Consortium Agreement

THIS CONSORTIUM AGREEMENT is based upon REGULATION (EURATOM) No 1314/2013 OF THE COUNCIL of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation which incorporates the rules for the participation and dissemination in Horizon 2020 provided by the Regulation (EU) No 1290/2013 in "Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)" of the European Parliament and of the Council (hereinafter referred to as "the Rules for Participation"), and the European Commission Multi-beneficiary Model Grant Agreement for the European Joint Programme (EJP) Cofund and its Annexes, and is made on June 1st, 2019 hereinafter referred to as the Effective Date.

BETWEEN:

1. **AGENCE NATIONALE POUR LA GESTION DES DECHETS RADIOACTIFS** (ANDRA), established in 1-7 rue Jean Monnet - Parc de la Croix Blanche, CHATENAY MALABRY 92298, France, **the Coordinator**,

2. **AGENCIJA ZA RADIOAKTIVNE ODPADKE LJUBLJANA ZAVOD** (ARAO), established in CELOVSKA C. 182, LJUBLJANA 1000, Slovenia

3. **BEL V** (BEL V), established in RUE WALCOURT 148, BRUXELLES 1070, Belgium

4. **BUNDES-GESELLSCHAFT FÜR ENDLAGERUNG MBH** (BGE), established in ESCHENSTRASSE 55, PEINE 31224, Germany

5. **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES** (CEA), established in RUE LEBLANC 25, PARIS 15 75015, France

6. **CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT** (CIEMAT), established in Avenida Complutense 40, MADRID 28040, Spain

7. **Chornobyl Research and Development Institute** (ChRDI), established in Staronavodnitska str., 6-b, Kyiv 01015, Ukraine,

8. **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS** (CNRS), established in RUE MICHEL ANGE 3, PARIS 75794, France,

9. **CENTRALE ORGANISATIE VOOR RADIOACTIEF AFVAL NV** (COVRA), established in SPANJEWEG 1 HAVEN 8601, NIEUWDORP ZLD 4455 TW, Netherlands,

10. **VALSTYBINIS MOKSLINIU TYRIMU INSTITUTAS FIZINIU IR TECHNOLOGIJOS MOKSLU CENTRAS** (FTMC), established in Savanoriu 231, VILNIUS 02300, Lithuania

11. **CENTRUM VYZKUMU REZ S.R.O**. (CV REZ), established in HUSINEC-REZ 130, HUSINEC-REZ 250 68, Czech Republic,

12. **Dansk Dekommissionering** (Dekom), established in Frederiksborgvej 399, Roskilde 4000, Denmark,

13. **ELLINIKI EPITROPI ATOMIKIS ENERGEIAS** (EEAE), established in NEAPOLEOS 4 PATRIARCHOU GRIGORIOU, AGHIA PARASKEVI 15310, Greece,

14. **EMPRESA NACIONAL DE RESIDUOS RADIACTIVOS S.A**. (ENRESA), established in Calle Emilio Vargas 7, MADRID 28043, Spain,

15. **FORSCHUNGSZENTRUM JULICH GMBH** (JUELICH), established in WILHELM JOHNEN STRASSE, JULICH 52428, Germany, represented by its Board of Directors, for. Institute of Energy and Climate Research Nuclear Waste Management and Reactor Safety (IEK-6)

16. **GESELLSCHAFT FUR ANLAGEN UND REAKTORSICHERHEIT** (GRS) gGmbH (GRS), established in SCHWERTNERGASSE 1, KOLN 50667, Germany,

17. **Ignalinos atomine elektrine** (IAE), established in Elektrinės g. 4 K47, Drūkšiniai,, Visaginas LT-31152, Lithuania, VAT number: LT 554500811,

18. **INSTYTUT CHEMII I TECHNIKI JADROWEJ** (INCT), established in ul. Dorodna 16, WARSZAWA 03-195, Poland,

19. **INSTITUT DE RADIOPROTECTION ET DE SURETE NUCLEAIRE** (IRSN), established in AV DE LA DIVISION LECLERC 31, FONTENAY AUX ROSES 92260, France, IRSN contract reference number: LS 21016

20 **INSTITUTO SUPERIOR TECNICO** (IST), established in AVENIDA ROVISCO PAIS 1, LISBOA 1049-001, Portugal,

21. **ASSOCIACAO DO INSTITUTO SUPERIOR TECNICO PARA A INVESTIGACAO E DESENVOLVIMENTO** (IST ID), established in AVENIDA ROVISCO PAIS 1, LISBOA 1049 001, Portugal

22. **INSTITUT JOZEF STEFAN** (JSI), established in Jamova 39, LJUBLJANA 1000, Slovenia,

23. **Joint Research Centre (**JRC) established in Rue de la Loi 200, BRUSSELS 1049, Belgium

24. **KARLSRUHER INSTITUT FUER TECHNOLOGIE** (KIT), established in KAISERSTRASSE 12, KARLSRUHE 76131, Germany,

25. **LIETUVOS ENERGETIKOS INSTITUTAS** (LEI), established in Breslaujos g. 3, KAUNAS LT-44403, Lithuania,

26. **MAGYAR TUDOMANYOS AKADEMIA ENERGIATUDOMANYI KUTATOKOZPONT** (MTA EK), established in KONKOLY THEGE MIKLOS UT 29-33, Budapest 1121, Hungary,

27. **NATIONALE GENOSSENSCHAFT FUER DIE LAGERUNG RADIOAKTIVER ABFAELLE** (NAGRA), established in Hardstrasse 73, WETTINGEN 5430, Switzerland,

28. **NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"** (NCSR), established in END OF PATRIARCHOU GRIGORIOU E AND 27 NEAPOLEOS STREET, AGIA PARASKEVI 15341, Greece,

29. **NUCLEAR ENGINEERING SEIBERSDORF GMBH** (NES), established in FORSCHUNGSZENTRUM, SEIBERSDORF 2444, Austria,

30. **Národný jadrový fond** (NJF), established in Mierová 19, Bratislava 821 05, Slovakia,

31. **NUCLEAR RESEARCH AND CONSULTANCY GROUP** (NRG), established in WESTERDUINWEG 3, PETTEN 1755 LE, Netherlands,

32. **NATIONALE INSTELLING VOOR RADIOACTIEF AFVAL EN VERRIJKTE SPLIJSTOFFEN** (ONDRAF/NIRAS), established in KUNSTLAAN 14, SAINT-JOSSE-TENNOODE 1210, Belgium,

33. **POSIVA OY** (POSIVA), established in OLKILUOTO, EURAJOKI 27160, Finland,

34. **PAUL SCHERRER INSTITUT** (PSI), established in FORSCHUNGSTRASSE 111, VILLIGEN PSI 5232, Switzerland,

35. **Public Limited Company for Radioactive Waste Management** (PURAM), established in Puskás Tivadar street 11, Budaörs HUNGARY,H-2040,

36. **REGIA AUTONOMA TEHNOLOGII PENTRU ENERGIA NUCLEARA** (RATEN), established in STRADA CAMPULUI 1, MIOVENI 115400, Romania,

37. **RADIOACTIVE WASTE MANAGEMENT LIMITED** (RWM), established in HERDUS HOUSE INGWELL DRIVE WESTLAKES SCIENCE AND TECHNOLOGY PARK MOOR ROW, CUMBRIA CA24 3HU, United Kingdom,

38. **STUDIECENTRUM VOOR KERNENERGIE / CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE** [also known as the Belgian Nuclear Research Centre], Foundation of Public Utility, SCK•CEN with its Registered Office in Belgium, Avenue Herrmann-Debroux 40, BE-1160 BRUSSELS and its Operational Office also in Belgium, Boeretang 200, BE-2400 MOL, with enterprise number 0406.568.867 and VAT number BE406.568.867, represented by Professor Eric van Walle, Director-General, and Professor Derrick P. Gosselin, Chairman of the Board of Governors,,

39. **SVENSK KARNBRANSLEHANTERING AKTIEBOLAG** (SKB), established in BOX 3091, SOLNA 169 03, Sweden,

40. **STATE ENTERPRISE STATE SCIENTIFIC AND TECHNICAL CENTER FOR NUCLEAR AND RADIATION SAFETY** (SSTC NRS), established in VASYLYA STUSA STREET 35 - 37, KYIV 03142, Ukraine,

41. **SLOVENSKA TECHNICKA UNIVERZITA V BRATISLAVE** (STUBA), established in VAZOVOVA 5, BRATISLAVA 81243, Slovakia,

42. **Správa úložišť radioaktivních odpadů** (SÚRAO), established in Dlazdena 6, Praha CZ-110 00, Czech Republic,

43. **STATNI USTAV RADIACNI OCHRANY v.v.i.** (SURO), established in BARTOSKOVA 28, Praha 14000, Czech Republic,

44. **NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO** (TNO), established in ANNA VAN BUERENPLEIN 1, DEN HAAG 2595 DA, Netherlands,

45. **TS ENERCON MERNOKIRODA KFT** (TS Enercon), established in CSALOGANY UTCA 23-33, BUDAPEST 1027, Hungary,

46. **TECHNICAL UNIVERSITY OF SOFIA** (TUS), established in Kliment Ohridsky Bd 8, SOFIA 1000, Bulgaria,

47. **UNIVERSITY OF CYPRUS** (UCyprus), established in KALLIPOLEOS STREET 75, NICOSIA 1678, Cyprus,

48. **HELSINGIN YLIOPISTO** (UHelsinki), established in FABIANINKATU 33, HELSINGIN YLIOPISTO 00014, Finland,

49. **UNITED KINGDOM RESEARCH AND INNOVATION** (UKRI), as represented by its component body, the British Geological Survey, established in POLARIS HOUSE NORTH STAR AVENUE, SWINDON SN2 1FL, United Kingdom,

50. **Teknologian tutkimuskeskus** VTT Oy (VTT), established in VUORIMIEHENTIE 3, Espoo 02150, Finland,

51. **VUJE AS** (VUJE), established in Okruzna 5, TRNAVA 91864, Slovakia,

hereinafter, jointly or individually, referred to as ”Parties” or ”Party”

relating to European Joint Programme on Radioactive Waste Management – First implementation phase (June 2019 - May 2024)

in short: EURAD

hereinafter referred to as “Action”

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WHEREAS:

Having regard to article 7 of the TREATY ESTABLISHING THE EUROPEAN ATOMIC ENERGY COMMUNITY (the “Community”)

Having regard to the Co-operation Agreement between the European Atomic Energy Community and the Swiss Confederation in the field of controlled thermonuclear fusion and plasma physics of 4 September 1978

Having regard to Decision (EU) No 2017/1247 and Decision (EU) No 2017/1248 on the conclusion, on behalf of the EU, of the Association Agreement with Ukraine EU/Euratom and their member countries’ Association Agreement with Ukraine

Having regard to Regulation (EU, EURATOM) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002.

Having regard to Commission Delegated Regulation (EU) No 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union.

Having regard to REGULATION (EU) No 1291/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and repealing Decision No 1982/2006/EC

Having regard to Council Regulation (EURATOM) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community – “EURATOM Programme” (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation

Having regard to Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for the participation and dissemination in “Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)” (hereinafter referred to as “the Rules for Participation”)

Having regard to European Commission Decision C(2018)6365 of 3 October 2018) on the Work Programme 2018 implementing the Euratom Research and Training Programme (2014-18).

Whereas the Community contributes to the Union Framework programme for research and innovation, through the implementation of annex I i) of the Council Regulation (EURATOM) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation, setting up a Programme co-fund action according to which a grant is to be awarded by the Commission to the legal entities established or designated by Member States and any third country associated to the Euratom Programme and that will develop a joint programme of activities implementing the EURAD Strategic Research Agenda and Roadmap.

Whereas the Parties wish to specify or supplement binding commitments among themselves in addition to the provisions of the specific Grant Agreement n°847593 to be signed by the Parties and the Commission (hereinafter “Grant Agreement”).

Whereas the Parties are aware that this Consortium Agreement is based upon the DESCA model consortium agreement (http://www.desca-2020.eu/).

Whereas all the Parties signatories of this Consortium agreement who are programme owner or programme manager have been mandated by their respective competent authority to act as programme manager of the European Joint Programme on Radioactive Waste Management.

NOW, THEREFORE, IT IS HEREBY AGREED AS FOLLOWS:

1 Section: Definitions

Words beginning with a capital letter shall have the meaning defined either herein or in the Rules for Participation or in the Grant Agreement including its Annexes.

“Access Rights”	means	rights to use Results or Background under the terms and conditions laid down in the Grant Agreement and the Consortium Agreement.
“Affiliated Entity”	means	any legal entity that is under the direct or indirect control of a participant, or under the same direct or indirect control as the participant, or is directly or indirectly controlling a participant; control may take any of the forms set out in Article 8(2) of the Rules for Participation.
“Background”	means	any data, know-how and/or information whatever their form or nature, tangible or intangible, including any rights such as intellectual property rights which are (i) held by participants prior to their accession to the Action, (ii) Needed for carrying out the Action or for exploiting the Results of the Action; and (iii) identified by the participants in accordance with Article 24 Model Grant Agreement.
“Beneficiary”	means	a Party to the Grant Agreement with the Commission.
“Commission”	means	the body awarding the grant for the Action.
“Consortium Work Plan” or “Work Plan”	means	the Description of Action (Annex 1 of the Grant Agreement) and the related agreed budget as first defined in the Grant Agreement (Annex 2 of the Grant Agreement) and which may be updated by the General Assembly and approved by the Commission.
“Consortium Annual Work Plan” or “Annual Work Plan”	means	the Description of the Action and the related agreed budget for each periodic report (Annex 7 of the Grant Agreement).
“Coordinator”	means	the legal entity having signed the Grant Agreement and which is acting as the intermediary between the Parties and the Commission.

“Defaulting Party”	means	a Party which the General Assembly has identified to be in breach of this Consortium Agreement and/or the Grant Agreement as specified in Section 4.2 of this Consortium Agreement.
“EURATOM Programme”	means	the document adopted by the EC for the implementation of the specific programme in accordance with Article 11 and annex 1 i) of the Council Regulation n° 1314/2013 of 16 December 2013 on Euratom Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation.
“Fair and Reasonable conditions”	means	appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the Results or Background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.
“Founding Documents”	means	the Vision, Strategic Research Agenda, Roadmap, Deployment Plan and Governance of EURAD. These documents are given in Attachment 10 of the Consortium Agreement.
“Grant Agreement (GA)”	means	the Grant Agreement (847593) concluded between the Commission and the Parties for the implementation of the Action and the related funding.
“Intellectual property”	means	patents, copyright and related rights, trade marks, know how, trade secrets, industrial designs, designs, drawings, reports, methods of research and developments, software, documented data, and description of inventions and discoveries.

"Needed"	means	for the implementation of the Action: Access Rights are Needed if, without the grant of such Access Rights, carrying out the tasks assigned to the recipient Party would be impossible, significantly delayed, or require significant additional financial or human resources. For exploitation of own Results: Access Rights are Needed if, without the grant of such Access Rights, the Exploitation of own Results would be technically or legally impossible.
"Party"	means	the parties of this Consortium Agreement and the Grant Agreement, which are also referred to as Beneficiaries. Each Party falls into one of the three following Colleges: Waste Management Organisation (WMO), Technical Support Organisation (TSO) and Research Entity (RE).
"Results"	means	any tangible or intangible output of the Action, such as data, knowledge and information whatever their form or nature, whether or not they can be protected, which are generated in the Action as well as any rights attached to them, including intellectual property rights.
"Software"	means	sequences of instructions to carry out a process in, or convertible into, a form executable by a computer and fixed in any tangible medium of expression.
" Third Party"	means	any entity other than the Commission, involved in the execution of the Grant in one of the forms foreseen in the Grant Agreement that has not signed this Consortium Agreement
"Linked Third Party"	means	a Third Party with a legal contractual link to a beneficiary is any legal entity which has a legal link to the beneficiary as specified in Art. 14 of the Grant Agreement' implying collaboration that is not limited to the Action. The Linked Third Party signs the Declaration of Honour form (Attachment 9).

2 Section: Purpose

In accordance with Article 41.3 of the Grant Agreement, and Article 24 (2) of the Rules for Participation, the purpose of this Consortium Agreement is to specify with respect to the Action the relationship among the Parties, in particular concerning the organisation of the work between the Parties, the management of the Action and the rights and obligations of the Parties concerning inter alia liability, Access Rights and dispute resolution.

3 Section: Entry into force, duration and termination

3.1 Entry into force

A legal entity becomes an initial Party to this Consortium Agreement upon signature of this Consortium Agreement by a duly authorised representative.

This Consortium Agreement shall have effect from the Effective Date identified at the beginning of this Consortium Agreement.

All decisions taken by the General Assembly from the entry into force of the Consortium Agreement will be binding for all Parties, which have signed it, irrespective of the date of their signature.

Such decisions shall be distributed in accordance with section 6.2.6.1 to those legal entities that are envisaged to join the Consortium but have not yet signed the Consortium Agreement and after a non-disclosure statement, the template of which shall be approved by the General Assembly, is signed by the entity envisaging to join the Consortium.

In accordance with 6.2.5.1 of the Consortium Agreement, a new legal entity may accede the Consortium Agreement upon signature of the accession document (Attachment 2) countersigned by the Coordinator. Such accession shall have effect from the date identified in the accession document.

3.2 Duration and termination

This Consortium Agreement shall continue in full force and effect during the Action as defined under Article 3 of the Grant Agreement and until complete fulfilment by each Party of their respective obligations under the Grant Agreement and under this Consortium Agreement.

However, this Consortium Agreement or the participation of one or more Parties to it may be terminated in accordance with the terms of this Consortium Agreement, if:

- the Grant Agreement is not signed by the Commission or a Party; or
- the Grant Agreement is terminated before the end of the Action; or
- a Party's participation in the Grant Agreement is terminated.

In the circumstances set out in the three limbs above, this Consortium Agreement shall automatically terminate in respect of the affected Party/ies, subject to the provisions surviving the expiration or termination under Section 3.3 of this Consortium Agreement.

3.3 Survival of rights and obligations

The provisions relating to Sections Results, Access Rights, non-disclosure of information, for the time period mentioned therein, as well as for all provisions related to liability, applicable law and settlement of disputes shall survive the expiration or termination of this Consortium Agreement.

Termination shall not affect any rights or obligations of a Party leaving the Consortium incurred prior to the date of termination, unless otherwise agreed between the General Assembly and the leaving Party. This includes the obligation to provide all input, deliverables and documents for the period of its participation.

4 Section: Responsibilities of Parties

4.1 General principles

Each Party undertakes to take part in the efficient implementation of the Action, and to cooperate, perform and fulfil, on time, all of its obligations under the Grant Agreement and this Consortium Agreement as may be reasonably required from it and in a manner of good faith as prescribed by Belgian law.

Each Party undertakes to notify without undue delay, in accordance with the governance structure of the Action, any significant information, fact, problem or delay likely to affect the Action.

Each Party shall provide without undue delay all information reasonably required by the General Assembly, the Programme Management Office or by the Coordinator to carry out its tasks.

Each Party shall take reasonable measures to ensure the accuracy of any information or materials it supplies to the other Parties and to only transmit information that, to its knowledge at the date of the transmission, is not subject of any proceedings for infringement of the IP rights of a Third Party.

4.2 Breach

In the event the General Assembly identifies a breach by a Party of its obligations under this Consortium Agreement or the Grant Agreement, the Coordinator or, if the Coordinator is in breach of its obligations, the Party appointed by the General Assembly, will give formal notice to such Party requiring that a proposal be submitted within four (4) weeks for approval by the General Assembly on how and by when to remedy the breach.

If such breach is substantial and is not remedied within the agreed period or is not capable of remedy, the General Assembly shall assess the consequences for the Consortium activities and may decide to declare the Party to be a Defaulting Party and to decide on the consequences thereof which may include termination of its participation, considering that termination extends to its Linked Third Parties (if any). Parties considered to be in default may not vote on such decisions.

4.3 Involvement of Third Parties

A Party that enters into a subcontract or otherwise involves Third Parties (including but not limited to Linked Third Parties) in the Action retains sole responsibility towards the Commission and the other Parties for its obligation(s). In particular, it remains responsible for carrying out its relevant part of the Action and for such Third Party's compliance with the provisions of this Consortium Agreement and of the Grant Agreement, and for the consequences arising from such Third Party's non-compliance. It has to ensure that the involvement of Third Parties does not affect the rights and obligations of the other Parties under this Consortium Agreement and the Grant Agreement.

5 Section: Liability towards each other

5.1 No warranties

In respect of any information or materials (incl. Results and Background) supplied by one Party to another under the Action, no warranty or representation of any kind is made, given or implied as to the sufficiency or fitness for purpose nor as to the absence of any infringement of any proprietary rights of Third parties.

Therefore,

- the recipient Party shall in all cases be entirely and solely liable for the use to which it puts such information and materials, and
- no Party granting Access Rights shall be liable in case of infringement of proprietary rights of a Third Party resulting from any other Party (or its Affiliated Entities) exercising its Access Rights.

5.2 Limitations of contractual liability

No Party shall be responsible to any other Party for any indirect or consequential loss or similar damage such as, but not limited to, loss of profit, loss of revenue or loss of contracts, provided such damage was not caused by a wilful act, or by a breach of confidentiality.

For any remaining contractual liability, a Party's aggregate liability towards the other Parties collectively shall be limited to once the Party's share of the total costs of the Action as identified in Annex 2 (column j) of the Grant Agreement provided such damage was not caused by a wilful act or gross negligence.

The terms of this Consortium Agreement shall not be construed to amend or limit any Party's statutory liability.

5.3 Damage caused to third parties

Each Party shall be solely liable for any loss, damage or injury to Third Parties resulting from the performance of the said Party's obligations by it or on its behalf under this Consortium Agreement or from its use of Results or Background.

5.4 Injury to the personnel of a Party

Each Party is responsible for the insurance coverage of its own employees in accordance with applicable national legal requirements for occupational injuries and diseases. As a consequence, each Party must fulfil the required formalities and sustain all the costs, if any, involved in the insurance policies underwritten to cover its own employees against these risks.

Each Party shall promptly inform the other Party of any incident or injury to the employees of such other Party occurring within its premises or installations or those which are known to it in the course of any work by the employees of such other Party received by it in order to allow such other Party to proceed to the formalities required by law within the prescribed time.

5.5 Force Majeure

No Party shall be considered to be in breach of this Consortium Agreement if it is prevented from fulfilling its obligations under the Consortium Agreement by Force Majeure as defined in the Grant Agreement.

Each Party will notify the General Assembly and the Coordinator of any Force Majeure without undue delay. If the consequences of Force Majeure for the Action are not overcome within 6 weeks after such notification, the transfer of tasks - if any - shall be decided by the General Assembly.

5.6 Insurance

Each Party shall comply with the foregoing requirements by acquiring financial protection it reasonably sees fit, for example, through governmental indemnities or private insurance, or any other appropriate financial protection.

6 Section: Governance structure

6.1 General structure

The *General Assembly* (GA) is the ultimate decision-making body of the EURAD consortium. It is responsible for agreeing the strategy of the EURAD in line with the content of the Founding Documents, as well as with the Euratom Work Programme.

The *Bureau* is an accompanying body to the General Assembly. It shall report to and be accountable to the General Assembly.

The Coordinator is the legal entity acting as the intermediary between the Parties and the Commission. The Coordinator shall, in addition to its responsibilities as a Party, perform the tasks assigned to it as described in the Grant Agreement and this Consortium Agreement.

The *Programme Management Office* (PMO) is in charge of scientific and technical coordination of the implementation of the Action, as well as the day-to-day management and communication activities. It is responsible to the General Assembly for the overall top-level planning, coordination and implementation of the EURAD Work Plan in line with the strategy agreed by the General Assembly. It shall report to and be accountable to the General Assembly.

The *External Advisory Board* (EAB) advises the General Assembly on strategic and implementation issues related to the EURAD Annual Work Plan and its coherence with respect to the Strategic Research Agenda and Vision.

6.2 General Assembly

6.2.1 Role

The General Assembly (GA) is the ultimate decision-making body of the EURAD consortium. It is responsible for agreeing the strategy of EURAD in line with the content of the Founding Documents and the Euratom Work Programme.

The General Assembly is responsible for agreeing and regularly reviewing the overarching strategy of EURAD as laid down in the Founding Documents and policies necessary to implement the Work Plan of the Consortium in a manner consistent with the Grant Agreement and the Euratom Work Programme. The details of the strategy and Work Plans, and any supporting policies and procedures, are elaborated by the Bureau and/or the Programme Management Office.

6.2.2 Composition

6.2.2.1

The General Assembly shall consist of one representative of each Party. Each Party shall designate its Representative duly authorised to deliberate, negotiate and decide on all matters listed in Section 6.2.5 of this Consortium Agreement. The complete list of all Parties' Representatives shall be held and updated by the Coordinator. Each of the Parties shall immediately give notice to the Coordinator in case of change of its Representative.

6.2.2.2

The Coordinator shall endorse the role of Secretary of the General Assembly for the duration of the Action.

In case the Representative is unable to attend the meeting, the respective Party may appoint a substitute or a proxy to attend and vote at any meeting. Such appointment or proxy shall be notified in advance to the Secretary. Parties that are unable to send a Representative to a meeting shall send an explanation to the Secretary.

6.2.2.3

Each Party of the General Assembly falls into one of the three following Colleges:

- Waste Management Organisation (WMO);
- Technical Support Organisation (TSO);
- Research Entity (RE).

The Representatives of the Waste Management Organisations form together the WMO College. The Representatives of the Technical Support Organisations (TSO) form together the TSO College. The Representatives of the Research Entities (RE) form together the RE College.

In case there is a change of Chair in a College, this shall be notified to the Secretary by a mail countersigned by the former Chair, if possible, and the new Chair.

Each college shall have its own rules of procedures. Cost for meetings of the Colleges are not eligible for funding within EURAD.

6.2.3 Preparation and organisation of meetings

6.2.3.1 Convening meetings

The Secretary shall convene ordinary meetings of the General Assembly at least twice a year.

Additional meetings may be held if required. Extraordinary meetings for urgent issues may be convened at any time upon written request of one third of the Parties of each College or on request of the Bureau, the Coordinator or the Programme Management Office.

The members of the Programme Management Office and the members of the Bureau shall be invited to attend the General Assembly meetings, except in the conditions set out in section 6.2.3.10.

The Commission representative shall be invited as guest to the meetings, except in the conditions set out in section 6.2.3.10.

The General Assembly may invite other persons as guests to its meetings as it deems necessary.

6.2.3.2 Notice of a meeting

The Secretary shall give notice in writing of a meeting to each Party as soon as possible and no later than 30 calendar days preceding an ordinary meeting and 15 calendar days preceding an extraordinary meeting.

6.2.3.3 Agenda of the meeting

The Secretary shall send each Party a written original agenda no later than two weeks preceding the meeting, or one week before an extraordinary meeting. The agenda shall be approved by the General Assembly and, amended if necessary and decided under the conditions hereinafter set out in section 6.2.3.4 and 6.2.3.5.

6.2.3.4 Adding agenda items

Any agenda item requiring a decision by the General Assembly must be identified as such on the agenda.

Any Party may add an item to the agenda by written notification to all of the other Parties no later than one week or three (3) calendar days for an extraordinary meeting preceding the meeting. In the latter case Saturday and Sunday do not count towards the three days.

6.2.3.5 Adding a new agenda item

During a meeting of the General Assembly the Parties present or represented can unanimously agree to add a new item to the original agenda notwithstanding the provision in 6.2.3.4. A Party that was not represented in a meeting may retroactively object to any decision taken on such an item within two weeks following issue of the summary of decisions. In that case the decision shall be void and the agenda item shall be added to the agenda of the subsequent General Assembly meeting.

6.2.3.6 Supporting documents

Supporting documents related to topics that require a decision other than those raised according to 6.2.3.5 shall normally be distributed no later than seven (7) calendar days preceding the meeting.

6.2.3.7 Written procedure

Any decision may also be taken without a meeting if the Secretary distributes to all Parties a written document. Provided the Secretary does not receive any objection within fifteen (15) calendar days (seven (7) calendar days for urgent issue) after having forwarded the proposals, the proposed decision(s) shall be adopted. In any case, the Secretary shall forthwith inform in writing the Parties of the result of such written procedure and shall report it to the next meeting. Written procedure by Email is possible. The Secretary shall keep the proof that the written document has been sent to all Parties and shall additionally make sure – using content management system tool used for management - that all Parties concerned by a decision have been reached by the information and has opened any document related to the decision.

In case of refusal, the decision(s) may be included in the agenda of the following General Assembly meeting.

In addition, decisions by other appropriate electronic means may be taken if this is agreed unanimously.

6.2.3.8 Participation by videoconference

Representatives may exceptionally participate to the meetings of the General Assembly by teleconference or other telecommunication means. Such form of participation shall be subject to the agreement of the Chairperson.

6.2.3.9 Decisions

Decision will only be binding once the relevant draft summary of decisions has been accepted according to Section 6.2.6 of this Consortium Agreement.

6.2.3.10 Closed sessions

When the Secretary deems it necessary, or on request of a Party, the General Assembly may, regarding either all or part of the agenda, be convened as a closed session where participation may be limited to the Representatives.

6.2.4 Quorum and votes and decisions

6.2.4.1 Quorum for standard decisions

For standard decisions according to 6.2.5.1, the General Assembly shall not deliberate and decide validly unless two-thirds (2/3) of the Parties Representatives are present or represented (quorum). If the quorum is not reached, the Secretary may convene a further meeting.

6.2.4.2 Vote for standard decisions

For standard decisions according to 6.2.5.1, each Party Representative in the General Assembly shall have one vote. Standard decisions shall be taken by a majority of two-thirds (2/3) of the votes cast.

In case a decision cannot be reached, the General Assembly shall discuss the matter with a view to reaching consensus.

6.2.4.3 Vote for specific decisions on prospective issues

For decisions on prospective issues according to 6.2.5.2, each Chair of the Colleges of the General Assembly shall express to the Secretary its position taken with its own internal rules. The decision is taken when the three Colleges adopt the same position. Decisions under this section 6.2.4.1 shall not affect a Party's own work, time for performance, costs, liabilities, intellectual property rights.

In case a decision cannot be reached, the Bureau shall discuss the matter with a view to reaching consensus. The Bureau shall come out with a new proposal to be submitted for approval to the three Colleges. If despite at least three unsuccessful trials the required majority cannot be reached the General Assembly shall decide by two-thirds majority on votes cast (abstentions not counting).

6.2.5 Decisions of the General Assembly

The General Assembly shall be free to act on its own initiative to formulate proposals and take decisions in accordance with the procedures set out herein. In addition, proposals made by the Bureau, the Coordinator and the Programme Management Office shall be considered and decided upon by the General Assembly.

6.2.5.1 Standard decisions

Unless stated otherwise in this Consortium Agreement, the General Assembly shall decide by a two-thirds (2/3) majority of the votes cast (abstentions not counting) for all decisions concerning the implementation of the Action and the execution of this Consortium Agreement, for the following matters:

- Approval of management procedures (incl. Quality Management Plan, settlement of payments, reporting procedures, internal communication procedures);
    - Approval of procedures for dissemination and publication;
    - Approval of procedures for preparing the reporting required under the Grant Agreement;
    - Approval of annual reports to Commission;
    - Approval of settlement of payments;
    - Approval to grant specific Access Rights to Parties/Linked Third Parties providing subcontractors;
    - Decision to delegate additional responsibilities to those already planned in 6.5.3 to the Programme Management Office;
    - Decision on transfer of tasks of a Defaulting Party and cessation of a defaulting Party as set out in 4.2;
    - Decision on the consequences in case of a Force Majeure as set out in 5.5;

- Approval of a new Party to the Consortium and approval of the settlement on the conditions of the accession of such a new Party;
- Withdrawal of a Party from the Consortium and approval of the settlement on the conditions of the withdrawal respecting legitimate interests of all Parties;
- Identification of a breach by a Party of its obligations under this Consortium Agreement or the Grant Agreement;
- Declaration of a Party to be a Defaulting Party;
- Remedies to be performed by a Defaulting Party;
- Termination of a Defaulting Party's participation in the Consortium and measures relating thereto
- Proposal to the Commission for a change of the Coordinator;
- Proposal to the Commission for suspension of all or part of the Action;
- Proposal to the Commission for termination of the Action and the Consortium Agreement;

Content, finances and intellectual property rights

- Proposals of changes to Annex I and II of the Grant Agreement to be agreed by the Commission;
- Approval of the Consortium Annual Work plan;
- Modifications to Attachment 1 (Background Included);
- Modifications to Attachment 7 (Internal funding rates)
- Additions to Attachment 3 (List of Third Parties for simplified transfer according to Section 8.3.2).
- Approval of non-disclosure agreement templates

6.2.5.2 Specific decisions on prospective issues:

The following decisions shall be adopted by unanimity of the three Colleges:

- Approval of updates of the Founding Documents
- Approval of any update of implementation mechanisms
- Approval of the Deployment Plan (this includes the definition of the second wave of RD&D and Strategic Studies)
- And any other decisions not covered under 6.2.5.1.

6.2.5.3 Secret ballot

In any case of personnel appointment, or otherwise upon the demand of three or more of the members present, voting shall be by secret ballot.

6.2.5.4 No voting of Secretary

The Secretary will have no voting rights and is substituted by another Representative of their Party.

6.2.5.5 Veto rights

6.2.5.5.1

A Party which can show that its own work, time for performance, costs, liabilities, intellectual property rights or other legitimate interests would be or are severely affected by any decision of the General Assembly may exercise a veto with respect to the corresponding decision or relevant part of the decision.

6.2.5.5.2

When the decision is foreseen on the original agenda, a Party may veto such a decision during the meeting only.

6.2.5.5.3

When a decision has been taken on a new item added to the agenda before or during the meeting, a Party may veto such decision during the meeting and within 15 calendar days after the draft minutes of the meeting are sent.

6.2.5.5.4

When a decision has been taken without a meeting a Party may veto such decision within 15 calendar days after written notification by the Secretary of the outcome of the vote.

6.2.5.5.5

In case of exercise of veto, the Party shall make every effort to resolve the matter which occasioned the veto to the general satisfaction of all its Parties.

6.2.5.5.6

A Party may neither veto decisions relating to its identification to be in breach of its obligations nor to its identification as a Defaulting Party. The Defaulting Party may not veto decisions relating to its participation and termination in the consortium or the consequences of them.

6.2.5.5.7

A Party requesting to leave the consortium may not veto decisions relating thereto.

6.2.6 Summary of decisions and minutes of meetings

6.2.6.1 Summary of decisions

The accuracy of the summary of decisions shall be approved by all the Parties at the end of the meeting and be communicated to them in writing within three (3) calendar days for comments within fifteen (15) calendar days.

6.2.6.2 Minutes of meeting

6.2.6.2.1

In addition to the text of the summary of decision already approved as stated in 6.2.6.1 at the end of the meeting the Secretary with the support of the Programme Management Office shall produce written minutes of each meeting, which shall be the formal record of all decisions taken. The Secretary shall send draft minutes to all Parties within fifteen (15) calendar days of the meeting.

6.2.6.2.2

The minutes shall be considered as accepted if, within two weeks from sending, no Party has sent an objection in writing to the Secretary with respect to the accuracy of the draft of the minutes. If a Party has sent objections the minutes shall be approved at the next meeting.

6.2.6.2.3

The Secretary shall send the accepted minutes to all the Parties. The Coordinator shall safeguard them.

6.3 Bureau

6.3.1 Role

The Bureau is an accompanying body to the General Assembly. The Bureau acts in close interactions with the Programme Management Office.

The Bureau shall:

- Assist the General Assembly in the preparation for meetings, propose documents and decisions, and prepare the agenda of the General Assembly;
- Assist the General Assembly in the elaboration of proposals:
    - Update of EURAD Strategic Research Agenda and Roadmap, as planned in the Work Plan;
    - Definition of the second wave of RD&D and Strategic Studies, work plan for Knowledge Management ;
- Support the Coordinator in preparing meetings with the Commission and in preparing related data and deliverables;
- Monitor the proper execution and implementation of the decisions of the General Assembly;
- Seek a consensus among the Parties.

6.3.2 Composition

6.3.2.1

The Bureau shall be composed of the following Members:

- Three WMOs' representatives nominated by the WMO College (including one representative from a country with early stage and/or small RWM programme);
- Three TSOs' representatives nominated by the TSO College (including one representative from a country with early stage and/or small RWM programme).
- Three REs representatives nominated by the RE College (including one representative from a country with early stage/small RWM programme).

The representatives of the Colleges are appointed according to their competence as individuals and shall not act as representatives of their organisations but as representatives of their colleges.

It shall not be possible for one single individual to cumulate several of the three following roles: PMO member, Bureau member and WP leader.

Members of the Bureau are appointed for minimum 24 months and maximum 36 months.

The composition of the Bureau is given in Appendix 5.

The Programme Management Office shall be invited to the Bureau meetings. The representative appointed by the Civil Society group as defined in Annex 1 of the Grant Agreement shall be invited to the Bureau meetings.

6.3.2.2

Before each Bureau meeting, the Bureau shall designate a Chairperson among its members.

The Bureau may appoint a secretary from the PMO.

6.3.3 Preparation and organisation of Bureau meetings

6.3.3.1 Convening Bureau meetings

The Chairperson and/or the Secretary shall convene ordinary meetings of the Bureau at least four times a year.

Additional meetings may be held if required. Extraordinary meetings for urgent issues may be convened at any time upon written request of any Bureau member-or on request of the Coordinator or the Programme Management Office.

The Bureau might invite guests to its meetings and appoint a secretary to the Bureau meetings.

6.3.3.2 Notice of a meeting

The Chairperson and/or the Secretary shall give notice in writing of a meeting to each Party as soon as possible and no later than two weeks preceding an ordinary meeting and one week preceding an extraordinary meeting.

6.3.3.3 Agenda of the meeting

The Chairperson and/or the Secretary shall send each Bureau member a written original agenda no later than two weeks preceding the meeting, or one week before an extraordinary meeting.

Any Bureau member may add an item to the agenda by written notification to all of the other Members no later than one week or 3 calendar days for an extraordinary meeting preceding the meeting. In the latter case Saturday and Sunday do not count towards the three calendar days.

During a meeting of the Bureau, Bureau members can unanimously agree to add a new item to the original agenda.

6.3.3.4 Written procedure

Any action may also be taken without a meeting if the Chairperson and/or the Secretary distributes to all Bureau Members a written document. Provided the Chairperson and/or the Secretary does not receive any objection within seven (7) calendar days after having forwarded the list of actions, the proposed action(s) shall be adopted. In any case, the Chairperson and/or the Secretary shall forthwith inform in writing the Parties of the result of such written procedure and shall report it to the next meeting. Written procedure by Email is possible.

6.3.3.5 Participation by videoconference

Representatives may exceptionally participate to the meetings of the General Assembly by teleconference or other telecommunication means. Such form of participation shall be subject to the agreement of the Chairperson.

6.3.3.6 Closed sessions

When the Chairperson deems it necessary, or on request of a Bureau member, the Bureau may, regarding either all or part of the agenda, be convened as a closed session where participation may be limited to the Bureau Members.

6.3.4 Summary of discussions and minutes of Bureau meetings

6.3.4.1 Summary of discussions

The summary of discussions shall be approved by all the Bureau members at the end of the meeting and be communicated to them in writing within three (3) calendar days for comments within seven (7) calendar days.

6.3.4.2 Minutes of meeting

6.3.4.2.1

In addition to the text of the summary of discussions already approved as stated in 6.3.4.1 at the end of the meeting the Chairperson with the support of the Secretary shall produce written minutes of each meeting, which shall be the formal record of all actions taken. The Chairperson and/or the Secretary shall send draft minutes to all Bureau Members within fifteen (15) calendar days of the meeting.

6.3.4.2.2

The minutes shall be considered as accepted if, within two weeks from sending, no Bureau members has sent an objection in writing to the Chairperson and the Secretary with respect to the accuracy of the draft of the minutes. If a member has sent objections the minutes shall be approved at the next meeting.

6.3.4.2.3

The Chairperson and/or the Secretary shall send the accepted minutes to all Bureau members, once accepted. The Coordinator shall safeguard them and make them accessible on the Intranet portal for information.

6.4 Coordinator

6.4.1 Role of Coordinator

The Coordinator shall be the intermediary between the Parties and the Commission and shall perform all tasks assigned to it as described in the Grant Agreement and in this Consortium Agreement.

6.4.2 Responsibilities

6.4.2.1 In particular, the Coordinator shall be responsible for:

- monitoring compliance by the Parties with their obligations under the Grant Agreement and the Consortium Agreement,
- keeping the address list of Parties Representative and other contact persons updated and available,
- chairing the Programme Management Office,
- collecting, reviewing and submitting information collected by the Programme Management Office on the progress of the Action and reports and other deliverables (including financial statements and related certification) and specific requested documents to the Commission,

- transmitting documents and information connected with the Action,
- administering the financial contribution of the Commission and fulfilling the financial tasks described in Section 7.2,
- providing, upon request, the Parties with official copies or originals of documents which are in the sole possession of the Coordinator when such copies or originals are necessary for the Parties to present claims,
- presenting an annual report on the distribution of payments to the General Assembly.

6.4.2.2 If one or more of the Parties is late in submission of any deliverable requested by the Commission, the Coordinator may nevertheless submit the other Parties' deliverables and all other documents required by the Grant Agreement to the Commission in time. The Coordinator shall together with the Programme Management Office propose for approval by the General Assembly a procedure for the preparation of periodic and final reports.

6.4.2.3 The Coordinator shall not be entitled to act or to make legally binding declarations on behalf of any other Party or of the Consortium, unless explicitly stated otherwise in the Grant Agreement or this Consortium Agreement.

6.4.2.4 The Coordinator shall not enlarge its role beyond the tasks specified in this Consortium Agreement and in the Grant Agreement.

6.4.2.5 If the Coordinator fails in its coordination tasks as specified above and in the Grant Agreement, the General Assembly may propose to the Commission to change the Coordinator.

6.5 Programme Management Office

6.5.1 Role

The Programme Management Office shall be responsible to the General Assembly for the overall top-level planning, coordination and implementation of the Consortium Work Plan and its day-to day management. The Programme Management Office shall be guided by the Bureau during the preparation of papers for decision on prospective issues by the General Assembly.

6.5.2 Composition

The Programme Management Office is composed of one representative of the Coordinator. The other members of the Programme Management Office are selected under the responsibility of the Coordinator who will seek the support of a panel as appropriate. In addition, a Chief Scientific Officer is appointed. The composition of the Bureau shall be reviewed for suitability of roles, responsibilities and membership at Month 30.

The composition of the Programme Management Office for the first thirty (30) months of the Programme is given in Attachment 6.

6.5.3 Responsibilities

6.5.3.1 The Programme Management Office is responsible for:

- Preparing the Consortium Work Plan, assessing the need for amending the Consortium Work Plan and preparing the required amendments in close collaboration with the Parties and proposing it to the General Assembly,
- Proposing the Consortium Annual Work Plan, assessing the need for amendments and preparing the required amendments to the General Assembly,

- Proposing the allocation of Work Packages among the Parties to the General Assembly,
- Monitoring the effective and efficient implementation of the Action and reporting it to the General Assembly,
- Monitoring the progress of the Roadmap and reporting to the General Assembly at least once a year,
- Acting as co-chair of the WP boards,
- Facilitating the updates of EURAD SRA/Roadmap in close collaboration with the Bureau,
- Preparing the content and timing of press releases and joint publications within the EURAD programme or proposed by the Commission in respect of the procedures of the Grant Agreement Article 29,
- Presenting to the General Assembly a proposal for a long term strategy on Knowledge Management,
- Proposing to the General Assembly a Consortium internal communication plan to ensure that personnel at all levels (including the laboratories) understand the Founding Documents and are motivated to contribute to the Action in an effective manner,
- Checking and following that the review process as defined in the Quality Management Plan is done properly,
- Any other action that would be delegated by the General Assembly to the Programme Management Office. This may lead to an increase of the budget allocated to the Programme Management Office.

6.6 External Advisory Board (EAB)

6.6.1 Role

The External Advisory Board (EAB) is a board advising the General Assembly on strategic and implementation issues related to the Annual Work Plan and its coherence with respect to the Strategic Research Agenda and Roadmap.

A non-disclosure agreement, the template of which shall be approved by the General Assembly is signed between each EAB member and the Coordinator representing all the Parties who shall be mandated based on this Consortium Agreement. Its terms shall be not less stringent than those stipulated in this Consortium Agreement, and it shall be concluded no later than sixty (60) calendar days after their nomination or before any confidential information will be exchanged, whichever date is earlier.

6.6.2 Composition

The size of the EAB will be decided by the General Assembly. Members to the EAB are appointed according to their competence as individuals and shall not act as representatives of their organisations. EAB members are nominated according to a procedure to be approved by the General Assembly for a duration of thirty months (renewable once).

The board shall propose its chairperson from among its members for appointment by the General Assembly.

6.6.3

EAB shall define its own rules of procedures.

7 Section: Financial provisions

7.1 General Principles

7.1.1 Internal Funding Rates

7.1.1.1 Notwithstanding that under the Grant Agreement the Commission will reimburse eligible costs at a single rate for the whole Consortium, the Parties have decided that the Commission's reimbursement shall be distributed by the Coordinator to the Parties as amounts calculated on the basis of different funding according to the types of the work package.

7.1.1.2 These internal funding rates to the Consortium are set out in Attachment 7. They may be varied by decision of the General Assembly and shall be so varied if the cumulative total reimbursement for the duration of the Grant Agreement as calculated according to these rates is foreseen to vary from the total reimbursement which will be provided by the Commission in accordance with the single rate set out in the Grant Agreement.

In any case where the Commission reduces the amount of reimbursement for one Party in accordance with the terms of the Grant Agreement, the amount of the adjustment actually applied by the Coordinator shall be calculated by reference to these internal funding rates.

7.1.2 Distribution of Financial Contribution

The financial contribution of the Commission to the Action shall be distributed by the Coordinator according to:

- the Consortium Work Plan
- the approval of reports by the Commission, and
- the provisions of payment in Section 7.3.

A Party shall be funded only for its tasks carried out in accordance with the Consortium Work Plan.

7.1.3 Justifying Costs

In accordance with its own usual accounting and management principles and practices, each Party shall be solely responsible for justifying its costs with respect to the Action towards the Commission. Neither the Coordinator nor any of the other Parties shall be in any way liable or responsible for such justification of costs towards the Commission.

7.1.4 Funding Principles

A Party that spends less than its allocated share of the budget as set out in the Consortium Work Plan, or - in case of reimbursement via unit costs - implements less units than foreseen in the Consortium Work Plan, will be funded in accordance with its actual duly justified eligible costs only.

A Party that spends more than its allocated share of the budget as set out in the Consortium Plan will be funded only in respect of duly justified eligible costs up to an amount not exceeding that share unless agreed otherwise by the General Assembly in accordance with article 6.2.5.1.

