

ANTARCTIC INFRASTRUCTURE RECAPITALIZATION (AIR)**\$60,000,000**

**Appropriated and Requested MREFC Funds
for the Antarctic Infrastructure Modernization for Science (AIMS) Project and the
Antarctic Infrastructure Recapitalization (AIR) Program**

(Dollars in Millions)

	FY 2019	FY 2020	FY 2021	FY 2022 Request ¹	FY 2023 Request	FY 2024 Estimate	FY 2025 Estimate	Total Project Cost
Authorized AIMS Total Project Cost	\$103.70	\$97.89	\$90.00	\$90.00	\$28.81	-	-	\$410.40
COVID-19 Adjustment	-	-19.40	-	-	-	-	-	-19.40
Unfunded AIMS scope transferred to AIR	-	-	-	TBD	-28.81	-	-	TBD
Revised Estimated AIMS Total Project Cost	\$103.70	\$78.49	\$90.00	TBD	-	-	-	TBD
AIR Request	-	-	-	TBD	60.00	60.00	60.00	TBD
AIMS+AIR TOTAL	\$103.70	\$78.49	\$90.00	\$90.00	\$60.00	\$60.00	\$60.00	\$542.19

¹ The final division of the FY 2022 Request between AIMS and AIR will depend on a re-baseline currently in progress.

Brief Description

The AIR program is a portfolio of investments in facilities and infrastructure across U.S. Antarctic Program (USAP) stations and gateways that will assure safety, enhance efficiency, increase resilience, and support USAP's continued leadership on the continent. As discussed below, FY 2022 support for the Antarctic Infrastructure Modernization for Science project (AIMS) will be used to complete funding of the re-baselined AIMS scope and initiate activities within a broader recapitalization portfolio of NSF's Antarctic infrastructure under the AIR program. Near-term AIR investments have been developed and prioritized in close coordination with internal and external stakeholders, and AIR work planned for FY 2022 and FY 2023 can proceed despite any continued COVID restrictions that may be in place. AIMS construction will continue with a focus on meeting near-term needs, and unfunded parts of AIMS will be considered for inclusion into the longer-term AIR program.

AIMS was initiated in FY 2019 with an investment of \$103.70 million, followed by \$78.49 million in FY 2020, \$90.0 million in FY 2021, and a final investment in FY 2022, which will be determined once the revised baseline is complete. The National Science Board (NSB) authorized a Total Project Cost (TPC) of \$410.40 million for AIMS, and the ongoing baseline revision will be completed in FY 2022 to inform a revised cost, scope, and schedule, including provisions to account for uncertainties presented by lingering COVID-19 impacts. The project was in the early stages of implementation when COVID-19 restrictions required on-ice construction to be placed on hold. That extended on-ice work stoppage, as well as substantial disruptions to workforce and supply chains, has significantly delayed completion of the project, requiring a re-baselining of AIMS.

Significant AIMS schedule delays also meant that other USAP investments in facilities and infrastructure emerged as priorities that could not be deferred until after completion of AIMS. As a result, the re-baselined scope of AIMS is anticipated to include only the Vehicle Equipment and Operations Center (VEOC) and the Lodging Building (and associated utilities), both of which continue to be important near-term needs. Unfunded AIMS scope will be considered within the broader AIR program. The FY 2022 Request of \$90.0 million will be used to complete funding of the re-baselined AIMS scope and to initiate activities within the AIR program. The enduring AIR program will ensure continued U.S. leadership and influence in this strategic region.

Scientific Purpose

NSF manages an Antarctic infrastructure portfolio that consists of a wide range of facilities, utilities, equipment, and fleet that enables the United States' world-leading science across three permanent stations, seasonal field camps, and two research vessels that are supported by three gateway/port locations. This infrastructure portfolio is unmatched by that of any other nation and underpins the entire USAP. From the facilities that house scientists and the generators that power the stations to traverse vehicles that enable drilling of climate-revealing ice cores and operation of field camps where scientists study the role of glaciers in future sea level rise, robust and healthy infrastructure is the foundation of Antarctic science.

