reactors; synthesis of the results on ^{14}C speciation in solution and in gas from leaching of French i-graphite.
- **Marina Rodríguez Alcalá (Ciemat)** - Ciemat contribution to WP5 – leaching test of irradiated and treated graphite.
- **Alfredo Luce (ENEA)** – ENEA activities in WP5 task 5.4 – ultrasound assisted organic solvents treatments – definition and optimisation of the process parameters; a complete characterisation of the obtained solutions; different solvents.
- **Jose Luis Leganés Nieto (Enresa)** – WP5 activities – thermal decontamination; impermeable graphite matrix (silicates compatible under El Cabril conditions).
- **Johannes Fachinger (FNAG)** – Overview of FNAG work.
- **Werner Von Lensa (FZJ)** – FZJ contribution to WP5 – Task 5.1 (relevant information on CARBOWASTE and CarboDISP; characterisation data of AVR, MERLIN and FRR graphites), Task 5.2 (simulation of recoil effects during ^{13}C (Π, γ) ^{14}C activation process and information on β hotspots), Task 5.3 (leach tests on untreated and treated i-graphite, determination of 'labile' fraction of ^{14}C inventory, harmonisation of leach experiment conditions).
- **Viorel Fugaru (IFIN-HH)** – Task 5.1 Characterization of the inventory of irradiated graphite from the thermal column of VVR-S Research Reactor (five graphite discs - aluminium cladding); Sampling of graphite- gamma emitting radionuclides content determination by gamma spectroscopy). Task 5.2 Development of a method for the ^{14}C measurement at low concentrations using the accelerator mass spectrometer facility (1.0 MV TANDETRON- AMS System); ^{14}C and ^{3}H distribution pattern in the irradiated graphite samples from the VVR-S Reactor (using 1.0 MV TANDETRON-AMS and BISPACE LAB with multi-isotope ^{14}C and ^{3}H sample holders). Task 5.3 Measurement of the rate of release of ^{14}C and ^{3}H species from irradiated VVR-S Reactor graphite to solution and gas phase.
- **Borys Zlobenko (IGNS) this presentation was given by Simon Norris on behalf of B. Zlobenko** – Task 5.1 IGNS will review the outcome of the IAEA project investigating conversion of i-graphite from decommissioning of Chernobyl-NPP into stable waste forms. IGNS will provide input on the use of graphite in the RBMK reactor. Task 5.3 IGNS will examine the effect of etching and removing the surface layer of graphite and study the long-term behaviour of ^{14}C in concrete waste packages.

- **Crina Bucar (INR)** – Task 5.1 – INR will review data on MTR i-graphite and correlate ^{14}C content and speciation with impurity content and irradiation history. Task 5.3 – INR will perform leaching tests on TRIGA i-graphite to measure the rate of ^{14}C release and the inorganic/organic ratio.
- **Nelly Toulhoat (CNRS/IN2P3)** – involved in Task 5.1, 5.2 and 5.5. CNRS and IPNL concentrate on understanding how irradiation effects influence migration and release of ^{13}C by carrying out experiments with different irradiation regimes to study the respective effects of nuclear displacements and electronic excitation/ionisation of ^{13}C migration.
- **Ernestas Narkunas (LEI)** - involved in Task 5.1, LEI will contribute to the D5.5 report, Task 5.2 LEI will model the ^{14}C inventory in a RBMK-1500 reactor core using new available data, and will produce deliverable D5.17) and Task 5.5 LEI will contribute to the D5.19 deliverable.

3 Presentations – Day 2

3.1 WP2 Steels – Kick-Off Meeting

All WP2 Participants were involved in a detailed overview of WP2. Each participant presented an overview of the work that will be carried out for this WP and the deliverables they are responsible for. The presentations were from:

