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EE documentation from Expert Group EE meeting inputs and outcomes concerning Work Package 2 final deliverable's Expert Elicitation

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ABSTRACT:
This memorandum summarises the quality assurance outcomes of the expert elicitation that was carried out for the DOPAS Work Package 2 final report draft D2.4 dated 21 August 2015. The elicitation was carried out during 1 September 2015 to 24 November 2015.

RESPONSIBLE FOR ORGANISING THE ELICITATION AND DOCUMENTING THE OUTCOME:
Posiva Oy, Marjatta Palmu

REVIEW AND OTHER COMMENTS:
Memorandum reviewed and approved by WP2 elicitation experts Johan Andersson, Wilhelm Bollingerfehr, Jan-Marie Potier and Juhani Vira by 23 November 2015. Experts comments related to the consensus meeting were included into this memorandum.
The memorandum produced does not represent the views of the DOPAS consortium or those of the individual consortium organisations.

APPROVED FOR SUBMISSION:
by Johanna Hansen, DOPAS coordinator on 26 November 2015

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Date	Monday 26 October 2015 from 9:00-16:30 hrs
Place	SKB, Blekholmstorget 30, 101 24 Stockholm, Sweden; Meeting room EF7;103
Present	Johan Andersson, SKB, PA/SA Expert (SKB Host) Wilhelm Bollingerfehr, DBETEC, Domain expert Marjatta Palmu, Posiva Oy (EE organiser) Jan-Marie Potier, consulting services, Domain expert Juhani Vira, tmi, PA/SA expert Matt White, GSL, WP2 D2.4 editor (observer)
Excused	Behnaz Aghili, SKB, Work package 2 leader

1 Introduction

1.1 EE - what is it?

The expert elicitation (EE) carried out in the DOPAS project is based on the methodology developed for Posiva's Safety Case expert elicitation by Ms. Kristiina Hukki from VTT (Posiva Work Report 2008-66). This elicitation work belongs under the tasks in WP6. The view taken in the elicitation is that the elicitation and validation process is regarded as a collaborative and cross-disciplinary whole.

The systemic character of the process sets requirements for the formal EE procedure (for expert judgment) as described in the report in detail. The procedure itself was deliberately designed to fulfil these requirements by supporting collaboration of the participating disciplines.

In general, structured performance, transparency and traceability are goals for an elicitation and validation process from the quality assurance point of view. If this process is considered from the safety case point of view as it was originally designed, the goal is to conduct the process in a way that efficiently produces valid input for safety analysis. The efficiency is dependent on the way of the participants' interact. Reaching a consensus on the validity of the input data or the common view formulated in the elicitation is desirable. A further desirable feature relates to the level of motivation and trust of individual persons participating in the process.

The expert elicitation process aims at collecting and documenting the different expert's review comments related to the target of elicitation in a transparent manner using a preset framework of review comments.

In the DOPAS project, the objective of the expert elicitation (EE) is to be a quality assurance tool for the final deliverables of the project's RTD and DEMO work packages WP2-WP5.

The application of this methodology for the DOPAS project was tested in a pilot elicitation carried out during May - October 2013 on the POPLU test plan and its consensus meeting outcomes were documented as the deliverable D6.1.1 Pilot EE consensus memorandum for D3.25 POPLU test plan.

The common grounds for the formal elicitation are based not only on the questionnaire tools used, but also on sharing the same descriptions about the elicitation target as a background. In the case of WP2, the "Design Basis Development Workflow for Plugs and Seals". Unlike in the elicitation for safety case, the requirements for experts selected for the elicitation is that they are fully independent of the direct DOPAS work itself even though their backgrounds include different disciplines and professional experiences.

The elicitation results reported in this WP2 EE Consensus Meeting memorandum present the outputs of the expert elicitation carried out on the DOPAS WP2 final draft deliverable D2.4 "WP2 Final Report. Design Basis for DOPAS Plugs and Seals".

1.2 About DOPAS Work Package 2

The DOPAS Work Package 2 had the following objectives.

- To develop design basis for different plugs and seals describing explicitly the process and approach of coming to the design basis; including transparency to the different national requirements and their comparison; and to explain the differences in the different experiments' design basis envisaged in current consortium member's repository systems in salt, clay and crystalline rock.
- To describe reference designs based on this design basis and to elaborate the strategies for demonstrating the conformity of the reference design to the design basis.
- To act as input to WP3 related to (especially) the (new) experiments FSS, EPSP, POPLU. DOMPLU provides information, as the experiment was already on-going, ELSA experiment will be implemented later.
- To integrate the WP2 results for wider use and to act as input for WP6 final report (D6.4) (including wider communication)

The communication objective was added to the objectives during the consensus meeting.

The Work Package 2 has produced already the following published background reports:

- DOPAS D2.1 Design Basis and Criteria (v.1.1, 2014)
- DOPAS D2.2 Designs of Reference Concepts and DOPAS Experiments: DOPAS Reference Design Reports (v.1, 2014)
- DOPAS D2.3 Strategies for Demonstrating Compliance of Reference Designs with the Design Basis (v.1, 2015)

These reports were also distributed as a background material to the experts for the elicitation of D2.4.

1.3 Target of WP2 elicitation

The target for the elicitation was defined as follows:

Is the D2.4 report complete and consistent regarding the objectives set for the work and is it "fit for use" i.e. representing an acceptable level of quality as a work package deliverable?

The elicitation should also focus on identifying potential uncertainties, ambiguities, and controversies

- in the report and especially in the workflow, and
- in proposed use of the results, and
- in the report's conclusions

in respect to the report content and experts' previous experiences.

1.4 The steps in the elicitation process

The generic process for the expert elicitation as defined in Hukki (2008) included the following steps:

- Selection of issue (generally something not easily agreed, but requiring judgment and consensus)
- Selection of forum
- Selection of domain experts (probabilistic SA)
- Selection of shared conceptual frameworks (description production)
- Preparatory work of safety analysts
- Training of domain experts
- Instruction of domain experts
- Independent work of domain experts
- Iterations (consensus meeting)
- Treatment of possible controversies (consensus meeting)
- Validation of expert judgments for later use
- Final documentation of the process (facilitator)

In the DOPAS elicitation process not requiring for example the use of probabilistic safety assessment, some steps have been omitted from the preparatory phase of the elicitation and both performance assessment and domain experts meet simultaneously at the same kick-off forum. If the elicitation process is applied in the original context of WP2008-66, these steps should be maintained as a part of the process.

1.5 Participants and timetable of the process

The experts to participate in the expert elicitation were selected from a consortium and EC screened short list and the relevant experts were recruited and their final number was based on their availability to participate in the elicitation within the agreed timeframe ranging from beginning of September 2015 to the end of November 2015. The kick-off meeting was held on 1 September 2015, the experts' review results by end of September and the consensus meeting was held on 26 October with the draft minutes out on 13 November 2015 for commenting and approval in a week.

The experts consisted of the following professionals in geological disposal:

Mr. Jan- Marie Potier, Domain expert and the expert that will participate in all of the WP6 elicitations for overall consistency of the process and its results. Mr. Potier has worked a long career in both underground mining industry and geological disposal at Andra, the French waste management agency. Since his retirement in 2009 from the position of IAEA's Head of Waste Management Section, he continues to be an active technical expert working on temporary assignments for the IAEA.

Dr. Johan Andersson, Performance Assessment/Safety Assessment Expert, the head of unit of analysis in SKB, the Swedish waste management company. Dr. Johan Andersson has worked extensively on the post-closure issues and related integrated modelling and technological development in geological disposal also in other waste management programmes and is currently in charge of requirements development.

Mr. Wilhelm Bollingerfehr, Domain Expert, the head of research and development department in DBE TECHNOLOGY GmbH (DBE TEC) has a long technology and operational consulting experience in the German nuclear waste management activities and facilities. One particular feature of the German activities is the national requirement for full-scale testing of all technologies at an early stage of their development.

Dr. Juhani Vira, Performance Assessment/Safety Assessment Expert has worked with Posiva's spent fuel disposal from the beginning and also before the establishment of Posiva, a Finnish waste management organisation since his retirement in 2015 from the position of Posiva's research director.

2 Agenda of the consensus meeting

The agenda of the consensus meeting was the following:

1. Opening, overall view and recap of the objectives of the WP2 EE process (Marjatta Palmu & experts)
2. Working during the day - Discussions and proposed modifications (Marjatta & experts)
3. General findings and improvement suggestions to the WP2 D2.4, the way forward (Marjatta & experts)
   3.1 Similarities in findings
   3.2 Differences in findings
   3.3 Individual additional findings by the experts and their handling
4. Clarifications and recap of change proposals (Marjatta, all)
5. Timing of approval of consensus meeting memorandum (Marjatta)
6. EE process - experts' experiences from the process and feedback

Closing

3 Inputs to the elicitation process - Summary of the experts comments by quantity and type

This expert elicitation meeting's inputs were based on the replies of the different experts on the expert elicitation questionnaires. The questionnaire forms are attached as Appendices 1 and 2.

The replies on the questionnaires were compiled by the facilitator and they formed the basis of the discussion point 3 on the consensus meeting agenda.