Most of this infrastructure operates year-round in one of the harshest environments on Earth. In 2012, a Blue Ribbon Panel (BRP) of experts noted the importance of ongoing infrastructure renewal by observing: "The lack of a capital budget and supporting plan to replace out-of-date facilities, together with the lack of a funded plan to address major maintenance needs, has led to a deteriorating and inefficient infrastructure, particularly at McMurdo Station." The AIR program fulfills that recommendation for renewal by improving physical infrastructure to assure safety, enhance efficiency and sustainability, increase resilience, and ensure the Nation's continued leadership on the continent.

Key objectives of the AIR program are to support current infrastructure and to take advantage of opportunities where advances in infrastructure can enable new science capabilities. For example, improved data connectivity can facilitate discovery at greater speed and scale and broaden participation in Antarctic science. Likewise, expanded traverse capabilities can dramatically reduce risk and cost for science teams accessing deep field locations. The AIR program will include technical support for needs assessments, cost-benefit analyses, and preliminary designs to define transformative solutions to Antarctica's unique challenges as an integral part of infrastructure renewal.

Baseline History

In 2011, the Office of Science and Technology Policy and NSF convened a BRP to evaluate the USAP logistical enterprise. The BRP was asked to conduct a review of NSF facilities and operations supporting science in Antarctica and to ensure that the facilities could support the scientific opportunities articulated by an earlier 2011 National Research Council (NRC) report, *Future Science Opportunities in Antarctica and the Southern Ocean*.¹ The BRP report, *More and Better Science in Antarctica Through Increased Logistical Effectiveness*,² made numerous recommendations regarding maintaining and enhancing the United States' world-class science program in Antarctica.

NSF responded to the BRP report by immediately addressing issues of safety, implementing operational efficiencies that resulted in a rapid return on investment, and developing long-term plans for each of the three year-round U.S. stations: Palmer, Amundsen-Scott South Pole, and McMurdo. The AIMS project was a pivotal component of the McMurdo Station Master Plan with a specific focus on the primary core functions of this critical logistics hub. The AIR program will continue to refine and carry forward those long-term plans.

¹ www.nap.edu/catalog/13169/future-science-opportunities-in-antarctica-and-the-southern-ocean

² www.nsf.gov/geo/opp/usap_special_review/usap_brp/rpt/index.jsp

Major Research Equipment and Facilities Construction

AIMS sought to enhance operational support for science by improving operations efficiency, containing operating costs, and enhancing safety. The following major scope elements were targeted to achieve these goals:

- Construction of a Centralized Services building that replaces and modernizes multiple existing facilities on station including centralized warehousing.
- Construction of an Emergency Operations Center to replace the existing fire station, medical facilities, and fitness and skills development facilities.
- Construction of a consolidated Field Science Support Facility.
- Construction of an Industrial Trades Shop to consolidate existing facilities across the station.
- Construction of a VEOC that facilitates maintenance and repair of both heavy and light equipment ranging from traverse tractors, cranes, loaders, and earth moving equipment to trucks, vans, snowmobiles, and field generators.
- Construction of one new lodging facility to ensure adequate bed space to support near-term needs, including population surges from an influx of construction workers. Importantly, this facility comprises primarily single-occupancy rooms recommended by the BRP to promote safety and health. Single rooms mitigate rest issues that can arise from unique work shifts and travel schedules of the station workforce and scientists; they also help control the spread of contagious illnesses.
- Upgrade of utilities distribution networks for fire protection water, domestic water, heating, power, communications, and sanitary sewer.

The AIMS Final Design Review was held in October 2018 and the NSB authorized NSF to award a contract for AIMS in February 2019. The AIMS award was made under the Antarctic Support Contract to Leidos. The NSB-approved not-to-exceed TPC for AIMS was \$410.40 million.