- **Jens Mibus (Nagra)** – WP2 Introduction and Requirements from Waste Management Organisations and National Programmes.
- **Steve Swanton (Amec)** – WP2 Task 1 – Literature review of rates of corrosion of steels and ^{14}C release, including an overview of Task 1 objectives and outputs, the scope of the report, the source of information for the report and requested inputs from WP2 participants, and a timetable for completing the report. The kick-off meeting acted as the 'call for information' from Amec to other WP2 participants - WP2 participants to provide input to Amec by 15th January 2014.
- **Eric Wieland (PSI)** – WP2 Task 2.2 'Analytical Development' overview of the aims and challenges for this Task, the expected carbon species in high-pH conditions, and the potentially applicable analytical techniques.
- **Tomo Suzuki-Muresan (Armines)** – contribution to the analytical development for WP2 in parallel with WP3. Analytical development for speciation determination (separation of organic/inorganic; analysis of remaining organic ^{14}C) and quantitative determination.
- **Hiromi Tanabe (RWMC)** - contribution to the analytical development for WP2 – cold specimens (various techniques under examination), hot specimens (same as for WP3).
- **Frank Druyts (SCK.CEN)** – Material Variation – stainless steel investigated by Amec/NRG. RWMC, ITU; unirradiated materials (stainless steel pipe, Japanese high carbon steel, iron carbide) investigated by VTT; carbon steel investigated by SCK.CEN; Inconel investigated by KIT.
- **Steve Swanton (Amec)** – overview of leaching experiments to be done in conjunction with NRG.
- **David Bottomley (ITU)** – overview of Task 2.3 – ITU's examination of ^{14}C releases from irradiated stainless steel cladding. ITU also gave an overview of their overall contribution to WP2: choose suitable stainless steel cladding sample; perform long-term corrosion testing of irradiated stainless steel cladding under alkaline and anoxic

aqueous conditions (repository with cement); attempt to measure total carbon and ^{14}C release; possibly determine ^{14}C partitioning; contribute to State of the Art review.

- **Tiina Heikola (VTT)** – overview of anaerobic leaching experiments with unirradiated steel materials and iron carbide.
- **Bernhard Kienzler (KIT)** – overview of quantification of the ^{14}C inventory in irradiated Inconel steel and determination of the speciation of mobilized ^{14}C; and thermodynamic modelling of carbon in the steel. KIT also gave an overview of the experimental design for aqueous and gaseous samples.
- **Jose Luis Leganés Nieto (Enresa)** – Enresa WP2 activities: leaching test of irradiated stainless steel – determine the release rate of ^{14}C from irradiated stainless steel from the Jose Cabrera (PWR) NPP.; understand the chemical processes during the leaching experiments; leaching test at El Cabril Laboratories, measuring the ^{14}C release rate.

Some of the specific discussion points for WP2 were:

- Alloy composition and characterization (especially N) as well as irradiation data (can be just total fluence) will need to be known. A round-robin-test in estimating the ^{14}C inventory from the N-content and the irradiation data is suggested. Those, who wish to participate, should give notice by e-mail to J. Mibus. The test can be evaluated after the real ^{14}C content has been measured.
- Needed for literature review: corrosion rates, ^{14}C release and speciation. S. Swanton will send a list on what information he needs.
- Inconel will be tested in non-oxidizing acid due to low corrosion rate.
- Bernhard Kienzler: Low Molecular Weight organic molecules do not sorb on cement. Eric Wieland: No sorption data available in literature, PSI is trying to measure.
- Steve Williams noted the need for agreed water recipes for the experimental work within CAST.
- Jose Luis Leganés Nieto: bentonite porewater proposed but agreed to also use cement porewater.
- Steve Swanton: With a saturated $Ca(OH)_2$ solution precipitation of $CaCO_3$ is possible (P. Reiller later estimated a concentration of 10^{-6} M CO_3^{2-}).
- Steve Williams: Saturated $Ca(OH)_2$ is sensitive to temperature fluctuations (precipitation) and thus a slightly under-saturated solution (e.g. SI ca. 0.9) should be used.
- Need to agree on common electrolyte /environment for the corrosion tests. The Coordinator will discuss this via email with the WP leaders.