As a result a total of around 80 different comments were received from the four experts. The nature of the comments varied as summarized in the table:

Types of inputs	Number of comments	Handling of comments
General view	all experts agree	The general comments included favourable comments about the report itself. The report is intended to be a stand-alone report, but it was noted that in some cases the reader needs to resort to the background reports for further details. However, in this respect it was not necessary according to the experts to change the D2.4 report, since the background reports are publicly available.
Controversial comments between experts	1	The main contradiction was related to the different backgrounds of the experts and inaccuracies in the input information to the WP2 - especially whether Andra's functional analysis is hierarchical or not. It is hierarchical.
Omissions from report	4	• **compliance assessment** described and linked with the requirements; • **hydraulic isolation** - to be included; • references related to the different approaches related to requirements (see above) • some terms to be added into the glossary and IAEA glossary reference
Similar change comments	3	• hydraulic isolation - add; • simpler plug - reformulate; • comparison of conditions in Äspö, ONKALO and Forsmark - remove
Work flow and context related comments	2, worked during the meeting	• changes in basic design and detailed design descriptions and names of the work flow boxes (Appendix 4)
Specific improvements	37	These are covered in the following chapter 4.
Terminology comments	3	• generic environmental conditions to design environmental conditions • post-closure safety; • requirement
Editing comments	17	• to be handled directly by the editor (a separate file provided)
To be considered in future WP reports	10	• Listed in chapter 5

Types of inputs	Number of comments	Handling of comments
Outside DOPAS scope	2	• DOMPLU grouting impact on pH • POPLU stainless steel reinforcement in plug concrete (not discussed)

4 Main comments and outcome of their handling as input to D2.4 draft

4.1 Overall evaluation of the content of the report - Fitness for use of the report

The experts found the report in general to be well written and that it would address a reader's needs with general objectives of being informed of the content as a stand-alone report that was the objective for the report. For more detailed information it was noted that a reader would need to resort to the background reports such as the D2.1 for more comprehensive information. However, the experts concluded that as the background reports are public and referenced in the D2.4 report appropriately, there is no requirement to complement the deliverable in this respect. The report D2.4 is foremost intended for the technical and management audiences of Waste Management Organisations, but can be found useful also by e.g. designers and implementers of either real or experimental plugs and seals.

The experts view on what can be expected to result from the DOPAS experiments is that the DOPAS experiments are likely to strengthen the confidence in the feasibility of producing plugs and seals with adequate performance. This topic is to be addressed in WP4 final report. The tests are seen unlikely to serve safety assessment, their focus is on feasibility of construction.

Major safety functions to be fulfilled by the complex systems of plugs or seal appear quite similar in all DOPAS countries, e.g.

- To provide for containment of disposed waste by restricting water flows in man-made underground openings;
- To contribute to preserving the integrity of disposed waste containers;
- To provide for mechanical support; and
- To provide for safe working environment for workers.

Despite the plug and seal safety functions appear to be similar, there may be significant differences in terms of their expected operational lifetimes including performance over time.

The workflow developed is useful in increasing confidence with the generic approaches. The use and transformation of the experiment results into a consistent set of requirements for the reference design is a potential beneficial result as described in more detail in the modified workflow (i.e. the use of the experiment experiences and results in the iterative process of quantifying requirements, which by nature are becoming more accurate and changing as the development work proceeds).

Also the conclusions of the report were clear and useful and the experts agree with the key messages in the report's section 6.4.

4.2 Specific improvements to the report content

4.2.1 Compliance strategies/assessment and the related challenges to be discussed

The main discussion item on the experts' comment related to the limited or implicit attention given to the description of the content of compliance assessment in the deliverable D2.4 draft.

As a background explanation for this comment is the need to identify the criteria for the fulfilment of the requirements already at the stage when requirements are formulated and used for design basis development was underlined. Otherwise it is not that easily to be understood how the compliance checking is to be carried out. Further, in the demonstration experiments the fulfilment may be shown by various monitoring/instrumentation systems that, however, may not be available for use in the real repository. Therefore, there has to be a strategy on how to show that the real system corresponds to the system demonstrated.

As a conclusion, the experts' suggest that the compliance assessment steps are to be included into the report. As an expert put it:
"In general, the compliance checking consists of a chain of validation, verification and qualification activities. I am using the word "validation" knowing that in a strict sense nothing can be validated, but understanding [this activity] as a series of theoretical modelling and experimentation tasks through which reasonable evidence is acquired to show that our understanding/description of a feature/process is correct in the scientific sense."

A more detailed description of the steps is provided in **Appendix 5** for editing into the D2.4 report into the appropriate context. This topic was also discussed in connection with the "Design Basis Development Workflow for Plugs and Seals" process description. See chapter **4.3. I**n the same context, it was noted that also the **individual description** in connection with each experiment are **rather vague** on this point.

At the same time, it was noted that some of the DOPAS experiments do not have as an objective to demonstrate compliance but only technical feasibility of design or construction/construction materials.

As a specific comment related to the statement about DOMPLU[1] the word "currently" shall be added:
"DOMPLU represents **currently** the main compliance demonstration test for deposition tunnel plugs in the SKB programme."

4.2.2 Source and structuring of requirements and the background of the approaches in coming up with requirements

Resulting from the experts' input, the main controversy in the inputs related to the theoretical approach used to come up with the requirement and simultaneously, the experts felt that **it was not very well captured in the report who produces the requirements** (after the higher level requirements have been set on e.g. regulatory level) and how they are produced.

Concerning the related level of requirements, the lifetime and the technical requirements need to be considered i.e. make a clearer distinction between the different levels of requirements since to show the compliance with (upper-level) performance requirements requires methods that differ from those used to verify the compliance with technical design requirements.

In the discussions it came evident that for the reader it would be clearer to **include some main background references** related to the different approaches used by the different waste management and other organisations in formulating the requirements, since **all approaches use a hierarchical approach** to requirements unlike stated in the report draft concerning Andra.

- SKB and Posiva apply requirements management system(s) that are derived from systems engineering.
- Andra applies also a systems engineering based approach i.e. functional analysis (as developed by NASA).
- In Germany, especially in the DOPAS related experiments the "C7 Eurocode: Standard for geotechnical design" is used.

Even though these approaches are stated in the report draft, the requirement is to add the proper **referencing to the background approaches into the text and to the report's list of references**. This would make it more transparent for the reader to recognise the

[1] (D2.4 draft page 46)

similarities in the application of hierarchical systems to come up with the requirements or functions or safety factors for the different plugs and seals. In this connection, too, it was noted that it would be of interest if the validation and review process related to the requirements could be described for each experiment and reference plug. The major difference in the requirements approaches was by SURAO as their approach is based on more general underground civil engineering experiences.

It is also noted to the statement[2] in the text in D2.4 section 5.3 about *"This process would typically include re-evaluation, and, potentially, re-writing, of the preliminary design requirements or the preliminary design specification statements, as part of an iterative development of the design basis."* **Check this text and the explanation to correspond with the revised workflow description and its terminology (see chapter 3).**

The above **shall also be complemented** to include the following: The changes of design requirements need to be made in a structured way and integrated with the safety case. In particular, once a license is obtained also the regulator need to be involved (and approve) the change.

It is stated[3] that *in crystalline rocks, there is a potential for both the host rock and the EDZ to provide groundwater flow paths that could short-circuit the plug.* There is a need to check whether such potential exists also in clay host rock environment.

Although the requirements' input data for producing design basis are mostly **dealing with scientific and technical considerations**, other requirements such as the constructability (the ability and ease to construct in a constrained environment), robustness, durability, cost-effectiveness of the structures, the construction methods deployed underground, and the overall repository conditions, which may be encountered when building the final structures should not be forgotten.

In addition to the verbal description of the workflow, these references together with the use of the IAEA Safety Glossary (2007?[4]) provide the grounds for interpreting the workflow. **Reference to the IAEA Glossary is to be added into the reference list.**

The generic consensus was like one expert commented that *"despite the different contexts and obligations, the design requirements present commonalities such as:*

[2] (D2.4 draft page 55)
[3] (D2.4 draft page 39)
[4] The version used by the author needs to be confirmed in the report references

- *Relying as much as possible on the experience gained from past tests and experiments on plugs and seals and/or from underground mining activities;*
- *Using an iterative process involving the design basis, performance assessment and safety evaluation is generally to fine tune the design requirements for the final plug / seal system, paying due consideration to the constructability and durability of these complex structures;*
- *Performing critical reviews periodically to assess the results, verify their compliance with design requirements, and identify possible upgrades to the design bases."*

4.2.3 Experiment vs. repository context and their differences

Making note of the more general **differences between the boundary conditions of the real repository and the experiments needs to be included** e.g. into the introduction of the report. Explicit boundary condition differences include the number of plugs and seals in the actual repository and its impact on the construction of these plugs and seals (incl. costs) and the use of instrumentation directly on the plug structure. In the DOPAS project only a single plug is constructed in each experiment. Thus some reference to the experiment context vs. the actual repository context is to be made in the report's introduction and a recommendation is made that the suggestions from this comment are included into the WP3 and WP4 final reports, too.