Project Status

To manage the potentially severe risks of COVID-19, on-site AIMS work at McMurdo was paused in March 2020 and construction personnel were not deployed to McMurdo for the FY 2021 or FY 2022 construction seasons. While plans are in place to resume construction as soon as it is safe to do so, this pause in construction activities, as well as disruption to the supply chain on which the project relies, resulted in multi-year delays to the AIMS construction schedule. AIMS is being re-baselined to include important near-term needs while unfunded AIMS scope will be considered within the broader AIR program. On-ice construction on AIMS is set to resume in October 2022.

Work was initiated in FY 2021 on the two highest priority AIR activities – acquisition of the planning and design support necessary to define efficient and effective technical solutions and minimize disruption to the science program, and the start of design work for a permanent McMurdo Cargo Offload solution that will dramatically reduce programmatic risk. Both projects are described more fully below.

Meeting Intellectual Community Needs

- NSF has collected and continues to seek feedback from members of the research community on the quality of the support they receive from the USAP in Antarctica.
- The research community participates in decisions regarding the necessary reach of the USAP's logistics system.

- Members of the research community participated in requirements development and refinement in the planning and design stages for AIMS, as well as in design reviews.
- The need for upgrades in many components of Antarctic infrastructure was informed by the 2011 NRC report and the 2012 BRP report. Additionally, the critical need to flexibly support a broad range of Antarctic research was further affirmed in a 2015 NRC report, *A Strategic Vision for NSF Investments in Antarctic and Southern Ocean Research*.³
- The AIR program will enable broad community engagement in the long-term vision for USAP infrastructure and logistics capabilities through the development of the South Pole Master Plan and routine updates to the plans already developed for each station.

Governance Structure and Partnerships

NSF Governance Structure

The AIR program is managed by GEO and implemented by the OPP Antarctic Infrastructure and Logistics (AIL) section. For oversight of AIR, NSF tailors the best practices outlined by NSF's Research Infrastructure Guide (formerly known as Major Facilities Guide), which includes the use of independent cost estimates where appropriate, routine status reports at the program and activity level, and periodic reviews of the portfolio by internal and external experts. The AIR program is overseen by the Chief Officer for Research Facilities and by a Capital Investment Review Board that includes NSF representatives from AIL and Antarctic Sciences Sections, Polar Safety and Occupational Health, Large Facilities Office, and Division of Acquisition and Cooperative Support.

Partnerships and Other Funding Sources

The National Oceanic and Atmospheric Administration is partnering with NSF to support upgrading satellite weather/communications data down/uplink facilities. That project is separate from AIR but will complement AIR in modernizing McMurdo Station and facilitating future communication improvements. As part of the transition to an enduring AIR program, the Capital Investment Review Board that oversees the portfolio of investments will be expanded to include inter-agency partners, providing a robust mechanism to develop future partnerships towards common objectives.

³ www.nap.edu/catalog/21741/a-strategic-vision-for-nsf-investments-in-antarctic-and-southern-ocean-research

