Name of the Public Contract:

Utilization of foreign experience in the siting process for a deep geological repository for radioactive waste in the Czech Republic

FRAMEWORK AGREEMENT

correction according to the additional information to Tender Conditions
pursuant to § 49 of the Act

No. 1 and No. 2

Contents

1. CONTRACTING PARTIES

1.1 Client: Česká republika – Správa úložišť radioaktivních odpadů

Registered office: Dlážděná 6, 110 00 Praha 1, Czech Republic
Represented by: RNDr. Jiří Slovák, Managing Director
ID: 66000769,
Banking details:
Name of Bank: ČNB, Na Příkopě 28, Praha 1
Account No.: 35-64726011/0710
Not a payer of VAT

(hereinafter referred to as the **"Client"**) and

1.2 Name of company: Posiva Oy (lead party) in consortium with Saanio & Riekkola Oy

Registered office: Olkiluoto, FI-27160 Eurajoki, Finland
Represented by: Janne Mokka
ID: 1029258-8
Tax ID: FI10292588

Banking details:
Name of Bank: Nordea (NDEAFIHH)
Account No.: FI 28 1660 3001 1003 98
(hereinafter referred to as the "**Supplier**")
(hereinafter both referred to as the "**Contractual Parties**"

1.3 Contact persons

1.3.1 The Client authorizes the following representatives to be responsible for communication with the Supplier during the implementation hereof:

a) With respect to FA activities:
Ing. Ilona Pospíšková e-mail: pospiskova@surao.cz
Project Manager
Ing. Antonín Vokál, CSc. e-mail: vokal@surao.cz
Deputy Project Manager

b) With respect to contractual matters:
RNDr. Jiří Slovák e-mail: slovak@surao.cz
Managing Director

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1.3.2 The Supplier authorizes the following representatives who shall be responsible for executing the subject matter of this FA and for communication with the Client:

a) With respect to FA activities

Name: Kimmo Lehto e-mail: kimmo.lehto@posiva.fi

Project Manager

Jere Lahdenperä e-mail: jere.lahdenpera@posiva.fi

Deputy Project Manager

b) With respect to contractual matters:

Name: Mika Pohjonen e-mail: mika.pohjonen@posiva.fi

1.4 Preamble

1.4.1 The Client has duly completed a Tendering procedure in order to procure for its requirements for an expert support for the transparent, credible and justifiable selection of a site for a deep geological repository for radioactive waste in the Czech Republic in such a way as to provide for the optimisation of siting activities by a Supplier who has experience in the respective fields of activity acquired during the siting process for a deep geological repository in crystalline rock and concerning which the siting process has reached the licencing phase. The tendering procedure was led pursuant to Act No. 137/2006 Coll., on Public Contracts, as amended (hereinafter referred to as the "Act") in the form of an open awarding procedure for an above-threshold public contract for services with the title the "Utilization of foreign experience in the siting process for a deep geological repository for radioactive waste in the Czech Republic" (hereinafter referred to as the "Public Contract" and the "Tender"). The completed Tender resulted in the selection of the present Supplier's tender; the Client and the Supplier (jointly referred to as the "Contractual Parties") hereby conclude, pursuant to § 89 of the Act and pursuant to § 1746(2) of Act No. 89/2012 Coll., the Czech Civil Code, as amended (hereinafter referred to as the "CCC"), on the day given below this Framework Agreement (hereinafter referred to as the "FA")

1.5 Identification data of the public contract

Published in:

Tenders Electronic Daily - CZ under No. - date: 528231 - 11/12/2015

Official Journal of the European Union under No. - date: 2015/S 243-441657 – 16/12/2015

1.6 Definition of basic terms and abbreviations

1.6.1 Basic Terms

For the purpose of the Tender documentation the following terms are defined:

Act	Act No. 137/2006 Coll., on Public Contracts, as amended
Services	activities of the Supplier defined in article 2 of the FA

1.6.2 Abbreviations

CCC	Act No. 89/2012 Coll., the Czech Civil Code, as amended
DGR	Deep geological repository for disposal of SNF and /or HLW
HLW	High Level radioactive Waste
SNF	Spent Nuclear Fuel
FA	Framework Agreement pursuant to § 11 of the Act
TD	Tender documentation pursuant to § 44 of the Act

2. PURPOSE AND SUBJECT OF THE FA

2.1 Purpose of the public contract

2.1.1 The purpose of the present public contract consists of the conclusion of a Framework Agreement with one Tenderer under § 89 of the Act so as to satisfy the Client's needs in terms of the provision of expert support for the transparent, credible and justifiable selection of a site for a deep geological repository for radioactive waste in the Czech Republic in such a way as to provide for the optimisation of siting activities by a Supplier who has experience in the respective fields of activity acquired during the siting process for a deep geological repository in crystalline rock and concerning which the siting process has reached the licencing phase, i.e. a request has been made for authorization to place the DGR in a final location.

2.1.2 According to the updated State Energy Policy two sites for a DGR should be chosen by 2020 and a final site by 2025.

2.2 Support will be required in the following areas:

a) the assessment and/or development of procedures and methods for the selection of the most suitable site for deep geological disposal, e.g.:
   i. the preparation of DGR development strategy and project management plan,
   ii. the preparation of site descriptive models of the selected sites,
   iii. the assessment and or/development of a geological database for data storage,
   iv. the assessment and/or development of specific site characterisation methods,
   v. the assessment and/or development of a safety case and supporting safety assessments,
   vi. the assessment and/ or development of the repository design including manipulation system,

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vii. the assessment and/or development of procedures and methods for the development of engineered barriers;

b) a cost estimate activities covering the preparation and construction of the deep geological repository and the relevant cost optimisation;

c) support for communication activities with the general public, the relevant authorities and NGOs.

2.3 The Supplier shall perform these Services via the application of his knowledge and expertise in the above-mentioned areas, including among others:

a) procedures and methods for the characterisation of selected sites (including the preparation of site descriptive models);

b) quality requirements concerning the various siting processes;

c) geo-disciplines (petrography, geomorphology, tectonics, geochemistry, geophysics, engineering geology, geological modelling, remote sensing etc.),

d) hydrogeology and hydrology,

e) engineering and project solutions concerning deep geological disposal,

f) environmental impact assessment,

g) safety case and supporting safety assessments,

h) cost estimation and budgeting of the preparation and construction of the DGR,

i) communication skills and experiences acquired during selection of the most suitable site for DGR.

2.4 The Framework Agreement constitutes a Framework Agreement within the meaning of § 11 of the Act.

2.5 The Supplier shall provide the Services to the Client based on individual / specific orders to be issued by the Client in line with § 92 (1)(a) of the Act.

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2.6 Anticipated structure of the Services stated in Article 2.2 :

Type of the Services	Anticipated share	Equivalent in hours
a) Assessment and/or development of procedures and methods for the selection of the most suitable site for deep geological disposal	80%	16 000
b) Cost estimate activities covering the preparation and construction of the deep geological repository and the relevant cost optimisation	10%	2 000
c) Support for communication activities with the general public, the relevant authorities and NGOs	10%	2000
Total	100%	20 000

2.7 The structure anticipated above does not represent a binding structure for the Services provided with regard to the total number of hours or the structure of individual types of Services. The Client shall not be obliged to use the full extent of the hours nor follow the presently anticipated structure.

3. CONDITIONS OF SERVICE PERFORMANCE

3.1 The Services shall be performed pursuant to individual orders placed by the Client either (i) at the offices or place of business of the Supplier (hereinafter referred to as "Supplier Sites"), and/or (ii) at the registered office or place of business of the Client, or as the need may arise, at other locations (e.g. DGR exploration areas in the Czech Republic) as may be specified by the Client (hereinafter referred to as "Client Sites"). All the outputs of Services performed by the Supplier shall be handed over to the Client at the Client's registered office at Dlážděná 6, 110 00, Praha 1.

3.2 The Supplier acknowledges that the Client will not be obliged hereunder to order Services up to reaching the total value of the public contract. The Supplier will thus not be entitled to demand that the Client order any of the activities hereunder nor will the Supplier be entitled to claim any payments, with the exception of the remuneration provided to the Supplier for services actually ordered and duly performed.

3.3 The Services will be performed on the basis of individual orders to be issued by the Client pursuant to § 92(1)(a) of the Act and only up until the contract price of the public contract stated in Article 4.1 of the Contract has been reached.

3.4 The period of the execution of the said Services

3.4.1 Anticipated commencement date: July / 2016

3.4.2 The anticipated duration of the Framework Agreement: 4 years.

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3.4.3 The commencement date will be subject to the proper completion of the tendering procedure and timely conclusion of the Framework Agreement. The Contracting Authority reserves the right to unilaterally change the anticipated commencement date for whatever reason including with regard to its operating and organizational requirements.

3.5 The Supplier declares that the following elements of the subject matter of the subject matter of the Services will not be performed by a sub-contractor:

3.5.1 the preparation of DGR development strategy and project management plan,

3.5.2 the assessment and/or development of safety case and supporting safety assessments,

3.5.3 a cost estimate activities covering the preparation and construction of the deep geological repository and the relevant cost optimisation.

3.6 Exclusion of conflict of interest

NA

3.7 Review Meetings

3.7.1 Regular performance review meetings will take place at the Client's premises unless the Parties agree otherwise throughout the FA period.

3.7.2 The exact timing and frequencies of such Review Meetings will be determined by the Client following the conclusion of the FA. It is anticipated that the frequency of the Review Meetings will be once per quarter year; the Parties agree to be flexible concerning the timing of these meetings.

3.7.3 The purpose of the Review Meetings will be to review the Supplier's performance under this FA and other Partial Contracts. The agenda for each Supplier Review Meeting shall be set by the Client and communicated to the Supplier in advance of such meetings.

3.7.4 The Supplier Review Meetings shall be attended, as a minimum, by the Client and Supplier representatives stated in Article 1.3 of the FA.

3.8 With respect to the processing of the outputs that will be specified in the Partial Contracts the Client will require that it provides comments in a draft version before such outputs are handed over as a final version to the Client. The Parties may agree to modify the following procedure and deadlines according to the scope of the documents in question:

3.8.1 The Supplier shall process and hand over its outputs to the Client in the form of a draft version;

3.8.2 The Client shall provide comments within 20 working days;

3.8.3 The Supplier will inform the Client on how it will process the Client's comments in order to obtain the Client's approval. This may be executed via correspondence or negotiation.

3.8.4 The Supplier shall incorporate such comments into the outputs within 10 working days following agreement on the manner in which they will be incorporated.

4. PRICE AND PAYMENT CONDITIONS

4.1 The Price (the "contract price") is set as the maximum price and amounts 2 748 900 EUR (in words two million sevenhundred fortyeight thousands ninehundred) without VAT.

4.2 The contract price includes the following parts:

4.2.1 Part of the price that amounts 2 499 000 EUR (in words two million fourhundred ninetynine thousands) without VAT corresponding to a labour intensity of 20,000 (in words: twenty thousand) man hours of which 10% consists of the category of highly qualified conceptual and coordination work, 50% the category of very challenging and conceptual work, 30% the category of hard work, 5% the category of less demanding work and 5% the category of auxiliary work for the entire period of performance. and

4.2.2 Part of the price that amounts to 249 900 EUR (in words twohundred fortyninethousand ninehundred) without VAT that includes necessary incidental expenses

4.3 The actual (invoiced) price of the execution of the Contract will be determined on the basis of work actually completed and, on the side of the Client approved acceptance protocol, with a statement of work, according to the: performed works (expressed in hours) x unit price (hourly billing rate), which is:

Item	Category of work	Average share of work [%]	Hourly billing rate without VAT [EUR]
1	Highly qualified conceptual and coordination work	10	166
2	Very challenging and conceptual work	50	138
3	Demanding work	30	112
4	Less demanding work	5	75
5	Auxiliary work	5	40

4.4 The hourly billing rates according to Article 4.3 of the FA shall be without VAT. These rates are agreed as being fixed for the duration of the FA and will be

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adjusted from 1 January each year commencing in 2017 in line with the average annual change in the price index of market services (CPV 71351000-3) according to static statement Eurostat Labour Cost index NACE_Rev.2, "Professional, scientific and technical activities" (wages and salaries total, baseline value for 2015=104,2. 1st Jan 2017 adjustment will be done using value for 2016).

4.5 The amount of the hourly billing rates shall include overheads, travel and accommodation expenses within the states of the permanent residence of the Supplier's personnel. Hourly billing rates shall not include travel expenses from and in the states of the permanent residence of the Supplier's personnel to the Czech Republic and their accommodation expenses in the Czech Republic. These shall form part of the incidental expenses of the Supplier and will be paid by the Client on the basis of documentation submitted with the following limits:

a) tourist flights ("economy") class,

b) train fares in "business" class,

c) car travel expenses with a limit according to Article b) of the Article,

d) Czech accommodation - EUR 100 / day.

4.6 Expenses for the printing of documents and the translation of texts into English shall be included in the incidental expenses of the Supplier.

4.7 The Supplier will charge the Client a price on the basis of the relevant acceptance protocol that will include a statement of work actually carried out according to Article 4.3 of this Agreement, broken down into individual activities, revised in accordance with Article 4.3 of this Agreement, on a quarterly basis, up to the tens day of the month following the end of each calendar quarter of the current year, in the form of a tax document (hereinafter "invoice"). The day of taxable supply will be regarded as the final day of the final month in the previous calendar quarter. Invoices will be accompanied by a Client agreed Statement of Work documenting the extent of the work actually carried out by individual workers and a breakdown of the Supplier's incidental expenses for the period.

4.8 Invoices shall be payable within 30 calendar days of the date of receipt by the Client. The Contractual Parties agree that the obligation to make payment will be fulfilled on the date upon which the respective amount is deducted from the Client's bank account in favour of the Supplier's bank account as indicated above, or as may be notified in writing to the Client at a later date.

4.9 The Supplier's invoices must provide detailed timesheet records of actually performed Services in a structure following the corresponding and actually ordered tasks in that particular invoicing period, providing a description of the specific activity / content for each ordered task, the name of experts who participated in the provision of the Services and the categories of work in compliance with Article 4.3. The invoices provided must also fulfil the requirements of an accounting document and tax receipt according to Act No.

563/1991 Coll., on Accounting, as amended, and Act No. 235/2004 Coll., on VAT, as amended. Invoices must also contain a declaration that the invoiced performance is provided in connection with the respective Project and must specify the Project title and registration number. Each invoice shall be accompanied by an acceptance protocol for that particular invoiced performance approved by the Client pursuant to 4.7 above. In the event that any of the Supplier's invoices fail to respect these requirements, or contain errors with respect to the amount of the price or errors with respect to the VAT applicable, the Client shall be entitled to return the erroneous invoice to the Supplier within 30 days of its receipt without payment. In such a case, the maturity period for each new corrected invoice shall run anew from the date of its receipt by the Client. The Supplier shall deliver all invoices to the Client's registered office using registered post.

5. ORDERING INDIVIDUAL TASKS – CONCLUSION OF PARTIAL CONTRACTS

5.1 Individual – partial contracts hereunder (hereinafter referred to as "Partial Contracts") shall be concluded as follows:

5.1.1 The Client in compliance with § 92 (1)(a) of the Act will send to the Supplier a written invitation to perform an individual task order (hereinafter referred to as the "Order"), which makes up a proposal to conclude a "Partial Contract".

5.1.2 Each Client Order shall define which Services (tasks) are required, including requirements for the resulting output of the Services, the extent (the required specialization of experts or the identification of persons to be involved) as well as binding deadlines with respect to particular tasks / the submission of resulting outputs etc.

5.1.3 The Supplier shall revert to the Client in writing within 20 (twenty) business days of the receipt of the Order with his confirmation or modification of the Order. The Supplier may modify the Order on the grounds of serious shortcomings in the Order due to which he could not be justly required to provide performance according to the Partial Contract on the basis of such an Order.

5.1.4 The Client shall settle all modifications by either accepting them or by providing an explanation as to the reasons for their non-acceptance.

5.1.5 The Order becomes binding upon the expiry of the 20 (twenty) business-day period or on the date of receipt of the settlement of modifications by the Supplier, and thus a Partial Contract is deemed to have been concluded for the performance as defined in the Order.

5.1.6 The Client shall be entitled to cancel any of its Orders and/or withdraw from a Partial Contract upon written notice with no sanctions resulting to the Client provided that the Supplier shall be compensated through the provision of partial remuneration corresponding to the already, and in good faith, expended costs of the Supplier at the time of the cancellation. The Supplier shall be

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required to demonstrate the amount of such already incurred costs. Any claims on the part of the Supplier for liquidated damages resulting from the cancellation of the Order shall be excluded.

5.1.7 The Supplier shall be obliged to provide the required cooperation in full with respect to the successful issuance of Orders.

5.2 The Contractual Parties agree to conclude Partial Contracts using the form included in Annex 4 of the FA.

6. RIGHTS AND OBLIGATIONS OF THE CLIENT

6.1 The Client shall have the right to have an inspection performed of the execution of Services by its employees or similar persons (such as the external consultants engaged by the Client on a contractual basis).

7. RIGHTS AND OBLIGATIONS OF THE SUPPLIER

7.1 The Supplier shall be obliged to perform the Services with the corresponding effort and due professional care. The Supplier declares that he is able, in respect to providing the performance hereunder, to act / perform with all pertinent knowledge and due diligence, which is associated with his position and status, and recognizes that any conduct falling potentially short of such due professional care will result in his liability.

7.2 The Supplier shall be obliged to reserve for the Client sufficient capacity in terms of persons responsible for the extent of each Partial Contract.

7.3 The Supplier shall participate in / perform the Services using exclusively the team members listed in Annex 2 hereto. Any change in terms of the team members performing the Services on the part of the Supplier, i.e. the participation of other persons than those listed as team members specifically in Annex 2, will be permitted only following the prior approval of the Client issued in writing.

7.4 The Supplier shall perform his obligations under this Framework Agreement in accordance with:

7.4.1 the requirements of this Framework Agreement;

7.4.2 the terms and conditions of respective Partial Contracts;

7.4.3 all relevant and applicable standards;

7.4.4 in compliance with all applicable legislation.

7.5 The Supplier shall bring to the attention of the Client, any conflict between any of the requirements of Article 7.4 and shall comply with the Client's decision on the resolution of any such conflict.

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8. INTELECTUAL PROPERTY RIGHTS / COPYRIGHT

8.1 Each of the Contractual Parties will be and will remain the sole owner of its intellectual property rights.

8.2 All rights to the know-how, information, documents, files, computer software, equipment, work methods and other material provided to the Supplier or its representative by the Client shall belong to the Client and the Supplier will not be allowed to use them for any other purpose than the completion of the Services, nor will the Supplier be allowed to convey them to third parties other than its affiliates, subcontractors or advisers in accordance with Article 9.

8.3 The Supplier undertakes not to breach the rights of third persons in performing the subject matter of this FA, which may arise to such persons in connection with intellectual property rights, especially copyright pursuant to Act No. 121/2000 Coll., on Copyright and Rights Related to Copyright and on Amendments to Certain Acts, as amended (hereinafter referred to as the "Copyright Act").

8.4 Should a result or part of the performance hereunder by the Supplier constitute a "work" which may be subject to copyright or related rights or subject to the rights of the maker to a database produced by him, the Supplier shall provide to the Client, as the author of such work, an exclusive licence to use such work in all known manner and form to an unlimited extent, from the date of handing over such work to the Client and for the entire duration of the existence of the ownership rights to the work and for use throughout the world; this licence shall be provided by the Supplier to the Client free-of-charge. The Client shall also be entitled to publish, process (including translation) modify or otherwise adjust the work and its name and integrate the work with other work or include it in aggregated work. The Client may grant, in connection with the provided exclusive unlimited licences, sub-licences or assign the licence to third persons at the Client's discretion; the Supplier hereby issues his express prior consent to all such acts. The Supplier expressly waives his rights to be informed by the Client pursuant to § 2364(2) of the CCC. The Client shall not be obliged to use the licence.

8.5 Should a result or part of the performance hereunder by the Supplier constitute an employee or collective work, which may be subject to copyright or related rights or subject to the rights of the creator to a database produced by him, the Supplier shall assign, as the employer or a person on whose initiative and under whose management the work was produced and under whose name the work is presented publicly, the exclusive right to execute the ownership rights of the author to the work to the Client as of the date on which the work was handed over to the Client; the assignment of the right to execute the ownership rights to the Client shall be made by the Supplier free of charge. The Supplier hereby declares that the author has agreed to its publication, processing (including translation) modifications to the work or its name, the integration of the work with another or the inclusion of the work in an aggregate work and to the completion of the employee's work, as well as with the fact that the Supplier will publicize the employee's work under the

Supplier's name, and that the author has expressly agreed with the assignment of the right to execute ownership rights to the Client and from the Client to third persons. The Supplier hereby declares that he provided all the authors with corresponding remuneration and that any and all duties and obligations of the Supplier to the author(s) have been duly settled. The Client shall not be obliged to make use of the assigned rights.

8.6 The Supplier hereby expressly declares that he is fully authorized to dispose of intellectual property rights, especially in connection with the above copyrights, and undertakes for this purpose to ensure the proper and undisturbed use of the work by the Client, or to procure such other approval, licences and sublicences from the author(s) of the work(s) or from other third persons who may be entitled on the basis of the copyright according to the Copyright Act.

8.7 For the sake of clarity and the avoidance of doubt, it is hereby understood that the licencing provisions herein above do not include licences covering the subject of intellectual property rights which are themselves subject to technology transfers, i.e. these provisions do not include the right of access or right to the use of the subjects of the rights protected by industrial property rights nor any other results of own research, contract research or cooperative research between the Supplier and other entities or the Supplier's founder.

9. COMMERCIAL SECRETS AND CONFIDENTIALITY

9.1 This article shall regulate information, documentation and data, which constitute commercial (trade) secrets pursuant to § 504 of the CCC and simultaneously all information, documentation and data, which will be designated by the Client or by the Supplier as confidential (hereinafter referred to as "Confidential Information"). It is generally understood that all the information exchanged as a result of the Services shall constitute Confidential Information and the commercial secret of the Contractual Parties.

9.2 The Contractual Parties undertake, for the term hereof and subsequently following the termination hereof without limitation, to observe the obligation of non-disclosure, to maintain confidentiality and protect Confidential Information of the other party, i.e. not to disclose, directly or indirectly, any Confidential Information as defined herein to any third party and/or not to make such Confidential Information available through its acts whether intentional or by omission or negligence and/or allow by its actions any third person to familiarize itself with such Confidential Information.

9.3 The Contractual Parties further undertake not to use the Confidential Information contrary to the purpose to which it was designated by the other party.

9.4 The Contractual Parties undertake to maintain confidentiality in any and all cases in which they were provided with Confidential Information by any means, i.e. verbally, in writing, electronically or otherwise.

9.5 In the event that the Client obtains Confidential Information in a physical form (i.e. in hardcopy, on data carriers etc.), he shall be obliged to return any such physical information to the Supplier without unnecessary delay upon request, unless they were provided in connection with the implementation of Partial Contracts, or for the purposes of other projects which directly follow on to the Partial Contracts due to phasing.

9.6 The Contractual Parties shall be obliged to limit the number of employees and other persons who have access to Confidential Information and to adopt effective measures which prevent and stop the leaking of Confidential Information, and to adopt, vis-a-vis all employees and other persons, other relevant measures, expressly aimed at ensuring that these persons do not disclose such Confidential Information and / or that competition clauses are adopted as may be deemed necessary.

9.7 The obligation to maintain confidentially does not apply in the following cases:

9.7.1 When any document, data, materials or information subject to confidentiality hereunder are provided without confidentiality restrictions, or these restrictions have been subsequently waived; any such release or waiver must be made in writing by the party which provided such a document, data, materials or information;

9.7.2 When the contents of any document, data, materials or information subject to confidentiality hereunder become publicly available through the actions of the party which provided such a document, data, materials or information or through other actions of that party or third persons which are directed at the publication of the confidential / protected information contained therein (without the assistance of the party which received such documents, data, materials or information hereunder);

9.7.3 In cases which such documents, data, materials or information are provided mandatorily by law or upon the request of a state administration body within their powers (via the courts, an attorney of the state or other competent administrative body as mandated by the legislation) and as long as they are used exclusively for these purposes.

