

## QUESTIONS AND ANSWERS

PLEASE REFER TO THE GENERAL FAQs SECTION OF ARPA-E'S WEBSITE ([HTTP://ARPA-E.ENERGY.GOV/?Q=FAQ/GENERAL-QUESTIONS](http://arpa-e.energy.gov/?Q=FAQ/GENERAL-QUESTIONS)) FOR ANSWERS TO MANY GENERAL QUESTIONS ABOUT ARPA-E AND ARPA-E'S FUNDING OPPORTUNITY ANNOUNCEMENTS. ADDITIONAL QUESTIONS SPECIFIC TO THIS FOA ONLY ARE INCLUDED BELOW. PLEASE REVIEW ALL EXISTING GENERAL FAQs AND FOA-SPECIFIC QUESTIONS BEFORE SUBMITTING NEW QUESTIONS TO ARPA-E.

### I. Concept Paper Phase Questions:

**Q1. IS A FOREIGN SMALL BUSINESSES WHO HAS A SUBSIDIARY INCORPORATED UNDER THE LAWS OF A STATE OF THE UNITED STATES, ELIGIBLE TO SUBMIT APPLICATION TO THIS FOA (DE-FOA-0002851)?**

**IF YES, SHOULD THE FOREIGN SMALL BUSINESSES SUBMIT THE APPLICATION, OR SHOULD ITS SUBSIDIARY SUBMIT THE APPLICATION?**

**ANSWER:** Please reference FOA Section III.A.3. Foreign Entities

**Q2. WE ARE EXPLORING TO SUBMIT A CONCEPT PAPER FOR DE-FOA-0002851 IN CATEGORY C [REDACTED].**

**WE HAVE TWO QUESTIONS -**

- 1. IS IT MANDATORY THAT THIS SOFTWARE NEEDS TO BE OPENSOURCE?**
- 2. ALSO IN THE SOLICITATION IT IS MENTIONED THE SOFTWARE NEEDS TO BE UPDATED EVERY 6 MONTHS FOR CATEGORY A AND CATEGORY B? IS THIS REQUIREMENT ENFORCED FROM THE BEGINNING OF THIS PROJECT OR AFTER THE COMPLETION OF THE PROJECT?**

**ANSWER:**

1. As per DE-FOA-0002851 COOLERCHIPS Funding Opportunity Announcement section 1.D.2, Technical Category C project teams shall make the software developed under the COOLERCHIPS program available under open-source, but it is not mandatory that the base software that it is developed upon be open-source. However, to the extent the software that is developed under an award is a modular add-on that requires access to additional software not available as compatible open source, such additional software is not required to be available as open source but must be generally available to any users of the model.

2. The 6 month requirement between each software update is enforced from the beginning of the project throughout its entire period of performance with ARPA-E. As per DE-FOA-0002851 COOLERCHIPS Funding Opportunity Announcement section 1.D.2, Technical Category C projects are expected to have their basic functionality of energy, reliability, CO2 footprint, and cost analysis

modeling capability ready by the first six months. Subsequent releases will have increased fidelity and capability.

### **Q3. DEAR ARPA-E CONTRACTING OFFICER:**

**1. IS THE UPCOMING FOA RFI-0000063 FOR NEW PROGRAM FOR DATA CENTER COOLING STILL PART OF THE ARPA-E PROGRAM OR HAS THIS SCOPE BEEN ROLLED INTO THE COOLERCHIPS FOA DE-FOA-0002851 AND FOA-0002852? I NOTE THAT RFI-0000063 REMAINS LISTED ON THE ARPA-E WEBSITE.**

**2. WHY ARE THERE TWO PROGRAM NUMBERS FOR THE COOLERCHIPS FOA, BOTH HAVE THE SAME TITLE? PLEASE CLARIFY THE DIFFERENCES IN SCOPE.**

**ANSWER:** 1. The RFI-0000063 announcement is a teaming partner list. Please refer to the announcement for guidance on how to use the list or to be added to the teaming partner list.

2. Please refer to the DE-FOA-0002852 COOLERCHIPS SBIR/STTR Funding Opportunity Announcement section 1.B. SBIR/STTR PROGRAM OVERVIEW.

### **Q4. ON PAGE 15 (1. PROGRAM BOUNDARY AND TECHNICAL CATEGORIES /SCOPE) THE FOA READS “[...] SOLUTIONS FOCUSED ON CHIP DESIGN, INTERNAL CHIP COOLING, [...] ARE CONSIDERED OUT OF SCOPE”.**

**THE CONVECTION CONTRIBUTION TO THE JUNCTION-TO-COOLANT THERMAL RESISTANCE IS ASYMPTOTICALLY DECREASING WITH THE HEAT TRANSFER COEFFICIENT FLUID-WALL. CONVERSELY, THE CONDUCTION CONTRIBUTION IS LINEARLY DECREASING WITH THE CONDUCTION THERMAL PATH LENGTH.**

**THEREFORE, A CHIP CO-DESIGN STRATEGY IN WHICH THE CHIP’S CASE IS NON-METALLIC AND SEAMLESSLY INTEGRATED WITH THE COOLER, WHILE STAYING EXTERNAL TO THE TRANSISTOR NETWORK, WOULD BE ATTRACTIVE FROM BOTH THE COOLING AND COEFFICIENT OF THERMAL EXPANSION PERSPECTIVES.**

#### **IS THE CHIP’S \_CASE\_ REDESIGN OUT OF SCOPE?**

**ANSWER:** Chip design is considered out of scope of the FOA as per Section III.C.3 of the DE-FOA-0002852 Funding Opportunity Announcement. Case or lid modification can be considered package modifications and are allowable.

**Q5. MY QUESTION IS ON THE ELIGIBILITY OF COMPANIES SUCH AS COMPANY X TO PARTICIPATE AS PARTNERS (SUBCONTRACTORS TO THE PRIME) SINCE NOT ALL OF OUR SOFTWARE REQUESTED BY THE PRIME FOR THE PROJECT WOULD BE OPEN SOURCE. WE ALSO HAVE SOFTWARE WHICH LINKS TO THIRD PARTY SOFTWARE. OUR SOFTWARE LICENSES ARE NON-EXCLUSIVE AND ANY ENTITY CAN ACCESS THE SOFTWARE UNDER LICENSE (IF NOT UNDER EXPORT COMPLIANCE CONTROL).**

**ANSWER:** See answer for FAQ 2.

**Q6. PLEASE FIND THE FOLLOWING QUESTIONS REGARDING THIS FOA:**

- 1. IN SECTION I.D.2 OF THE FOA UNDER TECHNICAL REQUIREMENTS FOR CATEGORY B, THE FOA STATES THAT DESIGNS "...SHOULD NOT ASSUME THE AVAILABILITY OF WATER." IS IT PERMISSIBLE (AND CONSISTENT WITH THE INTENT OF THE FOA REQUIREMENTS) FOR AN APPLICANT'S CONCEPT ASSUME THAT CIVIC WATER INFRASTRUCTURE EXISTS AT THE MODULAR LOCATION (AS WOULD BE EXPECTED IN ANY POPULATED AREA) WITHOUT ANY ACTUAL WATER CONSUMPTION OR USE WITHIN THE DATACENTER?**
- 2. WHAT ARE THE COST SHARE EXPECTATIONS/REQUIREMENTS FOR GOVERNMENT ENTITIES (I.E. STATE AND LOCAL GOVERNMENTS)?**
- 3. WILL THERE BE ANY INFORMATION SAFEGUARDING REQUIREMENTS (E.G., CUI (I.E., CONTROLLED UNCLASSIFIED INFORMATION, CONTROLLED TECHNICAL INFORMATION, COVERED DEFENSE INFORMATION) OR CLASSIFIED (I.E., SECRET, TS, ETC.) TO SUPPORT THE PERIOD OF PERFORMANCE?**
- 4. WILL THERE BE ANY EXPORT CONTROL REQUIREMENTS (E.G., EAR, ITAR)?**
- 5. WILL THERE BE ANY NATURALIZATION RESTRICTIONS (I.E., US CITIZENS OR US PERSONS) REQUIRED TO SUPPORT THE PERIOD OF PERFORMANCE?**
- 6. IS THE COVER SHEET INCLUDED IN THE CONCEPT PAPER PAGE COUNT LIMIT?**