7.1.5 Return of excess payments; receipts

7.1.5.1 Return of excess payments

In any case of a Party having received excess payments, the Party has to return the relevant amount to the Coordinator without undue delay.

7.1.5.2 Receipts

In case a Party earns any receipt that is deductible from the total funding as set out in the Consortium Plan, the deduction is only directed toward the Party earning such income. The other Parties' financial share of the budget shall not be affected by one Party's receipt. In case the relevant receipt is more than the allocated share of the Party as set out in the Consortium Work Plan, the Party shall reimburse the funding reduction suffered by other Parties.

7.1.6 Financial Consequences of the termination of the participation of a Party

A Party leaving the consortium shall refund all payments it has unduly received according to Grant Agreement Article 50.2.2. Furthermore a Defaulting Party shall, within the limits specified in Section 5.2 of this Consortium Agreement, bear any reasonable, proper and fully evidenced/justified additional costs occurring to the other Parties in order to perform its and their tasks.

7.2 Budgeting

The budget set out in the Consortium Work Plan shall be valued in accordance with the usual accounting and management principles and practices of the respective Parties, and shall comply with the conditions of the Grant Agreement for eligibility of costs.

7.3 Payments

7.3.1 Payments to Parties are the exclusive tasks of the Coordinator.

7.3.2 In particular, the Coordinator shall:

- notify the Party concerned promptly of the date and composition of the amount transferred to its bank account, giving the relevant references;
- perform diligently its tasks in the proper administration of any funds and in maintaining financial accounts;
- undertake to keep the Commission‘s financial contribution to the Action separated from its normal business accounts, its own assets and property;
- With reference to Articles 21.2 and 21.3.2 of the Grant Agreement, no Party shall before the end of the Action receive more than its allocated share of the maximum grant amount from which the amounts retained by the Commission for the Guarantee Fund and for the final payment have been deducted.

7.3.3 Distribution of payments to the Parties

The distribution by the Coordinator of pre-financing and interim payments to Parties, will be handled according to the following:

7.3.3.1 Distribution of Pre-financing

The pre-financing payment by the Commission, received after subtraction of the amount to be paid into the obligatory Guarantee Fund as stated in Art. 21.2 of the Grant Agreement, shall be distributed between the Parties by the Coordinator within forty-five (45) calendar days upon receipt. Receipt of the pre-financing payment by the Commission is expected 30 days after entry in force of the Grant Agreement or within 10 days before the starting date of the Action,

whichever is the latest, where it is understood that this delay is indicative and is out of the control of the Coordinator.

The distribution of the pre-financing to the Parties shall be in proportion to the amounts of the estimated reimbursement to each Party and their Linked Third Party/(ies) if any, foreseen in the Annex 2 of the Grant Agreement (calculated on the basis of the internal funding rates set out in Attachment 7). Parties shall distribute the prefinancing that belong to their Linked Third Party(ies), if any after it has received it from the Coordinator.

If the pre-financing payment made by the Commission is more than the amount to be distributed by application of the internal funding rates to allocated, the Coordinator shall retain the balance, for distribution at a later date.

7.3.3.2 Distribution of interim payments

The distribution of the interim payments to Parties shall be in accordance with the detailed procedures to be decided by the General Assembly and the principles set out below:

- Interim payments shall be distributed between the Parties by the Coordinator using the agreed internal funding rates (set out in Attachment 7) applied to the costs declared by the Parties/Linked Third Parties in periodic individual financial statements and accepted by the Commission – although the financial statements include a requested Commission contribution calculated in accordance with the EC single rate of 55%.
- Given that the internal funding rates used in the Consortium Agreement are different from the single rate used by the Commission , there may be circumstances where the amount of the interim payment transferred by the Commission (and calculated on the basis of the single funding rate) to the Coordinator is lower or higher than the amount calculated using the internal funding rates set out in the Consortium Agreement.

  If the interim payment received by the Coordinator is higher than the amount calculated using the Consortium Agreement's internal funding rates, the balance will be retained in the Coordinator‘s bank account for distribution to the Parties at the next reporting period.

  If the interim payment received by the Coordinator is lower than the amount of interim payment calculated using the Consortium Agreement's funding rates, (and if no balance has been retained from the previous reporting period), then the shortfall of the interim payment will be corrected in the next reporting periods.

Parties shall distribute the interim payments to their Linked Third Party/ies, if any, after it has received it from the Coordinator.

7.3.3.3 Distribution of final payments

Final payments which are based on actual cost claims accepted by the Commission after the last periodic report shall be forwarded by the Coordinator to Parties without delay and at the latest within 30 days after receipt of the corresponding payment. Parties shall distribute the payment to their Linked Third Party(ies), if any, after it has received it from the Coordinator .

7.3.4 Withholding of payments

The Coordinator is entitled to withhold any payments due to a Party identified by the General Assembly to be in breach of its obligations under this Consortium Agreement or the Grant Agreement or to a Beneficiary which has not yet signed this Consortium Agreement.

The Coordinator is entitled to recover undue payments already paid to a Defaulting Party in accordance with Grant Agreement Article 50.2. The Coordinator is equally entitled to withhold

payments to a Party when this is suggested by or agreed with the Commission, according to Grant Agreement Article 44.

7.3.5

Because of its particular status as a Commission Directorate-General, the Joint Research Centre – participating in this Action through Directorate G – Nuclear Safety and Security – has signed an Administrative Arrangement with DIRECTORATE-GENERAL FOR RESEARCH &INNOVATION (DG RTD). This Administrative Arrangement is established in Annex 3b to the Grant Agreement and regulates relations within the Commission including inter-Commission payments.

8 Section: Results

8.1 Ownership of Results

Results are owned by the Party/Parties that generate(s) them.

Rights of the Linked Third Parties are governed by Grant Agreement Article 26.3.

8.2 Joint ownership

Joint ownership is governed by Grant Agreement Article 26.2 with the following additions:

In case of joint ownership of Results, the joint owners shall negotiate in good faith a joint owner agreement in which the joint owners shall agree on all measures relating to protection of the Results.

In the absence of the joint ownership agreement, or pending its conclusions, and unless otherwise agreed:

- each of the joint owners shall be entitled to use their jointly owned Results for non-commercial research and development activities and non-commercial industrial activities and for public service mission on a royalty-free basis, and without requiring the prior consent of the other joint owner(s), and
- each of the joint owners shall be entitled to otherwise Exploit the jointly owned Results and to grant non-exclusive licenses to third parties (without any right to sub-license), if the other joint owners are given:

(a) at least forty-five (45) calendar days advance notice;

(b) Compensation according Fair and Reasonable conditions; and

(c) Warranty that no patent or patent procedures related to the jointly owned Results and likely to be licensed by one the joint owners, are affected.

8.3 Transfer of Results

8.3.1

Each Party may transfer ownership of its own Results following the procedures of the Grant Agreement Article 30.

8.3.2

Each Party may identify specific Third Parties it intends to transfer the ownership of its Results to in Attachment 3 to this Consortium Agreement. The other Parties hereby waive their right to prior notice and their right to object to a transfer to Third Parties listed according to the Grant Agreement Article 30.1.

8.3.3

The transferring Party shall, however, at the time of the transfer, inform the other Parties of such transfer and shall ensure that the rights of the other Parties will not be affected by such transfer. Any addition to Attachment 3 after signature of this Agreement requires a decision of the General Assembly.

8.3.4

The Parties recognize that in the framework of a merger or an acquisition of an important part of its assets, it may be impossible under applicable EU and national laws on mergers and acquisitions for a Party to give the full forty-five (45) calendar days prior notice for the transfer as foreseen in the Grant Agreement.

8.3.5

The obligations above apply only for as long as other Parties still have - or still may request - Access Rights to the Results.

8.4 Dissemination

8.4.1 Dissemination of own Results

During the Action and for a period of 1 year after the end of the Action, as defined in Article 3 of the Grant Agreement, the dissemination of own Results by one or several Parties and/or Linked Third Parties including but not restricted to publications and presentations, shall be coordinated by the plan for dissemination of Results to be approved by the General Assembly and to be delivered as part the Dissemination Strategy - Deliverable 1.6.

Dissemination of another Party’s unpublished Results or Background

A Party shall not include in any dissemination activity another Party's unpublished Results or Background without obtaining the owning Party's prior written approval. The same shall apply with regard to Linked Third Parties Results.

8.4.2 Cooperation obligations

The Parties and Linked Third Parties undertake to cooperate to allow the timely submission, examination, publication and defence of any dissertation or thesis for a degree that includes their Results or Background subject to the confidentiality and publication provisions agreed in this Consortium Agreement.

8.4.3 Use of names, logos or trademarks

Nothing in this Consortium Agreement shall be construed as conferring rights to use in advertising, publicity or otherwise the name of the Parties or any of their logos or trademarks without their prior written approval.

9 Section: Access Rights

9.1 Background included

9.1.1

In Attachment 1, the Parties have identified and agreed on the Background for the Action and have also, where relevant, informed each other that access to specific Background is subject to legal restrictions or limits.

Anything not identified in Attachment 1 shall not be the object of Access Right obligations regarding Background.

9.1.2

Any Party may add further own Background to Attachment 1 during the Action by written notice to the other Parties. However, approval of the General Assembly is needed should a Party wish to modify or withdraw its Background in Attachment 1.

9.2 General Principles

9.2.1

Each Party shall implement its tasks in accordance with the Consortium Plan and shall bear sole responsibility for ensuring that its acts within the Action do not knowingly infringe Third Party property rights. Continuous research efforts concerning possible third parties' rights are not expected.

9.2.2

Any Access Rights granted expressly exclude any rights to sublicense unless expressly stated otherwise.

9.2.3

Access Rights shall be free of any administrative transfer costs.

9.2.4

Access Rights are granted on a non-exclusive basis.

9.2.5

Results and Background shall be used only for the purposes for which Access Rights to it have been granted.

9.2.6

All requests for Access Rights shall be made in writing. The granting of Access Rights may be made conditional on the acceptance of specific conditions aimed at ensuring that these rights will be used only for the intended purpose and that appropriate confidentiality obligations are in place.

For the avoidance of doubt, this means that the owning Party may impose to the Party requesting an Access Right the execution of a separate licence agreement.

9.2.7

The requesting Party must show that the Access Rights are Needed.

9.3 Access Rights for implementation

Access Rights to Results and Background Needed for the performance of the own work of a Party under the Action shall be granted on a royalty-free basis for the duration of the Action, unless otherwise agreed for Background in Attachment 1. Such Access Rights shall also be granted to Linked Third Parties directly in charge of performing any work under the Action as stated in Annex 1 of the Grant Agreement if so requested by the respective Party it is related to.

9.4 Access Rights for Exploitation

9.4.1 Access Rights to Results

Access Rights to Results if Needed for Exploitation of a Party's own Results shall be granted on Fair and Reasonable conditions.

Access rights to Results for non-commercial research and development activities and public service mission shall be granted on a royalty-free basis.

9.4.2

Access Rights to Background if Needed for Exploitation of a Party's own Results, including for research on behalf of a Third Party, shall be granted on Fair and Reasonable conditions.

9.4.3

A request for Access Rights may be made up to twelve months after the end of the Action or, in the case of Section 9.7.2.1.2, after the termination of the requesting Party's participation in the Action.

9.5 Access Rights for Affiliated Entities

Affiliated Entities have Access Rights under the conditions of the Grant Agreement Articles 25.4 and 31.4, if they are identified in Attachment 4 (Identified Affiliated Entities) to this Consortium Agreement.

Such Access Rights must be requested by the Affiliated Entity from the Party that holds the Background or Results. Alternatively, the Party granting the Access Rights may individually agree with the Party requesting the Access Rights to have the Access Rights include the right to sublicense to the latter's Affiliated Entities [listed in Attachment 4]. Access Rights to Affiliated Entities shall be granted on Fair and Reasonable conditions and upon written bilateral agreement.

Affiliated Entities which obtain Access Rights in return fulfil all confidentiality and other obligations accepted by the Parties under the Grant Agreement or this Consortium Agreement as if such Affiliated Entities were Parties.

Access Rights may be refused to Affiliated Entities if such granting is contrary to the legitimate interests of the Party which owns the Background or the Results.

Access Rights granted to any Affiliated Entity are subject to the continuation of the Access Rights of the Party to which it is affiliated, and shall automatically terminate upon termination of the Access Rights granted to such Party.

Upon cessation of the status as an Affiliated Entity, any Access Rights granted to such former Affiliated Entity shall lapse.

Further arrangements with Affiliated Entities may be negotiated in separate agreements.

9.6 Additional Access Rights

9.6.1

In addition to the Access Right mentioned under 9.3, Linked Third Parties shall enjoy all other Access Rights as Parties. However, Access Rights may be refused to Linked Third Parties, provided this does not prevent the Linked Third Party from implementing its tasks.

9.6.2

Insofar as subcontractors do require Access Rights to fulfil their obligations towards the Party or Linked Third Party to which they are related, the respective Party or Linked Third Party shall submit a written request to the Secretary of the General Assembly. The General Assembly shall decide if and to which extent Access Rights shall be granted. Such decision may be requested by written procedure. To avoid doubt, Access Rights can only be granted to the extent that they are granted to the Party or Linked Third Party itself.

9.6.3

Linked Third Parties and subcontractors who subject to 9.6.1-9.6.2 obtain Access Rights must fulfil all confidentiality and other obligations accepted by the Parties under the Grant Agreement or this Consortium Agreement as if such Linked Third Parties or subcontractors were Parties.

9.6.4

For the avoidance of doubt any grant of Access Rights not covered by the Grant Agreement or this Consortium Agreement shall be at the absolute discretion of the owning Party and subject to such terms and conditions as may be agreed between the owning and receiving Parties.

9.6.5

Access Rights granted to any Linked Third Parties are subject to the continuation of the Access Rights of the Party to which it is linked, and shall automatically terminate upon termination of the Access Rights granted to such Party. Upon cessation of the status as a Linked Third Party, any Access Rights granted to such former Linked Third Party shall lapse. Further arrangements with Linked Third Parties may be negotiated in separate agreements.

9.7 Access Rights for Parties entering or leaving the consortium

9.7.1 New Parties entering the consortium

All Results developed before the accession of the new Party, the new Party will be granted Access Rights on the conditions applying for Access Rights to Background.

9.7.2 Parties leaving the consortium

9.7.2.1 Access Rights granted to a leaving Party

9.7.2.1.1 *Defaulting Party*

Access Rights granted to a Defaulting Party and such Party's right to request Access Rights shall cease immediately upon receipt by the Defaulting Party of the formal notice of the decision of the General Assembly to terminate its participation in the consortium.

9.7.2.1.2 *Non-defaulting Party*

A non-defaulting Party leaving voluntarily and with the other Parties' consent shall have Access Rights to the Results developed until the date of the termination of its participation.

It may request Access Rights within the period of time specified in Section 9.4.3.

9.7.2.2 Access Rights to be granted by any leaving Party

Any Party leaving the Action shall continue to grant Access Rights pursuant to the Grant Agreement and this Consortium Agreement as if it had remained a Party for the whole duration of the Action.

9.8 Specific provisions for Access Rights to Software

9.8.1 Definitions relating to Software

“Application Programming Interface”

means the application programming interface materials and related documentation containing all data and information to allow skilled Software developers to create Software interfaces that interface or interact with other specified Software.

"Controlled Licence Terms" means terms in any licence that require that the use, copying, modification and/or distribution of Software or another work ("Work") and/or of any work that is a modified version of or is a derivative work of such Work (in each case, "Derivative Work") be subject, in whole or in part, to one or more of the following:

- (where the Work or Derivative Work is Software) that the Source Code or other formats preferred for modification be made available as of right to any Third Party on request, whether royalty-free or not;
- that permission to create modified versions or derivative works of the Work or Derivative Work be granted to any Third Party;
- that a royalty-free licence relating to the Work or Derivative Work be granted to any Third Party.

For the avoidance of doubt, any Software licence that merely permits (but does not require any of) the things mentioned in the indents above is not a Controlled Licence (and so is an Uncontrolled Licence).

"Object Code" means software in machine-readable, compiled and/or executable form including, but not limited to, byte code form and in form of machine-readable libraries used for linking procedures and functions to other software.

"Software Documentation" means software information, being technical information used, or useful in, or relating to the design, development, use or maintenance of any version of a software programme.

"Source Code" means software in human readable form normally used to make modifications to it including, but not limited to, comments and procedural code such as job control language and scripts to control compilation and installation.

9.8.2 General principles for Software

For the avoidance of doubt, the general provisions for Access Rights provided for in this Section 9 are applicable also to Software as far as not modified by this Section 9.8.

Parties' Access Rights to Software do not include any right to receive Source Code and Source Code or Object Code ported to a certain hardware platform or any right to receive Source Code, Object Code or respective Software Documentation in any particular form or detail, but only as available from the Party granting the Access Rights.

The intended introduction of intellectual property (including, but not limited to Software) under Controlled Licence Terms in the Action requires the approval of the General Assembly to implement such introduction into the Consortium Work Plan and Consortium Annual Work Plan.

9.8.3 Access to Software

Access Rights to Software that is Results shall comprise:

- Access to the Object Code; and,
- where normal use of such an Object Code requires an Application Programming Interface (hereafter API): Access to the Object Code and such an API; and,
- if a Party can show that the execution of its tasks under the Action or the Exploitation of its own Results is technically or legally impossible without Access to the Source Code: Access to the Source Code to the extent necessary.

Background shall only be provided in Object Code unless otherwise agreed between the Parties concerned.

9.8.4 Software licence and sublicensing rights

9.8.4.1 Object Code

9.8.4.1.1 *Results - Rights of a Party*

Where a Party has Access Rights to Object Code and/or API that is Results for Exploitation, such Access shall, in addition to the Access for Exploitation foreseen in Section 9.4, as far as Needed for the Exploitation of the Party's own Results, comprise the right:

- to make an unlimited number of copies of Object Code and API; and
- to distribute, make available, market, sell and offer for sale such Object Code and API alone or as part of or in connection with products or services of the Party having the Access Rights;
- provided however that any product, process or service has been developed by the Party having the Access Rights in accordance with its rights to exploit Object Code and API for its own Results.

If it is intended to use the services of a Third Party for the purposes of this Section 9.8.4.1.1, the Parties concerned shall agree on the terms thereof with due observance of the interests of the Party granting the Access Rights as set out in Section 9.2 of this Consortium Agreement.

9.8.4.1.2 *Results - Rights to grant sublicenses to end-users*

In addition, Access Rights to Object Code shall, as far as Needed for the Exploitation of the Party's own Results, comprise the right to grant in the normal course of the relevant trade to end-user customers buying/using the product/services, a sublicense to the extent as necessary for the normal use of the relevant product or service to use the Object Code alone or as part of or in connection with or integrated into products and services of the Party having the Access Rights and, as far as technically essential:

- to maintain such product/service;
- to create for its own end-use interacting interoperable software in accordance with the Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the legal protection of computer programs

9.8.4.1.3 *Background*

For the avoidance of doubt, where a Party has Access Rights to Object Code and/or API that is Background for Exploitation, Access Rights exclude the right to sublicense. Such sublicensing rights may, however, be negotiated between the Parties.

9.8.4.1 Source Code

9.8.4.1.1 *Results - Rights of a Party*

Where, in accordance with Section 9.8.3, a Party has Access Rights to Source Code that is Results for Exploitation, Access Rights to such Source Code, as far as Needed for the Exploitation of the Party's own Results, shall comprise a worldwide right to use, to make copies, to modify, to develop, to adapt Source Code for research, to create/market a product/process and to create/provide a service.

If it is intended to use the services of a Third Party for the purposes of this Section 9.8.4.1.1, the Parties shall agree on the terms thereof, with due observance of the interests of the Party granting the Access Rights as set out in Section 9.2 of this Consortium Agreement.

9.8.4.1.2 *Results – Rights to grant sublicenses to end-users*

In addition, Access Rights, as far as Needed for the Exploitation of the Party's own Results, shall comprise the right to sublicense such Source Code, but solely for purpose of adaptation, error correction, maintenance and/or support of the Software.

Further sublicensing of Source Code is explicitly excluded.

9.8.4.1.3 *Background*

For the avoidance of doubt, where a Party has Access Rights to Source Code that is Background for Exploitation, Access Rights exclude the right to sublicense. Such sublicensing rights may, however, be negotiated between the Parties.

9.8.5 Specific formalities

Each sublicense granted according to the provisions of Section 9.8.4 shall be made by a traceable agreement specifying and protecting the proprietary rights of the Party or Parties concerned.

10 Section: Non-disclosure of information

10.1

All information in whatever form or mode of communication, which is disclosed by a Party (the "Disclosing Party") to any other Party (the "Recipient") in connection with the Action during its implementation and which has been explicitly marked as "confidential" at the time of disclosure, or when disclosed orally or visually during site visits has been identified as confidential at the time of disclosure and has been confirmed and designated in writing within fifteen (15) calendar days from oral disclosure at the latest as confidential information by the Disclosing Party, is "Confidential Information".

10.2

The Recipients hereby undertake in addition and without prejudice to any commitment on non-disclosure under the Grand Agreement, during the Action and for a period of 4 years after the end of the Action:

- Not to use Confidential Information otherwise than for the purpose for which it was disclosed;
- not to disclose Confidential Information without the prior written consent by the Disclosing Party;
- to ensure that internal distribution of Confidential Information by a Recipient shall take place on a strict need-to-know basis; and
- to return to the Disclosing Party, or destroy, on request all Confidential Information which has been supplied to or acquired by the Recipients including all copies thereof and to delete all information stored in a machine readable form to the extent practically possible. The Recipients may keep a copy to the extent it is required to keep, archive or store such Confidential Information because of compliance with applicable laws and regulations or for the proof of on-going obligations provided that the Recipient comply with the confidentiality obligations herein contained with respect to such copy for as long as the copy is retained.

10.3

The Recipients shall be responsible for the fulfilment of the above obligations on the part of their employees or Third parties (including Linked Third Parties) involved in the Action and shall ensure that they remain so obliged, as far as legally possible, during and after the end of the Action and/or after the termination of the contractual relationship with the employee or Third Party.

A non-disclosure agreement, the template of which shall be approved by the General Assembly shall be signed between:

- all attending persons of the General Assembly, the Programme Management Office, the Bureau, or of any implementation bodies if they are not staff of one of Parties or Linked Third Parties prior to receiving any confidential information.
- and the Coordinator, representing all Parties who shall be mandated based on this Consortium Agreement.

10.4

The above shall not apply for disclosure or use of Confidential Information, if and in so far as the Recipient can show that:

- the Confidential Information has become or becomes publicly available by means other than a breach of the Recipient's confidentiality obligations;
- the Disclosing Party subsequently informs the Recipient that the Confidential Information is no longer confidential;
- the Confidential Information is communicated to the Recipient without any obligation of confidentiality by a Third Party who is to the best knowledge of the Recipient in lawful possession thereof and under no obligation of confidentiality to the Disclosing Party;
- the disclosure or communication of the Confidential Information is foreseen by provisions of the Grant Agreement;
- the Confidential Information, at any time, was developed by the Recipient completely independently of any such disclosure by the Disclosing Party;
- the Confidential Information was already known to the Recipient prior to disclosure, or
- the Recipient is required to disclose the Confidential Information in order to comply with applicable laws or regulations or with a court or administrative order, subject to the provision Section 10.7 hereunder.

10.5

The Recipient shall apply the same degree of care with regard to the Confidential Information disclosed within the scope of the Action as with its own confidential and/or proprietary information, but in no case less than reasonable care.

10.6

Each Party shall promptly advise the other Party in writing of any unauthorised disclosure, misappropriation or misuse of Confidential Information after it becomes aware of such unauthorised disclosure, misappropriation or misuse.

10.7

If any Party becomes aware that it will be required, or is likely to be required, to disclose Confidential Information in order to comply with applicable laws or regulations or with a court

or administrative order or its supervisory authority and regulatory bodies, it shall, to the extent it is lawfully able to do so, prior to any such disclosure

- notify the Disclosing Party, and
- comply with the Disclosing Party's reasonable instructions to protect the confidentiality of the information.

10.8 End-User Group

End-User Group (EUG) shall cooperate with the Parties in the Action and represent their interests to the Action at their own costs.

10.8.1 End-User Group Members

The EUG members are persons affiliated with interested bodies (including waste producers).

A list of the EUG Members' at the time of signature of this Consortium Agreement is enclosed in the Attachment 8.

The members shall be modified or added after a decision by the Programme Management Office without being necessary to sign an amendment to the present Consortium Agreement.

10.8.2 Information exchange with EUG

The EUG members are not submitted to any obligation of confidentiality.

The Parties recognize that EUG members will only have access to Results which will be issued as public deliverable in accordance with the provisions of Grant Agreement (such as Article 29 - Obligation to disseminate results).

Prior any communication to the EUG members, and if Results not already published, each Results' owner shall give its agreement for the disclosure by written notification. It is up to the disclosing Party to make sure of the contents of the disclosed Results.

11 Section: Miscellaneous

11.1 Attachments, inconsistencies and severability

This Consortium Agreement consists of this core text and the following attachments:

Attachment 1 – Background included

Attachment 2 – Accession document

Attachment 3 – List of Third Parties for simplified transfer according to Section 8.3.2

Attachment 4 – Identified Affiliated Entities

Attachment 5 – Composition of the Bureau

Attachment 6 – Composition of the PMO

Attachment 7 – Internal funding rates

Attachment 8 – EUG Members

Attachment 9 – Declaration Form

Attachment 10 – EURAD Founding Documents

In case the terms of this Consortium Agreement are in conflict with the terms of the Grant Agreement, the terms of the latter shall prevail. However, the internal funding rules shall prevail.

In case of conflicts between the attachments and the core text of this Consortium Agreement, the latter shall prevail.

Should any provision of this Consortium Agreement become invalid, illegal or unenforceable, it shall not affect the validity of the remaining provisions of this Consortium Agreement. In such a case, the Parties concerned shall be entitled to request that a valid and practicable provision be negotiated that fulfils the purpose of the original provision.

11.2 No representation, partnership or agency

Except as otherwise provided in Section 6.4.2.3, no Party shall be entitled to act or to make legally binding declarations on behalf of any other Party or of the consortium. Nothing in this Consortium Agreement shall be deemed to constitute a joint venture, agency, partnership, interest grouping or any other kind of formal business grouping or entity between the Parties.

11.3 Notices and other communication

Any notice to be given under this Consortium Agreement shall be in writing to the addresses and recipients as listed in the most current address list kept by the Coordinator.

Formal notices:

If it is required in this Consortium Agreement (Sections 4.2, 9.7.2.1.1 and 11.4) that a formal notice, consent or approval shall be given, such notice shall be signed by an authorised representative of a Party and shall either be served personally or sent by mail with recorded delivery or telefax with receipt acknowledgement.

Other communication:

Other communication between the Parties may also be effected by other means such as e-mail with acknowledgement of receipt, which fulfils the conditions of written form.

Any change of persons or contact details shall be notified immediately by the respective Party to the Coordinator. The address list shall be accessible to all Parties.

11.4 Assignment and amendments

Except as set out in Section 8.3, no rights or obligations of the Parties arising from this Consortium Agreement may be assigned or transferred, in whole or in part, to any Third Party without the other Parties' prior formal approval. Amendments and modifications to the text of this Consortium Agreement not explicitly listed in 6.2.5 require a separate written agreement to be signed between all Parties.

11.5 Export control

All Parties are obliged to execute their obligations under this Agreement in accordance with applicable laws and regulations on export control. When Parties shall provide items (goods, software or technology), then the Parties shall where necessary take care of the timely and complete submission of the export license application. The other Parties shall timely provide all information that is reasonably relevant for the license submission, including information regarding any possible intention to re-export to other countries. If and when one or more export licenses are not obtained or not timely obtained, without this being attributable to the exporting Party, then the consequences thereof are not attributable to the exporting Party and neither shall such lead to any entitlement to compensation for damages.

11.6 Mandatory national law

Nothing in this Consortium Agreement shall be deemed to require a Party to breach any mandatory statutory law under which the Party is operating.

11.7 Language

This Consortium Agreement is drawn up in English, which language shall govern all documents, notices, meetings, arbitral proceedings and processes relative thereto.

11.8 Applicable law

This Consortium Agreement shall be construed in accordance with and governed by the laws of Belgium excluding its conflict of law provisions.

11.9 Settlement of disputes

All disputes arising out of or in connection with this Consortium Agreement, which cannot be solved amicably within sixty (60) days of the date of receipt of a formal request to settle the dispute – which may include escalation to an executive level employee of each Party in dispute such person must be without direct involvement in the Action, shall be finally settled in accordance with the WIPO Mediation Rules.

The place of mediation shall be Brussels unless otherwise agreed upon. The language to be used in the mediation shall be English unless otherwise agreed upon.

However, should any Party (e.g. a Public Body) show that certain provisions of its national law prevents it from submitting the relevant dispute to mediation, then the concerned Parties will submit the dispute to the Courts of Brussels.

If, and to the extent that, any such dispute, controversy or claim has not been settled pursuant to the mediation within sixty (60) calendar days of the commencement of the mediation, it shall, upon the filing of a Request for Arbitration by either Party, be referred to and finally determined by arbitration in accordance with the WIPO Expedited Arbitration Rules. Alternatively, if, before the expiration of the said period of 60 calendar days, either Party fails to participate or to continue to participate in the mediation, the dispute, controversy or claim shall, upon the filing of a Request for Arbitration by the other Party, be referred to and finally determined by arbitration in accordance with the WIPO Expedited Arbitration Rules.

The place of arbitration shall be Brussels if not otherwise agreed by the conflicting Parties.

The language of the arbitration shall be English.

The award of the arbitration will be final and binding upon the Parties.

However, should any Party (e.g. a Public Body) show that certain provisions of its national law prevents it from submitting the relevant dispute to arbitration, then the concerned Parties will submit the dispute to the Courts of Brussels.

Nothing in this Consortium Agreement shall limit the Parties' right to seek injunctive relief in any applicable competent court.

11.10 Personal Data

The Parties agree that any confidential information and/or any and all data and/or information that is provided, disclosed or otherwise made available between the Parties during this CA or an activity (“Shared Information”), shall not include personal data as defined by Article 4 of the General Data Protection Regulation (UE) 2016/679. The General Data Protection Regulation and its implementing local legislation are hereinafter collectively referred to as the Data Protection Legislation.

Accordingly each Party will ensure that all data and information contained in Shared Information is anonymized and functionally separated, whenever possible, such that it is no longer personal data, prior to providing the Shared Information to the other Party. Each Party who provides or otherwise makes Shared Information available to any other Party, (“Contributor”) represents that, as per applicable Data Protection Legislation: (i) it has the

authority to disclose the Shared Information, if any, which it provides under this CA; (ii) where legally required and relevant, it has a legal ground to provide the Shared Information; and (iii) there is no restriction in place that would prevent any such Party from using the Shared Information for the purpose of this Action.

This principle does not apply to the exchange of contact information of Data Subjects processed by the Parties and Linked Third Parties for the purpose of administering this Action, including Name, E-Mail, addresses and other related telecontact information which shall only be processed to the limited extent required to manage the relation between the Parties and Linked Third Parties.

By exception to the principle described above, during certain activities the Parties may share Personal Data. The provisions below hence apply to the activities where the processing of Personal Data might occur.

A Personal Data Addendum (PDA) will govern the processing and, use of Personal Data collected and processed during the actual performance of an activity. It does not govern the use of communications details of Data Subjects processed by the Parties for the purpose of administering this Action, including Names, E-Mail addresses and other related telecontact information which shall only be processed to the limited extent required to manage the business relation between the Parties.

The PDA will be prepared, agreed and formalized before a separate activity.

For the purpose of this section, capitalized terms not defined in this CA shall, have the meaning ascribed to them in Regulation (EU) 2016/679, where they appear as lower-case terms.

12 Section Signatures

AS WITNESS:

The Parties have caused this Consortium Agreement to be duly signed by the undersigned authorised representatives in separate signature pages the day and year first above written.

Each party recognizes to be linked to the other Parties to Consortium Agreement by its sole signature on separate page containing the exact reference of the Hashcode for EURAD Consortium Agreement.

SIGNATURE PAGE

For AGENCE NATIONALE POUR LA GESTION DES DECHETS RADIOACTIFS (ANDRA)
As the Coordinator

Name: Pierre-Marie ABADIE

Title: Director General

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
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SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For AGENCIJA ZA RADIOAKTIVNE ODPADKE LJUBLJANA ZAVOD (ARAO)

Name:

Title:

Date:

Signature:

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SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

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For BEL V (BEL V)

Name:

Title:

Date:

Signature:

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SIGNATURE PAGE

For BUNDES-GESELLSCHAFT FÜR ENDLAGERUNG MBH (BGE)

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Signature:

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SIGNATURE PAGE

For COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

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SIGNATURE PAGE

For CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT (CIEMAT)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

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SIGNATURE PAGE

For Chornobyl Research and Development Institute (ChRDI)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

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SIGNATURE PAGE

For CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)

Name: Reynald Pain

Title: Directeur du CNRS-IN2P3

Date:

Signature:

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SIGNATURE PAGE

For CENTRALE ORGANISATIE VOOR RADIOACTIEF AFVAL NV (COVRA)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
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SIGNATURE PAGE

For VALSTYBINIS MOKSLINIU TYRIMU INSTITUTAS FIZINIU IR TECHNOLOGIJOS MOKSLU CENTRAS (FTMC)

Name:

Title:

Date:

Signature:

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Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For CENTRUM VYZKUMU REZ S.R.O. (CV REZ)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Dansk Dekommissionering (Dekom)

Name: Ole Kastbjerg Nielsen

Title: Managing Director

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For ELLINIKI EPITROPI ATOMIKIS ENERGEIAS (EEAE)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For EMPRESA NACIONAL DE RESIDUOS RADIACTIVOS S.A. (ENRESA)

Name: *per procuram* Immo Wetcke

Title: Head of External Funding Management

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For FORSCHUNGSZENTRUM JULICH GMBH (JUELICH)

ppa. Immo Wetcke
Head of External Funding Management

i.V. Prof. Dr. Dirk Bosbach
Institute of Energy and Climate Research
Nuclear Waste Management and Reactor Safety (IEK-6)

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For GESELLSCHAFT FUR ANLAGEN UND REAKTORSICHERHEIT (GRS)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Ignalinos atomine elektrine (IAE)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For INSTYTUT CHEMII I TECHNIKI JADROWEJ (INCT)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For INSTITUT DE RADIOPROTECTION ET DE SURETE NUCLEAIRE (IRSN)

Name: Jean-Christophe NIEL

Title: Director General

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For INSTITUTO SUPERIOR TECNICO (IST)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For ASSOCIACAO DO INSTITUTO SUPERIOR TECNICO PARA A INVESTIGACAO E DESENVOLVIMENTO (IST-ID)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For INSTITUT JOZEF STEFAN (JSI)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For KARLSRUHER INSTITUT FUER TECHNOLOGIE (KIT)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For LIETUVOS ENERGETIKOS INSTITUTAS (LEI)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For MAGYAR TUDOMANYOS AKADEMIA ENERGIATUDOMANYI KUTATOKOZPONT (MTA EK)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NATIONALE GENOSSENSCHAFT FUER DIE LAGERUNG RADIOAKTIVER ABFAELLE (NAGRA)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS" (NCSR)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NUCLEAR ENGINEERING SEIBERSDORF GMBH (NES)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Národný jadrový fond (NJF)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NUCLEAR RESEARCH AND CONSULTANCY GROUP (NRG)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NATIONALE INSTELLING VOOR RADIOACTIEF AFVAL EN VERRIJKTE SPLIJSTOFFEN (ONDRAF/NIRAS)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For POSIVA OY (POSIVA)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For PAUL SCHERRER INSTITUT (PSI)

Name: Prof. Dr. Andreas Pautz

Title: Division Head Nuclear Energy and Safety

Date:

Signature:

Name: Prof. Dr. Sergey Churakov

Title: Laboratory Head Waste Management

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For PUBLIC LIMITED COMPANY FOR RADIOACTIVE WASTE MANAGEMENT (PURAM)

Name: Mr. Ferenc Kereki

Title: Managing director of PURAM

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For REGIA AUTONOMA TEHNOLOGII PENTRU ENERGIA NUCLEARA (RATEN)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For RADIOACTIVE WASTE MANAGEMENT LIMITED (RWM)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For STUDIECENTRUM VOOR KERNENERGIE / CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE (SCK•CEN)

The Studiecentrum voor Kernenergie/Centre d'Etude de l'Energie Nucléaire [also known as the Belgian Nuclear Research Centre], Foundation of Public Utility, SCK•CEN, with its Registered Office in Belgium, Avenue Herrmann-Debroux 40, BE-1160 BRUSSELS and its Operational Office also in Belgium, Boeretang 200, BE-2400 MOL, with enterprise number 0406.568.867 and VAT number BE406.568.867

Signature:

Name: Professor Eric van Walle

Title: Director-General

Date:

Signature:

Name: Professor Derrick P. Gosselin

Title: Chairman

Date:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For SVENSK KARNBRANSLEHANTERING AKTIEBOLAG (SKB)

Name: Eva Halldén

Title: Managing director

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For STATE ENTERPRISE STATE SCIENTIFIC AND TECHNICAL CENTER FOR NUCLEAR AND RADIATION SAFETY (SSTC NRS)

Name: Ihor SHEVCHENKO

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For SLOVENSKA TECHNICKA UNIVERZITA V BRATISLAVE (STUBA)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Správa úložišť radioaktivních odpadů (SÚRAO)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For STATNI USTAV RADIACNI OCHRANY v.v.i. (SURO)

Name: Zdeněk Rozlívka

Title : Managing director

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK (TNO)

Name: A.C. de Jong

Title: Drs.

Funciton: Managing director ECN.TNO

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For TS ENERCON MERNOKIRODA KFT (TS Enercon)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For TECHNICAL UNIVERSITY OF SOFIA (TUS)

Name: Prof. Dr. Ivan KRALOV

Title: Vice Rector R&D of TUS

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For UNIVERSITY OF CYPRUS (UCyprus)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For HELSINGIN YLIOPISTO (UHelsinki)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For UNITED KINGDOM RESEARCH AND INNOVATION (UKRI), as represented by its component body, the British Geological Survey

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Teknologian tutkimuskeskus VTT Oy (VTT)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	**Hashcode**
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For VUJE AS (VUJE)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

SIGNATURE PAGE

For Joint Research Centre (JRC)

Name:

Title:

Date:

Signature:

Hashcode for EURAD Consortium Agreement [17/09/2019]:

Algorithms	Hashcode
MD5	3D539908F2ECBFA0F925B1716DB0C888
SHA-1	0B73FD3C4BA7520FDBED0AE989819998427E549D
SHA-256	216310D7B55CA524EA2AAFDEE0196B17F991C81A49D525993B6A937391A73941
SHA-512	F016E8D3E05635575A35FCC413FF0E2B186BC0F02BBF9139B55AA853CE44D62E5F36DC57 6D42A4A696D1DAF97AAA93BBDB686ABEF11B2A5827DFCD100EC0A507

Attachment 1: Background included

According to the Grant Agreement (Article 24) Background is defined as “data, know-how or information (…) that is needed to implement the Action or exploit the results”. Because of this need, Access Rights have to be granted in principle, but Parties must identify and agree amongst them on the Background for the Action. This is the purpose of this attachment.

Andra

As to Andra, it is agreed between the Parties that, to the best of their knowledge the following background is hereby identified and agreed upon for the Action. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Title: Base de données Thermochimique International reference: IDDN.FR.001.120005.000.D.P.2014.000.10300 Date of first filing : 11/03/2014 – Version : 4.1.0 *ThermoChimie* is a thermodynamic database initially created and developed by Andra for more than twenty years (1995). In waste management, geochemical modelling is used in support of the assessment of radionuclide and non-radiological pollutant behaviour in a range of scenarios, such as within radioactive waste packages and geological disposal facilities, through the geosphere. However, for these models to be meaningful an accurate, consistent, and complete thermodynamic data set is required. *ThermoChimie* provides robust thermodynamic data for a wide range of radionuclides and chemotoxics elements, as well as major components expected within a geological disposal facility, including constituent host-rock mineral phases, bentonites, cements, and their evolving secondary phases.	Required approval by Andra.	Required approval by Andra.

This represents the status at the time of signature of this Consortium Agreement.

ARAO

As to ARAO, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of ARAO shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

BEL V

As to Bel V, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of Bel V shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

BGE

As to BGE, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of BGE shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

CEA

As to CEA, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of CEA shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

CIEMAT

As to CIEMAT, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of CIEMAT shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

ChRDI

As to ChRDI, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of ChRDI shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

CNRS

As to CNRS, it is agreed between the Beneficiaries that, to the best of their knowledge, the following Background is hereby identified and agreed upon for the Project.

Background of the CNRS is, all Know-how generated within the researches of: Sorin DUMITRESCU at the CNRS-LJAD (UMR7351) as far as needed to duly perform our work in the Project;

items of CNRS-ICSM identified in the table below.

Describe Background	Specific limitations and/or conditions for implementation	Specific limitations and/or conditions for exploitation
CNRS-LJAD hereby includes Access Rights to all Background that has been created by the Research headed by Sorin Dumitrescu and that is specifically needed for the implementation of the EURAD (GA N0 847593) project.	N/A	N/A
CNRS-LJAD : Models and algorithms for the coupling of Darcy and free flows as described in the following articles : L. Beaude, K. Brenner, S. Lopez, R. Masson, F. Smai, Non-isothermal compositional Darcy flows: formulation, soil-atmosphere boundary condition and application to high energy geothermal simulations, Computational Geosciences, online 3 dec. 2018. N. Birgle, R. Masson, L. Trenty, A domain decomposition method to couple nonisothermal compositional gas liquid Darcy and free gas flows, Journal of Computational Physics, 368, 1, pp. 210–235, 2018. R. Masson, L. Trenty, Y. Zhang, Coupling compositional gas liquid and free gas flow at porous and free flow domains interface. Journal of Computational Physics, 15 september, 321, pp. 708–728, 2016. R. Masson, L. Trenty, Y. Zhang, Coupling of a two phase gas liquid compositional 3D Darcy flow with a 1D compositional free gas flow. M2AN, 50, 5, 2016.	N/A	N/A

CNRS-LJAD : Open source code ComPASS http://www.anr-charms.org/page/compass-code distribué sous la licence GPL/CeCILL v2.1	N/A	N/A
CNRS-ICSM: Preparation of UO2 samples containing fission products, for which synthesis methods have been optimized (oxalate conversion, hydroxide conversion)	N/A	N/A
CNRS-ICSM : Multiparametric study of the dissolution (microscopic-macroscopic dual approach) in the field of the development of fuel reprocessing activities	N/A	N/A

This represents the status at the time of signature of this Consortium Agreement.

COVRA

As to COVRA, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of COVRA shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

FTMC

As to FTMC, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of FTMC shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

CV REZ

As to CV REZ, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of CV REZ shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

Dekom

As to Dekom, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of Dekom shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

EEAE

As to EEAE, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of EEAE shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

ENRESA

As to Enresa, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of Enresa shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement

GRS

As to GRS, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of GRS shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

IAE

As to IAE, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of IAE shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

INCT

As to INCT, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of INCT shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

IRSN

As to IRSN, it is agreed between the Parties that, to the best of their knowledge the following background is hereby identified and agreed upon for the Action. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Title: BACUCE in situ experiments 2 BACUCE (Bacterial Corrosion Under Cementitious Environment) experiments were started in December 2018 and will be characterized in the ACED WP. Analytical devices from the LUTECE laboratory, CT-scan, SEM-EDS, BET are available in Fontenay aux Roses. The Tournemire URL is available to develop new experiments in clayey environment in the ACED WP.		

This represents the status at the time of signature of this Consortium Agreement

IST

As to IST, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of IST shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

IST ID

As to IST-ID, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of IST-ID shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

JSI

As to JSI, it is agreed between the Parties that, to the best of their knowledge No data, know-how or information of JSI shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

JUELICH

As to JUELICH, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of JUELICH shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement

KIT

As to KIT, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of KIT shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

LEI

As to LEI, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of LEI shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

MTA EK

As to MTA EK, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of MTA EK shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

NAGRA

The FE information system (FEIS)

More than one million data are acquired daily in the FE experiment. Different measurement devices are connected to different data acquisition systems. The FE information system (FEIS) has been developed (by Chakraborty Software GmbH) to collect all the acquired data in one location, to control the quality of the recorded measurements and to easily compare data sets collected by different contractors. Nagra has direct control of the distribution of the software. FEIS can be accessed through an internet browser installed on any computer or tablet with internet connection. The FEIS (current version 1.5.1) uses the open source object relational PostgreSQL database with PostGIS and the statistical R language extensions. Custom user-friendly spatial operators were written using the power of PostgreSQL with advanced features. Data can be queried and/or downloaded at any specified time intervals. The FEIS also contains the project documentation—including reports, videos, photos, installation reports, sensor manuals etc.—related to the start, operation and monitoring of the experiment. The FEIS provides efficient review, data analysis and reporting capabilities for the FE experiment. The FEIS will be made available to the certain EURAD parties to complete a modelling benchmark exercise of the FE-experiment foreseen in WP7 HITEC.

This represents the status at the time of signature of this Consortium Agreement.

NCSR

As to NCSR, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of NCSR shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

NES

As to NES, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of NES shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

NJF

As to NJF, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of NJF shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

NRG

As to NRG, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of NRG shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

ONDRAF/NIRAS

As to ONDRA/NIRAS, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of ONDRA/NIRAS shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

POSIVA

As to POSIVA, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of POSIVA shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

PSI

As to PSI, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of PSI shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

PURAM

As to PURAM, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of PURAM shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement

RATEN

As to RATEN, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of RATEN shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

RWM

As to Radioactive Waste Management Limited (RWM), it is agreed between the parties that, to the best of their knowledge:

No data, know-how or information of RWM shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

SCK•CEN

As to Studiecentrum voor Kernenergie/Centre d'Etude de l'Energie Nucléaire (SCK•CEN), it is agreed between the parties that, to the best of their knowledge,

no data, know-how or information of SCK•CEN shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or exploitation of that other Party's Results (Article 25.3 Grant Agreement).

SCK•CEN's Background will be used only by SCK•CEN in order to carry out its tasks under the Action and/or exploit its Results. SCK•CEN will not grant any Access rights to such Background to the other Parties neither to carry out their own tasks under the Action nor for exploitation of their own Results.

The Parties hereby waive their rights to be granted Access Rights under such non included/excluded Background either for the implementation of this Action or for exploitation of their Results, under the Consortium Agreement and/or the Grant Agreement.

(Accidental) Transmission by SCK•CEN of any Background under this Consortium Agreement shall not be construed as expressly or impliedly granting the receiving Party an Access Right to such Background, nor as a transfer of ownership of such Background, and any intellectual property right whatsoever in respect of any elements in relation to such Background shall remain with SCK•CEN.

This represents the status at the time of signature of this Consortium Agreement.

