



SMRI Request for Proposal (RFP2023-04) “Research on Mechanical Integrity Tests for H₂ Storage Caverns”

1. Background

Hydrogen is regarded worldwide as a crucial energy carrier in a future energy system with a high share of variable renewable energy sources, especially in order to balance fluctuations in electricity generation, as an alternative for fossil resources in the industry and for mobility applications etc. These fluctuations can be compensated for by flexibility measures such as large-scale energy storage, namely in salt caverns.

The interest of SMRI members in underground storage of hydrogen and related research increased significantly in the last years. SMRI initiated a research report “Hydrogen Storage in Salt Caverns - Current Status and Potential Future Research Topics” (RR2023-1). The research report identified several topics for potential research with regard to hydrogen storage, where one of the key areas of research was on Mechanical Integrity Tests (MIT).

The MIT of the last cemented casing shoe is the basis for the evaluation of the tightness of a well with regard to the storage product. A successful MIT is a recommended practice, and a legal requirement for a start or continuation of a storage operation in many countries.

Since the decisive invention of the nitrogen/brine Mechanical Integrity Tests (MIT) in the 1970’s, salt caverns have the advantage that their tightness can be tested quite accurately. In its most common field implementation and interpretation practice today, it implies pressurizing the brine cavern, injecting nitrogen down to just below the last cemented casing shoe and running logs at the start, during and at the end of the test. A mass balance of the nitrogen is then calculated based on these measurements.

Besides the nitrogen/brine interface test, pressure observation tests are common practice for example in the US. During this test, the cavern remains in a gas-filled state and the inventory of the cavern is balanced over a predefined period of time by using sonar data of the cavern, constantly measuring surface pressure and downhole temperatures.

The test procedure itself and the acceptance criteria may vary upon companies and/or countries, but are generally established. Successive projects in a given country/company use the same technique and acceptance criteria, in compliance with the relevant regulatory authority and company’s standards.

The procedures to execute an MIT for a hydrogen storage cavern do not have similar established guidelines, even if they are expected to be similar to the current practice for natural gas caverns. In general, the MIT for natural gas caverns is conducted with an inert gas (nitrogen) to reduce negative impacts in case of a leakage. Given the difference in properties between nitrogen and hydrogen there remains uncertainty on the recommended approach for hydrogen storage caverns. Within hydrogen pilot projects, depending on the location of the project, slightly different approaches regarding the test medium and acceptance criteria have been used. In several cases, a combined MIT consisting of a test with nitrogen followed by a test with hydrogen has been performed.

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The research interest for this RFP is for MITs on cavern wells intended for hydrogen storage where guidelines are not established, and key questions rise for each project on relevant MIT parameters and processes as:

- Test procedure
- Acceptance criteria
- Comparability between nitrogen and hydrogen MITs

Therefore, the SMRI is requesting proposals that will enhance industry understanding and recommended practices for MITs on cavern wells intended for hydrogen storage.

2. Scope of Work

The overall objective of the study is to provide a greater understanding of how the MIT test should be conducted for testing the tightness of hydrogen storage salt caverns, and to ultimately propose a practice that should be both recognized by competent regulatory authorities and applicable on the field. This is the case, currently, for MIT test conducted for storage of natural gas, and other products, and this experience should be considered as one of the basis for the proposition of new tests.

To achieve this objective, SMRI expects the scope of work should strive to develop the following technical components related to MIT:

- Review of the state of the art practice of MIT among companies and countries, and of their acceptance criteria
- Review of the reasons why the (standard) MIT for natural gas caverns could have to be adapted, if any. A hypothetical leak scenario could be used to support the analysis.
- Analysis of the lessons learnt from field tests of successive N₂-brine interface MIT and H₂-brine interface MIT
- Recommended practice for hydrogen cavern MIT technique and acceptance criteria

The general scope of work is expected to generally align with the following tasks:

- Task 1: Review of state-of-the-art MIT techniques/procedures
- Task 2: Review of state-of-the-art MIT acceptance criteria/evaluation
- Task 3: Potential leakage mechanisms: Theoretical analysis, comparison between N₂/H₂ and impact on test performance
- Task 4: Conversion of established test criteria from nitrogen to hydrogen based on fluid properties and a hypothetical leak scenario
- Task 5: Test comparability and transferability of N₂/H₂ tests (results)
- Task 6: MIT test- Recommended Practice for hydrogen caverns
- Task 7: Results/conclusions, and final report

Within the tasks, at least the following topics should be dealt with:

- Comparison of different test methods including alternative test approaches or technologies (SoMIT, conventional interface test, pressure observation test, in-situ balance, in-situ compensation, Distributed Temperature Sensing (DTS) etc.),
- Impact of test medium (N₂/H₂) for performance of different methods

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- Advantages and disadvantages associated with selected test medium (N₂/H₂) including hazard analysis (in particular, additional safety measures / practical considerations for H₂ tests [e.g. venting, test environment / ATEX areas], difference in hazard associated with equivalent leaks of natural gas vs H₂, etc.).
- Potential evidence of comparability between nitrogen and hydrogen MITs from theoretical leakage scenario
- Conversion of established criteria for nitrogen to hydrogen (50 kg/d, 50 l/d in situ, 1,000 bbl/year) and evaluation if existing criteria for nitrogen are on side of caution for hydrogen
- Review of performed MITs with H₂ and H₂/N₂
- Potential evidence of comparability between nitrogen and hydrogen MITs from field tests
- Statement, if an MIT with nitrogen can also be utilized for hydrogen storage caverns and under which conditions
- Development of a guideline/Recommended Practice for the MIT of hydrogen caverns

At the completion of the project, the project team will develop a comprehensive report that discusses the background, approach, results, and conclusions of the research on H₂ MIT. The project duration is expected to be about 1 – 1.5 years. Longer duration projects may be considered, depending on the scope of work and the value of the research results.

3. Proposal Instructions

Responses to this RFP should be reasonably brief (less than 10 pages), describe the proposed effort and offer a succinct discussion of the technical approach.

This RFP anticipates that a fixed-sum contract will be used, and a project schedule and cost plan will be submitted.

The qualifications and experience of the proposed researcher(s) in the technical field described within the Scope of Work are likely the most significant proposal-evaluation criteria.

Teaming and subcontracting to bolster qualifications are encouraged, but a strong lead researcher (project manager) must be identified in the proposal and will be named in the research contract as key personnel. The level of commitment of the lead researcher to the research effort must be itemized in the proposal.

Proposals should be submitted in electronic form via email to Tim Bauer, SMRI Research Coordinator, (tbauer@solutionmining.org), by 31 January 2024. Please email a statement of your interest or intentions to respond to this RFP before 29 December 2023, so you can receive any updates or modifications to this RFP. Questions relating to this RFP should be directed in writing (via email) to the Research Coordinator. Answers to questions that apply to all potential proposers will be forwarded to all identified proposers.

4. Contract Award and Contract Specifics

Proposals will be evaluated solely based on information contained in the proposal. The proposer selected for negotiation of a contract will be the one that best meets SMRI’s needs and is economically sound. SMRI has the right to select or reject any or all proposals.

The research contract will be negotiated between the selected contractor and SMRI. The contractor will be solely responsible for coordination of any subcontracted work and for all payments to any sub-contractor(s).