**ANSWER:**

1. As indicated in Section I.D.2 of the DE-FOA-0002852 Funding Opportunity Announcement. the design of solution meeting Category B: *"should operate as stand-alone outdoor units without the need for any external cooling facilities in any US environment"*.
2. Please see COOLERCHIPS FOA Section III.B. (Cost Sharing)
3. No, please see COOLERCHIPS FOA Section VIII. (Other Information)

4. No, however, a Prime Recipient of an Award under this FOA will be required to comply with U.S. export control laws and regulations in the performance of work under such Award.
5. No, please see COOLERCHIPS FOA Section III.A.3. Foreign Entities.
6. Yes, the cover sheet is included in the concept paper page count. Please use the Concept Paper template when submitting your application.

**Q7. WE PLAN TO SUBMIT OUR PROPOSAL FOR COOLERCHIP FOA – TECHNICAL CATEGORY C (SOFTWARE DEVELOPMENT). PLEASE PROVIDE AN ANSWER THE FOLLOWING TWO QUESTIONS:**

- 1. WHAT ARE POTENTIAL USERS FOR THE OPEN-SOURCE SOFTWARE PLATFORM DEVELOPED FOR COOLERCHIP PROGRAM?**
- 2. HOW DETAILED SHOULD THE TOOL COVER PERFORMANCE MODELING NEEDS FOR VARIOUS COMPONENTS OF A DATA CENTER?**

**ANSWER:**

1. The initial users of the software developed in Technical Category C will be the performers in Technical Categories A and B. The software should be available as an option to be used by these performers to demonstrate that their technologies meet the FOA requirements for energy consumption, reliability and cost. As developed under open-source it is anticipated that the software will be made available to the general public.
2. As indicated in Section I.D.2 of the DE-FOA-0002852 Funding Opportunity Announcement, the modeling software should be available to be used to model and simulate the overall data center energy usage, CO<sub>2</sub> footprint, reliability, and cost of the technologies developed and sufficiently detailed to accomplish this purpose. The software will also calculate operational carbon footprint based on the energy results and suitable carbon emission factors.

**Q8. PLEASE FIND THE ATTACHED QUESTIONS THAT WE HAVE PUT TOGETHER ALONG WITH UNIVERSITIES AND INDUSTRIAL TEAM MEMBERS. THESE QUESTIONS ARE RELATED TO THE COOLERCHIPS FUNDING OPPORTUNITY NO. DE-FOA-0002851.**

- 1. WHAT IS THE TARGETED CHIP JUNCTION OR CASE TEMPERATURE FOR THE FUTURE 1000 W PROCESSORS?**
- 2. IT WAS MENTIONED IN THE FOA A CHIP TEMPERATURE OF 70 – 90 °C (PG. 7). IS IT THE CHIP JUNCTION OR THE HEAT SPREADER TEMPERATURE?**
- 3. THERE IS NO CURRENT CHIPSET THAT IS 1000 WATTS, SO HOW ARE WE GOING TO TEST REALISTIC SERVER CHIPSETS? IS IT MANDATORY TO USE REALISTIC SERVER CHIPSETS OR TTVS WITH UNIFORM HEATERS THAT CAN BE USED TO TEST THE PROPOSED SOLUTIONS?**
- 4. A STATEMENT QUOTED HERE FROM PG.8 OF THE FOA "COOLERCHIPS WILL TARGET A THERMAL RESISTANCE LOW ENOUGH TO ENABLE POTENTIAL FUTURE 1000 W PROCESSORS TO BE COOLED WITH A COOLANT TEMPERATURE OF FEWER THAN 10°C BELOW CASE TEMPERATURE".  
WHAT WAS MEANT BY SENDING THE COOLANT SUPPLY TEMPERATURE TO CHIP 10 °C BELOW CASE TEMPERATURE, IS CASE TEMPERATURE HERE REFERRED TO JUNCTION OR HEAT SPREADER TEMPERATURE?**
- 5. CAN YOU PLEASE ELABORATE ON THE FOLLOWING QUOTED STATEMENT FROM THE FOA UNDER TECHNICAL CATEGORY B "SMALLER UNITS CAN BE PROPOSED AS LONG AS THIS VOLUMETRIC POWER DENSITY TARGET AND A MINIMUM OF 100 KW TOTAL COMPUTE POWER" PG.17. IS IT POSSIBLE TO PROTOTYPE AND TEST ON 100 KW POWER AS LONG AS THE 20 KW/M3 POWER DENSITY IS MET?**
- 6. CAN WE REQUIRE ACCESS DOORS ALL AROUND THE PERIMETER OF THE "ISO-CONTAINER" SIZED PACKAGE? ALLOWS MORE USE OF INTERIOR SPACE.**
- 7. CAN WE REQUIRE THE ISO-CONTAINER TO SIT ATOP DUNNAGE (STEEL FRAME, PROVIDED BY SITE, IN LIEU OF CONCRETE SLAB) TO ALLOW AIRFLOW ETCETERA ACCESS TO UNDERSIDE OF ISO CONTAINER?**
- 8. CAN WE HAVE AN INSTALLER ATTACHED DUCTING ETC. TO THE ISO CONTAINER? TYPICAL FIELD INSTALLED TYPE OF DUCTING.**
- 9. CAN WE SPECIFY AIR-COOLED OR LIQUID COOLED SERVERS ACCORDING TO OUR BEST DESIGN? CAN WE SPECIFY THE ASHRAE TC9.9 THERMAL CLASSIFICATION (EXAMPLE A4 FOR AIR COOLED) SIMILARLY FOR WATER COOLED?**

10. CAN FOREIGN ENTITY BE A MEMBER OF A PROJECT TEAM IN CATEGORY A AND B? CAN WE HAVE PARTNERS FROM OUTSIDE THE US?
11. WHAT ARE THE LIMITATIONS REGARDING THE MANUFACTURABILITY OF SYSTEM COMPONENTS, IS IT MANDATORY TO BE INSIDE THE USA?
12. CAN WE SUBMIT MULTIPLE APPLICATIONS FOR THE SAME TECHNICAL CATEGORY? ON FOA, PG. 5 AND PG. 37, CAN YOU PLEASE ELABORATE ON THE LIMITATIONS ON THE NUMBER OF SUBMISSIONS.
13. CAN ANY EQUIPMENT BE PLACED ON THE CONTAINER ROOF?
14. IS THERE ANY LIMITATION ON THE CONTAINER Z-DIRECTION?
15. CAN WE USE TTVS FOR SYSTEM COMMISSIONING AND LATER PARTIALLY USING REAL SERVER CHIPSETS (CPUS, GPUS) FOR TESTING?
16. CAN WE USE A 52U RACK INSTEAD OF THE STANDARD 42U RACK?
17. IS THERE ANY LIMITATION ON INSTALLING EQUIPMENT ON THE SIDES OF THE CONTAINER? ANY DIMENSIONS?
18. IS IT ADVANTAGEOUS TO BE HIGHER THAN 1 KW/PROCESSOR?
19. CAN WE INSTALL ANY COMPONENTS BELOW THE CONTAINER? ANY LIMITATIONS?
20. DO WE NEED TO KEEP SPACE FOR HUMAN ACCESSIBILITY? ANY REQUIREMENTS?