SKB

As to SKB, it is agreed between the Parties that, to the best of their knowledge

The following background is hereby identified and agreed upon for the Action. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Non-confidential data, fuel history and calorimetric and nuclear measurements of fuel assemblies at Swedish Interim Storage facility Clab.	Required approval by SKB. Subject to export control regulation and required signing of non-disclosure agreement.	Required approval by SKB. Subject to export control regulation and required signing of non-disclosure agreement.

This represents the status at the time of signature of this Consortium Agreement.

SSTC NRS

As to SSTC NRS, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of SSTC NRS shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

STUBA

As to STUBA, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of STUBA shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

SÚRAO As to SÚRAO, it is agreed between the Parties that, to the best of their knowledge the following background is hereby identified and agreed upon for the Action. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
LTP TUL Simulation software Flow123d Developers' and users' site: http://flow123d.github.io/ Flow123d is a solver for simulation of saturated and unsaturated water flow, transport of dissolved substances, and heat transfer in fractured porous media. Main feature is the use geometries consisting of elements of different dimensions, with separate unknowns for each. Principal language C++. The development is under GNU GPL. Software is expected to be used for simulations supporting multiscale and uncertainty problems methods and benchmarking. New numerical schemes can also be developed as extending modules for the software or its future updates..	Use of the software is controlled by GNU GPL v3 licence.	Use of the software is controlled by GNU GPL v3 licence.
LTP CU Title: THM hypoplastic model for bentonite Hypoplastic models, including THM hypoplastic model for bentonite, have been developed at Charles University since 2005. In 2016, the model has been implemented into finite element code SIFEL developed at Czech Technical University. The model has since been used in simulations of bentonite behaviour in nuclear waste repositories. Title: THM high-temperature oedometer apparatus Oedometer apparatus designed for temperatures up to 150 °C and suctions up to 300 MPa (vapour equilibrium method) with load control (free vertical movement mode) or load measurement (fixed vertical movement mode) is available at Charles University since 2018.	-	-
LTP UJV Data, concerning transport properties (porosity, diffusion coefficient, sorption data) of crystalline,	Data would be available for WP Future and DONUT	-

groundwater composition, relevant experiment data), gained within SURAO projects		

This represents the status at the time of signature of this Consortium Agreement.

SURO

As to SURO, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of SURO shall be needed by another Party for implementation of the Action (Article 25.2 Grant

Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

TNO

As to TNO, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of TNO shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

TS Enercon

As to TS Enercon, it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of TS Enercon shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

TUS

As to TUS, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of TUS shall be needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

UCyprus

As to UCY it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of UCY shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

UHelsinki

As to UHelsinki, it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of UHelsinki shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

UKRI

As to UKRI, it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of UKRI shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

VTT

As to VTT, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of VTT shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

VUJE

As to VUJE, it is agreed between the Parties that, to the best of their knowledge no data, know-how or information of VUJE shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

JRC

As to JRC, it is agreed between the Parties that, to the best of their knowledge

No data, know-how or information of JRC shall be Needed by another Party for implementation of the Action (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

Attachment 2: Accession document

ACCESSION

of a new Party to

[Acronym of the Action] Consortium Agreement, version […, YYYY-MM-DD]

[OFFICIAL NAME OF THE NEW PARTY AS IDENTIFIED IN THE Grant Agreement]

hereby consents to become a Party to the Consortium Agreement identified above and accepts all the rights and obligations of a Party starting [date].

[OFFICIAL NAME OF THE COORDINATOR AS IDENTIFIED IN THE Grant Agreement]

hereby certifies that the consortium has accepted in the meeting held on [date] the accession of [the name of the new Party] to the consortium starting [date].

This Accession document has been done in 2 originals to be duly signed by the undersigned authorised representatives.

[Date and Place]

[INSERT NAME OF THE NEW PARTY]

Signature(s)

Name(s)

Title(s)

[Date and Place]

[INSERT NAME OF THE COORDINATOR]

Signature(s)

Name(s)

Title(s)

Attachment 3: List of Third Parties for simplified transfer according to Section 8.3.2.

Name of Beneficiary	Andra, France
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes, for cases where staff or students of the following Linked Third Party generate results, Andra shall transfer ownership to it: Bureau de Recherches Géologiques et Minières In the case that the results are jointly generated by staff or students of the Linked Third Party and Andra, the results shall be jointly owned by Andra and the Linked Third Party.

Name of Beneficiary	ChRDI, Ukraine
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : - National Science Center Kharkov Institute of Physics and Technology (KIPT, PIC Number 9698188320) - Institution State «Institute of Environmental Geochemistry of the National Academy of Science of Ukraine» (IEGNASU, PIC Number 953812253) - All above-listed LTP are linked to ChRDI as per the Convention they signed.”

Name of Beneficiary	CIEMAT, Spain
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes: - UNIVERSIDAD AUTONOMA DE MADRID (UAM PIC 999861354) - UNIVERSIDAD POLITECNICA DE MADRID (UPM PIC 999974844) - AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS (CSIC PIC 999991722) - UNIVERSITAT POLITECNICA DE CATALUNYA (UPC PIC 999976202) - IDOM INGENIERIA Y CONSULTORIA S.A. (IDOM PIC 999791902) All above-listed LTP are linked to CIEMAT as per the Convention they signed.”

Name of Beneficiary	CNRS, France
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : - INSTITUT MINES-TELECOM (IMT Altantique PIC°999849326) - UNIVERSITE GRENOBLES-ALPES (UGrenoble PIC°924833212) - UNIVERSITE DE LILLE (ULille PIC°910186018) - UNIVERSITE DE LORRAINE (ULorraine PIC°954931626) - UNIVERSITE DE MONTPELLIER (UMontpellier PIC°933640521) - UNIVERSITE DE NICE SOPHIA-ANTIPOLIS (Unice PIC°999877553) - UNIVERSITE D'ORLEANS (UOrléans PIC°999848550) - UNIVERSITE DE POITIERS (UPoitiers PIC°999859608) All above-listed LTP are linked to CNRS as per the Convention they signed."

Name of Beneficiary	IRSN, France
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes, for cases where staff or students of the following Linked Third Parties generate results, IRSN shall transfer ownership to it: Mines Paristech, Or NTW, Or MUTADIS. In the case that the results are jointly generated by staff or students of the Linked Third Parties and IRSN, the results shall be jointly owned by IRSN and the concerned Linked Third Party.

Name of Beneficiary	KIT
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (if yes, please state the complete names of such Third parties)	Universität Potsdam Technische Universität Clausthal Johannes Gutenberg Universität Mainz Federal Republic of Germany/Bundesrepublik Deutschland, (use restricted to its:

	- Bundesanstalt für Materialforschung und -prüfung (BAM) and – - Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)) Preussen Elektra GmbH AMPHOS 21 Consulting S.L. AMPHOS 21 Group S.L.

Name of Beneficiary	NAGRA, Switzerland
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : - CENTRE INTERNACIONAL DE METODES NUMERICS EN ENGINYERIA (CIMNE PIC°999658721) - ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE (EPFL PIC°999973971) - UNIVERSITAET BERN (UBERN PIC°999976493) - ZURCHER HOCHSCHULE FUR ANGEWANDTE WISSENSCHAFTEN (ZHAW PIC° 998291506) All above-listed LTP are linked to NAGRA as per the Convention they signed.

Name of Beneficiary	NCSR DEMOKRITOS, Greece
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : - DMT GmbH & Co. KG (DMT PIC° 994086071) All above-listed LTP are linked to NCSR “Demokritos” as per the Convention they signed.”

Name of Beneficiary	ONDRAF/NIRAS, Germany
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : - - UNIVERSITE DE LIEGE (ULiège PIC°999976105) - - EURIDICE (PIC°998199259)

Name of Beneficiary	PSI, Switzerland

Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes : EMPA (Eidgenössische Materialprüfungs- und Forschungsanstalt), 8600 Dübendorf, Switzerland

Name of Beneficiary	Helsingin yliopisto, Finland
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes, to the following Linked Third Parties: - TAMPEREEN KORKEAKOULUSÄÄTIÖ SR (TUT) - JYVÄSKYLÄN YLIOPISTO (JYU) - GEOLOGIAN TUTKIMUSKESKUS (GTK) - AALTO KORKEAKOULUSÄÄTIÖ SR (Aalto)

Name of Beneficiary	MTA EK, Hungary
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes, for cases where staff or students of the following Linked Third Party generate results, MTA EK shall transfer ownership to it: Social Organization for Radioecological Cleanliness (SORC) - PIC number: 998290439) In the case that the results are jointly generated by staff or students of the Linked Third Party and MTA EK, the results shall be jointly owned by MTA EK and the Linked Third Party.

Name of Beneficiary	VTT, Finland
Do you want to name any Third parties for simplified transfer in line with section 8.3.2? (*if yes, please state the complete names of such Third parties*)	Yes, to the following Linked Third Parties: - Galson Sciences Ltd (UK) - Fortum Power and Heat Oy (Finland) - Teollisuuden Voima Oy (TVO, Finland) - Fennovoima Oy (Finland)

Attachment 4: Identified Affiliated Entities

- CNRS-Innovation SIREN 388 461 154

  83 boulevard Exelmans 75016 Paris FRANCE
- SATT Linksium SIREN

  31 Rue Gustave Eiffel, 38000 Grenoble FRANCE
- SATT Conectus SIREN 539 210 559

  650 Boulevard Gonthier d'Andernach, 67400 Illkirch-Graffenstaden FRANCE
- AXLR, SATT DU LANGUEDOC ROUSSILLON N° SIREN : 753 642 248.

  950 RUE SAINT-PRIEST CSU BÂT 6 34090 MONTPELLIER FRANCE
- SATT Nord SIREN 753 847 011

  Immeuble Central Gare – 25, avenue Charles St Venant 59000 Lille FRANCE
- SATT Sud-Est SIREN 539768085

  35 Quai du Lazaret, 13002 Marseille FRANCE
- SATT Ouest Valorisation SIREN 753 000 611

  14c rue du Pätis Tatelin, CS 80804 – 35708 Rennes FRANCE
- SAYENS, SATT Grand-Est SIREN 501 704 969

  Maison régionale de l'innovation, 64a Rue Sully, 21000 Dijon FRANCE
- Aquitaine Science Transfert, SATT Aquitaine SIREN 753 027 663

  Bâtiment A31 – 3ème étage – 351, cours de la libération – 33405 Talence cedex – FRANCE

Attachment 5: Composition of the Bureau

From Month 1 to Month 30 of the Action, the Bureau is composed of the following members, appointed by their respective colleges:

Surname Name	Organisation
Dirk Bosbach	JUELICH (RE)
Christophe Bruggeman	SCK•CEN (RE)
Crina Bucur	RATEN (RE)
Valéry Detilleux	Bel V (TSO)
Suvi Karvonen	VTT (TSO)
Ole Kastbjerg Nielsen	DEKOM (WMO)
Stéphan Schumacher	Andra (WMO)
Ferenc Takats	TS Enercon (TSO)
Patrik Vidstrand	SKB (WMO)

Attachment 6: Composition of the Programme Management Office

From Month 1 to Month 30 of the Action, the PMO is composed of the following members:

PMO members
Marie Garcia (Coord. Andra)
Paul Carbol (JRC)
Bernd Grambow (CNRS)
Elisabeth Salat (IRSN)
Robert Winsley (RWM)

Attachment 7: Internal funding rates

EC funding corresponds to 55% of the total eligible costs that are necessary to implement the Work Plan. The Consortium is free to redistribute EC co-funding as it decides it, i.e. internal funding rates can be set for different types of activities.

The following funding rates have been established for EURAD:

Type of WP	Internal rate
Collaborative RD&D	50%
Strategic Studies	70%
Knowledge Management	70%
Programme Management Office	100%

Below is provided a table that provides EC contribution calculated with our internal funding rates and EC contribution calculated with EC single rate.

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
1	Andra	15 303 867	592 000	250 000	0	0	3 973 967	0	20 119 834	1	11 065 909	10 868 104	11 735 147
	BRGM	908 922	157 000	0	0	0	266 481	0	1 332 403	1	732 821	732 821	666 201
2	ARAO	5 103	5 000	0	0	0	2 526	0	12 629	1	6 946	6 946	8 840
3	Bel V	163 603	85 672	0	0	0	62 319	0	311 594	1	171 377	171 377	201 916
4	BGE	546 425	49 000	0	0	0	148 856	0	744 281	1	409 355	409 355	461 897
5	CEA	869 933	237 618	0	0	0	276 888	0	1 384 439	1	761 441	761 441	692 220
	EDF	446 300	53 700	0	0	0	125 000	0	625 000	1	343 750	343 750	311 844
	ORANO	88 760	9 000	0	0	0	24 440	0	122 200	1	67 210	67 210	85 540
6	CIEMAT	1 564 205	243 251	0	0	0	451 864	0	2 259 320	1	1 242 626	1 242 626	1 155 557
	CSIC	108 930	7 000	0	0	0	28 982	0	144 912	1	79 702	79 702	72 456
	IDOM	90 000	5 000	0	0	0	23 750	0	118 750	1	65 313	65 313	59 375
	UAM	115 000	43 200	0	0	0	39 550	0	197 750	1	108 763	108 763	98 875
	UPC	359 775	17 000	0	0	0	94 194	0	470 969	1	259 033	259 033	235 484
	UPM	194 448	44 558	0	0	0	59 751	0	298 757	1	164 316	164 316	149 379
7	ChRDI	9 000	5 000	0	0	0	3 500	0	17 500	1	9 625	9 625	8 750
	KIPT	27 000	5 000	0	0	0	8 000	0	40 000	1	22 000	22 000	20 000

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
	SIIGNASU	34 000	6 000	0	0	0	10 000	0	50 000	1	27 500	27 500	25 000
8	CNRS	1 524 726	673 660	0	0	0	549 597	0	2 747 983	1	1 511 390	1 511 390	1 420 941
	IMT Atlantique	214 046	0	0	0	0	53 512	0	267 558	1	147 157	147 157	207 454
	UGrenoble	281 900	0	0	0	0	70 475	0	352 375	1	193 806	193 806	159 938
	ULille	193 440	0	0	0	0	48 360	0	241 800	1	132 990	132 990	120 900
	ULorraine	342 999	0	0	0	0	85 750	0	428 749	1	235 812	235 812	199 938
	UMontpellier	68 970	0	0	0	0	17 243	0	86 213	1	47 417	47 417	43 107
	UNice	60 500	0	0	0	0	15 125	0	75 625	1	41 594	41 594	37 813
	UOrleans	79 000	0	0	0	0	19 750	0	98 750	1	54 313	54 313	49 375
	UPoitiers	249 868	0	0	0	0	62 467	0	312 335	1	171 784	171 784	129 468
9	COVRA	246 616	52 600	0	0	0	74 804	0	374 020	1	205 711	205 711	208 459
	TUDelft	144 490	11 000	0	0	0	38 872	0	194 362	1	106 899	106 899	86 208
14	FTMC	83 032	33 000	0	0	0	29 008	0	145 040	1	79 772	79 772	80 028
10	CV REZ	36 000	41 500	0	0	0	19 375	0	96 875	1	53 281	53 281	48 438
11	Dekom	17 400	8 500	0	0	0	6 475	0	32 375	1	17 806	17 806	22 663
12	EEAE	12 360	8 000	0	0	0	5 090	0	25 450	1	13 998	13 998	17 815

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
13	ENRESA	97 629	42 500	438 603	0	0	35 032	0	613 763	1	337 570	337 570	313 432
15	JUELICH	620 785	94 243	0	0	0	178 757	0	893 784	1	491 581	491 581	462 119
	HZDR	786 887	71 738	0	0	0	214 656	0	1 073 281	1	590 305	590 305	593 722
	UFZ	305 941	43 000	0	0	0	87 235	0	436 176	1	239 897	239 897	218 088
16	GRS	415 845	47 000	0	0	0	115 711	0	578 556	1	318 206	318 206	308 683
17	IAE	4 840	5 500	0	0	0	2 585	0	12 925	1	7 109	7 109	9 048
18	ICHTJ (=INCT)	16 920	8 000	0	0	0	6 230	0	31 150	1	17 133	17 133	21 805
19	IRSN	649 724	150 500	0	0	0	200 056	0	1 000 280	1	550 154	550 154	566 446
	Mines ParisTech	157 200	13 000	0	0	0	42 550	0	212 750	1	117 013	117 013	106 375
	MUTADIS	196 679	21 500	0	0	0	54 545	0	272 724	1	149 998	149 998	214 601
	NTW	159 845	114 500	0	0	0	68 586	0	342 931	1	188 612	188 612	342 931
20	IST	30 636	7 000	0	0	0	9 409	0	47 045	1	25 875	25 875	32 932
21	IST-ID	24 049	11 000	0	0	0	8 762	0	43 812	1	24 096	24 096	30 668
22	JSI	288 915	84 500	0	0	0	93 354	0	466 769	1	256 723	256 723	241 144
	EIMV	155 290	64 900	0	0	0	55 048	0	275 238	1	151 381	151 381	209 564
	ZAG	160 000	16 500	0	0	0	44 125	0	220 625	1	121 344	121 344	110 313

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
23	JRC	784 033	278 631	0	0	0	265 666	0	1 328 330	1	730 581	471 151	471 151
24	KIT	573 750	66 950	0	0	0	160 175	0	800 875	1	440 481	440 481	406 813
	A21	128 400	55 500	0	0	0	45 975	0	229 875	1	126 431	126 431	114 938
	BAM	173 190	5 000	0	0	0	44 548	0	222 738	1	122 506	122 506	111 369
	BGR	128 590	18 500	0	0	0	36 773	0	183 863	1	101 124	101 124	91 438
	JGU INC (UMAINZ)	264 600	33 000	0	0	0	74 400	0	372 000	1	204 600	204 600	186 000
	PEL	27 000	5 000	0	0	0	8 000	0	40 000	1	22 000	22 000	20 000
	TU Clausthal	33 000	5 500	0	0	0	9 625	0	48 125	1	26 469	26 469	33 688
	UPOTSDAM	80 000	5 000	0	0	0	21 250	0	106 250	1	58 438	58 438	53 125
25	LEI	224 700	39 500	0	0	0	66 050	0	330 250	1	181 638	181 638	175 050
26	MTA EK	194 000	51 000	0	0	0	61 250	0	306 250	1	168 438	168 438	153 125
	SORC	24 000	19 000	0	0	0	10 750	0	53 750	1	29 563	29 563	26 875
27	NAGRA	395 867	44 300	0	0	0	110 042	0	550 208	1	302 615	302 615	291 104
	CIMNE	153 000	26 000	0	0	0	44 750	0	223 750	1	123 063	123 063	111 875
	EPFL	181 999	19 000	0	0	0	50 250	0	251 249	1	138 187	138 187	125 625
	UBERN	299 600	24 700	0	0	0	81 075	0	405 375	1	222 956	222 956	202 688

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
	ZHAW	97 000	15 000	0	0	0	28 000	0	140 000	1	77 000	77 000	51 250
28	NCSR Demokritos	22 005	7 000	0	0	0	7 251	0	36 256	1	19 941	19 941	25 379
	DMT	80 220	13 000	0	0	0	23 305	0	116 525	1	64 089	64 089	81 568
29	NES	51 460	8 000	0	0	0	14 865	0	74 325	1	40 879	40 879	52 027
30	NJF	3 214	5 000	0	0	0	2 054	0	10 268	1	5 647	5 647	7 187
31	NRG	318 794	35 500	0	0	0	88 574	0	442 868	1	243 577	243 577	235 129
32	NIRAS/ONDRAF	220 224	34 500	0	0	0	63 681	0	318 406	1	175 123	175 123	193 591
	EURIDICE	56 894	29 800	0	0	0	21 673	0	108 367	1	59 602	59 602	54 184
	ULiege	457 300	16 000	0	0	0	118 325	0	591 625	1	325 394	325 394	295 813
33	Posiva	15 000	8 500	0	0	0	5 875	0	29 375	1	16 156	16 156	14 688
	Envirocase	15 888	5 500	0	0	0	5 347	0	26 735	1	14 704	14 704	18 715
34	PSI	1 625 070	128 892	0	0	0	438 490	0	2 192 451	1	1 205 848	1 205 848	1 101 832
	EMPA	99 000	22 000	0	0	0	30 250	0	151 250	1	83 188	83 188	75 625
35	PURAM	79 800	12 000	0	0	0	22 950	0	114 750	1	63 113	63 113	80 325
36	RATEN ICN	108 328	57 000	0	0	0	41 332	0	206 660	1	113 663	113 663	112 712
37	RWM/NDA	183 807	44 000	0	0	0	56 952	0	284 759	1	156 617	156 617	200 436

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
38	SCK-CEN	1 415 155	296 145	0	0	0	427 825	0	2 139 125	1	1 176 518	1 176 518	1 136 577
39	SKB	80 550	19 000	0	0	0	24 888	0	124 438	1	68 441	68 441	66 856
	UU	272 833	37 000	0	0	0	77 458	0	387 292	1	213 010	213 010	193 646
40	SSTC NRS	115 435	47 000	0	0	0	40 609	0	203 044	1	111 674	111 674	139 243
41	STUBA	17 538	12 500	0	0	0	7 510	0	37 548	2	20 651	20 651	26 283
42	RAWRA/SÚRAO	211 035	74 000	0	0	0	71 259	0	356 294	1	195 962	195 962	216 793
	CTU	546 644	122 575	0	0	0	167 305	0	836 524	1	460 088	460 088	424 792
	CU	123 700	31 800	0	0	0	38 875	0	194 375	1	106 906	106 906	97 188
	IGN	111 588	8 500	0	0	0	30 022	0	150 110	1	82 561	82 561	75 055
	TUL	111 150	12 700	0	0	0	30 963	0	154 813	1	85 147	85 147	77 406
	UJV	305 633	150 480	0	0	0	114 028	0	570 141	1	313 578	313 578	285 071
43	SURO	121 729	30 500	0	0	0	38 057	0	190 286	1	104 657	104 657	133 200
44	TNO	89 600	22 800	0	0	0	28 100	0	140 500	1	77 275	77 275	70 250
45	TS Enercon	83 397	12 750	0	0	0	24 037	0	120 184	1	66 101	66 101	63 704
46	TUS	147 416	38 483	0	0	0	46 475	0	232 374	1	127 806	127 806	131 375
47	University of Cyprus	19 192	10 500	0	0	0	7 423	0	37 116	1	20 414	20 414	21 331

No	Parties (and their Linked Third Parties)	(A) Direct personnel costs	(B) Other direct costs	(C) Direct costs of sub-contracting	(D) Direct costs of providing financial support to third parties	(E) Costs of inkind contributions not used on the beneficiary's premises	(F) Indirect Costs (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs	(H) Total estimated eligible costs (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution (=H*I)	(K) Requested EU Contribution/ **Using EC single rate of 55%**	(L) EC contribution **using our internal funding rates**
48	University of Helsinki	205 000	17 600	0	0	0	55 650	0	278 250	1	153 038	153 038	139 125
	Aalto Uni	32 850	5 000	0	0	0	9 463	0	47 313	1	26 022	26 022	23 625
	GTK	42 500	39 000	0	0	0	20 375	0	101 875	1	56 031	56 031	50 938
	JYU	122 200	25 000	0	0	0	36 800	0	184 000	1	101 200	101 200	92 000
	TUT	116 000	8 000	0	0	0	31 000	0	155 000	1	85 250	85 250	77 500
49	UKRI	1 060 314	260 884	0	0	0	330 300	0	1 651 498	1	908 324	908 324	597 729
50	VTT	527 169	187 442	0	0	0	178 653	0	893 263	1	491 295	491 295	450 694
	GSL	127 980	10 500	0	0	0	34 620	0	173 100	1	95 205	95 205	121 170
51	VUJE	6 700	5 000	0	0	0	2 925	0	14 625	1	8 044	8 044	10 238
	Total	**41 574 845**	**5 812 071**	**688 603**	**0**	**0**	**11 846 729**	**0**	**59 922 248**		**32 957 236**	**32 500 000**	**32 500 000**

Attachment 8: EUG Members

Attachment 9: Declaration of Honour Form by Linked Third Parties - EURAD Consortium agreement

I, the undersigned, representing the following entity:

[**insert full official name of the entity**]
[insert full official address of the entity]

linked to [insert name of the Party (beneficiary)]

hereby certify

that my Organisation, as Linked Third Party is aware of the following obligations and conditions, as set out in the Consortium Agreement of EURAD (Annex A) and that my Organisation as Linked Third Party has committed to comply with toward its Beneficiary :

- **Termination of a Beneficiary** extends to its Linked Third Party if any (Section 4.2 of the Consortium Agreement);

- **Prefinancing, interim and final payments** shall be transferred to Linked Third Parties by the Beneficiary they are linked to after it has received it from the Coordinator (Section 7 of the Consortium Agreement);

- **Ownership of Results** - Rights of the Linked Third Parties are governed by Grant Agreement Article 26.3 (Section 8.1 of the Consortium Agreement);

- **Dissemination of own Results** - During the Action and for a period of 1 year after the end of the Action, the dissemination of own Results by one or several Parties and/or Linked Third Parties including but not restricted to publications and presentations, shall be governed by the plan for dissemination of Results to be approved by the General Assembly and to be delivered as part the Dissemination Strategy - Deliverable 1.6 (Section 8.4.1 of the Consortium Agreement);

- **Dissemination of another Party's unpublished Results or Background** - A Party/Linked Third Party shall not include in any dissemination activity another Party/Linked Third Party's unpublished Results or Background without obtaining the owning Party/Linked Third Party's prior written approval (Section 8.4.2 of the Consortium Agreement);

- **Cooperation obligations** - The Parties and Linked Third Parties undertake to cooperate to allow the timely submission, examination, publication and defence of any dissertation or thesis for a degree that includes their Results or Background subject to the confidentiality and publication provisions agreed in this Consortium Agreement (Section 8.4.3 of the Consortium Agreement);

- **Access Rights for implementation** - Access Rights to Results and Background Needed for the performance of the own work of a Party under the Action shall be granted on a royalty-free basis for the duration of the Action, unless otherwise agreed for Background in Attachment 1. Such Access Rights shall also be granted to Linked Third Parties directly in charge of performing any work under the Action as stated in Annex 1 of the Grant

Agreement if so requested by the respective Party it is related to (section 9.3 of the Consortium Agreement);

- **Additional Access Rights**
  - In addition to the Access Right mentioned under 9.3, Linked Third Parties shall enjoy all other Access Rights as Parties. However, Access Rights may be refused to Linked Third Parties, provided this does not prevent the Linked Third Party from implementing its tasks (Section 9.6.1 of the Consortium Agreement);
  - Linked Third Parties who obtain Access Rights must fulfil all confidentiality and other obligations accepted by the Parties under the Grant Agreement or this Consortium Agreement as if were Parties (Section 9.6.3 of the Consortium Agreement);
  - Access Rights granted to any Linked Third Parties are subject to the continuation of the Access Rights of the Party to which it is linked, and shall automatically terminate upon termination of the Access Rights granted to such Party. Upon cessation of the status as a Linked Third Party, any Access Rights granted to such former Linked Third Party shall lapse. Further arrangements with Linked Third Parties may be negotiated in separate agreements (Section 9.6.5 of the Consortium Agreement);

- **Non-disclosure of information** - Linked Third Parties who obtain Access Rights must fulfil all confidentiality and other obligations accepted by the Parties under the Grant Agreement (Article 36) and the Consortium Agreement as if such Linked Third Parties were Parties. (Section 10 of the Consortium Agreement).

and that my Organisation, as Linked Third Party, commits to comply with all the obligations and conditions set in the Grant Agreement Articles 6, 14, 18, 20, 35, 36 and 38 and assures that the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 towards my Organisation.

Annex A: Consortium Agreement Version [17/09/2019]

SIGNATURE

For the Linked Third Party:

Name, position

Date

Attachment 10: EURAD Founding Documents

Aim of this document: This document is the first issue of the Vision, Strategic Research Agenda (SRA), Roadmap, Implementation Plan and Governance Scheme that was submitted with the EURAD first phase proposal to the EC in September 2018. It builds on the work of the EC JOPRAD project and good practice from other successful European Joint Programmes. It has been revised to integrate modifications approved during the granting phase with EC. The Founding Documents will be formally issued/made available publicly once the EURAD website will be running (Oct./Nov. 2019).

Endorsement of this document: All EURAD participants (i.e. all organisations that are named in the proposal) are reminded that through their participation in EURAD, they endorse the Vision and positively support the content and implementation of the EURAD Founding Documents. It is not anticipated that a formal/signed declaration will be made to confirm endorsement, rather this is "de facto" through Mandated Actors (and their Linked Third Parties) participation in the EURAD.

Timescales for development, review and endorsement:

- January 2018 – Table of Contents circulated to Core Group for approval - Completed
- 12th March 2018 – 1st Draft issued to Prof A. Hooper, P. Zuidema and ANDRA for initial review and update - Completed
- 30th March 2018 – Draft issued to Core Group representatives - Completed
- 7th May 2018 - 1st Preliminary Version Prepared and Issued to EURAD Community
- July 2018 – Approval
- September 2018 – Final Version Issued to EC with Proposal and Endorsed via Mandated Actors (and their 3rd Parties) participation in the EURAD
- September 2019 – revised to integrate modifications approved during the granting phase with EC.

Vision, Strategic Research Agenda (SRA), Roadmap, Implementation Plan and Governance Scheme: European Joint Programme on Radioactive Waste Management (EURAD) September 2019

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FOREWORD

All EU Member States generate radioactive waste, with national inventories ranging from single sources or small inventories, up to large and high activity inventories from those member states with extensive nuclear programmes, some of them including spent nuclear fuel or large stockpiles of nuclear material from reprocessing activities. Regardless of size they all have to manage radioactive waste safely in the long term. As some of the wastes will have a significant level of radioactivity for a very long time, many countries have decided to adopt the option of disposing of waste deep underground, a practice referred to as “geological disposal”. Deep geological disposal is recognised by participating Member countries of the NEA Radioactive Waste Management Committee (RWMC), as well as the European Commission and the IAEA, as the most safe and secure long-term solution, even though some countries wish to postpone implementation of disposal or to evaluate other options in parallel. Geological disposal of higher activity radioactive waste involves constructing an engineered facility, typically between 200 and 1,000 metres underground to isolate the wastes from the environment and to ensure the radioactivity is sufficiently contained so that it will not be released back to the surface (including surface groundwaters), in unacceptable amounts that may cause harm to humans and the environment.

Implementing disposal at a national level presents many technical, scientific, social, economic and environmental responsibilities, including a large research, development and demonstration (RD&D) effort required to understand overall safety and feasibility for the implementation of the required facilities, and to address the remaining challenges. In radioactive waste management, and especially in relation to disposal, the European Commission has been funding research and development for over 40 years, fostering what is today a strong cooperation between European laboratories, institutions and implementers. With Europe on the verge of operation of its first geological repositories for disposal of spent fuel and other long-lived radioactive wastes, a step-change in joint programming between Member States is timely to take advantage of the experience gathered by different Member States over the past decades. This also supports Member States in implementing the Council Directive (2011/70/Euratom) and the recently established common legal framework across Europe for the safe management of radioactive waste.

The EU Member States, through the EU’s Competitiveness Council and research and higher education ministers endorsed, in December 2008, a new concept of research collaboration: Joint Programming. This was defined as a process by which countries would develop common visions and strategic research agendas in order to address major societal but also scientific-technical challenges. The EU Joint Programme on Radioactive Waste Management (EURAD), which includes disposal, has been

established to complement the national efforts and enables effective use of resources by fostering and strengthening RD&D collaboration. As of today, 52 organisations and 23 countries have come together to develop and implement this new approach. It comprises the implementer, the regulatory expertise function, and those with scientific and technical responsibilities and a national mandate for research and development in radioactive waste management in their respective countries.

Building on the initial preparatory work of the EC JOPRAD project to identify remaining research priorities of common interest across Europe, the very first achievement of the EURAD has now been delivered by this document. This common Vision, Strategic Research Agenda (including Knowledge Management), Roadmap, Implementation Plan and Governance Scheme will guide cooperative research and investments in the field of radioactive waste management over the coming decades in Europe. The fruit of a tremendous amount of work and determination, this holistic, multi-generational and multi-disciplinary view is now a reality. This strategic approach will foster scientific capability and enhance the knowledge-base needed to implement the safe management, including disposal, of radioactive waste, promoting European research and delivering beneficial societal and economic impact for EU citizens.

Dr Jonathan Martin

Chair of IGD-TP

Dr Delphine Pellegrini

SITEX Network

Dr Christophe Bruggeman

Research Entity Network

MANDATED ORGANISATIONS

Country	Programme Owners	Mandated Actors/Beneficiaries	WMO	TSO	RE
Austria	Federal Ministry of Agriculture, Forestry, Environment and Water Management	**NES**	x		
Belgium	Ministre de la Sécurité et de l'Intérieur	**Bel V**		x	
	FPS Economy, SMEs, Self-Employed and Energy	**ONDRAF/NIRAS**	x		
	FPS Economy, SMEs, Self-Employed and Energy	**SCK•CEN**			x
Bulgaria	Ministry of Education and Science of Bulgaria	**TUS**			x
Cyprus	Ministry of Labour, welfare and social insurance	**UCyprus**			x
Czech Republic	State Office for Nuclear Safety	**SÚRO**		x	
	Minister of Education, Youth and Sports	**SÚRAO**	x		
	Minister of Industry and Trade	**CV REZ**			x
Denmark	Ministry of Higher Education and Science	**Dekom**	x		
Finland	Ministry of economic affairs and employment	**Posiva**	x		
		VTT		x	
		UHelsinki			x
France	Ministère de la transition écologique et solidaire Ministère de l'Enseignement Supérieur et de la Recherche	**Andra**	x		
		IRSN		x	
		CNRS			x
		CEA			x
Germany	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety Federal Ministry for Education and Research Federal Ministry for Economic Affairs an Energy	**BGE**	x		
		GRS		x	
		JUELICH			x
		KIT			x
Greece	Greek Atomic Energy Commission	**EEAE**	x		
		NCSR			x
Hungary	Hungarian Ministry of National Development	**PURAM**	x		
		TS Enercon		x	
		MTA EK			x

Lithuania	Ministry of Energy	**IAE**	x		
		CPST		x	
		LEI			x
The Netherlands	Authority for Nuclear Safety and Radiation Protection	**COVRA**	x		
		NRG		x	
		TNO			x
Poland	Ministry of Energy	**RWMP**	x		
		INCT		x	
Portugal	COMRSIN	**IST**	x		
		IST-ID			x
Romania	Ministry of Energy	**RATEN ICN**			x
Slovenia	Slovenian Research Agency	**JSI**		x	
	Ministry of Infrastructure of Republic of Slovenia	**ARAO**	x		
Slovakia	National Nuclear Fund	**STUBA**			x
	Ministry of Education, Science, Research and Sport	**NJF**	x		
	Ministry of Education, Science, Research and Sport	**VUJE**		x	
Spain	Ministry of Energy, Tourism and Digital Agenda	**ENRESA**	x		
	Ministry of Science, Innovation and Universities	**CIEMAT**		x	
Sweden	Nuclear Fuel and Waste Management Company, SKB	**SKB**	x		
United Kingdom	Department of Business, Energy and Industrial Strategy	**RWM**	x		
		UKRI-BGS			x
Switzerland	Federal Department of Economic Affairs, Education and Research	**NAGRA**	x		
	Swiss State Secretariat for Education, Research and Innovation	**PSI**			x
Ukraine	State Agency of Ukraine on Exclusion Zone Management	**ChRDI**	x		
		SSTC NRS		x	
EC		**JRC**			x

EXECUTIVE SUMMARY

1. Background, Vision and Objectives of the European Joint Programme on Radioactive Waste Management (EURAD)

Following decades of research, development and demonstration (RD&D) in support of the safe management and disposal of radioactive waste, a European Joint Programme on Radioactive Waste Management (EURAD) has now been established to coordinate activities on agreed priorities of common interest between European Waste Management Organisations (WMOs), Technical Support Organisations (TSOs) and Research Entities (REs).

Such Joint Programming is meant to complement National RD&D Programmes, by founding and carrying out activities jointly where there is added value at the European level, compared with conducting activities at the national level. It builds on existing networks, coordination activities and initiatives.

The vision of the European Joint Programme on Radioactive Waste Management (EURAD) is:

> *"A step change in European collaboration towards safe radioactive waste management (RWM), including disposal, through the development of a robust and sustained science, technology and knowledge management programme that supports timely implementation of RWM activities and serves to foster mutual understanding and trust between Joint Programme participants".*

By step-change we mean a new era of more effective and efficient use of public RD&D funding in Europe, and a deepening of research-cooperation between Member States. We aim to implement a strategic Joint Programme of research and knowledge management activities at the European level, bringing together and complementing national EU Member State programmes in order to ensure cutting edge knowledge creation and preservation in view of delivering safe, sustainable and publicly acceptable solutions for the management of radioactive waste across Europe now and in the future.

The scope of EURAD includes scientific and technical activities on radioactive waste management from cradle to grave (excluding dismantling and decommissioning of nuclear facilities):

- Radioactive waste characterisation and processing (incl. treatment, conditioning and packaging);
- Interim storage of radioactive waste; and
- Disposal solutions – mainly geological disposal of spent fuel, high-level waste (HLW) and long-lived intermediate level waste (ILW).

EURAD will generate and manage knowledge to support EU Member States with their implementation of the Waste Directive, taking into account the various differing stages of advancement of member state national programmes. This will encompass:

- Supporting Member-States in developing and implementing their national RD&D programmes for the safe long-term management of their full range of different types of radioactive waste through participation in EURAD; and
- Consolidating existing knowledge for the safe start of operation of the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste, and supporting optimization linked with the stepwise implementation of geological disposal.

From this, EURAD has established the following high-level objectives:

- Develop, maintain and consolidate the scientific and technical basis of safe radioactive waste management;
- Address important and complex issues and enable expert networking;
- Enhance knowledge management and transfer between organisations, Member States and generations; and
- Engage with Civil Society.

2. Contributors and Participants

EURAD contributors are those with scientific and technical responsibilities and a national mandate for research in radioactive waste management, including disposal. This includes:

- **Waste Management Organisations**

  With the ultimate responsibility for the implementation of geological disposal (which includes the management of a supporting RD&D programme), and for some the wider remit of radioactive waste management (including waste characterisation, treatment, packaging and interim storage), waste management organisations (WMOs) across Europe form a core part of EURAD. Providing the driving force for what is needed for successful and practical implementation from an industrial perspective, they are key contributors.

- **Technical Support Organisations**

  As safety cases for waste processing, storage and geological disposal develop, so too does the safety case review and independent scrutiny responsibility by regulatory organisations in the framework of the decision-making process. This requires specific skills from the regulatory expertise function undertaken by safety authorities, regulators, and their technical support organisations (TSOs). In that context, the regulatory expertise function, its RD&D interests and its independent participation in RD&D activities is promoted and included within EURAD.

- **Nationally Funded Research Entities**

  Providing scientific excellence and leading-edge research on basic components and generic processes in relation to the management of radioactive waste, research entities (REs) represent a large proportion of the contributions to EURAD. Promoting the safe management of radioactive waste, research entities work to different degrees on the challenges of radioactive waste management including disposal (and sometime in direct support to implementers or WMOs or TSOs), under the responsibility of Member States. This includes national research centres, some research organisations and some universities that could also be funded by other sources. It also includes R&D departments of Waste Producer organisations.

EURAD also includes observers and non-technical participants, who do not have a formal national mandate for research in radioactive waste management, including disposal, but who are considered as key interest groups and may benefit from, or influence the direction of, specific activities undertaken. This includes:

- **Civil Society Experts**

  The socio-political dimension is a critical aspect to the successful implementation of safe radioactive waste management, including disposal. Within EURAD, a group of

representatives of the European Civil Society Organisations (CSOs) who are involved in radioactive waste management activities at the EU or national level participate and interact with the JP. These interactions will be facilitated by Civil Society Experts.

- **Waste Producers**

  Waste Producers and those with a pre-disposal waste management remit are engaged via the Nuclear Generation II & III Association (NUGENIA). Although not direct contributors or participants of EURAD, continued engagement via dissemination and consultation will ensure NUGENIA and their dedicated R&D on nuclear fission technologies and predisposal activities and, will set a foundation for future collaboration in projects influencing the wasteform for final disposal. Waste Producers and Waste Management Organisations /Implementers at a national level are often well-connected and have existing cooperation activities that should support the integration of Waste Producers RD&D needs (that impact disposal), via the WMOs. Waste Producers are often responsible for contributing to financing of disposal facilities.

- **International Organisations**

  It is recognised that the scientific basis and public acceptance of radioactive waste management solutions, including geological disposal, is a global effort, and that new opportunities may emerge to link to worldwide RD&D efforts. Already EURAD has established close links with the International Atomic Energy Association (IAEA) from inception to avoid duplication of effort and resources. Such co-operation will continue, and extend to other organisations, including the Organisation for Economic Co-operation and Development – Nuclear Energy Agency (OECD-NEA), to strategically direct and offer clear added-value to EURAD objective.

- **Third Countries**

  Many past and ongoing EC projects have benefited from participation, exchange and cooperation with countries (or programmes) not a member of the Union. Defined as 'third countries' by the EC, it is anticipated that as EURAD becomes established, such cooperation will continue and become firmly established.

3. Scientific Themes & Activities of Common Interest

The Strategic Research Agenda (SRA), developed during EURAD preparation phase, provides a description of scientific and technical activities and knowledge management needs of common interest between EURAD contributors and participants. These activities are grouped into a number of scientific themes and based upon the scope established by the EC JOPRAD Project:

- **Theme 1: Managing implementation and oversight of a radioactive waste management programme**

  Implementation of a national radioactive waste management programme, including geological disposal, requires a strong technical foundation of national policy to provide a legal framework, a long term vision, appropriate regulatory oversight, funding, organisational infrastructure and sound management systems and processes and frequent exchange among stakeholders. For programmes in the early phase of establishing national policy or developing a waste

management programme, there is international entities support (IAEA, NEA) and EU-wide good practice and lessons learned that can be used to facilitate implementation of suitable organisational structures and strategic decision making.

- **Theme 2: Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal.**

  This involves characterizing the various waste types (requiring activation calculations, evaluation of contamination carry-over, development of waste treatment and packing technology, etc.), evolution of waste matrix properties during extended interim storage times, developing waste acceptance criteria and developing model predictions about future waste. This also includes development of sufficient interim storage capacity. Source term and radionuclide release mechanisms need to be assessed for different waste forms/waste packages considering the interaction of the various interfaces with the disposal environment. In this broad area of work much information is already available or can be acquired through co-operation. Where remaining issues remain, they are often site and design specific.

- **Theme 3: Engineered barrier system properties, function and long-term performance.**

  Engineered barriers (overpack, buffer, backfill, seals, etc.) are in a broad sense comparable in many programmes and much basic information is already available today as there have been many European and international project to-date. Existing needs can be further developed through continued co-operation, which includes the provision of utilising available underground research laboratories to conduct large-scale demonstration and verification testing. However, at a national programme level some specific development work is often necessary to improve the understanding of the system of engineered barriers, optimise it or adapt it to the specific situation at hand. Remaining research issues concern in particular cementitious and to a lesser degree clay-based materials.

- **Theme 4: Geoscience to understand rock properties, radionuclide transport and long-term geological evolution.**

  Geoscience focussing on host rocks representative of the broad range of geologies to understand long-term geological evolution (and stability), and on the detailed understanding of the relevant properties and behaviour of different types of host rocks. This includes the transport properties of radionuclides and fluids, redox phenomena, coupled phenomena to address facility-induced disturbances, and the impact of gas). This also includes the demonstration and verification that the important coupled geomechanical, thermal, hydrological and chemical phenomena are sufficiently well understood to allow for long term assessment of void space closure, fluid movement and behaviour of the material interfaces, in some cases through full scale experiments in an Underground Research Laboratory (URL). The broad area of geoscience will require significant activities that are specific to each country (especially regional geology but also the details of specific rocks), but with respect to the properties of rocks, much can be learned from other programmes working on similar rocks and may involve co-operative projects in URLs.

- **Theme 5: Facility design and the practicalities of construction, operations and closure.**

Facility design (covering early conceptual design during early programme phases, right through to detailed design for construction, operation and closure). In the area of geomechanics and excavation, much can be learned from the tunnelling and mining industries and the corresponding science and technology developments. The current focus is on the demonstration of waste transport and engineered barrier emplacement techniques, and to perform demonstration tests under real 1:1 scale and active conditions. Underground research laboratories and/or rock characterisation facility experiments, incl. monitoring activities often focus on demonstrating that technical aspects of facility construction and operation are suited for their purpose.

- **Theme 6: Siting and licensing.**

  The selection of a site (or sites) and licensing for a geological disposal facility is clearly the most important challenge to the successful implementation of long-term management of radioactive wastes. Site characterisation (exploration of geometrical aspects, rock layers, structures, and characterisation of key rock properties), acquiring site parameters through the use of geophysical techniques, hydraulic, and geochemical and geophysical measurements in boreholes and seismic investigations will contribute to the selection of the preferred site. As part of the full development of the selected site, underground testing will be required to allow detailed in-situ confirmation (and/or refinement) of some of the critical data on rock properties and state parameters before and during the construction of the repository. Site selection policies and procedures, regulatory arrangements and licensing requirements vary between member states, reflecting inter alia the socio-political context, geological factors, and the waste inventory. In this broad area of work a large part is of national focus and much can be learned from science and technology e.g. developed for hydro-carbon exploration, but also the wealth of information available from radioactive waste management programmes and from previously existing URLs must be considered. For URL-experiments, significant technology developments have been made (testing tools, sensors, etc.) that are essential for underground testing at repository sites. This area is very much suited for co-operation.

- **Theme 7: Performance assessment, safety analyses and safety case development.**

  For safety analyses (methodology, numerical tools, compiling all the information and data, drawing the conclusions), a wealth of information is already available. The development of the safety case and the task of integrating all the necessary information will always be specific to the system evaluated and thus, in this area, each country must develop its own capabilities in interaction with the various local stakeholders, however, confidence building requires often international exchange and the help of experienced experts from elsewhere. Common issues include typically the exchange on the treatment of uncertainties. It is important to recognise the need for independence between those supporting and managing safety case development and those supporting or managing the regulatory review and scrutiny of a safety case, this applies to all the SRA Themes, but especially relevant to Theme 7.

The SRA is further complemented by a Roadmap that provides a framework to describe the totality of scope of EURAD and its relevance to radioactive waste management (including disposal) programmes at different stages of maturity. The Roadmap effectively provides a framework upon which to organise the scientific and technical activities of the SRA, enabling programmes to ‘click-in’, and to access active

work or future plans. It also provides a framework for future periodic assessment of EURAD, and to evaluate future priorities and new work packages as new knowledge is acquired or as new needs are identified.

