



# U.S. Department of Energy

## Categorical Exclusion Determination Form

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Proposed Action Title: Raytheon Technologies Research Center - Additive, Topology-Optimized Ultra-Compact Heat Exchanger

Program or Field Office: Advanced Research Projects Agency - Energy

Location(s) (City/County/State): East Hartford, Connecticut; Madison, Wisconsin

Proposed Action Description:

SECOND AMENDED NEPA DETERMINATION: (See attached original Determination, dated July 16, 2019, and first amended Determination, dated August 29, 2019)

This Amended Determination follows the approval of additional funds to support the project team's small-scale, research and development activities to include additional testing of manufactured heat exchangers and components. Specifically, the project team will conduct temperature ramp-up tests of heat exchangers and components, and test the structural integrity of the heat exchangers to help validate survivability for use in aerospace applications. If successful, durable, reliable, and cost-effective higher-temperature and pressure heat exchangers that exceed current SOA would lead to substantially higher power conversion efficiencies that would reduce fuel consumption, system footprint, and emissions.

Project activities will be conducted at existing facilities at Raytheon Technologies Research Center (East Hartford, CT) and University of Wisconsin, Madison (Madison, WI). Project tasks continue to fit within the class of actions identified under the DOE Categorical Exclusion identified below and do not involve any extraordinary circumstances that may affect the significance of the environmental effects of the project. This assessment was based on a review of the proposed scope of work and the potential environmental impact of the project. Project tasks will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and local regulatory requirements

Categorical Exclusion(s) Applied:

B3.6 - Small-scale research and development, laboratory operations, and pilot projects

A9 - Information gathering, analysis, and dissemination

For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, including the full text of each categorical exclusion, see Subpart D of [10 CFR Part 1021](#).

Regulatory Requirements in 10 CFR 1021.410(b): (See full text in regulation)

The proposal fits within a class of actions that is listed in Appendix A or B to 10 CFR Part 1021, Subpart D.

To fit within the classes of actions listed in 10 CFR Part 1021, Subpart D, Appendix B, a proposal must be one that would not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, or similar requirements of DOE or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities (including incinerators), but the proposal may include categorically excluded waste storage, disposal, recovery, or treatment actions or facilities; (3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that preexist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources, including, but not limited to, those listed in paragraph B(4) of 10 CFR Part 1021, Subpart D, Appendix B; (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species, unless the proposed activity would be contained or confined in a manner designed and operated to prevent unauthorized release into the environment and conducted in accordance with applicable requirements, such as those listed in paragraph B(5) of 10 CFR Part 1021, Subpart D, Appendix B.

There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal.

The proposal has not been segmented to meet the definition of a categorical exclusion. This proposal is not connected to other actions with potentially significant impacts (40 CFR 1508.25(a)(1)), is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1508.27(b)(7)), and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement.

Based on my review of the proposed action, as NEPA Compliance Officer (as authorized under DOE Order 451.1B), I have determined that the proposed action fits within the specified class(es) of action, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

NEPA Compliance Officer: **GEOFFREY GOODE** Digitally signed by GEOFFREY GOODE  
Date: 2022.08.07 05:57:15 -04'00'

Date Determined:



# U.S. Department of Energy Categorical Exclusion Determination Form

Submit by E-mail

Proposed Action Title: High Intensity Thermal Exchange through Materials and Manufacturing Processes (HITEMMP) Program (FOA No. DE-FOA-0001970 & SBIR FOA No. DE-FOA-0001972)

Program or Field Office: Advanced Research Projects Agency - Energy (ARPA-E)

Location(s) (City/County/State): CA; CO; CT; FL; IN; LA; MA; MD; MI; MO; NC; NH; NM; NY; OH; OR; PA; TN; TX; VA; WI; WV

Proposed Action Description:

FIRST AMENDED DETERMINATION: (See attached Original Programmatic Determination, dated July 16, 2019)

The HITEMMP Program seeks to fund the development of new approaches and technologies for the design and manufacture of high temperature, high pressure, and highly compact heat exchangers and components. If successful, durable, reliable, and cost-effective higher-temperature and pressure heat exchangers that exceed current operating conditions could lead to substantially higher power conversion efficiencies that would reduce fuel consumption, system footprint (and thus capital and operation costs), and CO2 emissions.

The HITEMMP Program is composed of 15 small-scale research and development projects that will be conducted by universities, non-profit entities, for-profit entities, and federal laboratories. This Amended Determination adds two (2) projects to the Programmatic Determination. These 2 projects (UTRC and Thar Energy, LLC) are covered by this Determination and fit within the class of actions identified under the DOE Categorical Exclusions identified below and do not involve any extraordinary circumstances that may affect the significance of the environmental effects of the projects. This assessment was based on a review of the proposed scope of work and the potential environmental impacts of each project. All project tasks will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and Local regulatory requirements. No modifications will be made to the existing facilities to accommodate the proposed work.

Categorical Exclusion(s) Applied:

A9 - Information gathering, analysis, and dissemination

B3.6 - Small-scale research and development, laboratory operations, and pilot projects

B3.15 - Small-scale indoor research and development projects using nanoscale materials

For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, including the full text of each categorical exclusion, see Subpart D of [10 CFR Part 1021](#).