3.2 WP3 Zircaloy – Kick-Off Meeting

All WP3 Participants were involved in a detailed overview of WP3. Each participant presented an overview of the work that will be carried out for this WP and which deliverables they are responsible for. The presentations were from:

- **Stéphan Schumacher (Andra)** – overview of technical presentations.
- **Tomo Suzuki-Muresan (Armines)** – Task 3.2 – Characterisation of ^{14}C speciation liquid phases (analysis of liquid phase using a combination of techniques and special considerations for very low concentrations of ^{14}C).
- **Christine Lamouroux (CEA)** – Task 3.2 Development of analytical methods for measuring ^{14}C speciation – overview of analytical strategy (including global strategy, focus on speciation of organic molecules and analytical tools). Task 3.3 Characterisation of ^{14}C released from irradiated zirconium fuel clad wastes.

- **Crina Bucar (INR)** – INR objective is to assess the ^{14}C source term in irradiated Zircaloy-4 fuel claddings. INR are involved in Task 3.3 – characterisation of ^{14}C released from irradiated zirconium fuel clad wastes, including: compiling ^{14}C inventory in irradiated Zircaloy-4; ^{14}C accumulation during irradiation (ORIGEN simulations); Zircaloy-4 corrosion under simulated disposal conditions; long-term corrosion tests on un-irradiated oxidised Zircaloy-4 claddings; long-term corrosion tests on irradiated Zircaloy-4.
- **David Bottomley (ITU)** – Examination of ^{14}C from irradiated PWR Zircaloy cladding – choose a suitable irradiated Zircaloy cladding sample from PWR reactor; perform long-term corrosion testing of irradiated Zircaloy cladding under alkaline and anoxic aqueous conditions or other solutions as decided. Attempt measurement of total ^{14}C release during leaching/remaining in cladding. Possibly determine ^{14}C partitioning (solution/gas phase); if not determine upper total ^{14}C release under these conditions. Alternatively samples to be sent to INE for ^{14}C speciation and/or PSI for accel. MS analysis. Contribute to State of the Art Review
- **Bernhard Kienzler (KIT)** – Involved in Task 3.2 Development of analytical methods for measuring ^{14}C speciation, and Task 3.3 Characterisation of ^{14}C released from irradiated zirconium fuel clad wastes. In Task 3.3 KIT will dissolve irradiated Zircaloy-4 hulls from Gösgen PWR under acidic non-oxidising conditions in a hot cell; measure total ^{14}C inventories in Zircaloy and Zircaloy oxide films; perform thermodynamic modelling; improve understanding of ^{14}C in Zircaloy.
- **Hiromi Tanabe (RWMC)** –an overview of previous studies on ^{14}C generated from Zircaloy hull waste; the R&D schedule for Zircaloy; the inventory for Zircaloy metal and Zircaloy oxide film; the long-term corrosion model; leaching tests of irradiated Zircaloy; and corrosion tests of non-irradiated Zircaloy.
- **Frank Druyts (SCK.CEN)** – research plan for carbon speciation experiments at SCK including details on the preparation step and details on the experimental work (speciation pre-tests with inactive Zirconium alloys; and accelerated leaching tests of irradiated zirconium alloys).

The need for a range of analytical techniques for ^{14}C was noted by Steve Williams to allow selection of the most appropriate to meet the needs of the experiments, recognising that as the project progresses detailed analyses would by necessity be focused on a limited number of experiments.

3.3 WP4 Ion-Exchange Resins – Kick-Off Meeting

All WP4 Participants were involved in a detailed overview of WP4. Each participant presented an overview of the work that will be carried out for this WP and which deliverables they are responsible for. The presentations were from:

- **Pascal Reiller (CEA)** – Task 4.1 – Review of ^{14}C release from IE-resins and Task 4.2 ^{14}C Inventory: global inventory – analytical strategy (methods based on resin combustion with oxygen and mineral acid dissolution); discrimination mineral and organic form (tests on virgin resin spiked with mineral, organic and both ^{14}C forms). Task 4.3 ^{14}C Release and Speciation: ^{14}C released in cement water leaching experiments (long-term leaching tests in conditions representative of disposal; global ^{14}C measurement; ^{14}C speciation: focus on organic compounds).
- **Laurent Petit (EDF)** – 3 sources of SIERs expected to become available from December 2014 to February 2015. Will consider leaching in simple calcium hydroxide as representative of Stage II (portlandite) cement evolution.