10. NUCLEAR LIABILITY

10.1 The Client, as the owner and operator of contemplated or existing spent nuclear fuel disposal facilities or other nuclear facilities ("Nuclear Facilities") recognizes that it is a fundamental condition for the entering into this FA or any Partial Contract(s) by the Supplier that the Client shall be exclusively liable for any damage resulting from a Nuclear Incident at the Client's Nuclear Facilities.

10.2 The terms Nuclear Damage and Nuclear Incident, as used herein, shall have the same meaning as assigned to them in the Paris Convention and in the applicable enactments of the Supplier's state thereof.

10.3 The Supplier and its subsidiaries and associated companies and its sub-contractors of every tier or kind, including licensors and suppliers of

information and services and the employees of any of the foregoing entities (all of the foregoing entities and employees being hereinafter referred to as "Indemnified Parties"), shall under no circumstances and at no time be liable for any Nuclear Damage resulting directly or indirectly from a Nuclear Incident at the Nuclear Facilities. Consequently, the Client hereby irrevocably waives any right to pursue a claim against any of the Indemnified Parties for any Nuclear Damage whether based on contract, tort, strict liability or otherwise. The term Nuclear Damage used herein shall in addition to the meaning assigned to it in the Paris Convention and in applicable national enactments also include damage to the Nuclear Facilities themselves and/or to any part thereof and/or to property on or off the site.

10.4 The Client undertakes to indemnify and hold as harmless the Indemnified Parties (including, but not limited to, the Supplier and its sub-contractors) against any claims by third parties, including insurers, for any Nuclear Damage whether such claims are based on contract, tort, strict liability or otherwise. Further, the Client represents and warrants that the insurers of the Nuclear Facilities concerned shall have no rights of recourse or subrogation against the Indemnified Parties (including, but not limited to, the Supplier and its sub-contractors) for Nuclear Damage.

10.5 If, following the entering into force of the FA or Partial Contract (s), any applicable legislation or international convention expires or is modified in such a way that the Indemnified Parties may be held liable for Nuclear Damage in connection with a Nuclear Incident at the Nuclear Facilities, then the Client undertakes to inform the Indemnified Parties promptly thereof and to ensure by legally enforceable means (e.g. waivers of liability, government indemnity and/or insurance) that the Indemnified Parties shall incur no such liability.

10.6 With the exception of any existing 'sale/leaseback' or other financing arrangement in relation to any contemplated project deliverables, the Client represents that at the time of signing this FA, the Client is the sole owner of the Nuclear Facilities and that at such a time no other party has ownership or an equivalent interest in the said Nuclear Facilities.

10.7 The provisions of this Article 10 shall apply to:

a) any Nuclear Damage wherein the provision of any equipment, documentation, report, tool, goods or services or any information furnished in connection with the FA or the Partial Contract may have been involved in any manner or may be alleged to have been involved in any manner;

b) be in effect for as long as the said Nuclear Facilities are planned, constructed, operated, decommissioned and thereafter until no radioactive material exists in the Nuclear Facilities or results from the Nuclear Facilities;

c) be unaffected by any completion, termination or cancellation of the FA or any part hereof and shall prevail over and apply notwithstanding any other provisions of the FA.

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11. LIABILITY FOR DEFECTIVE PERFORMANCE

11.1 The Supplier shall be liable to the Client for any and all breaches of his obligation to observe due professional care with the exception of liability caused by the provision of incomplete or faulty instructions provided by the Client.

11.2 In the event of an error or other defect in the output elaborated by the Supplier, the Supplier shall be obliged to remedy such an error / defect at his own cost within 30 days of being notified thereof by the Client.

11.3 The total aggregate liability is limited by the contract value.

12. SANCTIONS

12.1 Should the Supplier be in delay with the delivery of an output duly ordered by the Client, the Supplier shall be obliged to pay a contractual penalty to the Client in the amount equal to 0.01% of the remuneration due under the Partial Contract for each day of delay. The Supplier shall be considered to have defaulted on the delivery of an ordered output upon the expiry of reasonable additional deadlines, as may be defined by the Client in writing following the Client not receiving the output within the deadlines defined in the Partial Contract, and where the Client has advised on the possibility of the enforcement of a contractual penalty.

12.2 Should the Supplier be in delay with remedying a defect / errors in his output, the Supplier shall be obliged to pay a contractual penalty to the Client in the amount of EUR 100 (EUR one hundred) for each day of delay.

12.3 Should the Client be in delay with the payment of an invoice hereunder, the Client shall be obliged to pay interest on the delayed payment accruing at 0.01% of the overdue amount per day of delay.

12.4 Should either party breach its obligations established in Article 9 (Commercial Secrets and Confidentiality), the party in breach shall be liable to pay to the other party a contractual penalty amounting to 1.000 EUR (one thousand EUR), within 15 days of being notified in writing of the breach and claim to pay the contractual penalty. The payment of a contractual penalty shall not prejudice the right to claim damages in an amount exceeding the amount of the contractual penalty; statutory regulated circumstances precluding liability will not be taken into account.

13. CHOICE OF LEGISLATION, DISPUTES

13.1 This Framework Agreement and any and all legal relations arising herein from shall be governed by the laws and regulations of the Czech Republic.

13.2 The Contractual Parties acknowledge and recognize that areas not explicitly regulated hereby shall be regulated by the respective provisions of the Czech Civil Code. In the case of factual disputes regarding the services provided IAEA documentation will be deemed relevant.

13.3 Any and all disputes arising in connection herewith shall be resolved by the Contractual Parties via negotiations. In cases in which a dispute cannot be resolved by negotiation within sixty (60) days, such a dispute shall be decided, following a motion of one of the Contractual Parties by a competent court in the Czech Republic having jurisdiction according to the registered office of the Client.

14. FINAL PROVISIONS

14.1 This Framework Agreement represents a complete agreement between the Client and the Supplier.

14.2 Should any of the provisions hereof appear or shall be determined invalid, ineffective, putative or unenforceable at a later date, then such invalidity, ineffectiveness or unenforceability shall not cause the invalidity, ineffectiveness or unenforceability hereof as a whole. In such a case, the Contractual Parties undertake, without any undue delay, to clarify such provisions pursuant to § 553(2) of the CCC or to replace, by mutual agreement, any such invalid, ineffective or unenforceable provision hereof with a new provision that most closely reflects the intentions of the Contractual Parties at the time of conclusion hereof, to an extent permitted by the laws and regulations of the Czech Republic.

14.3 This Framework Agreement becomes valid and comes into force on the date of its signature by the authorized representatives of both Contractual Parties.

14.4 This Framework Agreement may be amended or modified exclusively in the form of written and numbered amendments specifying the date and place thereof, and signed by the authorized representatives of the Contractual Parties. The Contractual Parties hereby expressly exclude within the meaning of § 564 of the CCC, the execution of any changes hereto by any other means or form.

14.5 This Framework Agreement is made out in the English language in four (4) copies, each having the force of an original. Each Contractual Party shall receive two (2) copies.

14.6 By attaching their signature hereto the Contractual Parties express their consent with the content hereof in its entirety.

15. ANNEXES:

15.1 The following Annexes form an integral part hereof:

15.1.1 Annex No. 1 Provided services

15.1.2 Annex No. 2 The Supplier's team members involved in the FA activities

15.1.3 Annex No. 3 The Quality Plan

15.1.4 Annex No. 4 The Order Form

15.1.5 Annex No. 5 Consortium Agreement

15.2 The above mentioned annexes complement each other and explain. In the case of ambiguity or conflict between the provisions of this Framework Agreement the provisions of the afore-mentioned Annexes shall take precedence. The provisions of the Annexes shall assume priority in the order stated above.

In (place).....
On (date).....

On behalf of the Client:

.....
RNDr. Jiří Slovák,
Managing Director

In (place).....
On (date).....

On behalf of the Supplier:

.....
Posiva Oy
Janne Mokka, CEO

.....
Posiva Oy
Tiina Jalonen, SVP

.....
Saanio & Riekkola Oy
Timo Saanio, MD

ANNEX NO. 1 PROVIDED SERVICES

1 HISTORY AND THE PLANNED PREPARATION OF THE DEEP GEOLOGICAL REPOSITORY

1.1 History of the Siting Process

a) The systematic development of a deep geological repository programme in the Czech Republic commenced in 1989.

b) In 1992 the Czech Geological Institute selected 27 sites deemed potentially eligible for deep geological repository siting. A comprehensive review of available geological data on the selected sites was conducted and eight of the sites were recommended for further research.

c) The first reference project for a deep geological repository at a hypothetical locality within the Czech Republic was developed in 1999 and updated in 2011 to take into account a horizontal emplacement variant with the following concept:

   i. the direct disposal of spent fuel (SNF) in steel based canisters in a crystalline host rock,

   ii. an operation period of 2065 – 2140,

   iii. a surface facility – SNF / high level waste (HLW) reception

   iv. an encapsulation facility – underground near the surface facility

   v. the disposal of HLW in a separate part

d) Following a critical evaluation of the candidate sites in terms of meeting the necessary criteria for the siting of nuclear installations in compliance with SÚJB (Czech State Office for Nuclear Safety) Regulation No. 215/1997 and possible conflicts with the protection of the environment, 11 candidate sites were selected in 2002 in three different rock types (in granitoid, metamorphosed and sedimentary rock). Subsequently, SÚRAO prioritised 6 of the 11 selected sites, all in granitic rock.

e) Evaluations were conducted of transport accessibility, population density and the advantages and disadvantages of siting at all of the six prioritised sites and in 2004 – 2005 geophysical research work was performed in order to reduce the spatial extent of the areas of interest.

f) In 2004 the Government accepted, by means of Decision No. 550/2004, the suspension until 2009 of all geological work at the six sites under investigation with a view to deep geological repository siting. The reason for the suspension consisted of the negative attitude of the communities concerned with regard to activities relating to deep geological repository construction.

g) Following an examination of archive geological data, the "Kraví hora" site in the "Vysočina" region was added to the list of potential sites.

h) For all seven preselected sites "Exploration area for special intervention into the Earth's crust" status has been granted by Ministry of the Environment of the Czech Republic with concern to surface geological investigation.

i) An examination of archive geological data has been contracted for the determination of potential sites in the proximity of the Temelín and Dukovany Nuclear Power Plants (NPP).

Other related information is provided at:
http://www.surao.cz/eng/Radioactive-Waste-Repository/Deep-Geological-Repository and in the SÚRAO annual report accessible at:
http://www.surao.cz/eng/Information-corner/Downloads/Annual-reports .

2 SERVICES RENDERED BY THE SUPPLIER

2.1 Support is required in the following areas:

a) the assessment and/or development of procedures and methods for the selection of the most suitable site for deep geological disposal, e.g.:

i. the preparation of DGR development strategy and project management plan,

First we want to shortly describe the team of organisations that the Tenderer has brought together to ensure that SURAO will get the best possible value for its investment into this Project.

The tendering Consortium consists of Posiva Oy, Finland and Saanio & Riekkola Oy, Finland. As subcontractors to the Consortium are SKB International AB from Sweden and The Geological Survey of Finland (GTK). These entities are shortly described in the following:

Posiva Oy

Posiva is an expert organisation responsible for the final disposal of spent nuclear fuel of its owners in Finland. Posiva is in charge of R&D work regarding the final disposal of spent nuclear fuel as well as the construction and operation of the encapsulation plant and disposal repository. Posiva has been established in 1995 and it is owned by Teollisuuden Voima Oyj (60%) and Fortum Power & Heat Oy (40%), both of which share the cost of nuclear waste management. Posiva employs around 80 people and ca. 200 persons are employed as subcontractors and consultants. The company had a turnover of some EUR 62 million in 2015 and is headquartered in Olkiluoto in the municipality of Eurajoki. The personnel works in two locations: Main Office in Olkiluoto and ONKALO Project Office in Olkiluoto.

Preparations for the final disposal of spent nuclear fuel in Finland began at the same time as the commissioning of the first nuclear power plants in the late 1970s. The schedule for the final disposal was set in 1983, when the Government decided on the objectives and programme for nuclear waste management. Posiva has more than 40 years experience of developing a safe final disposal solution for spent nuclear fuel in Finland.

After a long site investigation period, Posiva applied for a decision in principle which was given to Posiva in 2001. According to decision-in-principle ratified by the Parliament, spent fuel generated in the Olkiluoto plant units and the Loviisa plant units will be disposed of in a repository to be constructed in Olkiluoto, Eurajoki.

One element of the site investigations conducted at Olkiluoto is the excavation of the underground rock characterisation facility (ONKALO) that extends approximately to the depth of 450 meters. Posiva started to construct ONKALO in 2004. Research has been conducted there since the beginning of its construction. In addition to facilitating bedrock research,

ONKALO also provides an opportunity to develop excavation techniques and final disposal techniques in realistic conditions. The bedrock is studied with methods from geology, hydrology and geochemistry. ONKALO has aided in collecting the data needed for the application for the construction licence that was submitted in 2012. Later, the ONKALO facilities can be put into use when building and using the repository.

In December 2012, Posiva submitted the construction license application for a KBS-3 geologic repository in Olkiluoto. The construction license for the final disposal facility granted by Government in November 2015 makes it possible for Posiva to start the construction of the encapsulation plant as well as excavations for the final disposal repository. According to the preliminary schedule, the final disposal begins in early 2020.

Posiva works together with numerous Finnish and foreign expert organisations from a multitude of fields, and commissions studies related to nuclear waste management from universities and other institutions of higher education as well as from research institutes and consulting businesses.

Due to its role as implementer, Posiva Oy has first-hand experience in the following:

- siting of a geologic repository
- demonstration that disposal of spent nuclear fuel using the KBS-3 method is technically feasible
- production of the safety case regarding long-term safety
- co-development of the so-called horizontal disposal plan (KBS-3H) in co-operation with the Swedish company SKB.
- processing of the construction licence application and its related feedback from authorities progresses
- site investigation for site confirmation purpose
- implementation following the requirements of a nuclear facilities
- design, operation and safety management of a nuclear facility underground
- communication with the regulatory authorities
- communication with the members of the public
- lessons learned in the management of a nuclear waste management programme

The duties of the Posiva staff vary from various research, development and planning tasks associated with the final disposal of nuclear waste to the implementation planning and support activities for the repository. For this reason, the work environment at Posiva is broadly multidisciplinary: Posiva's staff consists of experts in fields including:

- geology
- geophysics
- physics
- chemistry
- hydrology
- rock mechanics
- structural engineering
- industrial engineering

and other fields of engineering, social sciences and business economics.

Posiva is certified according to ISO 9001, ISO 14001 and OHSAS 18001.

Final disposal solution for spent nuclear fuel attracts wide global interest and Posiva has in 2016 established a wholly-owned subsidiary Posiva Solutions Oy. Posiva Solutions provides its customers with tailored expert services related to final disposal in collaboration with an extensive network of sub-suppliers and cooperation partners.

Saanio & Riekkola Oy

Saanio & Riekkola (S&R) Oy is a Helsinki (Finland) based multi-discipline consulting company specialised in Nuclear Waste Management and rock, geotechnical, civil, structural, HVAC and mining engineering. S&R has a branch office also in Seoul, South-Korea, and a subsidiary laboratory company B+Tech focusing on the development and research of engineered barrier systems.

Nuclear waste management is the core expertise of Saanio & Riekkola Oy. The company has been heavily involved in the Finnish nuclear waste management program since 1979. This program, in terms of realisation, is the most advanced NWM program in the world. As a result, S&R has gained significant experience and technical competence in critical aspects of the development of deep geological repositories. Nuclear power companies TVO, Fortum and Fennovoima, as well as the nuclear waste management company, Posiva Oy, responsible for the geological disposal of nuclear waste, comprise S&R's main clients in Finland. In addition to clients in Finland, the company's know-how has been widely utilized internationally at a variety of organizations, including operators, implementers and regulatory and research bodies such as SKB in Sweden, KEPCO E&C, KORAD and KAREI in South Korea, JAEA in Japan, and NWMO in Canada.

As a result of our long standing experience in this field, and similarities of this project with work we have previously performed in the Finnish program, S&R can draw on an extensive pool of experts with unique experience that is relevant to all areas of this request for proposal. S&R will provide the necessary resources and capabilities required for the successful coordination and execution of every work package in this project. S&R aims to be a global leader in pioneering NWM solutions. S&R is fully confident in being able to provide the services described in this offer and support the needs of the client. We have the resources and technical capability to successfully execute this project and we have earned the knowledge and experience from similar work previously especially in the Finnish and Swedish NWM programmes.

S&R has extensive experience in NWM projects and is one of the few companies in the world that can cover all five important tasks in nuclear waste management: Site selection, Technical design, Long term safety analysis, Cost control and Public acceptance. The experience arises from work in 20 different waste repositories in 12 different countries in 500 separate projects. In addition S&R have done work for six different nuclear power facilities in three countries in 11 contracts.

The pool of about 100 qualified and highly educated experts at the main office has guaranteed good customer feedback in taking into account customer needs (flexibility), fast responses to customer requests (there is always back up expert if the main contact is out of reach), and keeping projects on schedule (enough allocated resources for the work). S&R has been using working project managers for most of the projects in engineering designing and safety analysis for radioactive waste repositories, and also for underground civil engineering projects. This is the efficient every day work culture at S&R.

S&R provides laboratory services through its subsidiary company B+Tech Oy. The company performs research and development on engineered barrier system technology for environmental protection, especially with regard to clay- and rock-based engineered barriers for spent nuclear fuel disposal. B+Tech Oy has a highly equipped laboratory and experimental facility, as well as the modelling tools, to support such work. Detailed information of the company is provided in www.btech.fi.

Site selection and site characterization experience relies on the strong participation in the Finnish and Swedish siting programs, including various types of expertise in-house, from site selection criteria development and geotechnical evaluations to site investigation know-how including e.g. site investigations (planning, development and interpretation) during site selection and repository development in Finland. In relation to site selection also peer reviews on the site properties and cost estimates for siting works have been carried out.

SKB International AB

SKB International AB is a leading consulting company in spent fuel and radioactive waste management in the world. It is a wholly owned subsidiary of the Swedish Nuclear Fuel and Waste Management Company, SKB, and makes available the knowledge and experiences from the development and operation of the Swedish spent nuclear fuel and radioactive waste management system to clients on the international market. The company relies on the expertise and the staff of SKB and its network of consultants and experts.

Since the mid 1970ies, the companies operating nuclear power plants (NPPs) are obliged, under Swedish law, to implement and finance all activities needed to secure the safe management of spent fuel and radioactive waste generated from operation of the NPPs. The nuclear power companies launched therefore in 1976 a joint company, SKB, with the mission to assume this obligation in practice. The responsibility of SKB includes the development and implementation of systems for transport, storage and final disposal of all spent nuclear fuel and radioactive waste from the operation of the NPPs (except for very low level waste, which is disposed of at the nuclear sites in Sweden).

Based on the policy for spent fuel and radioactive waste management established in Swedish laws and regulations, SKB has developed the strategy for implementing the policies and ensuring the safe management and disposal of these materials. The strategy is revisited every three years in the RD&D (Research, Development and Demonstration) report that the NPP owners (through SKB) is required to submit to the Government. Although some changes are introduced in each report to take the ongoing developments into account, the main lines of the strategy have remained stable since the start of the work in the mid 1970ies.

SKB has developed, owns and operates several radioactive waste management and spent nuclear fuel facilities:

- A Transport system (casks, containers, transport vehicles and a specially designed transport ship, the M/S Sigrid) for spent nuclear fuel and radioactive waste, taken into operation in 1982.
- Clab, the central interim storage for all spent nuclear fuel in Sweden, in operation since 1985 and extended at the end of 1990's.
- SFR, the near-surface final repository for short-lived radioactive waste, which was licensed and started its operation in 1988. SKB has just performed the site investigation for an extension of SFR to facilitate disposal of decommissioning waste. The extended SFR is planned to be operational in the early 2020's.
- The underground Äspö Hard Rock Laboratory, operational since 1995, with start of investigations in 1986.
- The Canister Laboratory, inaugurated in 1998.
- The Bentonite Laboratory, inaugurated in 2007.

In addition to the above facilities, an Encapsulation Plant and a Final Repository for geological disposal of spent nuclear fuel are in advanced stages of design. Licence applications for construction of the deep geological repository for spent nuclear fuel at Forsmark and the encapsulation plant adjacent to the Clab facility in Oskarshamn were submitted in March 2011. They are based on more than 35 years of research, development and demonstration of the KBS-3 method. This method has also been adopted by Posiva of Finland and used for an application for constructing a repository at Olkiluoto in Finland.

The SKB organization has access to a wide network of experts, both in-house and worldwide. The company has nearly 500 employees and engages about 400 consultants on a full-time basis, thus forming a large platform of knowledge for all fields related to a radioactive waste management programme.

SKB is regarded as having world leading experience and expertise in the area of underground storage and disposal facilities. The company is unique not only in disposal facility development but also in safety assessment and using the data gathered to apply for licences

and authorisations and, finally, construct and operate the facilities such as the and SFR facility, the Äspö laboratory and the Clab facility. The company is also dedicated to its public communication programme, which so far has been very successful in obtaining good dialogue between stakeholders, thus increasing the understanding of and support for SKB's programme on local, regional and national level.

Every three years, SKB also submits a comprehensive cost calculation and financing scheme for the whole life cycle of the national nuclear programme for evaluation and approval of the authorities. This has given SKB vast experience on how to optimise the system to save costs. The estimated cost for the Swedish programme is approximately EUR 7.5 billion (NPP decommissioning costs not included). During the last years SKB's annual turnover has been in the order of 150 Million €.

In summary, SKB has:

- A well-developed network of contractors and specialists in waste management and repository development techniques.
- Over 35 years of experience and a successful track record of planning, research, development and demonstration and successful implementation of national radioactive waste management facilities.
- Experience of characterising sites and undertaking modelling and safety assessment for repositories for a range of wastes and materials.
- The implementer's perspective, meaning that we know about the needs of the authorities and how to communicate with a regulating body
- An understanding of the stakeholder drivers associated with a radioactive waste management programme and means of addressing them.

The achievements of SKB have attracted international interest. In 1984 it was therefore decided to establish within SKB a separate department for managing this interest and sharing our expertise through consulting services. Out of this department, a separate engineering and consulting company was created in 2001, SKB International Consultants AB, later renamed in SKB International AB. Since 1984, contracts for more than 300 international projects have been signed with organizations in more than 20 countries. The company is a sought after and appreciated participant in international cooperation projects and peer reviews.

As a 100 % subsidiary of SKB, SKB International has full access to all facilities of SKB's waste management system. This gives a unique position to offer training and study visits by clients and partners to these facilities as a means of reaching a deeper understanding of the technical issues involved in the practical management of spent nuclear fuel and radioactive waste. Visits or tours of facilities organised by SKB/SKB International represent an added value to the services provided by SKB International. Furthermore, SKB International can offer access to SKB's comprehensive documentation regarding the design, construction and operation of the facilities.

SKB International is certified according to SS-EN ISO 9001 and ISO 14001.

The head offices of SKB and SKB International are co-located in Stockholm, Sweden. More information on SKB and SKB International can be found on the company website, www.skb.se.

The Geological Survey of Finland (GTK)

The Geological Survey of Finland (GTK) is a leading European competence centre under Finland's Ministry of Employment and the Economy. We employ approximately 460 full-time staff and are effectively engaged in tasks at the local, national and international level. GTK has been closely involved in the nuclear waste disposal studies since the suitability of the Finnish bedrock for the final disposal of spent fuel became under consideration in the late 1970's. GTK produces geological and geophysical information for power companies and authorities to support the implementation and decision making in nuclear waste management. In addition to the research contribution, GTK has provided expert's opinions and statements

for national and international bodies on aspects related to geological nuclear waste disposal. Nuclear waste disposal research is international by nature and cooperation especially with European and North-American research organizations is close.

In the initial phase of the site selection process in the late 1970s and early 1980s, GTK examined the general bedrock factors that would have to be taken into account in connection with final disposal with reference to the international guidelines adapted to Finnish conditions. On the basis of extensive research data, it was concluded that it is possible to find a potential disposal site that fulfils the geological safety criteria.

In the subsequent site selection survey covering the whole of Finland, carried out by GTK in 1983–1985, 101 potential investigation areas were discovered and classified. The grounds of the site selection survey was a block mosaic structural model of the bedrock, in which fracture zones of different sizes border the bedrock blocks.

