

**NATURAL HAZARDS ENGINEERING RESEARCH
INFRASTRUCTURE (NHERI)**

**\$10,950,000
-\$620,000 / -5.4%**

Natural Hazards Engineering Research Infrastructure Funding
(Dollars in Millions)

FY 2019 Actual ¹	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
			Amount	Percent
\$11.57	-	\$10.95	-\$0.62	-5.4%

¹Includes \$8.50 million in additional funding to upgrade the LHPOST facility.
Excluded is \$8.93 million in FY 2019 O&M costs obligated in FY 2018.

NHERI was established in 2015 by NSF as a distributed, multi-user, national research facility for use by the Nation’s natural hazards engineering research community. NHERI provides researchers with access to state-of-the-art facilities and tools, unavailable through any other agency, to study the performance of civil infrastructure, including buildings, geostructures, and underground structures, in response to individual and combinations of natural hazards. These facilities provide essential research infrastructure to support two federally-mandated interagency programs: the National Earthquake Hazards Reduction Program and the National Windstorm Impact Reduction Program.

The portfolio of research investigations, which is funded separately through NSF’s highly competitive, parallel proposal merit review process, involves large-scale experimentation linked to numerical modeling, and collection and sharing of data to increase the knowledge gleaned from investment in these facilities. Such research is essential to the development of more comprehensive and more realistic predictive models of how civil infrastructure responds to earthquakes, windstorms such as hurricanes and tornados, storm surge, and tsunamis. These advances, in turn, enable the design of more hazard-resilient civil infrastructure and improve safety for citizens during these events.

NHERI includes earthquake and wind engineering experimental facilities; a wave testing facility; a post-disaster, rapid-response research facility; cyberinfrastructure; computational modeling and simulation tools; and a research data repository. The research infrastructure investment also supports education and community outreach activities.

During FY 2015 and FY 2016, NSF established NHERI through eleven cooperative agreements:

- Network Coordination Office (NCO) at Purdue University,
- Cyberinfrastructure (CI) at the University of Texas at Austin,
- Computational Modeling and Simulation Center (SimCenter) at the University of California, Berkeley,
- Twelve-Fan Wall of Wind at Florida International University,
- Large-Scale, Multi-Directional, Hybrid Simulation Testing Capabilities at Lehigh University,
- Large Wave Flume and Directional Wave Basin at Oregon State University,
- Geotechnical Centrifuges at the University of California, Davis,
- Large, High-Performance Outdoor Shake Table (LHPOST) at the University of California, San Diego (UCSD),
- Boundary Layer Wind Tunnel, Wind Load and Dynamic Flow Simulators, and Pressure Loading Actuators at the University of Florida,
- Large, Mobile Dynamic Shakers for Field Testing at the University of Texas at Austin, and
- Post-Disaster, Rapid-Response Research (RAPID) Facility at the University of Washington.

The NCO serves as the national and international scientific leader, community focal point, and network-wide coordinator for NHERI governance and community-building activities. Key NCO activities include

convening the governance groups; working with NHERI PIs to develop consensus-based policies and procedures for NHERI, and the annual NHERI-wide work plan; implementing the facility scheduling protocol to provide user access to the experimental facilities; leading development of a community science plan; running NHERI-wide education and community outreach programs; and building strategic partnerships. NHERI awardees and the natural hazards engineering community work together, through governance and awardee activities, to establish a shared vision for NHERI, set natural hazards engineering research and education agendas and priorities, and make NHERI a highly value-added and productive research infrastructure. Approximately \$870,000 is included in the FY 2021 request for NCO activities.

The CI awardee serves as the integrator for enabling NHERI to be a virtual organization for the natural hazards engineering community, by providing an array of information, resources, and services, including the definitive NHERI website; research data repository (Data Depot); software service delivery platform with computational modeling, simulation, and educational tools (Discovery Workspace); collaboration tools; access to high-performance computing resources; and user training and support. The CI awardee also establishes and implements the NHERI-wide cybersecurity plan with all NHERI awardees.

The SimCenter develops a portfolio of computational modeling and simulation software and educational modules that reflects a balance of community-prioritized, new capabilities for earthquake, wind, and multi-hazard engineering research and education. The SimCenter’s tools are integrated into the CI awardee’s Discovery Workspace.

The experimental facilities provide well-maintained and fully-functioning facilities, services, and staffing to enable earthquake engineering, wind engineering, and post-disaster, rapid-response research requiring experimental work and data collection. Data generated by these experimental resources and their users are archived and shared in the publicly accessible NHERI Data Depot.

Along with direct operations and maintenance support for NHERI awardees, NSF provides support for research involving NHERI experimental facilities through separate, ongoing research and education programs. The primary NSF program supporting such activities is the Engineering for Civil Infrastructure (ECI) program in ENG’s Division of Civil, Mechanical and Manufacturing Innovation (CMMI).

