Request for Proposal RFP_2019_0221: Technology to Keep Hydrogen Concentration below 4% in Fuel Debris Canisters

RFP Title
Technology to Keep Hydrogen Concentration below 4% in Fuel Debris Canisters

Due Date
12/20/2019

Opportunity

Timeline

Financials

RFP Description
NineSigma, representing Tokyo Electric Power Company Holdings, Inc. (TEPCO, https://www7.tepco.co.jp/index-e.html), seeks technology to keep hydrogen concentration in fuel debris canisters below 4% (hydrogen LEL* is 4%vol.) Specifically, technologies such as hydrogen gas permeable membranes/membrane modules that do not leak radioactive dust and/or catalysts metals that can adsorb/absorb/decompose hydrogen gas for a long time are expected.

*the lower explosive limit (LEL): the minimum concentration of a particular combustible gas or vapor necessary to support its combustion in air

Background

Key Success Criteria
Technological Requirements
- Capable of keeping hydrogen concentration in fuel debris canisters below 4%vol. under low temperature conditions (room temperature to 150°C)
- No radioactive dust should be released from inside the container (e.g. Cs137 < 1E-7Bq/cm³)
- Size: Approx. 5 cm x 5 cm as a module (regardless of thickness)
- Desired storage period: 50 years (at indoor environment)
- Usable under high-dose radiation is welcomed

Backgrounds
- Current fuel debris canister design, material, storage conditions of fuel debris, etc. are as described below, although these are subject to change according to further investigations
  - Fuel debris canister
  - Material: SUS304 or SUS316L
  - Size: inside diameter: 220 mm; inside height: 1500 mm
  - Structure: See figure below
  - permeable membrane module are assumed to embed to canister’s lid
- Fuel debris
- Composition: UO2 (including fission products [FP]), zirconia alloy, stainless steel, low-alloy steel, Ni-based alloy, concrete, B4C, seawater, etc.
- Particle sizes: 1-4 mm
- Storage condition: pallet-shaped dry solid form** supposedly in an inactive gas atmosphere.

** dry solid form: mass loss within ±0.1% under vacuum heat treatment
- Environments inside fuel debris canisters
- High-dose radiations; α ray, β ray, γ ray, etc.
- Generation of corrosive substances, radioactive gas/dust under the influence of high-dose radiations
- - e.g. chlorides, sulfides, Cs137, etc.
- Internal temperature: Room temperature to 150°C
- Gas fluidity: 2.0 mm/s (at 1000 W/m3)
- Potentially adding of neutron adsorbent, iodine, etc.
- Keeping dry condition
- Storage environments for fuel debris canisters
- Planning to be stored in a normal warehouse environment.
Possible approaches might include, but not limited to:

- Hydrogen separation membrane and membrane module
- Hydrogen adsorption catalyst and metal
- A novel module that can adsorb/decompose hydrogen then adsorb generated water, etc.

**Approaches not of Interest**

The following technologies are not of interest:

- Off-gas processing technology

**Preferred Collaboration Types**

- Contract Research
- Joint Development
- Research Collaboration
- To Be Negotiated

**Background**

As part of decommissioning of Fukushima Daiichi Nuclear Power Plant (1F), TEPCO investigates how to retrieve and store fuel debris then how to transfer and store fuel debris canisters. According to the decommissioning of Three Mile Island Station 2 in the United States, following cases are reported that high-energy α rays, included in nuclear waste or fuel debris, cause hydrogen gas generation by decomposition of water during transportation and storage of fuel debris canisters. Hence, establishing a reliable method to maintain the hydrogen gas concentration below the lower explosive limit is essential to complete decommissioning 1F safely.

In association with hydrogen energy technologies, hydrogen adsorption and hydrogen permeable membrane are well investigated all over the world. Therefore, the client solicits help from all over the world to help solve this issue.

**Anticipated Project Process**

After the submission due date, the client will review all submitted proposals. NineSigma will send the review results to each proposer 6-8 weeks after the due date. The client possibly asks clarifying questions before selecting the most suitable candidates for collaboration. The client will select best candidates through evaluations. During the selection process, the client may execute NDA with selected respondents, seek further information disclosure, and discuss specific development targets or potential opportunities. The client will execute necessary agreements with the selected respondents and move to the advanced development phase. Specifics of any collaboration will be determined through consultation with the concerned parties.

**Notes on Response**

Proposal shall have clear points and should not include confidential information. Supplemental files may be submitted in addition to the proposal.

**Response evaluation**

The client will evaluate all responses with the following criteria.

- Overall scientific and technical merit
- Approach to proof of concept or performance
- Economic potential of concept
- Realism of the proposed plan (action items, timeline, roles, deliverables, cost estimation)
- Potential for proprietary position
- Respondents’ capability and related experiences

**Award Amount**

**Attachments**

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