Eventually, five areas were selected by Teollisuuden voima (TVO) for preliminary site investigations. The preliminary site investigations in 1987–1992 comprised deep drillings together with geological, geophysical, hydrogeological and hydrogeochemical investigations. A conceptual geological bedrock model was constructed for each site, including lithology, fracturing, fracture zones and hydrogeological conditions. On the basis of preliminary site investigations, TVO selected Romuvaara, Kivetty and Olkiluoto for detailed site investigations to be carried out during 1993–2000. After the feasibility studies, the island of Hästholmen, where Fortum's Loviisa nuclear power plant is located, was added to the list of potential disposal sites.

In the detailed site investigations, additional data on bedrock were gathered, the conceptual geological, hydrogeological and hydrogeochemical models were complemented, the rock mechanical properties of the bedrock were examined, and the constructability and the overall suitability of the sites for final disposal in terms of technical and safety aspects was evaluated. GTK's responsibilities in these phases were geological mappings, interpretation of ground and airborne geophysical data, drillcore loggings and geological modelling.

After the detailed site investigations, Posiva proposed Olkiluoto as the site of the final disposal facility. In December 2000, the Finnish Government made a decision in principle in favour of the project, and in May 2001, the Parliament ratified the Government's policy decision.

GTK is actively participating in the site confirmation studies at Olkiluoto as an expert of geology and geophysics. The main topics include construction of the geological 3D model, geophysical studies, geological mapping in ONKALO and investigations of thermal features of the bedrock.

Apart from the above, GTK has actively participated in research related to the evaluation of the long-term safety of geological disposal concept. The long-term hydrogeochemical stability in crystalline bedrock, including the hydrogeochemistry and the evolution of groundwater and the various aspects related to transport of solutes in fractured rock has been of major interest. Migration of radionuclides and corrosion of native copper have been studied under natural conditions applying natural analogue sites. Further, the effects of the glaciation cycle (e.g. postglacial faulting and crustal uplifting, effects of permafrost, influence of glacial melt waters) have been investigated within number of domestic and foreign sites. Most recently a co-operative research on microbes and their role in hydrosphere has been launched e.g. within Horizon 2020.

PREPARATION OF DGR DEVELOPMENT STRATEGY AND PROJECT MANAGEMENT PLAN

This tender aims at supporting SURAO's site selection programme for a HLW repository (Table 1). According to the programme the number of candidate sites is successively decreased, first to four sites, and then in 2020 to two candidates among which the suitable site will be chosen in 2025. The site selection process is carried out in parallel with a programme of geo-

scientific investigations, development of a suitable repository design and research into long-term safety of geological repositories. In the early phase the geological investigations at candidate sites are based on available literature and surface-based studies, including later deep drillings as well. However, SURAO has also access to underground facilities in Bedrichov and Josef for generic research and demonstration purposes and is constructing a rock laboratory in Bukov for the development of methods for rock characterization. In addition, SURAO is involved in international cooperation including specific multilateral projects for technical testing and demonstration and for the development of processes for site selection in a socially acceptable manner.

The Consortium will bring in the experience and knowledge obtained by Posiva and its partners in the Finnish and Swedish programmes for geological disposal of spent fuel. The idea is not to transfer the historical experience as such to the Czech Republic but instead, use the lessons learned in other site selection programmes during the past few decades for the review and development of the Czech programme with a particular view to efficient use of resources.

The proposed support programme assumes effective cooperation and allocation of responsibilities between SURAO and the Consortium. Accordingly, the primary role of the Consortium will be in providing technical assistance in the planning of SURAO's future activity programmes, ranging from strategic planning to the planning of detailed site investigations and performance assessment work. Secondly, the Consortium will participate in the review and quality assurance of the reports and other important documents produced by SURAO and its partners. In addition, the Consortium is ready to offer assistance in application of various site investigation techniques and safety assessment models as separately agreed.

Objectives

The overall objective of the support programme proposed is to help SURAO achieve its goals for the site selection process: to nominate, in 2025, a site for the HLW repository in the Czech Republic that is both suitable from the long-term safety point of view and socially acceptable both for the people living near the planned repository and other stakeholders, in the Czech Republic and internationally. Meeting the overall objective requires a successful outcome of the planned shortlisting process:

1) to reduce the number of candidate sites to four in 2016 – 2017

2) to select two alternative sites in 2020 for the final comparisons

3) to nominate the preferred alternative as the repository site in 2025.

These three goals also structure SURAO's site selection process into three successive phases during which an increasing amount of data and information is accumulated. The first shortlisting will inevitably be based on rather generic considerations of conditions and characteristics that are important for the long-term safety and practical implementation, while the final comparisons can be based on site-specific safety assessments and evaluations of the environmental and social aspects as a whole.

Table 1. Main stages of SURAO's programme for site selection of a HLW repository in the Czech Republic.

STAGE	ACTIVITIES	NUMBER OF SITES	SCHEDULE
Areas Reduction + Tentative sites selection	• Surface geological investigation • Boundary of host rock massive determination • Estimation of faults and fracture zones with deep water circulation • Prefeasibility studies updating • Safety cases - used only generic data	7 preselected sites	2013 - 2016
Two Candidate sites selection	• Geological investigation using drilling • Boundary of host rock massive in the depth • Preliminary host rock characterisation • Site specific feasibility studies • Preliminary site specific safety cases	4 potential sites	2017 - 2020
Final site selection	• Detail geological investigation (additional borehole drilling and in situ research) • Detail host rock characterisation • DGR´s Site specific design • EIA studies • Site specific Safety cases	2 candidate sites	2020 - 2025

Practical approach

The proposed support programme will address SURAO's overall strategy and practical planning of projects consisting of:

1) adaptive strategic programme planning

2) development of the repository concept and associated safety concept

3) stagewise planning and execution of the site characterization programme

4) development of the safety functions and associated performance criteria for the site and engineered barrier system

5) assessment of long-term site performance based of the criteria defined

6) development of technical designs based on the repository concepts

7) stakeholder interaction with local, national and international stakeholders.

The activities listed above are closely connected together and it is foreseen that developments related to a specific area will have an influence on other areas as well. Therefore, the programme needs to be based on an overall strategy and, furthermore, it needs to be adaptive to new findings from research, development and investigations as well as to changes in the external programme context. To achieve this in practice, strong management functions are needed to monitor and coordinate the activities in the different areas to keep the programme internally consistent. It is proposed that a comprehensive requirements management system should be used as a basis for such internal programme integration. The system may be fairly general in the first phase but become more detailed as new information accumulates from the site and the engineered barrier system.

It is proposed that SURAO and the Consortium will jointly develop an organizational scheme for the execution of the support and review programme. The first step in the development would be the establishment of a Joint Advisory Group (JAG) consisting of SURAO executives nominated by SURAO and members nominated by the Consortium, representing both the project management and expertise on planning and execution of nuclear waste disposal programmes as a whole. The JAG would discuss the strategic issues and needs of SURAO's programme, monitor the programme achievements and assess the needs for possible adjustments and changes in it, and decide on the allocation of the support resources to be provided by the Consortium.

For more detailed discussion and monitoring of the project plans in the specific areas mentioned above special task forces could be established. They could follow a similar structure as the JAG and, hence, would bring together management staff and expertise from SURAO and the Consortium, respectively.

NWM program

The overall waste management plan for SNF shall most probably have the following main objectives:

- to describe a sustainable solution (safe, optimised timing and cost efficient) for the disposal of SNF as regards the overall interests of society
- to provide a realistic total cost estimate for the different disposal alternatives

Requirement management

More recently, SKB and Posiva have produced further documentation related to the design criteria that may be useful as background information for this work. In these reports emphasis has been put on the linking between the design requirements of the underground openings and the long-term safety aspects including the performance of the engineered barrier system and its emplacement. Such reports include Design premises for a KBS-3V repository based on results from the safety assessment SR-Can and some subsequent analyses, SKB TR 09-22; Rock Suitability Classification, RSC-2012, POSIVA 2012-24; Design Basis for a Spent Nuclear Fuel Repository at Olkiluoto POSIVA 2012-03; Underground Openings Production Line 2012 – Design, Production and Initial State of the Underground Openings, POSIVA 2012-22.

As other nuclear engineering projects, a geologic repository for spent nuclear fuel is managed through different types of requirements: e.g. radiation safety, nuclear safety, safeguards, as well as a special category of requirements related to post-closure safety. Post-closure safety requirements apply to the long-term performance of the geologic repository and, in some cases, they could be in conflict with operation and operational safety requirements. For example, the use of cement is a standard practice in most engineering projects but cementitious materials can have a negative impact on the clay components of a KBS-3 geologic repository, hence its use is limited. Another example of conflicting requirement is the use of rock reinforcement for operational safety which adds complexity to the predictions of the performance of the engineered barriers.

The different types of requirements need to be managed through a requirements management system, which records the origin of each requirement (e.g. post-closure safety vs. operational safety), its justification and links the requirement at hand to the requirements (or the constraints) set to different components. Requirements need to be organised in a hierarchical and structured fashion illustrating the requirements verification process and to provide transparency and traceability. Requirements verification is particularly challenging for post-closure safety due to the long time periods considered. Hence, the verification of post-closure safety requirements relies heavily onto design requirements that can be verified during repository construction and operation.

The consortium believes that operation and maintenance aspects are important in the requirements both for the underground and surface facilities. Maintenance of the stable, controlled conditions in the underground repository is a prerequisite for safe operation thus e.g. the ventilation and smoke control needs to be considered in setting up the requirements.

As regard to the surface facilities, an important aspect to consider is their location, at least of the connections to the underground repository, with respect to the location of the underground facilities in order to limit any potential disturbances or restrictions to use the underground spaces.

Site selection

The assessment whether or not the "block of rock" at each candidate site within a siting area is suitable for hosting a generic underground repository will have the following process:

- Become familiar with input documents for this task
- Review the existing (current) generic layout and make it as a base case
- Agree on initial input data, the design targets and handling of nonconformities in a review meeting
- Organise 2-3 meetings with the client to discuss underground layout at the candidate sites in each siting area
- Develop a list of evaluation factors and associated weightings
- Prepare presentation and have a one day workshop of "engineering evaluation of candidate sites"
- Prepare of four engineering evaluation study memoranda (one for each siting area) describing the relative engineering suitability of various sites for hosting an underground repository
- Organise the delivery inspection at the end of the task

ii. the preparation of site descriptive models of selected sites,

A site descriptive model is an integrated model for geology, thermal properties, rock mechanics, hydrogeology, hydrogeochemistry, bedrock transport properties and a description of the surface system. The site descriptive model presents an integrated understanding of the site of interest at the completion of the surface-based characterisations. It also provides a summary of the abundant underlying data and the discipline-specific models that support the site understanding. The description relies on background reports that address, in particular, details in data analyses and modelling in the different disciplines.

Site descriptive model development is an iterative process that evolves with increasing knowledge of the site starting with a rather rough description in the initial stage of the site characterisation. The level of model detail increases with increased site data and knowledge.

It is proposed to base the development of the site descriptive model on the state of the art approach developed by SKB in Sweden and Posiva in Finland. The development of the site descriptive model comprises the iterative steps of evaluation of primary data, descriptive and quantitative modelling in 3D, and evaluation of the confidence in the resulting models.

The role of a site description

Site characterisation should provide all data required for an integrated evaluation of the suitability of the investigated site for a deep geological repository. A fundamental component in the characterisation work is the development of a site descriptive model.

Quality-assured data from site investigations, stored in databases are the input to site descriptive modelling. The site descriptive model is then used by repository engineering to design the underground facility and to develop a repository layout adapted to the site. In order to ensure that all data and information needed for the repository design and safety assessment are captured in the site characterisation work there is a need for a continuous exchange of information between the different technical activities:

- Investigations
- Site descriptive modelling
- Safety assessment
- Repository engineering
- Environmental impact assessment

Starting with the preliminary site description, compiled from data collected during the initial site characterisation stage, a preliminary repository layout can be established and a preliminary safety evaluation as well as a full safety assessment can be conducted. In the course of the work the technical activities will give feedback to one another which will in the end improve the site descriptive model.

Furthermore, the work is recommended to make use of all knowledge and understanding embedded in any earlier model versions and also of the feedback obtained from any safety assessments as well as of other types of feedback received from any earlier versions of the site descriptions. The specific objectives of the work are to:

- analyse the primary data available from all surface and borehole investigations
- describe evolutionary aspects at the site from the time the bedrock formed to the present day
- develop a full three-dimensional integrated site descriptive model covering all disciplines
- perform an overall confidence assessment including systematic treatment of uncertainties and evaluation of alternative interpretations
- perform modelling activities in close interaction with safety analysis and repository engineering

In the end, a site description should be a description of the site covering the current state of the geosphere and the biosphere as well as descriptions of on-going natural processes that can affect their long-term evolution.

Methodology and organisation of the work

The site descriptive modelling project is multi-disciplinary, in that it covers all potential properties of the site that are of importance for the overall understanding of the site, for the design of the deep repository, for safety assessment and for the environmental impact assessment. The overall strategy applied in the work (Figure 1) should be to develop discipline-specific models by interpretation and analyses of the quality-assured primary data stored in databases, and to integrate these discipline-specific models into a unified site description.

The site descriptive modelling comprises the iterative steps of evaluation of primary data, descriptive and quantitative modelling in 3D, and evaluation of the confidence in the resulting models. Data are first evaluated within each discipline and then the evaluations are cross-checked between the disciplines. Three-dimensional modelling, with the purpose of estimating the distribution of parameter values in space, as well as their uncertainties, follows. In this context, the geological models provide the geometrical framework for all discipline-specific modelling. The three-dimensional description presents the parameters with their spatial variability over a relevant and specified scale, with the uncertainty included in this description.

The end objective of the site descriptive modelling work is to develop and document an integrated description of the site, based on available complete site investigation data. The description should be supported by a large amount of data and the results of analyses and modelling that are mutually consistent. This demonstrates that a fundamental understanding of the current state of conditions and the on-going processes at the site, from the surface down to below the potential repository depth, has been achieved.

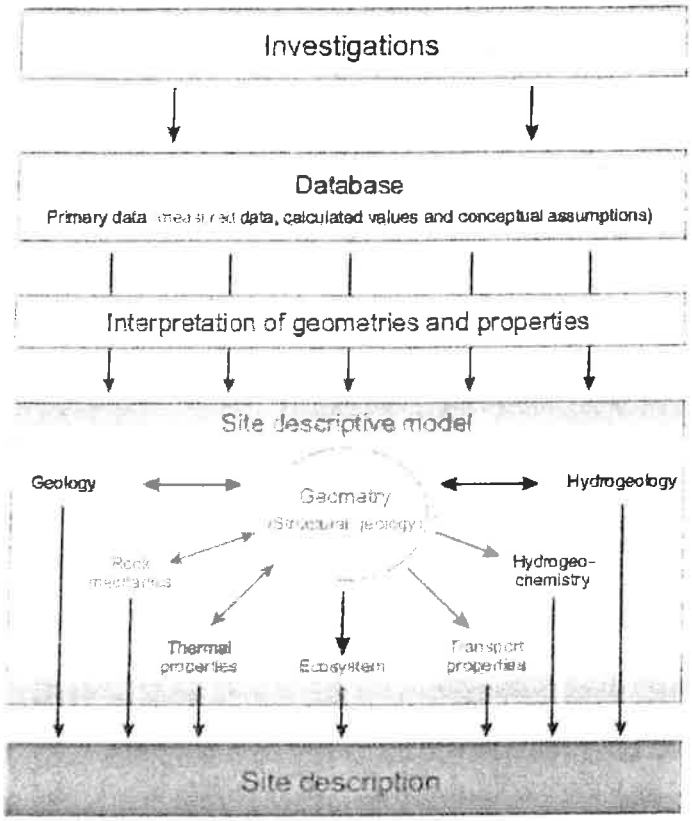

Figure 1. *From site investigations to site description. Quality-assured primary data from site investigations are collected in databases. Data are interpreted and presented in a site descriptive model, which consists of a description of the geometry of different features in the model and the corresponding properties of those features and of the site as a whole.*

Recommendation

Based on SKBs and POSIVAs experience it is recommended that the Client, with the assistance of the supplier, develops methodologies for generating site descriptive models and documents these in site specific reports:

- Geological site descriptive modelling
- Thermal site descriptive modelling
- Rock mechanics site descriptive modelling
- Hydrogeological site descriptive modelling
- Hydrogeochemical site descriptive modelling
- Transport properties site descriptive modelling
- Ecosystem descriptive modelling

In addition it is recommended to develop a strategy for sufficient integration between the disciplines when developing site descriptive models.

iii. the assessment and or/development of a geological database for data storage,

This part of the work will mainly be taken care of by GTK under supervision of Posiva. GTK has 20 years' experience of the capacity building for the management of geoscience data e.g. databases, GIS (geographical information system), user interfaces and data delivery. During the past ten years GTK has very extensively developed data processes and policies, databases, data quality and information systems to act as a national center for geoscience data in Finland. GTK's main strengths in data management are large and versatile information resources, the high competence of personnel for data management and information system development tasks and high-level ICT-infrastructure. GTK is also experienced of international data management projects for example in EU-level, in Africa and in Central Asia.

Based on the experiences of the earlier projects GTK can provide consultation for evaluating and commenting each stages and tasks of the database and data management development process described below.

1) Description of requirement analysis tasks

- The analysis clarifies the current state and the goal of the data management and databases and points which are the detected and prioritized development needs.
- In this phase it is necessary to analyze current data processes, existing data and system and technological architectures. The existing data and future needs are characterized to conceptualize logical application domains (e.g. geology, geophysics, hydrology, hydrogeochemistry and rock mechanics) and datasets belonging to each of these. It is necessary to understand how the data is generated and which its sources are; is it stored manually or on-line by measurement apparatus producing the data etc. For spatial data coordinate system and geometry types are defined. One of the most important issues is to clarify which are the typical use cases, applied software and data formats, for example, in multidimensional modeling. Data security requirements are defined. Technical infrastructure is described in coarse level.
- Methodology: methods and process of requirement analysis, user stories, use cases, UML (unified modeling language) and other relevant system modeling techniques

2) Description of information system design tasks

- The design is based on results observed in requirement analysis phase. Design methods are used to model what kind of solution solves the goal state's needs.
- Design phase produces data models in conceptual, logical and physical levels. Physical level database models contain all information needed for database schema creation (tables, fields, field types, relationships, keys, indexes etc...). International data model standards and vocabularies are used when it is relevant in addition to organizational ones. Data security rules are defined as well as data and access rights policies. Backup strategies are planned. Metadata profile is described based on organizational needs and international standards. Data storing and delivering methods and applications are also defined. If new components are needed for technical infrastructure, the technical architecture is designed and main decisions are made. If there are any uncertainties that need to be solved, quick proof of concept (POC) style demos can be used to identify the best available solution.
- Methodology and technologies: UML (Unified Modeling Language) class diagrams, database design methods, user interface design, SQL

3) Description of implementation tasks

- The components of ICT- infrastructure (servers, network components, server software e.g. database management system) are installed and implemented if not already available. Databases are created and test data stored to them. Database structures and performance are tested using test data to ensure that they are suitable for end

user's needs; e.g. modeling and statistical analysis. Data input methods and applications are implemented and tested. Old digital data is transferred to the new database and data which is only in paper format is digitized and transferred in to the system. Data extraction and delivering applications as well as metadata solution are implemented and tested. The performance of the system is tuned by optimizing certain parameters and indexes. Account rights to the database are constructed so that they fulfill the requirements of data and account right policies. Backup system is created and activated. During implementation careful unit-, module- and integration testing is necessary.

- Methodology and technologies: e.g. Microsoft, Linux, Oracle, SQL Server, SQL, GIS, data transformation methods, programming languages such as C#, Java, JavaScript and Python, XML, Unit-, module and integration testing, metadata profiles

Phases 1-3 constitute iterative cycles where development is made in smaller modules and process is repeated to achieve agile development with careful testing, feedback and development.

iv. the assessment and/or development of specific site characterisation methods,

Site characterisation programme

A comprehensive siting process and geological investigations have been carried out in Czech Republic. During corresponding tasks in Finland and after selecting the Olkiluoto Site, Posiva continued its programme with confirming site investigations and suitability assessment of the site. Confirming investigations were direct continuation of detailed site investigations and focused on open site related issues. During these stages, lessons have been learned related to investigation methods, data acquisition and processing, interpretations, integration of disciplines and producing the site description for end users such as safety assessment, design and construction.

A site characterisation is based on various investigation methods of different disciplines, to achieve reasonable level of confidence in the description of the site. Based on experiences from site investigation stages implemented by Posiva, we can offer support in review tasks and planning of site characterisation activities and detailed investigations in areas described later in this section.

One option to organize the detailed and confirming site investigations, are modelling teams covering the subjects of geology, rock, mechanics, hydrogeology and hydrogeochemistry, and a core group, consisting of representatives from the modelling teams, plus the task force leader.

The core group plans the characterisation and modelling work, assesses the progress and discusses all major findings, in order to ensure that the information and hypotheses generated in one discipline are disseminated and are compatible with those in the other disciplines. In addition, its task is to identify integration requirements and consider other critical issues. Cross-discipline interactions are ensured by regular and comprehensive information-sharing sessions.

One of the main products of the site characterisation tasks is a description or a model of the site, describing the geometry, properties of the bedrock and the water, and the interacting processes and mechanisms that are relevant for understanding the evolution of the site to the present day and the potential for future radionuclide migration. Therefore, this description is distinct from the measured data themselves. Site characterisation in general involves data acquisition, interpretations, extrapolating or interpolating between measurement points and calibrating the numerical models used to simulate the system against data, based on the various assumptions inherent in the conceptual model(s) being employed. The site description is divided into the disciplines.

Geology

Main data sources for geological site description are surface-based geological investigations: mapping of the outcrops and possible investigation trenches and drill core logging for understanding the geological setting, petrology and deformation, in particular, the fractures and brittle deformation zones. In addition, the airborne, surface and drillhole based geophysical surveys are a data source for geological site characterisation.

The geological model can be subdivided into subsidiary descriptions, covering lithology, alteration, deformation and fracturing, or other reasonable division. The subdivision is for the convenience of handling different types of data and should not be regarded as of fundamental significance. For example, the deformation zone model and fracture system model both represent the effects of brittle deformation at the site, describing deterministic, large-scale features and stochastic, small-scale features, respectively. However, this is clearly an artificial subdivision, geologically, since these features are closely related with regard to their mode of formation.

Rock mechanics

Rock mechanic site description includes e.g. hydraulic fracturing measurements in drillholes and by an accurate stress measuring device based on the LVDT (Linear Voltage Differential Transducer) cell and on the overcoring procedure developed by Posiva. Other data for rock mechanics modelling are collected during geological mapping like Q classification and Schmidt hammer tests, and by rock mechanics (uni- and tri-axial tests) and petrophysical analyses (e.g. P wave velocity, thermal properties, density), and measurements with TERO tool, developed by Posiva, for determination of the rock's thermal properties.

The rock mechanics model consists of the geometrical, mechanical and thermal descriptions of the rock mass. The geometrical description is based on the bedrock geological model, as described above. The mechanical description includes the in situ stress state and the deformation and strength properties of the intact rock, the fractures, the rock mass between deformation zones and the deformation zones themselves. The thermal description is based on the thermal properties of the intact rock. The rock mechanics model also include a description of the effects of excavation.

Hydrogeology

Data for hydrogeological site description is collected by monitoring of the groundwater table and the measurement of hydraulic heads in wells and drillholes at depth with packer systems. The hydraulic conductivity measurements and cross-hole flow measurements are carried out with Posiva Flow Log equipment.

Hydrogeological model consists of the structural and flow description. The structure model is the geometrical distribution of the hydrogeologically significant features of the rock and the hydraulic properties of these features. One of the modelling tasks is to describe relationship with the geological structures like fault zones. The rock mass between the zones also contains more sparsely connected transmissive fractures. These rock volumes are described in terms of a hydrogeological discrete fracture network model. The groundwater simulation model, with its boundary conditions and assigned hydraulic properties, is called the flow model.

Hydrogeochemistry and microbiology

For describing the hydrogeochemistry, a large enough set of ground water samples from various locations from shallow and deep ground waters is needed. There is also need for chemical and possible isotope analyses of fracture filling minerals. Dissolved gases and microbes are studied from drillholes, where the samples can be taken with pressurised water sampling equipment (PAVE) developed by Posiva.

