

**MID-SCALE RESEARCH INFRASTRUCTURE TRACK 2
(MID-SCALE RI-2)**

\$76,250,000

**Appropriated and Requested MREFC Funds for the
Mid-Scale Research Infrastructure Track 2 Program**

(Dollars in Millions)

FY 2020	FY 2021 Estimate	FY 2022 Request	FY 2023 Estimate	FY 2024 Estimate	FY 2025 Estimate	FY 2026 Estimate	FY 2027 Estimate
\$65.00	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25

Outyear estimates are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission.

Scientific Purpose

The Mid-scale Research Infrastructure program is an NSF-wide effort to meet the research community’s needs for modern research infrastructure to support priority science and engineering research. The overall Mid-scale RI program is described in the NSF-wide Priorities chapter. Here, we describe Track 2 (Mid-scale RI-2), covering projects with individual implementation costs between \$20.0 million and \$100.0 million,¹ with funding requested from the MREFC account.

Baseline History

The scientific importance of mid-scale research infrastructure is reflected in the 2017 American Innovation and Competitiveness Act (AICA), which directed NSF to “evaluate the existing and future needs, across all disciplines supported by the Foundation, for mid-scale projects.” NSF issued a Request for Information in late 2017 that resulted in nearly 200 ideas for research infrastructure with project costs in the \$20.0 million to \$100.0 million range, amounting to a prospective demand for approximately \$10 billion in funding. Mid-scale RI-2 funding is intended to respond directly to that demand.

In the 2018 appropriation for NSF, report language from the House of Representatives directed “NSB, in collaboration with the National Academies of Science, Engineering, and Medicine (NASEM), to consider steps to bridge the gap between the NSF’s Major Research Instrumentation Program (MRI) and the agency’s MREFC account and to develop appropriate processes to address this matter through the MREFC account within a restricted funding environment.” The NSB issued a report (NSB-2018-40)² that made several recommendations, including “a long-term *agency-level* commitment to mid-scale research infrastructure.”

NSF responded to the NSB recommendations and the AICA mandate to develop a strategy with the detailed Mid-scale RI program that is described in the NSF-Wide Priorities chapter of this budget submission. As part of that strategy, funding for the mid-scale projects with implementation costs above \$20.0 million was requested in the MREFC account as Track 2 of an NSF-wide mid-scale program, and funding was appropriated in that account beginning in FY 2020. NSF issued its first solicitation for Mid-scale RI-2 in December 2018, requesting proposals with total implementation costs in the range between \$20.0 million and \$70.0 million. A second solicitation with a new upper limit of \$100.0 million was issued in December

¹ The first NSF-wide Mid-scale RI-2 solicitation called for implementation proposals with total project costs in the range from \$20.0 million to \$70.0 million. The long-term intent is for Mid-scale RI-2 to cover a range extending up to \$100.0 million, to be maximally consistent with the definition of major multi-user research facility projects in the American Innovation and Competitiveness Act as amended by the 2021 National Defense Authorization Act.

² [nsf.gov/nsb/publications/2018/NSB-2018-40-Midscale-Research-Infrastructure-Report-to-Congress-Oct2018.pdf](https://www.nsf.gov/nsb/publications/2018/NSB-2018-40-Midscale-Research-Infrastructure-Report-to-Congress-Oct2018.pdf)

Major Research Equipment and Facilities Construction

2020; pre-proposals from that solicitation are currently under review, with invited full proposals due in September 2021.

Since Mid-scale RI-2 is a portfolio of implementation awards that spans all NSF research communities, it does not have a single set of *a priori* scientific goals. In the 2020 solicitation, NSF stated that “[t]he Mid-scale Research Infrastructure programs are aimed at transforming scientific and engineering research fields as well as science, technology, engineering, and mathematics (STEM) education research by making available new capabilities, while simultaneously training early-career researchers in the development, design, and construction of cutting-edge infrastructure.” The solicitation defines research infrastructure as “any combination of facilities, equipment, instrumentation, or computational hardware or software, and the necessary human capital in support of the same.” Past examples of mid-scale-size awards in individual directorates have included items such as mid-size telescopes or telescope systems, replacement of the Palmer Pier in Antarctica, next-generation computer networking testbeds, and higher-sensitivity instrumentation at LIGO.