Regulatory Requirements in 10 CFR 1021.410(b): (See full text in regulation)

The proposal fits within a class of actions that is listed in Appendix A or B to 10 CFR Part 1021, Subpart D.

To fit within the classes of actions listed in 10 CFR Part 1021, Subpart D, Appendix B, a proposal must be one that would not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, or similar requirements of DOE or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities (including incinerators), but the proposal may include categorically excluded waste storage, disposal, recovery, or treatment actions or facilities; (3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that preexist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources, including, but not limited to, those listed in paragraph B(4) of 10 CFR Part 1021, Subpart D, Appendix B; (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species, unless the proposed activity would be contained or confined in a manner designed and operated to prevent unauthorized release into the environment and conducted in accordance with applicable requirements, such as those listed in paragraph B(5) of 10 CFR Part 1021, Subpart D, Appendix B.

There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal.

The proposal has not been segmented to meet the definition of a categorical exclusion. This proposal is not connected to other actions with potentially significant impacts (40 CFR 1508.25(a)(1)), is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1508.27(b)(7)), and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement.

Based on my review of the proposed action, as NEPA Compliance Officer (as authorized under DOE Order 451.1B), I have determined that the proposed action fits within the specified class(es) of action, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

NEPA Compliance Officer:

Date Determined: 08/29/2019

**Attachment A: Projects in the HITEMMP (FOA No. DE-FOA-0001970 & SBIR FOA No. DE-FOA-0001972) Program**

<b>Prime Recipient (Control No.)</b>	<b>Project Title</b>	<b>Categorical Exclusion</b>
<b>GE Global Research (1970- 1502)</b>	Ultra Performance Heat Exchanger Enabled by Additive Technology (UPHEAT)	A9; B3.6
<b>Michigan State University (1970-1517)</b>	Heat-Exchanger Intensification through Powder Processing and Enhanced Design (HIPPED)	A9; B3.6; B3.15
<b>University of Missouri (1970-1532)</b>	UHT-CAMANCHE: Ultra-High Temperature Ceramic Additively Manufactured Compact Heat Exchangers	A9; B3.6
<b>Michigan Technological University (1970-1534)</b>	High-density SSiC 3D-printed lattices for compact HTHP aero-engine recuperators	A9; B3.6; B3.15
<b>Carnegie Mellon University (1970-1544)</b>	High Energy Density Modular Heat Exchangers through Design, Materials Processing, and Manufacturing Innovations	A9; B3.6
<b>University of Maryland (1970-1545)</b>	Additively Manufactured High Efficiency and Low-Cost sCO2 Heat Exchangers	B3.6
<b>Massachusetts Institute of Technology (1970-1570)</b>	MULTISCALE POROUS HIGH-TEMPERATURE HEAT EXCHANGER USING CERAMIC CO-EXTRUSION	A9; B3.6
<b>University of California: Los Angeles (1970-1585)</b>	SHOTEAM: Superalloy Heat exchangers Optimized for Temperature Extremes and Additive Manufacturability	A9; B3.6; B3.15
<b>Vacuum Process Engineering, Inc. (1970- 1594)</b>	Compact Diffusion Bonded Printed-Circuit Heat Exchanger Development Using Nickel Superalloys for Highly Power Dense and Efficient M	A9; B3.6
<b>International Mezzo Technologies (1972- 1504)</b>	A 2-5 MW Supercritical CO2 micro tube recuperator: manufacturing, testing, and laser weld qualification	A.9; B3.6
<b>Compnex, LLC (1972- 1511)</b>	Compact Heat Exchanger for High Temperature High Pressure Applications Using Advanced Cermet	A.9; B3.6; B3.15
<b>Thar Energy, LLC (1970- 1554)</b>	High Temperature, High Pressure, and High Performance Compact Heat Exchanger	A.9; B3.6

**Attachment A: Projects in the HITEMMP (FOA No. DE-FOA-0001970 & SBIR FOA No. DE-FOA-0001972) Program**

<b>Prime Recipient (Control No.)</b>	<b>Project Title</b>	<b>Categorical Exclusion</b>
<b>United Technologies Research Center (1970-1505)</b>	Additive, Topology-Optimized Ultra-Compact Heat Exchanger	A.9; B3.6



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Proposed Action Title: High Intensity Thermal Exchange through Materials and Manufacturing Processes (HITEMMP) Program (FOA No. DE-FOA-0001970 & SBIR FOA No. DE-FOA-0001972)

Program or Field Office: Advanced Research Projects Agency - Energy (ARPA-E)

Location(s) (City/County/State): CA; CO; FL; IN; LA; MA; MD; MI; MO; NC; NH; NM; NY; OH; OR; PA; TN; TX; WI; WV

Proposed Action Description:

The HITEMMP Program seeks to fund the development of new approaches and technologies for the design and manufacture of high temperature, high pressure, and highly compact heat exchangers and components. If successful, durable, reliable, and cost-effective higher-temperature and pressure heat exchangers that exceed current operating conditions could lead to substantially higher power conversion efficiencies that would reduce fuel consumption, system footprint (and thus capital and operation costs), and CO2 emissions.

