SFR Safety Experiments in Support of PGSFR Licensing

Final CRADA Report

Nuclear Science and Engineering Division

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Participants: Korea Atomic Energy Research Institute

November 1, 2021

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Non Proprietary Final CRADA Report

For the Office of Scientific and Technical Information (OSTI)

CRADA Number: C1501601

CRADA Title: SFR Safety Experiments in Support of PGSFR Licensing

CRADA Start Date 10/12/2015 – **End Date** 10/31/2021

DOE Program or Other Government Support

Program office: Office of nuclear Energy

Program manager name: Alice Caponiti, DAS for Reactor Fleet and Advanced Reactor Development

Program manager phone or email: alice.caponiti@nuclear.energy.gov

Participant(s)

Participant 1 name: Korea Atomic Energy Research Institute (KAERI)

Complete address: 989-111 Daedeok-daero, Yuseong-gu, Daejeon. 305-353, Korea

Participant 2 name: Click or tap here to enter text.

Complete address: Click or tap here to enter text.

Participant 3 name: Click or tap here to enter text.

Complete address: Click or tap here to enter text.

Argonne National Laboratory

Argonne PI(s): Yoon Il Chang

Funding Table

To add rows, right-click in bottom row and select "Insert" "rows above".

	Planned Funding	Actual Funding	In-Kind
Government	\$	\$	
KAERI	\$4,451,100	4,451,100\$	\$50,000
Enter Participant 2 here	\$	\$	\$
Enter Participant 3 here	\$	\$	\$
Total	\$4,451,100	\$4,451,100	\$50,000

Nature of Work

Describe the research (summary of Scope of Work and principal objectives of the CRADA):

Argonne National Laboratory and Korea Atomic Energy Research Institute entered into this CRADA to perform safety experiments and assessment of experimental results in the area of the metal fuel behavior in severe accident conditions to support the Prototype Generation-IV Sodium-cooled Fast Reactor (PGSFR) licensing process. The goal was to utilize the existing sodium facilities at ANL to perform experiments aimed at providing validation data associated with the source term determination and metal fuel characteristics which enables subcriticality and coolable geometry in postulated severe accident scenarios.

DOE mission area(s):

Energy and Environmental Science and Technology

Choose an item.

Choose an item.

Conclusions drawn from this CRADA; include any major accomplishments:

Metal fuel relocation experiments were conducted simulating typical fuel lattice design of the PGSFR. Typically, molten metal fuel reacted with the cladding and moved downward in the sodium coolant channel, resulting in a negative reactivity feedback effect. This negative reactivity feedback insertion will help a Sodium-cooled Fast Reactor (SFR) to terminate of the severe accidents. During the Phase II of the CRADA, metal fuel relocation experiments with pressure injection were successfully conducted to study more prototypic behavior of metallic fuels in postulated severe accidents in SFRs. In addition, a real time X-ray video system was successfully built and used in the experiment to observe the behavior of metal uranium fuel in real time. The relocation behavior of fuel during postulated severe accidents in SFRs obtained in these experiments can be utilized to validate the relocation models in accident analysis codes.

Technology Transfer-Intellectual Property**Argonne National Laboratory background IP:**

Technical details of the experimental results and the modeling results were documented in 21 Quarterly Progress Reports, Phase I Final Report (10/31/2017), and Phase II Final Report (7/31/2021). These reports were not released to OSTI.

Participant(s) background IP:

Technical details of the experimental results and the modeling results were documented in 21 Quarterly Progress Reports, Phase I Final Report (10/31/2017) and Phase II Final Report (7/31/2021).

Identify any new Subject Inventions as a result of this CRADA:

None.

Summary of technology transfer benefits to industry and, if applicable, path forward/anticipated next steps towards commercialization:

Summary results were published as listed in the next item, which can benefit all future metal-fueled SFR projects. Very strong inherent safety characteristics of metal fueled SFRs can be utilized in the licensing process.

Other information/results (papers, inventions, software, etc.):

The following papers or conference presentations are available in the open literature.

1. J. Diaz, T. Kim, V. Petrov, A. Manera, X-ray and Gamma-ray Tomographic Imaging of Fuel Relocation inside Sodium Fast Reactor Test Assemblies during Severe Accidents, Journal of Nuclear Materials, 543 (2021) 152567.
2. T. Kim, D. Harbaruk, D. Lisowski, N. Bremer, M. Farmer, C. Grandy, and Y.I. Chang, Experimental Studies on Metallic Fuel Relocation in a Pin Bundle Core Structure of a Sodium-Cooled Fast Reactor, Nuclear Engineering and Design, 365 (2020) 110719.
3. T. Kim, D. Harbaruk, D. Lisowski, N. Bremer, M. Farmer, C. Grandy, and Y.I. Chang, Experimental Studies on Metallic Fuel Relocation in a Pin Bundle Core Structure of a Sodium-Cooled Fast Reactor, Nuclear Engineering and Design, 365 (2020) 110719.
4. T. Kim, J. Fortner, D. Harbaruk, C. Gerardi, M. Farmer, Y. I. Chang, Experimental studies on eutectic formation between metallic fuel and HT-9M cladding in a single-pin core structure of a sodium-cooled fast reactor, Journal of Nuclear Materials, 505 (2018) 105-118.
5. J. Diaz, T. Kim, V. Petrov, A. Manera, X-ray and Gamma-ray Tomographic Imaging of Fuel Relocation inside Sodium Fast Reactor Test Assemblies during Severe Accidents, Journal of Nuclear Materials, 543 (2021) 152567.

6. T. Kim, D. Harbaruk, D. Lisowski, N. Bremer, M. Farmer, C. Grandy, and Y.I. Chang, Experimental Studies on Metallic Fuel Relocation in a Pin Bundle Core Structure of a Sodium-Cooled Fast Reactor, *Nuclear Engineering and Design*, 365 (2020) 110719.
7. T. Kim, J. Fortner, D. Harbaruk, C. Gerardi, M. Farmer, Y. I. Chang, Experimental studies on eutectic formation between metallic fuel and HT-9M cladding in a single-pin core structure of a sodium-cooled fast reactor, *Journal of Nuclear Materials*, 505 (2018) 105-118.
8. T. Kim, D. Harbaruk, C. Gerardi, M. Farmer, Y. I. Chang, Experimental studies on metallic fuel relocation in a single-pin core structure of a sodium-cooled fast reactor, *Nuclear Engineering and Design*, 322 (2017) 204-214.

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