Secondary assessment of proposals from Period 1 and primary assessment of proposals from Period 2 on technology for separating tritium from ALPS treated water, etc.

＜Reference Material＞
March 10, 2022
TEPCO Holdings
Fukushima Daiichi D&D Engineering Company

- Taking thorough action based upon the government's basic policy on the handling of ALPS treated water announced in April of this year, TEPCO has decided to continually keep a close eyes on new technological developments in tritium separation technology. The NineSigma Group (hereinafter referred to as, "NineSigma") has been selected as our third-party partner to ensure the transparency of investigations of these technological trends, and on May 27,2021, NineSigma began accepting proposals on technology for separating tritium from ALPS treated water from parties both within and outside of Japan.
- For Period 1 of the public appeal (May 27~September 30), 11 proposals (From within Japan: 4; From overseas:7) passed NineSigma's primary assessment, out of a total of 65 proposals※ (From within Japan:42; From overseas: 23).
- None of the proposals that passed NineSigma's primary assessment are technologies that are at the practical application stage as of this moment, however it has been deemed that they have the potential to fulfill all requirements needed to practically separate tritium from ALPS treated water, etc. in the future.

＜Already announced by December 16,2021＞

※ Includes some proposals not related to technology

- A secondary assessment, which included assessing the degree of certainty of NineSigma's primary assessment, was implemented for the 11 proposals that passed the period 1 proposal primary assessment upon using the information that was submitted with each proposal to review each proponent and also verify carefully the principles of the proposal by examining dissertations referenced or quoted within the proposals.
  - ✓ Number of proposals that passed the secondary assessment: 11（From within Japan: 4; From overseas:7）
    - ➢ Proposals that did not pass TEPCO's secondary assessment were not detailed and quantitative enough to determine whether or not they would be able to fulfill all technical requirements in the future (Refer to Page 6).
    - ➢ As with the primary assessment, the 11 proposals that passed the secondary assessment are not at the practical application stage where they can be immediately used for ALPS treated water, etc.

（Note）All of the proposed technologies are for separating water with high concentrations of tritium from water with low concentrations of tritium, and even if the technologies can be practically applied, water that contains tritium will have to be discharged in accordance with regulatory standards. TEPCO will continue to take action in accordance with the government's basic policy on the handling of ALPS treated water while also accepting and assessing technical proposals.

Secondary assessment of proposals from Period 1 and primary assessment of proposals from Period 2 on technology for separating tritium from ALPS treated water, etc. (cont.)

- Following the secondary assessment, we will ask participating proponents to conduct Feasibility Study (FS) (improve the accuracy and reliability of the technology and empirical data and examine feasibility based on more detailed conditions) in order to clarify issues that need to be addressed in order to reach the stage of practical application.

- In addition to asking proponents to acquire data required to improve the accuracy and reliability of the technology and empirical data as necessary, each proponent will work with TEPCO to examine details such as, the accuracy and reliability of the technology and equipment, compliance with Japanese law, such as the Nuclear Reactor Regulation Act, issues hindering practical application and approaches to solving these issues as well as the characteristics and amount of waste that would be additionally generated, the potential to comply with site restrictions. Based on these results, development targets shall be established upon identifying issues hindering practical application and technologies that require a breakthrough.

- Upon doing this the proposals shall be compared to identify those proposals that are closer to achieving practical application and targets for solving problems shall be established. When doing this, additional research and development shall be implemented as necessary along with small-scale demonstration test off-site. We shall also deliberate the implementation of demonstrations on-site at the Fukushima Daiichi Nuclear Power Station (Refer to page 4).

- Furthermore, we have received word from NineSigma that the primary assessment results of proposals received during period 2 of the public appeal (October 1~December 31, 2021) have been conveyed to the submitting parties.

  - ✓ Number of proposals submitted: 22※（From within Japan: 13; From overseas: 9）※ Includes some proposals not related to technology

  - ✓ Number of proposals that passed the primary assessment: 2（From within Japan: 0; From overseas: 2）

    - ➢ Proposals that did not pass NineSigma's primary assessment were not detailed and quantitative enough to determine whether or not they would be able to fulfill all technical requirements in the future (Refer to Page 6).

- As with the proposals from Period 1, Period 2 proposals that passed the primary assessment are not at the practical application stage where they can be immediately put to use, however it has been deemed that they have the potential to fulfill all requirements needed to practically separate tritium from ALPS treated water, etc. in the future. TEPCO shall also conduct a secondary assessment of these proposals.