Also it was noted that the experiment solutions as such are aimed to be transferred to the future reference design/s. In taking this into account it was noted that the **uncertainties related the transferability** of the experimental plugs and seals **should be discussed in the WP3/WP reports**. These include e.g. the reproduction capabilities of the plugs and seals in the repository (construction and other methods), the availability of the construction materials decades later and the amount or no instrumentation to monitor directly the plug or seal behaviour.

4.2.4 KBS-3 and POPLU related comments

<u>Requirement for hydraulic isolation of POPLU plug and KBS-3 plugs in general</u>

In the report, the **hydraulic requirement (tightness)** of the POPLU plugs is missing. This is an omission of a self-evident requirement and should be added[5].

[5] (D2.4 draft pages 17, 41 and 43)

The statement that the hydraulic isolation requirements are missing **does not mean that there would not be any hydraulic isolation requirements** for the plug. The value range for the requirement has not yet been fixed.

However some references and **comments**[6] **made to the leakage values** /water flow /hydraulic conductivity in the D2.4 report are premature and shall not be addressed in the text.

Further requirements of the KBS-3 concept for plugs

Add to the existing text[7] on D2.4 **section 3.1.1**: ...the principal role of the deposition tunnel plug is to hold the backfill in place during operations
and to prevent high flows from the backfilled tunnel into the rest of the pumped repository in order to ensure that the bentonite material will not be eroded away from the buffer and the backfill.

Note that this is actually what Posiva assumes also in TURVA-2012 even if there may not be an explicit quantitative criterion on that.

Deposition tunnel plug related post-closure safety function in Sweden

The report states[8] that *"Deposition tunnel plugs have no post-closure safety function in the Swedish repository, but they must not significantly impair the barrier functions of the other engineered barriers or host rock."*

A further explanation related to this point is needed based on the following expert comment:

The function of the plug during operation is necessary to ensure the post closure safety functions of the backfill and the buffer. This especially relates to the tightness requirements of the plug. Further the Swedish regulator (SSM) has stated in its preliminary review that it may take a long time before the outer part of the tunnel saturates after closure. Resulting from this also during this time (some additional 100 yrs) the plug should be tight.

POPLU plug as a "Simpler plug" - changes required

More discussion is needed on the impact of "simpler" plug and actual "simplicity". What the POPLU plug **has is a potentially simpler design**.

[6] (D2.4 draft pages 7, 45)
[7] (D2.4 draft page 38)
[8] (D2.4 draft page 12)

It should be noted that the POPLU experiment's requirements do not fully address all the reference plug requirements (no bentonite layer is included in the experiment). In parts of the text, this can be corrected just by **removing the word "simpler"**.

As an additional clarification one is to **state that the objective of the POPLU test is to find out whether this design (a potentially simpler design without the bentonite layer) is able to fulfil the same requirements as the DOMPLU test.** Modelling for the POPLU design alternatives was carried out prior the selection of the design - this is addressed in WP5 (and can be included into the WP3 final report).

On one hand, from the perspective of the safety assessment (SA), the more requirements are put on the system or subsystem, the easier is the safety argumentation. The technical feasibility and practical technical design problems on the other hand increase with the increasing number of requirements. Thus **a change is required to the statement[9] made** stating that a simpler design would make safety assessment easier is needed as the statement is not valid.

KBS-3 experiment plug pressurisation needs a more accurate explanation

Revise the text[10] related to the load case (i.e. pressurisation) of the plugs in the experiments. The only pressure that the plug needs to resist in the experiment is the hydraulic pressure in contrast to the reference plug design pressure. This is due to the pressurisation done by using an external water source that causes jacking of the rock fractures behind the plug in such a way that would never happen in the natural system with bentonite backfill behind the plug. This is one of the lessons learned during the DOMPLU experiment and transferred to the POPLU experiment (to be addressed in WP3/WP4).

Discussion on the changing nature of requirements needed

Currently, the **requirements on what is the accepted inflow and leakage still need to be defined**. Also **a new design premise and requirement related to limiting gas flow through the plug** is under discussion for the KBS-3 in cooperation between SKB and Posiva. Both experiments also contribute to quantifying these requirements.

In the report **discussion/conclusions part the changing nature of the requirements** as a part of the iteration process shall be included.

[9] (D2.4 draft page 56)
[10] (D2.4 draft pages 13 and 55)

Comparison of the site conditions in crystalline host rocks to be removed

The text **comparing**[11] **the site conditions and their hydraulic condition**s in Äspö, Forsmark and ONKALO **shall be removed**. This is not relevant to the content of this report or the experiment designs. **Edit the text in D2.4 section 3.2.2** and recheck the validity of the arguments made.

4.2.5 Clarify discussion and requirement vs. specification on low pH concrete materials

Defining **pH as below 11 is a requirement or a performance target**. The **calcium - silica ratio that Posiva uses is a specification**.

If pH value is used as a specification, the specification requires also the specification of the method by which the pH is defined. The pH value is measurement method dependent as the calcium to silica ratio is exact (unambiguous and comparable) and from practical point of view it is more useful for the mixers of the concrete removing the necessity to carry out the pH measurements.

The comment of the expert is accurate stating the pH level as below something is a requirement and the ratio is already a specification meeting the set requirement.

The intent of the different organisations is the same, the way how it is defined differs. This **part of the report requires changes** in the report text[12]. Also repetition[13] related to the low pH needs to be removed.

Related to Posiva and POPLU text, a **reformulation is also required** to the following text in the report: *"There is also no specific pH value requirement for the cementitious materials used in the plug. However, low pH is implied in specifying a value for the ratio of calcium to silica content. This avoids the need to consider the evolution of the pH value in time.* "
This is to be replaced with the following: **Low pH concrete materials are a must in POPLU and Posiva's repository. However, no specific pH value requirement has been defined for the cementitious materials of the reference plug. Instead the calcium to silica content ratio is used. Further studies on the topic [impact of low Ph materials] are on-going.**

[11] (D2.4 draft page 45)
[12] (D2.4 draft pages 17 and 42)
[13] (D2.4 draft page 45)

4.2.6 Clarify requirement vs. specification related to bentonite

The report[14] states that *"For some plugs and seals, bentonite **requirements** are expressed in terms of the swelling pressure and hydraulic conductivity to be achieved; in others it is expressed as the density of the bentonite."*

In this case like in 4.2.5: the **swelling pressure represents the requirement and the density value is already a specification.**

4.2.7 EDZ related changes

In connection with EDZ refer to **conductivity** (not porosity, after checking with Andra and Nagra how it is in clay).

A further change is required related to the following statement[15]:
In crystalline rocks, there is a potential for both the host rock and the EDZ to provide groundwater flow paths that could short-circuit the plug. Therefore, the plugs must be keyed into the host rock, and strict criteria to determine the suitability of the plug location must be established in advance of the decision on plug location. Typically, the criterion is that no through-going fractures are present, but the exact nature in which this criterion is applied is plug-location-specific and requires further consideration.

Replace with:
In the case of crystalline rock, both the host rock and the EDZ have potential to provide groundwater flow paths that could short-circuit the plug. Therefore, the plugs must be keyed into the host rock, and the selection and acceptance of each plug location must be based on criteria established in advance. Typically, the criteria aim at evading /rejecting volumes of rock, where natural fracturing might enable formation of hydraulic connections / groundwater flow paths spanning the entire length of the plug / entire plug location; the criteria still require further consideration, and their evaluation and development is currently continued by Posiva and SKB.

4.2.8 Thermal processes

The report states that for DOMPLU, the plug must withstand the thermal loads[16] caused by the rock and concrete expansion during the sealing phase.

[14] (D2.4 draft page 43)
[15] (D2.4 draft page 39)
[16] (D2.4 draft page 40)

The expert's comment suspects that this applies to all of the plug and seal experiments and reference plugs and seals, not only DOMPLU. **To be checked and complemented to the report.**

The report discusses the requirements for concrete component temperatures.

The experts comment states that one should separate handling the thermal impact from the plug (i.e. from the concrete sealing process) and the temperature range under which the plug must operate. The latter is obviously something all designs must consider (and would be able to address). **This needs to be addressed in the report text.**

4.2.9 Complementing the D2.4 discussion and conclusions

The report benefits from including into its discussion and conclusions part the **discussion on the conditions and limitations on the use of the Design Basis Development Workflow** as presented in the D2.4.

Related to the Construction Procedures as stated[17] in the report: *"WMOs have different views on the use of construction procedures for compliance demonstration. Some regard it as an important element of compliance demonstrations, and others consider it to be part of quality control during repository implementation."* - Further justification is needed as an expert states that it is questionable whether there is a real difference. *"The focus of the quality control must to a large extent rely on the practical experiences gained during "compliance demonstration". Furthermore, testing a suggested reference design, additional formal commissioning testing would be needed."*

The above comment has also impacted the revision of the workflow in chapter 4.3 and Appendix 4.