**ANSWER:**

1. The FOA does not specify a target case or junction temperature for future 1000 W processors. The FOA specifies a target thermal resistance that should be met regardless of case or junction temperature of relevant chipsets identified by the proposal.
2. The FOA specifies a target thermal resistance that should be met regardless of case or junction temperature of relevant chipsets identified by the proposal.
3. Realistic and relevant future chipsets are encouraged to be explored to ensure that relevant solutions are developed. Any test vehicle proposed needs to mimic realistic dynamic chip heat loads with relevant hot spots and non-uniformity as can be anticipated in relevant chipsets. It is not the intent that significant efforts in the projects are used to develop TTSV.
4. The top of the chip whether bare silicon or case.
5. Yes. The ISO 40 shipping container reference volume is a constraint on the maximum volume. Units with lower power and volume may be proposed as long as they meet the power density and minimum power requirements.
6. The ISO 40 container size is meant to be a reference volume, the configuration of the modular unit (including doors) may be specified by authors of the proposal.
7. In general there is no concern on having the modular compute system on a raised legs, however for fair comparison to other proposals, it would be easier to compare if during shipping these are folded or retracted and contained inside the ISO container system.

8. The system must initially fit within the volume of an ISO 40 shipping container for transport. Once on site and deployed, ducting may be installed or extended from the system as long as the ducting initially fit within the system boundary for transport.
9. There are no requirements relating to the server specifics as long as power density can be met.
10. Please see COOLERCHIPS FOA Section III.A.3. (Foreign Entities) and ARPA-E General FAQ 3.1.
11. Please see COOLERCHIPS FOA Section VIII. (Other Information), specifically, the Department of Energy's DETERMINATION OF EXCEPTIONAL CIRCUMSTANCES (DEC) UNDER THE BAYH-DOLE ACT TO FURTHER PROMOTE DOMESTIC MANUFACTURE OF DOE SCIENCE AND ENERGY TECHNOLOGIES. Further, any equipment or supplies acquired under an Award resulting from this FOA must be made or manufactured in the United States, to the maximum extent practicable.
12. Each application must contain only one proposed concept by one team applying to one Technical Category. However, teams may submit multiple applications in the same category if the applications are scientifically distinct, and may submit applications in multiple categories. Individual applicants may participate on multiple teams.
13. The Technical Category B systems must be initially fit within the volume of an ISO 40 shipping container for transport. It is acceptable to have components on the roof if the overall system fits within this constraint. Components may also be placed on the roof or extended from the modular system when deployed on site making the resulting system larger than an ISO 40 shipping container as long as those components fit within the system during transport.
14. The entire system must initially fit within the boundary of an ISO 40 shipping container for transport. This places a boundary on the Z-direction. Once deployed the system volume may exceed that of an ISO 40 shipping container with no constraint on the Z-direction under the condition that the entire system must fit within the ISO 40 shipping container boundary prior to deployment.
15. Realistic and relevant future chipsets are encouraged to be explored to ensure that relevant solutions are developed. Any test vehicle proposed needs to mimic realistic dynamic chip heat loads with relevant hot spots and non-uniformity as can be anticipated in relevant chipsets. It is not the intent that significant efforts in the projects are used to develop TTSV.
16. Yes, a 52U rack may be used as long as power density targets are met.
17. There are no restrictions on installing equipment on the sides of unit. However, all equipment must initially fit within an ISO 40 shipping container for transport prior to being deployed in the field. The final deployed unit may have equipment installed on or extended / deployed from the sides.
18. The FOA does not directly specify chip power, only minimum power density and minimum partial rack power. It is encouraged to look at relevant future chipsets.
19. In general there is no concern on having the modular compute system on a raised legs, however for fair comparison to other proposals, it would be easier to compare if during shipping these are folded or retracted and contained inside the ISO container system.
20. There are no FOA requirements for human accessibility, but proposals need to include realistic maintenance and operation practices that allow for commercial viability.

**Q9. WE HAVE THE FOLLOWING QUESTIONS ABOUT THE COOLERCHIPS FOA.**

- 1. WHAT WILL BE THE AVAILABILITY OF THE TEST FACILITIES OFFERED BY TECHNICAL CATEGORY D TO THE PROGRAMS IN TECHNICAL CATEGORIES A/B? WILL THE TEST FACILITIES BE AVAILABLE THROUGHOUT THE PROGRAM, OR ONLY DURING A SHORT TIME WINDOW AT THE END OF THE PROGRAM?**
- 2. WILL TTVS BE AVAILABLE TO TECHNICAL CATEGORIES A/B, OR DO THEY NEED TO SOURCE/CREATE THEIR OWN?**
- 3. REGARDING THE MASS FLOW RATE OF THE FACILITY WATER, IS THERE ANY PROGRAM CONSTRAINT AS TO WHAT CAN BE ASSUMED FOR THE FLOW RATE FOR TECHNICAL CATEGORY A? FOR EXAMPLE, CAN THE FLOW RATE BE INCREASED, AS LONG AS THE INCREASED PUMPING POWER BE INCLUDED IN THE ANALYSIS?**
- 4. DOES THE DESIRE TO HAVE LOWER WATER CONSUMPTION INCLUDE CLOSED-LOOP WATER USAGE?**

**ANSWER:**

1. Technical Category D schedules are not specified in the FOA. The intent is for Technical Category D facilities to be available to the Category A and B teams as early in the program as possible.
2. Realistic and relevant future chipsets are encouraged to be explored to ensure that relevant solutions are developed. It is the Applicant's responsibility to identify these and describe the relevance of their proposed chipset. Any test vehicle proposed needs to mimic realistic dynamic chip heat loads with relevant hot spots and non-uniformity as can be anticipated in relevant chipsets. It is not the intent that significant efforts in the projects are used to develop TTSV.
3. For Category A, teams are to develop a technology for inside the compute room with an energy target of less than 3% of IT\_load. In addition, teams are to develop a relevant system that articulates how total heat rejection to ambient can be achieved within 2% of the IT\_load. This includes primary cooling loop and any heat rejection to ambient energy. Mass flows and dry cooler dimensions for category A primary cooling loops are to be within conventional energy standards. Relevance and proper sizing of such a system has to be substantiated by references in any proposal.



4. Closed-loop water usage is allowed and not in conflict with a desire to lower operational water consumption..

**Q10. THANK YOU FOR THE RESPONSE. PER YOUR RESPONSE BELOW AS I UNDERSTAND THAT IT IS NOT MANDATORY THAT THE BASE SOFTWARE THAT IT IS DEVELOPED UPON BE OPEN-SOURCE BUT MUST BE GENERALLY AVAILABLE TO ANY USERS OF THE MODEL. DOES IT MEAN THE BASE SOFTWARE NEEDS TO BE MADE AVAILABLE TO ALL THE USERS OR ONLY TO THE GRANTEE OF THE DE-FOA-0002851? ALSO, CAN THIS BASE SOFTWARE BE MADE AVAILABLE AS PAID LICENSE TO THE NON-GRANTEE USERS?**

**YOUR RESPONSE TO OUR PREVIOUS QUESTION: AS PER DE-FOA-0002851 COOLERCHIPS FUNDING OPPORTUNITY ANNOUNCEMENT SECTION 1.D.2, TECHNICAL CATEGORY C PROJECT TEAMS SHALL MAKE THE SOFTWARE DEVELOPED UNDER THE COOLERCHIPS PROGRAM AVAILABLE UNDER OPEN-SOURCE, BUT IT IS NOT MANDATORY THAT THE BASE SOFTWARE THAT IT IS DEVELOPED UPON BE OPEN-SOURCE. HOWEVER, TO THE EXTENT THE SOFTWARE THAT IS DEVELOPED UNDER AN AWARD IS A MODULAR ADDON THAT REQUIRES ACCESS TO ADDITIONAL SOFTWARE NOT AVAILABLE AS COMPATIBLE OPEN SOURCE, SUCH ADDITIONAL SOFTWARE IS NOT REQUIRED TO BE AVAILABLE AS OPEN SOURCE BUT MUST BE GENERALLY AVAILABLE TO ANY USERS OF THE MODEL.**

**ANSWER:** It is not required for base software to be open source, but it has to be generally available. Generally Available Software means that the base software is commercially available to any member of the public under a widely accepted non-exclusive license agreement.