Cost and Schedule

Total Funding Requirements for AIMS and AIR

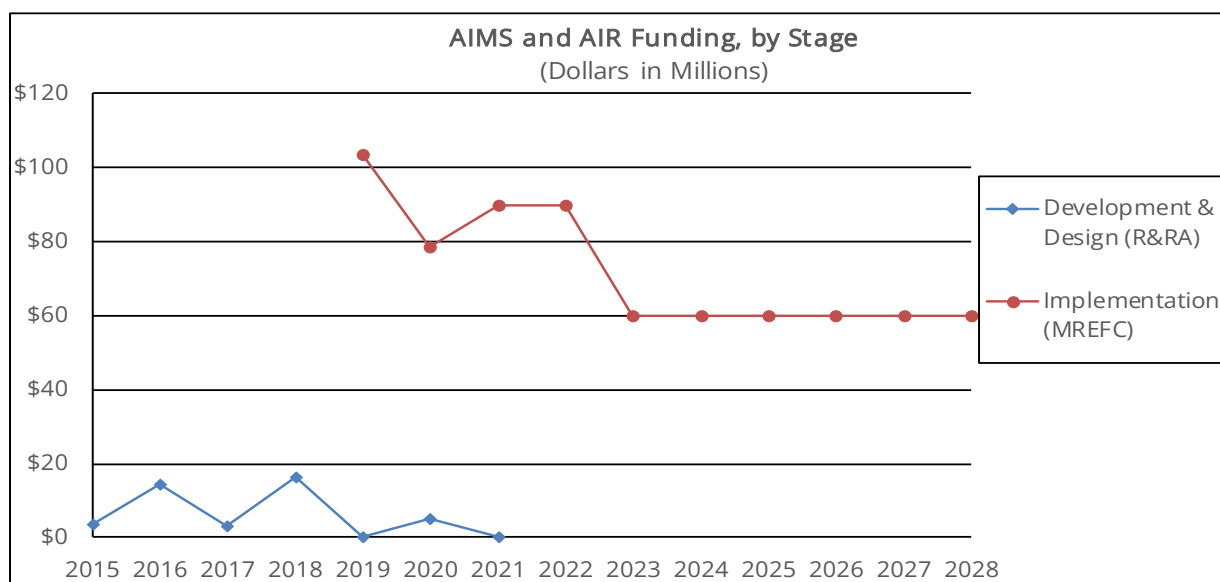
(Dollars in Millions)

	Prior Years	FY 2021 Actual	FY 2022 Request ²	FY 2023 Request	ESTIMATES ³				
					FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
R&RA:									
Development & Design	\$42.24	\$0.22	-	-	-	-	-	-	-
Subtotal, R&RA	\$42.24	\$0.22	-	-	-	-	-	-	-
MREFC:									
AIMS Implementation ¹	182.19	90.00	TBD	-	-	-	-	-	-
AIR Implementation	-	-	TBD	60.00	60.00	60.00	60.00	60.00	60.00
Subtotal, MREFC	\$182.19	\$90.00	\$90.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
TOTAL REQUIREMENTS	\$224.43	\$90.22	\$90.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00

¹ Includes \$115.84 million carried forward into FY 2022.

² The final division of the FY 2022 Request between AIMS and AIR will depend on a re-baseline currently in progress.

³ Outyear estimates are for planning purposes only.



Note: The AIR program will include future development and design activities within MREFC appropriations.

Construction of the VEOC and Lodging facility are anticipated to resume in October 2022 under a newly revised AIMS baseline schedule. The AIR program is being managed as a portfolio of investments guided by Station Master Plans that have been developed with robust engagement from across the science community and with inter-agency partners. Activities are prioritized by a Capital Investment Review Board as conditions and requirements change, which allows the program to be responsive to the research community, proactive in mitigating risks, and well-positioned to take advantage of opportunities as they arise. The table below shows active and near-term planned

investments.⁴ Scheduling of these investments will be dynamic, depending on a combination of Capital Investment Review Board prioritization and complex logistical considerations. Despite ongoing COVID-19 restrictions, these activities can all make progress without an immediate on-ice presence.