The D2.4 section 5.3 states[18] *"Following the elaboration of experiment design specifications, an experiment design can be developed. This will take account of experimental constraints (e.g., time available to perform the experiment and consideration of operational safety, which may be different to the constraints on plugs/seals in an operating repository) and site-specific environmental conditions encountered at the actual location of the experiment."* This is seen as a very useful concept (experimental design and experimental constraints). It is of course essential to be able to develop and tests concepts also outside the

[17] (D2.4 draft page 60)
[18] (D2.4 draft page 54)

envelop of decided requirement/s and selected concept. **This note is to be added to the conclusions section 6 of the D2.4.**

Further the conclusion in the report[19] about page 61: "*The principal safety functions of a plug or seal can be specified and stabilised once the repository concept has been specified and the national regulations developed*." requires additions related to the changing nature of requirements (see chapter 4.2.4) as referred to by an expert: *But further updates may be needed as the design work proceeds since the design work may imply that some overall design requirements may be hard to meet/verify and then a valid question is whether the design requirement based on the (usual) simplifications made on safety assessment are justified – or could be altered without jeopardizing overall safety.*

Into the overall conclusions belongs the **need to integrate the work described here with the safety case**. This was also addressed in the workflow revision. The application of the results needs more work in each participating organisation.

In general, the experts did not identify any WP2 internal discussion in the report, whether there were some uncertainties or difficulties in carrying out the work and the reporting. Potential uncertainties related to the scaling effects (also related to underground industrial implementation of plugs and seals) are not yet present in this work package's work.

4.3 The comments related to the Design Basis Development Workflow for Plugs and Seals (structural description)

4.3.1 General about the workflow

The experts concluded that the Design Basis Development Workflow captures the most essential points. However, the levels of design that are tested in the DOPAS experiments are not that clear. Thus changes into the workflow are proposed as described in **Appendix 4** and in the following.

4.3.2 Related to the compliance strategy

The workflow explanation that addresses the **content of the "compliance assessment" requires opening up** even though it is included in the description in an implicit way. See e.g. the comment chapter 4.1.2 and Appendix 5 for suggestions.

[19] (D2.4 draft page 61)

4.3.3 Related to the terminology used in the workflow

It is useful to note in the description of the workflow that **"Operational considerations need to be informed and aligned with the safety assessment"** since the safety assessment is carried out iteratively throughout the repository design and construction [and operations] processes.

Likewise, it was noted that the constraining factors (included in the **Operational considerations** above), which may need to be taken into account were not included in detail (like improvements and cost-effectiveness of plug / seal systems; Localisation in the repository system; Preserving their integrity and monitoring their performance over time; and Contingency planning during their operational lifetime: The solutions on how these constraints are tackled need to be addressed at the design stage (WP3).

Related to the workflow figure (on two locations in the report), see also **Appendix 4 following changes are requested** to clarify both the work flow and the relation of the DOPAS experiments to the workflow descriptions:

In Basic Design

- **add as input** to "Experiment Design Specification" in parallel to "Safety assessment" **"Operational constraints"**
- as an outcome of first part of the process the **result is "Full-scale test"** (instead of "Preliminary Basic Design Full-scale test" and in the description one shall not that also the experiment designs are "detailed", but not the "Detailed Designs" as described in the workflow. The full-scale tests as such depending on the licensing requirements also include more instrumentation than the subsystems intended for the commissioning tests of a repository.
- the **outcome of the "Basic Design" is also "Detailed Design Specification"** (instead of "Preliminary Design Specification")

In Detailed Design

- consequently the starting point of "Detailed Design" is as above the **"Detailed Design Specification"** (instead of "Preliminary Design Specification")
- **add as input** to "Quality control procedures/Construction Procedures" in parallel to "Operational constraints" **"Safety assessment"**
- **remove word "Preliminary" from all boxes,** as this stage is for commissioning (not anymore for experimenting)
- as an outcome of first part of the process the **result is** first **"Detailed Design"** (instead of Preliminary Detailed Design) followed by

"Commissioning test" (instead of "Preliminary Detailed Design Full-scale test"). There is a need to clarify in the description the differences between these design stages. In DOPAS the work relates to the conceptual and basic design. Its full-scale test is for checking if the tests comply as defined/required. The Commissioning test is a test contributing to the compliance assessment. However, this test may demonstrate some needs to change e.g. requirements, but hopefully not.

- In addition it was noted that the detailed design work flow is very general. More details like material specifications, construction procedures could be included. This does not need to be included in the WP2 flow, but could be also addressed at the later WP reports.

4.3.4 Production of a second workflow figure highlighting the DOPAS work

To clarify between the overall workflow and the work carried out in DOPAS a s**econd workflow figure can be produced to include and highlight the parts of where DOPAS work has been carried out.**

4.3.5 Production of an even more generic workflow

The workflow itself was found to be applicable for developing design bases for other repository subsystems in addition to plugs and seals. As a conclusion, it was advised **to produce a more generic workflow** that would have a wider use. This workflow would also take into account the complexity of the actual repository like considering the number of subsystems needed in the actual repository instead of a stand-alone subsystem used in the experiments. Other considerations include e.g. addressing the plugs and seals as a part of the repository system where their performance is also influenced by other parts of the system. For this reason also the glossary in this and potentially other reports needs to be **complemented with "system" and "subsystem" definition**s, chapter 4.4.4.

Such a description **would be most suited for the DOPAS final technical report D6.4.**

4.4 Comments to improve the report structure

4.4.1 To facilitate the comparison of approaches

Same structure is used to describe each DOPAS project partner's approach, i.e. <u>Safety Functions – Process – Reference Conceptual Design – Experiment Design – Experiment Design Basis.</u> This facilitates the comparison between the different countries approaches. **At a lower level on some points, under each heading, it would be useful to**

address some important points in a similar manner to facilitate the comparison.

4.5 Terminology and wording related comments

4.5.1 Generic environmental conditions

Changed to **Design environmental conditions.**

4.5.2 Plug/seal safety functions

Refer to **post-closure safety** instead of "safe closure". The **use of word post-closure safety in replacement of long-term safety is to be used** also elsewhere in the report text.

4.5.3 Design requirements/Basic design requirements

Clarify the definitions. The intention is that these requirements should be as strict as possible but it can be on a higher level than a design specification that is almost like a blueprint.

4.5.4 Addition of new terms into the Glossary

The following terms shall be included into the Glossary:

- System
- Subsystem
- Requirement
- Safety function
- Design basis
- Reference design

4.5.5 Caution in using the word "optimisation" or optimal => improvement

Despite the intent to improve the safety performance and other features of the plug, "optimisation" should be handled with care in the report or rather replaced e.g. **improvement/improvements**. Note changes also to Glossary.

4.5.6 Adding potentially as plug/seal water tightness not yet proven

The report states[20]: Owing to the potential for erosion of the bentonite buffer and backfill, the groundwater flux across the plug has to be low,

[20] (D2.4 draft page 59)

and this can **potentially** be achieved through the use of a watertight seal or by using a massive concrete plug.

Reason: one needs to see the results of the projects before such a conclusion can be made. This is not yet proven! To be addressed in the coming WP reports.

4.6 Conclusions from the handling

The expert elicitation form an integral part of the quality assurance of the DOPAS Work Packages' final deliverables. Thus the consensus outcome approved by the experts shall be included into the next version of the final draft or to the final report. This is dependent on whether the report will still undergo an organisational quality assurance review or if the report draft that has been submitted to the expert elicitation has already been review in the organisation in lead of the work package in question.

Editing comments are handled as edits into the final report not requiring further discussions. These comments have been provided to the author in a separate file.

5 Recommendations to be included in the other Work Package reports

The comments in chapter 4.1, 4.2, 4.3 and 4.5 include recommendations that would be more beneficial to be included in the other work packages' final reports:

4.1 The benefits and usefulness of the tests
- is to be discussed in WP4 final report:
- the tests are seen unlikely to serve safety assessment, their focus is on feasibility of construction.

4.2.3 Experiment vs. repository context and their differences
4.2.4 KBS-3 and POPLU related comments
- modelling for POPLU
- KBS-3 experiment plug pressurisation load cases in experiment vs. real repository plug with backfill

4.3.5 Producing a more generic design basis development workflow for D6.4 Final technical report
4.5.6 Discussing plug/seal water tightness
- not yet proven when WP2 was reported.

The production processes in D2.4 are well described. In the further reporting, explanation is needed about how well these processes were really followed in practice. The tests will be useful for the performance assessment if they can validate/verify the fulfilment (or failure) of certain performance requirements. Where they can do this is to be addressed in the WP3/WP4 reports.

Further the D2.4 report[21] discusses the development of the compliance strategy statements in a way that allows for a reconsideration of the design statements, and in certain cases suggestions for rewording or other types of feedback related to the design basis statements and claims that in this iterative development of the design basis and the requirement-by-requirement review of it, generic methods for demonstrating compliance to be identified. Further it is stated that this approach also allows feedback to the specification of the design basis to be captured and the methodologies and technologies used during each experiment to be evaluated and assessed.

In the following work a proper process for keeping the design of the experiments in line with the existing safety performance requirements and describing explicitly the verification/validation methods, the tests cannot be used as real demonstrations (of a plug that could be used in the real conditions). This discussion should be included in the WP3/WP4 reports. The experts request that examples of the stated feedback are presented in the future WP reports.

A detailed addition to the other work package reports is to include the discussion of the reasons why the POPLU test is not a test of the reference design.

6 Good practices

The approach used by several project partners is not to construct and test the complete full scale plugging / sealing system in compliance with the reference design, but only some system components playing key functions such as the bentonite core. Also in the case of POPLU not all testing is necessarily carried out underground or in full-scale in the field of material studies and selections like the concrete method tests (materials as such are outside the scope of the DOPAS project) or material specifications and samples that could be done e.g. at the mixing station above ground. Such an option is useful to consider as an alternative alongside the full-scale tests.