**Q11. I AM A RESEARCHER FROM [REDACTED]. I AM INTERESTED IN TECHNICAL CATEGORY (TC) B AND WOULD LIKE TO PROPOSE A RESEARCH CONCEPT SIMILAR TO THE 4TH EXAMPLE DESCRIBED IN THE FOA. I PLAN TO REDESIGN THE GEOMETRY OF THE MODULAR DATA CENTER FOR LOW-ENERGY HEAT REJECTION FROM THE INTERNAL COMPUTE SYSTEMS TO THE AMBIENT.**

**AS STATED IN THE FOA, TC B'S SCOPE IS MUCH LARGER THAN TC A. I HAVE THE FOLLOWING QUESTIONS.**

1. **CAN THE PROPOSAL MAINLY FOCUS ON THE BIO-INSPIRED ARCHITECTURAL DESIGN AND AIR MANAGEMENT TO OPTIMIZE HEAT REJECTION IN THE MODULAR DATA CENTER? OR WE ALSO NEED TO COVER THE CRAC SYSTEM DESIGN?**
2. **ALL TARGETS IN TABLE 5 MUST BE MET IN THE PROPOSAL? OR WE CAN JUST PICK THOSE HEAT REJECTION RELATED TARGETS AND USE THE OTHER TARGETS AS BOUNDARY CONDITIONS FOR THE DESIGN OPTIMIZATION?**

**ANSWER:**

1. Proposals for Technical Category B should be for **complete** modular pod systems. The FOA does not require the use of a CRAC system, but the proposed system must meet the FOA requirements and reject all generated heat to the ambient within the proposed power limits. Performers are encouraged to form multidisciplinary teams to produce complete testable prototypes that meet the FOA specifications.
2. All targets must be met as listed in Table 5.

**Q12. I HAVE READ YOUR ANSWER TO Q1 REFERENCING SECTION III.A.3. FOREIGN ENTITIES. HOWEVER, IT WASN'T CLEAR TO ME.**

**WOULD APPRECIATE IF YOU CAN ANSWER ME WHETHER A FOREIGN SMALL BUSINESSES WHO HAS A SUBSIDIARY INCORPORATED UNDER THE LAWS OF A STATE OF THE UNITED STATES, IS ELIGIBLE TO APPLY TO THIS FOA (DE-FOA-0002851) OR SHOULD IT APPLY TO DE-FOA-0002852?**

**ANSWER:** ARPA-E may not provide pre-submission assessments on a project team's eligibility. Applicants should carefully review the eligibility requirements for the specific FOA to which they intend to submit a Concept Paper or Full Application.

**Q13. I WAS WONDERING WHETHER THERE IS A MORE SPECIFIC ANNOUNCEMENT RELATED TO THIS CALL ON NEW COOLING TECHNOLOGIES FOR DATA CENTERS.**

**NAMELY, I WOULD LIKE TO KNOW WHETHER A SYSTEM DESIGN IS ACCEPTABLE, OR DO WE HAVE TO WORK WITH A COMPANY AND MAKE SOMETHING?**

**ANSWER:** The FOA is the definitive document related to this call for new cooling technologies for data centers. Performers in Technical Categories A and B must produce testable systems that can be demonstrated to meet the FOA targets. Performers are encouraged to form multidisciplinary teams to produce testable hardware based on innovative system designs. As per section Section III.C.3 of the DE-FOA-0002852 Funding Opportunity Announcement, paper study alone (i.e. without any hardware development and testing) will be deemed nonresponsive and will not be merit reviewed or considered.

## **II. Full Application Phase Questions:**

**Q14. [REDACTED] AS YOU KNOW, THE STATED DEADLINE FOR SUBMISSION OF FULL APPLICATIONS IS 9:30 AM EASTERN TIME ON JANUARY 27, 2023. DUE TO THE CHRISTMAS AND NEW YEAR'S HOLIDAYS VACATIONS IMPACTS, WE [REDACTED] REQUEST AN EXTENSION FROM THE ORIGINAL DATE TO 10 FEB 2022 AS THE UPDATED SUBMISSION DEADLINE FOR FULL APPLICATIONS FOR [REDACTED] ALL PROPOSERS.**

**ANSWER:** ARPA-E has considered your request, but declines to extend the full application due date at this time.

**Q15. TO REMAIN COMPLIANT, FOR SECTIONS 6 AND 7 WITHIN THE TECHNICAL VOLUME TEMPLATE, SHOULD SOMEONE NOT APPLYING TO THOSE CATEGORIES JUST DELETE THE NON-APPLICABLE SECTION OR SHOULD THEY LEAVE IT IN AND JUST MARK IT AS NON-APPLICABLE?**

**ANSWER:** Applicants should not delete any sections of the technical volume template. Sections that do not apply to your application may be marked "Not Applicable".

**Q16. I WOULD LIKE TO HAVE SOME CLARIFICATIONS ON THE FOA'S SECTION "3. PROGRAM STRUCTURE AND DELIVERABLES", PAGE 26.**

- **THE THIRD PARAGRAPH OF SECTION #3 SPECIFIES THE DELIVERABLES PRE- AND POST- GO/NO-GO MILESTONE. FOR TECHNICAL CATEGORY A, IT IS STATED THAT THE PRE- GO/NO-GO DELIVERABLES INCLUDE "SUCCESSFUL TESTING OF THE PROPOSED COOLING TECHNOLOGY ON AT LEAST ONE HIGH-POWER SERVER." WHAT IS THE DEFINITION OF "ONE HIGH POWER SERVER"? IS IT >10 KW, WITH A SYSTEM >80 KW/M<sup>3</sup>, AS PER TABLE 4?**

- **THE SAME PARAGRAPH READS: "[...] WITH THE INCLUSION OF THE ENTIRE BALANCE OF PLANT OF THE SECONDARY LOOP." DOES THE STATEMENT IMPLY THAT A SERVER/LOOP SYSTEM OF IT POWER [AT LEAST] 10 KW AND POWER DENSITY [AT LEAST] 80 KW/M<sup>3</sup> IS EXPECTED TO BE DEMONSTRATED AT THE END OF THE DE-RISK PHASE, PRIOR TO THE GO/NO-GO MILESTONE?**

- **THE SAME PARAGRAPH READS: "DEVELOPMENT ACTIVITIES POST GO/NO-GO ARE ANTICIPATED TO FOCUS ON THE APPLICATION AND TESTING OF THE PROPOSED COOLING TECHNOLOGY ON A FULL HIGH-POWER SERVER SYSTEM." WHAT IS THE RANGE OF POWER THAT DEFINES "HIGH-POWER SERVER SYSTEM"?**

**ANSWER:** It is expected that at the intermediate point of the project, major risks regarding the performance of the proposed solution are retired by a demonstration on a less than full-scale, but relevant system. It is up to the applicant to describe this system and articulate its relevance regarding meeting the FOA's target metrics at the end of the program. The power targets of the final system are described by the FOA target metrics. Please see FOA Section I.D.2 Technical Performance Targets.