The chemistry model consists of a description of the distribution of groundwater composition and an assessment of the processes controlling the evolution of the composition in time and space. This model needs to reflect some aspects of the hydrostructure model. The water-rock

interaction is modelled to describe hydrogeochemical and microbial interactions between water and rock, which control the pH and redox conditions in the groundwaters.

v. the assessment and/or development of safety case and supporting safety assessments,

Development of the safety case along with the site selection can support the site selection by identifying the characteristics affecting the long-term safety and assessing their impact on the long-term safety of the repository. The feedback of the safety case can be used to focus the characterisation activities on the key properties of the site and guide the design development. The safety case development is an iterative process that evolves along with the design development and increasing knowledge about the sites. Thus, the level of detail and the analysis done at the early phase of the site selection can be quite coarse and simple models are used, the level of detail increases along with the advance of the design and accumulation of the site characterisation data.

The elements of the safety case are defined according to the international state of the art of the safety case compilation. This approach is considered acceptable by the authorities and by the public as it reflects the international consensus and has been implemented in several recent safety cases including those supporting the licence applications by Posiva in Finland and SKB in Sweden. Accordingly, the Consortium proposes to structure the safety case work according to the activities described below. The Consortium offers its support in the planning, executing or reviewing activities or carrying out any of the activities except for specific numerical modelling needed for the analysis of the system evolution and radiological consequences, as requested by the Client.

Plan for the safety case to support the site selection phase

The first activity is to produce a more detailed plan for the safety case for the site selection phase. To give the framework for the safety case work, the safety case plan shall present the purpose of the safety case and the safety concept, summarise any existing results related to long-term safety of the repository in the proposed sites or similar sites and summary of the related legislation and requirements by the authorities.

A key element of this plan is the methodology for the safety case production and its adaptation to the increasing body of knowledge on site characterisation data and barriers design. Essentially a safety case is compiled for a given step in the waste management programme (e.g. site selection, construction, operation, closure), for a reference design and a specific version of the site model. However, as the site characterisation is evolving, it can be considered whether more focused safety evaluations of the impact of specific aspects of the site properties either on the evolution of the disposal system, on the performance of the barriers or on the radiological consequences are a more efficient way to provide feedback for the site selection process than a full safety case.

The safety case plan presents the main elements of the safety case or the safety evaluations and the supporting activities e.g. modelling and data acquisition needed to carry out them. The safety case plan presents also discussion on how the uncertainties are managed, the quality management of the safety case as well as plans for reporting the safety case and for implementation of the safety case.

Safety concept and long-term safety related requirements

This activity consists of documentation of the safety concept, definition and discussion of how the different barriers contribute to the safety i.e. the safety function of the barriers. Further, the performance requirements can be defined, at least qualitatively, for the different barriers to highlight the properties of a given barrier that are important for the long-term safety. The focus in the site selection phase is naturally on the host rock. However, it is considered important to discuss also the engineered barriers to get understanding on how their performance can be affected by the host rock conditions.

According to the experience of the Tenderer, it is beneficial to define the requirements in a hierarchical manner, i.e. to derive the performance requirements from the safety functions and the use the performance requirements as basis for the requirements on the design of the barriers and the repository including requirements in selection of the location of disposal canisters, that shall be fulfilled at the initial state of the repository. This approach adds transparency to the significance of the barrier properties to the long-term safety and can thus support also the development of the site selection criteria.

For the summary of the long-term safety related requirements, a review of the regulatory and other stakeholder requirements is carried out, the main loads and on the repository system during the assessment period are identified and the safety functions, performance targets and preliminary design requirements are defined.

Description of disposal system

This activity defines and documents the initial state for the host rock, the engineered barriers and the waste to the level of detail needed for the safety case. As part of the description of the disposal system, the impact of the repository construction on the initial state is considered, this includes e.g. estimation of the foreign materials used. The biosphere is described to the extent needed for the dose calculations and to address future human activities based on the selected modelling approach. This task is supported by the preparation of the site descriptive models (2.2.2a, ii) and assessment/development of the repository design (2.2.2a, vi) and assessment/development of the engineered barriers (2.2.2a, vii).

Features, events and processes

This tasks aims to identify and document the features, events and processes, FEPs that affect the system evolution or the radionuclide release and transport. This task consists of a compilation of a generic list of FEPs from existing databases, either national and/or international, screening of this FEP-list for the relevant FEPs for the long-term safety of the proposed design and the specific site in question. The screening may be updated once more as site data becomes increasingly available. A short description of the FEPs is provided in the FEPs list. FEPs that are different for the different sites, e.g. different groundwater chemistry processes at the site, will be considered particularly attentively as they may be of importance for the site selection.

Formulation of scenarios

In this task, scenarios of the future evolution of the disposal site are defined. When assessing the long-term safety, it is important to consider the performance of the disposal system under both present and future conditions including varying climate conditions. This can be achieved through the formulation and analysis of a set of scenarios. Scenarios are descriptions of alternative possible evolutions of the disposal system that represents structured combinations of features, events and processes (FEPs) relevant to the performance of the disposal system. The methodology for defining the scenarios to support the site selection is first defined. The aim is to cover the range of plausible future conditions at the site. A reference scenario is defined to assess the normal evolution of the site and engineered barriers. Further scenarios can be defined to assess the uncertainty in the system evolution due to deviations from the initial state, uncertainties in the FEPs affecting the system evolution and especially the host rock conditions. The safety functions and performance targets can be used as guidance for the type of changes during the assessment period that can have an impact on the long-term safety. Regarding the site selection, the possibility of different types of scenarios is of interest.

Analysis of the system evolution

This activity consists of analysis of the repository evolution over the assessment period under the reference scenario and other scenarios to study account for the uncertainty in the system evolution. The aim to assess whether the barriers perform and the containment is upheld or are the uncertainties that may lead to potential releases, which are then analyzed as part of the Analysis of radiological consequences, see below. For the analysis of the evolution of the system, modelling of the different parts of the system is required. Again, the focus is on the

host rock conditions and on such changes that can affect the performance of the host rock as barrier (as indicated by the performance targets) or lead to conditions such that the performance of the engineered barrier system is declined. Such changes can be related to the stability of the rock, the flow rates and groundwater chemistry. Also the impact of the repository construction and operation including the presence of the underground encapsulation plant is taken into account. In the beginning of the site selection phase, the modelling can be done by scoping analyses based on analytical or relatively simple models, more complex can be applied once more data from the specific sites are available. Future human actions are also considered.

Analysis of the radiological consequences

This task consists of the analysis of the radionuclide releases and doses from the scenarios including releases. The calculation endpoints need to be defined based on what is required by the legislation and authorities and what is considered as most useful in terms of comparing and selecting between different sites. This task includes definition of the calculation cases representing the selected scenarios, definition of the data for the calculation cases, calculation of the releases and/or doses for the different scenarios and calculation cases considering the near field, far field and surface environment. Future human actions are also considered.

Models and data

This activity consists of identification, description and justification of the models used for in the site selection phase to assess the system evolution and radionuclide release and/or doses including how the surface environment is treated. Of the various evolution models those addressing host rock evolution, e.g. mechanical stability, groundwater flow and groundwater chemistry at the site, are of most relevance; however, if there is lack of data, elaborate models cannot be used in this phase. Regarding the assessment of radiological consequences, it is desirable to decide early on whether deterministic or probabilistic methods will be used.

Conceptual models, mathematical model, computer codes and selection of the data for these models need to be described and justified. Relatively simple, transparent and robust models are generally well accepted by the regulator. The models and data should describe the relevant processes that are captured by the models, their applicability to the given site and to the assessment period. Ideally, the same models could be used for all the sites but some adjustments may need to be done if different processes need to be considered for different sites. For the following phases of the project, it is important to discuss the models and data uncertainties: the main reasons for these uncertainties, potential ways to reduce the uncertainty in the models or suggest alternative more suitable modelling methods. Considering the data used in the models, its origin e.g. whether site specific or general data, the suitability of the data for the given purpose as well as the sensitivity of the model results to a given data set and parameter values need to be discussed.

Complementary considerations

This task is carried out to provide additional evidence, arguments and analyses to build confidence on the safety case. With respect to the site selection phase of special interest are observations and analyses from natural and anthropogenic analogues that can support the understanding of the processes related to the site evolution, e.g. palaeohydrogeology. Based on the FEPs relevant for the sites, a literature review of potential analogues could be carried out.

Another topic that can be potentially assessed as part of the complementary consideration is the potential of the natural resources at the site

Safety case synthesis

This task is carried out to summarize the findings of the all safety case related tasks. In case of the safety case for supporting the site selection phase, the synthesis can focus on the positive and negative aspects of the different sites and the potential differences between the sites, e.g. distinct FEPs, comparing the results of the analyses of the system evolution and the

analysis of the radiological consequences. Furthermore, the significance of any observed differences between the sites, are the differences still within the range of uncertainties or are there real differences between the sites, or can such difference be taken care of by adjusting to design to site-specific conditions. Furthermore, the synthesis should summarize the feedback from the safety case with regard to the further site characterization and design development.

Rock Suitability Classification (RSC)

Rock Suitability Classification (RSC) system development for SÚRAO can be supported by consortium. Classification shall be developed to locate suitable volumes of rock for spent nuclear fuel repository design and construction. The RSC system includes criteria and procedures for defining volumes of rock suitable for the repository panels, to assess the suitability of deposition drifts or drift sections for locating supercontainers and for the acceptance of supercontainer sections for emplacement. The aim is to avoid features of the host rock that may be detrimental to the favourable conditions for safety, either initially or in the long term. The RSC shall be derived from target properties, which set the general long-term safety-related requirements for the host rock.

vi. the assessment and/ or development of a repository design including manipulation system,

Preliminary design and outline designs

During the preliminary design stage, several different alternatives shall be considered. Typically, no or minor site-specific examinations results are available. At the end of the preliminary design, the number of principal alternatives is limited (for example the number of separate access routes in terms of operational safety). In the outline design stage, the details are developed and the most suitable format is chosen as a reference for further development. Issues such as flexibility for implementation, logistics, working environment and feasibility for characterization during construction period are important factors. *These factors have also an influence on site comparison and selection.*

(Pre)feasibility study

A (Pre)feasibility study can be produced or supported for the whole DGR (or part of it) including an underground dry storage for the SF and underground encapsulation plant. Some advantages of underground hillside encapsulation plant and SF storage compared to buildings above ground (as in Finland) could be identified *from the siting perspective*, such as:

- natural shielding against radiation, large aircraft crash/ missile strike
- safe from storm winds, exceptional outdoor temperatures and wild fires
- easy to shield from flood
- impact of earthquake is smaller in rock caverns than above ground
- minimal land surface footprint, unlimited capacity, stable environment

The Basic contents of the (pre)feasibility study could be:

- Introduction
- Design bases and initial data
- Implementation (facility, systems, safety classification, fire safety, layout adaptation, construction techniques, construction schedule, enlargements)
- Operation (controlled area, radiation safety, incidents and accidents cases, safeguards)
- Licensing
- Investment and operational costs
- Conclusions
- Recommendations

Underground test laboratory

The task could consist, for example, of updating existing underground test laboratory plan/ memorandum according to the following process:

- Become familiar with input document(s) for this task
- go through operation experience of SKB Äspö Hard Rock Laboratory and Posiva's ONKALO.
- Agree on the initial input data, the design targets and handling of nonconformities in a review meeting.
- Update work of underground demonstration facility memorandum and organise 2 rounds of meetings with client stakeholders to understand any changes needed for the facility
- Organise design review meetings to check that the design work meets the design targets. The checking is declarative in its nature. The actual checking is being carried out during the design work itself.
- Organise the delivery inspection in the end of the task.

Surface facilities

The basis of the work is the functional analysis of existing design and of new inputs available: logistics, safety, location of each function divided into main and service processes.

- a logistic study would evaluate the following::
  - material flow amounts and staff movement into and out of the site and inside the site
  - traffic (roads, parking lots, yards and storage areas)
- size of areas reserved for each building and utilities keeping in mind the possible growth in the future
- safety & security, location of buildings
  - to minimize the movements and access points into the site and especially to the protected area
  - to minimize the disturbances caused by the handling of extracted rock and sealing materials production (dust, noise, shake)
  - defence zoning and barriers (passive security methods), control points (active methods)
  - location of parking lots and other risky activities
  - fire & rescue; evacuation, extinguishing, construction materials, separations (worst case study)
  - power redundancy
- impact of weather conditions
  - storm water control
  - space for piling up snow
  - landscaping

Conclusions will be adapted and documented in drawings and technical memorandum. These conclusions will affect the site selection.

Layout design and description of operation

The layout design for the DGR is done based on the available information of the operation, layout determining features and other design criteria of the bedrock. *For example, the effect on the layout and site suitability of operation, orientation of the main principal stress, thermal properties, fracture cleavage and stepwise implementation need to be assessed.*

Generic repository layout concept work could be described according to the following process:

- Become familiar with input documents for this task
- Review the existing (current) generic layout and make it as a base case
- Agree on initial input data, the design targets and handling of nonconformities in a review meeting.
- Review the most recent SKB and Posiva layout concepts KBS-3H (and 3V).
- Prepare concept layout using the following process
  - Recognize the possible rock volume for the underground repository and area for the surface facility.

- Identify compatible positions for the shafts (grouped together with the underground services area) and the surface facility. The shafts and the underground services area need to be connected to the surface facility so that the operation and progressive excavation (separate traffic flow in all development stages, ventilation, mucking etc.) is achievable without jeopardizing the long term safety principles (avoiding large scale geologic features).
- Adapt the panels (perimeter tunnels, central access tunnels, panel access tunnels, placement rooms) to the allowed rock volumes. They must also be compatible with the operation and progressive excavation (separate traffic flow in all development stages, ventilation, mucking etc.) without jeopardizing the long term safety (avoiding large scale geologic features).
- Develop the traffic flow plan§

- Review separately the possibility of eliminating the perimeter shafts from the design and the flexibility of avoiding geologic conditions detected during underground construction. A flexible *(siting)* dual central access tunnel concept (without the perimeter shafts) as the one implemented in Finland could be developed. S&R has developed a flexible *(siting)* dual central access tunnel concept (without the perimeter shafts) for Posiva and has the knowledge needed (for example the ventilation practices, emergency exit practices and layout flexibility).
- Organise design review meetings to check that the design work meets the design targets. The checking is declarative in its nature. The actual checking is being carried out during the design work itself.
- Organise the delivery inspection at the end of the task.

The basic work plan and contents for the layout report could be:

- Introduction (fuel inventory, schedule)
- DGR (URL, encapsulation galleries, SF storage gallery, disposal galleries, technical galleries...)
- Layout design bases and initial data
- Layout
- Stepwise implementation
- Alternative layouts (for different amounts of SF, location of shafts...)
- Summary
- Conclusions

Rock engineering and construction/ operation planning

The planning of construction could be carried out according to the following process:

- Become familiar with input documents for this task
- Review the base case layout
- The initial input data, the design targets and actions caused by nonconformities will be agreed in a review meeting.
- Prepare construction plan. Report will describe for example how construction works will be done in progressive steps and include drawings and figures to illustrate the repository and laydown area. Also the need for the development of new construction materials is assessed. To avoid unnecessary high (and expensive) galleries the lift heights are studied (now it seems like optimisation for current SÚRAO lifting heights can be done and it effect on some gallery rock coverage / siting). Construction method also effects on siting: for example, rock hoisting and shaft sinking methods need muck handling area right above the DGR and inclined ramp mucking and raise boring doesn't.
- Prepare schedule.
- Design review meetings are organized to check that the design work meets the design targets. The checking is declarative in its nature. The actual checking is being carried out during the design work itself.
- The delivery inspection is organised in the end of the task.

Development and design of installation machines

- The development of the engineered barriers installation machines should be based on the engineered barriers' design information, which means that concept designs of engineered barriers have to be ready before the concept design of installation machines. Once the concept designs become available, these could be used as a basis for facility layout designs.
- After site selection phase, when the designs of engineered barriers can be fixed, the first prototypes of installation machines could be detailed designed and manufactured. The first tests could be made above ground and later testing should be done underground in real repository conditions. Prototypes could be used first in real-scale system tests for engineered barriers installation.
- Posiva can provide consultation regarding concept development of installation machines. Review of client plans and reports concerning canister, buffer and bäckfill installation. Taking part in workshops organised by the client. Supplier's experience on installation demonstrations can be used to evaluate client plans.

Development and design of encapsulation plant's systems

- Posiva can provide consultation regarding concept development of encapsulation plant's systems. Review of client plans and reports concerning encapsulation process and main process steps and systems needed. Taking part in workshops organised by the client. Supplier's experience on encapsulation plant designing and system licensing can be used to evaluate client plans. Supplier has been developed needed process systems for safe spent fuel encapsulation in Posiva's encapsulation plant.

vii. the assessment and/or development of procedures and methods for the development of engineered barriers;

Engineered barrier system is developed in phases: conceptual design, basic design, and detailed design. In Finland the conceptual design has been used for the parliamentary Decision in Principle phase, the basic design in Construction license application and detailed design split in several stages when preparing the implementation phase. Posiva may support the SURAO in all phases, but the work should be targeted for creation of EBS basic design, which can be used in several steps before licensing procedure for DGR. SÙRAO and its consultants have been working in many areas related to the EBS behaviour, but Posiva may give support how to apply and combine the information into the background material for discussions with regulatory body and different stakeholders. Posiva can support in creation of systematic approach for buffer and backfill design including the build up of requirement management system for subsystem components and setting the performance and design requirements based on the design basis and constraints. Posiva can support the creation of three step programme for developing the design, production and performance assessment for buffer, backfill and closure based on the information gathered by Czech parties working within disposal (like CVÙT, NRI REZ, Czech Geological Survey).

The assessment/development of procedures and methods for the development of engineered barriers (buffer, backfill and closure) could be divided into the following preliminary work packages, the content of which would be agreed in more detail in with SÚRAO during the project.

Design work package could include, but is not limited to, the following issues

1. Basic design development for backfill/buffer/closure

   - to support basic design development of buffer, backfill and closure including the establishment the requirement management. Review of client plans and reports concerning buffer, backfill and closure. Taking part in workshops organised by the client.
   - to support the material selection for backfill/buffer/closure and review of client plans and reports concerning material selection. Preparing an expert recommendation

document for selecting materials based on buffer/backfill/closure performance requirements and the physical/chemical and mineralogical properties of the materials and their long-term stability. One option is to discuss and review the applicability of the procedures and methods currently used by the client. This work could include an analysis of the methods used (weaknesses and strengths) and recommendation for development of the methods to be used as standard-like method in future studies.

- to study Czech bentonites and support the quality control procedure of EBS materials for buffer, backfill and closure. Laboratory study on selected Czech bentonites and reference bentonite MX-80 and other possible materials. This work could be part of the development of the methods but also to compare how the results differ depending on the laboratory/method. For example, 6 pieces of parallel samples studied in Czech could be studied also in Finland with comparative methods. The results and methods would then be compared and the differences analysed.

2. Development for backfill/buffer/closure production
   - to support the selection of manufacturing and emplacement methods and techniques based on the experiences gathered in Finland and applying it to the SÚRAO needs. To clarify the Finnish legislation and regulatory guidance and related procedures In addition, logistics, quality control etc. can be taken into account in the work.
   - to support in field tests performed by the client can be provided through the review of the plans and reports and progress of the work in area. Additionally expert assistance on monitoring and instrumentation and numerical modelling can be offered.
3. Performance assessment of backfill/buffer/closure
   - to support the creation the programme for studying the early evolution of backfill/buffer /closure components and how this can be used as reasoning for fulfilment of requirements
   - to assist the methodology how to investigate long-term stability and evolution of Czech bentonites by reviewing of client plans and reports.

In addition, the different processes, which may influence to the initial behaviour e.g. cement/bentonite, titanium/bentonite and iron/bentonite interactions can be analyzed in laboratory studies depending on the needs of the client.

Concept development of canister

The disposal concept of Surao is based on steel canister and the concept of Posiva is based on copper canister. Even though there are differences on canisters, same methodology can be used on each assessment and development phases. Canister development can be divided into different assessment and development work packages starting from conceptual design up to detailed design.

Development of canister manufacturing and inspection technology

Posiva can provide consultation regarding development of canister manufacturing and inspection of the components (NDT) and design of experiments of the canister development. Posiva can also give support to project planning from concept development to qualification of the manufacturing processes. Review of client plans and reports concerning canister manufacturing and NDT. Taking part in workshops organised by the client.

Development of the sealing of the canister and inspection technology

Posiva can provide consultation regarding development of the sealing of the canister and inspection of the sealing (NDT). Posiva can also support of the sealing of the canister and NDT. Support includes evaluation of the properties of the sealing (welding) to define initial state of the canister before disposal. Posiva can support project planning from concept development to qualification of the sealing and NDT processes. Review of client plans and

reports concerning canister manufacturing and NDT. Taking part in workshops organised by the client.

Design of the canister components and performance assessment of the canister

To support and to consult designing of canister taking account requirements set by regulator and standards including quality assurance of the designing and analyses in each development phases (concept development to construction plan). Posiva could support and to consult on requirements and managing requirements of the canister (from safety functions to design specifications). Consulting to design canister so that it will full fill requirements set by encapsulating and disposal processes starting from concept design to detailed design including different analyses. Posiva can consult to design canister so that it will full fill performance targets. To consult and to support performance assessment of the canister including short and long term chemical, mechanical, thermal and radiation load on canister, heat transfer and criticality analyses. Supporting cost optimisation of disposal system based on heat transfer analysis. Review of client plans and reports concerning canister design, design analyses and performance assessment. Taking part in workshops organised by the client.

b) a cost estimate activities covering the preparation and construction of the deep geological repository and the relevant cost optimisation;

Cost estimates are needed for the site selection phase, the site confirmation phase and the DGR construction. In addition, for cost optimisation, a cost estimate for the operation and closure of the DGR is required. Cost estimates develop along with the concept development and can be used as a driver for the concept development, too.

Posiva has very long experience in cost estimation from the general concept phase to the detailed construction phase. Posiva's main support to SÚRAO's DGR project could be in reviewing the cost estimates prepared by SÚRAO. Posiva's experience could also be used when preparing cost estimates for different project phases and for analysing alternatives for cost optimisation.

c) support for communication activities with the general public, the relevant authorities and NGOs.

A precondition for conducting site investigations is that the local inhabitants are well informed about the repository project and willing to accept and to commit to the long lasting investigations "in their backyard". A strategy for public relations would help to facilitate Surao's endeavours in regard to the site investigations in the long term. In order to be able to proceed to detailed site investigation at a later stage, it would be desirable to gain public acceptance for final repository at least in two of the investigation sites. Along with the building up of the local acceptance a strategy for public relations would cover communication measures with other relevant stakeholders like authorities, NGOs, politicians and media.

The strategy for public relations would cover communication measures for the first five years of the preliminary site investigation phase. Before the actual strategy can be compiled, a review of the present situation of communications with regard to siting would be needed *(current state analysis).* This data can be readily available to Consortium, based on the previous research conducted by Surao or on other data. If not, a stakeholder survey among the relevant stakeholders of Surao could be conducted. Current state analysis forms the basis for the compilation of the strategy for public relations.

Based on the information gained from the current state analysis, the strategy will identify objectives, issues and result indicators for communication aligning these elements to be applied with different key stakeholders.

Work program

For gathering information for the current state analysis, a workshop should be arranged between Consortium and Surao. The information presented here could consist of data of public

opinion polls regarding acceptance of final disposal, surveys dealing with the reputation and communication of Surao, media-analysis on the public discussion of final repository etc. On the basis of the discussions and the information available, the need for further stakeholder research will be decided.

Structure and compilation of the communication strategy

Based on the discussions and the information available in the workshop, Consortium would compile a strategy for public relations that consists of the following parts:

1) Introduction
2) The current state analysis
3) Communication at the local level
4) Communication with media
5) Communication with other relevant stakeholders
6) Training program for the employees (management level, experts)
7) Key result indicators
8) Follow-up
9) Risks
10) Involvement and coordination
11) Timeline
12) Summary

The content for the different parts of the strategy can be described as follows

Communication plan for the local level

This plan consists of different communication measures in order to keep the local people of the investigation sites well informed about Surao's activities and to enhance acceptance towards final repository. The plan will cover organization of the local communication measures including liaison groups, public information meetings, plan for information bulletin delivered to the people in the investigation sites, integration of Surao's website to local communication, a plan for local sponsorship etc.