4. Initial 5 Year Deployment Plan

A number of deployment activities will be needed to deliver the SRA and to refine the Roadmap for the initial 5 year period, recognising that there are a broad range of options that could be used. The Deployment Plan comprises a series of Work Packages, that each include elements of:

- **Collaborative RD&D**

  RD&D focused on science, engineering and technology advancements that support the generation of new knowledge to progress radioactive waste management, including disposal, across Europe. The activities to be carried out are a balance between operational / implementation-driven, safety-driven and prospective RD&D.

- **Strategic Studies to Address Important and Complex Issues and Enable Expert Networking**

  Strategic studies to agree upon needs for future activities, including further specific thematic studies or RD&D at the forefront of science. This may also be referred to as 'think-tank' activities and will enable experts and specialists to network on methodological/strategical issues and advance significant challenges that are common to various national programmes and that are in direct link with scientific and technical issues.

- **Knowledge Management**

  Actions consisting of establishing State-of-Knowledge and ensuring its transfer to end-users, developing descriptive methodological guidance, and developing and delivering training and mobility.

- **Interaction with Civil Society**

  Actions allowing interactions between WMOs, TSOs, REs and Civil Society Organisations (CSOs) in order to facilitate the translation of scientific/technical results and create the conditions for CSOs to express their expectations and views. Such interactions shall improve the mutual understanding on RD&D performed to support the development of safe solutions of processing and disposal of radioactive waste.

The Deployment Plan is delivered in practical terms through the establishment of a clear governance scheme (and Joint Programme Terms of Reference), in addition to a dedicated Project Management Office that deals with the scientific and technical coordination of the overall programme, day-to-day administration and management, and communication and dissemination activities.

5. Summary

The European Joint Programme on Radioactive Waste Management (EURAD) is a new and flexible mode of European research collaboration that has the capability to supplement and enhance national programme capabilities to address remaining scientific and technical challenges. This document sets out the common Vision of the 22 European countries involved and provides a strategic approach to

support collaborative research and knowledge exchange that can exploit emerging scientific opportunities and open scientific questions, and jointly support progress with respect to radioactive waste management, including disposal. The activities of common interest identified in the Strategic Research Agenda and Roadmap address a broad spectrum of research needs and drivers from programmes at all stages of implementation and recognise the important role that each stakeholder group has in delivering this agenda. This includes close interaction between experts from different backgrounds, organisations and perspectives to maintain a sustainable presence and openness on the underlying science and to reinforce the quality of the decision-making process for managing radioactive waste, including spent nuclear fuel. The ultimate goal is to undertake research, development and demonstration, technical strategic studies and enhance access to knowledge and management tools and infrastructure that aids national radioactive waste management programmes with their successful implementation.

GLOSSARY

Advanced Stage Programme	Radioactive waste management programmes that are close to implementation of disposal. This typically includes programmes that are licensing for construction, completing site-specific and detailed site characterisation, or programmes that have produced comprehensive safety cases (and their supporting evidence base) for detailed conceptual designs suitable for regulatory scrutiny and/or subject to international peer review.
CSO	Civil Society Organisation.
Early Stage Programme	Radioactive waste management programmes that are at an early stage of development with respect to implementing disposal. This typically includes programmes in establishment or undertaking preliminary site evaluation and selection, or programmes yet to develop demonstrable competence for producing comprehensive safety cases (and their supporting evidence base) for detailed conceptual designs.
EBS	Engineered Barrier System.
EC	European Commission.
EDZ	Excavation Disturbed Zone.
EURAD / JP	European Joint Programme on Radioactive Waste Programme / Joint Programme.
EURATOM	European Atomic Energy Community.
GDF	Geological Disposal Facility.
HLW	High Level Waste.
IAEA	International Atomic Energy Agency.
IGD-TP	Implementing Geological Disposal Technology Platform.
ILW	Intermediate Level Waste.
Licence	A legal document issued by the regulatory or governmental body granting authorization to perform specified activities related to a facility or activity. The holder of a current licence is termed a licensee. A licence is a product of the authorization process, although the term licensing process is sometimes used.
LLW	Low Level Waste.
NUGENIA	NUclear GENeration II & III Association.
RCF	A Rock Characterisation Facility excavated to the anticipated repository depth to give further information on the bedrock and groundwater conditions of the final disposal site, as well as on the impact of the construction (e.g. to investigate the rock at tunnel scale, to conduct in-situ testing, to develop excavation and final disposal techniques in realistic conditions).
RD&D	Research, Development and Demonstration.
RE	Research Entity.
RWM	Radioactive Waste Management (which includes predisposal activities and disposal)

Safety Case	An integrated collection of claims, supporting arguments and evidence to demonstrate the safety of a facility. This will normally include a safety assessment, but could also typically include information (including supporting evidence and reasoning) on the robustness and reliability of the safety assessment and the assumptions made therein. It may involve various stakeholders. The safety case evloves with the increase of maturity of the repository project.
SITEX Network	Sustainable network for Independent Technical Expertise of Radioactive Waste Management. The purpose of the SITEX Network is to enhance and foster cooperation at the international level in order to achieve a high quality Expertise Function in the field of safety of radioactive waste management (RWM), independent from organizations responsible for the implementation of waste management programs, aiming at supporting the Regulatory Authorities, as well as the Civil Society (CS).
Small Inventory Programme	Radioactive waste management programmes that have a small inventory typically containing medical waste, disused and sealed radioactive sources and possibly a small amount of spent nuclear fuel from research reactors. Such programmes typically consider the construction of a dedicated national geological repository unfeasible and work in pursuit of economical ways for disposing of small amounts of radioactive waste, either through the possibility of shared regional facilities, borehole disposal or through a focus on long-term storage.
SRA	Strategic Research Agenda.
TSO	Technical Support Organisation is a generic term referring to organisations fulfilling an “regulatory expertise function ”, i.e. carrying out activities aimed at providing the technical and scientific basis for supporting the decisions made by the national regulatory bodies.
URL	Underground Research Laboratory, may be built for in situ testing or tests may be carried out in an actual repository excavation. Such a facility allows to measure the full range of repository environment properties and waste repository system interactions be measured. Tests are conducted within a geological environment that is essentially equivalent to the environment of a potential geological disposal facility.
WMO	Waste Management Organisation.
Waste Processing	Any operation that changes the characteristics of waste, including pre-treatment, treatment and conditioning.

1. INTRODUCTION

1.1. Successful RD&D collaboration across Europe

For more than 40 years, considerable scientific and technical knowledge has been acquired in Europe in the field of radioactive waste management (RWM), including for near-surface disposal (see, IAEA Scientific and Technical Basis for Near Surface Disposal of Low and Intermediate Level Waste) and geological disposal (see, IAEA Scientific and Technical Basis for the Geological Disposal of Radioactive Waste). This has supported countries to progress towards licensing of geological disposal facilities (e.g. Finland, Sweden and France) and contributed to the progress of numerous Member States' disposal programmes. RD&D efforts in radioactive waste management, including disposal, will continue to be necessary:

- To develop, maintain and consolidate scientific and technical knowledge throughout the stepwise development, operation and closure of disposal facilities, which will be spread over many decades and make this knowledge available to end users;
- To ensure optimisation of waste management routes and of disposal solutions;
- To address evolving regulatory concerns;
- To bridge the risk of shortage of the skilled, multidisciplinary human resources needed to develop, assess, license and operate facilities for RWM; and
- To help in gaining and maintaining public confidence.

The European Commission (EC) has supported the acquisition of knowledge at the European level by supporting collaborative RD&D projects through the EURATOM programme on RWM. More recently, the EC has also enhanced coordination and networking activities by supporting the establishment of the Implementing Geological Disposal Technology Platform (IGD-TP) - a network for European Waste Management Organisations (WMOs) which is now independently funded, and the SITEX Network for the regulatory expertise function undertaken by regulatory authorities, regulators, and their technical support organisations (TSOs), which is also now independently funded.

Today, the EC promotes a step-change in pan-European research cooperation between EU Member States' national programmes by promoting the setting-up of inclusive research and innovation joint programmes in Europe, attracting and pooling a critical mass of national resources on specific objectives and challenges. By step-change we mean a new era via a more effective and the efficient use of public RD&D funding in Europe, and a deepening of research-cooperation between Member States. The objective for the EC is therefore to promote and co-fund ambitious programmes rather than individual projects, bringing together those legal entities from EU Member-States or associated countries able to direct national funding and/or manage a national research and innovation programme.

The EC JOPRAD project was launched in June 2015 with the objective to assess if the RWM community could be meaningfully integrated in a Joint Programme and to prepare the establishment of such a Joint Programme. By identifying those with key responsibility for directing RD&D in the field of RWM, and engaging them in the process of developing a shared Vision and Strategic Research Agenda, JOPRAD demonstrated the feasibility of creating such a Joint Programme in the field of RWM.

Based on this positive achievement, the EC confirmed its willingness to co-fund such a Joint Programme and a dedicated topic is included in the EURATOM WP2018 call that has been recently published (indicative EC available budget for 5 years: 26-32,5M€).

Link: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/euratom/h2020-wp1820-euratom_en.pdf

1.2. Status of European national radioactive waste management programmes

National RWM programmes across Europe cover a broad spectrum of stages of development and level of advancement, particularly with respect to their plans and national policy towards implementing geological disposal. Programmes differ significantly depending on the national waste inventory, with some member states only responsible for relatively small volumes of medical and research reactor-derived wastes, compared to others that have comparatively large and /or complex waste inventories derived from large nuclear power (and fuel reprocessing) and defence programmes. Programmes also differ significantly in the way in which they are managed, particularly with respect to the national policy and socio-political landscape with respect to long-term storage solutions and geological disposal.

Box 1: Illustration of the diversity of contexts within EU

In the EU, 16 Member States have a civil nuclear power programme.

12 Member States (Malta, Luxembourg, Cyprus, Croatia, Ireland, Greece, Portugal, Latvia, Estonia, Denmark, Austria and Poland) have no civil nuclear power programme.

Of these, 7 Member States (Portugal, Latvia, Estonia, Denmark, Austria, Greece and Poland) are operating or have operated research, training or demonstration reactors.

15 Member States have plans for geological disposal of intermediate level waste, high-level waste and spent fuel. Finland, France and Sweden are aiming at starting operation respectively by 2022, 2025 and 2030.

All Member States are at different phases of stepwise decision making in long-term radioactive waste management. A description of these phases, together with the collective experience of some Member States with advanced disposal programmes is given in IAEA - Planning and Design Considerations for Geological Repository Programmes of Radioactive Waste.

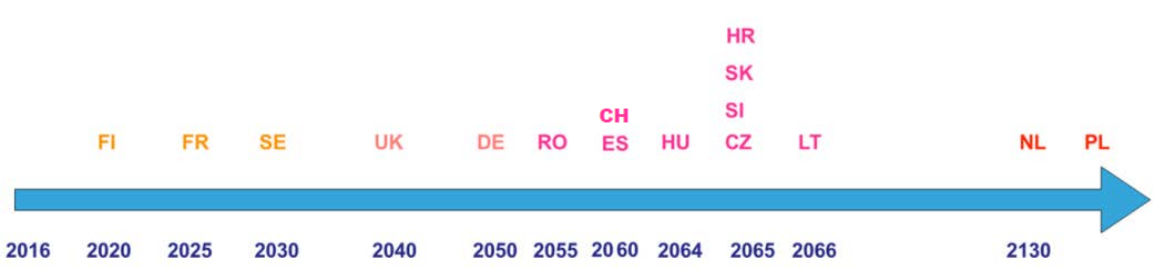


Figure 1- Planned start of operation of deep geological facilities (reproduced from: EC Progress Report on Progress of Implementation of Council Directive 2011/70/EURATOM)

Across Europe, the terms 'Advanced Stage Programme', 'Early Stage Programme' and 'Small Inventory Programme' are typically adopted (see Glossary for definitions). Regardless of size and stage of implementation, all Member States are responsible for the safe management of radioactive waste and are required to report periodically on the status of their national programme (See, Waste Directive).

The EURAD therefore includes:

- Member States with no nuclear power programme operating, or that have operated research, training or demonstration reactors, or other sources of radioactive waste;
- Member States with a nuclear programme;
- Member States with different amounts of radioactive waste to manage;
- Member States at different stages of advancement in the implementation of their national RWM programme; and
- Member States with plans for geological disposal for Spent Fuel, High-level Waste and long-lived intermediate level waste, with different disposal concepts and at different stages of implementation.

1.3. Contributors of European RD&D and participants of the EURAD

Across Europe, the organisation for how RD&D is managed and completed, in support of the safe management, including disposal, of radioactive waste, varies widely. At the highest level, most Member States have programme owners such as a ministry, national/regional authority or private organisation in charge of setting-up and thereafter the administration of a national programme. This is often followed by varying levels of 'programme managers', who have a formal mandate and delegated responsibility for technical research, development (and demonstration) activities associated with the national programme.

Recent work (see, JOPRAD) identified three distinct categories of organisation, from across 28 EU Member States, Switzerland and Ukraine, with scientific and technical responsibilities and a national mandate for research in RWM, and that are willing to share a Strategic Research Agenda (SRA) for European collaborative RD&D:

- **Waste Management Organisations** (WMOs) have ultimate responsibility for the implementation of geological disposal (which includes the management of a supporting RD&D programme), and for some the wider remit of RWM (including waste characterisation, treatment and packaging). WMOs from across Europe form a core part of EURAD and provide a driving force for what is needed for successful and practical implementation from an industrial perspective. WMOs have established a network and coordination framework for RD&D needs of the implementers of geological disposal at the European level via the Implementing Geological Disposal Technology Platform (see, IGD-TP);

- **Technical Support Organisations** (TSOs) carrying out activities aimed at providing the technical and scientific basis for supporting the decisions made by a national regulatory body[1]. As safety cases for waste processing, storage and geological disposal develop, so too does the safety case review and independent scrutiny responsibility by regulatory organisations in the framework of the decision-making process. This requires specific skills from the regulatory expertise function undertaken by safety authorities, regulators, and their technical support

[1] It is noted that the distinction between TSOs and REs in several Member States is a somewhat grey area as several Research Entities also fulfil (at least partially) an expertise function in their country and therefore also meet the conditions associated with the terms of a "TSO".

organisations (TSOs). Several TSOs, together with other organisations fulfilling a regulatory expertise function and CSOs have established the SITEX network to support independent technical expertise in the field of safety of geological disposal of radioactive waste; and

- **Nationally Funded Research Entities** (REs) working to different degrees on the challenges of RWM including disposal (and sometime in direct support to implementers or WMOs or TSOs), under the responsibility of Member States. This includes national research centres, some research organisations and some universities that could also be funded by other sources. RE's provide scientific excellence and leading-edge research on basic components and generic processes in relation to the management of radioactive waste, and therefore represent a large proportion of the contributions to EURAD.

EURAD also includes observers and non-technical participants, who do not have a formal national mandate for research in RWM, including disposal, but who are considered as key interest groups and may benefit from, or influence the direction of, specific activities undertaken. This includes:

- **Civil Society Experts**

  The socio-political dimension is a critical aspect to the successful implementation of safe RWM, including disposal. Within EURAD, a group of representatives of the European Civil Society Organisations (CSOs) who are involved in RWM activities at EU or national level interact with JP participants. These interactions will be facilitated by Civil Society Experts.

- **Waste Producers**

  Waste Producers and those with a pre-disposal waste management remit are engaged via the Nuclear Generation II & III Association (NUGENIA). Although not direct contributors or participants of EURAD, continued engagement via dissemination and consultation will ensure NUGENIA and their dedicated R&D on nuclear fission technologies and predisposal activities, will set a foundation for future collaboration in projects influencing the wasteform for final disposal. Waste Producers and Waste Management Organisations /Implementers at a national level are often well-connected and have existing cooperation activities that should support the integration of Waste Producers RD&D needs (that impact disposal), via the WMOs. Waste Producers are often responsible for contributing to financing of disposal facilities.

- **International Organisations**

  It is recognised that the scientific basis and public acceptance of RWM solutions, including geological disposal, is a global effort, and that new opportunities may emerge to link to worldwide RD&D efforts. Already EURAD has established close links with the International Atomic Energy Association (IAEA) from inception to ensure synergies and to avoid duplication of effort and resources. Such co-operation will continue, and extend to other organisations, including the Organisation for Economic Co-operation and Development – Nuclear Energy Agency (OECD-NEA), to strategically direct and offer clear added value to EURAD objective.

- **Third Countries**

Many past and ongoing EC projects have benefited from participation, exchange and cooperation with countries (or programmes) not a member of the Union. Defined as 'third countries' by the EC, it is anticipated that as EURAD becomes established, such cooperation will continue and become firmly established.

1.4. Remaining challenges of radioactive waste management

The community involved in the management of radioactive waste and the development of a geological disposal facility will face several challenges over the coming years, each presenting its own scientific needs that will need to be addressed using a broad range of activities:

- The implementation of the first geological disposal facilities by the more advanced programmes;
- The harmonisation of practices fostered by European initiatives such as WENRA, Waste Directive, Nuclear Safety Directive, and Aarhus Convention, etc.;
- The development and update of early stage programmes to start a disposal siting and licensing process, taking benefit of the experience gained by advanced programmes;
- The establishment of the State-of-Knowledge and its transfer to end users;
- The availability of competencies, research infrastructures and programmes to accompany the implementation and contribute to optimizing the management, including the disposal, of radioactive waste; and
- The necessity of creating a multi-decennial research and knowledge management perspective, considering the more than 100 years process between siting, licensing, operation and closure of a typical geological disposal programme.

2. EURAD - VISION

2.1. Our vision

A step change in European collaboration towards safe radioactive waste management (RWM), including disposal, through the development of a robust and sustained science, technology and knowledge management programme that supports timely implementation of RWM activities and serves to foster mutual understanding and trust between Joint Programme participants.

By step-change we mean a new era via a more effective and efficient public RD&D funding in Europe, and a deepening of research-cooperation between Member States. The aim is to implement a joint Strategic Programme of research and knowledge management activities at the European level, bringing together and complementing EU Member State programmes in order to ensure cutting edge knowledge creation and preservation in view of delivering safe, sustainable and publicly acceptable solutions for the management of radioactive waste across Europe now and in the future.

2.2. Our goals

EURAD will support the implementation of the Waste Directive in EU Member-States, taking into account the various stages of advancement of national programmes. Our Goals are to:

- Support Member-States in developing and implementing their national RD&D programmes for the safe long-term management of their full range of different types of radioactive waste through participation in the RWM Joint Programme;
- Develop and consolidate existing knowledge for the safe start of operation of the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste, and supporting optimization linked with the stepwise implementation of geological disposal;
- Enhance knowledge management and transfer between organisations, Member States and generations.

2.3. Joint Programme governing principles

EURAD shall respect the following principles:

- **Positive Participation –** Contributors will work positively towards achievement of EURAD Vision. All contributions will be valued. Work will be carried out considerately and respectfully by all, maintaining relationships that respect diversity, different roles and boundaries, and respect the knowledge, insight, experience and expertise of others.
- **Maintenance of Independence** – It is possible for different organisations with different roles in their national programme to work together, without prejudice to their own role in the national implementation process. Most important is the independence between the “expertise function” (fulfilled by TSOs and by some Research Entities) and the “implementer function” (fulfilled by WMOs). Different parties (WMOs and TSOs in particular) can have common agreement of what RD&D should be done and how, and Research Entities have a long term vision of research needs. All can collaborate in the oversight of that research, however, developing their own views on the interpretation of the research results and data that are generated is essential;

- **Transparent Governance** – A transparent, balanced and efficient mode of governance, taking into account Joint Programme participants with a national mandate for research in radioactive waste management;
- **Scientific Excellence** – RD&D activities shall focus on achieving passive safety (safety of a disposal facility is provided for by means of passive features inherent in the characteristics of the site and the facility and the characteristics of the waste packages, together with certain institutional controls, particularly for surface facilities) and reducing uncertainties through excellence in science.
- **Balanced Programme** – Recognising that different Member States have a wide variance in the status of their National Programme, the scope should support programmes at all stages of advancement;
- **Added Value** – Ensuring that Joint Programming provides real added value (e.g. improved financial arrangements, improved stakeholder acceptance of outputs, more robust RD&D outputs, etc.). Administration costs should represent a small proportion (including ongoing legal, EC admin., etc.) versus money spent on the technical and scientific scope;
- **Inclusiveness** – Ensuring that the different categories of actors and groups of interest are involved in the definition and implementation of EURAD;
- **Equitable Financing** – Financial costs (financial/in-kind) should be equitable; participants should contribute what they can afford, or what they consider matches their interest in a project;
- **Complementary Participation** – Participation in Joint Programme is complementary to RD&D activities which will continue to be undertaken nationally or jointly outside of the auspices of EURAD where required; and
- **Tangible Results** – The scope is appropriately prioritised and focused on the objective to achieve tangible results within a reasonable timeframe. A key aspect is that participants recognise that EURAD is a distinct change from past work (and other collaborative working) on radioactive waste management. Translating the societal challenge of radioactive waste management (including disposal) into operational reality requires the generation of new knowledge, combined with the consolidation, maintenance and transfer of existing knowledge.

2.4. Joint Programme scope and objectives

2.4.1. Develop, maintain and consolidate the scientific and technical basis of radioactive waste management (RWM)

The research, development and demonstration (RD&D) carried out in support of safe radioactive waste management (RWM), including disposal, is considered a key component of each national programme. Given the long timescales and socio-political dimension, RD&D provides primarily the scientific basis for implementing safe RWM solutions, whilst also contributing to building stakeholder trust, public acceptance, and training and education for generations of the workforce.

EURAD consists of collaboratively developing, maintaining and consolidating at the European level the scientific and technical basis of RWM, including disposal.

The scope of EURAD includes scientific and technical activities on RWM from cradle to grave:

- Radioactive waste characterisation and processing (incl. treatment, conditioning and packaging);
- Interim storage of radioactive waste; and
- Disposal solutions – Mainly geological disposal of spent fuel, high-level waste (HLW) and long-lived intermediate level waste (ILW).

Specific RD&D required for near-surface or surface disposal and low-level waste (LLW), will be addressed, and is encompassed within the RD&D needs identified for waste characterisation and processing, interim storage and geological disposal of radioactive waste. Nuclear facility dismantling and decommissioning activities are however excluded, although interfaces, and particularly aspects that impacts final disposal will be considered.

EURAD scope is organised at a strategic level by 7 scientific themes. Each theme is further split into a list of topics and sub-topics (mostly collaborative RD&D, and relevant strategic studies or knowledge management activities), that in-part, or in-full, contribute to the overall European effort to address remaining challenges of RWM, including disposal.

EURAD implements in a collaborative way those aspects of RD&D activities required within national research RWM programmes as well as associated activities where synergy from Joint Programming at European level has been identified. The prioritised scope identified is described more fully in the Strategic Research Agenda (SRA – see Section 3) and will support achievement of EURAD Vision.

2.4.2. Address important and complex issues and enable expert networking

Complementary to RD&D and in support to the implementation of the Member States' national programmes, EURAD shall give the opportunity to participants and expert contributors to network on methodological and strategic issues and challenges that are common to various national programmes and in direct links with scientific and technical issues:

- Share knowledge and discuss common methodological/strategical challenging issues (strategic studies) that are in close link with scientific, technical and societal aspects on RWM and that are common to various national programmes;
- Identify the contribution of past and on-going RD&D projects to the resolution of these issues;
- Identify any emerging topics for collaboration that could be addressed within EURAD;
- Take into account emerging science and technology as well as research priorities originating from other programmes (for example results from Horizon 2020 projects or IAEA outputs).

2.4.3. Enhance knowledge management and transfer between organisations, Member States and generations

It is essential to implement an efficient and integrated Knowledge Management programme at the EU level in order to establish, capitalize and transfer the state of scientific and technical knowledge in the field of RWM. Objectives are to:

- Develop an approach to ensure preservation and accessibility of publicly financed knowledge generated over the past, ongoing and future RD&D activities
  Preservation / capitalisation of generated knowledge

- Make sure that Member-States with national programmes at an early-stage of implementation can take advantage of existing knowledge and know-how from the Member-States with

advanced national programmes, primarily to access state of the art, and second to ease access to knowledge developed during previous EC supported RD&D projects.
Transfer of knowledge towards Member-States with early-stage RWM programmes

- In view of the long lead-times and operational time-spans for RWM, provide support to ensuring that the necessary expertise and skills are maintained through generations of experts for ongoing and future projects.
Transfer of knowledge between generations

- Disseminate and demonstrate progress, results and added-value of the European Joint Programme to a wider audience.
Dissemination of knowledge

2.4.4. Engage with Civil Society

The successful implementation of RWM National Programmes relies on both scientific and technical aspects for a sound safety strategy and scientific and engineering excellence and societal (social, legal, ethical, political) aspects.

Civil Society Organisations (CSOs) are not research organisations but have a specific concern on RWM safety and are involved in the perspective of the implementation of the UNECE Aarhus Convention which reinforces the requirements of access to information, public participation in decision-making and access to justice in environmental matters. European programmes therefore undertake work to address these requirements through local and national stakeholder engagement activities to enable Civil Society (representative organisations, e.g. Non-Government Organizations, Local Community Partnerships, etc.) to participate in defining their national RD&D programmes and the evaluation of RD&D results in the perspective of safety.

Interacting with Civil Society is important in this perspective and therefore one objective of EURAD is to allow interactions between WMOs, TSOs, REs and Civil Society Organisations. These interactions will facilitate the translation of scientific/technical results and create the conditions for Civil Society Organisations to express their expectations and views. Such interactions shall improve the mutual understanding on RD&D performed to support the development of safe solutions of processing and disposal of radioactive waste. It shall also contribute to developing ideas, propositions and methodologies on how to interact with Civil Society on scientific and technical results uncertainties (inherently linked to the long timeframes and numerous processes considered for geological disposal), and on how to interact with Civil Society stakeholders in order to promote mutual benefit of the available knowledge, based on cooperation and sharing.

2.5. Joint Programme expected impacts

2.5.1. How EURAD will complement the National Programmes

EURAD is not intended to replace National Programmes, rather it complements the national efforts and enables effective use of resources by sharing RD&D efforts and by making existing knowledge easily available to end users. Member States' National Programmes are organised and funded independently, and their participation in EURAD is the responsibility, and at the sole discretion, of each

national programme owner. By mandating organisations to participate, Member States demonstrate that the European Joint Programme has an EU-added value beyond their National Programme.

EURAD will generate and manage knowledge to support EU Member-States with their implementation of the Directive 2011/70/Euratom (Waste Directive), and more specifically with the development and implementation of their national RD&D programmes for the safe long-term management (including disposal) of their full range of different types of radioactive waste. More specifically, EURAD will:

1. **Support compliance with European regulations** – by supporting Member-States in implementing RD&D, developing skills and providing for transparency in order to develop solutions for their radioactive waste (see, Waste Directive articles 8, 10 and 12.1(f));
2. **Support passive safety of radioactive waste** – by contributing to the responsible and safe management of radioactive waste in Europe, including the safe start of operation of the first geological disposal facilities for high-level and long-lived radioactive waste / spent nuclear fuel as well as improvement, innovation and development of science and technology for the management and disposal of other radioactive waste categories;
3. **Help to gain or maintain public confidence and awareness in radioactive waste management** - by fostering transparency, credibility and scientific excellence;
4. **Support radioactive waste management innovation and optimisation** – by supporting the development of solutions for different waste streams and types and continuously improving and optimising waste management routes and disposal solutions, including identifying needs specific to small inventory programmes with their particular challenges with respect to access to critical mass of expertise in developing appropriate disposal options;
5. **Contribute to addressing scientific/technical challenges and evolving regulatory concerns** – by prioritising activities of high common interest, and creating conditions for cross fertilization, interaction and mutual understanding between different Joint Programme contributors and participants;
6. **Enhance knowledge transfer to early stage programmes** – by providing an opportunity for less advanced programmes, and in particular those in an early stage of geological disposal programme implementation, to benefit from the cross-European fertilisation in radioactive waste management;
7. **Foster efficient use of the RD&D resources at the EU level** - by sharing and advancing existing knowledge, facilities and infrastructure rather than repeating and duplicating efforts; and
8. **Foster a better transfer of knowledge across generations of experts** – by helping to bridge the risk of shortage of the skilled, multidisciplinary human resources and critical infrastructure needed to develop, assess, license and operate RWM facilities, in view of the long lead-times and the intergenerational operational time-spans.

2.6. Joint Programme Endorsement

All Joint Programme participants, through their participation in EURAD, endorse the Vision and positively support the content and implementation of the EURAD Founding Documents.

3. EURAD – STRATEGIC RESEARCH AGENDA

The Strategic Research Agenda (SRA) of EURAD has been developed in a stage-wise manner, Step 1 - taking over entirely the scope developed within the EC JOPRAD Project (See, D4.2 Programme Document), and Step 2 – enhanced with a small number of additional needs identified by ongoing EC

projects and approved for inclusion between the key contributors of the JP. The detailed methodology used for both of these steps is described fully in Annex 2.

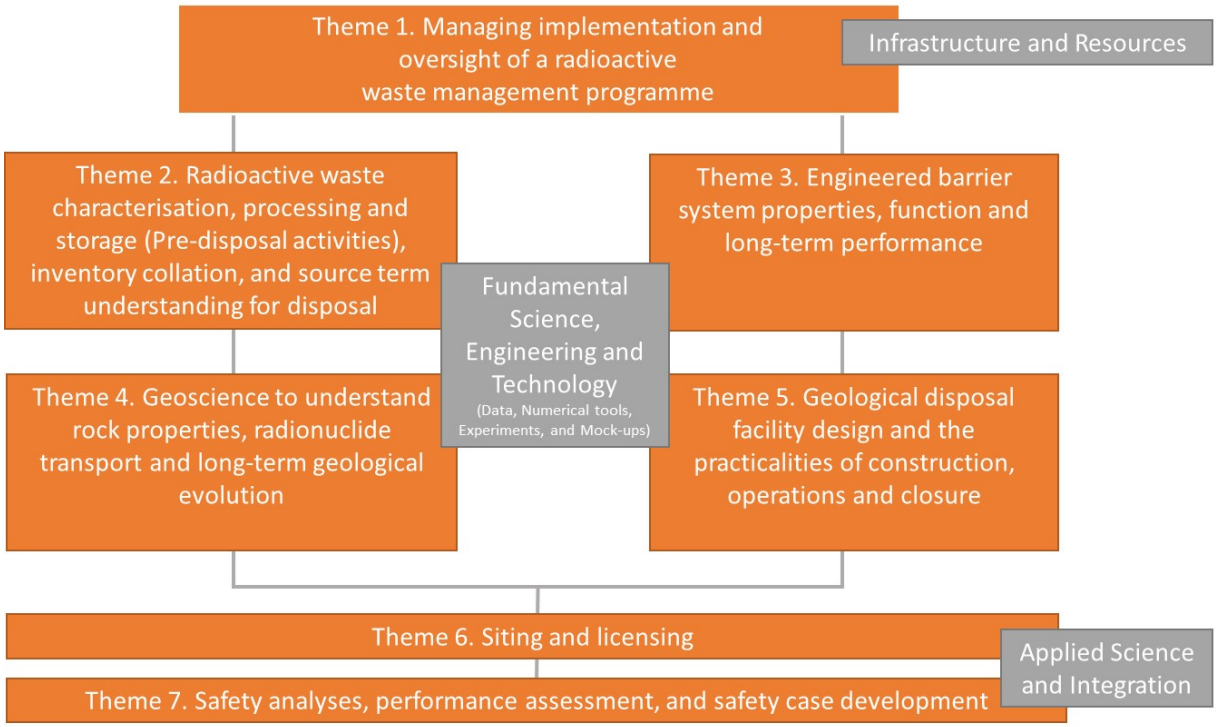
The Strategic Research Agenda (SRA) will be a dynamic and living document that shall be updated periodically in order to integrate outcomes of RD&D activities as well as any emerging collaboration needs identified by the RWM community during the implementation phases of EURAD.

We anticipate that there will be regular 'soft' updates to make minor edits and additions. This will be complemented by periodic extensive updates to coincide with future Work Package developments (for example during identification and prioritisation of EURAD 2 scope) where it is anticipated that significant changes may result to take account of learning from EURAD 1 and align the SRA, Roadmap and Work Package scope and methodologies with how things evolve, particularly with respect to the JP governance scheme and how the criteria used to identify needs of the WMOs, TSOs and REs.

In its current form, together with the Roadmap in Section 5, it should be considered a first version, and be open to changes in structure, content, scope, titles, and new numbering in the future, particularly to account for maturity of EURAD and evolution of different Programmes' needs. It is anticipated that new scope suggestions and/or edits will be made in consultation with EURAD participants in an open and transparent manner.

The SRA scope is structured by seven Scientific Themes, as illustrated in Figure 2. These themes are also used in the roadmap. Although all technical in nature, Theme 1 is an overarching theme, Themes 2-5 are predominantly focussed on fundamental science, engineering, and technology, and Themes 6 and 7 include aspects more of an applied science and integration focus.

Figure 2. Scientific Themes of EURAD SRA

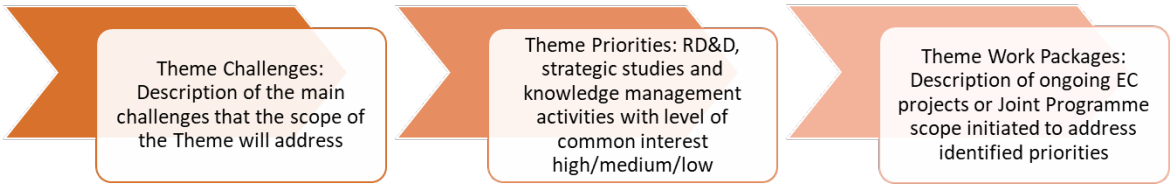


Within each theme, the SRA provides (i) a short introduction and background section, broken down into a number of topics that are further used in the roadmap. The SRA then provides (ii) a list of RD&D priorities, strategic studies and Knowledge Management activities of common interest to be addressed

by EURAD, using the tasks numbers from the EC JOPRAD project (in the future version a new numbering system shall be implemented). For each there is an indication of relevant cooperation and past EC projects that should be considered at the time of task initiation; and (iii) a summary of ongoing and active work (including Horizon 2020 projects) that address in-part, or in-full, the activities and priorities identified for each Theme. This structure is further summarised by Figure 3 below.

An important consideration in developing the SRA themes, and their further delineation into topics and sub-topics, has been to avoid grouping scientific and technical scope according to rock type (e.g. clay, hard-rock, or salt systems) or by disposal concept and design (e.g. vertical borehole, horizontal tunnel or vaulted systems). Rather, EURAD SRA considers integration of scope across programmes with varying rock types and concept designs as highly beneficial, resulting in enhanced cross-fertilisation between established communities of practice for specific areas of scientific and technical competence.

Figure 3. The Structure of EURAD SRA



EURAD SRA does not describe activities that are handled by individual Member States' RD&D programmes, and should not be considered an exhaustive list of all RD&D initiatives or active work within Europe. It only includes initiatives that are currently coordinated and funded by the EC and those that have been brought to the attention, and considered relevant for cooperative work, by Joint Programme participants. Recognising the potential overlaps with existing initiatives and the coordination needed to ensure that EURAD delivers on its remit to provide European added value, for each RD&D activity, the SRA includes an indication of known opportunities for interaction. This will also be addressed within the knowledge management activities. (**Note that this activity has yet to be completed in coordination with IAEA*).

The SRA Tables of RD&D Priorities indicate the surveyed High, Medium or Low level of Common Interest, as identified by EC Project JOPRAD (see Annex II). The enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities identified of common interest (by JOPRAD) that relate to each Theme are included without an indication of High, Medium or Low level priority. It is anticipated that the first phase of JP implementation will address this by additionally surveying Member States needs on these aspects and developing a specific list of priorities as a basis for the future JP work, beyond the collaborative RD&D scope.

Theme 1: Managing implementation and oversight of a radioactive waste management programme

Programme planning

Radioactive waste management (RWM) programmes present special challenges in their planning and execution, for which on-going programmes have already lasted for several decades. They involve not only significant science, technology and engineering, but also substantial elements of programme management, regulation, politics, financing, resourcing, and most importantly, public participation and stakeholder engagement. Such elements are included in the Waste Directive and elaborated further in the ENEF NAPRO Guide (see Annex 4). International collaboration on these aspects hold many advantages for both early-stage programmes and advanced programmes, and although not considered pure RD&D, they require expert technical knowledge, sharing of good practice, and hence are included within EURAD scope.

Establishing very early on a national programme with decision milestones, and clear roles and responsibilities, enables all parties (i.e. government, regulator, operator and public) to commit to progress. Particularly when implementing geological disposal, public participation and stakeholder involvement has great importance to the planning of the programme. Lessons learned from past programme experiences show that engineering aspects tend to be well understood, with sufficient experience to accurately plan the effort and resources required. In contrast, the scientific effort (site characterisation, process modelling, safety assessment etc.), while already providing understanding of process understanding and impacts on safety, is evolving over time leading to new view points and sometimes new uncertainties and it is less predictable in the outcome, duration or resources that may eventually be required. Accounting for such uncertainty has become a key part of successful programme planning, and would benefit from continued sharing of methodologies and experience.

A clear strategy and commitment to involvement of stakeholders is essential to the decision-making process at all stages of a waste management programme. This will include how stakeholders with interest in RD&D will be involved and ways of communicating the scientific basis of waste management solutions for a range of audiences, including those for disposal. Throughout the preparatory work of the Joint Programme EURAD (see, the EC JOPRAD project), experts of Civil Society have contributed to and influenced the scope of work to be addressed.

Organisation

All programmes benefit from an established waste management and disposal policy and regulatory framework established prior to the initiation of substantial site work. These should be clear, comprehensive and in line with accepted principles promulgated internationally. It is essential that those working in direct support of the national regulatory bodies continue to network and harmonise views on how to develop, maintain and apply regulations.

The Waste Directive requires Members States to ensure they have National Programmes leading to implementation of safe and responsible management of spent fuel and radioactive waste. This includes the requirement to each develop a dedicated RD&D programme and transparent policy, see Waste Directive Articles 12 (1,F) and 12(1,J). Member States completed their first notification to the Waste Directive in 2015,

however their responses have not been made available or used directly to determine the scope of EURAD. Rather, Member States with this responsibility are able to influence EURAD scope through their participation. Inputs from early-stage programmes have already been included into EURAD by earlier work undertaken by the Implementing Geological Disposal Technology Platform (IGD-TP) which prepared a preliminary Guide on RD&D programme planning for geological disposal in 2015, the PLANDIS Guide. Aimed at early-stage programmes, it suggested a number of activities that would benefit from further guidance, anticipated to be developed within EURAD Knowledge Management Scope.

Resources

In the perspective of decades-long programme management, organisational capabilities related to resources (competence maintenance, education and training), financing (forecasting and costing), and the adoption of sound management systems and processes are all needed.

Across Europe there are a large number of organisations within many countries with resources (databases, equipment, capabilities, etc.) relating to the management and disposal of radioactive waste. Further networking and documentation of such infrastructure could aid early-stage programmes to tap into an existing talent pool and also help advanced programmes manage emerging skill gaps either for new competencies identified, or to manage capacity when key individuals have retired or local/national resources are unavailable. Sharing of competence matrices for different roles (regulator versus implementor) and how these evolve through successive phases of a waste management programme would be highly advantageous.

Information management, record keeping and maintaining memory are important activities within the context of implementing geological disposal (and long-term waste storage). The IAEA and OECD-NEA are involved in providing guidance in support of those aspects. The outcome of their work is transferred through participation in project activities establishing the guidance and recommendations, as well as through dissemination of the outcomes through conferences, proceedings and guides.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[2]:

Theme 1: Managing implementation and oversight of a radioactive waste management programme	• **EU research infrastructure:** To document the extent of European research infrastructure and competencies, and establish conditions allowing for transnational access to and/or sharing of facilities and established networks (J3.15/High). - Expected outcomes and impact: Improved understanding of the breadth and depth of research infrastructure across Europe. - Cooperation and relevant past projects: possibility to explore training / mobility exchange at some sites / URLs
	• **Pre-licensing management:** To identify RD&D and knowledge transfer needs in support of defining pre-licensing activities that can support success in the siting and licensing phase/process (J3.11/Low). - Expected outcomes and impact: Enable programmes to structure and prepare successfully for licensing.

[2] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

	- Cooperation and relevant past projects: ?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 1: Managing implementation and oversight of a waste management programme.

How to establish and implement a radioactive waste management RD&D programme: To develop a common guidance document to support waste management programmes, including disposal, with establishment and implementation of a RD&D programme (Originates from needs identified by the IGD-TP PLANDIS Guide (See Annex 4).

- **Training and competence maintenance of skills and expertise to support safe radioactive waste management including disposal:** To ensure knowledge is managed and disseminated, and that there is competence maintenance, education and training of the workforce (J3.16).
- **Information management:** To maintain information, knowledge and records over the long lead- and implementation-timelines of geological disposal programmes, from pre-licensing through to the post-operational phase (J3.14/Medium).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 1:

As previously mentioned, the Member States responses to the Waste Directive, together with Member States responsibility towards the IAEA Joint Convention provide considerable inputs and enable access to networks, resources and experience for how to establish the key components of a RWM programme at a national strategic level.

Regarding training, the EC ANNETTE project (2016-2019) is consolidating existing achievements to tackle the challenges in ensuring a qualified nuclear workforce is available to support future nuclear energy, decommissioning and waste management requirements. ANNETTE aims to enhance European-wide efforts initiated in the past decades by different organisations belonging to academia, research centres and industry to maintain and develop education and training in the different nuclear areas. Links between ANNETTE and EURAD Knowledge Management Work Package on Training are anticipated.

Within the JP first phase, it is anticipated that one of the first guidance documents to be produced will be on establishing and implementing a RWM RD&D programme, building on the work of the IGD-TP PLANDIS Guide.

Theme 2: Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal

Introduction and background:

Waste handling, characterisation, treatment and packaging

Sufficient knowledge of the waste characteristics is necessary to define suitable treatment and conditioning, both for passive safety and for final disposal. Spent Fuels and vitrified high-level wastes are generally well characterised. Remaining uncertainties include inventories of some long-lived beta emitting activation products like Cl36, C14 etc. Regarding long-lived intermediate level and low-level wastes, often, countries need to manage historical radioactive waste without adequate information about their origin and radionuclide content, and in some cases waste streams have been mixed. The problem may be more pronounced in countries having small amounts of radioactive waste which may not have the necessary funds to characterise the waste using available technology. Therefore, there is a need for developing reliable and affordable technologies for cost-effective characterization and segregation of historical preconditioned radioactive waste. Non-destructive assay techniques could enable the rapid characterisation of wastes prior to packaging, during storage, prior to dispatch to a GDF, or upon receipt at a GDF. These techniques could allow characterization of the gamma-radionuclide content, fissile content, physical and chemical characteristics of waste packages.

Significant progress has been made in the development of robust disposal concepts (including packaging options) for spent fuel, high-level wastes and many intermediate and low-level wastes. There is an opportunity for the identification of good practice between Member States where disposal concepts have been developed, however there is also a need to develop novel conditioning technologies for problematic wastes and further explore less-investigated waste conditioning options, such as geopolymers.

Interim storage

Radioactive waste may be transported and placed in interim storage prior to disposal covering a timespan of several decades up to a century or more. Unexpected delays in disposal programmes may extend storage periods beyond what was originally anticipated in the national programme. Therefore key considerations include degradation of the wasteforms and packaged waste during these relatively long or extended timespans, and the resulting impacts on the safety of the storage facility, as well as on the operational and post-closure safety of the geological disposal facility. Key considerations currently include waste package storage monitoring systems, aging and sealing of spent fuel storage casks, potential impacts of defects on spent fuel performance and re-packaging and/or re-working of packaged waste.

Transportation between facilities

Once a disposal facility is constructed and regulatory authorisation has been given to accept wastes for disposal, waste will need to be transported safely and securely to the facility from the sites where it is being stored. International standards and guidance for the safe transport of radioactive materials have been developed on the basis of world-wide experience and best practice. This experience is distilled into the International Atomic Energy Agency (IAEA) Transport Regulations, which apply to road, rail, sea and air transport of radioactive materials. Within EURAD, we anticipate sharing of good practice and experience to continue, particularly as advanced programmes move closer to

transport and emplacement of waste in Europe's first geological disposal facilities.

Radionuclide inventory and source term

The nature and quantity of wastes for disposal, including their chemical and physical form, their packaging / conditioning and their radionuclide and chemical composition are known as the radioactive waste inventory for disposal. Improved understanding of (i) the inventory, (ii) the radionuclide source term and (iii) more generally, the evolution of the waste behaviour throughout the planned interim storage, operational and post-closure phases of a geological disposal facility lifecycle is important for designing the disposal system.

For wastes, such as Spent Fuel or vitrified High-level Waste, their wasteform is fixed, and therefore their physical and chemical form is used as a direct input to design of the disposal system, including disposal packaging. For other wastes (e.g. long-lived ILW), where more varied processing and treatment options are encountered, some enhancements in the robustness of the wasteform (and disposal package), and its contribution to overall safety performance of the disposal system may be considered, and therefore may vary depending on the disposal approach and concept adopted by each disposal programme owner to complement site conditions. For these wastes, knowledge of the radionuclide and chemical inventory (including metals and organic compounds) and the chemical state of its components are important. Data quality of waste inventories is variable, with uncertainty often dominated by waste heterogeneity.

In general, only a small subset of radionuclides will dominate the post-closure safety case of a disposal facility. However, since the composition of a wasteform contributes to the overall performance of the disposal multi-barrier system, improved mechanistic understanding for the release kinetics of the radionuclide and chemical species may enhance understanding of the source-term for key species in performance assessments.

The source term for a wasteform is not always an intrinsic wasteform property but may also depends as well on its disposal environment. Oxidizing or reducing disposal environments or the presence of hydrogen are of particular importance for the source term from spent nuclear fuel waste packages. In the case of vitrified waste, strong coupling exists between the wasteform performance and the presence of near field materials (e.g. clay interactions with iron corrosion products). The presence of water vapor in unsaturated settings of disposal vaults, or water flow rates in saturated environments are also an important factor influencing the source term. Fundamental understanding of these couplings is available, but the long-term operation of the governing mechanism needs to be assured. Some work on natural analogue systems may help clarify such long term post-closure process understanding.

The EC CAST project (2013- March 2018) provided understanding of the ^{14}C source term (focused on speciation) for graphite, activated metals (Zircaloy and stainless steel) and ionic exchange resins. Further understanding may be helpful, particularly in support of the disposal of intermediate and low-level wastes, in order to provide confidence that the environmental and radiological impact of any release of these species will be acceptable. The management of some radioactive waste is still a challenge, while for some others there is the potential for optimisation. This includes operational wastes, by-products from existing processes (e.g. sludges), chemically reactive wastes, irradiated graphite, etc. Radioactive waste treatment processes (for example, thermal treatment) could be applied to a wide range of waste streams and could provide benefits in feasibility to meet waste

acceptance criteria at a disposal facility, safety demonstration, volume and hazard reduction and cost savings.

