

PROJECT ANNEX

To
IMPLEMENTING ARRANGEMENT
BETWEEN
THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA
AND
THE MINISTRY OF TRADE, INDUSTRY AND ENERGY OF THE REPUBLIC OF KOREA
FOR COOPERATION
IN THE AREA OF CLEAN ENERGY RESEARCH AND TECHNOLOGY

CONCERNING HYDROGEN INFRASTRUCTURE

The Department of Energy of the United States of America (DOE) and the Ministry of Trade, Industry and Energy (formerly, the Ministry of Knowledge Economy) of the Republic of Korea (MOTIE), hereinafter collectively the "Parties":

DESIRING to collaborate on development of a risk assessment program for hydrogen infrastructure, and

ACTING pursuant to section 4 of the Implementing Arrangement between the Department of Energy of the United States of America and the Ministry of Knowledge Economy of the Republic of Korea for Cooperation in the Area of Clean Energy Research and Technology, signed October 11, 2011 (the Implementing Arrangement),

Have agreed as follows:

1. Technical Scope of Work

- a. The goals of the activities to be performed under this Project Annex are to develop a qualitative and quantitative risk assessment process and program for hydrogen infrastructure and to develop methods to analyze hydrogen incidents.
- b. The activities to be carried out include:
 - Developing a qualitative and quantitative risk assessment process for hydrogen infrastructure;
 - Developing a damage analysis model for hydrogen incidents;
 - Surveying, including failure rate, of components and equipment installed in liquefied petroleum gas (LPG) stations, compressed natural gas (CNG) stations, and hydrogen infrastructure;
 - Performing an empirical experiment of a damage impact model, jet fire analysis model, and explosion analysis model;
 - Developing an incident frequency analysis model; and
 - Developing an individual or societal risk assessment model of hydrogen fueling station incidents.
- c. Additional information on the scope of work and schedule is provided in Appendix 2 attached to this Project Annex.
- d. All activities carried out under this Project Annex are subject to the provisions of the Implementing Arrangement, which is itself subject to and governed by the Agreement on Science and Technology Cooperation between the Government of the United States of America and the Government of the Republic of Korea signed July 2, 1999, as extended (the S&T Agreement). In the event of any conflict between the provisions of the foregoing, the terms of the Implementing Arrangement shall have priority over the terms of this Project Annex and the terms of the S&T Agreement shall have priority over the terms of the Implementing Arrangement.

2. Participating Organizations

The activities under this Project Annex shall be performed by the following organizations:

- a. For DOE: Sandia National Laboratories (SNL), which are government-owned national laboratories operated under a contract for DOE;
- b. For MOTIE: Hoseo University and Korea Gas Safety Corporation (KGS), which

will perform the research under a contract with MOTIE administered by the Korea Institute of Energy Technology Evaluation and Planning (KETEP), which is a Korean government agency under the authority of MOTIE. Acting on behalf of MOTIE, KETEP shall fund, manage, and evaluate the research undertaken by the Korean participants.

3. Implementation

a. Key Personnel

The principal investigators and other key points of contact are identified in Appendix 1 attached to this Project Annex.

b. Program Management and Communications

SNL, Hoseo University, and KGS shall be responsible for planning and executing technical work to be performed under this Project Annex. SNL, Hoseo University, and KGS shall communicate directly with each other, unless otherwise directed by DOE and MOTIE (through KETEP). SNL, Hoseo University, and KGS shall prepare work plans with projected milestones for each phase of the joint project and report on progress as requested by DOE and MOTIE (through KETEP). SNL, Hoseo University, and KGS shall review Appendices 1 and 2 annually and update them as necessary. SNL, Hoseo University, and KGS shall report on progress during the annual DOE-MOTIE Bilateral Clean Energy Policy Consultation, in accordance with Section 4.4 of the Implementing Arrangement.

c. Funding

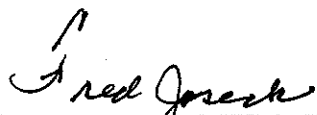
All costs associated with the implementation of activities under this Project Annex shall be the responsibility of the entity that incurs them. The implementation of activities under this Project Annex shall be subject to the availability of funds. Projected levels of funding from DOE and MOTIE (through SNL and KETEP) for this Project Annex are shown in Appendix 2.