1． The process following the secondary assessment

The process following the secondary assessment

- Feasibility Study (FS) (Examine feasibility based on more detailed conditions)
  - Acquire additional data required to improve the accuracy and reliability of the technology and empirical data, and;
  - Set design conditions for use at Fukushima Daiichi,
  - Identify issues hindering practical application and technologies that require a breakthrough (miniaturization, stability, etc.) in light of the concept design of actual plants and demonstration proposals,
  - Compare proposals to identify those proposals that are closer to achieving practical application

  ※ When conducting the assessment, scholars and experts with expert knowledge of each field shall be included in discussions. The details and background of discussions will be continuously disclosed to the public in order to ensure a third-party perspective and transparency (this shall be done for all processes hereafter)
- Small-scale demonstration test off-site at the Fukushima Daiichi Nuclear Power Station
  - The objective is to solve problems identified during FS and achieve targets

  ※ To be implemented ahead of additional research and development is necessary
- On-site demonstration test at the Fukushima Daiichi Nuclear Power Station
  - The objective is to solve issues hindering practical location that are identified during small-scale demonstration test

	NineSigma	TEPCO	TEPCO, third-parties		
Process	Primary assessment	Secondary assessment	Feasibility Study ※ Proponents may be asked to participate	Small-scale demonstration test ※To be implemented ahead of additional research and development is necessary	Demonstration test
			• Assess proposals that are closer to practical application • Compare each feasibility study to assess proposals that are closer to practical application		
Assessment method	• Are the proposals detailed or quantitative enough to determine whether or not they would be able to fulfill all technical requirements (Refer to page 6) in the future? • Carefully assess during the secondary assessment by reviewing each proponent and also examining/confirming the principles of the proposal by examining dissertations referenced or quoted within the proposals.	• Set design conditions for use at Fukushima Daiichi, deliberate practical application in light of the concept design for actual plants and demonstration proposals.	TBD Off-site demonstration test at Fukushima Daiichi	TBD On-site demonstration test at Fukushima Daiichi	

2． Examples of items examined during the Feasibility Study

During the Feasibility Study, design conditions for use at Fukushima Daiichi will be set, and proposals for conceptual design for actual plants and demonstrations shall be asked for in order to assess/examine practical application.

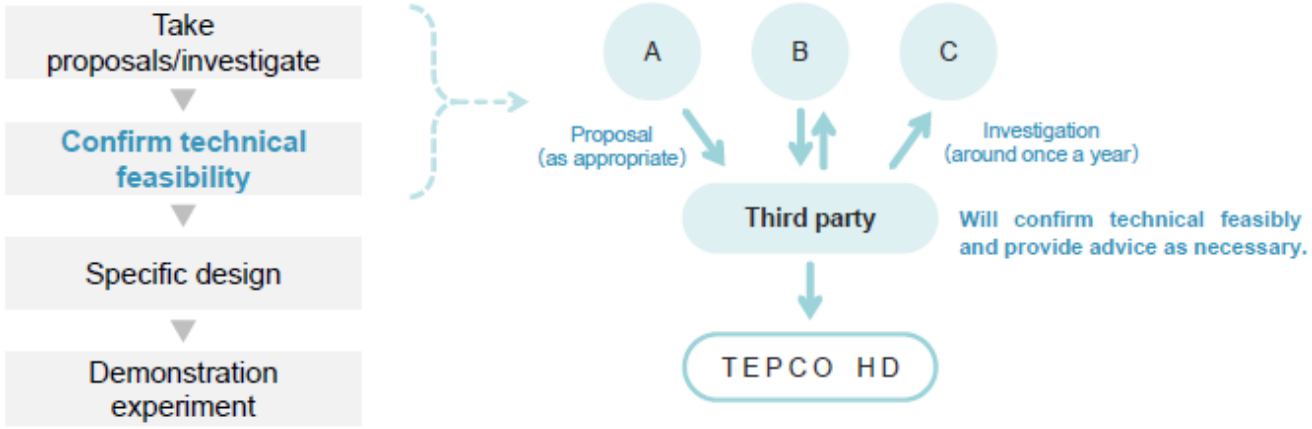
Request details	• Acquire additional data required to improve the accuracy and reliability of the technology and empirical data • Propose detailed plans for off-site, small-scale (approximately 1/100 or 1/10 actual size) demonstration test for proving feasibility that can be scaled up for an actual plant, and that can fulfill the following criteria for use at actual plants.
The technical prowess of proponents and the potential for achieving practical application	• Large-scale (treatment amount or depletion decontamination coefficient, enrichment concentration coefficient) hydrogen isotope concentration experiments performed, or participated in, by the proponents, and the results of such experiments (treatment amount, concentrations before and after treatment, and isotope yield, etc.), and the degree of involvement by the proponent. • Technical explanation of plans for achieving operation capability (Concentration: Less than 1,500Bq/L; Maximum treatment flow: 500m^3/day) to achieve targets for treated water with minimum concentrations (100,000Bq/L) and maximum concentrations (2.16 million Bq/L), in light of the results of the aforementioned tests and the attributes of actual treated water.
Waste, etc.	• Materials (primary materials) brought on site and the estimated amount of these materials • The amount and physical/chemical attributes of waste produced by the process (including concentrated tritium) during storage, as well as storage methods, required site, energy, and maintenance/management methods based on the amount and physical/chemical attributes, in consideration of the attributes of actual treated water. • If a byproduct that can be repurposed will be produced, state of the byproduct, the amount that will be generated, and its expected use.
User-friendliness	• Required facility configuration and installation area (Including areas temporarily occupied for construction, maintenance and disassembly) for facilities with the target operation capability (Concentration prior to treatment: 100,000Bq/L; Concentration after treatment: Less than 1,500Bq/L; Maximum treatment flow: 500m^3/day) • Personnel (including required education and training), supplies, energy, and other consumables, and the quantity of such, required for facility operation (operation and maintenance). • Approach to safety design.
Law compliance, etc.	• Compliance with Japanese and international laws, such as the Nuclear Reactor Regulation Act and building codes, etc. • Explanation of the quality assurance system
Other	• Means of involvement by proponent if the proposal is adopted, and anticipated partners (if any), as well as a summary of the schedule leading up to the beginning of small-scale demonstration test.