**Q17. MY NAME IS \*\*REDACTED\*\*, PRINCIPAL INVESTIGATOR WITH \*\*REDACTED\*\* FOR COOLERCHIPS JOINT PROPOSAL WITH SUBRECIPIENTREDACTED\*\*. IN PREPARATION OF A FULL APPLICATION FOR OUR ABSTRACT SUBMISSION \*\*REDACTED\*\*, WE WOULD LIKE TO CLARIFY THE FOLLOWING QUESTIONS:**

**A. GENERAL QUESTIONS:**

- 1. IS THE SUBRECIPIENT PERMITTED TO SUBMIT QUESTIONS INDEPENDENT OF THE PRIME RECIPIENT?**

**B. FINANCE AND BUDGETARY QUESTIONS**

- 1. \*\*REDACTED\*\* AS THE PRIME RECIPIENT IN COLLABORATION WITH \*\*REDACTED\*\* AS A SUBRECIPIENT PLANS TO APPLY FOR AN OTA FUNDING AGREEMENT WITH ARPA-E BASED ON MILESTONE DELIVERABLES DUE TO THE COMPLEXITY OF OUR BUSINESS PROCESSES AND THE FACT THAT OUR FINANCIAL SYSTEMS ARE NOT APPROVED TO TRACK COST PLUS WORK. UNDER AN OTA AGREEMENT, DO WE STILL HAVE TO FILL OUT THE SF-424A FORM?**
- 2. IN THE CASE OF SALARY CAP GUIDANCE GIVEN THAT INDUSTRY PAY RATES ARE TYPICALLY HIGHER THAN \$200K, CAPPING SALARY TO THIS EFFECTIVELY INCREASES OUR COST SHARE. SHOULD WE SHARE SALARY ACTUALS TO MAKE THE COST SHARE COMMITMENT MORE TRANSPARENT?**
- 3. SHARING FULL SALARY AND INDIRECT RATE INFORMATION FOR THE INDIVIDUAL WOULD EXPOSE PERSONAL INCOME DATA THAT IS NOT ALIGNED WITH COMPANY POLICY. WE PROPOSE TO USE AN AVERAGE RATE TO KEEP INDIVIDUAL PAY CONFIDENTIAL, IS THIS ACCEPTABLE?**
- 4. UNDER AN OTA AGREEMENT, IF WE DO NOT ALREADY HAVE AN INDIRECT COST RATE AGREEMENT, DO WE NEED TO SUBMIT A PROPOSAL FOR ONE AND BE SUBJECT TO ANNUAL AUDITING FOR THIS?**

## C. TECHNICAL QUESTIONS:

1. **THE DEFINITION OF TCASE IN THE FOA IS A LITTLE UNCLEAR. THE INDUSTRY-ACCEPTED DEFINITION OF TCASE IS THE TEMPERATURE OF THE CENTER (TYPICALLY) OF THE INTEGRATED HEATSINK (OR LID) THAT IS PLACED OVER THE BARE DIE. HOW IS TCASE DEFINED IF A PROPOSER WORKS DIRECTLY WITH BARE DIE, I.E., WITH THE LID AND TIM1 (TIM1 = THERMAL INTERFACE MATERIAL 1) REMOVED?**
2. **IN RELATION TO TECHNICAL QUESTION #1, CAN A TJ (JUNCTION TEMPERATURE) BE USED INSTEAD OF TCASE IF WORKING WITH BARE DIE? IF TJ CAN BE USED, WOULD IT BE SUFFICIENT TO SHOW THAT THE COOLING SOLUTION IS CAPABLE OF KEEPING THE CPU/GPU/ASIC/OTHER WITHIN A SPECIFIC MANUFACTURER'S TJ REQUIREMENT, AS OPPOSED TO HAVING TO SHOW, PER THE FOA, THAT THE COOLING SOLUTION CAN KEEP A 1 KW DEVICE'S TCASE WITHIN 10C OF THE INCOMING FLUID TEMPERATURE?**
3. **IS IT NECESSARY TO DEMONSTRATE BOTH 126 KW/RACK AND A DATA CENTER DENSITY OF 80 KW/M3, OR IS IT SUFFICIENT TO DEMONSTRATE 80 KW/M3 WHILE USING A RACK THAT IS UNDER 126 KW?**

**ANSWER:** A.1. yes, anyone can submit a question to ARPA-E regarding an existing FOA.

B.1. Applicants must complete and submit all required Application documents. ARPA-E will not provide a pre-submission assessment of a project team's potential agreement with ARPA-E. If selected, ARPA-E will address the form of the award during negotiations.

B.2. ARPA-E will not provide a pre-submission assessment of a project team's cost share.

B.3. Please reference ARPA-E General FAQ 7.12 regarding marking confidential, proprietary, and privileged information in your Full Application. B.4. ARPA-E will not provide a pre-submission assessment of a project team's potential agreement with ARPA-E. If selected, ARPA-E will address the form of the award during negotiations.

C.1. In that case, the performer should use the top of the die as the location of the temperature consideration, i.e. the location of Tcase.

C.2. regardless of the solution proposed, the FOA thermal resistance target as defined in Section I.D.4 must be met

C.3. For Category A, as defined in Section 1.D.4, Table 4, the proposed solution should meet the volumetric rack power density as defined in Section 1.C., Table 1, (which includes balance of plant) of at least 80 kW/m<sup>3</sup>. A minimum of 10 kW for a partial rack (or system) is expected for a demonstration at the end of the program, as indicated by Table 1 to meet FOA target.

**Q18. PAGE 18 OF THE FOA STATES "THE SIMULATIONS MAY USE MODELS DEVELOPED BY THE TEAMS THEMSELVES OR BY USING SOFTWARE DEVELOPED BY A TECHNICAL CATEGORY C TEAM."**

**WOULD IT BE REASONABLE THEN FOR A PROPOSAL FOR TECHNICAL CATEGORY A TO SIMPLY STATE THAT WE WOULD USE "SOFTWARE DEVELOPED BY A TECHNICAL CATEGORY C TEAM" WITHOUT KNOWING WHICH TEAM WOULD PROVIDE IT, IE, ASSUMING ARPA-E PM WOULD FACILITATE THIS? OR IS IT CONSIDERED A REQUIREMENT OF TECHNICAL CATEGORY A TEAMS TO HAVE PLANS TO DEVELOP SUCH A MODEL OR TO HAVE IDENTIFIED A TEAM APPLYING FOR TECHNICAL CATEGORY C THAT IS COMMITTED TO SHARING THEIR SOFTWARE?**

**ANSWER:** Categories A and B applicants are to justify their concept meeting FOA targets in their proposals using data and models. During the program this capability can potentially be complemented by Category C team provided additional modeling capability

**Q19. THE QUESTION IS STATED AS FOLLOWS:**

**"3M HAS RECENTLY ANNOUNCED THEIR EXIT FROM MANUFACTURING NOVEC AND FLUORINERT FLUIDS -- HOW WOULD THE FUTURE RESEARCH OF 2-PHASE IMMERSION COOLING BE IMPACTED BY THIS DECISION, GIVEN 1) IT MAY BE DIFFICULT TO FIND A REPLACEMENT SUPPLIER AND 2) COMPATIBILITY AND PERFORMANCE OF ALTERNATIVE FLUIDS IS A TOPIC WORTH EXPLORING?"**

**ANSWER:** Teams should provide a commercially viable solution meeting the FOA targets.

**Q20. FOR THE TECHNICAL CATEGORY A, THE POWER DENSITY METRIC IS 80 KW/M<sup>3</sup>:**

**-VOLUME: DOES THIS INCLUDE THE PRIMARY LOOP HEAT EXCHANGER THAT REJECTS HEAT TO AMBIENT?**

**-POWER CONSUMPTION, DOES THIS INCLUDE THE ENERGY CONSUMED BY THE PRIMARY LOOP, SUCH AS PUMPING POWER AND DRYCOOLER FAN POWER? DOES THIS INCLUDE THE POWER CONSUMPTION OF COMPUTE COMPONENTS IN ADDITION TO THE MAIN PROCESSORS, SUCH AS DIMMS, POWER SUPPLIES, AND HARD DRIVE COMPONENTS?**

**ANSWER:** The power density metric for Technical Category A relates to the secondary loop only. The power density volume includes any CDU or heat exchanger that reject heats from secondary loop to primary loop but does not include any other components in the primary loop like heat exchangers from primary loop to ambient. In Technical Category A the requirement is for the power consumption of the secondary loop to be less than 3% of the IT load. The overall heat rejection to ambient should not exceed 5% of the IT load estimated by simulation as described in Section I.D.2 Table 4.