7 Potential bias in the elicitation experts' focus and potentially selection

The experts also noted that the participants in the elicitation process had more background on the KBS-3 related requirements related to plugging and that the EPSP experiment information did not receive that much attention from the experts.

[21] (D2.4 draft page 47)

The result from this is that the facilitator will complement the following work package's elicitation expert short list with an expert familiar with the Czech repository programme.

8 Feedback related to the EE process

The typical features of the EE process include

- looking at the same target from different perspective
  - applying a defined role in working for the project
  - looking at the face evidence provided by the documents
- producing a transparent view of one's underlying thinking
  - contrasting the evidence with one's own experience
  - explaining and making visible why one is in agreement or why something is not agreeable or is omitted from the material subject to elicitation =>
- providing an opportunity to expand both sides' knowledge and views on the EE target of the process

with the purpose of giving directions for improved and more structured and complete outcome for the future work that has been elicited.

<u>Feedback from the experts on the process and tools:</u>

The assessment was not particularly difficult as such. Some questions were often repetitious or required interpretation and the experts wondered if he had failed to understand the true differences between them or the intended content of the question/s.

In the WP2 elicitation one question could have addressed the sequence of the planning steps; first developing a design and then deriving requirements or vice versa. It was also noted that this was covered when discussing the workflow itself.

Further formatting and structuring of especially the domain expert's form was recommended.

For the next elicitation kick-off meetings, it was suggested to spend some time presenting the Experts' Elicitation form to the Elicitation Experts, to provide the rationale for the questionnaire and the purpose of some questions, and to clarify the formulation of questions as needed in order to prevent misinterpretation by the Elicitation Experts.

It was also agreed that the next elicitation forms would be commented by Mr. Potier for the next elicitation.

Experiences at SKB are that a similar type of consensus meeting is often held after receiving report reviews. Less interactive formal discussions on review comments are used in other organisations. Mainly the editor in charge is left to deal with the experts' comments and to decide what is to be included in the final report.

The facilitator's views on the forms and process

The forms are intended to speed up the process. The use of the form enables a faster tracking of the different perspectives from the experts vs. reviewing direct comments on a track changes or commented report as the forms have matching questions though from a different perspective. This highlights the discussion topics for the consensus meeting quicker.

For the deliverable author hopeful, the process provides more complete change suggestions and requirements without requiring more questioning and interpretations of the several review comments.

The elicitation forms themselves are raw input forms: the less formatting and structure they contain, the easier it makes the extraction of the data for summarizing.

9 Final acknowledgement

The research leading to these results has received funding from the European Union's European Atomic Energy Community's (Euratom) Seventh Framework Programme FP7/2007-2013, under Grant Agreement No. 323273 for the DOPAS project

Appendices

Tools and descriptions:
1. Performance assessment expert's form
2. Domain expert's form
3. Context of the WP - including overall context description v.1
4. Workflow change proposals (Structural description)
5. Steps in Compliance Assessment

PERFORMANCE ASSESSOR'S (/SAFETY ANALYST'S) ELICITATION FORM
(DOPAS EE WP2)

The outcome of the work in DOPAS WP2 is reported in the final report D2.4. This report is currently at the final draft stage. After the elicitation, the D2.4 will further undergo SKB's internal quality assurance prior publication.

Topic under elicitation[1]
Is the D2.4 report complete and consistent regarding the objectives set for the work and is it "fit for use" i.e. representing an acceptable level of quality as a work package deliverable?

The elicitation should also focus on identifying potential uncertainties, ambiguities and controversies

- in the report and especially in the workflow, and
- in proposed use of the results, and
- in the report's conclusion

in respect to the report content and experts' previous experiences.

Name of expert responding

Explain your expertise in regard to the target under elicitation (personal involvement in the input data production (i.e. the requirements for design basis/experiment design basis or as external reviewer), relevant experience in the area in general including previous engagement in (in either performance assessment or safety analysis/safety cases)

Appropriateness and completeness of the methodology and approach used for producing the results of the WP2 in terms of moving from requirements to design basis for a plug or a seal?

1. How comprehensive are the methods and approaches used for the issue under elicitation from the performance or compliance assessment point of view taking into account that the end point of the WP2 is the work flow leading to design basis? What are the main uncertainties related to the methodology and approach used?

Role of the expert input data in the production and translation of the reference design requirements into the experiment requirements and the completeness of the experiment design basis with the objectives of the demonstrating the compliance of the design basis with a) the reference designs and b) with the experiment designs.

[1] describe how you understand this elicitation task for the issue under elicitations, what are your objectives for the elicitation from quality assurance point of view

2. Can the results from WP2 be directly used in performance or safety assessment or are they an intermediate result in the data production chain for coming up with a further experiment stages?

Preliminary assessment of the adequacy of the requirements input data, of other models, methods and tools used for coming up with the plug or seal design basis

3. What is your opinion on the adequacy and suitability of the input requirements data, theoretical models or work methodology used as input in producing the WP2 outcomes? Do you foresee any inadequacies[2] in the way the input data or the work flow from requirements to design basis have been produced? Should the design bases developed as a consequence of design decisions from the previous stages be more developed with a reference to "problem" or "solution" to be addressed?

4. In which ways can the foreseen inadequacies cause uncertainty and reduce the quality of the produced design basis used in full-scale experiments? Please take into account the different objectives of the individual experiments (e.g. some experiments represent only technical feasibility testing).

5. What is your opinion on the adequacy and suitability of the methodology and tools used in the coming up with the design basis? Do you foresee any inadequacies[3] in the way they are planned to be used or have been used?

6. In which ways can the foreseen inadequacies in the design basis production cause uncertainty and reduce the quality of the produced performance data from the experiments?

Definition and the origins of the requirements and the related expert judgments for the performance assessment

7. How are the expert input data and the requirements produced and used in the assessment of the component / plug performance and how are they used in the definition of the initial state of the plug or plug component?

8. If you foresee uncertainty caused by the way the requirements or input data have been produced, how is this kind of uncertainty handled in the test plan and further in performance assessment?

9. Are there difficulties in handling this kind of uncertainty in performance assessment or in the assessment of other compliance with the requirements? If so, why? What are the reasons?

10. What is the possible or predicted influence of this kind of uncertainty on the performance assessment results when using the developed design basis and on the understanding of the initial state[4] of the plug or the plug component foreseen to result from the design based on this design basis?

[2] e.g., ungrounded or undocumented choices, omissions, generalizations etc.
[3] e.g., ungrounded or undocumented choices, omissions, generalizations etc.
[4] the state in which the plug (or its component) is after the last man-made action targeted to the plug and its near-field

Adequacy of the requirements' input data for producing design basis and the appropriateness of the workflow for use including the impact on foreseen outcomes?

11. Do you feel any doubt concerning the adequacy of the produced and used experiment design basis or the produced work flow itself or its outcomes? If so, about what and why, what are the reasons?

12. Does the workflow present a useful tool in planning design basis development and demonstrate consistency with the state of the art?

13. To what extend could the developed workflow be used for other repository components than plugs and seals?

14. Could possible inadequacies in the workflow process influence the desired performance (or the performance assessment results) and the compliance with the desired initial state of the plug/seal (as defined in the safety case)? If so, in which ways?

15. What type of uncertainties do you see remaining related to the requirements selected as input, the design basis and its potential outcomes? How has this been tackle in the reported work?

Rationale and way of thinking underlying your preliminary assessment (previous)

16. What are the assumptions and grounds[5] underlying your assessment?

17. Did you experience difficulties in making your assessment? If so, what kind of difficulties and for why? What were the reasons?

18. Do you feel any doubt concerning the adequacy of your assessment? If so, about what and for what reasons?

Other review comments related to the D2.4 and workflow (e.g. other information to be included to the report concerning terminology, theories, referencing to other work related to plugs and seals)

Feedback on the EE process and the form:

This is a pilot process. What are your proposals for changes or additions concerning the questions and visual appearance of this form, needed for improving the usability of the form as a tool in the formal expert elicitation process of this type of full-scale demonstration project?

[5] e.g., literature, pilot modelling results, sensitivity analysis, use of conservatism, authorities' requirements

DOMAIN EXPERT'S ELICITATION FORM
(DOPAS EE WP2)

The outcome of the work in DOPAS WP2 is reported in the final report D2.4. This report is currently at the final draft stage. After the elicitation, the D2.4 will further undergo SKB's internal quality assurance prior publication.

Elicitation Task/Topic under elicitation (WP2) Is the D2.4 report **complete and consistent regarding the objectives set for the work and is it "fit for use"** i.e. representing an acceptable level of quality as a work package deliverable? The elicitation should also focus on identifying potential uncertainties, ambiguities and controversies • in the report and especially in the workflow, and • in proposed use of the results, and • in the report's conclusion in respect to the report content and experts' previous experiences.