【Reference】Investigation Regarding Tritium Separation Technology

Review Status of Facilities to Secure Safety on the Handling of Water Treated with Multi-Nuclide Removal Equipment (August 25, 2021 Excerpts from documents)

We will continue to keep a close eye on new technological developments in tritium separation technology.

- In accordance with TEPCO's plan announced on April 16, we have devised a new model for eliciting proposals and promoting widescale research on tritium separation technology that employs the help of a third party in order to ensure transparency.
- NineSigma Holdings, Inc. has been selected as our third-party partner. On May 27, NineSigma posted links on its website that give details on the open call project and where to apply. This marks the commencement of our public appeal to Japan and the rest of the world for proposals and research related to tritium separation technology.
  Links： (Japanese) https://www.ninesigma.com/s/TEPCO-galleryJP
  (English) https://www.ninesigma.com/s/TEPCO-galleryEN
- Going forward, when technologies are proposed via NineSigma's website, NineSigma shall confirm/evaluate the details of such technology and provide advice as necessary. The results will then be examined by TEPCO, and if it turns out that the technology is able to be realistically applied to water purified with multi-nuclide removal equipment (ALPS treated water, etc.), detailed designs will be drawn up and verification tests of the technology conducted with the aim of establishing the technology.



©Tokyo Electric Power Company Holdings, Inc. All Rights Reserved.

秘密情報 目的外使用・複製・開示禁止 東京電力ホールディングス株式会社

【Reference】NineSigma's Primary Assessment Items

Review Status of Facilities to Secure Safety on the Handling of Water Treated with Multi-Nuclide Removal Equipment (August 25, 2021 Excerpts from documents)

- All of the following requirements need not be fulfilled at the time the proposal is submitted, but must be fulfilled at some point in the future.

＜Requirements＞

Separation/ measurement	All of the following requirements must be met: • The concentration of tritium after treatment must be less than 1/1,000 of that prior to treatment. （Technology that can reduce the concentration of tritium to 1/100 or less at present is anticipated, which was required in the government's Demonstration Project for Verification Tests of Tritium Separation Technologies) • The reliability of measurement of tritium concentration can be explained. • The material balance of tritium throughout the tests can clearly be indicated.
Treatment capacity	• There is a technical prospect that is able to be increased to target operating capacity levels (50~500 m^3/day)

＜ Recommended items ＞

Principle	It is recommended that one, or both, of the following conditions be fulfilled: • The principle of separation technology has been widely recognized at academic conferences, etc. • The principle of separation technology has been recognized by third parties, e.g., included in peer-reviewed papers.

- Regarding Technologies for which practical application has been deemed feasible by the primary and secondary assessments, nature and volume of waste generated, compliance with the Nuclear Reactor Regulation Law, and the size of the area required for equipment installation, etc. will be reviewed by TEPCO.

©Tokyo Electric Power Company Holdings, Inc. All Rights Reserved.
秘密情報 目的外使用・複製・開示禁止 東京電力ホールディングス株式会社