- **Alfredo Luce (ENEA)** – Task 4.2 ^{14}C Inventory and speciation in SIERs – experimental measure on the volatile and non-volatile fractions in SIERs using different experimental approaches. Activity 1 – IERs degradation process experiments (design of degradation experiment, morphological characterisation of IERs in different stages of the degradation process). Activity 2 – Targeted device for speciation of carbon constituents in IERs (definition of the operational parameters for the separation of volatile and non-volatile fraction in IERs; design and implementation of the device for speciation; LSC measurement of ^{14}C in different fractions).
- **Werner Von Lensa (FZJ)** – Task 4.1 Current Status review of ^{14}C and its release from SIERs (contribution to state of the art review; sample choice/retrieval). Task 4.2 ^{14}C Inventory and speciation in SIERs (identification of source terms; quantification/separation through combustion/thermal treatment; measurement of ^{14}C in water in equilibrium with SIERs; measurements and analysis of coolant (if possible); morphological micro-optical studies; reproduction of operational processes in bench-scale). Task 4.3 ^{14}C release from SIERs and its speciation (leaching experiments in various conditions; qualitative and quantitative speciation of leached ^{14}C labelled species; releases from dewatered/dried resins; analytical developments to lower detection limits; investigations on the degradation of SIERs from BWRs; reproduction of accidental conditions). Task 4.4 Synthesis of experimental data and interpretation (contribution to systematic correlation of results and experimental parameters (database); contribution to develop an interpretation of ^{14}C behaviour from SIERs; contribution to summarize and synthesise the experimental studies in a final report).
- **Crina Bucar (INR)** – Task 4.2 ^{14}C inventory and speciation from SIERs – ^{14}C inventory in CANDU SIERs from Cernavoda NPP and its partitioning between inorganic and organic species. Task 4.3 Release from SIERs and ^{14}C speciation – leaching tests on CANDU SIERs, and degradation tests of CANDU SIERs. SIERS uncontaminated by fuel-derived radionuclides have sufficient ^{14}C content.
- **Klas Källström (SKB)** – determination of ^{14}C – organic and inorganic – in SIERs; better estimations on how much is deposited and where in SFR in different rock caverns; updated Kd-factors for concrete conditions; refined biosphere model looking over conservatisms.
- **Petr Vecernik (UJV)** – participation on planning, preparation and realisation of experiments, evaluation of results and reporting. Two phases of research: release of ^{14}C species from ion-exchange resins; and release of ^{14}C species from solidified ion-exchanges. Phase I involves experiments with pure ion exchange resins with simple organic and inorganic 14 species; experiments with real samples from reactor operation and analysis of ^{14}C activity and speciation. Phase II involves fixation of resins into the cement or geopolymer matrix; determination of leaching rates over a defined time period; analysis of ^{14}C activity and speciation.

Participants in WP4 were requested to send information on their SIER sample choices, and identify the information that was allowed to be published openly. This, and other information and text, for the state of art review should be sent to Pascal Reiller. The intention is to send the state of the art review to the coordinator by September 2014.

3.4 WP6 Relevance of results in national contexts and safety assessments – Kick-Off Meeting

All WP6 Participants were involved in a detailed overview of WP6. Each participant presented an overview of the work that will be carried out for this WP and which deliverables they are responsible for. The presentations were from:

- **Stéphan Schumacher (Andra)** – overview of design and inventory for France; overview of recent/ongoing studies on ^{14}C and the main uncertainties around the work; overview of the safety/performance assessments models used for the migration of ^{14}C (solute and gas). For WP6, Andra will provide information on the modelling of diffusion-sorption of dissolved species of ^{14}C through cementitious and clay rock systems (speciation input from CAST will inform this); the assessment of release and transport at compartment scale; the assessment of two-phase flow migration of ^{14}C at repository scale.
- **Alfredo Luce (ENEA)** – overview of the present situation in Italy and ENEA's involvement in WP6: Task 6.1 – contribution to overview of current handling of ^{14}C in most recent safety assessment; contribution to overview of most important aspects of current WMO Safety Assessment analysis. Task 6.2 – definition of ^{14}C state of knowledge in Italian radioactive waste inventory. Task 6.3 – conceptual model of repository and host site will be developed with data and information from international experience (repository) and with data and information from Italian geo-territorial context (host site).
- **Jose Luis Leganés Nieto (Enresa)** – overview of role of ^{14}C in reference geological disposal concepts in granite or clay; inventory; and main hypotheses in Performance Assessment; consequences in PA and expectations from CAST.
- **Jari Tuunanen (Fortum)** – overview of final disposal concept for the operational and decommissioning waste from Fortum's Loviisa NPP; main uncertainties and treatment in safety analysis, overview of work plan for CAST.
- **André Rübel (GRS)** – overview of national context in Germany; preliminary safety analysis for Gorleben (2010-2013); main tasks of GRS in CAST (compile input from German programme; compilation and estimations about the influence of different parameters; examination of the applicability of data obtained in CAST on the conditions expected in the salt case; carrying out performance assessment simulations for the salt case; compiling remaining uncertainties for the salt case).
- **Crina Bucar (INR)** – to assess the impact of new knowledge for ^{14}C release from spent IER to be disposed of in the LIL waste repository at Saligny on the safety case improvement. Task 6.1 Handling of ^{14}C in current safety assessments: INR will review ^{14}C source term approach in Romanian safety assessment for the LIL waste repository; uncertainty analysis related to ^{14}C for the Romanian safety case; microorganism effect on the ^{14}C speciation and migration based on expert opinion on previous experience and evidence (subcontracted). Task 6.3 Integration of CAST results to safety assessment: INR will integrate the experimental results obtained in WP3; update the FEP list and assessment of the impact of ^{14}C release fluxes; assess the impact of the new information on the uncertainties based on updated performance analysis.
- **Ernestas Narkunas (LEI)** – overview of Lithuanian disposal concept, available knowledge and current treatment of ^{14}C in the safety assessment. In WP6 LEI will concentrate on RMBK-1500 reactors; available information will be collected and models will be developed based on Lithuanian site characterisation; nuclide migration

by water and gas pathways will be analysed; uncertainties will be analysed and a sensitivity evaluation will be undertaken.

- **Jens Mibus (Nagra)** – overview of Swiss disposal concept, model inventory, knowledge and uncertainties, treatment of ^{14}C in safety analysis and Nagra's contribution to WP6 (use of existing models/codes for safety analysis; modifying scenarios and parameters according to CAST findings; estimation of transport parameters in cement and in argillaceous host rock by expert judgement based on results from CAST; sensitivity analysis).
- **Steve Williams on behalf of Helen Kendall (NDA)** – overview of UK Programme for Higher Activity Wastes; overview of waste inventory; overview of current calculated ^{14}C gas generation rates for disposal concept in higher-strength rocks; overview of contribution to WP6 (UK current status based on generic DSSC; review of state of the art reports from WP 2, 3 and 5 in the context of UK safety assessment; use of the results from WP2, 3 and 5 to update gas generation calculations using SMOGG based on a fractured higher-strength rock concept; assess qualitative impacts on generic DSSC).
- **Hiromi Tanabe (RWMC)** – overview of study on TRU waste disposal in Japan, reference concepts and inventory, uncertainties, overview of contribution to WP6 (evaluation about the influence of Zircaloy and stainless steel; leaching models of ^{14}C from Zircaloy and stainless steel; speciation of ^{14}C).
- **Klas Källström (SKB)** – overview of the Swedish system; treatment in safety assessment; contribution and expectations.
- **Antonin Vokál (Surao)** – overview of the Czech concept; inventory of ^{14}C; main interests and contributions to WP6 (review of current safety cases in respect of ^{14}C treatments; analysis of WP2 – 5 results to update safety case parameters; update concepts and models used in current safety case; performance calculations).

4 Meeting Close

Steve Williams (NDA) closed the meeting, thanking all participants for attending.
The next CAST General Assembly Meeting will be held in the week commencing 20th October 2014.
Potential hosts for the next General Assembly meeting were requested to contact the Coordinator. If nobody feels able to host the next meeting then one of the WP Lead organisations will be requested to host the meeting.

Figure 1: Members of the CAST consortia at the London Kick-Off Meeting in November 2013.