Total Obligations for NHERI
(Dollars in Millions)

	FY 2019	FY 2020	FY 2021	ESTIMATES ²				
	Actual ¹	(TBD)	Request	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
Operations & Maintenance	\$3.07	-	\$10.95	\$12.00	\$12.00	\$12.00	\$12.00	-
Facility Upgrade	8.50	-	-	-	-	-	-	-
Total	\$11.57	-	\$10.95	\$12.00	\$12.00	\$12.00	\$12.00	-

¹ Includes \$8.50 million to upgrade the LHPOST facility. Excluded is \$8.93 million of FY 2019 O&M costs obligated in FY 2018.

² Outyear funding estimates are for planning purposes only. The current cooperative agreement ends in FY 2020.

In FY 2018 and FY 2019, NSF provided funding totaling \$16.31 million to UCSD to upgrade its LHPOST facility from its current one degree of freedom to a full six degrees of freedom capability. In its upgraded configuration, the LHPOST will be able to reproduce all six components of motion (two horizontal and one vertical translational components, as well as pitch, roll, and yaw rotational components) experienced by the ground during earthquakes. The LHPOST experimental facility will be the only large-capacity facility in the United States capable of performing such tests and has the world’s largest payload capacity. Because there are no overhead height restrictions, this facility can accommodate the tallest structures ever tested on any shake table.

FY 2019 Operations and Maintenance obligations were lower than in previous years as NSF provided a significant amount of year five funding in the previous fiscal year to ensure continuity of operations.

Management and Oversight

- **NSF Structure:** NSF oversight is handled by two program officers in ENG/CMMI working cooperatively with staff from ENG; the Office of Budget, Finance, and Award Management (BFA); the Office of General Counsel; the Office of Legislative and Public Affairs; and the Chief Officer for Research Facilities in NSF’s Office of the Director. Within BFA, the Large Facilities Office (LFO) provides advice to program staff and assists with agency oversight and assurance.
- **External Structure:** Each NHERI awardee is led by a principal investigator (PI), who is responsible for the overall award operations. The NCO awardee coordinates NHERI governance and network activities. Governance is comprised of the following groups: (a) a Council, which consists of the PI of each NHERI award, to provide collective and coordinated leadership for NHERI as a national facility; (b) Network Independent Advisory Committee (appointed by the NCO), with diverse representation from the broad scientific and engineering communities served by NHERI, to provide independent external guidance and advice to the Council; (c) User Forum, consisting of representatives from the broad scientific and engineering communities served by NHERI; and (d) Council-identified committees, comprised of internal awardee staff and/or users, to advise the Council on community priorities and needs for NHERI.
- **Oversight:** NSF provides oversight to NHERI awardees through 11 cooperative agreements. Awardee operations and activities are reviewed through monthly calls with the NHERI Council, quarterly and annual project reports (for the 11 cooperative agreements) submitted by awardees, which include metrics, annual work plans, project usage, and expenditures. In addition, NSF conducts annual reviews of the NCO, CI, SimCenter and RAPID facilities and through periodic site visit and reverse site visit reviews for the seven experimental sites.

Studies

- In FY 2010, NSF supported two studies to assess the need for earthquake engineering experimental and cyberinfrastructure facilities beyond 2014, as described in the Dear Colleague Letter (DCL) NSF 10-071.¹ One study, a workshop held by the National Research Council on Grand Challenges in Earthquake Engineering Research, was completed in FY 2011, and the second study was completed in FY 2012. These studies provided input to NSF for the determination of support for future earthquake engineering research infrastructure beyond FY 2014. The plan to support a smaller “second generation” Network for Earthquake Engineering Simulation (NEES) (NEES2) during FY 2015-2019 was presented to the National Science Board at their July 2012 meeting and described in DCL NSF 12-107.² The plan



The above image displays the University of California, San Diego outdoor shake table, which allows large structures to be tested against seismic activity. Here, a wooden building shows damage after testing. *Credit: UCSD/Jacobs School of Engineering.*

¹ www.nsf.gov/pubs/2010/nsf10071/nsf10071.jsp

² www.nsf.gov/pubs/2012/nsf12107/nsf12107.jsp

proposed a lower annual operations budget, reflected in the \$8.0 million reduction from FY 2014 in NSF's FY 2015 Budget Request, from \$20.0 million to \$12.0 million, to allow larger investment in earthquake engineering research using NHERI facilities.

- In 2012, the National Institute of Standards and Technology and NSF jointly supported a workshop that led to a roadmap report for measurement science research and development for windstorm and coastal inundation impact reduction, which was published in January 2014.³
- In February 2013, NSF released solicitation NSF 13-537 to compete and operate NEES2 for FY 2015-FY 2019. Based on the merit review of proposals submitted under NSF 13-537, NSF made no award.
- Based on the above studies and report, NSF established the plan for NHERI in FY 2014. This led to the release of solicitations, NSF 14-605 and NSF 15-598, to establish 11 NHERI cooperative agreements through two competitions. Those competitions were completed in FY 2016. The 11 awards for NHERI operations involve commitments for five years, contingent on available funds and satisfactory performance.

Renewal/Recompetition/Termination

During FY 2019, the NSF Director granted ENG approval to extend NHERI through September 30, 2025, through support of renewal proposals to be submitted during 2020 and 2021 by the 11 NHERI cooperative agreement awardees, pending the outcomes of external merit review and available funds.

³ www.nist.gov/customcf/get_pdf.cfm?pub_id=915541