Name of expert replying

Explain your expertise in regard to the target under elicitation (personal involvement in the input data production (i.e. the requirements for design basis/experiment design basis or as external reviewer), relevant experience in the area in general including previous engagement in similar activities:

Assess the role of the expert judgment in the requirements as input[1] data for the production of design basis for the DOPAS experiments and for the reference design (in general) of plugs or seals.
• The requirements as input data are intended for the production of the plug/seal design basis for the repository reference design.
    a) Who produces these requirements?
    b) What view do you have on the different processes how these requirements have been produced and described in the WP2?
    c) Who is the customer using the input data and/or the design basis and the potential outputs if not or in addition to the domain expert?
 	
• What influence does it have that the DOPAS requirements are applied to the experiment design basis instead of reference design basis?
• What type of differences and uncertainties can be identified in relation to the experiment

[1] expert input data refers to input that requires making a selection for data that is not clearly defined (e.g. from a range of values) or requirements that are more the result of expert judgment or conflicting scientific research or technical tests

design basis and reference design basis in general?

Rationale underlying the definition and production of the requirements (see above) and definition and production of the design basis work flow from the requirements. Make a note, if the D2.4 does not address any of the questions below.

- How have the requirements for the design basis been produced (for the workflow)

  a) On which basis are the input components for each of presented three different design bases in the work flow chosen?

  b) What is the reasoning underlying the steps moving from the input data (requirements specific to the reference design basis) to the design basis of the experiments?

  c) How are the requirements selected for the experiments' design basis from a set of functions required, requirements or the sub-system requirements (e.g. backfill), and on which grounds?

  d) What level of completeness does the process (workflow) moving from requirements to the design basis represent? And what parts of the workflow can be universally applied to all types of plugs'/seals' design basis development? What parts cannot be applied? And on which grounds?

  e) On which kind of theories or models or abstractions is the workflow based on? Should the underlying theories or models etc. be more explicit in D2.4?

  f) What are the assumptions and grounds underlying the interpretations made in the work flow?

  g) What kinds of simplifications (e.g. linearization, omissions) have been made in the formulation of the workflow and on which grounds?

  h) Is the level of detail in this work flow appropriate? On what grounds?

  i) What type of other constraining factors have been taken into account and which approaches or methods have been used to tackle with them?

Adequacy of the requirements' input data for producing design basis and the appropriateness of the workflow for use including the impact on foreseen outcomes?

- Do you feel any doubt concerning the adequacy of the produced and used experiment design basis or the produced work flow itself or its outcomes? If so, about what and why, what are the reasons?

- Does the workflow present a useful tool in planning design basis development and demonstrate consistency with the state of the art?

- To what extend could the developed workflow be used for other repository components than plugs and seals?

- Could possible inadequacies in the workflow process influence the desired performance (or the performance assessment results) and the compliance with the desired initial state of the plug/seal (as defined in the safety case)? If so, in which ways?

- What type of uncertainties do you see remaining related to the requirements selected as input, the design basis and its potential outcomes? How has this been tackle in the reported work?

Challenges in producing the report and the workflow

- Has there been difficulties / what are the difficulties possibly encountered in producing workflow and what are / might be the reasons for the difficulties?

- How have these problems been solved / how could this kind of problems be solved?

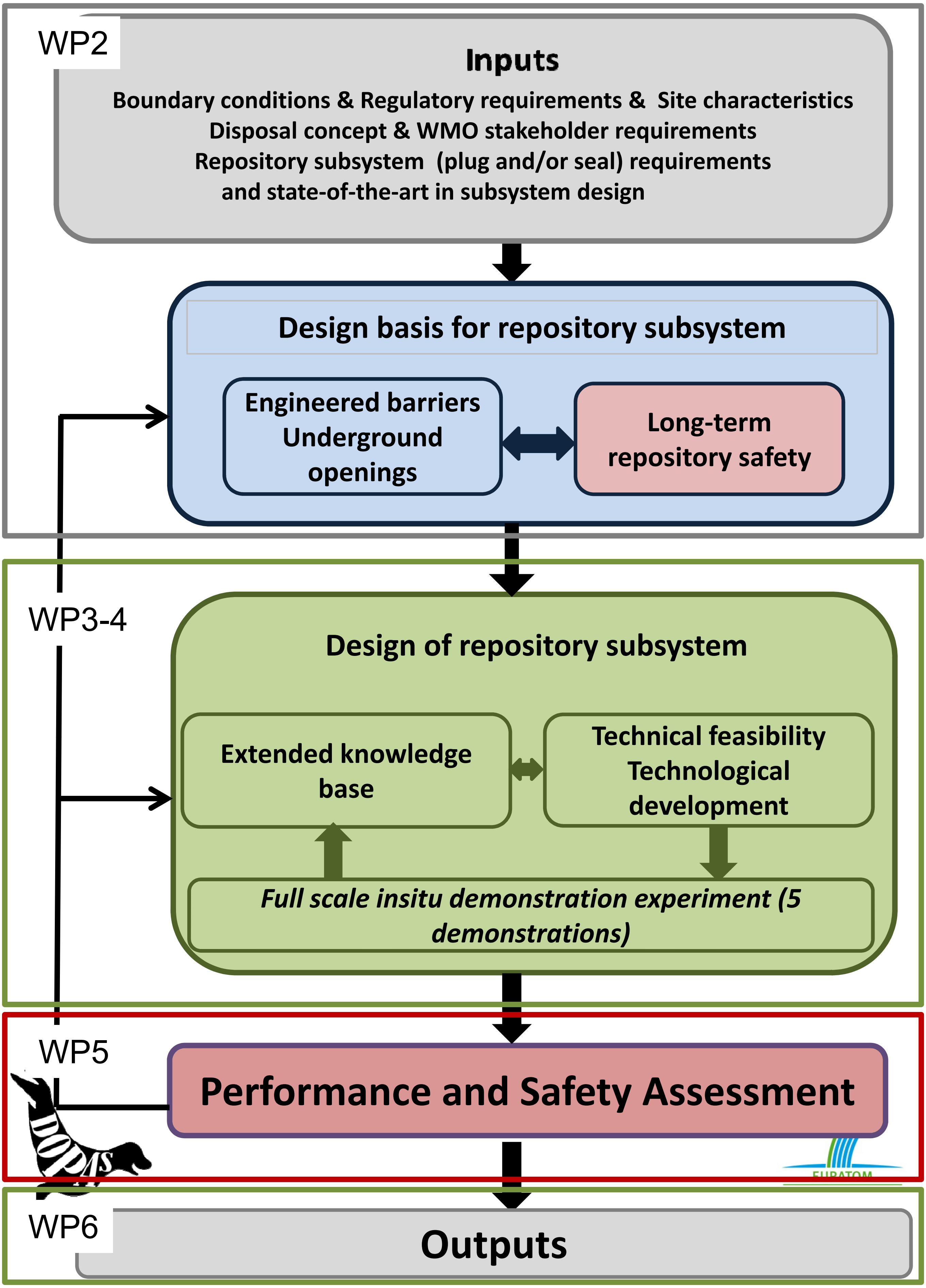
Other review comments related to the D2.4 and workflow (e.g. other information to be included to the report concerning terminology, theories, referencing to other work related to plugs and seals)

Feedback on the EE process and the form:

This is a pilot process. What are your proposals for changes or additions concerning the questions and visual appearance of this form, needed for improving the usability of the form as a tool in the formal expert elicitation process of this type of full-scale demonstration project?