Regarding spent fuel, the EC FIRST Nuclides project aimed to determine the fraction and the chemical form of some relevant elements, mainly ^{14}C, ^{36}Cl and ^{79}Se. Quantification of the activation products ^{14}C and ^{36}Cl that arise from N and Cl impurities in fuel, and understanding the impurity level ranges in fuels from different suppliers is still an open question identified at the end of the project. Internationally, considerable effort has been devoted to the long-term consideration of fission and activation product releases from spent fuel that may become exposed to groundwater once its container is breached (post-closure/disposal phase).

Waste acceptance criteria

As programmes move close to implementation, understanding of the nature and quantities of waste becomes formalized by waste acceptance criteria (WAC). This criteria includes a set of requirements for each waste management facility (including a geological disposal facility), taking into account specific characteristics of the waste to be disposed, the disposal concept adopted, and local site conditions. International cooperation and coordination in developing better understanding of the processes governing the source term and how this translates into waste acceptance criteria, as well as its use in the safety assessment, requires ongoing development.

Multi-national, regional or shared facilities

Some programmes across Europe consider the feasibility of regional or shared facilities (including multi-national repositories) that can provide infrastructure for all, or part, of the waste management route for a specific waste type. Planning of such facilities encompasses important and innovative developments (including the legal framework), which have been considered in work under the auspices of the EC or IAEA (See, IAEA - Developing multi-national radioactive waste repositories). Within EURAD, scope undertaken to understand waste management routes, as part of pre-disposal activities may consider aspects that are important to those national programmes that consider the use of multi-national, regional or shared facilities.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[3]:

Scientific Theme 2: Radioactive waste characterisation, processing and storage (Pre-	• **Identifying good practice in the management of inventory data and uncertainty treatment.** - Expected outcomes and impact: Improved understanding of those species that dominate the transport, operations and post-closure safety cases and targeted fit-for-purpose assay that can enable cost-effective data quality improvements (J1.1.1/High). - Cooperation and relevant past projects: EC FIRST Nuclides project
	• **Developing novel conditioning technologies for non-mature and problematic waste.**

[3] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

disposal activities), and source term understanding for disposal.	- Expected outcomes and impact: Identification and sharing of good practice and in waste conditioning and packaging approaches for problematic wastes (J1.1.3/High). - Cooperation and relevant past projects: Check for EU-wide waste producers forum?
	• **Improved understanding of radionuclide release from existing and future wasteforms other than Spent Fuel.** - Expected outcomes and impact: Improved understanding of the radionuclide release mechanisms and associated kinetics for vitrified waste (ILW and HLW), metallic wastes, high organic content wastes, graphite, and cementitious wasteforms (J1.1.4/High). - Cooperation and relevant past projects: EC CAST project
	• **Developing reliable and affordable technologies for the radiological characterization and segregation of historical preconditioned radioactive waste.** - Expected outcomes and impact: Develop and demonstrate enhanced and/or novel non-destructive assay techniques (which maintain waste package integrity and containment) to provide quality assurance of packages being stored, transported or received at a disposal facility (J1.1.2/Medium). - Cooperation and relevant past projects: EC CHANCE project
	• **Improved understanding of the impacts of extended storage on waste package performance.** - Expected outcomes and impact: Identification, characterisation and management of uncertainties related to the performance of the final waste package (including the waste form) during prolonged storage, e.g. ageing, confinement integrity, handling constraints, including effects on specific materials of casks for dry storage of Spent Fuel (J1.2.2/High). - Cooperation and relevant past projects: ?
	• **Improved understanding of the generation and release of radioactive trace gases and bulk gases from wasteforms and waste packages.** - Expected outcomes and impact: To further understand bulk gas generation from ILW, and gas generation from HLW and spent fuel, and potential impacts on the disposal system. To identify and resolve outstanding RD&D requirements arising from the EC CAST project, to increase understanding of the generation and release of gases (H2, CO2, CH4, HCl, CO, HF, HCN, etc.) resulting from radiolysis of polymers, including the influence of temperature, and to increase understanding of the generation and release of hydrogen resulting from corrosion (J1.4.2/High). - Cooperation and relevant past projects: EC CAST project
	• **Demonstration of geopolymer performance in representative disposal conditions.** - Expected outcomes and impact: To develop an appropriate understanding of the radiolytic performance and product stability, gas-permeability, resilience to cracking from gas production, fire performance and long-term chemical stability (leach performance) of geopolymers used for waste solidification in the context of the disposal environment (J1.1.5/Medium). - Cooperation and relevant past projects: Existing development group?

	• **Improved understanding of the nature and quantities of the likely chemotoxic component of common wastes.** - Expected outcomes and impact: Enhanced confidence in packaging and conditioning methods, and of the long-term environmental and radiological impact of wastes containing chemotoxic elements (J1.1.7/Medium). - Cooperation and relevant past projects: Existing development group?
	• **Optimisation of radioactive waste treatment techniques where there is potential for volume/hazard reduction and potential cost savings.** - Expected outcomes and impact: Optimisation of waste treatment options leading to potential benefits in terms of Waste Acceptance Criteria, safety demonstration, volume and hazard reduction and cost savings (J1.1.8/Medium). - Cooperation and relevant past projects: EC projects CAST, Carbowaste and THERAMIN
	• **Improved understanding of the behaviour of packaged Spent Fuel for a range of hypothetical fire and impact scenarios during operations and transport, and consolidation of existing understanding of post-closure Spent Fuel release processes.** - Expected outcomes and impact: Improved mechanistic understanding of the release of fission products from the different types of spent fuels to better predict the radionuclide source term for operational and post-closure safety assessment (J1.1.9/Medium). - Cooperation and relevant past projects: EC projects SFS, MICADO, FIRST Nuclides, DISCO
	• **Fourth generation (Gen (IV)) wastes.** - Expected outcomes and impact: To understand the nature and quantities of wastes arising from a fourth generation of nuclear reactors, identify challenges to the disposal of such wastes and enable early feedback to reactor system designers in order to mitigate associated risks (J1.1.6/Low). - Cooperation and relevant past projects: ?
	• **Quantification of fissile content of spent fuel.** - Expected outcomes and impact: Improved understanding of the characteristics of spent fuel (J1.1.10/Low). - Cooperation and relevant past projects: ?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 2: Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal:

Strengthened links between Implementers and Waste Producers: To enhance cooperation in the process of spent fuel and nuclear waste disposal solutions and to improve understanding of spent fuel arisings, including those from innovative fuel types (J3.7)

Inventory collation and forecasting: To ensure that all countries implementing a disposal facility develop a comprehensive inventory (J3.5).

Methodologies applied to define radionuclide inventories: To further understand evolution of the radionuclide inventory after disposal including the use of radionuclide vectors, and uncertainties about databases of radionuclide properties (J3.6).
Understanding of the potential for long-term storage as a management option for disused sealed radioactive sources: To understand the potential impact of improving technology for the treatment or re-use of disused sealed radioactive sources as an alternative to disposal (J3.10).
Management of damaged waste packages and the criteria and methods for reprocessing aged waste: To share good practices with respect to minimising radiological consequences and addressing waste acceptance criteria in the event that packages have aged and require re-processing or have become damaged prior to transfer to a geological disposal facility (J1.2.4)
Operational lifespan of interim storage facilities: To support the safe management and safety assessment of existing storage facilities and design criteria for new storage facilities (J.2.4.5).
Waste acceptance criteria: To develop good practice guides for the derivation of waste acceptance criteria and increase confidence in, and further refinement of, inventory uncertainty quantification methods, including sensitivity studies (J2.1.6).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 2:

With the purpose of sharing experience and knowledge on waste management routes between interested organisations from different countries, with programmes at different stages of development, with different amounts and types of radioactive waste), a strategic study (EURAD WP9-ROUTES) has been initiated to look holistically at waste management routes in Europe from cradle to grave. Specifically this will look across the spectrum of challenging wastes, characterisation approaches and waste acceptance criteria established across Europe, and identify areas of focus for the EURAD in the future.

The EC Horizon2020 call, supported 4 projects running from 2017-2021 which will contribute further understanding and knowledge to address remaining challenges in Scientific Theme 1 - CHANCE, DISCO, INSIDER and Theramin.

The CHANCE project aims to address the as yet unsolved and specific issue of the characterization of conditioned ILW radioactive waste (CRW). CHANCE will establish a comprehensive understanding of current characterization methods and quality control schemes for conditioned radioactive waste in Europe. CHANCE will develop, test and validate already-identified and novel new techniques that will undoubtedly improve the characterization of CRW. One of the project's key tasks will be identification of links and overlaps between waste acceptance criteria and actual waste characterization technologies available, in order to identify specific, as yet unsolved, methodology issues and technology gaps.

The DISCO project aims to fill the gap of knowledge on spent fuel dissolution arising from the development and use of novel types of fuel (Cr-doped and MOX). The project aims to enhance understanding of spent fuel matrix dissolution under conditions representative of failed containers in reducing repository environments and to assess whether novel types of fuel behave like the conventional ones. This project aims to expand the database on spent fuel dissolution with results from dissolution studies. The effects of dopants will be investigated through experiments using both spent nuclear fuel and synthetic materials specifically designed for

the project. In addition, chemical modelling will be employed to enhance understanding.

The INSIDER project aims to develop new methodologies for more accurate initial estimation of contaminated materials, resulting waste volumes and timely planning during decommissioning and dismantling (D&D) operations. The envisaged project outcomes will enable building of a fit-for-purpose representation of the radiological status of facilities (or components), at a relevant precision level allowing improved decision making when considering different D&D scenarios and options.

The Theramin project is focussed on thermal treatment for radioactive waste minimisation and hazard reduction. Relevant technologies include in-container vitrification, gasification, plasma treatment and hot isostatic pressing. Project outputs will provide an EU-wide strategic review and assessment tool to assess the value of thermal technologies applicable to a broad range of waste streams (ion exchange media, soft operational wastes, sludge, organics and liquids). This will include the applicability and achievable volume reduction of the technologies through 'first-of-a-kind' active and non-active full-scale demonstration tests, and will assess the disposability of residues. THERAMIN will establish a pan-European network of expertise on thermal treatment, will provide for cross-European technology transfer, and will identify prospects for sharing of facilities between countries facing similar problems.

Within EURAD first phase, an RD&D work package on spent fuel characterisation and evolution has been established. This will study the properties, behaviour and associated uncertainties of spent nuclear fuel from the time when it is irradiated in the reactor up to the time it is emplaced in a geological disposal facility. Both experimental and numerical activities are proposed. The work seeks to understand fundamental out-of-core behaviour of fuel and cladding to ultimately ensure safe, reliable and economical use of storage and disposal systems. The work package includes Knowledge Management activities, including a state-of-the-art review on spent fuel characterisation and sources of uncertainties, and the development of guidance for model calculations, radionuclide inventory calculations, characterization methods and uncertainties calculations for spent fuel.

Theme 3: Engineered barrier system (EBS) properties, function and long-term performance

Introduction and background:

Spent Fuel and high-level waste disposal canisters

The conditioned waste is placed in a container (sometimes called a canister), creating what is referred to as the waste package. The container must be chosen so that the waste can, if needed, be safely transported and handled leading up to its disposal. The material and design of the container can be chosen to then provide reliable physical containment under disposal conditions for extended periods of time. This can be achieved in a variety of ways, for example, in the case of metallic containers, by using a metal such as copper that is highly corrosion-resistant under certain chemical conditions or by using sufficient thickness of a metal such as carbon steel so that it will take a long time to be corroded through. For HLW and Spent Fuel, packaging developments are relatively mature and hence a continued exchange on latest developments is envisaged within EURAD. With new waste streams (advanced fuel cycles) and new host rock systems under consideration, alternative container materials for HLW/SF may be considered.

Containers for long-lived intermediate and low level wastes

For intermediate and low-level wastes, stainless steel, ductile cast iron and concrete containers are typically considered. Such containers have been used to package wastes across Europe, and therefore there is a wealth of existing information that can be shared through cooperation actions.

Clay-based backfills, plugs and seals

The backfill (or buffer) in this context refers to material that is placed immediately around emplaced waste containers in a disposal facility. The material and design can be chosen so that the buffer or backfill provides one or more beneficial functions.

Many studies have been performed to characterise the behaviour of swelling clay, including bentonites. The main requirements are on swelling capacity to fill the technological voids and on low hydraulic conductivity. This implies a good understanding of physical processes that occur throughout the lifecycle of the bentonite component (EBS, sealing or backfill) and a capacity to perform robust predictive simulations. Studies have concerned several types of bentonites in several physical forms, such as compacted blocks or pellet mixtures. Investigations of the behaviour of bentonites under particular conditions associated with their use in an industrial context need to be pursued. Especially, the role of heterogeneities due to installation or to external conditions such as local water inflow or temperatures in excess of 100°C. Such phenomena may lead to changes in the mineralogical composition of the bentonite, particularly in its clay content. These changes may affect the component as a whole (e.g. illitization) or an interface zone with the perturbation source (e.g. alkaline transformation).

For clay-based materials (e.g. bentonite) intended for use as a seal or to backfill galleries in the disposal facility, ongoing needs are also recognised. The main need is to consolidate the long-term performance of the seals at the component scale, taking into account all the (T)HMC perturbations between the different materials (concrete, bentonite, host-rock). For instance, there is still a need to improve our understanding of the consequences of chemical interactions at the interface between clay-based materials and concrete on long-term THM behaviour of the seals.

Cementitious-based backfills, plugs and seals

Cement-based backfills are envisaged for a number of disposal facilities for intermediate level wastes across Europe, and are commonly used as liners in disposal cells or as part of waste containers in many Member States existing facilities for low level waste / near-surface disposal. Further understanding is required to support their use as a backfill material for longer-lived wastes in geological disposal, particularly to understand their contribution to overall system performance during late post-closure timeframes. For cementitious materials, their physical behaviour, especially during the operational phase and post-closure THM-transient periods, is strongly influenced by boundary conditions, controlled by both the disposal system and the host rock (water saturation, temperature, etc.). To assess the evolution of the performance of the cementitious components these studies have to be extended to a longer time-period, considering various operating conditions.

Cementitious materials are also extensively planned to be used as disposal structures (buffer, plugs, waste matrices) which require further understanding of their long-term degradation behaviour, including the impacts of organics. This is especially the case for low pH cements.

Salt backfills

Salt backfill regimes and seals are essential elements of the EBS for a HLW repository in salt.

EBS system understanding

At the disposal-cell scale, once packaged wastes, and backfills and seals are emplaced in the disposal facility, the spectrum of processes and interactions to be considered in the performance assessment is rather broad and covers waste-container, container – backfill/buffers, and waste package-host rock interactions. Regarding data and models to support the long-term safety assessment, feasible and well-instrumented integral experiments and improved models may provide for more realistic understanding of engineered barrier system (or near-field) evolution and related uncertainty treatment.

Across the range of backfill and buffer materials under consideration, there is a need for improved understanding of the coupled mechanical/chemical evolutions at the interfaces with the waste package materials (glass/iron/clay, cement/bentonite, cement/metal, bentonite/metal) and between these materials and the host rock (iron/clay interactions, alkaline perturbation). Of particular interest are unsaturated conditions, where glass is corroded by water vapor. Understanding further relatively ‘short-term’ interactions (e.g. resaturation) versus ‘long-term’ interactions (e.g. development of gas pressure, backfill degradation etc.) occurring at interfaces is considered important. Another perturbation which has to be addressed is the influence of gases and microbes on geochemistry. These studies need to be supported by mock-ups (at different scales) and in-situ experiments to verify that the components will behave as expected and that all the relevant processes have been taken into account, but also to demonstrate the ability to build complex components (buffer, plugs and seals).

Co-disposal of radioactive waste of different classifications or properties may be possible in some geological disposal facilities. Interactions between wastes with different properties may occur, unless only one type of waste is disposed of (e.g. spent fuel, vitrified waste, etc.). Even when disposing of one waste type, such as long-lived alpha containing waste, the diversity of the waste may lead to a situation where dissolution plumes can influence each other. Therefore there is an ongoing interest in optimisation of the disposal of wastes with differing characteristics and properties and

the appropriate selection of engineered barrier materials when co-disposed in a single geological facility.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[4]:

Scientific Theme 3: Engineered barrier system (EBS) properties, function and long-term performance	• **Improved understanding of the interactions occurring at interfaces between different barriers including waste packages in the disposal facility.** - Expected outcomes and impact: Knowledge of the physical and chemical transformations at the interface between waste packages and different barriers and materials and development of pore-scale models describing the impact on radionuclide migration and fluid transport, potential clogging in bentonite/cement or host-clay/cement interfaces, or increase in porosity in other interfaces under real repository conditions (J1.2.1/High). - Cooperation and relevant past projects: ?
	• **Characterised bentonite / clay-based material evolution under specific conditions to provide data on hydro-mechanical, thermal and chemical behaviour.** - Expected outcomes and impact: Enhanced understanding of post-closure safety considerations of bentonite and clay-based materials by extensive characterisation of different phenomena, including variations of properties arising from barrier installation, hydration history, elevated temperatures and chemical influences on long-term evolution behaviour (J1.3.1/High). - Cooperation and relevant past projects: EC BENIPA and BELBaR project
	• **Improved chemical and microbial data to better quantify gas generation and the consequences of microbial processes.** - Expected outcomes and impact: Improved mechanistic understanding, rather than bounding assumptions, to quantify kinetics of microbial catalysis of both gas consumption or gas production reactions, and the competition between them, and improved understanding of the topological description of rock surfaces interacting with gases (J1.3.2/High). - Cooperation and relevant past projects: EC MIND project
	• **Improved quantification and understanding of cement-based material evolution to improve long-term modelling and assessments.** - Expected outcomes and impact: Increased confidence in simulations by reducing uncertainties in input data and understanding of key processes (for both young and aged materials), taking into account specific conditions for waste disposal (temperature, radiation, redox etc.) and considering hydromechanical behaviour (shrinkage and creep), and passive and active corrosion impacts (J1.3.3/High). - Cooperation and relevant past projects: EC CEBAMA project
	• **Improved understanding of the impacts of different metallic and cementitious component phenomena on near-field evolution via improved models.**

[4] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

	- Expected outcomes and impact: Improved geochemical models used in near-field modelling through numerical and experimental characterisation of their evolution and identification of the key THMC evolution processes (including metal corrosion / secondary phase formation, cement alteration and alkaline perturbations on the host rock) (J1.3.5/High). - Cooperation and relevant past projects: EC projects CAST, Carbowaste and THERAMIN
	• **Improved understanding of gas reactivity in the EBS.** - Expected outcomes and impact: Increased understanding of gas reactivity in the EBS and host rocks under representative conditions and its potential impacts on geochemistry, safety-relevant processes and radionuclide migration (J1.4.4/High). - Cooperation and relevant past projects: ?
	• **Improved understanding of the performance of plugs and seals.** - Expected outcomes and impact: To further understand the coupled THMC behaviour of plugs and seals throughout the post-closure phase and to develop improved modelling capability to provide reassurance over the long-term (J2.2.2/High). - Cooperation and relevant past projects: EC projects RESEAL II, DOPAS
	• **Developing alternative HLW and Spent Fuel container material options and improved demonstration of their long-term performance.** - Expected outcomes and impact: Identification of alternative container materials or coatings beyond combined copper/cast iron or carbon steel, suitable for fulfilling container safety functions in current disposal systems and suitable for packaging novel wasteforms (J1.2.3/Medium). - Cooperation and relevant past projects:
	• **Improved understanding of low pH cements.** - Expected outcomes and impact: Increased understanding of low pH cements and their evolution (pH, mineralogy), including their composition, their potential for retarding particular radionuclide migration, determining suitable methodologies for measuring the pH of cements, understanding of the reinforcement corrosion process in low pH concrete if reinforced concrete is used, and their behaviour under high temperatures (up to 90 °C) (J1.3.4/Medium). - Cooperation and relevant past projects: EC CEBAMA project
	• **Improved description of the spatial and temporal evolution of transformations affecting the porous media and degrading materials in the near-field of HLW and ILW disposal systems.** - Expected outcomes and impact: Improved understanding of coupled interactions between reactive transport models, the waste alteration (e.g. corrosion of glass, polymer radiolysis/hydrolysis, etc.) and near-field materials (e.g. steel, concrete, etc.) (J1.3.7/Medium). - Cooperation and relevant past projects: ?
	• **Improved understanding of a salt backfill.** - Expected outcomes and impact: Improved understanding of the long-term behaviour and properties of a salt backfill, including influences of pressure and temperature on behaviour (J1.3.6/Low). - Cooperation and relevant past projects: EC BAMBUS II project, NEA-Salt Club

	• **Identify co-disposal interactions of importance to long-term safety.** - Expected outcomes and impact: Identified waste types and compositions that can generate plumes problematic for the integrity and retention of other wastes in a single facility and assessment of their potential impact on safety to support design optimisation (1.3.8/Low). - Cooperation and relevant past projects: ?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 3: Engineered barrier system (EBS) properties, function and long-term performance

Use of clay-based materials in a geological disposal facility: To understand the properties and performance of different clay-based materials depending on their origin or mineralogy (1.3.1).
Low pH cement understanding: To consolidate existing knowledge on low pH cements, including their composition, impact on radionuclide migration and practical implementation (1.3.4).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 3:

There are several ongoing EC projects that will provide information and knowledge to support understanding of the Engineered Barrier Systems. The Horizon 2020 call supported the EC BEACON project running from 2017-2021 which will develop and test the tools necessary for assessment of the hydro-mechanical evolution of an installed bentonite barrier and its resulting performance in a disposal facility. Now that several European national programs are moving towards licensing, construction and operation of repositories, verification of EBS component behaviour is of high common interest. Therefore within BEACON, cooperation between design and engineering, science and performance assessment experts is planned in order to verify the performance of current designs for buffers, backfills, seals and plugs as part of the EBS.

A project nearing completion with outputs of direct relevance to this Theme includes the EC MIND project. It is a unique multidisciplinary project which brings together a broad range of leading research institutions and stakeholders in the field of radioactive waste disposal. The project aims to reduce uncertainty of safety-relevant microbial processes controlling radionuclide, chemical and gas release from long-lived intermediate level wastes (ILW), high-level waste and spent fuel geological disposal. Outputs will be of direct relevance to several of the JP first phase projects described herein, so supporting ongoing dissemination activities with the knowledge management activities is recognised.

Completing in 2019, the CEBAMA project addresses key issues of relevance for long-term safety and key scientific questions related to the use of cement-based materials in nuclear waste disposal applications. It includes materials used as waste forms, liners and structural components as well as sealing materials in a broad variety of applications. It aims to provide insight on general processes and phenomena and to develop a model for predicting the transport characteristics such as porosity, permeability and diffusion parameters of cement-based materials in contact with the engineered and natural barriers of repositories in crystalline and argillaceous host rocks.

Within EURAD first phase, a work package is included to understand the influence of temperature on clay-based material

behaviour. Both clay host rock and bentonite buffer and their behaviour at high temperature are included (ranging from 100 °C to ~150°C). Mechanical behaviour is the focus area, with an overall objective to evaluate whether an increase of temperature is feasible and safe. The programme of work will aim to provide results that are applicable to a wide range of buffer material and clay host rocks, which can be useful for different national programmes.

Within EURAD a work package is included to support the assessment of the chemical evolution at the disposal cell scale . It considers interactions between disposal system components/materials and thermal, hydraulic and/or chemical gradients of relevance to ILW and HLW disposal concepts. The study of the disposal cell in this work package ranges from microscale processes at interfaces between different materials up to interactions of waste packages with their immediate surrounding near field environment and the host rock. The main objective is to identify, understand and describe the relevant processes driving the chemical evolution within selected generic disposal cell designs by analysing and combining information from available experimental studies and modelling exercises at both the process and system levels.

Also supported within EURAD is a work package dedicated to cement-organics-radionuclide-Interactions (CORI). Organic materials are present in some nuclear wastes and as admixtures in cement-based materials and can potentially influence the performance of a geological disposal system, especially in the context of low and intermediate level waste disposal. Therefore CORI aims to develop improved knowledge on organics degradation, organics-cement-interactions, and radionuclide-organics-cement-Interactions, all within the content of the post-closure radionuclide transport pathway for geological disposal facilities for ILW and LLW/VLLW, including surface/shallow disposal.

Theme 4: Geoscience to understand rock properties, radionuclide transport and long-term geological evolution

Introduction and background:

Long-term stability (uplift, erosion and tectonics)

A site should be geologically stable in order to ensure safety and also be predictable over long timescales to the extent required for assessing safety performance. A stable geological environment is not likely to be subject to sudden or rapid detrimental changes over long timescales because of its resilience with respect to internal and external perturbations. The geosphere contributes to isolation by providing a stable location deep underground that protects the geological disposal facility from any significant perturbations to the natural environment that may occur over the timescales of interest. The geosphere also contributes to containment by delaying the movement of any potential small amounts of long-lived radionuclides that are released from the EBS/near field, enabling their decay before they can pose a hazard to the biosphere.

The natural processes which may impact on the geosphere over the very long timescales associated with geological disposal are tectonics, uplift or subsidence and erosion,

and the impacts of future climate, particularly potential future glaciations and related subglacial erosion and permafrost formation. Processes generally occur more slowly at depth; therefore reasonable predictions of long-term behaviour and evolution can be made.

Perturbations (gas, temperature and chemistry)

The properties of the host rock and geosphere control the slow release and migration of radionuclides in both the gas and aqueous phase once released from the EBS. The key issues to be addressed depend upon the geological environment and the associated disposal concept for the facility.

In a low permeability host rock, such as the Clay stones or evaporites, there is the possibility that gas could be generated at a faster rate than it can be removed without inducing fracturing in the host rock. Thus, depending on the likely rates of bulk gas generation, the potential for significant over-pressurisation may need to be considered for these concepts. For a disposal facility in a fractured higher strength rock it is likely that transport of gas through the host rock would be sufficient to prevent significant over-pressurisation of the EBS. In several disposal concepts, the potential for migration of free gas containing gaseous radionuclides to the biosphere is an important issue.

The EC FORGE (Fate Of Repository Gases) project investigated gas migration issues of relevance to geological disposal performance assessment.

Further needs identified include water (including solutes) and gas transfer during the resaturation phase, and understanding further complexity with respect to the coupling between hydraulic and other processes. The coupling with thermal processes is already implemented in most of the two-phase flow numerical codes and can be used on large scales. Concerning mechanical coupling however, the high complexity of incorporating full coupling, limits for the moment its use to a restricted volume. Having a simplified version of such a coupling, enabling its use in a full scale two-phase flow evaluation, would be highly useful.

Aqueous pathways and radionuclide migration[5]

Regarding the aqueous phase releases, the rate of radionuclide migration depends not only on the distance of the disposal area from the biosphere and the rate of groundwater flow, but radionuclide migration is further retarded by the interaction of dissolved radionuclides with the diverse surfaces of wasteform and container degradation products, backfill materials, minerals and organic matter. Retention on solid surfaces may be reduced by the formation of soluble solution complexes and organic or inorganic colloids. The migration process is different for each type of radionuclide and influenced strongly by the geochemical environment.

There has been research on the various topics of radionuclide migration for more than 30 years, often funded by the European Commission. This has included both detailed mechanistic and applied studies. The present

[5] This includes scope related to radionuclide transport (in the aqueous and gas phase) through the EBS and host rock, in addition to the Geosphere.

programme focuses on remaining uncertainties related to the influence of temperature, organic ligands, microbial perturbations, colloidal interactions and redox conditions on radionuclide behaviour (within the engineered barrier system – in Theme 3) the excavated disturbed zone, host rock and the far field (i.e. the geosphere). Scope continues to include laboratory-scale experiments, modelling and also the upscaling of process understanding through the use of URLs and large-scale mock-ups and/or full scale in situ testing.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[6]:

Scientific Theme 4: Geoscience to understand rock properties, radionuclide transport and long-term geological evolution	• **To increase understanding of gas migration in different host rocks.** - Expected outcomes and impact: Further understanding of gas generation and migration through the EBS and far field, including the fate of reactive gases (including upscaling from laboratory / URL studies) and the mechanical behaviour of host rock. Scope to consider carbon-14 migration, gas flow in EBS materials at elevated temperatures, gas interactions between packages and backfill, the impact of engineering design on gas migration, refined models of gas migration, including the treatment of uncertainty arising from the nature of the geological environment (J1.4.1/High). - Cooperation and relevant past projects: EC CAST and GASNET Project
	• **Improved understanding of gas reactivity in different host rocks.** - Expected outcomes and impact: Increased understanding of gas reactivity in the EBS and host rocks under representative conditions and its potential impacts on geochemistry, safety-relevant processes and radionuclide migration (J1.4.4/High). - Cooperation and relevant past projects: ?
	• **Improved representation of sorption mechanisms and coupled chemistry / transport processes for various media.** - Expected outcomes and impact: To represent heterogeneous media (cement-based materials, clay-rock, crystalline rocks, bentonite, corrosion products…) in speciation, sorption (considering competitive effects) and transport models considering the variability of barrier properties at all scales (J1.5.2/High). - Cooperation and relevant past projects: EC CatClay project
	• **Improved understanding of bounding conditions for the effects of microbial perturbations on radionuclide migration to support performance assessments.** - Expected outcomes and impact: Quantification of microbe populations, energy and carbon source availability, and their impact on radionuclide migration, barrier performance and chemical environmental conditions as a function of time (J1.5.5/High).

[6] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

	- Cooperation and relevant past projects: EC project MIND
	• **Develop and implement two-phase flow numerical codes to increase gas transient representation at the disposal scale.** - Expected outcomes and impact: Increase the degree of representativeness of two-phase flow models which may be used at the disposal scale by increasing the level of coupling with mechanics especially (J1.4.3/Medium). - Cooperation and relevant past projects: ?
	• **Quantification of long-term entrapment of key radionuclides in solid phases to inform reactive transport models.** - Expected outcomes and impact: Experimental thermodynamic and kinetic data and supporting models to quantify mechanisms for irreversible entrapment in solid phases for key radionuclides (e.g. 14C and U as carbonates and 79Se in sulphur-bearing phases) (J1.5.3/Medium). - Cooperation and relevant past projects: Project SKIN (Slow processes in close-to-equilibrium conditions for radionuclides in water/solid systems of relevance to nuclear waste management).
	• **Improved understanding of the transport of strongly sorbing radionuclides.** - Expected outcomes and impact: Improved representation of heterogeneous media, anoxic environmental conditions, and retention of redox sensitive radionuclides or toxic elements in transport models (J1.5.4/Medium). - Cooperation and relevant past projects: EC projects SKIN, CatClay
	• **Improved understanding of the role of organics (either naturally occurring or as introduced in the wastes) and their influence on radionuclide migration.** - Expected outcomes and impact: Improved understanding of the nature of the organic molecules generated by the organic waste or admixture degradation, their stability with time, their effects on radionuclide migration, organic mixtures, the nature and release rate of organic compounds resulting from polymers radiolysis and hydrolysis, and implementation in a reactive transfer model (J1.5.6 & J1.5.10 / Medium). - Cooperation and relevant past projects: ?
	• **Improved understanding of the influence of temperature on radionuclide migration and representation of effects in geochemical models.** - Expected outcomes and impact: Improved understanding of sorption constants for radionuclides (distribution coefficients or surface complexation constants) as a function of temperature, groundwater composition as a function of temperature, and the effect of temperature on potential transformations of solid phases, radionuclide speciation and any associated impact on solubility (J1.5.7/Medium). - Cooperation and relevant past projects: EC projects MIND
	• **Improved understanding of the role of colloids and their influence on radionuclide migration.** - Expected outcomes and impact: Experiment data and model development for colloid generation and transport, including transport parameters for inorganic colloids and radionuclide/organic complexes (J1.5.8/Medium). - Cooperation and relevant past projects: EC project BELBAR
	• **Improved understanding of the influence of redox on radionuclide migration.**

	- Expected outcomes and impact: Improved understanding of the temporal and spatial evolution of redox conditions in engineered barrier systems, the effect of redox perturbations able to modify the expected oxidation states (and mobility) of radionuclides, and the role of kinetics of radionuclide reduction/oxidation (J1.5.9/Medium). - Cooperation and relevant past projects: EC project ReCosy
	• **Developing a geochemical model for volatile radionuclides.** - Expected outcomes and impact: To develop a geochemical model for a non-saturated system describing the distribution of volatile radionuclides between surface films of water, the aqueous phase and the gas phase, and to develop understanding of the capacity of host rocks and cement-based materials to interact with mainly 3H and 14C (J1.5.11/Medium). - Cooperation and relevant past projects: EC project Carbowaste, CAST
	• **Enhanced treatment of climate change, non-human biota, land-use and parameter derivation in biosphere models** - Expected outcomes and impact: To enhance understanding of biosphere processes so as to improve safety case confidence (J2.2.6/Medium). Cooperation and relevant past projects: EC projects BIOCLIM, BIOMOSA
	• **Developing models of groundwater evolution.** - Expected outcomes and impact: To increase understanding of groundwater evolution, including composition and flow, relating to past and future events, such as climate change, glaciation and related subglacial erosion and permafrost formation (J1.6.3/Medium). • Cooperation and relevant past projects: ?
	• **Improved understanding of the processes of fracture filling.** - Expected outcomes and impact: Further understanding of fracture filling, including modelling of the composition of fracture filling minerals and the associated mechanical strength of the fillers as a function of temperature and time (J1.6.1/Low). - Cooperation and relevant past projects: EC CROCK project
	• **Improved understanding of the impact of rock-matrix diffusion on radionuclide travel time through the geosphere.** - Expected outcomes and impact: Improved understanding of the impact of rock-matrix diffusion on radionuclide travel time through the geosphere (J1.6.4/Low). • Cooperation and relevant past projects: ?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 4: Geoscience to understand rock properties, radionuclide transport and long-term geological evolution

Impact of rock matrix diffusion on travel time through the geosphere: To ensure that learning from site characterisation activities in advanced programmes is disseminated to less-advanced programmes (J1.6.4).

Development of site evolution models, and how to manage data as it is obtained during the site characterisation phase: To further knowledge on site evolution models, and how the physical,

geochemical, geotechnical and hydrogeological properties of the host rock and disposal facility change over time (J3.2).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 4:

Within EURAD a work package on mechanistic understanding of gas transport in clay materials is included. It aims to determine the range of conditions under which each identified gas transport regime is possible, in clay materials representative of the potential host rocks (and EBS components – relevant for Theme 3) considered in Europe. In this way, data will be obtained in conditions spanning low (diffusion) to high (advection) gas generation rates. For each of these gas transport regimes, the effects on performance related properties of the materials being tested will be investigated. The experimental effort will be complemented by the development and evaluation of modelling tools for simulating gas transport in clay-rich media for a wide range of gas transport regimes.

Also supported by EURAD is a work package which is focussed on fundamental understanding of radionuclide retention. Scope covers radionuclide and chemical species migration focussed on sorption processes, heterogeneous redox processes and in particular overall radionuclide mobility in "real" systems. Regarding sorption, the work package will address open issues on sorption reversibility, uptake mechanisms (adsorption vs. incorporation), molecular structure of surface complexes, effect of temperature as well as the thermodynamics of porewater-surface interfaces (acid/base surface properties, Kw), sorption site density (e.g. accessibility), sorption competition and surface diffusion. Investigations on surface induced (heterogeneous) redox processes will provide a better understanding of the coupled sorption and electron transfer interface reactions governing the retention of redox-sensitive radionuclides at Fe(II)/Fe(III) bearing minerals surfaces so as to improve our capacity to model, and thus predict, the fate of these elements in the context of radioactive waste storage. Studies on the mobility of radionuclides in "real" clay rocks as well as crystalline rocks will provide insight into the role of microstructures and the impact of chemical boundary conditions on radionuclide migration.

Theme 5: Geological disposal facility design and the practicalities of implementation

Introduction and background:

Facility and disposal system design

The feasibility and suitability of a selected or preferred disposal concept(s) is an ongoing activity to review design and layout of the disposal system, together with the associated evaluation of operational and long-term safety and an assessment of socio-economic aspects. With respect to overall concept feasibility assessment, a common view on areas of significant safety impact could be identified and proposal formulated for appropriate degree of regulatory control. As disposal programmes progress through successive stages of development, the process for concept adaptation and optimisation requires careful consideration.

An important part of the facility design is asset management, which refers to the strategic plan, processes and actions that are needed to upkeep the disposal facility production system in an efficient and effective manner over the

whole life cycle of the system. Engineering asset management offers a set of processes, methods and tools for system reliability evaluation, life cycle cost assessment, maintenance development and setting Key Performance Indicators for asset management operations.

Constructability, demonstration and verification testing

There is a need to demonstrate that the concepts for disposal are practical in terms of their actual implementation in a host rock. There are many aspects to this, from large-scale testing of systems and equipment, to iterating the final design of the facility to allow for adaptations to actual site conditions. This is often referred to as the industrialisation phase of a disposal programme which, together with optimisation activities (including optimisation of radiation protection), remains a key part of advanced programmes currently moving towards construction and operations.

Once facilities become operational, there will be an ongoing need to evaluate the behaviour of key components of the disposal system, or the impacts of the disposal system and its operation on the environment – and thus to support decision making during the disposal process and to enhance confidence in the disposal process. Observations may be continuous or periodic in nature, and may include measurements of engineering, environmental, radiological or other parameters and indicators / characteristics.

Health and safety during transport, construction, operations and closure

During facility operations, all activities performed shall respect the requirements of long term safety. Nevertheless, some technologies and practices, if improperly implemented, may result in harm to workers and negative impacts on the long-term performance of the disposal system. It would therefore be beneficial to share lessons learned from other operational experience, incidents and health and safety -related accidents internationally.

Monitoring and retrievability

During the operational phase of a geological disposal facility it is likely that appropriately selected parameters will be monitored in order to provide reassurance of the as-built integrity of the disposal facility. In practice, the selection of monitoring technologies is based on the safety case, concept and requirement for each parameter (measuring period, frequency). Although considerable effort has been invested, further development utilising evolving technologies would be beneficial. The combination of non-invasive techniques is considered an essential aspect of monitoring due to their advantages over common intrusive methods. The ambition includes an increase in the range of physical and chemical properties that are monitored to allow the means for cross-correlating monitoring results.

Monitoring technology selection is also based on the need to provide minimal disturbance to the engineered barriers. R&D is necessary in order to develop and characterise improved monitoring technologies that will not disturb the disposal cell, seal and plug, and that may be functional for long periods of time (for example, in excess of one hundred years).

Retrievability of wastes and reversibility of waste emplacement and decision making during implementation are treated at the national level, as they are pursuant to local and national requirements and legislation. How such requirements impact on design criteria has been an area of ongoing work within EC projects and NEA initiatives. Some technologies for retrievability of wastes packages were developed and tested within the EC ESDRED project, however further work is identified to continue development of technologies to retrieve waste packages (e.g. development of robots and sensors). Likewise, many challenges remain with respect to

reversibility of decisions, including those related to safety and the economy.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[7]:

Scientific Theme 5: Geological disposal facility design and the practicalities of construction, operations and closure	• **Developing monitoring strategies appropriate to the operational phase (including facility construction and work acceptance) of geological disposal facilities that will not adversely affect the performance of the disposal system** - Expected outcomes and impact: To capitalise on recent advances in monitoring technologies by developing, trialling and assessing a range of monitoring strategies utilising state-of-the-art cost-efficient monitoring technologies. To investigate the impact of monitoring technology on the performance of a range of disposal systems (J2.5.1/High). - Cooperation and relevant past projects: EC Projects SOMOS, MoDeRn, MoDeRn 2020.
	• **Developing innovative monitoring technologies.** - Expected outcomes and impact: To develop innovative technical solutions and improvement of existing technologies to facilitate the integration of monitoring technologies into the final repository design and to maintain the reliability of the monitoring systems (J2.5.3/High). - Cooperation and relevant past projects: EC Project MoDeRn 2020.
	• **Developing appropriate monitoring technologies for closure and a period of post-closure institutional control in links with relevant parameters for safety.** - Expected outcomes and impact: To provide reassurance of conditions following closure by identifying possible parameters for monitoring during the post-closure stage up to the end of institutional control including the development of appropriate monitoring techniques (e.g. wireless transmission, large energy autonomy technologies) (J2.5.2/Medium). - Cooperation and relevant past projects: ?
	• **Optimisation of backfilling and other major implementation processes, including waste emplacement, retrieval and sealing technologies.** - Expected outcomes and impact: To characterize at various scales (from laboratory scale to demonstration at full scale) the capability of the backfill material to meet the main requirements. This would require the study of mixtures between excavated rock with some additives such as cement to improve mechanical properties or bentonite to increase swelling capacity. Effects of long term storage should also be studied as it could lead to storage recommendations (J2.5.7/Medium). - Cooperation and relevant past projects: ?
	• **Developing cost-effective asset management strategies for use in the design.** - Expected outcomes and impact: To enable definition of the requirements arising from the upkeep and improvement of assets in the facility design, including a preliminary asset management strategy (J2.5.8/Medium)

[7] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

	- Cooperation and relevant past projects: ?
	• **Developing operational hazard assessment methodologies (inc. flooding risk)** - Expected outcomes and impact: To identify potential pathways for water ingress from representative geological disposal facility designs. To assess impacts of flooding on operational safety and long-term safety and performance (J2.4.2/Low). - Cooperation and relevant past projects: ?.
	• **Improved understanding of waste package durability and disposal facility infrastructure with respect to retrievability.** - Expected outcomes and impact: To improve understanding of the durability of waste packages ensuring their ability to be handled, durability of structures ensuring the maintenance of functional free play, removal operations performed without jeopardising safety, and the aptitude for dismantling of partial closure components (for cells and drifts) and for re-equipping the facility (J2.5.4/Low). - Cooperation and relevant past projects: EC ESDRED project
	• **Assessment of the technical feasibility and lifecycle adaptation of a geological disposal concept for a specific site and specific nuclear waste type.** - Expected outcomes and impact: Development of a common view on areas of significant safety impact with respect to technical feasibility of a geological disposal concept. Development of change control approaches to appropriately capture design adaptation and feedback into safety assessment (J2.5.5& 3.8/Low). - Cooperation and relevant past projects:?
	• **Verify robustness of disposal system designs using large scale mock ups.** - Expected outcomes and impact: To verify the robustness, and demonstrate feasibility and performance of disposal facility designs and to demonstrate the capacity to build some complex components such as seals or the engineered barriers (J2.5.6/Low). - Cooperation and relevant past projects:?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 5: Geological disposal facility design and the practicalities of construction, operations and closure

Accident management and emergency preparedness: To improve the understanding of potential safety issues with regards to RWM, including disposal (J2.4.4).
Asset management: To develop criteria for managing assets that balances risk, cost and benefit of the assets over their life cycles and evaluate alternative scenarios for asset management approaches (J2.5.8).
Managing co-disposal: To optimize the use of geological facilities by enabling disposal of wastes with a variety of compositions and properties (J3.12).
Radiation protection optimisation principle: Improved methodologies for applying the principles of 'Best Available Technology' (BAT), 'As Low As Reasonably Practicable' (ALARP) and 'As Low As Reasonably Achievable' (ALARA) to disposal system development to ensure the safety and radiological risks resulting from the disposal system throughout its lifecycle are reduced so far as

reasonably practicable and immediate (operational) risks are balanced against the post-closure risk (J3.13).
Reversibility: To develop a common position across Europe, and to exchange good practices (J3.17).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 5:

Based on the outcomes of the EC MODERN project, collaborative efforts continue through MODERN2020 on monitoring technologies and strategies for use in a geological disposal. It aims to provide the means for developing and implementing an effective and efficient repository operational monitoring programme, that will be driven by safety case needs, and that will take into account the requirements of specific national contexts (including inventory, host rocks, repository concepts and regulations, all of which differ between Member States) and public stakeholder expectations (particularly those of local public stakeholders at (potential) disposal sites). The work in the Modern2020 Project will address: i) Strategy: development of detailed methodologies for screening safety cases to identify needs-driven repository monitoring strategies and to develop operational approaches for responding to monitoring information; ii) Technology: carry out research and development (R&D) to solve outstanding technical issues in repository monitoring, which are related with wireless data transmission technologies, alternative long term power supplies, new sensors, geophysics, reliability and qualification of components.; iii) Demonstration and Practical Implementation: enhance the knowledge on the operational implementation and demonstrate the performance of state-of-the-art and innovative techniques by running full-scale and in-situ experiments; and iv) Societal concerns and Stakeholder Involvement: Develop and evaluate ways for integrating public stakeholders concerns and societal expectations into repository monitoring programmes.

Theme 6: Siting and licensing

Introduction and background:

The selection of a site (or sites) for a geological disposal facility is clearly the most important challenge to the successful implementation of long-term management of radioactive wastes. Therefore this topic is of great interest to early-stage programmes that have yet to identify a preferred site for a geological disposal facility, including in this case those programmes that have experienced reversals in past site selection projects. This theme represents the clearest example of the importance of societal engagement in decision-making, including the necessity to engage at national, regional and local community levels. This engagement has to take full account of the relevant formal policies, legislation and regulations laid down by society. An implementing organisation must earn “a licence” to proceed at all stages of its programme and this typically translates into a formal regulatory requirement for licensing at key stages. Site selection policies and procedures, regulatory arrangements and licensing requirements vary between member states, reflecting inter alia the socio-political context, geological factors, and the waste inventory. Therefore there is no single best practice in meeting this key challenge, but there are common components that can contribute to a successful outcome. These form the basis for JP activities on this theme.

Site selection process

The process to be followed in selecting a site for a GDF is typically determined at national government level but, in establishing the relevant policy, the implementing organisation, regulators and civil society are likely to be required to play a part. Increasingly emphasis is placed upon the involvement and support of potential, “host” communities that would be most affected by

eventual development of a GDF. The process is likely to involve the initial evaluation of a number of potential sites with a progressive narrowing down, eventually to identify a single preferred site. In order to maximise the prospect of a successful outcome, the stakeholders and in particular potential host communities must be provided with the information that they require to make informed decisions and be confident that the process is open, transparent and legitimate. A wide range of criteria are involved in selecting a preferred site, including impacts of development and operation on the natural environment and landscape, impacts on any specially designated natural or archaeological features, impacts on the human environment especially the transport infrastructure, impacts on socio-economic conditions, and costs. Whereas these might be required to be evaluated to an unusually high standard in the case of a GDF, these criteria and their evaluation are familiar in many major civil engineering projects. There is scope in investigating the best means of making the relevant information accessible to stakeholders, for example by means of on-line geographical information systems.

Although by no means the only selection criterion, the main focus of the JP in this area concerns the geological conditions at potential sites. At the initial stages of a site selection process it is unlikely that detailed information will be available on the geology at GDF depth such that the process has to progress with a recognised level of uncertainty. At these early stages it is valuable to identify the relevant national geoscience database, giving the already-known characteristics of the geology at depth, and to develop methods to make this information accessible to stakeholders. At the outset of evaluating geology, it is usually necessary to identify exclusion criteria in an open and transparent manner. Exclusion criteria are likely to include the presence of exploitable mineral or hydrocarbon resources, the existence of significant geological instability such as seismically active zones or volcanism, the existence of unfavourable hydrogeological activity such as thermal springs or karstification (dissolving of minerals such as limestone),or the existence of large-scale hydraulic features such as large fracture zones. Particularly for this last criterion the implementing organisation needs to use survey methods such as aeromagnetic surveying and classical surveys of rock outcrops and to build confidence that the relevant features can be detected and a potential siting area eliminated if necessary. Generally there is much good practice that can be shared.