McMurdo Cargo Offload Infrastructure	Status: Acquisition
<p><u>Mission Need:</u> McMurdo, South Pole Station, and field camps are all reliant on resupply vessels that bring food, fuel, equipment, and materials each January. Vessels have historically offloaded at McMurdo via an ice pier in Winter Quarters Bay where materials are then trucked, traversed, or flown to their destination. The ice pier has failed three times in the past 12 years, requiring the last-minute deployment of temporary offload solutions that are costly and inefficient.</p>	
<p><u>Project Scope:</u> This project will construct and deploy a barge-type structure that will be moored off McMurdo and can be used reliably and efficiently year after year, significantly reducing program risk.</p>	
Antarctic Recapitalization Planning and Design Support	Status: Acquisition
<p><u>Mission Need:</u> Robust and independent planning, analysis, and early-stage design support is essential for ensuring that the AIR program delivers maximum benefit to the science community through innovative solutions. Once work is underway, integrated planning will minimize unnecessary disruption for science teams and ensure work is well-integrated with operations and science support.</p>	
<p><u>Project Scope:</u> This acquisition will provide technical support for needs assessments, cost-benefit analyses, and preliminary designs to define transformative solutions to Antarctica’s unique challenges as an integral part of infrastructure renewal. It will also provide an integrated planning and scheduling capability to minimize science disruptions.</p>	
McMurdo Power Plant Switchgear Controls Upgrade	Status: Acquisition
<p><u>Mission Need:</u> Control systems manage eight generators and three wind turbines that provide power for McMurdo Station as well as New Zealand’s Scott Base. The system has no redundancy, is unreliable, and has frequent outages.</p>	
<p><u>Project Scope:</u> New software will eliminate outages related to control errors and support future generator replacements. The upgrade will enable an increase in monitoring, remote diagnostics, and will resolve information technology security vulnerabilities.</p>	
Future USAP Data Center	Status: Planning
<p><u>Mission Need:</u> The USAP Data Center is currently housed in its own facility, which limits NSF’s ability to take advantage of the efficiency and security available in the cloud environment.</p>	

⁴ Total project cost information is included when no longer procurement sensitive, which is typically when the activity has been awarded for construction.

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<u>Project Scope:</u> This project will identify a cost-effective cloud provider and migrate the USAP data center to the new service.	
South Pole Blue Building Lifting System and ARO Raise	Status: Planning
<u>Mission Need:</u> South Pole Station’s Blue Buildings (e.g., the IceCube Lab, the Dark Sector Lab that houses the South Pole telescope, Martin A. Pomerantz observatory (MAPO) with its attached BICEP array, and the Atmospheric Research Observatory (ARO)) are being buried in snow and without action, will become unusable.	
<u>Project Scope:</u> This project will lift the ARO and provide a “proof of principle” for the remaining structures. Lifting the buildings will extend their useful lifespan by 20 years and drastically reduce annual snow management workload.	
SPoT2 Module Refresh	Status: Planning
<u>Mission Need:</u> The South Pole Traverse (SPoT)-2 delivers approximately 100,000 gallons of fuel to the South Pole Station each year at a fraction of the cost of airlifting the fuel. SPoT-2 modules, such as the mobile kitchen and crew quarters, were acquired in 2003, have traveled over 60,000 miles, and are failing structurally and electrically.	
<u>Project Scope:</u> This project replaces the generator module, living module, and kitchen module.	
Fleet and Equipment Refresh	Status: Planning
<u>Mission Need:</u> More than two-thirds of the USAP fleet, which includes cargo and passenger transport vehicles, snowmobiles, loaders, light tracked utility vehicles, and light trucks, is beyond end-of-life, in some cases by decades. Air Traffic Control and mobile communications equipment is also aging and at increasing risk of failure.	
<u>Project Scope:</u> This investment returns the fleet to a safe, sustainable state, allowing USAP to transition to more fuel efficient and environmentally friendly vehicles, and refreshes aging communications equipment.	
Environmental Satellite Ground System	Status: Planning
<u>Mission Need:</u> Environmental satellite ground systems are crucial for weather forecasting and flight planning. They are also essential for safe aviation, station operations, and science support. The current McMurdo and Palmer Station systems, Tera Scan, are at or beyond end-of-life.	
<u>Project Status:</u> This project will replace the McMurdo and Palmer systems, providing modern weather forecasting tools that ensure compatibility with new and future weather satellites.	
McMurdo Power Plant Generator Replacement	Status: Planning
<u>Mission Need:</u> McMurdo Station has five primary generators that power the stations. The existing generators are aging and have experienced two catastrophic failures since 2018.	