The HITEMMP Program is composed of 15 small-scale research and development projects that will be conducted by universities, non-profit entities, for-profit entities, and federal laboratories. Eleven (11) (listed in Attachment A) of the 15 projects are covered by this Determination and fit within the class of actions identified under the DOE Categorical Exclusions identified below and do not involve any extraordinary circumstances that may affect the significance of the environmental effects of the projects. This assessment was based on a review of the proposed scope of work and the potential environmental impacts of each project. Project tasks for these 11 projects under the HITEMMP Program will be conducted in accordance with established safety and materials/waste management protocols and pursuant to applicable Federal, State, and Local regulatory requirements.

Categorical Exclusion(s) Applied:

A9 - Information gathering, analysis, and dissemination

B3.6 - Small-scale research and development, laboratory operations, and pilot projects

B3.15 - Small-scale indoor research and development projects using nanoscale materials

For the complete DOE National Environmental Policy Act regulations regarding categorical exclusions, including the full text of each categorical exclusion, see Subpart D of 10 CFR Part 1021.

Regulatory Requirements in 10 CFR 1021.410(b): (See full text in regulation)

The proposal fits within a class of actions that is listed in Appendix A or B to 10 CFR Part 1021, Subpart D.

To fit within the classes of actions listed in 10 CFR Part 1021, Subpart D, Appendix B, a proposal must be one that would not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, or similar requirements of DOE or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities (including incinerators), but the proposal may include categorically excluded waste storage, disposal, recovery, or treatment actions or facilities; (3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that preexist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources, including, but not limited to, those listed in paragraph B(4) of 10 CFR Part 1021, Subpart D, Appendix B; (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species, unless the proposed activity would be contained or confined in a manner designed and operated to prevent unauthorized release into the environment and conducted in accordance with applicable requirements, such as those listed in paragraph B(5) of 10 CFR Part 1021, Subpart D, Appendix B.

There are no extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal.

The proposal has not been segmented to meet the definition of a categorical exclusion. This proposal is not connected to other actions with potentially significant impacts (40 CFR 1508.25(a)(1)), is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1508.27(b)(7)), and is not precluded by 40 CFR 1506.1 or 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement.

Based on my review of the proposed action, as NEPA Compliance Officer (as authorized under DOE Order 451.1B), I have determined that the proposed action fits within the specified class(es) of action, the other regulatory requirements set forth above are met, and the proposed action is hereby categorically excluded from further NEPA review.

NEPA Compliance Officer:

Date Determined: 07/16/2019

**Attachment A: Projects in the HITEMMP (FOA No. DE-FOA-0001970 & SBIR FOA No. DE-FOA-0001972) Program**

<b>Prime Recipient (Control No.)</b>	<b>Project Title</b>	<b>Categorical Exclusion</b>
<b>GE Global Research (1970- 1502)</b>	Ultra Performance Heat Exchanger Enabled by Additive Technology (UPHEAT)	A9; B3.6
<b>Michigan State University (1970-1517)</b>	Heat-Exchanger Intensification through Powder Processing and Enhanced Design (HIPPED)	A9; B3.6; B3.15
<b>University of Missouri (1970-1532)</b>	UHT-CAMANCHE: Ultra-High Temperature Ceramic Additively Manufactured Compact Heat Exchangers	A9; B3.6
<b>Michigan Technological University (1970-1534)</b>	High-density SSiC 3D-printed lattices for compact HTHP aero-engine recuperators	A9; B3.6; B3.15
<b>Carnegie Mellon University (1970-1544)</b>	High Energy Density Modular Heat Exchangers through Design, Materials Processing, and Manufacturing Innovations	A9; B3.6
<b>University of Maryland (1970-1545)</b>	Additively Manufactured High Efficiency and Low-Cost sCO <sub>2</sub> Heat Exchangers	B3.6
<b>Massachusetts Institute of Technology (1970-1570)</b>	MULTISCALE POROUS HIGH-TEMPERATURE HEAT EXCHANGER USING CERAMIC CO-EXTRUSION	A9; B3.6
<b>University of California: Los Angeles (1970-1585)</b>	SHOTEAM: Superalloy Heat exchangers Optimized for Temperature Extremes and Additive Manufacturability	A9; B3.6; B3.15
<b>Vacuum Process Engineering, Inc. (1970- 1594)</b>	Compact Diffusion Bonded Printed-Circuit Heat Exchanger Development Using Nickel Superalloys for Highly Power Dense and Efficient M	A9; B3.6
<b>International Mezzo Technologies (1972- 1504)</b>	A 2-5 MW Supercritical CO <sub>2</sub> micro tube recuperator: manufacturing, testing, and laser weld qualification	A.9; B3.6
<b>Complex, LLC (1972- 1511)</b>	Compact Heat Exchanger for High Temperature High Pressure Applications Using Advanced Cermet	A.9; B3.6; B3.15