Detailed site investigation

At some point in the site selection process when the number of potential sites has been narrowed down sufficiently, it becomes necessary to conduct more detailed geological investigations with the aim of establishing whether a GDF can be developed, meeting the required levels of safety and security, at one or more of the remaining sites and possibly to support the identification of a preferred site. There is considerable overlap with Theme 4 (Site characterisation) at this stage but in this Theme 6 the focus is on developing and improving methods that support the decision-making process. Good practice in advanced programmes has shown the benefit of developing what is termed a site-descriptive model (SDM) at the same level of detail for each of the sites undergoing detailed geological investigation. The SDM captures the key results and conclusions of the investigations in a relatively short report that makes the relevant information accessible to stakeholders and provides a traceable audit trail to the relevant underlying technical reports. There is scope for investigating how best to develop and present the SDM. A further valuable development is to present a

"confidence assessment" recognising that there remain residual uncertainties and discussing whether these uncertainties should prevent progressing to the next stage, i.e. further investigations from the surface, going underground to obtain more detailed information that is inaccessible from the surface, or if appropriate moving directly to develop the GDF. In the case of going underground to undertake more detailed investigations, there is useful guidance available on this step (See, NEA – Underground Testing, and Underground Research Facilities).

As site investigations proceed there is a need to develop and refine the layout and design of the prospective GDF to take account of the developing knowledge of the geology at depth. There is considerable overlap with Theme 5 (GDF design) but in this Theme 6 the focus is on developing approaches to demonstrating optimisation in the prospective exploitation of the site. Important aspects are likely to include selection of the optimal depth for the disposal tunnels/ rooms, determination of spacings of disposal tunnels/ rooms and spacings between waste packages, development of exclusion criteria to apply at specific disposal locations, and the relationship of the underground excavations to the surface waste receipt facilities and the means of access to the underground, classically whether by inclined drift tunnel or vertical shafts – or a combination.

Licensing

It has to be recognised that the formalities of licensing and the number of licensing steps will vary considerably between member states. In some countries a single regulator is largely responsible for the various stages of GDF implementation whereas in other countries a large number of regulators can be involved over the different stages, including those responsible for land-use planning, mining, radiological protection (of both public and workers), transport, long-term safety, security and safeguards. Licence applications will have to be tailored to match these arrangements and there will be no single best practice in this regard. However there is scope for developing and improving the information and argumentation in support of licence applications, particularly in respect of long-term, post-closure safety. There has been a significant reduction in the reliance once placed on numerical modelling results and a corresponding increase in the use of more qualitative arguments alongside evidence of the level of understanding of physical processes. More specifically regulators and stakeholders need to have confidence that, at a given stage of implementation, the residual uncertainties have been identified and that sufficient evidence has been presented to justify progressing to the next stage of implementation. There is scope for developing and improving approaches to this aspect.

Although a distant prospect for even the most advanced member state programmes, it is envisaged that an application will eventually be made for the withdrawal of regulatory control of the operator of a GDF site and pass the responsibility of institutional control to the state once all the relevant wastes have been emplaced. Whereas it would not represent a good use of resources at present to study such an application in detail, it would be valuable at this stage to understand any technical aspects that may be required to be in place from the early stages of implementation to support such an application in the future.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[8]:

Scientific Theme 6: Siting and licensing	• **Maintaining and developing understanding of tools and techniques for developing site descriptive models.** - Expected outcomes and impact: To ensure that state-of-the-art techniques needed to interpret and model site characterisation information are available or can be made available in a timely manner to support site investigation activities (J1.6.5/High). - Cooperation and relevant past projects: ?
	• **Developing state-of-the-art on the methods of uncertainty management associated with site characteristics.** - Expected outcomes and impact: Identification, characterisation and management of uncertainties related to site characteristics, including possible geodynamics and tectonic perturbations of the site in the long-term (J1.6.2/Medium). - Cooperation and relevant past projects: ?

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 6: Siting and licensing

Methodologies for site uncertainty treatment: To develop and document best practice guidance to support site selection processes, recognising the uncertainty inevitable present due to a lack of detailed site characterisation data (J3.1).
Site selection process: To develop a process reflecting best practice when deciding upon siting for geological disposal (J3.3).
Technical and socio-political siting criteria: To examine the technical and socio-political criteria on which a partial or full closure of the disposal facility could be decided. To identify the conditions required to implement the decision-making process based on criteria, in terms of technical means (surveillance strategy and methods), pluralist expertise and governance scheme involving the various stakeholders (J3.4).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 6:

Siting and licensing of facilities are typically very specific to national and political considerations, often involving local communities and technical work in support of addressing needs that are site-specific. Thus at present there are no dedicated 'technical' or 'scientific' work packages envisaged that related to this Theme in the first phase of EURAD. Within EURAD Work Package on Uncertainty Treatment (further described in Theme 7), methodologies for site uncertainty treatment will be explored.

Theme 7: Performance assessment, safety case development and safety analyses

Introduction and background:

Integration of safety-related information

[8] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

Prior to construction, and throughout successive phases, most disposal programmes are centred around key milestones and regulatory licencing to demonstrate safety. This includes transport, construction, operational and post-closure safety for the very long-term of the disposal facility. There are well-established existing international networks, NEA/OECD and IAEA guidance to support programmes in their preparation of safety cases and supporting analyses, in addition to state-of-the-art examples from advanced disposal programmes (See, IAEA Safety Standards Series SSG-23). A safety case is a set of statements concerning the safety of the disposal, substantiated by a structured collection of both quantitative and qualitative arguments and evidence. The development of the safety case and the task of integrating of all the necessary information will always be specific to the system evaluated and thus, in this area, each country has to develop its own capabilities in interaction with its local stakeholders, however, there is added value with seeking the help of experienced experts from elsewhere and adopting international good practice with respect to safety case methodologies. The safety case needs to be updated regularly by improved treatment of process understanding and refinement of modelling capabilities, particularly with respect to upscaling and coupling of processes during the post-closure phase but as well for safety during the operational phase.

Performance assessment and system models

To evaluate the long-term evolution of all disposal facility components, a sufficient understanding of coupled thermal-hydro-mechanical and chemical (THMC) processes is needed. Further improvements identified include: Component material descriptions and their degradation during storage periods, together with understanding of post-closure evolution descriptions, particularly the transition from the non-saturated system to fully saturated one; The potential development of microorganisms which can catalyse certain chemical reactions; The variation of redox conditions, including the impact of substances released from waste packages ; The thermo-hydro-mechanical behaviour of the rock and, in particular, the evolution of the damaged zone is of interest; Gas generation and identification of transfer pathways; Water saturation and swelling of bentonite used for backfill, plugs and seals; and Thermal evolution of the host rock and engineered barriers.

One of the challenges is to describe all of the couplings between those processes and to identify those most relevant both for performance and safety assessment. Modelling long-term THMC performance of the host rock, Excavated Disturbed Zone, bentonites, or disposal system components is usually done by means of a spatial and temporal finite element analysis. Upscaling of THMC models in time and space and the study of its validity and representativeness at all scales, constitutes a large field of research. This will combine both numerical developments and experimental work to confirm the choices in terms of representative volumes. This includes the representation of THMC parameters which could exhibit, in some cases, a significant natural variability.

Understanding of physio-chemical processes affecting the evolution of disposal components and geological systems, and their consequences on radionuclide transfer, is based on both an experimental approach and the use of predictive modelling at different temporal and spatial scales. Relevance of modelling and numerical simulation is strongly linked to the development of tools able to represent complex systems in terms of processes and geometry over large time and space scales. Thus, the complexity of some

mechanisms, strong multiple couplings, multi-scale approaches, complexity of objects and heterogeneities to be simulated, management of uncertainties to identify key parameters, and integrated systems are all potential areas for RD&D in order to improve the understanding of disposal systems, and increase robustness in performance and safety assessment applications. In this field, some particular topics that would benefit from further development include multi-scale approaches from the atomic scale (< nm) to the scale of the geological formation (> 100 m) in order to validate relevant phenomena and input data utilizing homogenization and up-scaling techniques.

Management of heterogeneity at all scales, such as natural variability of properties, anisotropy, singularities (fractures, fissures network), non-porous materials and voids, and numerical techniques which allow such heterogeneities to be taken into account are of continued interest. Development of multiple-process modelling, including development of algorithms and numerical methods for strong couplings at the large scale continues. Capability gaps exist in two-phase flow, reactive transport modelling and THMC couplings. Development / improvement (performance, accuracy, robustness) of tools in the area of high performance computing, as applied to system modelling, with numerical resolution methods allowing representation of complex integrated and heterogeneous systems is also of interest.

Treatment of uncertainties

Management and treatment of uncertainties (epistemic, aleatoric) in process understanding, in complex models as well as in its safety implications both for the long term and the operational phase is a continuous activity, in order to identify the key input data of the integrated system, to identify priorities or research and as well to gain confidence in a repository project among stakeholders.

As advanced programmes move close to implementation, consideration of the safety case and its ongoing management and development during construction and operations has become of interest. Linked closely to the implementers management system, understanding of deviations in planned implementation scenarios and pre-closure disturbances, and their effect on performance assessment outputs, safety implications and design adaptation is of continued interest.

RD&D Priorities and Activities of Common Interest to be addressed by the JP[9]:

Scientific Theme 7: Performance assessment,	• **Improved understanding and models for the impact of THMC on the behaviour of the host rock and the buffer materials.** - Expected outcomes and impact: To further understand the impact of THMC on the behaviour of the host rock and the buffer materials, and to develop appropriate models coupling all the relevant phenomenology impacting the key processes

[9] Numbering scheme is taken over from EC JOPRAD Project, See Annex II. A JP numbering scheme will be implemented in the future

safety case development and safety analyses	during the transition from the non-saturated period to saturation following closure (J2.2.1/High). - Cooperation and relevant past projects: EC project BENCHPAR, HE (Heater Experiment).
	• **Improved understanding of the upscaling of THMC modelling for coupled hydro-mechanical-chemical processes in time and space.** - Expected outcomes and impact: To extend deterministic and/or stochastic approaches to take into account the upscaling aspects regarding THM parameters (J2.2.4/High) - Cooperation and relevant past projects: ?
	• **Improved multi-scale reactive transport models.** - Expected outcomes and impact: To further develop the capability to model the migration of contaminants from the repository to the biosphere (J2.3.4/High). - Cooperation and relevant past projects: ?
	• **Further develop transparent and quality assured thermodynamic databases for use in performance assessments and supporting models.** - Expected outcomes and impact: Improved thermodynamic data for key radionuclides, principal elements of the disposal system, secondary phases and solid solutions, filling gaps for specific environments and using natural analogues to assess slow kinetic constraints (metastability). Thermodynamic data may be required in order to validate predictions at higher temperatures and salinity, and to underpin models considering cement phases, alkaline conditions, redox, etc. Improved treatment of uncertainty in thermodynamic data is also anticipated (J1.5.1/High). - Cooperation and relevant past projects: NEA TDB Project, Thermochimie (WMOs: ANDRA, RWM, Ondraf)
	• **Improved understanding of the influence of pre-closure disturbances on long-term safety.** - Expected outcomes and impact: To develop common approaches (including scenarios) for safety case adaptation and update during facility operations and closure (J2.1.1/Medium). - Cooperation and relevant past projects: ?
	• **Further refinement of methods to make sensitivity and uncertainty analyses.** - Expected outcomes and impact: Develop common approaches to demonstrate operational and post-closure safety and overall facility lifecycle evolution. Improved uncertainty treatment (models and data) using evolution scenarios (i.e. improved system representation during different timescales and for complex scenarios such as those involving multiple strongly coupled processes) (J2.1.3/Medium). - Cooperation and relevant past projects: ?
	• **Improved performance assessment tools.** - Expected outcomes and impact: Improved mathematical methods to analyse the importance of physical properties defined as input of a simulation on the relevant output of the simulation (sensitivity analysis), and to quantify the effect of uncertainties on these outputs (uncertainty analysis) (J2.3.1/Medium). - Cooperation and relevant past projects: ?

	• **Improve geosphere transport models.** - Expected outcomes and impact: Improved representation of the transport of contamination through the geosphere in support of the safety case (J2.3.3/Medium). - Cooperation and relevant past projects: ?
	• **Improved understanding the role of physical/chemical processes at different scales and linking bottom-up and top-down approaches in performance assessments.** - Expected outcomes and impact: To extend up-scaling to the materials involved in radioactive waste disposal, e.g. cementitious-based materials, to develop multi-scale approaches for coupled processes (including chemistry, mechanics, hydraulic, etc.) and to develop multi-scale strategies to represent complex phenomena (redox processes, microbiology, mineral transformation, etc.). (J2.3.5/Medium). - Cooperation and relevant past projects: ?
	• **Improved treatment of heterogeneity.** - Expected outcomes and impact: To provide a modelling capability which can integrate available site data to account for heterogeneities in the near field (J2.3.6/Medium). - Cooperation and relevant past projects: ?
	• **Improved computing.** - Expected outcomes and impact: To enable the use of numerical and highly parallelized code on a heterogeneous grid or cluster, to represent hydraulic and solute transfer in huge integrated systems (disposal and geological media), two-phase flow and transfer at the system level, reactive transport at the scale of many components, and THM couplings at a large scale. (J2.3.7/Medium). - Cooperation and relevant past projects: DECOVALEX
	• **Improved understanding for the impact of deviations in planned implementation scenarios on the performance assessment outputs of the disposal facility.** - Expected outcomes and impact: Understanding how deviation (unplanned events) may impact the handover state of the facility as the starting condition for long-term performance assessments. Develop improved scenario treatment and communication of deviations from normal operating scenarios to understand key controls on the performance assessment (J2.1.5/Low). - Cooperation and relevant past projects: ?
	• **Improved understanding of the spatial extent and evolution with time of oxidative transients, as well as the possible impact on safety functions.** - Expected outcomes and impact: To investigate the oxidative transient in the near field during the construction and operational phases, notably with regard to corrosion of metallic components (J2.2.3/Low). - Cooperation and relevant past projects: EC projects BENIPA, NF-PRO, FEBEX
	• **Open-source performance assessment code** - To develop high performance computing oriented code which can simulate multi-phase flow and transport in unsaturated porous media (J2.3.2/Low)

	- Cooperation and relevant past projects: ?
	• **Improve fire and impact assessment** - To assess the impact of fire or explosions on the underground systems during the operational phase (J2.4.1/Low). - Cooperation and relevant past projects: ?
	• **Improve understanding of the impacts of operational safety** - To minimise the disturbance of operations on long-term safety sharing by lessons learned across operating facilities within the nuclear industry and other mining operations (J2.4.3/Low). - Cooperation and relevant past projects: GEOSAF

Enabling Knowledge Management, Strategic Studies and other Cross-cutting Activities Identified of Common Interest that relate to Theme 7: Performance assessment, safety case development, and safety analyses

Assessment methodologies: To continue to share good practice internationally and continue development of advanced methodologies for construction and facility licensing (J2.1.2).
Dose thresholds: To facilitate exchanges on good practice on the development of safety indicators applied in specific safety cases taking into account realistic facility evolution scenarios and time periods. To undertake epidemiological studies of low-dose radiological impacts (J2.1.4).
Use of natural analogues: To verify and build confidence in long-term, large-scale processes, and upscaling of models to repository scale (J2.2.5).
Safety case guidelines, management and review: To evaluate experience from different countries' arrangements for identification of possible gaps or weaknesses in the expertise function's expectations. To develop a common view on areas of significant safety impact and proposals formulated for an appropriate degree of regulatory control (J3.9).
Improve understanding of the impacts of operational safety: To minimise the disturbance of operations on long-term safety sharing by lessons learned across operating facilities within the nuclear industry and other mining operations (J2.4.3).

Ongoing and active work (inc. Horizon 2020 projects) addressing Theme 7:

The European Commission (EC) PAMINA project – Performance Assessment Methodologies in Application to Guide the Development of the Safety Case – was conducted over the period 2006-2009 and brought together 27 organisations from 10 countries. PAMINA had the aim of improving and developing a common understanding of performance assessment (PA) methodologies for disposal concepts for spent fuel and other long-lived radioactive wastes in a range of geological environments. This was followed by a Nuclear Energy Agency (NEA) sponsored project on Methods for Safety Assessment of Geological Disposal Facilities for Radioactive Waste (MeSA).

EURAD first phase includes a number of networking activities to promote knowledge sharing, including a strategic study on understanding of uncertainty, risk and safety from the perspectives of different participants. The objective is to identify precise areas of focus that could be taken forward in future phases of EURAD. The strategic study will develop a common understanding among the different categories of participants (WMOs, TSOs, REs & Civil Society) on uncertainty management and how it relates to risk and safety. In cases where a common understanding is beyond reach, the

objective is to achieve mutual understanding on why views on uncertainties and their management are different for different actors.

4. EURAD - ROADMAP

A **Roadmap**, with clear objectives, linking EURAD activities (as listed in the SRA) to milestones typical of different phases of a radioactive waste management (RWM) programme has been developed (focussed on those planning for disposal). The Roadmap relates to Joint Programme Founding Documents (and was not addressed by the preparatory work carried out in the EC JOPRAD project). It draws from the IAEA work (see, IAEA Planning and Design Considerations for Geological Repository Programmes of Radioactive Waste). The IAEA definitions of recognised phases of a waste disposal programme (and their associated major objectives) are used to provide the Roadmap framework:

- Phase 0: Policy, framework and programme establishment*;
- Phase 1: Site evaluation and site selection;
- Phase 2: Site characterisation;
- Phase 3: Facility construction;
- Phase 4: Facility operation and closure;
- Phase 5: Post-closure.

**Note that Phase 0 was not covered by IAEA-TECDOC-1755, but added to recognise the needs of Members States who are in the process of establishing a waste management programme.*

For each of the phases above, EURAD Roadmap explains how aspects related to, disposal facility design, and safety case development (and supporting safety analyses) span across all phases, including Phase 0. The Roadmap elaborates further on the how the emphasis of work on each of these differs and changes through successive Phases.

The Roadmap demonstrates the totality of scope of EURAD and its relevance to waste management and disposal programmes at different stages of maturity. The Roadmap effectively provides a framework upon which to organise the scientific priorities of the SRA, enabling users and programmes to 'click-in', and to access existing knowledge and active work or future plans. It also provides a framework for future periodic assessment of EURAD, and to evaluate future priorities and new work packages as new knowledge is acquired or as new needs are identified.

The Roadmap comprises 7 tables:

- A theme-specific table showing how identified scope of the EURAD SRA relate to different Phases of implementation and typical Waste Management Programme objectives for each theme (grey boxes).
- The SRA topics/sub-topics within each Theme are flagged ( ) to illustrate those being addressed in-part or in-full by scope of active EC-funded projects, including those of the EURAD 1. Topics/sub-topics that will be addressed in future work of EURAD are also flagged ( ).
- RD&D, Knowledge Management and Strategic Studies are each coloured differently.

The Roadmap tables will be used throughout EURAD as a tool to support the management of the SRA in reviewing progress, to support prioritisation of new scope suggestions (importance and urgency) and communicating completed, ongoing and future work activities to those interested in our work.

Please note that contrary to the request by the EC for the SRA to be translated into a roadmap, with clear objectives, deliverables and high-level milestones for technical solutions per waste streams and waste types, we have intentionally avoided this. Rather we have utilised a work break down structure using themes and IAEA phases (focussed on geological disposal) that combines topics of RD&D relevant to many waste streams and technical solutions. Technical solutions need to be tailored and developed for the specific needs of a national waste management programme, particularly taking account of the waste characteristics and the options for siting. There is no one size fits all technical solution for each waste stream, choices on this remain the responsibility of the national waste management programme.

The IAEA phases used in the roadmap are of a general nature and are each applicable to several waste streams and waste types and include scope on knowledge management to share experiences. The same is also true of SRA themes with the topics / sub-topics where, however, some of the topics have less relevance for the other disposal routes. Furthermore, it is important to recognise that the disposal routes for the other waste streams (lower activity wastes consisting mainly of shorter-lived isotopes) do often not include geological disposal but surface or near-surface disposal. This technology is well established with a number of variants tailored to the specific needs (volumes and exact types of wastes) and boundary conditions (land use planning, etc.) of the respective countries. Depending upon the needs of the Beneficiaries it is suggested that the topic of developing a Roadmap for these types of waste is managed through the Strategic Study on “waste management routes in Europe from cradle to grave” with the support of experts managed by the Programme Office. This may need some modification of that WP in the course of the first year.

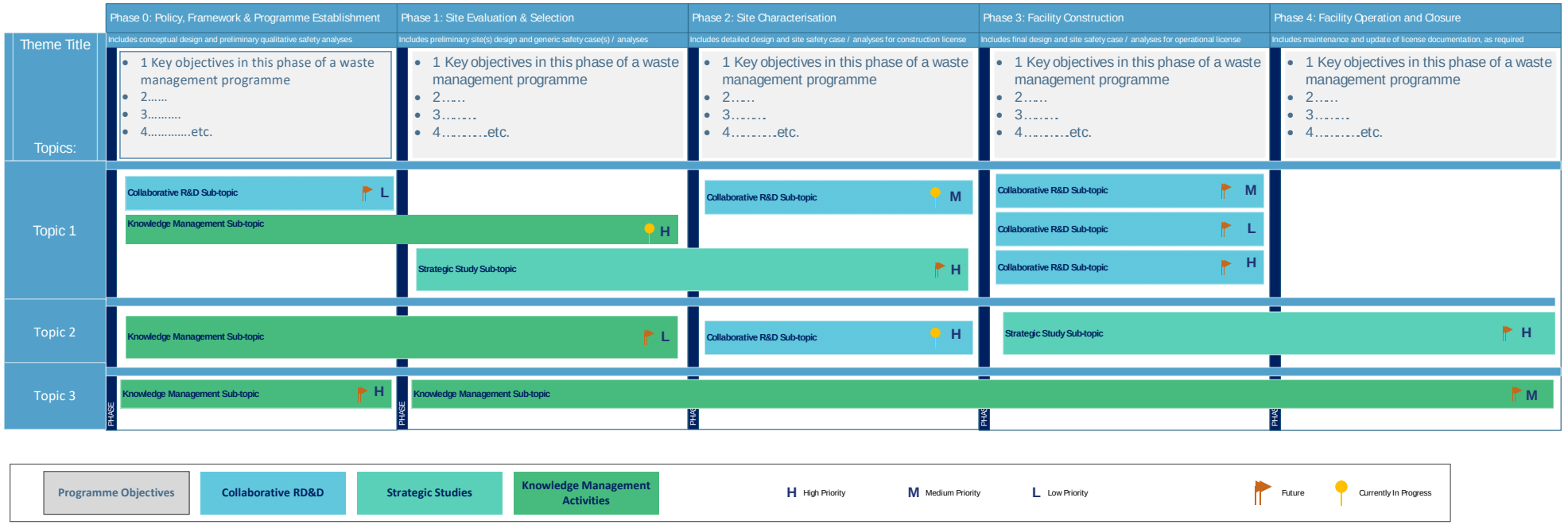
Key to Roadmap Diagrams:

(1) Top Line - Typical Phases of a Waste Management Programme (Phase 0 to Phase 4);

(2) Second Line – Design and Safety Case Focus in each Phase (Conceptual to Site-specific);

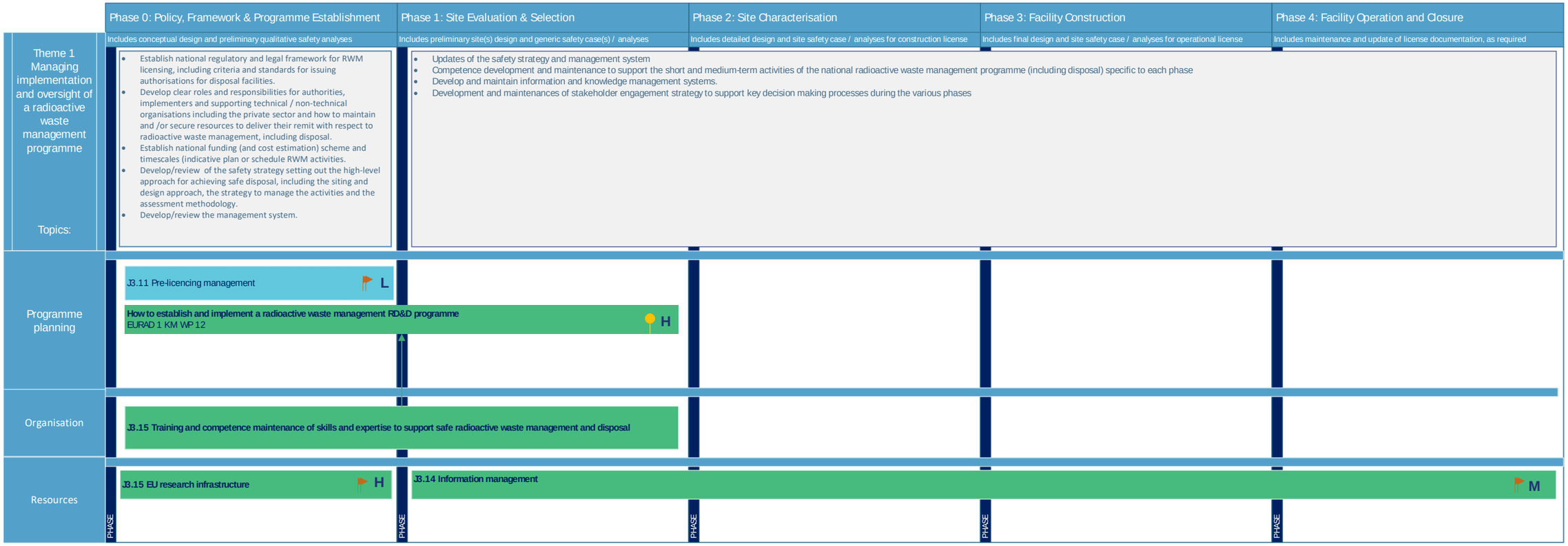
(3) Third Line (light grey boxes) – Typical Programme Objectives (How focus evolves from early stage to advanced-stage focus);

(4) Fourth Line onwards (lines with multi-coloured boxes) - Map of EURAD SRA Topics and Sub-Topics (colour coded according to RD&D, Strategic Studies or Knowledge Management Tasks)



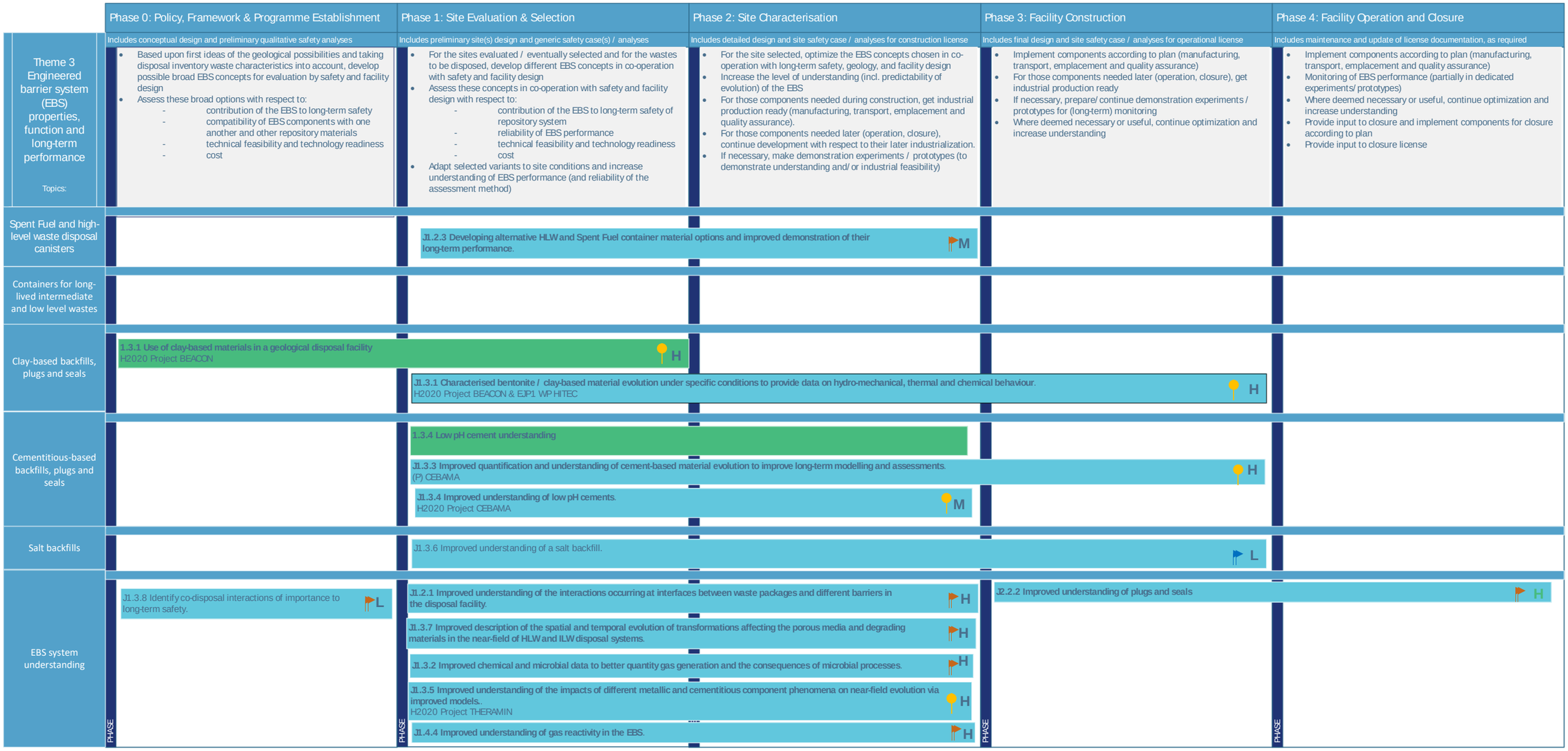
There are a total of 7 roadmap diagrams (as illustrated above), one for each Theme of the EURAD SRA.

Roadmap Theme 1: JP Priorities and Activities of Common Interest that relate to Managing implementation and oversight of a radioactive waste management programme

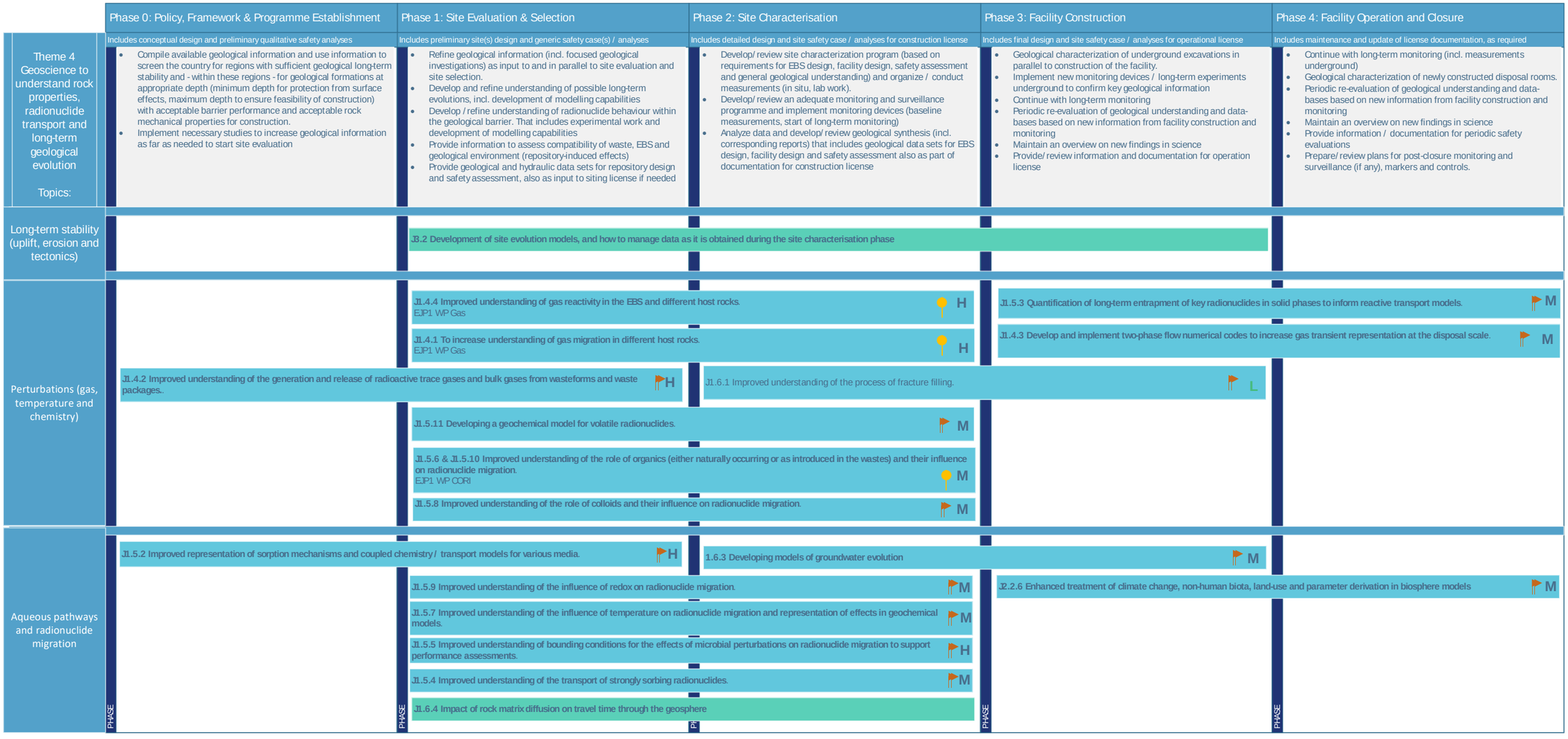


Roadmap Theme 2: JP Priorities and Activities of Common Interest that relate to Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal

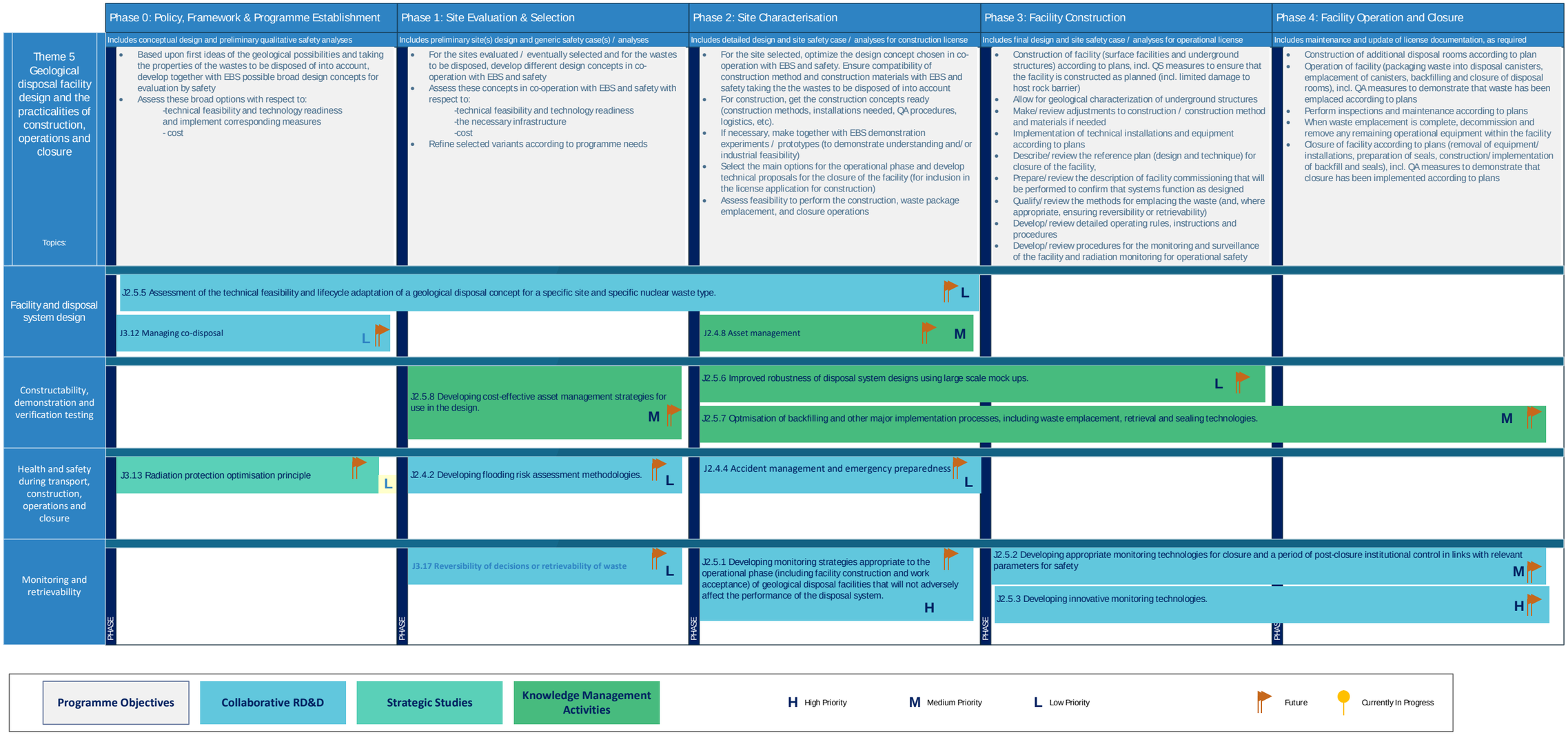
Roadmap Theme 3: JP Priorities and Activities of Common Interest that relate to Engineered barrier system (EBS) properties, function and long-term performance



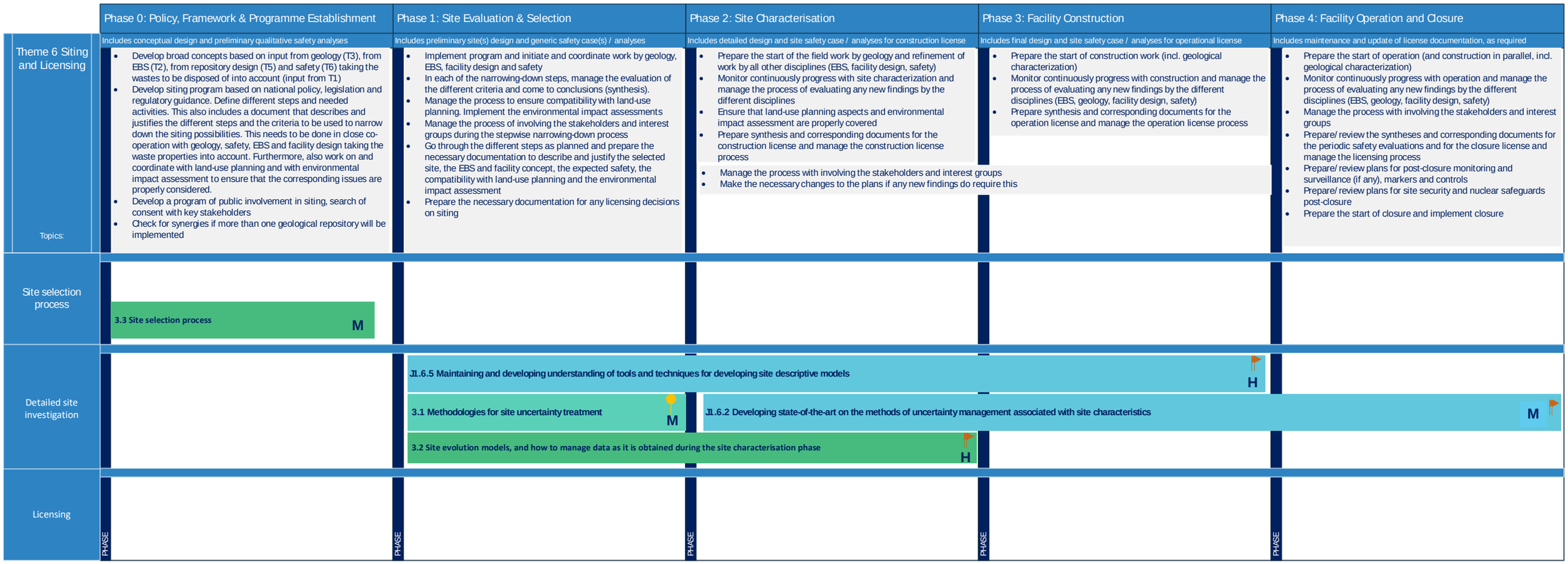
Roadmap Theme 4: JP Priorities and Activities of Common Interest that relate to Geoscience to understand rock properties, radionuclide transport and long-term geological evolution



Roadmap Theme 5: JP Priorities and Activities of Common Interest that relate to Geological disposal facility design and the practicalities of implementation



Roadmap Theme 6: JP Priorities and Activities of Common Interest that relate to Siting and Licensing



Roadmap Theme 7: JP Priorities and Activities of Common Interest that relate to Performance assessment, safety case development and safety analyses

5. EURAD – DEPLOYMENT PLAN 2019-2024 (EURAD 1)

Building on the initial preparatory work of the EC JOPRAD project to identify activities of common interest between EURAD contributors and participants, an initial five year deployment plan has been established at inception. The plan adopts a series of Work Packages to organise the activities in a formal work breakdown structure, with scope and participation co-developed throughout 2017/18 in consultation with each of the main JP contributors – the WMOs, the TSOs and the REs (See, Annex 3 - Development of the JP Deployment Plan 2019-2024).

5.1. Framework for the initial Deployment Plan 2019-2024

5.1.1. EURATOM WP2018 Call

Published on October 27th, 2017, the EURATOM WP2018 includes a topic (NFRP-6) to call for the official establishment of EURAD on RWM and its initial implementation phase for 5 years (EURAD 1) (available EC contribution: max 32,5M€). Submission deadline is 27 September 2018. If accepted, EURAD 1 shall be launched mid-2019 for 5 years (2019-2024), after the signature of the Grant Agreement with EC.

The call clearly states that the first implementation phase of EURAD shall be funded by EC through the H2020 *EJP Cofund* instrument. This instrument implies specific provisions for participation rules, as described in the next section.

5.1.2. H2020 European Joint Programme Cofund - Participation rules

In the early phase of JOPRAD and given that the RWM community has already been sufficiently integrated for several years, the option for an internal implementation of activities has been retained, meaning here that the EURAD Beneficiaries are expected to be directly the RD&D actors, and not funding agencies as it is the case in other European Joint Programmes.

Therefore, the participation as **Beneficiary** is limited to organisations having received a mandate by their national programme owner(s) (usually Ministry/regional authority) to participate in the JP implementation phase and that are willing to share the JP Vision/SRA/Roadmap. The mandate shall confirm that organisations are responsible for managing/implementing a RWM programme and/or managing/implementing a RD&D programme needed for implementation as:

- **Waste Management Organisations** (WMOs) whose mission covers the management and disposal of radioactive waste;
- **Technical Support Organisations** (TSOs) carrying out activities aimed at providing the technical and scientific basis for notably supporting the decisions made by a national regulatory body; and
- **Nationally funded Research Entities** (REs) working to different degrees on the challenges of RWM (and sometimes in direct support to implementers) under the responsibility of the Member States.

Beneficiaries can call for **Linked Third Parties** (LTP) to carry out part of the work plan in the Work Packages. A Linked Third Party is an organisation to which a Beneficiary has a pre-existing legal relationship (options are: Memorandum of Understanding, agreement, contract, affiliation, joint research unit…) which is not based on a contract for the purchase of goods works or services.

Other legal entities (such as association) may participate if justified by the nature of the action, in particular entities created to coordinate or integrate transnational research efforts.

Reference documents are the H2020 Participation rules, and the EJP Co-fund Annotated Grant Agreement Model.

5.1.3. H2020 European Joint Programme Cofund rate and form of grant

With a European Joint Programme Cofund, the EURATOM contribution takes the form of a **grant** consisting of reimbursement of total eligible costs related to the implementation of the actions (Work Packages). In EURATOM WP2018, the cofunding rate for the JP on RWM has been set at 55% of total eligible costs. There will be **no cash collection** from the Programme Owners to be put in a "common pot". Therefore, participants (Beneficiaries and Linked Third Parties) shall be able to bear the costs that are not funded by EC, or to find other co-funding sources.

5.1.4. Eligible costs under H2020 European Joint Programme Cofund

Eligible costs are the costs that are necessary to implement the WPs (See Article 6 of the Grant Agreement Model for full details) and that fall under the following categories:

- Direct Personnel costs (unit or actual costs)
- Other Direct costs:
  - Travel
  - Equipment
  - Costs of large research infrastructure
  - Other goods and services
- Indirect costs (flat rate: 25% of direct costs)
- Costs for subcontracting

5.2. Deployment mechanisms

The EURAD Vision, SRA and Roadmap will be delivered through 5-year implementation phases according to the EJP Co-fund Instrument. The Work Plan of an implementation phase is broken down into a set of Work Packages, Tasks and Sub-Tasks. To deliver against EURAD objectives, four different types of Work Package (WP) have been adopted, as well as specific cross-cutting tasks - interactions with Civil Society and providing access to knowledge/results – that will be directly embedded in specific WPs. These are each described below.

5.2.1. RD&D Work Packages

RD&D WPs focus on science, engineering and technology advances that support the generation of new knowledge to progress RWM, including disposal, across Europe. The activities to be carried out are a balance between those with a direct link to operational RD&D (direct links with implementation of deep geological disposal or other waste management route) and prospective RD&D (long-term experiment and/or modelling works to demonstrate the robustness of the waste management concepts and contribute to maintain scientific excellence and competences throughout the stepwise long-term management of radioactive waste).

5.2.2. Strategic Studies Work Packages

Strategic studies WPs are initiated in order to agree upon and define in some detail the needs for future activities, including further specific thematic studies or RD&D at the forefront of science. This may also be referred to as 'think-tank' or networking activities to determine if there is a RD&D need on an emerging issue, if there is a need of a position paper or if it is considered mature and suitable for knowledge management activities. Such studies will enable experts and specialists to network on

methodological/strategical issues and advance significant challenges that are common to various national programmes and that are in direct link with scientific and technical issues.