Q21. 1. IS THE LEAD INSTITUTION REQUIRED TO PROVIDE A HIGHER PERCENT OF PROJECT?  
EXAMPLE:

CURRENT LEAD INSTITUTION=25% (HIGHER EDUCATION UNIVERSITY)

SUB-A=11% (ACADEMIC)

SUB-B=18% (FFRDC)

SUB-C=46% (LARGE BUSINESS)

CAN THE CURRENT LEAD STAY THE LEAD OR DOES SUB-C TAKE OVER AS LEAD?

2. COST SHARING. I HAVE READ THE ANNOUNCEMENT WITH A DOZEN PEOPLE AND EVERYONE INTERPRETS IT DIFFERENTLY. GIVEN THE ABOVE EFFORTS AND ORGANIZATION TYPES, DO WE QUALIFY FOR A REDUCED RATE (10%) OR DO WE NOT MEET THE REDUCTION CRITERIA AND MUST USE THE STANDARD 20%

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- Project Teams where domestic educational institutions, domestic nonprofits, small businesses, and/or FFRDCs perform greater than or equal to 80% of the total work under the funding agreement (as measured by the Total Project Cost) are required to provide at least 10% of the Total Project Cost as cost share. However, any entity (such as a large business) receiving patent rights under a class waiver, or other patent waiver, that is part of a Project Team receiving this reduction must continue to meet the statutory minimum cost share requirement (20%) for its portion of the Total Project Cost.

ANSWER:

1. The lead can stay as long as they meet the criteria in Section III.A of the FOA.
2. Under that arrangement you do not meet the reduction criteria and would be required to provide 20% cost share.

**Q22. PLEASE FIND THE ATTACHED QUESTIONS THAT WE HAVE PUT TOGETHER ALONG WITH UNIVERSITIES AND INDUSTRIAL TEAM MEMBERS. THESE QUESTIONS ARE RELATED TO THE COOLERCHIPS FUNDING OPPORTUNITY NO. DE-FOA-0002851.**

- 1. FOR SMALL BUSINESS ENTITY WE WOULD LIKE TO VERIFY THAT THE COST SHARE IS 10% AND MAY BE INVESTED AS "IN KIND", LABOR, MATERIALS, FACILITIES ETC. IS THIS CORRECT?**
- 2. SHOULD PERFORMANCE TESTS SHOWING COOLING POWER < 5% IT POWER BE DONE AT DESIGN CONDITION (40 C AMBIENT) OR THE PERFORMANCE CAN BE EXTRAPOLATED FROM MEASUREMENTS DONE AT OTHER CONDITIONS?**
- 3. HOW DOES ARPA-E PLAN TO SYNERGIZE EFFORTS OF TECH CATEGORY B WITH THAT OF TECH CATEGORY C, ESPECIALLY WITH TOOLS TO DESIGN AND ANALYZE DATA CENTER SYSTEM PERFORMANCE AND COSTS?**
- 4. ARPA-E EXPECTS TO DEMONSTRATE A PATH TO ACHIEVE A COST SIMILAR TO THAT OF CONVENTIONAL DATA CENTERS TODAY. IS IT LIFE CYCLE COST OR CAPITAL COST?**
- 5. IS THERE ANY LIMITATION FOR HIRING CONSULTANTS?**
- 6. IS THERE ANY LIMITATION FOR HIRING SUBCONTRACTORS?**
- 7. FOR CAT B, DOES THE SYSTEM NEED TO BE DEPLOYED IN A CONTAINER? IF NOT, ARE THERE ANY REQUIREMENTS FOR THE LAB OR THE TEST FACILITY THAT THE SYSTEM CAN BE DEPLOYED IN?**
- 8. IF THE SYSTEM IS INSTALLED INSIDE A LAB OR A TEST FACILITY, THERE MIGHT BE SOME CONNECTIONS BETWEEN THE INTERNAL SYSTEM AND THE EXTERNAL HEAT REJECTION UNIT THAT WILL NOT BE REQUIRED IN THE ACTUAL MODULAR DATA CENTER. IS THAT ACCEPTABLE?**
- 9. FOR CAT B, A RACK-LEVEL DEPLOYMENT CAN BE TESTED IN THE ENVIRONMENTAL CONDITIONS SPECIFIED BY THE FOA. HOWEVER, TESTING THE OVERALL SYSTEM UNDER THESE HARSH ENVIRONMENTAL CONDITIONS MIGHT BE CHALLENGING. ARE THERE ANY SPECIFIC REQUIREMENTS FOR THE FULL-SCALE DEPLOYMENT TEST ENVIRONMENTAL CONDITIONS?**
- 10. FOR THE FINAL DEPLOYMENT CAT B, DOES THE WHOLE LOAD NEED TO BE ACTUAL SERVERS, OR IT COULD BE A COMBINATION OF TTVS AND ACTUAL SERVERS?**
- 11. WHAT IS THE MINIMUM SCALE OF DEPLOYMENT IN KW AND THE NUMBER OF RACKS FOR CAT B?**
- 12. HOW CAN WE CONFIRM IF THERE IS AN AVAILABLE CAT D TEST FACILITY?**



- 13. IS USING A CAT D TEST FACILITY MUST BE CONSIDERED AS A PART OF THE PROJECT BUDGET?**
- 14. FOR CAT B, IS IT OK TO USE RENTAL TEST FACILITIES FOR THE FULL DEPLOYMENT?**
- 15. THE PERFORMANCE METRIC FOR COOLING IS GIVEN AS IN THE UNITS OF K/W, INSTEAD OF AN AREA- INDEPENDENT RESISTANCE OF K-CM<sup>2</sup>/W. THE METRIC K/W IS HIGHLY INFLUENCED BY THE HEAT FLUX (I.E. HEAT GENERATED PER UNIT AREA) ON THE DIE OR CHIP; THE SAME COOLING TECHNOLOGY APPLIED TO DIFFERENT DIES WITH DIFFERENT HEAT FLUXES, WILL HAVE A K/W THAT SCALES WITH THE INVERSE OF THE HEATED AREA OF THE CHIP. HOW DOES A REVIEWER PLAN TO DIFFERENTIATE BETWEEN DIFFERENT COOLING TECHNOLOGIES BETWEEN DIFFERENT PROPOSALS GIVEN THIS ISSUE?**
- 16. IS A GWP<10 REQUIRED FOR SINGLE PHASE COOLANTS AS WELL?**
- 17. FOR THE 1.5YR CHECKPOINT, TO VALIDATE TECHNOLOGY RISK MITIGATION IN ORDER TO PROCEED TO THE 3YR FINAL PROJECT GOALS, IS IT SUITABLE TO USE A) DETAILED ANALYSIS AND/OR B) SCALE MODEL TESTING. COULD ONE OR THE OTHER (ANALYSIS OR TESTING), OR BOTH BE PROPOSED WITH EQUAL SUITABILITY, PER ENGINEERING DETERMINATION? THIS FOR A CRITICAL NEW TECHNOLOGICAL INNOVATION THAT MUST MEET CERTAIN PERFORMANCE LEVELS IN ORDER TO ACCOMPLISH PROJECT GOALS. ONE EXAMPLE IS: A NOVEL HEAT EXCHANGER CONFIGURATION WITH MUCH HIGHER KW/M<sup>3</sup> DENSITY THAN CURRENTLY AVAILABLE. ANOTHER EXAMPLE IS: A NOVEL TECHNIQUE FOR MANAGING SINGLE- AND TWO-PHASE FLOW STREAMS TO ACCOMPLISH SYSTEM EFFICIENCIES BEYOND CURRENT STATE OF THE ART?**
- 18. CAN THE FULL PROPOSAL CONTAIN ALTERNATIVE TECHNOLOGY SOLUTIONS THAT MAY BE SELECTED AS A PART OF ANALYSIS AND TEST RESULTS DURING THE PROJECT WORK? THESE ALTERNATES MAY ALLOW TECHNOLOGY RISK MITIGATION. THESE ALTERNATES MAY ALSO ALLOW PROVISION FOR DIFFERENT ADVANTAGES (SUCH AS HIGHER EFFICIENCY OR SIMPLICITY ON ONE HAND COMPARED TO FASTER COMMERCIALIZATION POTENTIAL ON THE OTHER HAND), OR THEY MAY SIMPLY BE ALTERNATE EMBODIMENTS. ONE EXAMPLE IS: AN AIR-COOLING SOLUTION FOR CERTAIN SERVER ELEMENTS, AND A LIQUID IMMERSION ALTERNATIVE FOR THOSE SAME ELEMENTS.**