<u>Project Scope</u> : This project replaces McMurdo generators with modern, efficient equipment.	
Doppler Weather Radar	Status: Planning
<u>Mission Need</u> : Successful and safe flight operations rely on accurate and timely weather information. McMurdo does not have any Doppler weather radar capabilities.	
<u>Project Scope</u> : This project will deploy Doppler weather radar to McMurdo, greatly enhancing weather forecasting capabilities which in turn improves the level of science support possible with USAP flight operations.	
Tactical Air Navigation Upgrade	Status: Planning
<u>Mission Need</u> : Tactical Air Navigation (TACAN) systems are critical for providing bearing and distance guidance and non-precision landing approach capability at McMurdo. The current TACAN is beyond end-of-life, and the Department of Defense will no longer support its use in coming years.	
<u>Project Scope</u> : This project will replace the McMurdo TACAN with a new, modern system.	
Undersea Fiber Optic Cable – Feasibility Study	Status: Planning
<u>Mission Need</u> : McMurdo Station’s bandwidth is equivalent to that of a single 4G LTE cell phone. Providing the ability to dramatically increase the rate of data transfer to the station could be transformational and open the door to broader participation in Antarctic science.	
<u>Project Scope</u> : This project will conduct a feasibility study, including a hydrographic route survey, physical survey of McMurdo Station, environmental assessments in New Zealand and McMurdo, and risk mitigation methods.	

Reviews

Conceptual Design and Preliminary Design Reviews (PDR) for AIMS were passed successfully in FY 2015 and FY 2017, respectively, resulting in an NSB resolution (NSB-2017-20) authorizing NSF to include AIMS in a future budget request. The AIMS Final Design Review (FDR) was conducted in October 2018. The external panel found that the project execution plan was well-developed for the FDR and recommended that the project proceed to the Construction Stage. They also recommended that NSF attempt to retain all the major science-support capabilities in the original scope, despite a cost increase since PDR related to commodity prices and market conditions, in order to realize the long-term benefits to the USAP. An Independent Cost Estimate was also carried out to support NSF’s cost analysis in conjunction with the FDR process.

In addition to daily and weekly communications with Leidos’ AIMS project management, NSF conducts a formal monthly project management review. This review covers progress described in the monthly project management report produced by Leidos. Also planned are annual Construction Reviews by OPP, the Large Facilities Office, and an external panel, with the first one having occurred in November 2020. Given the severe impacts of COVID-19 on the AIMS project, as discussed above, a re-baselining

Major Research Equipment and Facilities Construction

of the remaining components of AIMS will be completed in FY 2022 to inform a revised cost, scope, and schedule.

The last Capital Investment Review Board meeting to prioritize activities in the Antarctic Infrastructure Recapitalization program was held in January 2022. In FY 2022, readiness reviews for AIR activities will be conducted based on the scale and complexity of individual projects.

Risks

If the infrastructure that enables Antarctic science is not kept robust and efficient, USAP is at risk of losing science capabilities year over year as facilities, utilities, equipment, and vehicle fleet degrade.

As described above, ongoing and planned near-term activities in the AIR program will mitigate critical risks facing USAP, including some that represent single points of failure to the mission. In executing the projects, NSF has implemented a rigorous risk management approach that includes the identification of risks and mitigation strategies. Robust risk management will also be required of contractors and awardees. In all cases, NSF holds the risk of cost and schedule increases that are beyond the control of the contractor, including events such as pandemics, unpredictably severe weather, icebreaker and supply vessel availability, and macroeconomic changes.

COVID-19 impacts on the construction market, labor force, supply chains, travel restrictions, and safety protocols present the greatest near-term risk to AIMS and AIR(?) due to its size and complexity.