4. Period of Performance

- a. This Project Annex shall be effective from the date of signature until completion of the period of performance identified in Appendix 2.
- b. The period of performance of activities to be carried out under this Project Annex is identified in Appendix 2. It may be modified or extended by written agreement of the Parties.

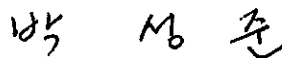
Signed at Washington, on December 11, 2017, in duplicate, in the English language.

For the Department of Energy
of the United States of America:



Fred Joseck
Acting Technology Acceleration Manager
Fuel Cell Technologies Office
Office of Energy Efficiency and
Renewable Energy

For the Ministry of Trade, Industry and
Energy of the Republic of Korea:



Sung Joon Park
Director
Energy Technology Division

Appendix 1: Key Personnel

Republic of Korea	United States of America
Ministry of Trade, Industry and Energy	Department of Energy
<p>Sung Joon Park Director Energy Technology Division Sjpark77@korea.kr +82-44-203-4540</p>	<p>Sunita Satyapal Director Fuel Cell Technologies Office Office of Energy Efficiency and Renewable Energy Sunita.Satyapal@ee.doe.gov +1-202-586-2336</p>
Korea Institute of Energy Technology Evaluation and Planning	<p>Ronald C. Cherry Senior Policy Advisor Office of Asian Affairs Office of International Affairs Ron.cherry@hq.doe.gov +1-202-586-2285</p>
<p>Hyunkeong Kim Head of International Cooperation Division Office of Energy Technology Strategy keongkim@ketep.re.kr +82-2-3469-8340</p>	
Hoseo University	Sandia National Laboratories
<p>Prof. Dr. -Ing. Kwangwon Rhie System Safety Engineer Dept. of Safety & Health Engineering kwrhie@hoseo.edu +82-10-3403-8164</p>	<p>Chris LaFleur Fire Protection Engineer Risk & Reliability Department aclafle@sandia.gov +1-505-844-5425</p>
Korea Gas Safety Corporation	
<p>Dr. Sung-joon Choi Gas Safety Engineer Deputy General Manager Dept. of Fire Explosion Research shoo@kgs.or.kr +82-10-3043-9737</p>	

Appendix 2: Technical Scope of Work and Schedule

Project Title		Developing Qualitative and Quantitative Risk Assessment Program for Hydrogen Infrastructure			
Period of Performance		FROM: July 1, 2017 TO: June 30, 2020			
		Year 1	Year 2	Year 3	Total
Project Period		July 1, 2017 to June 30, 2018	July 1, 2018 to June 30, 2019	July 1, 2019 to June 30, 2020	
DOE Funding*		\$275,000	\$275,000	\$275,000	\$825,000
MOTIE Funding**		500,000,000 KRW	500,000,000 KRW	500,000,000 KRW	1,500,000,000 KRW
Total Budget***		\$710,000	\$710,000	\$710,000	\$2,130,000
Scope of Work Summary	ROK Participants (Hoseo University, KGS)	Qualitative risk assessment (Hazop & FMEA module) development Development of risk assessment process for hydrogen station Empirical test method and data investigation analysis	Quantitative risk assessment (FTA & ETA module) development Survey of components failure rate for LPG/CNG/H2 stations CFD simulation for high pressure gas (H2, CNG, LPG) leak and jet flame Leakage jet demonstration experiment	Individual or societal risk assessment model development CFD simulation for high pressure gas (H2, CNG, LPG) explosion Jet fire demonstration experiment and explosion demonstration experiment	
	U.S. Participant (SNL)	Support the HAZOP and FMEA risk assessment module development Provide information on the flexibility of quantitative risk assessment for other high pressure gases	Quantitative risk assessment module development Provide background material related to GH2 risk analysis	Continue with quantitative risk assessment development Support the incorporation of other high pressure gas (H2, CNG, LPG) models into a risk analysis framework	

*DOE funding noted is as part of an existing project with SNL, but includes international collaboration funding for this project.

**MOTIE and Korean participant's funding and project period may differ from Appendix 2 according to the fiscal year system of Korea.

***Estimate based on exchange rate of 1 USD to 1,150 KRW.