5.2.3. Knowledge Management Work Packages

Knowledge Management is enabled by three permanent WPs that derive directly from EURATOM expectations under WP2018, and that will be implemented through the Annual Work Plan:

- **State of Knowledge** - Activities under this WP consist of developing a systematic approach of establishing the state-of-knowledge in the field of RWM research. This shall be done on a stepwise basis: i) establishing of procedures to document the state of knowledge (SoK); ii) testing and improving these procedures on a few demonstration topics/sub-topics (of the Roadmap); iii) performing a review on existing tools/platforms and evaluating the added-value of establishing such a platform dedicated to provide access to SoK developed in EURAD.
- **Methodological guidance** - Activities under this WP consist of developing a comprehensive suite of instructional guidance documents that can be used by Member-States with RWM programmes that are at an early stage of development with respect to their national RWM programme. Such WP shall pursue and complement the work initiated with the PLANDIS Guide.
- **Training/mobility -** Activities under this WP consist of developing a diverse portfolio of tailored basic and specialised training courses under the umbrella of a "School of Radioactive Waste Management", taking stock of and building upon already existing initiatives (i.e. IAEA and NEA) and creating new initiatives to bridge the identified gaps. The end-users are defined as professionals and potential new professionals at graduated and post-graduated level from EU and non-EU countries (via the IAEA and NEA programmes), and in particular the next generation of experts. This WP will also organise a mobility programme to provide access to dedicated infrastructures associated with the Mandated Actors/Linked Third Parties within EURAD. This work will be carried out in close interaction with European networks having a recognised experience in training/mobility in the field of RWM.

In addition to the three permanent Knowledge Management Work Packages above, there are additional Knowledge Management activities integrated with the RD&D Work Packages, for example, state of art activities.

As emphasised with respect to Methodological Guidance, identified as a priority and clearly underlined in the EURATOM WP2018 call, there is a need to carry out a prioritisation exercise with WMOs, TSOs and REs in order to identify key existing knowledge and target competences that shall be covered in both State-of-Knowledge and Training/Mobility WPs under the EURAD 1 for the target audiences.

Thus, a very first task of both State-of-Knowledge and Training/Mobility WPs (as part of the first Annual Work Plan) shall consist of carrying out this prioritisation of existing knowledge. This will be coordinated by the Programme Management Office. The outputs will be directly integrated into the EURAD Roadmap and will serve as the framework for establishing the State-of-Knowledge and Training/Mobility WPs' Annual Work Plans and also help the evaluation of new RD&D proposals to ensure their relevance and that no duplications will occur. This knowledge management scope will consider the large body of information produced by WMOs over past decades that is in the public domain (in addition to other knowledge sources), and therefore should be considered as complementary to (and not in-conflict with) commercial consultancy services offered by some WMOs.

5.2.4. Programme Management Office Work Package

A WP will be dedicated to the activities of the Programme Management Office (PMO) which is responsible for the proper coordination and implementation of the overall work plan of the JP implementation phase as approved by the General Assembly. The Programme Management Office is in charge of:

- Scientific and technical coordination of the overall programme (RD&D, Strategic Studies, Knowledge Management, Civil Society Interactions);
- Support in the extension/updates of the Roadmap and SRA;
- Day-to-day management (budget follow-up, reporting exercises…);
- Communication/dissemination activities (Annual JP meetings, Newsletters, website…); and
- Administration of online access tools (Extranet, Knowledge Management platform, EC Grant Agreement system).

5.2.5. Interaction with Civil Society – cross cutting component

As described in the Vision Document, one objective of EURAD is to allow innovative ways for close interactions between experts from WMOs, TSOs and REs and Civil-Society (CS) Organisations. Based on a model of pluralistic interactions as developed and tested in previous projects (SITEX-II, JOPRAD, Modern2020, etc.), EURAD proposes a framework for interaction with CS that consists of:

- Translating scientific/technical results for communication to CS group at the annual workshops of CS and by extension to the public;
- Gathering CS views on future EURAD activities;
- Improve the mutual understanding on RD&D performed to support the development of safe solutions of processing and disposal of radioactive waste ;
- Develop propositions on how to interact with CS on scientific and technical results, how to deal with uncertainties (inherently linked to the long timeframes and numerous processes considered for geological disposal), and on how to interact with CS stakeholders in order to promote mutual benefit of the available knowledge, based on cooperation and sharing.

To do so, the EURAD has the ambition to establish interaction activities with a group of representatives of civil society organisations (the CS group). The composition of the CS group will be established at the start of EURAD via an open call by the EURAD consortium to CS organisations such as local communities having interest in RWM (local association, local Committee of Information, local partnership), national or European CS Organisations taking part in interactions in the field of RWM at the national or European level. The candidates shall demonstrate evidence of a standing engagement in the follow-up of RWM activities. Each participant of the CS group will approve the principle of participating in EURAD ICS activities as described in the EURAD Terms of Reference.

The interactions with the CS group will be facilitated by Civil Society facilitators (also called CS experts), working for Linked Third Parties to mandated actors in EURAD, having a long-term engagement on RWM and/or having skills/experience on the involvement of Civil Society in scientific and technical issues. The CS experts will interact with the institutional experts from the WMOs, TSOs and REs in order to understand the field of study and to prepare interactions with the CS group. The process will enable CS group to express their views on the RD&D performed to support the development of safe solutions for processing and disposal of radioactive waste. The CS experts will work in an organised process together with representatives from WMOs, TSOs and REs.

Deployment Plan Table 1: Deployment Mechanisms to be used by the EURAD

Type of WP	Type of actions	Examples of possible deliverables
Collaborative RD&D WPs	Activities aiming at developing and consolidating scientific and technical knowledge. Activities shall be a balance between those with a direct link to operational RD&D (direct links with implementation of deep geological disposal or other waste management route as well as safety concerns) and prospective RD&D (short and long-term experiment and/or modelling works to demonstrate the robustness of the waste management concepts, to increase understanding and predictability of the impact of fundamental processes and their couplings or to maintain scientific excellence and competences throughout the stepwise long-term management of radioactive waste).	State-of-the-art[10] (initial and update), S/T deliverables, reports, demonstrator, pilot, prototype, plan designs, software, technical diagram...
Strategic Studies WPs	Actions consisting of enabling experts and specialists to network on methodological/ strategical issues and advance significant challenges that are common to various National Programmes and that are in direct link with scientific and technical issues.	Position paper (e.g. emerging needs for future RD&D/Strategic Studies/KM activities), report on generic methodologies, best practices…
Knowledge Management WPs	Actions consisting of developing State of Knowledge; developing descriptive methodological guidance and developing/delivering Training modules and mobility measure.	State-of-knowledge documents; Guidance documents, Training delivery and materials…
Programme Management Office WP	Day-to-day administrative, financial and legal management, reporting exercises, interactions with EC, communication and dissemination activities, administration of JP website, Extranet, Scientific and technical coordination/integration of the overall JP (monitoring EURAD progress)	Management tools, Periodic reports, financial statements, website, platforms…

[10] SOTA reports to be prepared by all EURAD WPs, will be compiled in line with international good practice. This will include communication of the existing knowledge related to post-closure safety. In the final version this will be done in a general or generic way, without direct reference to specific safety assessments, safety cases or national programmes. It is the responsibility of the National Programmes to evaluate outputs and results with respect to their own needs (towards implementation) as specified in Section 6.2 of the EURAD Founding Documents and section 1.2 of the Part B. In the initial version of the SOTA report (before start of the WP), those that participate in the corresponding WP should explain their motivation specific to their national programme to actively participate in the WP.

5.3. EURAD 1 – funding and cofunding mechanisms

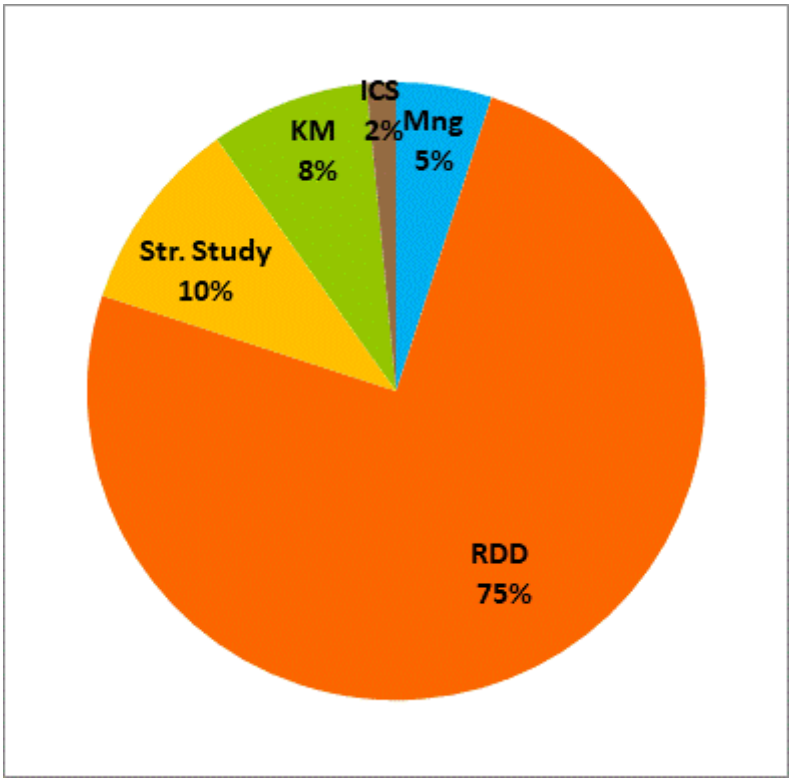
5.3.1. Indicative distribution of EC funding between the different type of activities

The indicative distribution of EC funding between the different types of activities for the first 5 years of EURAD (EURAD 1) has been set as follows:

- 75% of the EC funding will be dedicated to RD&D WPs;
- 10% of the EC funding will be dedicated to Strategic Studies WPs;
- 8% of the EC funding will be dedicated to Knowledge Management WPs;
- 2% of the EC funding will be dedicated to Interaction with Civil Society Organisations;
- 5% of the EC funding will be dedicated to Programme Management and Dissemination.

The distribution of EC contribution between the different types of activities shall not be capped. It can be subject to modification after approval by the General Assembly.

Deployment Plan Figure 1: Distribution of EC funding between the different activities of the EURAD (KM=Knowledge Management, ICS=Interactions with Civil Society, Str=Study-Strategic Studies, RDD=RD&D, and Mng=Joint Programme Management and Administration)



*ICS – This reflects total Interaction with Civil Society budget, which during implementation is integrated across RD&D, Str. Study and Management.

** KM – This reflects total standalone Knowledge Management activities handled by the Knowledge Management Work Packages. This figure is higher (in reality) as there are additional Knowledge Management Activities, such as state of the art reports, undertaken and integrated within the RD&D and Str. Study Work Packages.

5.3.2. Internal funding rates for each type of activity

EC will reimburse 55% of the total eligible costs that are necessary to implement the Work Plan. The consortium is free to redistribute EC co-funding as it decides it, i.e. internal funding rates can be set for different types of activities.

The following funding rates have been established for EURAD 1:

Type of WP	Indicative internal rate
Collaborative RD&D	50 %
Strategic Studies	~70 % (it will be adjusted so that RD&D funding rate does not go under 50%)
Knowledge Management	
Interaction with Civil Society	
Programme Management Office	100 %

5.3.3. Flexibility mechanisms

According to the EC, the EURAD must remain flexible to **include new activities** in order to be as needs-driven as possible; and to **integrate new organisations** that would be mandated after the submission of the proposal or during the course of an implementation phase.

For RD&D WPs, the principles of flexibility is implemented as follows: about 70% of the RD&D budget shall be allocated to WPs/tasks that will start at Month 1 of EURAD 1. The remaining 30% shall be allocated to WPs/tasks that will be approved by the EURAD Consortium (General Assembly) during year 2 and start at Month 24 (for a maximum duration of 36 months).

For Strategic Studies WPs, the principles of flexibility are implemented as follows: about 70% of the budget for Strategic Studies shall be allocated to WPs/tasks that will start at Month 1 of EURAD 1. The remaining 30% shall be allocated to WPs/tasks that will be approved by the EURAD 1 Consortium (General Assembly) and that will start from Month 24 (for a maximum duration of 36 months.

Proposals for new RD&D and Strategic Studies WPs will emerge as EURAD progresses, these will be considered in an open and transparent manner via the PMO and GA. The EURAD Roadmap will support this by providing the framework for performing a structured gap analysis. A technical coordinator will be appointed and will take the lead of the proposal development. When ready, the WP will be reviewed and approved by the General Assembly, if approved, it will be included in EURAD 1 and will start at Year 3.

For Knowledge Management, the principle of flexibility is ensured by a yearly allocation of KM budget. About 20% of the KM budget will be allocated to tasks that will be implemented in the first year. The KM budget will be then allocated on an annual basis.

5.4. EURAD 1 - Work Packages

For the 2019-2024 plan, the following Work Packages have been initiated:

a. RD&D WPs

WP2 - Assessment of Chemical Evolution of ILW and HLW Disposal Cells (ACED);
Multiscale approach and process integration to improve long-term modelling and assessments

'What'

This WP improves the methodology to integrate knowledge on the geochemical processes in and between the materials in a disposal cell for ILW and for HLW waste in order to understand and assess the long-term evolution of such complex system. A multi-process and multi-scale modelling framework will enable the assessment of the chemical evolution at various materials interfaces and thermal, hydraulic and/or chemical gradients from the microscale to the disposal cell scale (ILW, HLW) considering the near field environment and the host rock for larger temporal scales. Starting from small-scale process understanding, it seeks to evaluate in which detail geochemical processes need to be included for representative assessments of the chemical evolution in view of the needs in repository design and post-closure safety assessment.

'Why'

The WP ACED is included already in EURAD phase 1 as it covers an important number of high priority items of the roadmap of EURAD. These are in particular the EBS systems understanding in phase 1, 2 and 3 of the Roadmap:

- Improved understanding of the interactions occurring at the interfaces between waste packages and different barriers in the disposal system
- Improved description of the spatial and temporal evolution and transformations affecting the pore space and the alteration of materials in the near field of HLW and ILW disposal systems
- And concerns also the high priority item for phase 1 in performance assessment and systems models
- Improved understanding of the role of physical/chemical processes at different scales and linking bottom-up and top-down approaches in performance assessment

More specific: the work will allow identifying in which detail and complexity these processes should be incorporated in models for different types of studies related to safety and performance. The information gained through investigation of generic but representative HLW and ILW disposal cells representative for European programmes can later be used and adapted for more specific, national disposal cell designs.

The outcomes will impact the safety case and repository design in different ways e.g. with respect to material specifications and establishment of requirements for disposal procedures. The representative designs are defined for ILW and HLW in both crystalline and sedimentary rock types, representing prevailing designs by the WMOs as end-users. The clear interest of the mandated actors in this WP is demonstrated by the fact that the WP activities are carried out by a large number of partners, with a good balance between WMO, TSO and RE representatives.

WP3 - Cement-Organic-Radionuclide interactions (CORI);

Improved understanding of the role of organics (either naturally occurring or as introduced in the wastes and their influence on radionuclide migration in cement-based environments)

'What'

This WP aims to improve the in-depth understanding of the interaction of cementitious materials with organic matter and with radionuclides. Organic materials are present in some nuclear waste and as aditives in cement-based materials and can potentially influence the performance of a geological disposal system, especially in the case of low and intermediate level waste disposal. The potentia effect of increasing mobility of organic molecules on radionuclide migration is related to the formation of complexes in solution with some radionuclides of interest (actinides and lanthanides) which can (i) increase radionuclide solubility and (ii) decrease radionuclide sorption. The WP's raison d'être is to better quantify the impact of organic material on accelerating radionuclide migration in the post closure phase of geological repositories for ILW and LLW/VLLW, including surface/shallow depth disposal.

'Why'

The thematic represented by the WP CORI has been selected for the first phase of EURAD as "improved understanding of the role of organics (either naturally occurring or introduced by the wastes) and their influence on radionuclide migration" was identified as an important subject in theme 4 (Geoscience to understand rock properties, radionuclide transport and long-term geological evolution) in phase 1 and 2 of the roadmap. Due to the potential degradation of organic matter, this subject is particularly challenging in cementitious environments. Due to the importance of this subject in national programs, various mandated actors are working already since long time on the issues addressed by this WP (see for instance the meetings of the former TSWG in May 2013, Ghent, Belgium, leading to CEBAMA, or the latter extended discussion on CORI at the IGD-TP EF 6 (2015) in London, UK). Over this entire period, partners were eager to join forces for a strong improvement in scientific understanding allowing assessing long-term radionuclide mobility in organic rich cementitious waste disposal environments.

WP4 - Development and Improvement Of Numerical methods and Tools for modelling coupled processes (DONUT);

Improved understanding of the upscaling of THMC modelling for coupled hydro-mechanical-chemical processes in time and space

'What'

This WP will develop and improve specific numerical methods and tools that allow efficient modelling of coupled processes, considering (i) the versatility of numerical methods used in the various tools used by "end-users"; and (ii) a demonstration of robustness and added-value of developments by benchmark of the methods and tools on representative test cases at large repository temporal and spatial scales.

'Why'

The DONUT WP has been selected for the first phase of EURAD as it will address the following activities identified as a high or medium level of common interest in Theme 7 "Performance assessment, safety case development and safety analyses" of the Roadmap:

- Improved understanding of the upscaling of THMC modelling for coupled hydromechanical-chemical processes in time and space (Phase 1 of the Roadmap).
- Improved understanding and models for the impact of THMC on the behaviour of the host rock and the buffer materials (Phase 2 of the Roadmap).
- Improved multi-scale reactive transport models (Phase 2 of the Roadmap)

- Improved performance assessment tools (Phases 0 and 1 of the Roadmap).
- Further refinement of methods to make sensitivity and uncertainty analyses (Phases 2 and 3 of the Roadmap)
- Improved computing (Phases 3 and 4 of the Roadmap).

Furthermore, by improving the numerical methods and tools that are able to manage multi-physical coupled processes, the work conducted in this WP is relevant for better descriptions of site evolution and design optimization. Both can be applied to deep geological and near surface radioactive waste disposal. Finally, by providing efficient numerical means for analysis, DONUT will contribute to abstraction for simplified models to be used for the safety case (quantification of safety margins, detailed assessment of safety functions allocated to components…).

WP5 - Fundamental understanding of radionuclide retention (FUTURE)

Quantification of long-term entrapment of key radionuclides in solid phases as input to reactive transport models also considering the influence of redox

'What'

This WP aims at realizing a step change in quantitative mechanistic understanding of radionuclide retention in the repository barrier system, the key mission of any repository for radioactive waste. In consequence, the raison d'être of this WP concerns the identification of constraints and the increase in predictability of RN migration properties in "real" clay and crystalline rocks, quantifying the influence of key parameters of the heterogeneous rock/water system such a rock structure, redox interfaces, water saturation, reversibility etc. with the goal to develop multicomponent mechanistic sorption models, fracture and/or pore scale simulations of radionuclides transport in both in crystalline and clay rocks considering the combined analysis of reactivity, structure, flow field, and RN mobility/retention.

'Why'

"Radionuclide mobility" has been identified by the mandated actors of WMO, TSO and RE as one of the key themes (4) of EURAD, the SRA and its concretization in the roadmap. It is a key theme in all radioactive waste management countries in Europe, a cornerstone for any proof of safety of nuclear waste disposal concepts. Hence, it was evident to all actors that this theme should also be part of the EURAD-1, acknowledging that there has been research on the various topics of radionuclide migration for more than 30 years, often funded by the European Commission, but realizing as well that various key themes have not been addressed in previous European projects (e.g. FUNMIG, SKIN, RECOSY) in great depth l for their application in the real repository systems in clay or crystalline rocks. The results of the project are expected to reduce uncertainties and improve the scientific basis and the realism for the safety case of deep geological disposal in clay and crystalline rocks.

WP6 - Mechanistic understanding of gas transport in clay materials (GAS);

To increase understanding and predictability of gas migration in different host rocks

'What'

This WP will provide data and develop process-level models to improve mechanistic understanding of transport processes in natural and engineered clay materials, including couplings with mechanical behaviour and impact on the clay properties. Experimental work will determine, for

each identified gas transport regime, the conditions under which that regime is possible, in clay materials representative for host rock and clay EBS components. Data will be obtained that are pertinent for low (diffusion) to high (advection) gas transport rates.

Work will also show how knowledge gained from lab and in situ experiments is integrated in the conceptualisation of gas transport through different components of a repository system and how gas could affect (or not) the performance of the system. This will involve (i) more detailed development of phenomenological descriptions of gas transport and of its likely consequences at the relevant scale and (ii) additional testing of different approaches to represent the effects of gas at repository scale and bounding its consequences in terms of repository performance.

'Why'

Theme 4 of the EURAD Roadmap (Geoscience to understand rock properties, radionuclide transport and long-term geological evolution), increasing the understanding of gas migration is a high priority topic. Gas generation and transport is a key issue as it is possible that gas could be generated at a faster rate than it can be removed through clay host rocks (and clay EBS components – Theme 3) without creating discrete, gas-specific pathways through these low-permeability components. In several disposal concepts, the potential for migration of free gas containing radionuclides to the biosphere is an important issue. Consequently, the raison d'être of this this WP is to answer two key end-users questions:

- How can gas migrate within the repository and which water soluble and volatile radionuclides could be associated with it?
- How and to what extend could the hydro-mechanical perturbations induced by gas affect barrier integrity and performance?

This WP will build on the outcomes of FORGE and other projects. Experiments in FORGE revealed complex mechanisms and emphasized the importance of the mechanical control exerted by the porous material on gas transport. It was suggested that this complexity can be addressed as long as one can bound the effects of these mechanisms using simple and robust descriptions for evaluation purposes (e.g. two-phase flow models for gas transient representation at repository scale, identified as a medium priority under Theme 4). A necessary condition for this is that the scientific bases are integrated properly, in a traceable way throughout the system conceptualisation process. Hence, the structure of this WP follows this process, imposing interactions at each step to ensure close cooperation between experimentalists, process modellers and those involved in evaluation of system performance. This should allow the development of robust evaluation approaches that support the expert judgement formulated at the end of FORGE that gas is not a feasibility challenging issue for geological disposal but more a challenge of managing uncertainties.

WP7 - Influence of temperature on clay-based material behaviour (HITEC); and

Improved THM description of clay-based materials at elevated temperatures

'What'

This WP aims to develop and document improved THM understanding of clay-based materials (host rock and buffer) exposed to elevated temperatures (>100°C) for extended durations. The WP's raison d'être is to evaluate whether or not elevated temperature limits (of 100-150°C) are feasible and safe for a variety of geological disposal concepts for high heat generating wastes (HHGW).

HITEC will study clay host rock formations (<120°C) and establish the possible extent of elevated temperature damage in the near or far field (e.g. from over-pressurisation) and also the consequences of any such damage. The WP will also look at buffer bentonite and determine if

temperature influences the buffer swelling pressure, hydraulic conductivity, erosion or transport properties (i.e. inhibits buffer safety functions).

'Why'

The HITEC WP has been selected for the first phase of EURAD as the activity "Characterise bentonite/clay-based material evolution under specific conditions to provide data on hydro-mechanical, thermal and chemical behaviour" was identified as a high priority subject in theme 3 (EBS properties, function and long-term performance) phases 1-3 of the roadmap. Furthermore, the theme 4 (Geoscience to understand rock properties, radionuclide transport and long-term geological evolution) topic of "Improved understanding of the influence of temperature on radionuclide migration and representation of effects in geochemical models" was also rated as a medium priority activity.

For the disposal of HHGW it is important to understand the consequences of the heat produced on the properties (and their long-term performance) of the natural and engineered clay barriers. Most safety cases (for disposal concepts that involve clay) currently involve a temperature limit of 100°C. Being able to tolerate higher temperature, whilst still ensuring an appropriate performance, would have significant advantages (e.g. shorter above ground cooling times, more efficient packaging, fewer disposal containers, fewer transport operations, smaller facility footprints etc.).

This WP has the potential to effectively integrate with the parallel SFC RD&D WP (i.e. interrogate the validity of the currently applied thermal limits and also the importance of the accuracy of the assumed radiological waste properties).

WP8 - Spent Fuel characterisation and evolution until disposal (SFC);

Reduce uncertainties in spent fuel properties in predisposal phase

'What'

This WP will develop and document an experimentally verified procedure to accurately determine the properties of irradiated spent fuels. It will also develop characterisation techniques that will allow to more fully understand the physiochemical evolution of irradiated spent fuels (pellets and cladding) under normal and credible accident scenarios following reactor discharge (i.e. during interim storage (wet and dry), transport to and emplacement in a GDF).

'Why'

Accurately determining key properties (see "…management of inventory data and uncertainty treatment") and their evolution (see "Improved understanding of the impacts of extended storage…") of spent fuel is fundamental to safety assessment. This is reflected in the fact that both of these Roadmap theme 2 activities are given high priorities. Parameters such as decay heat and nuclear reactivity (fissile content) need to be known to decide how much fuel can be safely loaded into a disposal container and how closely disposal containers can be emplaced at disposal. In the absence of accurate knowledge there is a possibility that these parameters could be too conservatively estimated. Conservatisms would then affect container loadings and facility layouts, potentially resulting in substantially more containers than necessary, more transport operations and ultimately a larger facility footprint. This would have safety and cost ramifications. Conversely, the alternative is also possible (i.e. too optimistic parameters are estimated), which could then be detrimental to safety, i.e. inadvertently breach a thermal or criticality safety limit.

WMOs are particularly interested in the possibility of an NDA technique that could allow swift and accurate corroboration of spent fuel records, prior to loading the fuel into the container (i.e. compliance with waste acceptance criteria (WAC), such as a fuel burn-up measurement or a thermal

limit acceptance check). WAC is a key thematic area under theme 2of the EURAD Roadmap and is typically of most interest to more advanced stage programmes (Phase 2 onwards).

This WP has the potential to effectively integrate with the parallel HITEC RD&D WP (i.e. scrutinise actual thermal output and also the validity of currently applied thermal limits).

b. Strategic Studies WPs

For the first wave of EURAD-1, the following two Strategic Studies WPs have been collaboratively established. The two WPs will enable experts and specialists to network on methodological/ strategical issues that pose significant challenges o to various National Programmes and are directly related to scientific and technical issues. The WPs are initiated to investigate – and if needed – to agree upon and define in more detail the needs for future activities, including further specific thematic studies or RD&D at the forefront of science. This may also be referred to as 'think-tank' or networking activities to determine for different emerging issues whether there is a need for RD&D, for a position paper or if the issues are considered mature and suitable for knowledge management activities.

- **WP9 - Waste Management routes in Europe from cradle to grave (ROUTES)**

Share experience and knowledge on RWM routes between WMOS, TSOs and REs from different countries, with programmes at different stages of development, with different amounts and types of radioactive waste to manage

'What'

This WP will describe and compare the different approaches to characterisation, treatment and conditioning and to long-term waste management routes between MS (member states). The interested organisations are from different countries, with programmes at different stages of development, with different amounts and types of radioactive waste to manage. In this WP, the safety-relevant issues and their R&D needs associated with the waste management routes (cradle to grave) will be Identified, including the management routes of legacy and historical waste. The WP will consider past and present EU projects on the topics of interest and other initiatives carried out at the international level by IAEA and NEA in order not to duplicate the work. The aim of this WP is to identify relevant R&D topics which could be collaboratively launched in the second wave of EURAD.

'Why'

As noted under the EURAD Roadmap Theme 2 - Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal - the pre-disposal activities including radioactive waste characterization, treatment and conditioning as well as storage are considered as high priorities. Moreover, as highlighted in the Roadmap, sufficient knowledge of the radionuclide and chemical content of the waste is a prerequisite for the development of the complete waste management route.

The common interests addressed in the ROUTES strategic studies are identified in the Roadmap and related to the Theme 2: Inventory collation and forecasting (3.5), the Methodology to define radionuclides inventories (3.6), understanding of the potential for long-term storage as a management option for disused sealed radioactive sources (3.10), the management of damaged waste packages and methods for reprocessing aged waste (1.2.4), waste acceptance criteria (2.1.6). All these subtopics are related to Roadmap Phase 0 (Policy, Framework & Programme Establishment), except the subtopic WAC which is related to Phase 2 (Site Characterisation) and Phase 3 (Facility Construction).

Consequently, the raison d'être of this WP is to provide an opportunity to the organisations of the Member-States to share their experience and to identify common R&D interests on thesetopics. For this, safety-relevant issues and R&D needs associated with the waste management routes

(cradle to grave) will be identified, considering waste characterisation, the development of preliminary waste acceptance criteria (WAC) prior to the availability of disposal facilities, options for disposal of small waste inventories. In addition to providing an overview of good practices for different steps in radioactive waste management and guidance for research activities, the work package will provide an opportunity to consider sharing of technology and facilities.

- **WP10 - Understanding of uncertainty, risk and safety (UMAN)**.

Further refinement of methods to perform sensitivity and uncertainty analyses and the development of multi-actor network for uncertainty management

'What'

This WP is dedicated to the management of uncertainties potentially relevant to the safety of different radioactive waste management concepts and designs. It includes various activities such as exchanges on views, practices and uncertainty management options and the review of existing strategies, approaches and tools. Interactions between different types of actors including civil society are central to this WP. These interactions are aimed at meeting the shared objective of fostering a mutual understanding of uncertainty management strategies, approaches and preferences. A particular focus is put on uncertainties directly linked with RD&D WPs and with a high (and where relevant medium) priority subdomain of the SRA for which exchanges of information and experiences and strategic studies have been identified as beneficial by the JP actors themselves. The WP will consider past and present EU projects on the topics of interest and other initiatives carried out at international level by IAEA and NEA to avoid duplicating existing work. The WP will allow identifying the contribution of past and on-going RD&D projects to the overall management of uncertainties as well as remaining and emerging issues associated with uncertainty management that could be addressed in subsequent waves of EURAD.

'Why'

Decisions associated with radioactive waste management programmes are made in the presence of irreducible and reducible uncertainties. Several choices made on the basis of limited information in early programme phases may also have to be confirmed before or during the construction and operation of the facility. At the end of the process, some uncertainties will inevitably remain but it should be demonstrated that these uncertainties do not undermine safety. Hence, the management of uncertainties is a key issue when developing and reviewing the safety case of waste management facilities and, in particular, of waste disposal facilities due to the long-time scales during which the radiotoxicity of the waste remains significant.

As noted under the EURAD Roadmap Theme 1 - Managing implementation and oversight of a radioactive waste management programme - a clear strategy and commitment to involvement of stakeholders is essential to the decision-making process at all stages of a waste management programme. It is also explained that scientific activities associated with a waste management programme (site characterisation, process modelling, safety assessment etc.) are evolving over time leading to new view points and sometimes new uncertainties and are not fully predictable in outcome, duration or resources that may eventually be required to resolve emerging issues. Accounting for such uncertainty has thus become a key part of successful programme planning, and would benefit from continued sharing of methodologies and experience.

Therefore, uncertainty is a cross-cutting issue of the different themes and stages identified in the Roadmap. The term "uncertainty" is also explicitly mentioned in the title of several activities of common interest considered as having a medium or a high priority: Inventory uncertainty (1.1.1), Site uncertainty treatment (3.1), Geological uncertainties (1.6.2), Uncertainty treatment (2.1.3). Furthermore, RD&D activities are aimed at improving the state-of-knowledge and thus are expected to reduce uncertainties. Understanding the contribution of these activities to the overall uncertainty management is important for the different actors involved in the decision-making process as well as for the identification of future EURAD priorities and activities.

Consequently, the raison d'être of this WP is to provide an opportunity to the organisations and different actors of the Member-States to share their experience and views on uncertainty management and to identify emerging needs associated with this topic. The WP will also contribute to understanding the added value of RD&D activities for the safety case and the decision-making process within the different programmes. It also contributes to the vision of EURAD by fostering mutual understanding and trust between Joint Programme participants.

c. Knowledge Management WPs

Under EURAD-1, Knowledge Management is enabled by three permanent WPs that are directly derived from EURATOM expectations under WP2018:

- **WP11 - State of Knowledge** - Activities under this WP consist of developing a systematic approach of establishing the state-of-knowledge in the field of RWM research. This shall be done on a stepwise basis: i) establishing of procedures to document the the SoK; ii) testing and improving these procedures on a few demonstration topics/sub-topics (of the Roadmap); iii) performing a review on existing tools/platforms and evaluating the added-value of establishing such a platform dedicated to provide access to SoK developed in EURAD.
- **WP12 - Methodological guidance** - Activities under this WP consist of developing a comprehensive suite of instructional guidance documents that can be used by Member-States with RWM programmes that are at an early stage of development with respect to their national RWM programme. This WP will pursue and complement the work initiated with the PLANDIS Guide.
- **WP13- Training/mobility -** Activities under this WP consist of developing a diverse portfolio of tailored basic and specialised training courses under the umbrella of a "School of Radioactive Waste Management", taking stock of and building upon already existing initiatives (i.e. IAEA and NEA) and creating new initiatives to bridge identified gaps. The end-users are defined as professionals and potential new professionals at graduated and post-graduated level from EU and non-EU countries (via the IAEA and NEA programmes), and in particular the next generation of experts This WP will also organise a mobility programme to provide access to dedicated infrastructures associated with the Mandated Actors/Linked Third Parties within EURAD. This work will be carried out in close interaction with European networks having a recognised experience in training/mobility in the field of RW.

d. Contribution from Civil Society

For the first wave of the EURAD-1, the two Strategic Studies Work Packages have been selected for specific contribution from civil society because they are focusing on generic aspects of radioactive waste management and are of interest for civil society in EU countries:

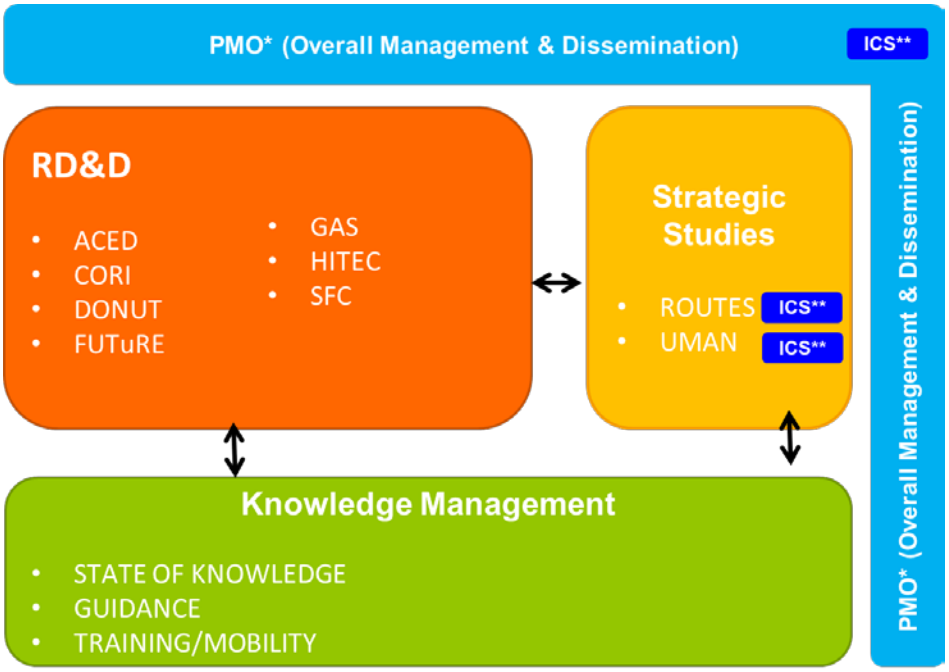
- SS WP9 - Waste Management routes in Europe from cradle to grave (ROUTES); and
- SS WP10- Understanding of uncertainty, risk and safety (UMAN).

In close collaboration with the WP Boards (WP Leader and task leaders) the role of **CS Experts** (in charge of translating the WP work content and results to the CS group as described in Section 1.1.4) is to:

- Sketch out and map the key stakes related to the work performed in the different tasks/subtasks of the WPs from a CS point of view in order to translate the work content and the results to the broader CS group and gather its feedback at annual workshops;

- Contribute to the work performed in the tasks/subtasks of the selected WPs and participate in key working meetings of these tasks;
- Raise awareness of the broader CS group on the scientific/technical research issues for radioactive waste management solutions by preparing and animating a specific session dedicated to the selected WPs in the CS annual workshop of EURAD (see above).

Furthermore, under the PMO WP, a **dedicated coordination task** is established to coordinate, support and integrate at the programme level all the interactions activities with Civil Society. This coordination task will consist of providing methodological support for CS interactions with RWM stakeholders: elaboration of material, methodologies, processes and sessions to prepare EURAD participants and CS representatives in order to facilitate fruitful interactions, as well as the assessment of the on-going experimental model of Interaction between EURAD participants and Civil Society. This coordination work will also consist notably of organizing yearly a workshop involving the participants of the CS group, the CS Experts together with a panel of experts from WMOs, TSOS and REs participants in EURAD.



*Programme Management Office
** Interactions with Civil Society

Figure –EURAD-1 overall structure of the work plan ('first wave')

e. PMO - Update of the SRA/Roadmap during EURAD 1

During EURAD-1, and in addition to its responsibility of administrative, legal and financial management and the coordination of the overall scientific and technical coordination/integration/evaluation of impacts (RD&D, Strategic Studies and KM), the PMO shall support the EURAD General Assembly in the task of extending/updating the SRA and the Roadmap. During EURAD-1, the following extensions/updates are anticipated:

- [Year 1]

- **Roadmap Extension** - Complete EURAD Roadmap with a **Competency Matrix**, to identify competencies needed for the different Actors (WMOs, TSOs and REs) and to **map existing/available SoK, Guidance and Training material** (open access) against Themes of EURAD SRA for different phases of implementation of a RWM programme. This shall support the identification of the key need-gaps, which will then be used to prioritise the scope of each of the main KM WPs. This task will be undertaken by the PMO, with inputs from participants of the KM WPs and with oversight and guidance by the appointed Joint Programme Fellows/Experts.

- [Year 2]
  - **'Soft' update of the SRA/Roadmap** in view of the preparation of the 2nd wave of RD&D and Strategic Studies WPs where it is anticipated that minor edits and additions should be made, e.g. assessing the level of common interest of topics that emerged lately in the process of developing the SRA; identification of emerging RD&D needs and assess level of common interest.
- [Year 4-5]
  - **'Extensive' update** of the SRA/Roadmap (exact timing to be adjusted in order to be in line with Euratom work programme) to coincide with preparation and prioritisation of the scope of the potential EURAD-2. During this extensive update, it is anticipated that significant changes may result to take account of learning from EURAD-1 and align the Vision, SRA, Roadmap and RD&D, Strategic Studies and KM Work Packages scope and methodologies with how things evolve, particularly with respect to governance scheme and how the criteria used to identify needs of the WMOs, TSOs and REs.

The figure below provides an indicative overview of these important milestones (soft/extensive updates of the SRA/Roadmap), as well as all milestones for the programme coordination.

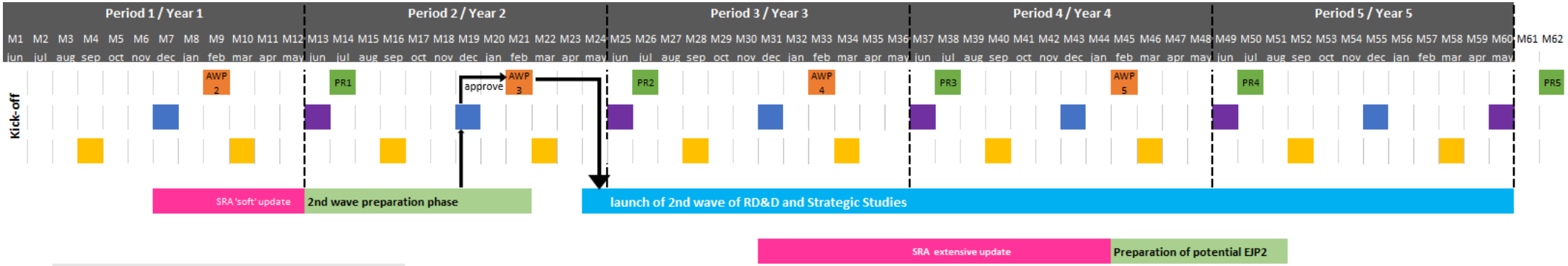

Period 1 / Year 1
Period 2 / Year 2
Period 3 / Year 3
Period 4 / Year 4
Period 5 / Year 5
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12 M13 M14 M15 M16 M17 M18 M19 M20 M21 M22 M23 M24 M25 M26 M27 M28 M29 M30 M31 M32 M33 M34 M35 M36 M37 M38 M39 M40 M41 M42 M43 M44 M45 M46 M47 M48 M49 M50 M51 M52 M53 M54 M55 M56 M57 M58 M59 M60 M61 M62
jun jul aug sep oct nov dec jan feb mar apr may
AWP 2
PR1
approve
AWP 3
PR2
AWP 4
PR3
AWP 5
PR4
PR5
Kick-off
SRA 'soft' update
2nd wave preparation phase
launch of 2nd wave of RD&D and Strategic Studies
SRA extensive update
Preparation of potential EJP2
to be adapted depending if and when EC plans to launch a call for EJP2
AWP
Annual (Y+1) Work Plan - submission to EC
PR
Periodic Report (Y-1) - submission to EC
General assemby
Annual EJP Meeting + General Assembly
Bureau meeting

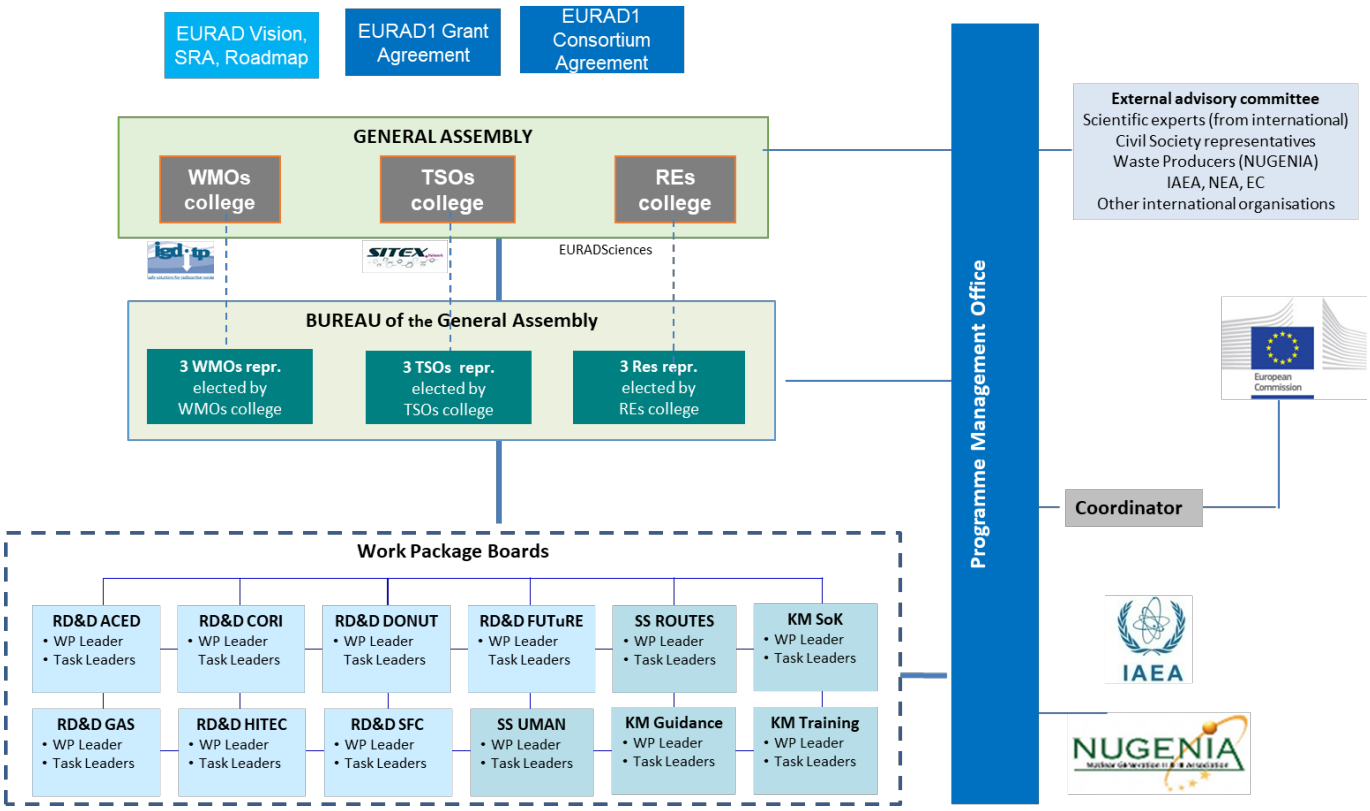
Table 1: Overview of EURAD-1 Work Packages (2019-2024)

EURAD 1 Work Packages (2019-2024)		Indicative Budget	EURAD Strategic Research Objectives	EURAD Beneficiaries			
		Total Cost (EC + Beneficiary Contributions)	How the Work Package will address objectives, priorities and activities of high common interest in the EURAD Strategic Research Agenda	WMOs	TSOs	REs	Coordinator
				◆ = Beneficiary Organisation; ◆ = Coordinating Beneficiary Organisation			
Programme Management Office		**7%**					
WP1	Administration, Scientific Coordination, Communication and Dissemination	€2.7 M		◆◆	◆	◆◆	ANDRA (France)
Collaborative RD&D		**75%**					
WP2	Assessment of Chemical Evolution of ILW and HLW Disposal Cells (ACED)	€5.1 M	Multiscale approach and process integration to improve long-term modelling and assessments .	◆◆◆◆◆	◆◆◆◆◆	◆◆◆◆◆◆◆	SCK-CEN (Belgium)
WP3	Cement-Organics-Radionuclide-Interactions (CORI)	€4.7 M	Improved understanding of the role of organics (either naturally occurring or as introduced in the wastes) and their influence on radionuclide migration in cement based environments.	◆◆	◆◆◆	◆◆◆◆◆◆◆◆◆	KIT (Germany)
WP4	Development and Improvement of Numerical Methods and Tools for Modelling Coupled Processes (DONUT)	€3.7 M	Improved understanding of the upscaling of THMC modelling for coupled hydro-mechanical-chemical processes in time and space.	◆◆◆	◆◆◆◆◆	◆◆◆◆◆◆◆◆	ANDRA - BRGM (France)
WP5	Fundamental Understanding of Radionuclide Retention (FUTURE)	€4.6 M	Quantification of long-term entrapment of key radionuclides in solid phases to inform reactive transport models and the influence of redox.	◆◆	◆◆◆◆◆	◆◆◆◆◆◆◆◆	FZJ (Germany)
WP6	Mechanistic Understanding of Gas Transport in Clay Materials (GAS)	€5.6 M	To increase understanding and predictability of gas migration in different host rocks.	◆◆◆◆◆◆	◆◆◆	◆◆◆◆◆◆◆◆	ONDRAF/NIRAS (Belgium)
WP7	Influence of Temperature on Clay-based Material Behaviour (HITEC)	€5.3 M	Improved THM description of clay based materials at elevated temperatures.	◆◆◆◆◆◆◆◆◆	◆◆	◆◆◆◆◆◆	VTT (Finland)
WP8	Spent Fuel Characterisation and Evolution Until Disposal (SFC)	€5.8 M	Reduce uncertainties in spent fuel properties in predisposal phase.	◆◆◆◆◆	◆◆◆◆◆	◆◆◆◆◆◆◆◆◆	SKB-UU (Sweden)
Strategic Studies to Address Complex Issues and Expert Networking		**10%**					
WP9	Waste management routes in Europe from cradle to grave (ROUTES) *	€1.7 M	Waste Management Routes across Europe considering different waste types and their specified endpoints.	◆◆◆◆◆◆◆◆◆◆◆◆	◆◆◆◆◆◆◆◆◆◆	◆◆◆◆◆◆◆◆◆◆◆	IRSN (France)
WP10	Uncertainty Management multi-Actor Network (UMAN) *	€1.7 M	Further refinement of methods to make sensitivity and uncertainty analyses and the development of a multi-actor network for uncertainty management.	◆◆◆◆◆◆◆◆◆	◆◆◆◆◆◆◆◆◆◆◆	◆◆◆◆◆◆◆◆◆	BelV (Belgium)
Knowledge Management		**8%**					
WP11	KM State-of-Knowledge (SoK)	€1.4 M	To maintain information, knowledge and records over the long lead- and implementation-timelines of geological disposal programmes, from pre-licensing through to the post-operational phase.	◆◆	◆◆	◆◆	BGE (Germany)
WP12	Guidance	€0.5 M	To identify RD&D and knowledge transfer needs in support of defining pre-licensing activities that can support success in the siting and licensing phase/process.	◆◆	◆◆◆		SURAO (Czech Republic)
WP13	Training & Mobility	€0.6 M	Training and competence maintenance of skills and expertise to support safe radioactive waste management including disposal.	◆◆	◆◆◆	◆◆	SCK-CEN (Belgium)

* Interactions with Civil Society

6. EURAD – GOVERNANCE & EVALUATION

The overall organisation of the EURAD can be seen in the Figure below.