Communication plan for the media

The plan is based on the proactive approach, where information is delivered systematically along the course of investigations with a different emphasis on the local and national media. The plan will also include delivery of background information related to final repository with the aim of building up the generic knowledge of media on nuclear wastes and disposal.

Communication plan for decision makers/politicians/authorities

A precondition for a successful repository siting project is the commitment of decision makers and authorities to speak and act in favour of final disposal. The plan aims at keeping up systematic communication to relevant decision makers/authorities with consistent messages about the repository project.

Training program for the employees of Surao

For the implementation of the strategy for public relations in the organization, management should be committed to the strategy and be able to engage the rest of the organization to the strategy. Since the employees are the ambassadors of the final repository project they should be competent and credible to speak in favour of the final disposal project. In this regard, experts of final disposal should be converted to communicators/spoke persons of the company, a task that preconditions training in communication with different audiences.

Key result indicators describe how well the organization has met the objectives set for each stakeholder and the corresponding strategic issues that are dealt with in the communication.

Plan for the follow-up

Communication with stakeholders should be measured systematically and continuously. For doing this, key result indicators will be set for each stakeholder group and for each strategic theme (e.g. safety of final disposal, economical benefits of the repository project etc.) that is addressed with respective stakeholder group. Plan for the follow-up will entail assessment of performance at different points of time in regard to communication with different stakeholders.

Risks related to the strategic themes that are dealt with different stakeholders are assessed and measures to mitigate the risks are presented in the strategy.

Involvement and coordination point out the responsibilities for different actors within the organization to realize the strategy.

Timeline describes timing for different communication measures in an annual level.

In the **summary,** the communication strategy will be visualized, which supports internal communication of the strategy in an effective and an understandable way.

2.2 The Supplier shall perform these Services via the application of his knowledge and expertise in the above-mentioned areas, including among others:

a) procedures and methods for the characterisation of selected sites (including the preparation of site descriptive models)

The data for the multidisciplinary site description are collected based on the site investigation programme first aiming at the site selection and later at the site confirming. An extensive drilling programme with related drillhole investigations, including hydrogeological, geophysical, hydrogeochemical and rock mechanical studies, is carried out and the results are used in the development of site-scale models for each of the various disciplines. Our knowledge in methods for investigating the bedrock are described in the following.

One of the main products of the modelling is a descriptive model of the site, i.e. a model describing the geometry, properties of the bedrock and the water, and the interacting processes and mechanisms that are relevant for understanding the evolution of the site to the present day and the potential for future radionuclide migration. This description is, therefore, distinct from the measured data themselves. Modelling involves interpreting data, extrapolating or interpolating between measurement points and calibrating the numerical models used to simulate the system against data, based on the various assumptions inherent in the conceptual model(s) being employed. For example, the Olkiluoto site description is divided into the following disciplines: surface system, geology, rock mechanics, hydrogeology and hydrogeochemistry. In the final reporting, itegration of understanding across scientific disciplines is enhanced by requiring the presentation of information from each discipline to follow a pre-set outline, including

- Presentation of the conceptual model
- Evaluation of information
- Assessment of interaction with other disciplines
- Presentation of the descriptive modelling
- Evaluation of uncertainties.

SKB and POSIVA have extensive experience in planning and performance of site characterisations. SKB planned and performed a dress rehearsal site characterisation, at Äspö in the municipality of Oskarshamn, in the investigation preceding the selection of the site for the un-

derground laboratory. The development of site characterisation methodology and techniques to be used in the future site characterisations of the two potential sites for a deep repository for spent nuclear fuel started with the site characterisation at Äspö during a 5 year period between 1986 and 1990. The experiences from the successive characterisation programme at Äspö as well as the development of site descriptive models proved to be valuable in the planning and execution of future site characterisations. The verification of the site descriptive models from the construction of the underground laboratory further strengthens the experiences and its application in the planning and execution of future site characterisations.

SKB initiated the planning stage for the site characterisations for the deep repository for spent nuclear fuel, in Oskarshamn and Östhammar, in 1990's.The site specific characterisation planning was complemented by the development and documentation of detailed investigation methodologies and the preparation for the development of site descriptive models.

SKBs experience shows that a site characterisation is of such magnitude in time, space and content that a division in stages is necessary for a rational implementation of all examinations and analyses. A staged implementation also gives better opportunities for a site specific investigation methodology and efficient feedback from evaluation.

- The initial site characterisation stage identifies the area subject to the complete site characterisation
- The complete site characterisation stage aims to develop a complete geoscientific understanding of the current state and the naturally occurring processes of the site

The initial site characterisation defines the starting point for the site descriptive model as well as of the complete site characterisation stage. SKB has successfully divided the characterisation activities and the site descriptive model development of the complete characterisation stage into campaigns by imposing data freezes. The site characterisation programme was continuously developed based on the successively increasing understanding of the site.

Site characterisation includes surface investigations, such as aerial photography, airborne and surface geophysics, surface mapping and monitoring and ecological inventory surveys, and sub-surface investigations through a series of boreholes. Borehole investigations include core logging, downhole geophysical surveys, groundwater sampling and hydraulic testing.

SKB has successfully carried out two complete site characterisations for the siting of a deep repository for spent nuclear fuel in which quality-assured data from the site investigations have been used as input to the development of site descriptive models. The site descriptive model has in turn been used by repository engineers for the design of underground facilities and to develop repository layouts adapted to the sites. The site descriptive models have also played an essential role for the safety assessment, since the models are the only source for site-specific input.

SKB submitted a licence application, in March of 2011, to construct a deep repository for spent nuclear fuel in Östhamar according to the Swedish Nuclear Activities Act and the Environmental Code. The application was based on the comprehensive site characterisations performed in Oskarshamn and Östhammar and the site descriptive model developed in parallel to the characterisation activities.

Posiva has essentially the same experiences as SKB in relation to the planning and performance of site characterisation for the siting of a deep repository of a deep repository for spent nuclear fuel in crystalline rock.

In addition to the licence application, according to the Swedish Nuclear Activities Act and the Environmental Code, to construct a deep repository SKB has in 2014 submitted a licence application for the extension of the existing repository for short lived operational waste, SFR. The application is based on the existing facility and the site characterisation performed between 2008 and 2010.

SKB, and Posiva alike, has state of the art experiences from the planning and performance of site characterisations activities in the field as well as of developing site descriptive models as an integrated model for geology, thermal properties, rock mechanics, hydrogeology, hydrogeochemistry, bedrock transport properties and a description of the surface system.

b) quality requirements concerning the various siting processes;

Posiva applies a management system based on the ISO 9001:2000 standard for all activities, including the production of the site related investigations and reporting, and requires the pursuit of the same quality assurance principles from all its contractors and suppliers. The system was first launched in 1997 and has later been subject to continuous maintenance, updating and several internal and external audits.

The purpose of Posiva's management system is to ensure, in a documented and traceable way, that Posiva's products - whether they abstract knowledge and information, are published reports or physical objects - fulfil the requirements set for them. The general quality objectives, requirements and instructions defined in Posiva's management system will also in the future form the foundation of the quality management for investigation and safety case activities. The purpose of the enhanced process control is to offer full traceability and transparency of the data, assumptions, modelling and calculations.

As noted above, the quality management of the site investigations and the processing of the primary measurement and observations data is based on ISO 9000:2000 and is covered by Posiva's management system. The system also applies to the subsequent modelling and interpretation activities regarding the responsibilities of the suppliers, the supplier audits, the application of computer codes, the use of datasets, and the documentation and product control. The quality achieved also relies, however, on the application of scientific principles, such as the critical use of data and information, an open publication policy, the repeatability of the experiments and the traceability of the information used. In particular, the Olkiluoto Site Descriptions are subject to an expert review before publishing. The outcome of the review is documented, together with the responses taken on the basis of the comments.

A quality plan concerning this project has been prepared in accordance with ISO 10005 or ISO 10005: 2005 Quality management systems - Guidelines for quality plans and is attached as the annex 3 of the Framework Agreement.

c) geo-disciplines (petrography, geomorphology, tectonics, geochemistry, geophysics, engineering geology, geological modelling, remote sensing etc.)

Related to geo-disciplines, we can offer our expertise in the following areas on the basis of lessons learned in Olkiluoto during detailed investigations and site confirmation stage.

Before the geological field mapping, all existing geological data will be gathered as the background data for the mapping. Processed aerogeophysical maps and digital elevation models are used to define and complement the lineament interpretations made in the site selection phase in order to get a more precise view of the fracture zones and the block structure of the study site.

In the general geological mapping of the outcrops rock types and their distribution within the study site will be determined. Also the structures of the ductile and brittle deformation will be mapped, Detailed structural geological investigations can be focused into specific key areas. Within soil-covered areas geological mapping will be complemented by drilling short drillholes and/or by excavating investigation trenches. They help to locate lithological contacts and fracture zones more precisely than is possible by outcrop mapping.

Detailed logging of oriented drillcores include observations of rock types, fractures, fracture infillings, hydrothermal alteration etc. Fracture and foliation data obtained from the oriented drill cores are supplemented by the orientation data from the optical (OBI) and acoustic (ABI) images. From these images, the orientation of the fractures and foliation data can be determined also from strongly-fractured drillhole sections.

Ductile and brittle deformation zones are identified and described from the drill cores and the borehole-TV images. The orientation of these zones is determined on the basis of geophysical methods and the orientation of fractures. The determined deformation zones coupled with the orientation data constitute the basics of the 3D modelling. Representative samples for petrological, geochemical and petrophysical investigations are taken from outcrops and drill-cores.

The Quaternary deposits/soil cover are described on the basis of existing information. Site specific data can be collected by areal soil mapping with associated laboratory investigations in order to get more detailed information on the depth of the overburden, the distribution of different soil types and their physical and chemical properties. Data of the soil cover can be used in the modelling of the geosphere-biosphere connections, hydrogeology and hydrogeochemistry.

The rock mechanical observations and measurements during drilling and in the laboratory include the determination of the quality of the rock (Q'-classification), the strength tests (unaxial compressive strength, tension strength, Young's modulus and Poisson's ratio) and rock stress measurements (e.g. LVDT method and HF).

Drillhole observations, statistics and experiences in modelling tasks can be used for estimating reasonable and cost-effective drilling density for further studies and programmes.

Geophysical surveys are done to supplement geological observations from the ground surface. They provide additional information especially with depth. Several geophysical methods, sensitive to different physical properties and with different investigation depths, are used. Integrated interpretation provides a better image of the bedrock structure from the ground surface to the depth.

Airborne low-altitude datasets (magnetic, EM and radiometric), are the starting point, providing a general picture of e.g. lithological variation and deformation zones of the site. Magnetic data is processed by compiling different versions of maps for interpretation. In qualitative interpretation, rock type units and deformation zones as well as other conducting features are outlined. In quantitative interpretation, the geometries and properties of geological features are determined.

Geophysical ground surveys are done and interpreted to locate deformation zones and determine rock type distribution in more details. The survey includes e.g. magnetic total field and electromagnetics (HLEM or VLF +R). Ground penetrating radar gives information on surficial deposits and bedrock fracturing. Electrical Resistivity Tomography (ERT) gives an overview of distribution of electric conductivity in surficial deposits and shallow parts of the bedrock to the depth of 100 metres. Wide-band electromagnetic soundings extend the information down to the depth of 1000 metres. EM soundings can be used in mapping saline groundwater or mineral conductors in the bedrock. A number of seismic refraction survey lines are measured across supposed deformation zones when needed to confirm their existence. Seismic refraction soundings give information also on depths and properties of surficial deposits. If there are mafic formations within the study area or in its near surroundings, a gravity survey would be justifiable. The survey results also provide information on the thickness of the soil layer.

Geophysical drillhole investigations can be utlilized in mapping e.g. rock type distribution, groundwater conditions, deformation zones and even single fractures. Some methods provide information on small-scale variations nearby a drillhole, whereas some others can be used to characterize larger volumes around the hole. Standard single-hole loggings (for studying rock type variation, deformation zones, porosity, fracturing, elastic properties, stress field etc.) include natural gamma radiation, gamma gamma density, back-scattering of neutron radiation, electric resistivity, single point resistance, acoustic full waveform, velocities of P and S wave, caliper of the drillhole and groundwater temperature and resistivity. Certain investigations, imaging larger volumes around the drillholes, need to be done as well. With seismic VSP (Vertical Seismic Profiling) and drillhole radar, orientations and extents of deformation zones and rock type contacts can potentially be determined. Furthermore, a number of certain special geophysical surveys can be done if needed, such as in situ thermal loggings. To study

the structure of bedrock, also mise-a-la masse, seismic or electric tomography or EMRE crosshole radiowave imaging can be useful.

d) hydrogeology and hydrology

We can offer our expertise in hydrogeology and hydrology on the basis of experience in Olkiluoto during detailed investigations and site confirmation stage.

The safety of the geological nuclear fuel disposal concept is based on the stability of bedrock conditions and the predictable performance of the technical release barrier. Key questions for the latter topic are the corrosion risk of the various engineered components and the behaviour of bentonite under variable hydrogeochemical conditions. Additionally, the stability (dissolution rate) of the spent fuel is linked with the prevailing redox conditions and the groundwater flow is the only mechanism in the Finnish bedrock, which can transport radionuclides from the deep repository to biosphere. In a way or another, all these processes are controlled by the hydraulic properties of the bedrock. Therefore, it is necessary to understand the surface and deep groundwater conditions and the affecting factors in order to compare the candidate sites and justify the final selection.

The aim of the hydrological surface investigations is to delineate the catchment areas, provide estimates for the local water balance and for the direction and rate of (shallow) groundwater flow. In order to monitor the groundwater table a network of groundwater observation tubes needs to be established. Number of observation points depends on the size of the investigation area, topography, and the thickness and type of the overburden. A catchment model is compiled using available elevation models and observations on surface water flow directions.

Hydraulic conductivity (K-value, m/s) of the Quaternary deposits is estimated based on the grain size distribution of the samples collected during the installation of groundwater observation tubes, or preferentially based on in situ hydraulic tests.

Hydrogeochemical characterization of rain, surface waters and shallow groundwaters aims to assess the chemistry of recharging water potentially mixing with the deep groundwaters. Surface water samples are collected from springs, brooks and lakes. Shallow groundwaters are sampled by pumping from groundwater observation tubes. In populated areas also drilled wells can be sampled. Field measurements (pH, electrical conductivity, temperature) are always made during the samplings. Samples are analysed for major and minor components, and pH and electrical conductivity are measured in laboratory. Additionally, the isotopic composition of oxygen and hydrogen are determined.

Hydraulic testing of deep drillholes aims to provide information of groundwater flow distribution in bedrock and hydraulic properties (water conductivity, hydraulic heads) of water-conducting zones. It should be noted, that the testing can be done only after the hydraulic disturbance generate by the drilling campaign has calmed down. E.g. Posiva Flowlog provides the following information:

- Location of the water-conducting fractures and zones
- Transmissivity (m^2/s) of the fractures/zones
- Flow rate (ml/h) in the fractures
- Hydraulic head in the drillhole (m) as a function of depth
- Hydraulic head in individual water-conducting fractures/zones
- Direction of flow within the test section (flow into hole/flow out from hole)
- Groundwater temperature (°C) in the test section
- Electrical conductivity (S/m) of the groundwater within the test section
- Single point resistance (Ohm) of the bedrock with 1 cm resolution

Geometry of the observed hydraulic zones can be studied with different tests. For example, by monitoring groundwater table or hydraulic head in drillholes, or in packed-off hydraulic sections, during pumping tests. Received data reveals hydraulic connections between the drillholes, but it also allows to estimate the hydraulic properties of the connecting structures. It is possible to calculate the K-value (m/s) and the transsmissivity (m2/s) for the hydraulic zone.

Hydrogeochemical characterization of deep groundwaters aims to identify the different water types at the site, to define their hydrogeological context and to estimate the long-term stability of the groundwater system. Possible scenarios include, for example, mixing of surface waters, water-rock interaction and the impacts of past seawater stages or glacial meltwater intrusions, if relevant. To support detailed hydrogeochemical studies, a multi-packer equipment is installed into the drillholes. The packers prevent water flow along the drillhole and restore the natural hydrogeological conditions. Generally each section is instrumented with pressure, temperature and electrical conductivity sensors. Multi-year monitoring generates data for the assessment of the stability of deep groundwater conditions, e.g in response to seasonal variations.

Studies of dissolved gases, microbes and redox sensitive elements (eg. Fe(II) and S-) need groundwater sampling methods, which maintains the samples under hydraulic pressures prevailing at the sampling depth and prevents atmospheric contamination. Samples for standard chemistry can collected from water pumped to the surface. Preferentially open-hole sampling should be done with double-packer equipment, ie. from isolated hydraulic sections.

Hydrogeochemical characterization involves the analyses of the main and minor elements, as well as, the lab measurements of pH and electrical conductivity. Additionally, the stable isotope (oxygen, hydrogen) and tritium (3H) are determined. The analytical program will be expanded later when the studies and data needs evolve.

e) engineering and project solutions concerning deep geological disposal

NWM program

In 2013-2014 S&R produced the overall report "Fennovoima Oy's nuclear waste management plan for spent nuclear fuel" to the client's satisfaction.

Requirement management

Recently, SKB and Posiva have produced further documentation related to the design criteria that may be useful as background information for this work. Such reports include Design premises for a KBS-3V repository based on results from the safety assessment SR-Can and some subsequent analyses, SKB TR 09-22; Rock Suitability Classification, RSC-2012, POSIVA 2012-24; Design Basis for a Spent Nuclear Fuel Repository at Olkiluoto POSIVA 2012-03; Underground Openings Production Line 2012 – Design, Production and Initial State of the Underground Openings, POSIVA 2012-22.

The personnel of Saanio & Riekkola Oy have been participating in the projects related to concept development, design and development of a safety case for a KBS-3 type deep geological repository in Finland over two decades. These projects have included several tasks related to development of the safety functions and design requirements of both the vertical design alternative KBS-3V and the horizontal design alternative KBS-3H. The most recent published reports were supporting the construction license application submitted by Posiva in 2012. The development of the KBS-3H alternative has been a joint project by the Posiva Oy and its Swedish counterpart SKB. Currently, projects related to further development of the requirements of both repository design alternatives are ongoing.

Main tasks related to requirement management carried out by Saanio & Riekkola Oy's personnel has been participation in the development of the rock classification for a KBS-3V type repository that aims in adaptation of the rock facilities to the host conditions at the site. At first, mainly the engineering aspects were considered in the requirements, but since the early 2000 the long-term safety aspects taking into account also the performance of the engineered barrier system have been guiding the development of the requirements. In the first projects,

the also other sites studied in Finland for deep geological disposal were considered and a classification system not specific to a particular site was developed, whereas later, the focus has been on a deep geological site developed at Olkiluoto. S&R has had a big role in publishing reports and conference papers related to these projects including:

- Engineering rock mass classification of the Olkiluoto investigation site. POSIVA 2000-08.
- Preliminary KBS-3H layout adaptation for the Olkiluoto site – Analysis of rock factors affecting the orientation of a KBS-3H deposition hole. Posiva Working Report 2002-57.
- Host rock classification. Phase 2: Influence of host rock properties. Posiva Working Report 2003-04.
- Host rock classification. Phase 3: Proposed classification system (HRC-system). Posiva Working Report 2005-07.
- RSC-Programme – Interim Report. Approach and Basis for RSC Development, Layout Determining. Features and Preliminary Criteria for Tunnel and Deposition Hole Scale. Posiva Working Report 2009-29.
- Rock Suitability Classification, RSC-2012. POSIVA 2012-24.

Since 2007 S&R has been managing Posiva's technical requirements for different underground rock opening types including layout requirements.

Saanio & Riekkola was contributing to the compilation of the Site Engineering Report by Posiva (POSIVA 2012-23) by providing expertise on Olkiluoto bedrock conditions, ground types, construction of and experiences from ONKALO, editing the report and also reviewing part of the report.

Saanio & Riekkola's personnel has participated also in the development of the requirements for the engineered barriers mainly by reviewing the requirements from the perspective of the long- term safety aspects (see e.g. POSIVA 2012-03) and development of the requirements for the closure (POSIVA 2012-19).

Saanio & Riekkola participating in the management of the KBS-3H project and the safety evaluation of the KBS-3H, has been involved in defining and review of the KBS-3H specific requirements (see e.g. Safety Assessment for a KBS-3H Spent Nuclear Fuel Repository at Olkiluoto, Evolution Report, POSIVA 2007-08 and Description of KBS-3H Design Variant POSIVA, 2012-05).

Preliminary design and outline designs

S&R has produced and reported the preliminary designs and outline designs in 2001 and 2002 for the Posiva ONKALO and disposal facility (DGR) which enabled to continue with one selected reference solution. In 2000-2001 S&R produced alternative preliminary design for the first part of the disposal facility of Posiva R&D –report 2001-06 (not public report with 208 pages). The published report partly dealing with this work is Posiva Working Report 2003-58 "Evaluation of Access Routes to the ONKALO Underground Rock Characterisation Facility.

(Pre)feasibility study

S&R most recent (pre)feasibility study in analogous hillside location has been completed in 2016 (client confidential).

Underground test laboratory

S&R & Posiva have been involved in several experiences and demonstrations and have operation experience also of SKB Äspö Hard Rock Laboratory and Posiva & S&R have already good knowledge of Posiva ONKALO facility, because also S&R has been involved in several investigations and demonstrations there. The Consortium has an excellent opportunity to use the experience for the benefit of client demonstration work.

S&R has participated in SKB Äspö Hard Rock Laboratory demonstration work in Sweden (for example pilot borehole drilling, parallel cut-sawing for plugs, EDZ water conductivity and KBS-3H drift push reaming).

S&R has participated in ONKALO demonstration and investigation planning and work at Olkiluoto since the 1990's. S&R is involved with every investigation niche and demonstration tunnel of ONKALO (e.g. bentonite, sealing, hydraulic measurements, spalling, EDZ water conductivity, radioactive retention properties, disposal hole drilling and plugging).

S&R has participated in Olkiluoto LILW-repository demonstration tunnel planning and work since the 1990's (e.g. disposal hole drilling tests). S&R has had a key role in the design and has adapted a layout positioning including demonstration tunnel at the depth of 100 m at the Olkiluoto bedrock, Finland in 1990.

S&R has been managing Posiva's technical requirements also for demonstration tunnels and investigation niches requirements since 2007.

Surface facilities

S&R references for Posiva Oy projects:

- Architectural and principal design of ventilation and hoist & entrance building for underground spaces (ONKALO & repository) 2008-2015.
- Principal drawings of encapsulation plant. Principal design 2011-2012.
- Master plans for the surface facilities, development by years until the beginning of disposal process in 2022: architectural design 2008-2014
- Planning for the surface facilities land reservation and development tasks: architectural design 2001-2005.
- Conceptual design for the surface premises and areas of ONKALO. Architectural and principal design 2001-2002

S&R references for Teollisuuden Voima Oy projects:

- Planning for the power plant land reservation and development tasks: architectural design 2001-2005
- Site layout drafts for each nuclear power plant tendering options in alternative locations Olkiluoto (OL3) and Loviisa (LO3) 2001-2002

Layout design and description of operation

S&R have a long track record of managing Posiva's technical requirements for different underground rock opening types, including also layout requirements. S&R has been involved with updating Posiva's DGR layout in 2015 (Posiva working report 2015-52). Therefore we have an excellent opportunity to use the most recent Finnish experience for the benefit of clients layout work.

Examples of S&R layout experience is described in the following Finnish and international underground nuclear facility projects for both Low and Intermediate Level Waste (LILW) repositories and Deep Geological Repositories (DGR):

- KBS-3V layout at the Olkiluoto in 2015
- Layout for the underground LILW Repository at the Hanhikivi bedrock, Finland in 2015
- Participation in KBS-3H layout work with SKB (and Posiva)
- Layout development (updates) of ONKALO and disposal facility 2008-2015
- Layout for the underground rock characterization facility (ONKALO) in different stages during 2001-2008
- KBS-3H layout at the Olkiluoto bedrock in 2007
- KBS-3V and -3H layout at the Olkiluoto in 2006-2007
- KBS-3V layout at the Olkiluoto in 2003-2004
- KBS-3H layout at the Olkiluoto in 2002
- KBS-3 and medium long hole (MLH) layout at the Olkiluoto in 2000
- Underground LILW Repository layout at the Wolsong bedrock, Korea in 2006.
- Layout positioning for the underground LILW Repository at the Olkiluoto in 1990 and an expansion plan layout 1992.