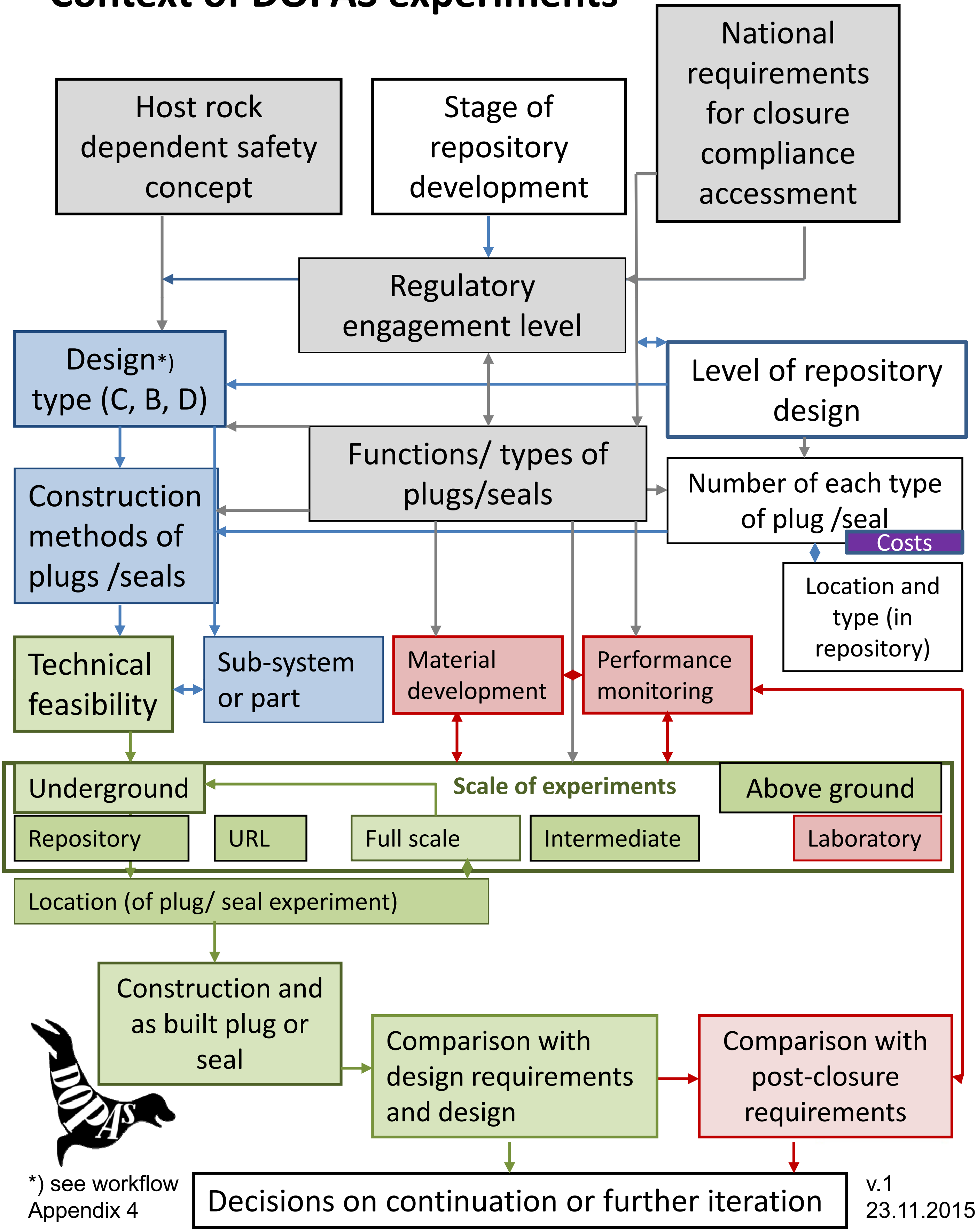
Context of DOPAS and especially WP2

23.11.2015 Marjatta Palmu, Posiva Oy


WP2
Inputs
Boundary conditions & Regulatory requirements & Site characteristics
Disposal concept & WMO stakeholder requirements
Repository subsystem (plug and/or seal) requirements
and state-of-the-art in subsystem design
Design basis for repository subsystem
Engineered barriers
Underground
openings
Long-term
repository safety
WP3-4
Design of repository subsystem
Extended knowledge
base
Technical feasibility
Technological
development
Full scale insitu demonstration experiment (5
demonstrations)
WP5
Performance and Safety Assessment
WP6
Outputs

Appendix 3

Context of DOPAS experiments



*) see workflow Appendix 4

v.1
23.11.2015

DOPAS Work Package Objectives

WP2

- **To develop design basis for different plugs and seals**
  - describing explicitly the process and approach of coming to the design basis
  - including transparency to the different national requirements
  - and their comparison
  - to explain the differences in the different experiments' design basis
  - envisaged in current consortium member's repository systems in salt, clay and crystalline rock
- **To describe reference designs based on this design basis**
  - and elaborate the strategies for demonstrating the conformity of the reference design to the design basis
- **To act as input to WP3**
  - related to (especially) the (new) experiments FSS, EPSP, POPLU. DOMPLU provides information, as the experiment was already on-going, ELSA experiment will be implemented later
- **To integrate the WP2 results for wider use**
  - acting as input for WP6 final report (D6.4)

DOPAS Work Package 3 Objectives

- **To develop further the a comprehensive design basis for the in-situ demonstration experiments FSS, EPSP and POPLU**
  - *develop the engineering designs*
- ***To develop and understand the materials (behaviour) needed for the implementation of the engineering designs (from construction and post-closure point of view)***
  - *low pH concrete and shotcrete recipes/formulas*
  - *bentonite and clay materials in the in-situ test*
- ***To develop and prepare the test plans for the large full-scale and laboratory tests (incl. material behaviour, monitoring, instrumentation)***
  - *testing the developed materials (approval/selection criteria)*
- **To carry out large full-scale tests in URL, mock-up drifts or ONKALO**
  - *applying developed plug location selection criteria*
  - *implementing the engineering designs*
  - proving that the stated reference design, which is used as a system justification in the license applications for repositories
- **To monitor full-scale demonstrator (DOMPLU) in Äspö HRL**
- **To address seal plug materials with respect to long-term behaviour**
  - providing experimental data for numerical simulations to demonstrate material suitability
  - address hydro-mechanical material behaviour
  - address hydro-chemical material behaviour

DOPAS Work Package Objectives

WP3 cont.

- ***To provide a base line input for WP4 for the assessment and evaluation***
- ***To intergrate the WP3 results for wider use***

WP4

- **To assess and evaluate the construction methodologies and techniques for plugs and seals (as applied in WP3 experiments)**
- **To assess and evaluate**
  - the results of the subsequent monitoring phase
  - the results of the subsequent dismantling activities (FSS)
  - the results against predicted performance
- **To summarize the achievements made in design and industrial scale implementation**
  - in light of the specified required performance of plugs and seals as defined in WP2
- **To provide a basis and direct input for performance assessment related activities in WP5**
- ***To integrate the WP4 results for wider use***

DOPAS Work Package 5 Objectives

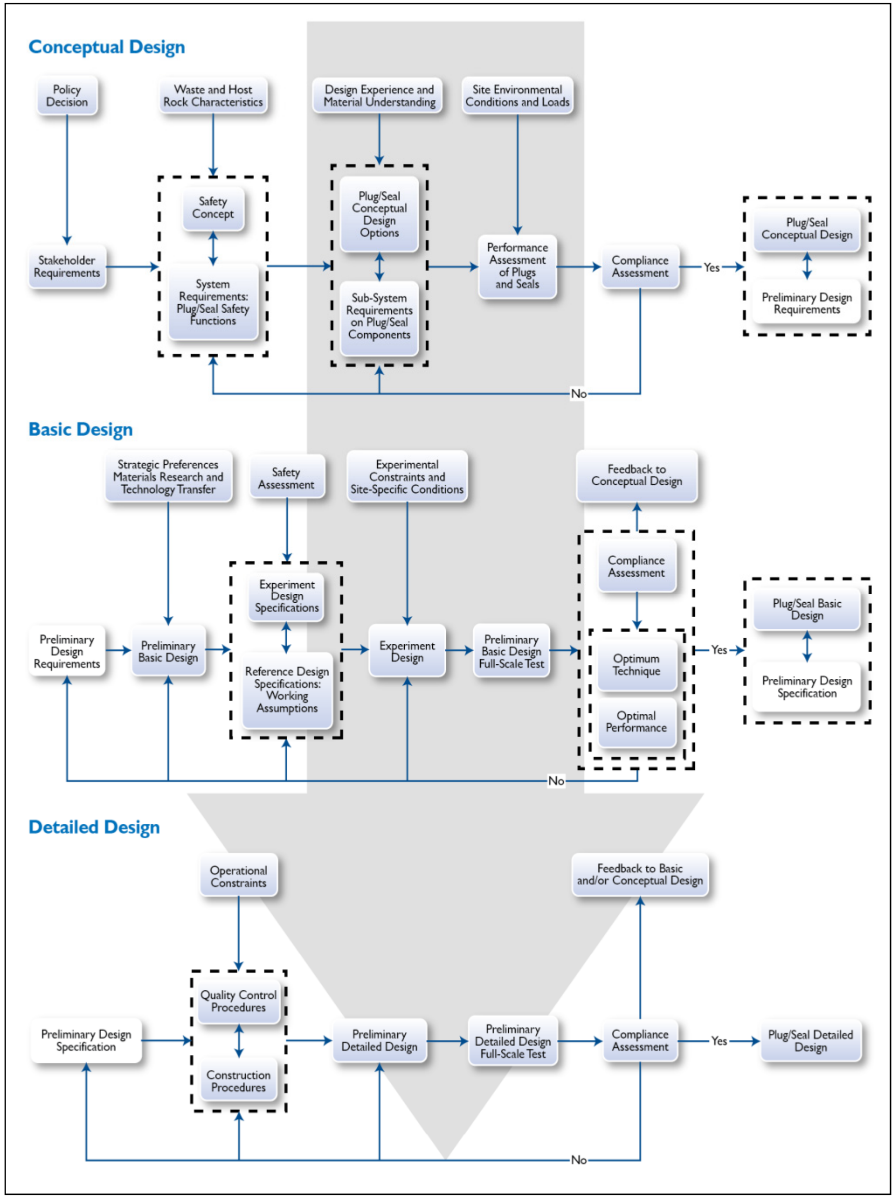
- **To understand the implications of the plugs and seal performance on the overall safety**
  - for the whole reference period of a final waste repository of one million years (ELSA, pot. FSS).
- **To develop justification of model simplifications for long-term safety assessment simulations**
- **To improve the state-of-the-art in process modelling and its abstraction in integrated performance assessment**
  - *identification of the relevant tools for predicting the behaviour of a complete sealing system*
  - process modelling of the experiments performed in WP3 to gain process understanding
  - identify the main processes that are relevant and thus to be considered for predicting the short and long-term behaviour of the plug and sealing systems
  - identify remaining uncertainties and their influence on performance assessment
  - development and justification of conceptual models of plugs and seals for the different disposal concepts and geological environments
  - simulation of processes and their evolution within individual sealing components (ELSA)
  - *describe Andra's PA methodology for sealing systems in clay*
  - *to summarise the lessons learned from the different PA modelling*
  - further develop and apply the PA methodology and (conservative) PA models for analysing the system behaviour
- **Be based on, and integrate the results of from WP2 to WP4**
- **To provide an integrated report outlining the role of plug and seals in the safe performance of a repository**