19. THE PERIOD OF PERFORMANCE IS LISTED AS “UP TO 36 MONTHS” (PAGE 6). IS IT ACCEPTABLE TO HAVE AN ACCELERATED PROPOSAL WITH LESS THAN 36 MONTHS COMPLETION? IS THERE ANY ADVANTAGE TO AN ACCELERATED PROPOSAL FOR THE PURPOSE OF SELECTION FOR FUNDING, SUCH AS BEING THAT MUCH CLOSER TO COMMERCIALIZATION?
20. THE CATEGORY B REQUIREMENT FOR “99.982% AVAILABILITY” ALSO “EQUIVALENT TO TIER 3 UPTIME” BRINGS TO MIND THE CONCEPT OF A “RUNNING STANDBY”. THAT IS, THE RELIABILITY NARRATIVE IN WHICH AN N+1 OR SIMILAR APPROACH FOR MODULAR REDUNDANCY CAN ALLOW THE STANDBY MODULE(S) TO OPERATE, WITH AN ADDED BENEFIT OF HIGHER EFFICIENCY. IS IT ACCEPTABLE TO USE THAT PEAK N+1 RUNNING EFFICIENCY TO DEMONSTRATE THE 5% GOAL, WHILE AT THE SAME TIME ACCEPTING THAT WHEN THE REDUNDANT MODULE IS SHUT DOWN FOR MAINTENANCE, THEN DURING THAT MAINTENANCE INTERVAL, THE COOLING ENERGY CONSUMPTION IS >5%?
21. FOR THE TARGET OF 20 KW/M3 POWER DENSITY IN CAT B, DO WE NEED TO CONSIDER THE VOLUME OF REDUNDANT (STANDBY) UNITS?
22. THE THERMAL RESISTANCE OF 0.01 K/W IS DESCRIBED AS “COOLANT TO CHIP”. WE ASSUME THIS IS THE TEMPERATURE DIFFERENCE BETWEEN THE JUNCTION TEMPERATURE IN THE SILICON AND INLET TEMPERATURE OF THE COOLANT DIVIDED BY THE TOTAL POWER, CORRECT? PLEASE CONFIRM.
23. IN POWER DENSITY REQUIREMENT OF TECHNICAL TABLE. POWER DENSITY  $\geq 80$  KW/M3, INCLUDES VOLUME OF ANY BALANCE OF PLANT (CDUS, PUMPS, HEAT EXCHANGERS) THAT IS EITHER INSIDE THE RACK OR AS STAND-ALONE UNIT SIMPLIFIED AS BOUNDING BOX ENCOMPASSING THE OUTER DIMENSIONS OF THE SYSTEM, PLEASE CLARIFY WHAT DOES THAT MEAN?
24. WHAT DOES MINIMAL PARTIAL POWER OF > 10KW MEAN, PLEASE ELABORATE? SO, FOR CATEGORY A, WE NEED TO DO THE FINAL EXPERIMENTS ON ONE COMPLETE RACK OF 126 KW? MINIMUM REQUIREMENT IS 1U=3 KW. IS THIS CORRECT?
25. CAN WE DEMONSTRATE OUR TECHNOLOGY USING ONE SERVER AND AT RACK LEVEL DEMONSTRATION CAN WE USE TTVS?
26. FOR CATEGORY A FINALLY WE NEED TO SHOW THAT 126 KW 42U RACK WITH (CDU, PUMP HEAT EXCHANGER, FANS) THAT CONSUMES MAX POWER  $\leq 3\%$  IT LOAD AND AT CHIP LEVEL THERMAL RESISTANCE  $\leq 0.01$  K/W?

**27. IN THE CATEGORY A FIRST PARAGRAPH IT IS MENTIONED THAT CATEGORY A FROM CHIP TILL CDU OR HEAT EXCHANGER WHERE SECONDARY COOLANT EXCHANGE HEAT WITH FACILITY SIDE BUT IN TECHNICAL REQUIREMENTS IN POWER CONSUMPTION COLUMN YOU ARE TALKING ABOUT HEAT REJECTION TO AMBIENT < 5% IT LOAD. IF WE ASSUME THAT CATEGORY A HAS CRITERIA OF HEAT REJECTION TO AMBIENT < 5% OF IT LOAD BUT AS MENTIONED FOA FOR CATEGORY B, WE CAN SHOW TECHNOLOGY AT PARTIAL LOAD AND IF I ASSUME THAT PARTIAL LOAD TO BE 126KW FOR CATEGORY B. DOESN'T THE CATEGORY B BECOME CATEGORY A? PLEASE CLARIFY ON IT?**

**ANSWER:**

1. Small businesses – or consortia of small businesses – may provide 0% cost share from the outset of the project through the first 12 months of the project (hereinafter the “Cost Share Grace Period”). If the project is continued beyond the Cost Share Grace Period, then at least 10% of the Total Project Cost (including the costs incurred during the Cost Share Grace Period) will be required as cost share over the remaining period of performance.

Project Teams may provide cost share in the form of cash or in-kind contributions. Cash contributions may be provided by the Prime Recipient or Subrecipients. Allowable in-kind contributions include but are not limited to personnel costs, indirect costs, facilities and administrative costs, rental value of buildings or equipment, and the value of a service, other resource, or third-party in-kind contribution.

2. Efforts should be made to test as close to the design conditions as possible. It is anticipated that extrapolation will be required to reach the full design conditions.

3. Support from Tech Category C teams is described in Section I.D.2, Table 6.

4. Cost of the system should target system payback of 7 years and investment rate of return (IRR)  $\geq$  10% targets as described in Section I.D.2., Table 4.

5. There are limitations to the extent the costs are reasonable, necessary and allocable to the project.

6. See answer 5. above.

7. The system needs to be transportable, and its shipping volume should not exceed a regular ISO 40 container as described in Section I.D.2., Technical Category B. There is no requirement for it to be in a container. Any test facility needs to be able to provide power and other requirements as described in Section I.D.2., Table 7.

8. Yes, during development that is acceptable. FOA targets need to be met for the final deliverable.

9. Environmental testing of Technical Category B technologies **may** include simulated environments as well as outdoor testing as described in Section I.D.2., Table 7.