S&R has been managing the Posiva disposal facility blue prints since 2000 and developed the needed updates for the previous layouts. S&R has produced these in a non-public A3-size drawing-reports (preliminary design stage 1, 2004, preliminary design stage 2, 2007, outline design, 2010 and main drawings stage, 2012). These consisted of several one- and two-storey layouts for the disposal facility at the depth of 420-520 m at the Olkiluoto site. The work has included drawings for construction licencing made by S&R in 2014 as submitted to the Radiation Safety Authority STUK.

S&R has adapted a layout positioning for the underground rock characterization facility (ONKALO) including also the surface facility (access routes) at the Olkiluoto bedrock in different stages during 2001-2008 (Posiva Working reports 2003-26 and 2008-01). It consisted of several two-storey layouts for the ONKALO at the depth of 420-520 m.

S&R has adapted a layout positioning example at the Olkiluoto bedrock in 2007 (Posiva Working report 2007-77). It consisted of one-storey layout for the KBS-3H type repository at the depth of 420 m.

S&R has adapted 3 layout positioning examples at the Olkiluoto bedrock in 2006-2007 (Posiva Working report 2006-92). They consisted of one- and two-storey layouts for the KBS-3V and -3H type repository in the depth range of 420-520 m.

S&R has adapted 6 layout positioning examples at the Olkiluoto bedrock in 2003-2004 (Posiva Working report 2004-68). They consisted of one- and two-storey layouts for the KBS-3V type repository in the depth range of 420-520 m.

S&R has adapted 4 layout positioning examples at the Olkiluoto bedrock in 2002 (Posiva Working report 2002-57). They consisted of one-storey layouts for the KBS-3H type repository in the depth range of 400-500 m. These layouts were based on shaft access only.

S&R has adapted 18 layout positioning examples at the Olkiluoto bedrock in 2000 (Posiva Working report 2000-52). They consisted of one- and two-storey layouts for the KBS-3 and medium long hole (MLH) type repositories in the depth range of 400-500 m. These layouts were based on shaft access only.

S&R has adapted a layout positioning for the underground LILW Repository (at the depth of 130 m) at the Wolsong bedrock, Korea in 2006. It was part of 15 work packages S&R did for Korea during 2004-2014 including for example rock design guideline development, engineering design, site investigation programming (and analyses), technical evaluation and licensing support.

S&R has a key role in the design and monitoring the Olkiluoto LILW repository which started operation in 1992 and has been operated successfully over 20 years. S&R has adapted a layout positioning for the underground LILW Repository (at the depth of 100 m) at the Olkiluoto bedrock, Finland in 1990. An expansion plan layout design for TVO is done in S&R in 1992.

S&R has adapted a layout positioning for the underground LILW Repository (at the depth of 90 m) at the Hanhikivi bedrock, Finland in 2015. It was part of S&R work for Fennovoima during 2013-2015 including for example nuclear waste management plan for spent nuclear fuel and ground surveying program participation.

Rock engineering and operation & construction planning

Optimisation of the current SÚRAO lifting heights can be done. Posiva provides experience to simplify and optimise costs from the manipulation systems and thorough it also the underground galleries heights, volumes and costs might be lowered.

S&R has actively participated in the compilation of the construction experiences from the ONKALO construction during 2004 – 2010. Experience in constructing an underground facility in crystalline rock to the anticipated repository depth (i.e. 420-450 m) gives useful, additional practical information for this task. (Site Engineering Report, POSIVA-report 2012-23.)

S&R has conducted similar work in Finland first for TVO and later for Posiva, work started early 1990's with a layout only considering shafts but it was later (early 2000's) updated to include the access ramp, as well.

In 2000-2001 S&R produced alternative preliminary design for the first part of the disposal facility of Posiva R&D –report 2001-06 (not public report with 208 pages). It covers roughly the same issues as is needed in this task (e.g. shaft sinking, cage decking equipment, headgear, dirt disposal conveyor, mucking, heap of blasted rock, Galloway set-up/take down, grouting, ground support, schedules, cost estimates, temporary sumps). The work was carried out in collaboration with UK and Canadian experts. The published report partly dealing with this work is Posiva Working Report 2003-58 "Evaluation of Access Routes to the ONKALO Underground Rock Characterisation Facility.

In 2011-2012 S&R produced a construction plan for disposal facility for Posiva. It also covers roughly the same issues as is needed in this task (e.g. mucking, grouting, ground support, schedules, cost estimates, temporary sumps, organization, contracts and laydown area).

In addition to nuclear waste-related projects S&R's every day work involves planning of the various underground facilities like tunnels, caverns, storages in hard, crystalline rock conditions. The works includes excavation and construction planning, planning of rock support and sealing/grouting, estimation of groundwater leakages, construction schedule and cost estimation. In crystalline rock fracture or weakness zones are often encountered and special attention has been applied to design those rock sections. Such more fractured rock sections with large groundwater flows require special sealing/grouting design.

S&R professionals have participated in a joint operation in controlling groundwater inflow in ONKALO underground rock characterization facility (URCF) and also the underground disposal facility since 2008. Currently Aimo Hautojärvi is a member of Posiva's seepage water control group. Before the seepage water group and at its early phases, in 2006-2009, S&R has prepared an estimate of water inflow into the repository and participated in preparing a strategy for groundwater inflow management and designing grouting of fractured zones in ONKALO URCF, with emphasis also on grouting material development (e.g. Posiva WRs 2009-2, 2008-45, 2008-44, 2007-102 and 2006-45). In 2009-2010 S&R has participated in investigations concerning silica grouts, during which time material investigations and silica grouting tests were performed in ONKALO URCF. As a continuation to that S&R also participated in experimental silica grouting in ONKALO demonstration tunnel in 2011-2012 (Posiva WR 2012-84).

Concept development for manipulation systems and installation machines

Posiva has developed concepts for fuel and disposal canister transfer systems in encapsulation plant and installation machines for the disposal canister in the disposal facility.

Some references:

- Encapsulation plant design 2012. Working Report 2012-49
- Transfer trolley and docking station design for spent fuel cask. Working Report 2009-72
- Canister transfer trolley and canister transfer corridor equipment. Working Report 2011-57
- The fuel handling machine and the auxiliary systems of the fuel handling cell. Working Repot 2012-54
- Remote controlled mover for disposal canister transfer. Working Report 2012-53
- Preliminary Design for Spent Fuel Canister Handling Systems in a Canister Transfer and Installation Vehicle. Working Report 2008-38.

Concept development of backfill/buffer/closure

With regard to the performance of engineered barrier systems and concept development the key expertise used in this project would be provided by Posiva Oy and S&R/B+Tech Oy. Posiva is responsible for management of concept development and supervision of the work. Posiva has been produced a comprehensive set of reports supporting the construction license

application. Under Posiva's supervision S&R and B+Tech has been contributed as consultants to the following areas. S&R/B+Tech Oy held a project lead position in Posiva's 2012 backfill design project and is currently leading Posiva's backfill design update. Additionally, S&R/ B+Tech Oy has had a key role in development of the KBS-3H concept. S&R/ B+Tech Oy has its own laboratories and has significant experience in designing and conducting small and large-scale experiments for bentonites used in buffer, backfill and closure designs. The role of S&R/ B+Tech Oy in EBS concept development for SÚRAO would be to provide expert support.

Some references

- KBS-3H Complementary studies. POSIVA report 2013-3.
- Deposition tunnel backfill design for a KBS-3V repository. Hansen, J. Korkiala-Tanttu, L., Keski-Kuha, E. & Keto, P. 2009.Working Report 2009-129. Posiva Oy, Eurajoki.
- Backfill production line 2012 by Keto et. al. (2012).
- Closure Production Line 2012 – Design, production and initial state of underground disposal facility closure. Sievänen, U., Karvonen, T. H., Dixon, D., Hansen, J. & Jalonen T. POSIVA 2012-19. Posiva Oy, Eurajoki. ISBN 978-951-652-200-8.Posiva 2012-19.
- Underground disposal facility closure design 2012. Working report 2012-9.
- Closure of the investigation boreholes by Karvonen (2015). Working report 2012-63
- Dixon D.A., P. Keto, T. Sandén, D. Gunnarsson, J. Hansen and S. Anttila. 2008a. Studies to quantify effects of water inflow rate on backfill behaviour, Am. Nuclear Society Conference, 2008 Sept. 8-11, Las Vegas.
- Koskinen K. 2014. Effects of cementitious leachates on the EBS. Posiva 2013-04. Posiva Oy, Olkiluoto, Finland.

Material selection for backfill/buffer/closure / Long-term stability and evolution of Czech bentonites / Study of parallel samples / quality control of backfill/buffer/closure

The key, S&R/ B+Tech Oy expert in the field of material characterisation is Sirpa Kumpulainen. She has a long experience in the field of chemical and mineralogical analysis of bentonite materials and can provide assistance with regard to material selection, long-term stability and quality control.

Some references in the field of material characterisation: ALMA alternative material study for Posiva (under finalisation). Retrieval and performance evaluation of OL-KR24 borehole closure materials by Karvonen et al. (2015) *publication pending*. See also references in "Concept development".

Some references in the field of long-term stability: Long-Term Alteration of Bentonite in the Presence of Metallic Iron. Posiva Working Report 2010-71. Long-term effects of Fe-heater and Äspö groundwater on smectite clays – Chemical and hydromechanical results from in-situ alternative buffer material (ABM) test package 2. Clay Minerals, 2016.

Some references in the field of quality control: Quality Control and Characterization of Bentonite Materials. Posiva Working Report 2011-84. Characterization of bentonite and clay materials 2012-2015. Posiva Working Report 2016-05.

Assessment/ Development of procedures and methods for studying buffer/backfill and closure materials

Methods for testing bentonites used in EBS have been under development by Posiva and SKB with the aim to standardize the methods used in the studies. The key-expert in this field is Tim Schatz / S&R/B+Tech Oy.

Some references: Laboratory Tests and Analyses on Potential Olkiluoto Backfill Materials. Posiva Working Report 2012-74. Laboratory Studies on the Effect of Freezing and Thawing Exposure on Bentonite Buffer Performance. Posiva Report 2010-06. Laboratory Tests to

Determine the Effect of Olkiluoto Bounding Brine Water on Buffer Performance. Posiva Working Report 2011-68.

Support in field testing and monitoring of backfill/buffer/closure

S&R/B+Tech Oy has had a key-expert role in design, implementation, monitoring and numerical modelling for large-scale tests for buffer and backfill by Posiva Oy. The key experts in this field are Pieti Marjavaara, Matti Halonen and Xavier Pintado from S&R/B+Tech Oy.

Some references: Designing, Comissioning and Monitoring of 40% Scale Bentonite Buffer Test. Posiva Working Report 2015-08. Initial data report for the Multi Purpose Test by Pintado et al. (2015). LUCOEX project. THM modelling of buffer by Toprak et. al. (2013). POSIVA 2012-47. TH modelling of buffer and backfill by Pintado and Rautioaho (2013). POSIVA 2012-48.

Full-scale demonstrations

Posiva has been drafted a demonstration plan for ONKALO. Anttila,P., Arenius,M., Haapala,K., Hansen,J., Hellä,P., Jalonen,T., Lahdenperä,J., Lyytinen,T., Mellanen,S., Vuorio,P., & Äikäs,T. 2009. Testing and Demonstrations in ONKALO – Aims and Needs. Working Report 2009-24. Posiva Oy, Eurajoki. 108 p.

Posiva is currently coordinating the FP7 DOPAS Project for Full-scale demonstration of plugs and seals and implementing one of the Experiments POPLU (a deposition tunnel end plug).

Concept development of canister

Canister concept of Posiva is based on KBS-3, copper canister with cast iron insert. Posiva has developed copper-cast iron canister since early 1990's. Development consist R&D in following fields: designing the canister and canister components, manufacturing, inspection (NDT) of the components of the canister and sealing of the canister and NDT of the sealing. Canister development is nowadays almost ready. Now Posiva is now finalising definition of requirements, quality plans and construction plans of canister and canister components. Posiva will start qualification of manufacturing processes and NDT of the canister 2016.

Some references:

- Raiko H.: Canister design 2012, Posiva report 2012-13, ISBN 978-951-652-194-0
- Raiko et.al, Canister Production line 2012-16, ISBN 978-951-652-197-1 .
- Pitkänen, J. 2010. Inspection of bottom and lid welds of disposal canister. Report POSIVA 2010-04, Posiva Oy. 98 p. ISBN 978-951-652-175-9.
- Pitkänen, J. 2012. Inspection of Disposal Canister Components. POSIVA 2012-35, Posiva Oy. ISBN 978-951-652-216-9.
- Holmberg, J.-E., Kuusela, P. 2011. Analysis of probability of defects in disposal canisters.
- Posiva Working Report 2011-36. Posiva Oy, Eurajoki, Finland.
- Nolvi, L. 2009. Manufacture of Disposal Canisters. Report POSIVA 2009-03, Posiva Oy. 76 p
- Raiko, H., Meuronen, I., Pitkänen, J., Salonen, T., Wikström, N.-C., Ämmälä, V.-M. 2009. EB-DEMO – Canister Sealing Demonstration. Working Report 2009-126. Posiva Oy. 105 p.
- Meuronen, I., Salonen, T. 2010. Welding of the lid and bottom of the disposal canister. 2010. Report POSIVA 2010-05, Posiva Oy. p. 90. ISBN 978-951-652-176-6.
- Purhonen, T. ; State of the Art of the Welding Method for Sealing Spent Nuclear Fuel Canister Made of Copper: Part 1 - FSW, Working report 2014-22
- Salonen T., State of the Art of the Welding Method for Sealing Spent Nuclear Fuel Canister Made of Copper: Part 1 - EBW, Working report 2014-23
- Holmström et.at, Creep Properties of EB Welded Copper Overpack at 125-175 °C, Working Report 2012-03
- Holmström et.at, Creep Life Simulations of EB Welded Copper Overpack, Working Report 2012-96

- Gripenberg, H., Hänninen, H. 2006. Residual Stress Measurements of Copper Canister EB-welds. Posiva Working Report 2006-55. Posiva Oy
- Gripenberg, H., Hänninen, H. 2006. Residual Stress Investigation of Copper Plate and Canister EB-Welds: Complementary Results. Posiva Working Report 2009-21. Posiva Oy
- Romppainen A.-J., Immonen E. 2011. Residual Stress Measurement with Contour Method. Posiva Working report 2011-95. Posiva Oy.
- Laakkonen, M. Residual stress measurement of electron beam welded copper plates using Prism Hole Drilling method. Posiva Working report 2011-96. Posiva Oy. p 81.
- Aronen et.al: Simulation of Residual Stresses and Deformations in Electron Beam-Welded Copper Canisters, Posiva Working report 2013-20. Posiva Oy. p 68.
- Karhula, T.: Metallographic Studies of Electron Beam Welded Copper Lids: EBSD Studies of the Cross-Section of XK049 at 323deg, Posiva Working Report 2014-23, Posiva Oy p. 40
- Karhula, T.: Metallographic Studies of Electron Beam Welded Copper Lid: Macroscopic Studies and Hardness Measurements of the Cross-Section of XK049 at 323deg, Posiva Working Report 2014-24, Posiva Oy p. 54
- Karhula, T.: Metallographic Studies of Electron Beam Welded Copper Plates: EBSD Studies of the Cross-Sections and Determination of EBSD Reference Curves by EB-Welded Tensile Test Samples, Posiva Working Report 2013-14, Posiva Oy p. 242
- King, F., Lilja, C., Pedersen, K., Pitkänen, P., Vähänen, M. 2011. An update of the state-of-the-art report on the corrosion of copper under expected conditions in a deep geologic repository. POSIVA 2011-01. Posiva Oy, Olkiluoto.
- Anttila, M. 2005a. Criticality safety calculations for three types of final disposal canisters. Posiva Working report 2005-13, Posiva Oy, Olkiluoto. p. 27
- Anttila, M. 2005b, Radioactive Characteristics of the Spent Fuel of the Finnish Nuclear Power Plants. Posiva Working report 2005-71. Posiva Oy. p. 310
- Anttila, M. 1999. Criticality safety calculations of the nuclear waste disposal canisters for twelve spent fuel assemblies. Posiva Working Report 99-03, Posiva Oy, Helsinki. p. 20
- Ikonen, K. & Raiko, H. 2012. Thermal dimensioning of Olkiluoto repository for spent fuel. Working Report 2012-56. Posiva Oy.
- Ikonen K., Fuel Temperature in Disposal Canisters, Posiva Working report 2006-19, Posiva Oy
- Ikonen K., Thermal Analysis of Repository for Spent EPR-type Fuel, Posiva Working report 2005-6, Posiva Oy

f) an environmental impact assessment,

Finland, like the Czech Republic, has signed the so called UN Espoo Convention (1991), which means that all projects, which could possibly have environmental, social, economic or other impacts in other countries, do need to carry out the environmental impact assessment (EIA) with international hearing and participation. All EIAs for nuclear projects (*eg. nuclear power plants, spent fuel final disposal projects, low and intermediate waste disposal projects etc.)* are subject to international hearing and participation. Depending on the project in question, 4 - 12 countries have participated in the Finnish Nuclear EIAs.

Posiva has conducted an environmental impact assessment project (EIA) for the final disposal facility for spent nuclear fuel between years 1997-1999. It is still today one of the most comprehensive EIAs in Finland.

In 1999 - 2001 EIAs for nuclear power plants (NPPs) Olkiluoto 3 and Loviisa 3 were carried out. Posiva provided information and expertise concerning final disposal of spent fuel into these EIA-processes, as the question of final disposal of spent nuclear fuel has to be thoroughly addressed also in an NPP EIA, not only in SNF final disposal-spesific EIA.

In 2008 Posiva carried out an EIA -process for the planned enlargement of its final disposal site in Olkiluoto. The enlargement was designed to cover the SNF to be produced by the planned units Olkiluoto 4 and Loviisa 4.

Furthermore, in years 2007 - 2010 EIA's for 3 NPP-projects were carried out in Finland; Olkiluoto 4, Loviisa 3 (*as the previous EIA was already outdated*) and Fennovoima. Posiva has provided information and expertise concerning final disposal of spent fuel into all these EIA-processes.

In June 2016, Fennovoima started the EIA of its spent nuclear fuel final disposal project. Posiva is in central role in this EIA, providing information and expertise into this EIA and also actively participates to the interaction with stakeholders in Finland and abroad. This is the newest EIA-process for SNF final disposal in the world.

In addition, team members of the Consortium have been in key expert and project management positions in nuclear EIA's also in other countries than Finland. Furthermore, Mr. Pohjonen has also worked as an advisor for the IAEA since 2011 in developing the guideline for Nuclear EIA in newcomer countries (*see IAEA Nuclear Energy Series No. NG-T-3.11; Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes*) and other EIA-related issues.

g) a safety case and supporting safety assessments

Safety Case KBS-3V type repository

A safety case for a geological disposal facility documents the scientific and technical understanding of the disposal system, including the safety barriers and safety functions that these are expected to provide, results of a quantitative safety assessment, the process of systematically analysing the ability of the repository system to maintain its safety functions and to meet long-term safety requirements, and provides a compilation of evidence and arguments that complement and support the reliability of the results of the quantitative analyses.

In 2011-2014 Saanio & Riekkola Oy's Long-Term Safety Department participated in the TURVA-2012 safety case project. This project produced the safety case for a KBS-3V disposal facility for spent nuclear fuel at Olkiluoto, Finland supporting Posiva's construction licence application (POSIVA 2012-12). The licence application was submitted in December 2012, and was reviewed by STUK - the regulatory body in Finland and the licence was granted by the Finnish Government in November 2015. In addition to several background reports, the project included the compilation of 11 major safety case portfolio reports, 8 of which were compiled at Saanio & Riekkola Oy. These reports are mainly published in early 2013. The project is a continuation of years of work in the field of long-term safety studies and safety assessments for a spent nuclear fuel repository in Finland and it was preceded by the compilation of an interim safety case mainly by Saanio & Riekkola Oy, which was completed in 2009-2010.

Saanio & Riekkola Oy's Long-Term Safety Department participated in both the operation of the SAFCA (Safety Case) project group (including project management, the implementation of the SAFCA project plan, work related to the SAFCA Coordination Group, SAFCA Steering Group, SAFCA Core Group, sub-group Data Handling and Modelling to responsible for description of the models and data, sub-group Conceptualisation and Methodology and sub-group Assessment responsible for the FEP-screening, assessment of the performance of the disposal system, formulations of scenarios and definition of the calculations cases. S&R employees participated in meetings with the Finnish Radiation and Nuclear Safety Authority and providing answers to the requests by STUK. S&R employees participated also in the compilation of the portfolio and background reports of the SAFCA project and in the work related to the three-years Research, Technical Design and Development (RTD) programmes for nuclear waste management at Olkiluoto and Loviisa Power Plant. Saanio & Riekkola Oy has also participated in Posiva's Greenland Analogue Project, in the NEA-IGSC group, in the NEA MeSa project (Methods for Safety Assessment of Geological Disposal Facilities for Radioactive Waste) and EC PAMINA project (Performance Assessement methodologies in

application to guide the development of the safety case), in Posiva's safety group, in the rLUPA project, in the follow-up and evaluation of several studies (e.g. fuel and canister studies) and has assisted in the planning and coordination of SAFCA work, the compilation of assignments, the acquisition of resources and the follow-up of the implementation of the work.

Posiva has started the work to compile the safety case to support the operation licence application. The employees of S&R long-term safety department are currently involved planning the safety case, definition of the requirements concerning the disposal system, definition of the initial state of the disposal system, screening and describing the FEPs, assessment of the performance of the disposal system including a spent nuclear fuel repository and a repository for low and intermediate level waste from the encapsulation plant, formulation of the scenarios and defining the modelling needed to support the safety case and procedures for data management. S&R continues also to compile data and provide understanding of the surface environment processes to support the biosphere assessment.

Safety Evaluation of KBS-3H repository

Since 2014 S&R is participating in a Posiva-SKB joint project aimed to provide a safety evaluation for a KBS-3H disposal facility for spent nuclear fuel at Olkiluoto, Finland. KBS-3H is a design alternative, where the canisters are emplaced horizontally in long deposition drifts instead of emplacing them vertically in deposition holes as in the KBS-3V alternative. Saanio & Riekkola Oy's Long-Term Safety Department participates in both the operation of the project group (including project management, the implementation of the project plan). This project is not a full safety case, but rather aims at addressing the safety relevance of the specific aspects of the KBS-3H design alternative.

In addition to several background reports, the project includes the compilation safety case portfolio reports on the design basis, FEPs, description of the disposal system and performance assessment, all compiled at Saanio & Riekkola Oy.

Saanio & Riekkola participated also extensively in production of the reports of the earlier phase of the KBS-3H repository safety evaluation reported in 2007 including the summary report, radionuclide transport report, evolution report, process report and complementary evaluations report.

Safety Case for KAERI's High Level waste (HLW) and Low and Intermediate Level Waste (LILW)

In 2011-2012 S&R carried out a project to set up a generic safety case plan for the disposal of high and intermediate-level radioactive waste and the compilation of a detailed implementation plan for developing a Safety Case for the Advanced Korean Reference Disposal System (A-KRS), located at KAERI Underground Research Tunnel (KURT) site, used as a reference site, at the request of the Korea Atomic Energy Research Institute (KAERI).

The first aim of the project was to specify the main elements of the safety case and to outline an overall plan and schedule for safety case studies. The produced report comprises the main elements of the safety case and an overall plan for reporting, a discussion on the contents of the main elements, common aspects related to the handling of FEPs (features, events, and processes), scenarios, calculation cases, and management of uncertainty, a plan for the safety assessment including performance assessment and a roadmap towards licensing the disposal facility.