Total Funding Requirements for Mid-scale RI-2¹

(Dollars in Millions)

	Prior Years	FY 2020 ²	FY 2021 Estimate	FY 2022 Request	ESTIMATES ³				
					FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
<i>R&RA:</i>									
Development & Design	-	-	-	-	-	-	-	-	-
Subtotal, R&RA	-	-	-	-	-	-	-	-	-
<i>MREFC:</i>									
Implementation	-	-	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25
Subtotal, MREFC	-	-	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25
TOTAL REQUIREMENTS	-	-	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25	\$76.25

¹Operations costs to be borne by the lead disciplinary directorates are not included in this table but are discussed below in the section on Future Operations Costs.

² FY 2020 funding of \$65.0 million was carried over into FY 2021.

³ Outyear numbers are for planning purposes only. NSF will evaluate mid-scale in the context of agency priorities for each future budget submission

Management and Oversight

Mid-scale RI-2 proposals have been solicited from all scientific disciplines covered by NSF, as noted above. In anticipation of the funding of such proposals, the NSF Major Facilities Guide (NSF 19-068)³ was updated with an extensive discussion of management and oversight processes for Mid-scale RI, found in Section 5 of that Guide. Because of the varied nature of potential Mid-scale RI-2 awards, the Major Facilities Guide states the following:

“Mid-scale project oversight requirements are to be tailored based on each project’s unique characteristics such as the technical scope, the type and mix of work performed (e.g., standard procurement by the Recipient, software development, or civil construction), and an assessment of the associated technical and programmatic risks. However, NSF is committed to the principle that this flexibility does not preclude the requirement for appropriate rigor on the part of NSF or the Recipient. Appropriate use of NSF major facility oversight practices will be determined on a case-by-case basis.”

³ www.nsf.gov/pubs/2019/nsf19068/nsf19068.pdf

Each mid-scale project has a program officer from a relevant research directorate as well as a grants and agreements officer from BFA. Additionally, within BFA, the Large Facilities Office has designated liaisons for the entire mid-scale portfolio, including the Mid-scale RI-2 program, to assure a common overall approach to these awards. Oversight requirements for individual awards are detailed in the grant or cooperative agreement terms and conditions. Portfolio-wide oversight ensuring that the Mid-scale RI-2 program meets its overall objectives, is led by the Chief Officer for Research Facilities in the Office of the Director.

In order to enable appropriate oversight, all Mid-scale RI-2 proposals are required to submit a detailed Project Execution Plan. This plan helps NSF assess project risk and complexity in order to tailor the oversight for each project once awards are made.

Mid-scale RI Track 2 Status

The final steps in the first portfolio selection are complete and NSB authorization for the first awards was given in May 2020. The authorized awards underwent full cost analyses and final award negotiations, including Independent Cost Estimates required under AICA and any imminent impacts from COVID-19. The first three Mid-scale RI-2 awards from the MREFC account were made in October 2020. Those three awards are listed below and described further in an NSF special report:⁴

- “High Magnetic Field Beamline,” Cornell University, \$32.69 million;
- “Global Ocean Biogeochemistry Array,” Monterey Bay Aquarium Research Institute, \$52.94 million; and
- “Grid-Connected Testing Infrastructure for Networked Control of Distributed Energy Resources,” University of California at San Diego, \$39.47 million.

NSB authorized additional awards for proposals from the first round in February 2021. Those proposals are currently undergoing cost analyses; it is expected that the additional awards will be made prior to the end of FY 2021.