10. It acceptable to use thermal test vehicles (TTV) that simulate realistic server chipsets operating realistic workloads where relevant, however it is up to the applicant to describe this system and articulate its relevance.

11. The number of servers and internal rack size of the Technical Category B data centers is not constrained. The rack power density shall be at least 3 kW/U with at least 100 kW IT load overall as described in I.D.2., Technical Category B.
12. The COOLERCHIPS program intends to also award two support Technical Categories: Technical Category C and Technical Category D.
13. It is expected that Technical Category A and Technical Category B teams operate the tests themselves with support from the Technical Category D facility team as described in I.D.2., Technical Category D and budget accordingly.
14. The system-wide total cooling energy target of  $\leq 5\%$  IT load shall be verified experimentally by the teams themselves using their own facility or using facilities provided by the Technical Category D team(s) as described in Section I.D.2., Technical Category B.
15. It is important that chip and electronics cooling innovations are proposed on realistic server chipsets operating realistic workloads. From FOA, Section V.A.2: "Full Applications are evaluated based on the following criteria [...] Substantiation that the proposed project is likely to meet or exceed the technical performance targets identified in this FOA".
16. Yes, as defined by Section I.C., Table 3.
17. See answer to Q16.
18. Yes, as long as it is articulated how FOA targets are met. Awards will include a specific Go/No-Go milestone approximately halfway through the project to evaluate the overall progress made in de-risking during the first period with an assessment presented of the potential for success of evaluating the technology at scale during the remaining project term as described in Section I.D.3.
19. Period of Performance can be less than 36 months. The applicant is responsible to decide what to propose.
20. Any standby equipment that is operating to meet FOA reliability targets should be include in the performance evaluation. There is no requirement to meet FOA targets during maintenance or unscheduled outage.
21. See answer Q22-20.
22. The FOA describes Section I.D.2., Technical Category A; target chip surface to facility coolant supply thermal resistance of less than 0.01 K/W. This describes the temperature difference from chip surface to facility coolant divided by the chip heat dissipation.
23. The power density reference volume consists of the sum of the rack volume and the volume of the balance of plant components. These volumes may be calculated by calculating the volume of bounding boxes placed around the racks and around the balance of plant components (such as CDUs, pumps and heat exchangers, etc).
24. A reference rack with total power dissipation of 126 kW was used to evaluate the power density target. Having a rack that dissipates 126 kW is not a requirement. COOLERCHIP technologies that service partial racks shall meet the power density target of 80 kW/m<sup>3</sup> and in addition must have a minimum rack power of 10 kW as described by Section I.D.2., Table 4.

25. COOLERCHIP technologies that service partial racks shall meet the power density target of 80 kW/m<sup>3</sup> and in addition must have a minimum rack power of 10 kW. Use of TTVs is described in answer Q21-10.

26. See answer Q21-24. The FOA targets on power consumption and thermal resistance must be met.

27. Technical Category A will focus on innovations in the secondary cooling loop rejecting heat from the compute room electronics to the facility supply. In Technical Category A the requirement is for the power consumption of the secondary loop to be less than 3% of the IT load. The overall heat rejection to ambient should not exceed 5% of the IT load estimated by simulation as described in Section I.D.2 Table 4.

Technical Category B will focus on modular EDGE data center designs that manage heat rejection from chipsets to ambient with minimal carbon footprint. This could be a single cooling loop optimized for the modular computing system or multiple loops as needed. The power consumption requirement for Technical Category B is that the overall heat rejection to ambient should not exceed 5% of the IT load. Category B technologies may perform at loads as low as 100 kW but must also meet other conditions as specified in Table 5.

**Q23. I HAVE A QUESTION ABOUT ENGAGING US NATIONALS AS CONSULTANTS IN THE COOLERCHIPS PROPOSAL. IS THERE A PREFERRED MECHANISM FOR ENGAGING CONSULTANTS, AND ARE THERE ANY REGULATIONS/RESTRICTIONS RELATED TO THEIR INVOLVEMENT. THE FOA DOES NOT MENTION ANYTHING ABOUT CONSULTANTS. IS IT OK TO ADD THEM TO THE TEAM (SPECIFIED AS CONSULTANTS) WHILE NOT MENTIONING THEM AS CO-PI, AND INCLUDE THEIR BUDGETS ACCORDINGLY? IS A LETTER OF COMMITMENT NEEDED FROM THE CONSULTANT?**

**ANSWER:** Consultants are allowable. No letter of commitment is required. See 2CFR 400.459 Professional Services Costs for more information. Please include the consultant in the Personal Qualification Summary in the Technical Volume.

**Q24. I HAVE THE FOLLOWING QUESTIONS REGARDING COOLERCHIPS TECHNICAL AREA B:**

- 3. ARE THERE ANY SPECIFIC REQUIREMENTS (BEYOND THE CHIP RELIABILITY REQUIREMENTS) FOR AIR TEMPERATURE INSIDE THE MDC?**
- 4. IRR OF THE MDC IS GOING TO BE DIFFERENT FOR DIFFERENT CUSTOMERS AND APPLICATIONS. RATHER THAN CALCULATING THE IRR OF THE SYSTEM, AS IT APPEARS TO REQUEST IN THE TECHNICAL AREA B TABLE, I AM ASSUMING THAT WE SHOW THE IRR AND PAYBACK TIME ON THE NEW TECHNOLOGIES ADDED TO/REMOVED FROM THE SYSTEM RELATIVE TO TODAY'S CURRENT SYSTEM. IS THIS CORRECT? IS THERE A PREFERRED IRR FORMULA (SINCE THERE ARE DIFFERENT ONES)?**

**ANSWER:**

1. There are no FOA requirements for air temperature inside the Technical Category B modular data center.
2. This FOA is targeted towards development of efficient and sustainable cooling technologies for data centers. Consequently, we expect the calculations to reflect overall project economics for a new build versus retrofitted data centers. In most instances this tends to be project finance IRR models but we are open to alternate economic calculations that are appropriately justified for specific segments (e.g. hyperscale, colocation etc.).

**Q25. WE ARE CATEGORY D TEAM AND PROPOSE TO COVER BOTH CATEGORY A AND B DATA CENTER SOLUTIONS. WE HAVE A FEW QUESTIONS BELOW:**

- 1. FOR CATEGORY A TESTING, IS A 200 KW RACK HEAT LOAD DESIRABLE OR REQUIRED?**
- 2. FOR CATEGORY A TESTING, ARE TWO RACKS DESIRABLE OR REQUIRED?**
- 3. ARE INDIVIDUAL SERVER POWER AND COOLING REQUIRED FOR CATEGORY D AND THEREFORE MEASUREMENTS MADE AT THE SERVER LEVEL? OR DOES CATEGORY D FOCUS ON ALL MEASUREMENTS AND EQUIPMENT FROM THE CHILLED WATER INLET OF THE CDU TO THE INTERFACE OF THE RACK?**

**ANSWER:**

1. It is up to teams to propose a relevant system that meets FOA targets as described in Section I.D.2, Table 4.
2. See Answer Q25-1
3. Measurement capability for Technical Category D teams is described in Section I.D.2., Table 7.

**Q26. WE HAVE THE FOLLOWING QUESTION FOR CLARIFICATION:**

- 1. CAN WE USE THE "OTHER TAB H" ON THE SF424-A FORM TO CAPTURE DIRECT AND INDIRECT SALARY COSTS ABOVE THE \$200K DIRECT SALARY CAP TOWARDS COST SHARE? IF NOT, WHERE SHOULD WE CAPTURE THIS?**

**ANSWER:** Personnel costs should be entered in "Tab a. Personnel" and should not exceed \$200,000/yr/person. You may enter any additional explanations/comments in the space provided at the bottom of the tab. Tabs for Indirect Costs and Cost Share similarly contain a space for such explanations.