The second aim of the project was a direct continuation for the previously produced report Generic Safety Case Plan for KAERI. It completed the Task 2 requested by KAERI (Task 2: The specific elements of a Safety Case for each step in the structure of a Safety Case), and covers Task 3: The implementation plan for each specific element of a Safety Case. The goals were to provide a detailed implementation plan for the specified main elements of the safety case defined in the Generic Safety Case Plan report, to propose a schedule for the safety case

Saanio & Riekkola Oy's Long-Term Safety Department was solely responsible for the project and performed all related tasks, including project management, project planning, organisation of meetings and the compilation and editing of the reports "Generic Safety Case Plan for KAERI" and "Safety Case Implementation Plan for KAERI".

Foreign materials in the repository – Update of estimated quantities

The post closure material quantity estimations are essential data for defining safety case and long term safety of the disposal of radioactive material. Ingress and egress of stray materials are monitored in ONKALO URCF: the proposed underground disposal facility for spent nuclear fuel in Finland and estimations of material type and quantity remaining after the operational period are made in this project. Saanio & Riekkola performed the initial estimation of these foreign material quantities of Olkiluoto facility in 2003 and the estimations are updated regularly as the work proceeds with the latest update for the construction licence application in 2010-2011.

A variety of materials are used during the construction process and the operation of the underground disposal facility for spent nuclear fuel at Olkiluoto in Eurajoki, Finland. In addition to materials necessary for the construction and operation, some materials may be transported in the facility through the ventilation air, as emissions from vehicles etc. Both of these two types of materials, intentionally introduced and unintentionally transported, are considered in the project and both introduced quantities and the quantities that remain in the disposal facility after closure are estimated based on the most recent information available. This work is intended to be an update on the previous estimations, and it takes advantage of the experience collected during the construction of the underground rock characterisation facility ONKALO at Olkiluoto. The implemented quantities as well as designs and preliminary designs have been used in calculating the quantities of the foreign materials.

Saanio & Riekkola personnel were responsible for gathering the required information and completing the update of post closure material quantities. The work included in foreign material quantity estimations is as follows:

- review of materials used in constructing ONKALO,
- detection of designs and production methods for proposed disposal facility and those volumes of ONKALO not yet excavated (e.g. closure design, grouts, blasting, rock support),
- definition of the specific materials of designed components and which of them are considered as foreign materials,
- re-evaluation of the quantity of substances unintentionally transported to the underground openings (e.g. pollums, vehicle emissions) according to previous quantity estimations and present knowledge,
- calculating the total post closure quantities,
- defining the uncertainties in quantity estimations,
- defining the key issues concerning the material quantities in terms of long term safety and in relation to the Engineered Barrier System (EBS).

Rock Suitability Classification (RSC)

Saanio & Riekkola Oy has participated in the Rock Suitability Classification (RSC) programme, in the coordination of the RSC modelling reports and RSC work with the Safety Case work and in the commenting of several RSC reports. The work in 2011-2014 has also included the management of TASK 1: Target properties, background work related to the evaluation and updating of target properties and participation in the work of the RSC Coordination Group, the evaluation of the criteria used in the RSC demonstration, the compilation of the RSC-2012 Report and other tasks according to the RSC programme which pertain to the characterisation of the repository site at Olkiluoto, Finland.

h) cost estimation and budgeting of the preparation and construction of the DGR

Posiva has prepared the total cost estimates of spent nuclear fuel disposal including concept development, site selection and detailed design, construction, operation and decommissioning/closure of the facilities for Posiva's owners TVO and Fortum since 1996. The recent work includes the detailed cost estimates of the construction of Olkiluoto DGR and encapsulation plant and the cost estimate of the development programme to demonstrate the fulfilment of the regulatory requirements. Posiva has also carried out cost comparison on alternative disposal concepts and cost optimisation studies concerning the operation of spent nuclear fuel disposal facilities.

S&R has participated in calculating cost estimations for Posiva since 1995 and before that for TVO starting from early 1980's. S&R has also done cost estimations for several organisations, for several purpose and also for several specific technical areas. As example decommission waste for Finnish nuclear reactors (TVO, Teollisuuden Voima), overall costs for the management plan for spent nuclear fuel (Fennovoima), review and cost estimation of site investigation activities for High Level Waste disposal (KAERI, Korea Atomic Energy Research Institute), cost comparison between horizontal and vertical canister disposal alternatives of DGR (SKB, Swedish Nuclear Fuel and Waste Management Company), closure structures for DGR (Posiva), cost for possible retrieval of canisters (Posiva).

Posiva and S&R can analyse the costs for each phase of the project; site selection, construction, operation and closure of DGR. The Consortium is familiar with all cost estimating methods, depending always on how detailed data for cost estimation is available. Depending on the design and other relevant data, cost estimation can be based on reference project information, on construction units and unit prices or if designs are detailed enough then cost can be calculated by analysing all the resources that are needed to produce each unit. For all methods, Consortiums state-of-the-art -information of relevant resources, unit costs for salaries, machinery, equipments etc. can be used.

i) communication skills and experiences acquired during selection of the most suitable site for DGR

The current state analysis

The supplier has conducted several surveys and public opinion polls in order to compile strategies for communications. These surveys include i.a.:

- Posiva's stakeholder analysis, 2002
- Posiva's stakeholder analysis 2006
- Media analysis 2008

Communication on the local level

The supplier has implemented several strategies that involve Posiva's communication activities on the local level. To demonstrate the success of these strategies the following favourable decisions have been taken by the Eurajoki municipality:

- Approval of the decision-in-principle on the construction of the final disposal municipality in 2000 (by votes 20-7)
- Approval of the decision-in-principle on the extension of the final disposal facility, 2009
- Approval of the construction of the final disposal facility, 2012

Communication with media

The supplier has successfully conducted communications with media. This can be verified by the research that deals with Posiva's communication conducted by the University of Tampere, School of communication, Media and Theatre (publications available in Finnish).

Communication with other relevant stakeholders

The supplier has been responsible for the decision-maker oriented communication of Posiva during 1998-2015. During this time the supplier has compiled and implemented strategies that have supported Posiva's endeavors to gain political acceptance for final disposal of spent nuclear fuel. The following decisions demonstrate the success of these strategies:

Finnish Parliament's Ratification of the decision-in-principle on the construction of the final disposal facility in Eurajoki municipality in 2001 by votes 159-3.

Finnish Parliament's Ratification of the decision-in-principle on the extension of the final disposal facility in Eurajoki municipality in 2010

Training program for the employees

The supplier has organized several training programs for Posiva's experts in order to improve their skills to communicate with media and with the public at large. The supplier has organised the following training program for Posiva's personnel:

Media and crisis communications in 2002

Media and crisis communication in 2007

Training of the upper management in 2010

Training of the experts, involving media training and presentation training in 2011

ANNEX NO. 2 THE SUPPLIER'S TEAM MEMBERS INVOLVED IN FA ACTIVITIES

Table of the supplier's team members included in FA activities

Team Member's Name and Surname (company)	Knowledge area (Article 138.138 and 138.3 of the FA)	Position	Hourly billing rate without VAT [EUR] (Article 4.3 of FA)
Aimo Hautojärvi (S&R)	geosciences, safety case	Adviser	138
Antti Ikonen (S&R)	geosciences, design of deep geological disposal system, project management planning, environmental assessment	Adviser	138
Antti Öhberg (S&R)	geosciences, project management planning	Senior Adviser	166
Nuria Marcos Perea (S&R)	geosciences, safety case	Adviser	138
Timo Ruskeeniemi (GTK)	geosciences, public relation	Senior Expert	112
Jussi Mattila (Posiva)	geosciences, geological modelling	Senior Expert	112
Ismo Aaltonen (Posiva)	geosciences, geological modelling, design of deep geological disposal system	Adviser	138
Assen Simeonov (SKB)	geosciences, geological modelling	Adviser	138
Ignasi Puigdomenech (SKB)	geosciences	Adviser	138
Birgitta Kalinowski (SKB)	geosciences	Adviser	138
Peter Wikberg (SKB)	geosciences, hydrogeology and hydrology, safety case	Senior Adviser	166
Diego Mas Ivars (SKB)	geosciences	Adviser	138
Seppo Paulamäki (GTK)	geological modelling	Adviser	138
Markku Paananen (GTK)	geological modelling	Senior Expert	112
Pirjo Hellä (S&R)	geological modelling, data management, project management planning, environmental assessment, safety case	Adviser	138

Heini Reijonen (S&R)	data management, safety case	Adviser	138
Niina Ahtonen (GTK)	data management	Senior Adviser	166
Jyrki Liimatainen (Posiva)	data management	Senior Expert	112
Lasse Koskinen (Posiva)	hydrogeology and hydrology, safety case	Adviser	138
Petteri Pitkänen (Posiva)	hydrogeology and hydrology	Adviser	138
Jere Lahdenperä (Posiva)	hydrogeology and hydrology	Adviser (deputy project manager)	138
Emma Johansson (SKB)	hydrogeology and hydrology	Senior Expert	112
Magnus Oden (SKB)	hydrogeology and hydrology	Adviser	138
Patrik Vidstrand (SKB)	hydrogeology and hydrology	Adviser	138
Jan-Olov Selroos (SKB)	hydrogeology and hydrology	Senior Adviser	166
Mansueto Morosini (SKB)	hydrogeology and hydrology	Adviser	138
Paula Keto (S&R)	development of engineered barriers	Adviser	138
Xavier Pintado (S&R)	development of engineered barriers	Adviser	138
Taina Karvonen (S&R)	development of engineered barriers	Senior Expert	112
Sirpa Kumpulainen (S&R)	development of engineered barriers	Adviser	138
Jukka-Pekka Salo (Posiva)	development of engineered barriers, design of deep geological disposal system	Adviser	138
Johanna Hansen (Posiva)	development of engineered barriers	Senior Expert	112
Timo Salonen (Posiva)	development of engineered barriers	Adviser	138
Petteri Vuorio (Posiva)	logistic of the DGR system (transport and manipulation), design of deep geological disposal system	Adviser	138
Aki Alanko (S&R)	design of deep geological disposal system	Adviser	138
Jari Gerlander (S&R)	design of deep geological disposal system	Adviser	138

Daniel Eklund (SKB)	design of deep geological disposal system	Adviser	138
Timo Saanio (S&R)	project management planning, price estimation of the DGR and economic analysis	Senior Adviser	166
Kimmo Lehto (Posiva)	project management planning	Project Manager	138
Erkki Palonen (Posiva)	project management planning	Senior Adviser	166
Juhani Vira (Posiva)	project management planning, safety case	Senior Adviser	166
Jussi Palmu (Posiva)	price estimation of the DGR and economic analysis	Adviser	138
Pohjonen Mika (Posiva)	environmental assessment, public relation	Senior Adviser	166
Annika Hagros (S&R)	safety case	Adviser	138
Anne Kontula (Posiva)	safety case	Adviser	138
Barbara Pastina (Posiva)	safety case	Senior Adviser	166
Seppälä Timo (S&R)	public relation	Adviser	138
Toivo Wanne (S&R)	geosciences, project management planning	Adviser	138
Harri Issakainen (GTK)	data management	Senior Expert	112
Janne Kallunki (GTK)	data management	Senior Expert	112
Susan Pietilä (Posiva)	public relation	Senior Expert	112
"Project engineer" (to be named to ordered tasks according to need)	Less demanding work	Project engineer	75
Eliska Vrbova (freelancer to Posiva)	auxiliary work (translations, interpretations, local arrangements etc)	Assistant	40

CVs of the supplier's team members included in FA activities

are presented in the following, parts 13, 14, 15 and 16 of the proposal.

Annex No. 3

QUALITY PLAN

1 Preface

This quality plan has been drawn up as an attachment to the tender submitted by Posiva Oy to SÚRAO. The tender concerns the provision of services related to SÚRAO's site selection process as well as services related to the assessment of costs. This Quality Plan has been prepared in accordance with ISO 10005 or ISO 10005:2005 Quality management systems - Guidelines for quality plans.

2 Posiva – company information

Posiva is an expert organisation, established in 1995, responsible for the final disposal of the spent nuclear fuel of its shareholders (Teollisuuden Voima Oyj and Fortum Oyj).

Posiva has in place for the management of quality and safety a management system certified to the ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007 standards. Posiva's operations fulfil the requirements set out in the standards for quality management, environmental management, as well as occupational health and safety.

3 Objectives of the assignment

Posiva's objectives in the assignment include the execution of the research activities according to high quality and scientific standards to ensure that the data produced can be utilised by the Client for the intended purpose. The goal is to assist the Client in the preparation of documentation that fulfils the requirements set out in laws and regulations in order to facilitate the progress of the implementation of geological final disposal.

4 Organisation for the assignment

The preliminary project organisation is described in the tender. The Management Group of the project consists of persons appointed by the Supplier and the Client. The Project Group consists of the Project Manager and persons specifically appointed by Posiva for project control tasks. Both Groups convene once a month, or as necessary.

The organisation will be described in the project plan to be prepared for the project in more detail according to the tasks to be executed in the project.

4.1 Personnel

Posiva can boast decades of experience in the execution of research, development and implementation activities related to the final disposal of nuclear waste. The extensive special expertise of Posiva's personnel covers the various sub-areas of site characterisation studies, implementation of nuclear facilities as well as licensing.

The CVs of the persons who execute the work will be submitted to the Client. Posiva's personnel has been provided with training in the general procedures followed in the nuclear industry. Training specific to the project will be provided to persons involved in the project.

5 Supply chain and management of supply chain

If required, Posiva's suppliers will be used in the assignment as sub-suppliers for the assignment.

Posiva has experience in the practices used in the nuclear industry and in the implementation of supply chain management. Posiva's purchasing practices have been specified in accordance with ISO standards and the YVL Guides of the Radiation and Nuclear Safety Authority of Finland as well as the requirements of IAEA (e.g. GS-R-3).

The procedures related to supplier selection and assessment are described in Posiva's management system. Posiva only purchases products and services from suppliers who have been assessed. Posiva will not order anything from suppliers who have not been assessed and approved. All suppliers who supply products that are significant to safety are subjected to audits.

The approval of the Client will always be acquired in advance for all the sub-suppliers to be used in the assignment. The Project Manager appointed for the project is in charge of the control of the sub-supplier's operation.

6 Input data

The Client shall provide Posiva in advance with documentation containing all input data relevant to the execution of work. A start meeting will be organised before work is started to review all the requirements, regulations and boundary conditions that are relevant to

the execution of work. If Posiva finds any shortcomings or errors in the input data provided by the Client, Posiva will inform the Client about them.

7 Regulations and instructions for the assignment

Posiva's activities shall comply with Posiva's own management system as well as the instructions and requirements specified by the Client.

8 Management system processes

The processes of Posiva's management system, which have been specified based on the needs of Posiva's final disposal project, shall be used in the assignment.

The site characterisation studies conducted by Posiva are described in Posiva's process "specification of final disposal solution". Work related to cost estimates is described in Posiva's process "design of final disposal solution".

Posiva's purchasing procedure is described in the process "purchasing and product control" which also includes supplier assessments.

In long-term projects, Posiva targets internal audits at the projects for purposes of the verification and development of quality and safety management.

9 Risk management

Risk identification, assessment and management procedures are implemented in compliance with Posiva's risk management procedure which is in line with the ISO-31000 standard. The project plan shall include a risk management plan which describes risk management in this project. The risk management plan describes the procedures and records to be used in order to verify that everybody involved in the project is aware of the risks.

10 Execution and control of work and communication with Client

Site characterisation studies are divided into phases which include the design, the execution and the modelling of the site characterisation studies. The responsibilities and the control procedures related to the sub-projects shall be specified for each phase.

At each phase, a start meeting and an end meeting are organised between the Client, the Supplier and any sub-suppliers. The matters addressed in

the start meeting include the input data documentation, the risks and procedures related to the execution of work, as well as the objectives of work. The end meeting deals with the results of work and the experience gained. The progress of the project is monitored in meetings in which also representatives of the Client are invited, if necessary. Joint follow-up meetings with the Client are agreed on during the assignment.

Work is executed using methods used and proven in Posiva's own site characterisation studies. The management of these methods is based on Posiva's management system.

Posiva shall inform the Client of any needs for changes immediately if such needs are identified. All changes shall be agreed on and the Client's approval for them shall be acquired in advance.

11 Handling of nonconformances

Posiva's management system contains instructions for the management of nonconformances. All nonconformances are recorded in a centralised nonconformance management system (KELPO). The causes that have resulted in nonconformances are determined and recorded in this system. The elimination of the non-conformance as well as corrective and preventive actions are also documented in the same system.

All nonconformances are reported to the Client immediately when identified and again after the handling process has been completed.

In addition to nonconformances, also safety observations and environmental accidents are recorded and handled in compliance with the principles of nonconformance handling.

12 Document management and delivery of results to Client

Posiva's management system contains descriptions of and instructions for the procedures used in document management, including management of information security.

Document control in the project shall be described in the project plan with specifications for the review and approval of project documents as well as recording locations. As a rule, the Project Manager approves the project documents.

Documents are archived in electronic form in Posiva's document management system (Kronodoc). The information security procedures

specified by the Client are complied with when handling data provided by the Client.

The documentation produced as a result of the assignment shall be delivered to the Client in electronic form. The documents to be delivered to the Client undergo a review and approval procedure at Posiva.

13 Occupational safety

The Project Manager is in charge of occupational safety in the project. The Safety Function at Posiva supports the Project Manager in the management and development of occupational safety. Posiva's management system which has been certified to OHSAS 18001 describes the procedures to be used for the management of occupational safety.

The procedures to be used for the management of occupational safety are specified on the basis of the risks involved in work. The occupational safety goal is zero accidents.

14 Environmental aspects

The Project Manager is in charge of environmental safety in the project. The Safety Function at Posiva supports the Project Manager in the management and development of environmental aspects. Posiva's management system which has been certified to ISO 14001 describes the procedures to be used for the management of environmental safety.

The work covered by the tender does not involve any significant environmental aspects, as it is office work in nature. However, environmental aspects are taken into consideration in the design of the project as concerns e.g. travelling. The impact on the environment shall be kept as small as possible.

15 Maintenance of quality plan

The points described in the quality plan shall be described in the project plan to be prepared for the project and maintained at the various phases of the project.

ANNEX NO. 4 THE ORDER FORM

Utilization of foreign experience in the siting process for a deep geological repository for radioactive waste in the Czech Republic

Name of Partial Contract: xx

Areas of Services: xx

ID of Services: xx

	Function	Name	Date	Signature
Client approved for chapter 1	Project Manager	Ing. Ilona Pospíšková		
Supplier approved for chapter 2	Project Manager			
Partial Contract approved by the Client	Managing Director	RNDr. Jiří Slovák		
Partial Contract approved by the Supplier	xx			

1 CLIENT'S ASSIGNMENT

1.1 Requirements for the scope and technical specification

a) The Client specifies the purpose of the Partial Contract activities to be achieved.

b) The Client shall hereinafter state briefly the requirements concerning the specific activities to be performed by the Supplier and specifies all the outputs of the performance that the Supplier is required to hand over to the Client.

c) The Client shall hereinafter state any requirements in a break-down of the Services for partial performance.

1.2 Required Services deadlines

a) The Client shall state deadlines (milestones)for specific activities.

b) There may also be indicated a period of time from the handover of the documents of the Client to the Supplier to the handover of the required outputs of the Services to the Client.

1.3 Estimated labour intensiveness or its limitation

a) The Client shall hereinafter state his estimation of labour intensiveness in person-hours broken down according to the categories of Services stated in the FA or,

b) May state a limit for the labour intensiveness in person-hours which should not be exceeded by the Supplier.

1.4 Specific requirements concerning the organisation of the Services

a) The Client shall state requirements concerning those experts to be included in the Services,

b) Place of the performed Services,

c) Other specific requirements.

2 CONFIRMATION / MODIFICATION OF THE ASSIGNMENT OF SERVICES BY THE SUPPLIER

2.1 Scope of Services and technical specification

a) The Supplier should confirm the assignment of Services by the Client stated in Article 1.1 or suggest its modification or partial changes.

b) The Supplier should elaborate the scope of services in greater detail with the aim of "tuning" them to the needs of the Client.

2.2 Fulfilment dates

a) The Supplier should include here a time schedule of the Services rendered in respect of the Partial Contract that should be in compliance with the deadlines stated in Article 1.2 by the Client.

b) The Supplier may suggest changes to the partial deadlines; however, the final deadline should be in line with the requirements of the Client.

2.3 Price of the Partial Contract

a) The Supplier states here the price limit of the Partial Contract which must be based on labour intensity determined in accordance with Article 2.4 of this document and the rates specified in Article 4.3 of the FA.

b) The Supplier shall justify all his necessary incidental expenses.

2.4 Organization of Services

a) The Supplier shall specify the activities corresponding to the schedule and the persons involved in those activities, their roles and their labour intensity by

category of work according to Article 4.3 of the FA. When determining labour intensity, the Supplier shall take into account the limit required by the Client in Article 1.3 of the Partial Contract.

b) The Supplier shall describe in detail the way in which project management is performed and the organisation and accountability of the individual persons involved in the Partial Contract.

2.5 Risk identification

a) The Supplier shall describe in detail the risks and potential problems associated with the solution of the Partial Contract and provide suggestions on how to reduce or eliminate those risks.

3 CONCLUSION OF THE PARTIAL CONTRACT

a) Here shall be a statement from the Contractual Parties that indicates deviations from the agreed Articles numbers 1 or 2 of this Partial Contract or confirmation of their validity in full. The sub-project is subject to the approval of persons authorised in contractual matters pursuant to Article 1.3 of the FA.

b) The Partial Contract will be concluded in line with Article 5 of the FA.

c) This Partial Contract becomes valid and comes into force on the date of its signature by authorized representatives of both Contractual Parties.

ANNEX NO. 5 CONSORTIUM AGREEMENT BETWEEN POSIVA OY AND SAANIO & RIEKKOLA OY

CONSORTIUM
AGREEMENT

FOR THE

"Utilization of foreign experience in the siting process for a deep geological repository for radioactive waste in the Czech Republic"

BETWEEN

POSIVA OY/POSIVA SOLUTIONS OY

AND

SAANIO&RIEKKOLA OY

This **CONSORTIUM AGREEMENT** (hereinafter "**Agreement**") is dated as of 30th of June, 2016

BETWEEN

POSIVA OY, a joint stock company duly organized and existing under the laws of Finland or at its directions on behalf of Posiva Solutions Oy (hereinafter referred to as "**POSIVA**"), with its registered office: Töölönkatu 4, 00100 Helsinki (Finland),

AND

Saanio&Riekkola Oy, a joint stock company duly organized and existing under the laws of Finland (hereinafter referred to as "**S&R**"), with its registered office: Laulukuja 4, 00420 Helsinki (Finland).

Hereinafter collectively referred to as the "**Parties**" and individually as a "**Party**"

WHEREAS

A. On April 8, 2016 SURAO (*Správa úložišť radioaktivních odpadů, Dlážděná 1004/6, 110 00 Praha 1, Česká republika*) hereinafter referred to as the **"Client"**, has issued a public tender invitation, which the Parties intend to participate by submitting a tender (as hereinafter referred to as the "**Tender**"), with the following subject **"UTILIZATION OF FOREIGN EXPERIENCE IN THE SITING PROCESS FOR A DEEP GEOLOGICAL REPOSITORY FOR RADIOACTIVE WASTE IN THE CZECH REPUBLIC"**, hereinafter referred to as the **"Project"**, for which a Contract (as hereinafter defined) may be awarded as a result of the Tender.

B. The Project is financed by SURAO

C. The Parties now wish to jointly prepare a Tender for the Project and, if the Parties' Tender is successful, they shall jointly negotiate, initialise and sign and implement the Contract with the Client.

D. As a result of the willingness to participate in the tendering phase of the Project and, if successful, implement the Project, the Parties have agreed to enter into this Consortium Agreement, which sets out the respective rights and obligations of the Parties with respect to the preparation and submission of the Tender, negotiation and finalisation of the Contract with the Client, as well as implementation the work/services pursuant to the Contract.

E. This Agreement shall automatically terminate upon the occurrence of the circumstances of termination set out in clause 11 (Duration) and clause 17 (Continuing Obligations).