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1. SMRI contract for this Work will be fixed sum for the defined statement of work. The proposed fixed-sum payment must be clearly defined in the proposal. Payment will be made upon acceptance by the Research Committee of the final research report. No other progress or interim payments would normally be made.
2. SMRI's Project Sponsor will be named after contractor selection. The Project Sponsor will be the contact for any project-related communications.
3. The research project is to be completed within the time frame agreed on for the project.
4. The contractor shall present progress reports at each SMRI Research Committee meeting during the project and an oral research report at the end of the project. The costs for these presentations, if any, are to be included in the fixed-sum cost of the project. The Project Sponsor or Research Coordinator may present one of the two required progress reports per year to the Research Committee using materials (text and PowerPoint) prepared by the project team.
5. A final research report is required in the form of a standard scientific or technical report. The research report will provide standard information such as background and purpose for the research, theoretical basis and methods, data collected, analysis, references, and research conclusions. Depending on the amount of information used, either lists of information in appendices or separate electronic files of the information, or both, might be required. All report submittals (drafts-for-review and final) will be as electronic files, both MS-WORD (*.doc) and PDF (*.pdf). SMRI will supply formats/contents for its standardized report covers, title pages, and forward/disclaimer for its research reports. The research report will be reviewed by the Project Sponsor, the Research Coordinator, and the Research Committee. Before final report acceptance, the researchers must satisfactorily address all review comments.
6. The enclosed Standard Terms and Conditions for SMRI Research Contracts, dated 3 January 2023, shall apply. Additional limitations or modifications are possible before contract negotiation.
7. SMRI retains ownership and copyright of the work products resulting from this research. Limitations on publishing and release of information are listed in the Terms and Conditions.

Tim Bauer
Research Coordinator

Enclosures:
Standard Terms and Conditions for SMRI Research Contracts, dated 3 January 2023

Cc: John Nadeau, Executive Director
Andreas Reitze, 2023 SMRI President
Daniel Noack, 2023 SMRI Research Chairman
Members of the SMRI Research Committee

SMRI RFP2023-04_H2MIT.pdf

**ATTACHMENT
STANDARD TERMS AND CONDITIONS**



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Standard Terms and Conditions for SMRI Research Contracts **3 January 2023**

1. The contractor shall perform the scope of work and submit the contract deliverables specified in the Request for Proposals (RFP) and the contractor's proposal. If differences exist between the RFP and the contractor's proposal, the RFP shall govern, unless otherwise specified in the contract. All written or electronic communication regarding the research is to be in English.
2. The SMRI Project Sponsor(s) will provide technical oversight to include review of project plans, will assist in resolution of any technical issues which might impact the project or research results, will approve contractor progress reports, and will review all invoices for accuracy.
3. During the project, progress reports may be given by the contractor during Research Committee meetings generally on the Saturday before SMRI conferences begin, or the brief progress reports must be given to the Project Sponsor prior to the Research Committee meetings for informing the Committee.
4. After the first draft report is approved by SMRI's Research Committee, SMRI will provide a report number, a cover page, a disclaimer regarding the report contents, and a copyright notice which will become part of the final report. A filename and format will then be designated for the final report. All draft and final versions of the research report must include the date at the end of the filename
5. The final report shall be provided in electronic format in Adobe Acrobat word searchable (.pdf) format. The electronic report may consist of text, figures, tables, maps, data files, etc. Reports in electronic format may contain color, (such that colors will print visibly in black and white). Files too large for email attachment may be sent to SMRI via an FTP site.
6. The final results of the research shall be presented in a 30-minute oral report at an SMRI meeting. The report may, at the discretion of SMRI, be at a members-only meeting, or as part of a technical conference. Any and all costs associated with the presentation are part of the contract and included in the contractor's proposal.
7. Upon SMRI acceptance of the final report, the Contractor shall send an invoice electronically to the SMRI Executive Director, Assistant Executive Director, Research Coordinator, Project Sponsor, and copy to accounting@solutionmining.org for approval and payment.
8. SMRI owns the copyright and has the sole right to distribute the report and research products in all versions and formats, including the right to charge for it. The Contractor may distribute the report without charge within the Contractor's organization.
9. SMRI has the right to cancel the contract for any reason and at any time. Should SMRI elect to do so, it shall reimburse the contractor for all costs incurred through the cancellation, unless the cancellation is due to inadequate or late performance.
10. SMRI will not pay any costs or reimburse any expenses not specifically included in the contract. Any changes to the contract must be approved in writing by SMRI and the researcher prior to such additional work or expense. Full costs of the project will be paid by SMRI upon acceptance of the final report by the Research Committee, unless partial payments are specified in the proposal and contract.