As stated above, a solicitation for a second round of proposals for Mid-scale RI-2 was released in December 2020, and NSF anticipates making new awards from that competition in the first half of FY 2023.

Future Operations Costs

The Mid-scale RI-2 solicitation specifically prohibited inclusion of operations costs in the individual project budgets, but proposers were required to present operations and utilization plans as well as estimates of full lifecycle costs. For each individual proposal considered for inclusion in the award portfolio, the lead directorate was required to estimate and commit to any additional operations costs to reap the scientific benefits of an award. At a hypothetical level of ~\$200.0 million in awards from the first solicitation and an upper limit to the operations cost of 10 percent of the capital costs per project per year, the total operations cost impact from the first round of Mid-scale RI-2 awards could potentially ramp up to a steady state of no more than ~\$20.0 million per year by FY 2025. Given the variety of operational models, this cost would only be partially borne by NSF.⁵ Operations costs of projects funded from the second solicitation released in FY 2021, and from subsequent solicitations, would not begin until well after FY 2025.

⁴ www.nsf.gov/news/special_reports/announcements/102920.jsp

⁵ An annual operations cost of 10 percent of the total capital costs is a typical “high-end” estimate for a major infrastructure project. Since some of the Mid-scale RI-2 awards being made by NSF are additions to existing facilities or infrastructure, the predicted increments to the operations costs are less than that high-end estimate for several projects.

Reviews

The Mid-scale RI-2 proposals do not go through the Conceptual/Preliminary/Final Design phases of major facility projects, with their accompanying reviews, enabling a more agile process for these important, but smaller, projects. However, the Mid-scale RI-2 program only considers projects that have reached a high state of readiness for implementation through previous developmental investments. The program has been designed to include a two-step, pre-proposal/full-proposal process to limit the burden on the research community of both preparing and reviewing full proposals. Lead NSF directorates are identified to review each pre-proposal and full proposal. Pre-proposals are externally reviewed according to the standard NSF merit review criteria and solicitation-specific review criteria, with a subset invited to submit full proposals. Those full proposals are also externally reviewed, with a subset invited to a Reverse Site Visit at NSF (or virtual) for detailed assessment of the Project Execution Plans. Some highly meritorious projects with weaknesses in their Project Execution Plans may be asked to submit revised Project Execution Plans, responding to reviewer recommendations and subsequent NSF guidance, before final funding recommendations are made.

Based on the extensive input from external merit review, the most meritorious proposals are identified by the lead directorates and submitted to the Mid-scale RI-2 Working Group. That working group prepares sample portfolios of those proposals at different levels of total funding and forwards them to the Office of the Director. A final recommended portfolio is constructed that also takes account of strategic agency considerations, technical and programmatic risk, projected funding availability, and overall portfolio balance. The Director recommends, and the NSB authorizes, the full portfolio of awards. During the recommendation process, NSF also conducts a rigorous cost analysis of each candidate project to ensure compliance with GAO good practices as required by the solicitation and the Major Facilities Guide. That analysis may inform modifications to the award portfolio if it reveals substantial deficiencies in the proposed cost of a project.

Risks

Technical risks and risk management for the individual projects are included as part of the Project Execution Plans and evaluated rigorously by an external panel of experts. The final portfolio construction also relies significantly on an evaluation of agency risks. These include, for example, a constraint that not all of the projects should have very high or very low technical risk,⁶ potential cost risks identified during the review process, assessment of any potential partnership risks, the risk that events out of the control of an awardee might significantly impact an individual project, and/or the risk of overcommitting future budgets such that the next solicitation might be significantly delayed.

⁶ NSF does not want all projects to have very high technical risk, because of the desire for a high probability of very successful projects coming out of the Mid-scale program. On the other hand, NSF does not want all projects to be “safe” projects with very low technical risk, because a portfolio consisting only of such projects might have less potential for dramatic increases in scientific knowledge.