NOW THEREFORE, in consideration of the foregoing, the Parties agree as follows:

1. INTERPRETATION

1.1 In this Agreement the following terms shall have the following meanings unless the context requires otherwise:

"Agreement" means this Consortium Agreement;

"Client" means SURAO

"Contract" means the contract to be entered into between the Client and the Consortium stipulating all terms and conditions relevant to the supplies and services to be provided;

"Contract Price" means the aggregate fee payable by the Client pursuant to the Contract;

"Contractual Work" means those supplies and services to be provided to the Client by the Parties pursuant to the Contract in consideration of the payment by the Client of the Contract Price;

"Consortium" means the unincorporated Consortium formed by the Parties pursuant to the Agreement in order to develop and execute the Project according to the Contract with the Client;

Draft Framework Agreement: FA template included in the RfP (Tender Invitation Documentation) for the Project

"Intellectual Property" means any and all intellectual property rights pertaining to and subsisting in any country throughout the world including but not limited to any patents, trademarks or service marks (whether registered or unregistered), registered designs, utility models, copyrights, design rights, rights in databases, topography rights, know how/show-how, technical information, confidential process information and any applications and any rights to apply for any of the foregoing;

"Lead Party" means **POSIVA Oy or/and Posiva Solutions Oy;**

"Loss" means any and all liability arising under or otherwise in connection with this Agreement and/or the preparation of the Tender including without limitation:

(a) Damages;
(b) Costs and expenses;
(c) Fines;
(d) Penalties;
(e) Liquidated damages;
(f) Surcharges; and
(g) Increased costs incurred in providing services;

"Project" means the project of "UTILIZATION OF FOREIGN EXPERIENCE IN THE SITING PROCESS FOR A DEEP GEOLOGICAL REPOSITORY FOR RADIOACTIVE WASTE IN THE CZECH REPUBLIC", performed by the Consortium under the Contract.

"**Task**" and "**Subtask**" means work scopes as defined in the Annex I.

"Tender" means the Parties formal documentation to participate in the tender phase;

"Tender Submission Deadline Date" means the date by which the Tender must be given to the Client, that is 11 July 2016.

"Third Party" means any natural or legal person(s) other than Posiva or S&R or the Client.

"Working Day" means any day other than Saturday and Sunday and any other day on which major clearing banks in Finland are authorized to be closed.

"Work-share" means in respect of each Party their share of the Contractual Work to be completed and the responsibilities to be assumed by that Party pursuant to and in accordance with the Tender;

"Work-share Value" means in relation to each Party the value of that Party's Work-share including recoverable costs.

1.2 The headings in this Agreement are for convenience only and are not to be used in construing this Agreement.

1.3 Any reference in this Agreement to:

1.3.1 Any statute, decree, law, statutory instrument or other regulation having the force of law shall be deemed to include any lawful modifications thereto or re-enactments thereof after the date of signature of this Agreement;

1.3.2 The plural shall include the singular and any reference to the singular shall include the plural and any reference to one gender shall include all genders;

1.3.3 A person shall include natural persons, partnerships, firms and other unincorporated bodies, companies and all other legal persons of whatever kind or however constituted;

1.3.4 An annex shall (unless otherwise stated) be a reference to an annex to this Agreement and any reference to a clause shall (unless otherwise stated) be a reference to a clause of this Agreement;

1.3.5 "including" or "includes" or any similar phrases shall be construed without limitation to the generality of the preceding words;

1.3.6 "approval" shall be construed to mean an approval in writing;

1.3.7 Any English legal term for any action remedy method of judicial proceeding legal document, legal status, official or any other legal concept shall in respect of any jurisdiction be deemed to include the term or legal concept which most nearly approximates in that jurisdiction to the English term or legal concept.

2. CONSORTIUM PRINCIPLES

2.1 The Parties hereby agree to collaborate, according to the principles of this Agreement, for the preparation and submission of a Tender for the Project and for the negotiation, signature and implementation of the Contract with the Client in case of Contract award by the Client.

2.2 The Parties shall co-operate fully with each other in good faith in the best interest of the Consortium in order to promote the successful award and implementation of the Contract and shall refrain from any action or conduct which may work contrary to this principal objective.

2.3 Should the final Contract's terms and conditions differ from what has been proposed by SURAO in the Draft Framework Agreement (part of the Tender Invitation documentation), the Parties may modify the terms and conditions of this Agreement on unanimous decision. In such case any further rights and obligations of the Parties applicable to the phase of Contract implementation that may be defined by the Parties, shall be incorporated into this Agreement.

3. SCOPE AND WORK SHARE

3.1 The Parties agree that each Party's participation in the Consortium is based on the following Work-share Values (1):

POSIVA	40 %
S&R	40 %
For the sake of clarity: Third Parties SKBI and GTK (Subcontractors)	max. 20 %

Each party's final Work-share will be based on the final negotiations with the Client and the actual Task Orders received under the Contract, if awarded the Contract.

3.2 Subject to prior written consent of the other Party, not to be unreasonably withheld, each Party may subcontract part of its tasks in accordance with the terms of the Contract, however, offering the task in question first to the other Party.

4. ORGANISATION OF THE CONSORTIUM

4.1 STEERING COMMITTEE

4.1.1 A Steering Committee shall be set up after Contract award and composed of four members, two of each Party appointed respectively by the Parties. Each member can appoint a substitute. The member nominated by the Lead Party acts as the chairman.

4.1.2 Decisions to be taken by the Consortium shall be made by unanimous approval of the Parties, during meetings of the Steering Committee held quarterly and, if needed, upon the request of a Party indicating the subject. The Steering Committee meetings will be called by the chairman by a two weeks prior notice by e-mail with confirmation of receipt indicating the time, place and subjects of the meeting.

4.1.3 In the case of continued inability to agree upon a specific matter, the Parties will face the problem by recourse to their respective executive Management.

4.1.4 If the Parties agree, decisions can be made in writing after due information and by unanimous approval by the Parties.

4.1.5 The Lead Party shall co-ordinate and keep minutes of the meeting of the Steering Committee and shall record decisions taken by the Consortium during the meetings or otherwise, and shall send a copy of any such record to the other Party within 14 days after the decision recorded was taken. Unless the Lead Party receives written objection to any such record within another 14 days counting from the date of receipt thereof, such record shall be deemed to be a correct and complete reflection of the decision made by the Consortium.

4.2 THE LEAD PARTY

4.2.1 The Lead Party shall be responsible for co-ordinating the activities of the Parties under this Agreement and administering the Tender generally.

4.2.2 The particular responsibilities of the Lead Party under and for the duration of this Agreement are.

- Co-ordinate and liaison between the Parties;
- Submit the Tender to the Client within the Tender Submission Deadline Date;
- Act as a single point of contact for Tender matters and negotiation and Contract implementation activities thereof with the Client;
- Transmit a copy of all relevant correspondence with the Client to other Party.
- Co-ordinate the preparation of and compile the documents to be submitted for the Tender;
- Co-ordinate the interfaces between the Tasks related to Contract implementation;
- Liaise and co-ordinate all activity with the Client as and when required.
- Receive from the Parties their deliverables as required in the Contract and deliver them to the Client
- Draw up and present the administrative reports, if any, to the Client;
- Send Invoices, receive payments on behalf of the Consortium and forward to the others Party the sums due to them respectively [as stated in financial arrangements 5];
- Represent the Consortium with regard to Third Parties, in aspects related to the Contract.

4.2.3 The Lead Party shall not take any decision engaging the other Party without the prior written consent of it.

5. FINANCIAL ARRANGEMENTS

5.1 All invoices shall be drawn up in English and all amount invoiced and paid shall be in EURO.

5.2 The Lead Party shall invoice and receive payments on behalf of the Parties according to the Contract. It shall forward to the other Party and to the Third Parties all sums due to them, as soon as possible, however within a maximum term of ten (10) days from receipt of the payments from the Client. Sharing of a payment to the Parties and the Third Parties is defined by the realized work division in each Task performed.

5.3 In the event of non-payment of any invoice, the Lead Party shall send a reminder to the Client and a copy of the reminder to the other Party. In the event the Client refuses to pay an invoice or any part thereof, the Lead Party shall immediately notify the other Party and may, when necessary, instruct the other Party to assist him to conduct all dealings with the Client. The other Party will be paid accordingly to the payments actually made by the Client. In this case, the other Party shall not hold the Lead Party responsible for non-payment or delay in payment of an invoice.

5.4 The Lead Party charges a fee of 10 % of the work invoicing of the other Party. For clarity, this 10 % shall not be applied to expenses, which shall be dealt "at cost" between Parties.

5.5 Each Party shall bear the bank charges for handling the payments for its share of the Work.

6. TAXES

6.1 Each Party shall bear all taxes, fees, duties and social insurance or similar expenses whatsoever related to its activities levied in its own country.

7. SUBMISSION OF TENDER AND CONTRACT NEGOTIATIONS

7.1 Without prejudice to or derogation from clause 4 above, the Lead Party shall have overall responsibility for the structure and definition of work division of the Tender to the Client but will be reasonably supported by the other Party.

7.2 Each Party is responsible for preparation of its sections of the Tender according to the work division and in time schedule defined by the Lead Party. Additionally the Parties shall exchange such information as is necessary and as is requested by other Party to facilitate the preparation of the Tender as promptly as possible and in any event to enable the Tender to be submitted at the latest by the Tender Submission Deadline Date and otherwise in accordance with the requirements of the invitation to Tender.

7.3 The Parties shall provide the financial information necessary in order to allow the Lead Party to prepare the financial part of the Tender.

7.4 The Lead Party shall compile the Tender and submit it to the other Parties for approval prior to its submission to the Client, and the other Parties shall promptly notify the Lead Party of its approval of or comment on the Tender. In any event the other Party shall notify the Lead Party within reasonable period as defined by the Lead Party at the time of submission of the finalised Tender for approval. The time periods required in the invitation to Tender will need to be considered and observed with respect to submission of the Tender.

7.5 No Tender shall be submitted by the Lead Party to the Client unless such Tender has been unanimously approved by the Parties. Once the Tender has been submitted to the Client no Party may withdraw from the Tender and if the Tender is accepted by the Client it shall be binding on the Parties who shall be jointly and severally responsible to the Client for its performance.

7.6 The Lead Party shall have to co-ordinate and conduct all negotiations with the Client following submission of the Tender and the other Party shall participate in such negotiations, if not otherwise agreed with the Lead Party. In any case the other Party shall support the Lead Party during such negotiations in a timely manner as and when required by the Lead Party and in particular shall supply to the Lead Party such information and documentation as the Lead Party shall reasonably require for such purposes. The Lead Party will advise the other Party in a timely manner, of any proposed material change, by the Client, to the Work-share and/or Work-share Value of any of the Parties and of any proposed material change to the Tender generally. The acceptance by the Lead Party of a material change proposed by the Client to the Work-

share and/or Work-share Value of a Party shall be subject to the prior agreement of the Parties and unanimously approved by the other Parties.

7.7 Where the Client requires clarification of any item in the Tender or in the Contract activities, it is intended that the Party having responsibility for the performance of that item, shall provide such information as is necessary for the Lead Party to respond to the Client.

7.8 Where the Client seeks to persuade the Parties to change any price or other material aspect of the Tender it is intended that such changes can only be agreed in writing (letter or email) by the Parties.

7.9 The Lead Party shall have no liability for loss suffered by the other Party other than in relation to the Lead Party's fraud.

7.10 If the negotiations between the Client and the Consortium after submission of the Tender lead to a Contract which deviates from the Tender such Contract shall be unanimously approved in writing by the Parties before signature of the Contract.

8. EXCLUSIVITY

8.1 Each Party undertakes that it will not during the continuance of this Agreement either on its own account or as a subcontractor for any other person or in conjunction with or on behalf of any other person directly or indirectly:

8.1.1 Submit, or participate in the submission of, any tender or offer for the provision to the Client of services in competition with those anticipated by the Tender or enter into discussions with any person(s) other than the Parties in accordance with this Agreement with respect to the possible provision of such services to the Client or said Group Company of the Client; or

8.1.2 Provide goods or services to the Client or any Group Company of the Client the same as or substantially similar to or in competition with any of the services which are anticipated by the Invitation to Tender.

9. TENDER COSTS AND EXPENSES

9.1 Each Party shall bear its own costs and expenses in connection with the preparation, submission and negotiation of the Tender unless otherwise agreed in written.

9.2 Where additional reasonable expenses are incurred in executing the activities anticipated by this Agreement, and such expenses are agreed in writing and in advance between the Parties, such expenses shall be itemised and the cost of the same shared between the Parties pro rata their respective Work-share Value.

10. PROJECT IMPLEMENTATION

10.1 The work to be performed shall be allocated to each Party in tasks as shown in article [3.1] of this Agreement, and in article [4.2] for the specific obligations of the Lead Party.

10.2 The usual place of work will be on-site or at the Parties own respective offices.

10.3 Each Party shall provide all supplies and services required for the proper fulfilment of the Work-share allocated to it, including any revision(s) required under the Contract, provided that it is related to that Party's Work-share. However every such Work-share revision required under the Contract and agreed with the Client, Client requesting for changes, has to be confirmed in writing by the Lead Party to the Party.

The Party :

- Shall fully comply with the requirements of the Contract;
- Shall perform the work diligently, in a professional manner in accordance with good engineering practice;
- Shall provide sufficient people with the necessary skills and experience throughout Work-share implementation
- Shall co-operate effectively with the other Party or the Third Parties for completion of the Project.
- Shall report regularly the progress of the work in their Subtasks to the Lead Party.

10.4 Each Party shall immediately inform in writing the other Parties of any matters, which may affect performance of the Contract or the other Parties' Work-share.

10.5 Any extension or amendment to the Contract shall require express agreement of the Parties.

11. DURATION

11.1 This Agreement shall become effective upon the date of the signature by the Parties and shall remain in full force and effect until the occurrence of the first of the following events:

1. The Tender is unsuccessful;
2. The Parties agree not to submit the Tender or agree to withdraw the Tender;
3. The Parties mutually agree in writing to terminate this Agreement;
4. Upon successful completion of the Contract activities.

11.2 Notwithstanding anything contained in this Agreement, termination of this Agreement shall not affect the rights and liabilities of the Parties accrued prior to the date of termination.

12. AGENTS

No Party shall be entitled to hold itself out as being the agent of the other for any purpose whatsoever without receiving the prior written consent of the other Party.

13. ASSIGNMENT

No Party shall sell, assign or in any manner transfer its interest or part of its interest in this Agreement by operation of law or otherwise without obtaining the prior written consent of the other Party.

14. DEFAULT

14.1 For the purposes of this Agreement a Defaulting Party is a Party which:

- Is in fundamental breach of its obligations under this Agreement which is capable of being remedied and fails to remedy such breach within 30 days from receipt by it of a written notice from the other Party expressly referring to this and requiring the remedy of such breach; or
- Is in fundamental breach of its obligations under this Agreement which is incapable of being remedied.

14.2 After the occurrence of any such default as referred to in clause 14.1 in the event that the non-defaulting Party serves a written notice upon the Defaulting Party expressly referring to and invoking the provisions of this clause then forthwith upon the service of such notice, the Defaulting Party and its administrators, trustees or representatives shall have no right to participate in the administration of the Tender or Contract or to any distribution of compensation from the Tender or Contract. The Defaulting Party shall be liable for the costs, excluding indirect and consequential costs of performing the Defaulting Party's obligations in relation to this Agreement.

15. CONFIDENTIALITY

15.1 Throughout the continuance of this Agreement and for a period of two years thereafter, all information acquired by a Party (or from a Third Party in relation to the Tender) and any information jointly prepared by the Parties relating to the Tender from a Party for the purpose of preparing, submitting and negotiating the Tender shall be treated as confidential by the recipient and shall not be used for any other purpose without the prior written consent of the other Party providing such information, unless such information:

- Is or later becomes public knowledge other than by breach of this Agreement; or
- Is or was lawfully already in the possession of the recipient with full right to disclose prior to its receipt from the other Party; or
- Is or was lawfully acquired by the recipient from a third party having the full right to disclose it on a non-confidential basis; or
- Is required to be disclosed pursuant to its obligations under this Agreement or other documents relating to the Tender, or pursuant to the operation of law.

15.2 For the purposes of this clause references to a Party shall include Party's personnel, its subsidiaries and controlling companies and their personnel as well as nominated sub-suppliers for the Project approved by the Consortium.

16. INTELLECTUAL PROPERTY RIGHTS

16.1 For the avoidance of doubt, the rights (including but not limited to the rights of use and disclosure), and any limitations thereof, in regard of any Intellectual Property, confidential information, other information and material and/or project results arising from any earlier agreements between the Parties shall remain in force as agreed upon

in such earlier agreements despite the execution of this Agreement and the Project by the Parties.

16.2 Save as expressly provided for herein, nothing in this Agreement shall afford to a Party any right in or to the Intellectual Property of the other Party.

16.3 If so allowed by the Contract and unless otherwise agreed in writing, information, know-how or invention jointly developed by the Parties within the framework of the Project and not on the basis of the other Party's Intellectual Property, shall be common property of the Parties and shall be legally protected as the Parties may agree.

17. CONTINUING OBLIGATIONS

17.1 The Obligations of this Agreement are valid as long as any of the consortium obligations of the Contract or any open obligations between the Parties, whichever is later.

17.2 Without prejudice to clause 17.1, the provisions contained in clauses 15 (Confidentiality), 16 (Intellectual Property Rights), 21 (Publicity) and 23 (Governing Law and Arbitration) shall survive the termination under subclauses 11.1.1...11.1.4 of this Agreement.

18. INSURANCE

18.1 The Parties shall be responsible in providing all the necessary insurance to their and their subcontractors' personnel in such manner that each Party shall be responsible of any damage that may be caused by its personnel to third parties.

18.2 Each Party shall contract any other necessary insurance covering all its and its subcontractor' activities to be developed during implementation of the works object of the Contract and this Agreement.

19. LIABILITY

19.1 It is agreed between the Parties that they shall be jointly and severally liable to the Client only.

19.2 In the event of the Parties joint and severally liability being called upon by the Client, it is expressly agreed that the Party responsible for the portion of Work giving rise to the claim shall hold harmless and indemnify the other Parties from the result of such claim.

19.3 If the Client makes a direct claim against a Party who is not responsible, such Party shall immediately inform the Party responsible, who shall without delay hold harmless the Party against whom the claim was made.

19.4 If the Parties are jointly responsible for events subject of a claim by the Client, each Party shall be liable to the extent of its degree of responsibility for those events. If the degree of respective responsibility cannot be established or can only be established within an unreasonable period or at an unreasonable cost for such claim, the Parties should satisfy on a prorate bases according to the Work-share Values.

19.5 If the Parties are in dispute as to which Party is responsible for satisfying a claim of the Client, the Parties shall provisionally make payment in proportion to the Work-share Values. Following the provisional payment, if an agreement is reached as to which Party is liable and in what amount, or if the matter has been decided by arbitration

according to the rules of article 23, the Parties shall reimburse each other accordingly, within nineteen days following the agreement.

19.6 Each Party shall be personally liable for the Work entrusted to it and its employees or subcontractors and any consequences of such Work as regards Third Parties.

19.7 The Party responsible for any event giving rise to the Third Party to claim shall handle the event giving rise to a claim by a Third Party and such Party shall bear the cost of any damages resulting therefrom.

19.8 If a Third Party makes a direct claim against a Party who is not responsible, such Party shall immediately inform the Party responsible, who shall without delay hold harmless the Party against whom the claim was made.

19.9 If the Parties are jointly and severally responsible for a claim, each Party shall be liable to the extent of the degree of its responsibility or, if this cannot be established within a reasonable period or at reasonable cost, in proportion to its Work-share Value.

19.10 No Party shall, without the prior approval of the other Party, recognise claims or give any statement involving the responsibility of the Consortium or the other Party in whole or in part.

19.11 No Party shall be liable to the other Party for any, special, punitive, indirect, or consequential damages or losses (including any loss of business, revenue, profits or contracts) arising from any breach or non-observance of this Agreement or otherwise at law and, regardless of whether such losses were foreseeable and/or arose from the negligence or negligent misstatement of such Party.

19.12 As between themselves the Parties shall be fully liable for the work entrusted to them whether handled by such Party itself or its subcontractors and excluding liability for consequential damages, indirect damage, loss of profit or production stoppage.

19.13 With respect of nuclear civil liability and non-nuclear civil liability the Parties will endeavour to have in the Contract, written so that the Client shall fully indemnify the Parties and their subcontractors from any nuclear liability and against any claims by third parties including the insurers of the Client.

20. FORCE MAJEURE

The Force Majeure (Exemption) clause of the International Chamber of Commerce (ICC Publication n°421) is hereby incorporated in this Agreement.

21. PUBLICITY

No publicity of any kind concerning this Agreement or the Tender or the Contract shall be made by any Party without the prior written consent of the other Parties.

22. ANTI-CORRUPTION

The Parties declare, guarantee and accept that, in relation to the Agreement:

22.1 Have complied and shall continue to comply with all applicable laws governing anticorruption and shall certify compliance with the anti-corruption laws, as reasonably requested by the other partner, by signing the certificate provided for this purpose.

22.2 Have not promised, offered or paid and shall not promise, offer or pay, directly or indirectly, any bribes, payments to facilitate transactions or other improper payments to any third party in connection with this Agreement.

22.3 Have not corruptly promised, offered or paid, and shall not corruptly promise, offer or pay, directly or indirectly, anything of value in order to (i) influence any act or decision of a third party; (ii) ensure any undue advantage for the Parties; or (iii) induce a third party to influence the acts or decisions of a government official.

22.4 Shall not give, offer, promise or make contributions, donations or other payments of any items of value or in any manner, relating to this Agreement, to any government official without the prior written authorisation of the Parties.

22.5 Shall not communicate or meet with a government official in relation to the Contract without the prior consent of the Party.

22.6 Shall notify the other Party if any of his or her employees, directors or officials is the object of an investigation relating to corruption or any other unlawful conduct during the course of this Agreement.

22.7 Shall keep precise and complete books and records in relation to this Contract or any related activity, including the records of payments to third parties, in accordance with the generally accepted accounting principles, which shall remain at the disposal of the Parties.

22.8 Have no knowledge of any government official who benefits personally, directly or indirectly from this Agreement or from any other related activity.

22.9 Have not contracted any commercial agent or business consultant and, should he or she wish to do so, the partner shall be duly notified and no such contract may be signed without the prior written authorisation of the partners and without a written contract requiring that such third parties comply with all anti-corruption rules.

22.10 Shall act in accordance with its own code of conduct

Notwithstanding any provisions to the contrary in this Agreement, in the case of a material breach of this Agreement, the compliant Party shall have the unilateral right to terminate this Agreement and take other suitable measures in accordance with the terms of this Agreement.

23. GOVERNING LAW AND ARBITRATION

23.1 Any differences or disputes arising out or in connection with the validity, interpretation or execution of this Agreement shall be settled by an amicable effort of the Parties. Such effort shall be deemed to have failed when the Party so notifies to the other Party in writing. If the effort as settlement has failed, the dispute shall be finally settled by arbitration in accordance with the Arbitration Rules of Finland Chamber of Commerce, by one arbitrator appointed in accordance with the said Rules. Any award given by the Arbitrator shall be final and binding to the Parties and shall be in lieu of any other remedies.

23.2 The arbitration shall be held in Helsinki, Finland. The language of the arbitration shall be Finnish.

23.3 The Agreement, in all relative to the interpretation, application, execution, fulfilment or resolution, shall be governed according to Law of Finland.

24. CONTACT PERSONS

24.1 The official addresses and contact persons for each Party are as follows:

POSIVA	
Address:	**Töölönkatu 4, 00100 Helsinki, Finland**
Contact Person:	**Mika Pohjonen**
Email:	**mika.pohjonen@posiva.fi**
Tel.:	+358 40 525 1417

S&R	
Address:	Laulukuja 4, 00420 Helsinki
Contact Person:	Timo Saanio
Email:	timo.saanio@sroy.fi
Tel.:	+358405065671

Each Party may modify its address for notices by advance written notice to the other Party.

25. ENTIRE AGREEMENT OR MODIFICATION

This Agreement contains the entire agreement made among the Parties with respect to the Project and supersedes any and all prior understandings, correspondence or agreements (oral or written) between them. No change or modification of this Agreement shall be valid or binding upon a Party unless such change or modification shall be in writing and duly signed on behalf of the said Party.

IN WITNESS whereof this Agreement is made in English in two (2) original copies and signed by duly authorized representatives of each Party as of the date first written above.

POSIVA OY

Janne Mokka, Managing Director

SAANIO&RIEKKOLA OY

Timo Saanio, Managing Director