Governance & Evaluation Figure 1: Overall Organisation of the EURAD

6.1. Governance

The **General Assembly** is the ultimate decision-making body of the EURAD consortium. It is responsible for agreeing the strategy of the EURAD in line with the content of the SRA/Roadmap and the Euratom Work Programme. It is composed of one representative of each Beneficiary (Mandated organisations). Beneficiaries fall into one of the three following categories: Waste Management Organisations (WMOs), Technical Support Organisations (TSOs) and Research Entities (REs). Each category has its own **college** within the General Assembly: WMOs college, TSOs college and REs college[11].

The General Assembly shall be free to act on its own initiative to formulate proposals and take decisions, following preview with the Bureau and/or Programme Management Office[12]. In addition,

[11] The establishment of the colleges is meant to be compatible with the boundary conditions of independence (Maintenance of Independence principle) between the "expertise function" (fulfilled by TSOs and by some Research Entities) and the "implementer function" (fulfilled by WMOs). It shall allow verification that the positions/decisions of the GA are inclusive in terms of actors (Inclusiveness principle).

[12] All individual proposals are made to the Programme Management Office in the first instance, and then directed up the reporting chain if it requires either technical or wider oversight. First to the Bureau, and then second to the General Assembly. Any items taken to the General Assembly must have been discussed with the PMO and sponsored for wider discussion by the Bureau.

proposals made by the Bureau and by the Programme Management Office shall be considered and decided upon by the General Assembly.

The General Assembly shall meet regularly (at least twice a year). The members of the Bureau and the PMO shall also participate in the General Assembly meetings. It is anticipated that the WP Leaders and the CS representative shall be invited as observers, however the General Assembly reserves the right to call closed meetings, if required.

Terms of Reference of the General Assembly can be seen in Annex 1.

The General Assembly shall establish a **Bureau**. The Bureau is accountable to the General Assembly. It proposes documents and decisions to be taken by the General Assembly. It acts on behalf of the General Assembly in close interactions with the Programme Management Office during the elaboration of proposals, for subsequent decision by the General Assembly. The Bureau shall be composed of a total of nine representatives; 3 elected by each General Assembly college.

- The WMOs College appoints its three Bureau representatives (including one representative from a country with early stage/ small RWM programme).
- The TSOs College appoints its three Bureau representatives (including one representative from a country with early stage/small RWM programme).
- The REs College appoints its three Bureau representatives (including one representative from a country with early stage/small RWM programme).

The Bureau members shall represent the interest of their respective community and not the interest of their own organisation or country. The composition of the Bureau shall be regularly reviewed/re-elected for suitability of roles, responsibilities and membership (at least by mid-term of the first 5-year implementation). This shall be done through consultation with each of the Colleges and any changes approved by the General Assembly.

Participation of a CS Expert (facilitator) in Bureau meetings as Observer

A representative from an organisation acting as CS Expert (LTP) may be invited by the bureau in a number of bureau meetings to express CS views on the activities to develop by the EJP. He/she will be designated by the CSO group.

The aim is to enable CSOs through one of their CS Expert to express their views during the update of the Strategic Research Agenda/Roadmap and the definition of future waves of activities. The ambition of the EURAD Consortium is to establish an effective dialogue with Civil Society in order to enhance the mutual understanding on the RD&D planned to support the development of safe solutions in the processing and of the disposal of radioactive waste.

If the Chairperson of the Bureau deems it necessary, or on request of a Bureau member, the Bureau may, regarding either all or part of the agenda, be convened as a closed session where participation may be limited to the Bureau members.

Terms of Reference of the Bureau of the General Assembly can be seen in Annex 1.

The **Programme Management Office** (PMO) is in charge of scientific and technical coordination of the implementation of the programme, as well as the day-to-day management and communication activities. It is responsible to the General Assembly for the overall top-level planning, coordination and implementation of the EURAD Work Plan in line with the strategy agreed by the General Assembly. It

interacts with the EC and key stakeholders: national programmes, international organisations/ programmes, Civil Society Organisations, science/policy interface.

The PMO is housed in the premises of the Coordinator which is the legal entity acting as the intermediary between the Parties and the European Commission. Staff from other organisations (WMO/TSO/RE) shall also be involved in the PMO. The PMO shall organise regular meetings gathering all the WP Leaders to ensure interactions between the WPs and ensuring joint programming of activities. A dedicated Work Package is established for the activities of the PMO. In addition, the PMO shall be reinforced with a **Chief Scientific Officer** that shall act as a EURAD high-level spokesperson with a recognized broad and high-level strategic overview, able to contextualize EURAD progress and results vis-a-vis the Roadmap, i.e. linking EURAD scientific/technical/strategic outcomes to milestones typical for different phases of a RWM programme. Such a role shall be given on a rolling basis, e.g. every two years.

Terms of Reference of the PMO and the Coordinator can be seen in Annex 1.

For each technical Work Package a **Work Package (WP) Board** is set-up. It is composed of the Work Package Leader and the task leaders. The WP Board ensures that the WP is progressing according to the agreed specifications, milestones and planning. The WP Board is also responsible for reporting the work progress, any WP deliverables and eventual modifications of the WP work plan to the Programme Management Office.

Terms of Reference of Work Package Board can be seen in Annex 1.

External advisory board (EAB) advises the General Assembly on strategic and implementation issues related to the EURAD and its coherence with respect to the Strategic Research Agenda and Vision. The EAB is composed of scientific and technical experts at international level, Civil Society Expert (external to EURAD, e.g. a social scientist or CS expert outside Europe), IAEA representative, NUGENIA and other potential international organisations, nuclear safety authorities' representatives (through WENRA and ENSREG networks). The constitution of the EAB shall be approved during the first General Assembly meeting. The EAB shall be invited to the annual meeting and shall provide external advice and recommendations for the implementation of the EURAD.

6.1.1. Conditions for Participation

The beneficiaries in EURAD have received a mandate by their National Programme owner to participate in the EURAD implementation phase (the mandate shall confirm that organisations are responsible for managing/implementing a RWM programme and/or managing/ implementing a RD&D programme needed for implementation). EURAD assumes no responsibilities for maintenance or impact of the National Programme. EURAD is complementary to Member-States National Programme, and the interactions between the two are managed via the national mandate. This includes the preservation of the independence and role of Beneficiaries in the national-decision making process.

According to Article 6 of the 2011/70/EURATOM directive, Member-States shall ensure that the competent regulatory authority is functionally separated from any other body or organisation concerned with the management of spent fuel and radioactive waste, in order to ensure effective independence from undue influence on its regulatory function. This requirement has several implications for the expertise function which is aimed at providing the technical and scientific basis for supporting the decision made by the regulatory function. Arrangements must therefore be made by the Member-States National Programme to maintain the independence role of potentially different EURAD participants. Regarding EURAD, the use and interpretation of results, (produced by EURAD) in

the context of the national geological disposal programme is the respective responsibility of the WMOs and TSOs.

6.2. Evaluation

At the WP level - To assess EURAD outputs, early affects and long-term impacts, monitoring and evaluation criteria will be constructed that will serve as the basis for the development of a set of key performance indicators (KPI). Such KPIs shall help measuring outcomes and impacts towards the phases of the Roadmap and in terms which can also be assessed by decision makers (EC, Programme Owners). These KPIs are built in close consultation and collaboration with EURAD participants and will align with objectives within the scientific Themes, and prioritized RD&D, strategic studies and knowledge management activities presented in the Strategic Research Agenda. This will be managed by the PMO, together with each work package. The set of KPI will be included in the Quality Management Plan (Deliverable 1.1).

At the Programme level – By mandating organisations to participate, Member-States demonstrate that EURAD has an EU-added value beyond their National Programme. As EURAD is not working in direct support for implementation of RWM operations or geological disposal, it is the responsibility of the National Programmes to evaluate outputs and results with respect to their own needs (towards implementation). As part of this, towards the end of EURAD-1, the PMO shall prepare a tool (e.g. questionnaire aligned to the Waste Directive) for getting the views from national programme owners on EURAD impacts during phase 1.

Assessment of quality and scientific excellence can however be shared, and will represent a primary criterion for the evaluation of EURAD results and achievements, and assumes over-riding importance in the first 5-year implementation plan.

The scope of criteria for evaluating the overall EURAD Programme (and the individual Work Packages) will include:

- EURAD Programme/Work Package must articulate the overall research vision. To enhance the potential of achieving it, a world-class team of complementary expertise shall have been brought together.
- EURAD Programme/Work Package shall be ambitious, creative, innovative, and address key research challenges. It shall also be sustainable beyond the lifetime of the programme itself.
- A strong scientific case for support must be demonstrated by EURAD Programme/Work Package with the proposed research set into the context of the current state of knowledge and other work under way in the field.
- The outputs of EURAD Programme/Work Package shall result in a major impact on the research area beyond the immediate project, resulting in an appreciably raise in the international profile of European radioactive waste RD&D.
- EURAD Programme/Work Package shall clearly demonstrate the methods intended to be used to attain the stated objectives and describe clearly how appropriate they are for the planned activity and their scientific or technical feasibility. Where there is not a detailed methodological plan for the whole period of the implementation plan, the proponents shall explain how the research objectives for the latter years will be identified.
- EURAD Programme/Work Package shall identify the most significant challenges to achieving the stated objectives and explain how these will be addressed.

- EURAD Programme/Work Package must show clearly how meaningful, independent peer review will be integrated on a timely basis within the overall implementation plan.

In addition, the PMO will actively maintain and monitor a Risk Register to document those risks identified within each Work Package that may impact the overall performance of the EJP. With respect to the WPs that require significant coordination and strategic oversight to ensure consistency and continued support by each College, it is anticipated that a key risk will be raised that relates to meeting the needs of safety assessment end-users with a focus on generic methodologies (exact wording to be agreed). This risk will be managed through identified mitigation measures to be developed and continuously monitored together with the WP Leader, Key WP Contributors from each College, and the PMO.

Annex 1 – EURAD Terms of Reference

Terms of Reference – General Assembly of the European Joint Programme on Radioactive Waste Management (EURAD)

COMPOSITION

It is composed of one representative of each organisation having received a mandate by their national programme owner to participate as Beneficiary in EURAD implementation phase (the mandate shall confirm that organisations are responsible for managing/implementing a RWM programme and/or managing/ implementing a RD&D programme needed for implementation).

Beneficiaries fall into one of the three following colleges, and:

- Waste Management Organisations (WMOs) college;
- Technical Support Organisations (TSOs) college; and
- Research Entities (REs) college.

ROLE

The General Assembly is the ultimate decision-making body of EURAD consortium. It is responsible for agreeing and regularly reviewing the overarching strategy of the EURAD as laid down in the Founding Documents and policies necessary to implement the work plan and the Euratom Work Programme. The General Assembly shall be assisted by the Bureau and by the Programme Management Office. The details of the strategy and Work Plans, and any supporting policies and procedures, are elaborated by the Bureau and the Programme Management Office. The General Assembly shall be free to act on its own initiative to formulate proposals and take decisions, following preview with the Bureau and/or Programme Management Office.

The General Assembly responsibilities are to:

- Approve updates of the Founding Documents (Vision, SRA, Roadmap, Governance, Deployment Plan)
- Approval of management procedures (incl. Quality Management Plan, settlement of payments, reporting procedures, internal communication procedures);
- Approve evolution of the Parties
- Approve evolution of the content, finances and intellectual property rights

DECISION-MAKING PROCESS

Decisions in the General Assembly shall preferably be taken by consensus view*, without a formal voting system. In the event that a decision cannot be taken by consensus view in a first instance, the following stepwise approach applies:

- **For "specific decisions" concerning *Vision*, *Roadmap*, *SRA*, *Governance* and *Deployment Plan***

Each college of the General Assembly (WMO college, TSO college and RE college) expresses its position regarding the decision to be taken with its own internal rules. The decision is taken when the three colleges' positions take the same decision.

If after the colleges' position the decision is not taken, the General Assembly mandates the Bureau to work on a new proposal that shall take into account comments made by General Assembly.

- **For "standard decisions" concerning the implementation of the action :**

Each Beneficiary shall have one vote. Decisions shall be taken by a majority of two-thirds of the votes cast.

**No formal quorum has been established by the EURAD.*

MEETINGS

The General Assembly shall meet at least twice a year. Extraordinary meetings for urgent issues may be convened at any time upon written request of at least 10% of its members.

The members of the Bureau and the PMO shall be invited to attend the General Assembly meetings.

Terms of Reference – Bureau of the General Assembly of the European Joint Programme on Radioactive Waste Management (EURAD)

COMPOSITION

The Bureau shall be composed of three representatives appointed by each General Assembly college:

- The WMOs College nominates its three Bureau representatives (including one representative from a country with early stage/ small RWM programme).
- The TSOs College nominates its three Bureau representatives (including one representative from a country with early stage/small RWM programme).
- The REs College nominates its three Bureau representatives (including one representative from a country with early stage/small RWM programme).

The composition of the Bureau shall be regularly reviewed for suitability of roles, responsibilities and membership (at least by mid-term of the first 5-year implementation). This shall be done through consultation with each of the Colleges and any changes approved by the General Assembly.

ROLE

The Bureau is an accompanying body to the General Assembly for what concerns high-level strategic issues as laid down by the Founding Documents. It shall prepare any decisions to be taken by the General Assembly that concerns any update of the Vision, SRA and Roadmap as well as proposals for the Deployment Plan (this includes the second wave of RD&D and Strategic Studies, as well as the Annual Programme of Knowledge Management).

The Bureau Members are appointed according to their competence as individuals and shall not act as representatives of their organisations but as representatives of their colleges.

The Bureau members act in close interactions with the Programme Management Office.

MEETINGS

The Bureau shall meet regularly, at least four times a year (. The Project Management Office shall participate in the Bureau meetings. Additional experts and Civil Society representatives may also participate in the Bureau meeting as needed.

Terms of Reference – Programme Management Office (PMO) and Coordinator of the European Joint Programme on Radioactive Waste Management (EURAD)

COMPOSITION

The PMO is composed of one representative of the Coordinator. The other members of the PMO are selected under the responsibility of the Coordinator who will seek the support of a panel as appropriate, including a *Chief Scientific Officer* who shall act as a EURAD high-level spokesman with a recognized broad and strategic overview, able to contextualize EURAD progress and results vis-a-vis the Roadmap, i.e. linking EURAD scientific/technical/strategic outcomes to milestones typical of different phases of a RWM programme. The composition of the Bureau shall be reviewed for suitability of roles, responsibilities and membership at Month 30.

ROLE

The PMO shall be responsible for the proper execution and implementation of the work plan approved by the General Assembly. The PMO is in charge of scientific and technical coordination of the overall programme (RD&D, Strategic Studies, Knowledge Management), as well as the day-to-day management (budget follow-up, reporting exercises…) and communication/dissemination activities.

The PMO, together with the Bureau, makes proposal to be decided upon by General Assembly. The PMO interacts with the EC and key stakeholders: national programmes, international organisations/programmes, External Advisory Board, etc.

MEETINGS

The PMO shall organise regular meetings (at least twice a year) gathering all the Work Package Leaders to facilitate good interactions between themselves and to maintain coordination of all their activities, to ensure joint programming.

Terms of Reference: Work Package Boards of the European Joint Programme on Radioactive Waste Management (EURAD)

COMPOSITION

For each Work Package (WP) a WP Board is set-up. It comprises the Work Package Leader and the task leaders.

ROLE

The WP Board is in charge of the scientific and technical coordination of the WP. The WP Board ensures that the WP is progressing according to the agreed specifications, milestones and planning. The WP Board is also responsible to report work progress, any WP deliverables and eventual modifications of the WP work plan to the Programme Management Office.

MEETINGS

At least 2 meeting per year, at least one shall be in coordination with all EURAD WP Boards together with the PMO to encourage interactions, integration and cross-harmonisation.

Terms of Reference: External Advisory Board (EAB) of the European Joint Programme on Radioactive Waste Management (EURAD)

ROLE

The external advisory board advises the General Assembly on strategic and implementation issues related to the EURAD Work Plan and its coherence with respect to the Strategic Research Agenda and Vision.

COMPOSITION

- Scientific and technical experts at international level ;
- Civil Society Representatives
- EC representative
- IAEA representative
- Other international organisations

The EAB will be invited to one annual GA meetings and shall provide external advices and recommendations for the implementation of the EURAD.

Annex 2 – Development of the EURAD Strategic Research Agenda

The Strategic Research Agenda of EURAD has been developed in a stage-wise manner, Step 1 - taking over entirely the scope developed within the EC JOPRAD Project (See Annex 4, JOPRAD Programme Document D4.2), and Step 2 – enhancing with a small number of additional needs identified by ongoing EC projects and approved for inclusion between the key contributors of the JP.

Step 1 – Taking over the EC JOPRAD Project Scope: EURAD has reorganised the JOPRAD scientific and technical scope into 7 Scientific Themes (as described fully in Chapter 3, EURAD SRA). Each activity has retained (i) the activity title (with some minor editing to make the research objectives more SMART - Specific, Measurable, Attainable, Relevant and Timely); (ii) the indicator of High, Medium or Low for the 'level of common interest' between the WMOs, TSOs, and REs groups represented within JOPRAD, and further commented on by an open European consultation (managed by the JOPRAD project) during the summer of 2017; and (iii) an indication of whether scope to address the identified activity would benefit from a Knowledge Management component.

*The EC JOPRAD project methodology for identifying the scientific and technical basis of the JOPRAD SRA was carried out in 5 steps:

1. **Compiling Activities for Inclusion**: Drafting a first compilation of combined activities suggested as suitable for inclusion within a potential future Joint Programme. A key part of this step was to organise and coalesce suggested activities (identified from WMO, TSO and RE-specific SRAs) into a suitable structure, considering the different types of activities suggested and the adoption of a common terminology and appropriate scope definition for a potential future Joint Programme;
2. **Surveying Representative Joint Programme Participant Views**: Eliciting JOPRAD participants' opinions on their preferences and motivations for prioritising activities. This was completed by issuing a comprehensive questionnaire of suggested activities, allowing JOPRAD participants to comment and express views on activities suggested by all the represented groups for the first time;
3. **Identifying Priorities and Activities of High Common Interest**: Analysing the questionnaire responses to identify the themes with high common interest, and the adoption of screening criteria used to prioritise what should be included in EURAD. This step included development of a methodology to cross-check that all prioritised activities met with the established boundary conditions for EURAD;
4. **1st Draft SRA**: Drafting a first compilation of EURAD scientific and technical scope with a clear description of prioritised RD&D activities agreed and supported by all JOPRAD participants;
5. **SRA Consultation and Finalisation**: Consultation of the draft scientific and technical scope within the broader European radioactive waste management community. Obtaining feedback and end-user input to facilitate updating of the final Programme Document.

The JOPRAD WP4 Programme Document (see chapter 6) also includes specific "socio-political confidence building themes" addressing the complexity of RWM. Three main areas of scope were identified, which could be integrated within future R&D and strategic studies WPs, where appropriate. Integration in this way would ensure the JP does not give rise to self-standing social and political research activities, separate from the technical aspects of RWM.

EURAD Themes	JOPRAD RD&D Sub-topics and New Scope (*greyed boxes show new scope since JOPRAD and origin / title changes made in the JP, shown in italics and brackets*)	Level of Common Interest for RD&D	Identified Knowledge Management Activity
Theme 1: Managing Implementation and oversight of a Radioactive Waste Management Programme	3.15 EU Research Infrastructure	High	✓
	Establishment and implementation of a RD&D programme (Originates from guidance needs identified by the IGD-TP PLANDIS Guide)	High	✓
	3.14 Information Management (NEA RepMet)	Medium	✓
	3.16 EU DGR Curricular (*JP title: Training and competence maintenance of skills and expertise to support safe radioactive waste management including disposal*)	Low	✓
	3.11 Pre-licensing Management	Low	✓
Theme 2: Radioactive waste characterisation, processing and storage (Pre-disposal activities), and source term understanding for disposal	1.1.1 Inventory Uncertainty *(JP title: Identifying good practice in the management of inventory data and uncertainty treatment*)	High	✓
	1.1.3 Non-mature and Problematic Waste Conditioning (*JP title: Developing novel conditioning technologies for non-mature and problematic waste*)	High	✓
	1.1.4 Radionuclide Release from Wasteforms other than Spent Fuel (*JP title: Improved understanding of radionuclide release from existing and future wasteforms other than Spent Fuel*)	High	✓
	1.1.2 Waste Characterisation Techniques (*JP title: Developing reliable and affordable technologies for the radiological characterization and segregation of historical preconditioned radioactive waste*)	High	
	1.2.2 Impacts of Extended Storage on Waste Packages (*JP title: Improved understanding of the impacts of extended storage on waste package performance*)	High	✓
	1.4.2 Gas Generation Processes (*JP title: Improved understanding of the generation and release of radioactive trace gases and bulk gases from wasteforms and waste packages*)	High	
	2.4.5 Interim Storage Facility Safety (*JP title: Operational lifespan of interim storage facilities*)	High	
	Waste Management Routes across Europe considering different waste types and their specified endpoints (Originates from networking needs identified by ENEF NAPRO Guide)	High	✓
	1.1.5 Geopolymers (*JP title: Demonstration of geopolymer performance in representative disposal conditions*)	Medium	
	1.1.7 Chemotoxic Species (*JP title: Improved understanding of the nature and quantities of the likely chemotoxic component of common wastes*)	Medium	
	1.1.8 Novel Radioactive Waste Treatment Techniques (*JP title: Optimisation of radioactive waste treatment techniques where there is potential for volume/hazard reduction and potential cost savings*)	Medium	

	1.1.9 Spent- Fuel Evolution (*JP title: Improved understanding of the behaviour of packaged Spent Fuel for a range of hypothetical fire and impact scenarios during operations and transport, and consolidation of existing understanding of post-closure Spent Fuel release processes*)	Medium	✓
	3.5 Inventory Collation & Forecasting	Medium	✓
	2.1.6 Waste Acceptance Criteria	Medium	✓
	1.1.10 Spent Fuel Fissile Content (*JP title: Quantification of fissile content of spent fuel*)	Low	
	3.7 Link to Waste Producers/ Fuel Manufacturers (*JP title: Strengthened links between Implementers and Waste Producers*)	Low	✓
	3.6 Evolution of Waste Inventory (*JP title: Methodologies applied to define radionuclide inventories*)	Low	✓
	3.10 Disused Sealed Radioactive Sources (*Understanding of the potential for long-term storage as a management option for disused sealed radioactive sources*)	Low	✓
	1.2.4 Reworking of Damaged and Aged Waste Packages (*JP title: Management of damaged waste packages and the criteria and methods for reprocessing aged waste*)	Low	✓
	1.1.6 Fourth generation (Gen (IV)) wastes	Low	
Theme 3: Engineered barrier system properties, function and long-term performance	1.2.1 Waste Package Interfaces (*JP title: Improved understanding of the interactions occurring at interfaces between waste packages and different barriers in the disposal facility*)	High	
	1.3.1 Bentonite and other Clay Based Components (*JP title: Characterised bentonite / clay-based material evolution under specific conditions to provide data on hydro-mechanical, thermal and chemical behaviour*)	High	
	1.3.2 Microbial Influence on Gas Generation (*JP title: Improved chemical and microbial data to better quantity gas generation and the consequences of microbial processes*)	High	
	1.3.3 Cementitious Component Behaviour (*JP title: Improved quantification and understanding of cement-based material evolution to improve long-term modelling and assessments*)	High	
	1.3.5 Metallic & Cementitious Chemical Perturbations (*JP title: Improved understanding of the impacts of different metallic and cementitious component phenomena on near-field evolution via improved models*)	High	
	1.4.4 Gas Reactivity in the EBS (*JP title: Improved understanding of gas reactivity in the EBS*)	High	
	2.2.2 Performance of Plugs and Seals (*JP title: Improved understanding of the performance of plugs and seals*)	High	
	1.2.3 Alternative HLW/Spent Fuel Container Material Development (*JP title: Developing alternative HLW and Spent Fuel container material options and improved demonstration of their long-term performance*)	Medium	

	1.3.4 Low pH Cements (*JP title: Improved understanding of low pH cements*)	Medium	
	1.3.7 HLW/ILW Near-field Evolution (*JP title: Improved description of the spatial and temporal evolution of transformations affecting the porous media and degrading materials in the near-field of HLW and ILW disposal systems*)	Medium	
	1.3.6 Salt Backfill (*JP title: Improved understanding of a salt backfill*)	Low	
	1.3.8 Co-Disposal Interactions (JP title: Identify co-disposal interactions of importance to long-term safety)	Low	✓
Theme 4: Geoscience to understand rock properties, radionuclide transport and long-term geological evolution	1.4.1 Gas Migration through the Excavated disturbed Zone/EBS and Far-Field (*JP title: To increase understanding of gas migration in different host rocks*)	High	
	1.4.4 Gas Reactivity in the Geosphere (*JP title: Improved understanding of gas reactivity in different host rocks*)	High	
	1.5.2 Sorption, Site Competition, Speciation and Transport (*JP title: Improved representation of sorption mechanisms and coupled chemistry / transport processes for various media*)	High	
	1.5.5 Effects of Microbial Perturbations on Radionuclide Migration (*JP title: Improved understanding of bounding conditions for the effects of microbial perturbations on radionuclide migration to support performance assessments*)	High	
	3.2 Site Evolution Models (*JP title: Development of site evolution models, and how to manage data as it is obtained during the site characterisation phase*)	High	
	1.4.3 Gas Transients (*JP title: Develop and implement two-phase flow numerical codes to increase gas transient representation at the disposal scale*)	Medium	
	1.5.3 Incorporation of Radionuclides in Solid Phases (*JP title: Quantification of long-term entrapment of key radionuclides in solid phases to inform reactive transport models*)	Medium	
	1.5.4 Transport of Strongly Sorbing Radionuclides (*JP title: Improved understanding of the transport of strongly sorbing radionuclides*)	Medium	
	1.5.6 Organic-Radionuclide Migration (*JP title: Improved understanding of the role of organics (either naturally occurring or as introduced in the wastes) and their influence on radionuclide migration*)	Medium	
	1.5.7 Temperature Influence on Radionuclide Migration (*JP title: Improved understanding of the influence of temperature on radionuclide migration and representation of effects in geochemical models*)	Medium	
	1.5.8 Colloid Influence on Radionuclide Migration (*JP title: Improved understanding of the role of colloids and their influence on radionuclide migration*)	Medium	

	1.5.9 Redox Influence on Radionuclide Migration (*JP title : Improved understanding of the influence of redox on radionuclide migration)*	Medium	
	1.5.10 Ligand-Influenced Transport Modelling (*JP title: Improved understanding of the role of organics (either naturally occurring or as introduced in the wastes) and their influence on radionuclide migration*)	Medium	
	1.5.11 Transport of Volatile Radionuclides (*JP title: Developing a geochemical model for volatile radionuclides*)	Medium	
	2.2.6 Biosphere Models (*JP title: Enhanced treatment of climate change, non-human biota, land-use and parameter derivation in biosphere models*)	Medium	
	1.6.3 Groundwater Evolution (*JP title: Developing models of groundwater evolution*)	Medium	
	1.6.1 Fracture Filling (*JP title: Improved understanding of the processes of fracture filling*)	Low	
	1.6.4 Rock Matrix Diffusion (*JP title: Impact of rock matrix diffusion on travel time through the geosphere*)	Low	
Theme 5: Geological disposal facility design and the practicalities of its safe management:	2.5.1 Operational Monitoring Strategies (*JP title: Developing monitoring strategies appropriate to the operational phase (including facility construction and work acceptance) of geological disposal facilities that will not adversely affect the performance of the disposal system*)	High	
	2.5.3 Monitoring Technologies (*JP title: Developing innovative monitoring technologies*)	High	
	2.5.2 Monitoring Strategies for Closure and Post-closure (*JP title: Developing appropriate monitoring technologies for closure and a period of post-closure institutional control in links with relevant parameters for safety*)	Medium	
	2.5.7 Industrialization (*JP title: Optimization of backfilling and other major implementation processes, including waste emplacement, retrieval and sealing technologies*)	Medium	
	2.5.8 Engineering Asset Management(*JP title: Developing cost-effective asset management strategies for use in the design*)	Medium	✓
	2.5.4 Retrievability (*JP title: Improved understanding of waste package durability and disposal facility infrastructure with respect to retrievability*)	Low	
	2.5.5 Concept and Design Adaptation (*JP title: Assessment of the technical feasibility and lifecycle adaptation of a geological disposal concept for a specific site and specific nuclear waste type*)	Low	
	2.5.6 Mock-up Experiments (*JP title: Verify robustness of disposal system designs using large scale mock ups*)	Low	
	2.4.4 Accident Mgt. and Emergency Preparedness	Low	✓
	2.4.2 Flooding Risk Assessment (*JP title: Developing operational hazard assessment methodologies (inc. flooding risk*))	Low	
	3.8 Concept Adaptation and Optimisation (*JP title: Assessment of the technical feasibility and lifecycle*	Low	✓

	adaptation of a geological disposal concept for a specific site and specific nuclear waste type)		
	3.12 Co-disposal Interactions (*JP title: Managing co-disposal*)	Low	✓
	3.13 Radiation Protection Optimisation Principle	Low	✓
	3.17 Reversibility	Low	✓
Theme 6: Siting and licensing:	1.6.5 Site Descriptive Models (*JP title: Maintaining and developing understanding of tools and techniques for developing site descriptive models*)	High	✓
	3.1 Site Uncertainty Treatment *(JP title: Methodologies for site uncertainty treatment)*	High	✓
	1.6.2 Geological Uncertainties (*JP title: Developing state-of-the-art on the methods of uncertainty management associated with site characteristics*)	Medium	
	3.3 Site Selection Process	Medium	✓
	3.4 Technical and Socio-political Siting Criteria	Low	✓
Theme 7: Performance assessment, safety case development, and safety analyses:	2.2.1 THMC Evolution (*JP title: Improved understanding and models for the impact of THMC on the behaviour of the host rock and the buffer materials*)	High	
	2.2.4 Upscaling THMC Models (*JP title: Improved understanding of the upscaling of THMC modelling for coupled hydro-mechanical-chemical processes in time and space*)	High	
	2.3.4 Multi-scale Reactive Transport Models (*JP title: Improved multi-scale reactive transport models*)	High	
	1.5.1 Chemical Thermodynamics (*JP title: Further develop transparent and quality assured thermodynamic databases for use in performance assessments and supporting models*)	High	
	2.1.1 Pre-closure disturbances (*JP title: Improved understanding of the influence of pre-closure disturbances on long-term safety*)	Medium	✓
	2.1.2 Assessment Methodologies	Medium	✓
	2.1.3 Uncertainty Treatment (*JP title: Further refinement of methods to make sensitivity and uncertainty analyses*)	Medium	✓
	2.2.5 Natural Analogues (JP title:)	Medium	✓
	2.3.1 Performance Assessment Tools (*JP title: Improved performance assessment tools*)	Medium	
	2.3.3 Long-range Transport Models (*JP title: Improve geosphere transport models)*	Medium	
	2.3.5 Upscaling in Support of Performance Assessment (*JP title: Improved understanding the role of physical/chemical processes at different scales and linking bottom-up and top-down approaches in performance assessments*)	Medium	
	2.3.6 Heterogeneity (*JP title: Improved treatment of heterogeneity*)	Medium	
	2.3.7 Improved Computing	Medium	
	3.9 Safety Case Guidelines, Management & Review	Medium	✓
	2.1.4 Dose Thresholds	Low	

	2.1.5 Managing Deviations (*JP title: Improved understanding for the impact of deviations in planned implementation scenarios on the performance assessment outputs of the disposal facility*)	Low	
	2.2.3 Oxidative Transients (*JP title: Improved understanding of the spatial extent and evolution with time of oxidative transients, as well as the possible impact on safety functions*)	Low	
	2.3.2 Open-source Performance Assessment Code	Low	
	2.4.1 Fire and Explosion Assessment (*JP title: Improve fire and impact assessment*)	Low	
	2.4.3 Improve Understanding of the Impacts of Operational Safety	Low	

Further details of the JOPRAD methodology for identifying the scientific and technical basis of EURAD is presented in Section 4 of JOPRAD deliverable D4.2 Programme Document.

Step 2 – EURAD has been developed in parallel with the completion/near completion of EC Horizon 2020 projects (See Annex 4, Horizon 2020). Several new needs have therefore been identified as a result of recent RD&D results, and / or that are now considered of higher common interest by the contributors and participants of EURAD. These needs have been approved for inclusion in the SRA through various meetings between representatives of WMOs, TSOs and RE's to ensure the needs meet with the same boundary conditions used by JOPRAD, and are suitable for Joint Programming.

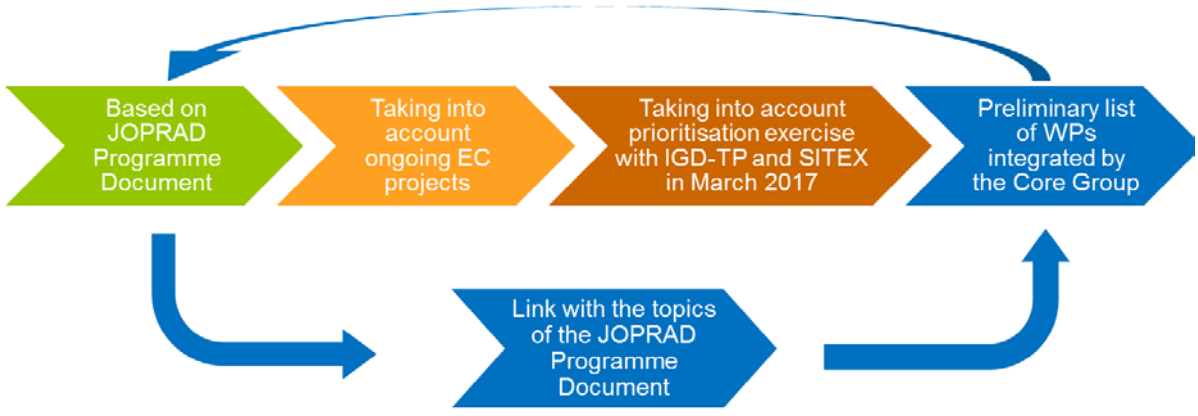
The table below maps the JOPRAD sub-topics, and newly identified scope to the 7 Scientific Themes of the EURAD SRA.

Table: EC JOPRAD scope and newly identified scope mapped to Themes of the EURAD SRA

Annex 3 – Development of the EURAD Deployment Plan 2019-2024

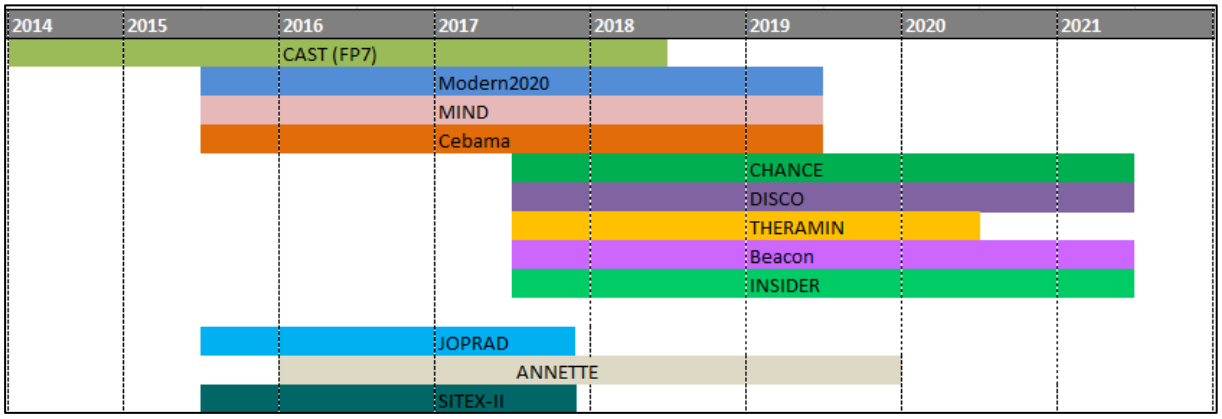
This Annex describes how the list of RD&D/Strategic Studies WPs for the launch at the start of EURAD were established, i.e. for the first phase, referred to as EURAD 1 ("first wave"). A similar process shall be used for the launch of the "second wave".

The preliminary list of collaborative RD&D, strategic studies and knowledge management work packages (WPs) have been established based on the following process:



In February 2017, the core group specified the following boundary conditions that have to be taken into account prior suggesting RD&D and networking WPs:

- Each WP has to be in line with the vision and the JOPRAD Programme Document, in particular with respect to the results of the questionnaire. Specifically, each WP has to address mainly topics of high or medium level of common interest from the JOPRAD Programme Document.
- The suggested WPs have to be of common interest by the different categories of actors: REs, TSOs and WMOs.
- The suggested WPs should avoid (i) duplication of existing international activities (e.g. from NEA or IAEA) and (ii) re-doing what has been done in the past (at national or European level).
- The WPs have to address topics which are not currently addressed by ongoing EC projects. The ongoing EC projects are given on the following figure. The different topics addressed in ongoing EC projects are the following: monitoring (Modern2020), microorganisms (MIND), concrete alteration (Cebama), non-destructive assay methods (CHANCE), waste thermal treatment (THERAMIN), bentonite mechanical evolution (Beacon) and characterization of dismantling waste (INSIDER). The aim of this is to wait for feedback from these ongoing projects before launching any follow up WP within EURAD 1.



The selection process followed a top-bottom approach. In March 2017, a first list of WPs was prioritized by the Executive Group (EG) of IGD-TP for the WMOs, and SITEX for the TSOs. Following this, the Core Group established a list of potential WPs and issued a call for interest.

1. WMOs Proposal

The main ideas that guided the selection of the EG of the IGD-TP were first to find a good balance between mature and emerging projects to be launched at start of EURAD 1, and then to keep it simple for the first round.

As a result, a set of four topics was first issued by RWM and SKB, and three subsequent topics were then added by ONDRAF/NIRAS and Andra. This list included three matures projects and four new and challenging topics. The three mature projects are listed hereafter:

- Cement-Organics-Radionuclides-Interactions: this topic address both surface disposal and deep geological disposal. It needed to be reworked and significantly improved;

- Safety of Extended dry storage of nuclear spent fuel: this project may not be relevant to all EG members. It needed to be reworked and significantly improved;
- High temperature clay interactions: the topic is a first step toward optimization of the architecture of the deep geological disposal. The idea was to continue the work begun at WG3 from EF7.

The four emerging topics fall into two different categories:

- The topic dedicated to the assessment of chemical evolution of ILW and HLW disposal seems adequate in the context of an Joint Programme towards implementation of actual repositories. It corresponds to an integration challenge that all WMO's are facing or will be facing at some point (managing the complexity of the phenomenological evolution of these subsystems, managing uncertainties…);
- The other three topics fit in the area of long-term scientific endeavour to strengthen safety cases, reduce conservatism and maintain skills:
    - Fundamental understanding of radionuclide mobility;
    - Mechanistic understanding of gas migration; and
    - Numerical methods and tools applied to performance assessment.

2. TSOs proposal

The five following topics have been suggested:

- Metallic component behaviour along the stages of storage and disposal programmes;
- Gas migration;
- Radionuclide migration through disturbed engineered barrier systems and host rocks,
- Conditions for closure; and
- Management of uncertainties.

Based on the proposals from WMOs and TSOs, the Core Group established the following list of RD&D/Strategic Studies WPs:

- (RD&D) Modelling of process couplings and numerical tools applied to PA;
- (RD&D) Assessment of chemical evolution of ILW and HLW disposal cell;
- (RD&D) Mechanistic understanding of gas migration (mainly in clay-based materials);
- (RD&D) Influence of temperature on clay-based material behaviour;
- (RD&D) Cement-Organics-Radionuclide-Interactions;
- (RD&D) Fundamental understanding of radionuclide mobility;
- (RD&D) Spent Fuel characterization and evolution until disposal;
- (Strategic Studies) Understanding of uncertainty, risk and safety; and
- (Strategic Studies) Waste management routes in Europe from cradle to grave*.

* This Strategic Studies emerged in April 2017 following the JOPRAD Programme document workshop in London in order to meet the expectations from small / early stage programmes.

This list of potential WPs was then checked and agreed by REs (this work was coordinated by CNRS).

Based on this list of potential WPs, a Call for Interest was issued in April 2017 to collect interest/ potential contributions by the different organisations. All WPs received a high-level of interest. Nine working groups have been established in June 2017 to officially start the proposals development.

Annex 4 – Supporting Documents & References

1. Aarhus Convention: The United Nations Economic Commission for Europe (UNECE) Convention on access to information, public participation in decision-making and access to justice in environmental matters, Aarhus, Denmark, 25 June 1998.
2. EC Progress Report on Progress of Implementation of Council Directive 2011/70/EURATOM: Report from the Commission to the Council and European Parliament on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects, Brussels, 15.5.2017, COM(2017) 236 final.
3. ENEF NAPRO Guide: Guidelines for the Establishment and Notification of National Programmes developed by the European Nuclear Energy Forum (ENEF) Work Group, 2013.
4. EU Horizon 2020 Research and Innovation Programme: Research at European level funded through Euratom Research and Training Programmes. Fission research actions cover: safety of nuclear systems; safe long-term management of radioactive waste; development and sustainability of nuclear expertise and excellence in the EU; risks of low and protracted exposure to ionising radiation, including in medical applications; and research infrastructures and education and training.
5. IAEA - Developing Multi-national Radioactive Waste Repositories - Viability of Sharing Facilities for the Disposal of Spent Fuel and Nuclear Waste, IAEA-TECDOC-1658, 2011.
6. IAEA Joint Convention: Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, IAEA, Vienna, Austria, 1997.
7. IAEA Safety Standards Series SSG-23: The Safety Case and Safety Assessment for the Disposal of Radioactive Waste, No. SSG-23, ISBN:978-92-0-128310-8, IAEA, 2012.
8. IAEA Scientific and Technical Basis for Near Surface Disposal of Low and Intermediate Level Waste, IAEA Technical Report Series #412, STI/DOC/010/412, ISBN 92-0-118702-5, IAEA 2002.
9. IAEA Scientific and Technical Basis for the Geological Disposal of Radioactive Waste: IAEA Technical Report Series #413, STI/DOC/010/413, ISBN 92-0-100103-7, publ. IAEA 2003.
10. IAEA Planning and Design Considerations for Geological Repository Programmes of Radioactive Waste: IAEA-TECDOC-1755, ISBN:978-92-0-109914-3, IAEA, 2014.
11. IGD-TP - Implementing Geological Disposal Technology Platform: The collaborative body which coordinates RD&D needs of the implementers of geological disposal at the European level, established in 2009. The IGD-TP publish and maintain their own strategic research agenda.
12. JOPRAD - Towards a Joint Programming on Radioactive Waste Disposal: EC project that completed initial preparatory work for the potential setting up of Joint Programme on radioactive waste management and disposal. JOPRAD identified the scientific and technical basis of a future joint Programme in the D4.4 Programme Document together with considerations for a financing and governance scheme, published in the D3.2 Conditions for Implementing a Joint Programme.
13. NEA - Stepwise Implementation: Stepwise Approach to Decision Making for Long-term Radioactive Waste Management, Experience, Issues and Guiding Principles, NEA No. 4429, Nuclear Energy Agency, 2004.
14. NEA – Underground Testing: Going Underground for Testing, Characterisation and Demonstration, NEA Radioactive Waste Management Committee Report NEA/RWM(2001)6/REV, publ. OECD Nuclear Energy Agency 2001.

15. NUGENIA - Nuclear Generation II & III Association: Association of more than 100 members worldwide to advance the research and development of nuclear fission technologies, in particular for Generation II and III nuclear plants.
16. Official Journal of the European Union Nuclear Safety Directive: OJEU (2011), The Council Directive 2009/71/EURATOM, establishing a Community framework for the nuclear safety of nuclear installations, Official Journal of the European Union, f 25 June 2009.
17. Official Journal of the European Union Waste Directive: OJEU (2011), The Council Directive 2011/70/EURATOM, establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, Official Journal of the European Union, 2 August 2011.
18. PLANDIS Guide: RD&D Planning Towards Geological Disposal of Radioactive Waste Deliverable D-No:2.3, Guidance for less-advanced programmes, 2015.
19. SITEX - Sustainable Network for Independent Technical Expertise of Radioactive Waste: A network of organisations carrying out activities aimed at providing the technical and scientific basis for notably supporting the decisions made by the national regulatory body established in 2012. The SITEX network issued their first strategic research agenda in 2016.
20. Underground Research Facilities: Underground Research Facilities and Rock Laboratories for the Development of Geological Disposal Concepts and Repository Systems by I. Blechschmidt and S. Vomvoris, Chapter 4 in Geological Repository Systems for Safe Disposal of Spent Nuclear Fuels and Radioactive Waste, ISBN 978-1-84569-542-2, publ. Woodhead Publishing 2010.
21. WENRA - Western European Nuclear Regulators Association: WENRA is a network of chief nuclear safety regulators in Europe exchanging experience and discussing significant safety issues. It aims to develop a common approach to nuclear safety and to provide an independent capability to examine nuclear safety in applicant countries.

END OF DOCUMENT