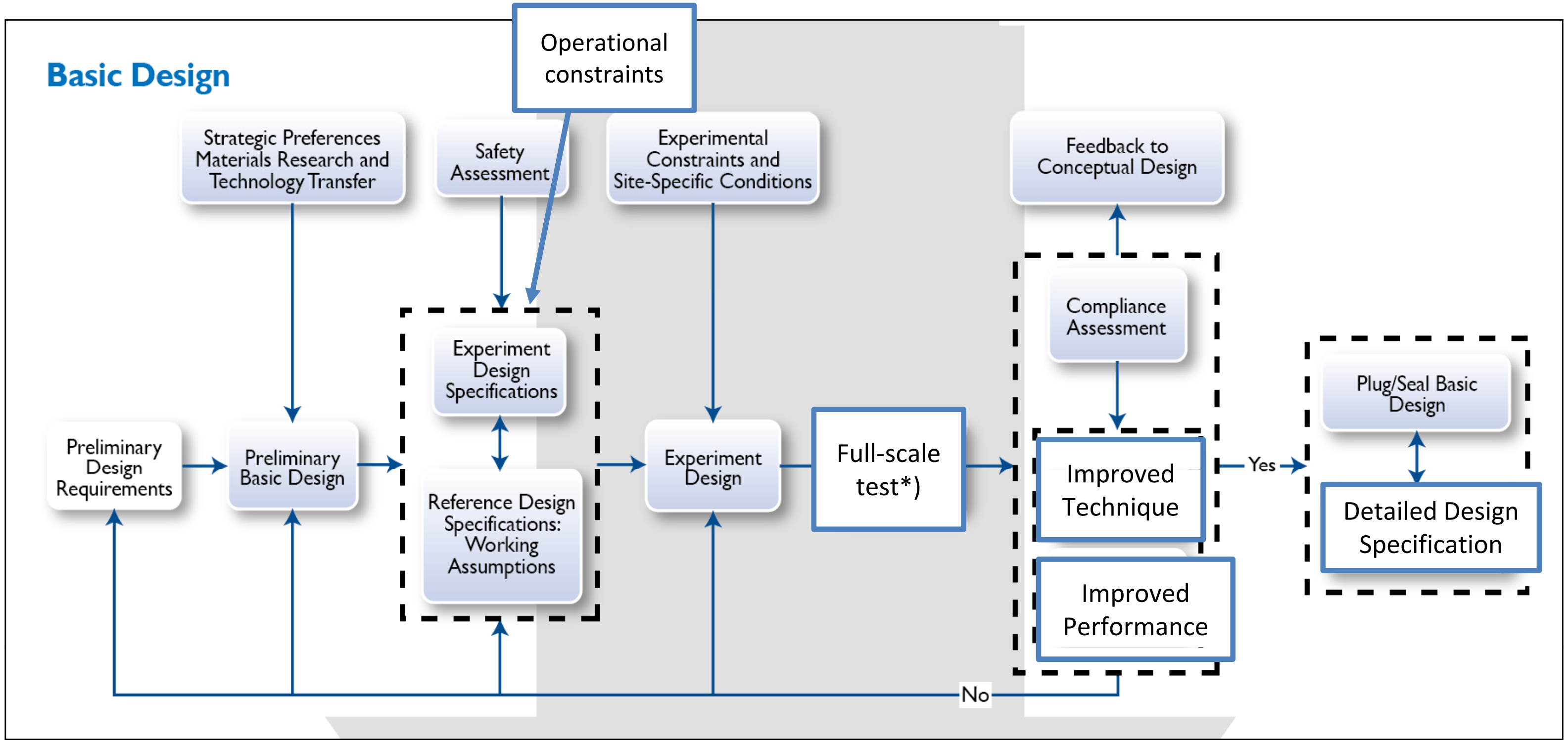
Changes to DOPAS WP2 workflow

WP2 EE consensus meeting outcome

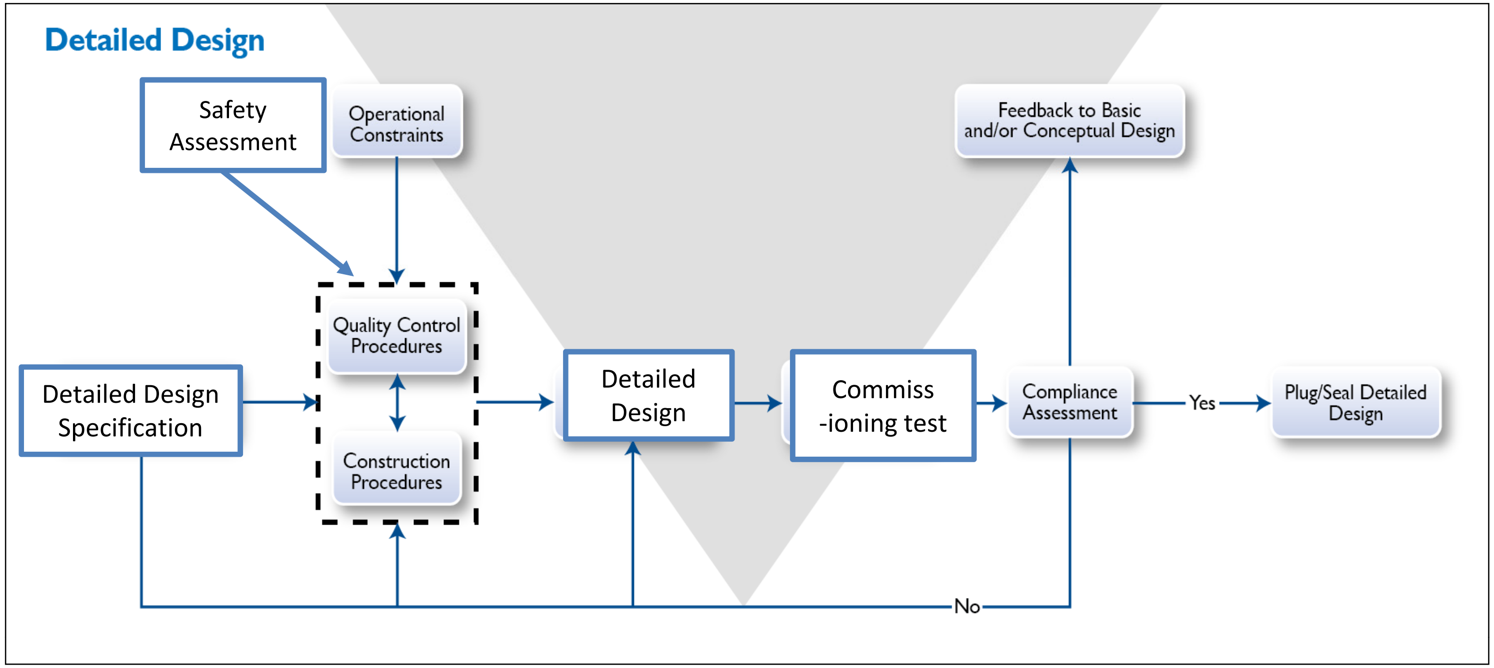
Appendix 4 2(4)

D2.4 draft version of work flow





Modifications to Basic Design and to its description.



Modifications to Detailed Design and to its description.

Suggested compliance content steps to be discussed in the report - general

- In general, **the compliance checking consists of a chain of validation, verification and qualification activities.** The **word “validation”** is used here knowing that in a strict sense nothing can be validated, but understanding **it as a series of theoretical modelling and experimentation tasks through which reasonable evidence is acquired to show that our understanding/description of a feature/process is correct in the scientific sense.**

Suggested compliance assessment content steps to be discussed in the report (Step 1)

- **First** we need **to validate our understanding of the safety functions: we need to show that the assumed technical design requirements produce the safety performance needed** (i.e. a “satisfactory/sufficient” level of the safety functions is reached).
- in the end there **has to be a criterion** for what is “sufficient” and normally this can only be formulated through safety (performance) assessment

Suggested compliance assessment content steps to be discussed in the report (Step 2)

- Secondly, **we need to verify that the system produced and installed complies with the technical design requirements**.
- Since the **verification method** may not be trivial in practice, it **has to be formulated at the same time as the requirement is formulated.** Otherwise, the requirement is may not be practicable/useful.

Suggested compliance assessment content steps to be discussed in the report (Step 3)

- **Thirdly, there has to be a strategy on how to show that the system to be built and used in the repository fulfils the requirements** (that have been shown to be met in the tests/demonstrations).
- In the demonstration experiments the fulfilment may be shown by various monitoring/instrumentation systems that, however, may not be available for use in the real repository.
- **Therefore, there has to be a a further strategy on how to show that the real system corresponds to the system demonstrated**.

- In the case of the workflow, there are actually thus two iteration cycles (in the updated version of the flow)