Capability Portfolio Status Report

High End Computing Capability

June 10, 2019

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Modular Data Center Installed at NAS Facility Expansion Site

- The first module of the NAS Facility Expansion (NFE) complex was delivered and installed onto its concrete pad in mid-May.
  - The module was transported in three sections via trucks from Ohio, lifted into position with a crane, and assembled into one building on site.
- The module provides 1,375 square feet of interior space for 12 HPE E-Cells.
  - The module was fully fitted with the E-Cell cooling distribution piping, electrical switchboards and cabling, and the fire suppression system.
- A 2.5-megawatt transformer and two 300-ton hybrid dry coolers were also craned into place to support the module.
  - Electrical connections and plumbing will be installed in June between the module, transformer, and coolers.
- The first four E-Cells are scheduled to be installed in the module on July 1, and available to users in August.

Mission Impact: The NAS Facility Expansion will provide the infrastructure to support four times the amount of existing HECC resources to support NASA's ever-increasing demand for HPC resources.

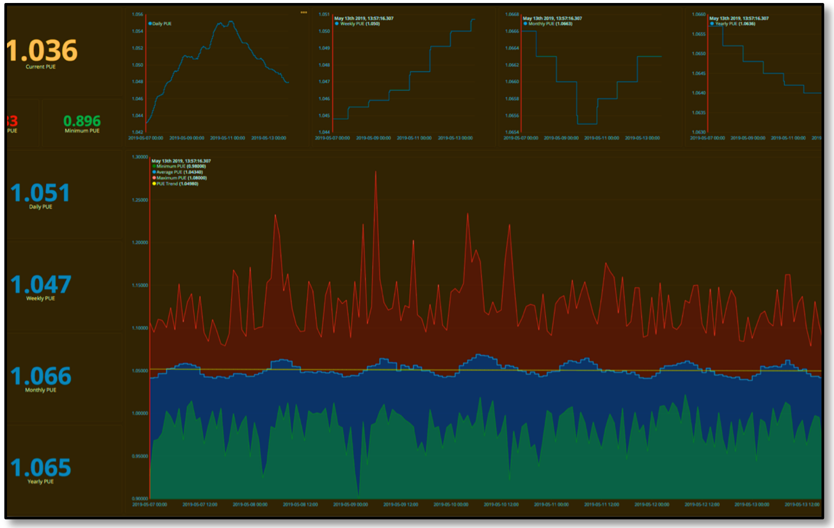
The first module installed on the NAS Facility Expansion site, with one hybrid cooler shown in the background.

POC: Chris Tanner, christopher.tanner@nasa.gov, 650-604-6754, NASA Advanced Supercomputing Division, ASRC

Analyzing and Monitoring of Electra's Module 2 Container Telemetry Data

- HECC's Intelligent IT Operations (IITO) team deploys systems to collect, analyze, display, and monitor Electra's Module 2 container for the HECC Facilities team.
- Industrial control systems (ICS) in Module 2 continuously generate telemetry data containing over 500 unique fields.
- Utilizing Elasticsearch, a real-time search and analytics tool, telemetry data is:
  - Collected and normalized in a central location.
  - Displayed and analyzed using visualization.
  - Monitored to detect issues with the container environment and ICS subsystems.
- Future work includes:
  - Adding alert notifications for events of interest.
  - Adding additional trend analysis.
  - Exploring the use of machine learning to predict failures in the ICS subsystems.

Mission Impact: HECC-developed monitoring system allows facility engineers to quickly analyze industrial control systems telemetry data and monitor the health of the Electra modular supercomputer.



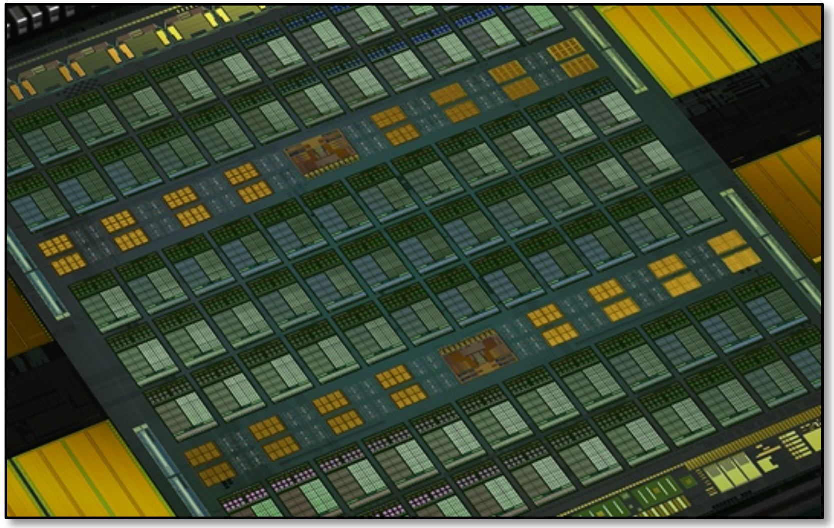
Elasticsearch Dashboard displaying the Electra supercomputer's Module 2 power usage effectiveness (PUE).

POC: Derek G Shaw, derek.g.shaw@nasa.gov, (650) 604-4229, NASA Advanced Supercomputing Division

Pleiades Augmented with General-Purpose Graphics Processing Unit (GPGPU) Nodes

- HECC engineers installed a three-rack GPGPU system with a double-precision peak performance of 728 teraflops (TF) to augment Pleiades' capability.
- This 19-node augmentation consists of 17 nodes with two Intel Skylake processors and four NVIDIA V100 Volta SXM2 GPUs; and two nodes with two Intel Skylake processors and eight NVIDIA V100 Volta SXM2 GPUs.
- Three of the 4-GPU nodes were procured for a specific project, which have exclusive use. The other 16 nodes are currently available for early-access users and system testing prior to being made available for general use.
- The nodes are configured to use NVIDIA's GPUDirect, in order to lower CPU overhead and reduce latency when running across nodes.
- Release to production is targeted for the end of June. The Standard Billing Unit (SBU*) rates for the nodes are:
  - 4 V100 Skylake nodes: 9.82
  - 8 V100 Skylake nodes 15.55

Mission Impact: HECC regularly and significantly augments the supercomputing resources it provides to support agency mission requirements.



The Tesla V100 accelerator with Volta SXM2 general-purpose graphics processing units.

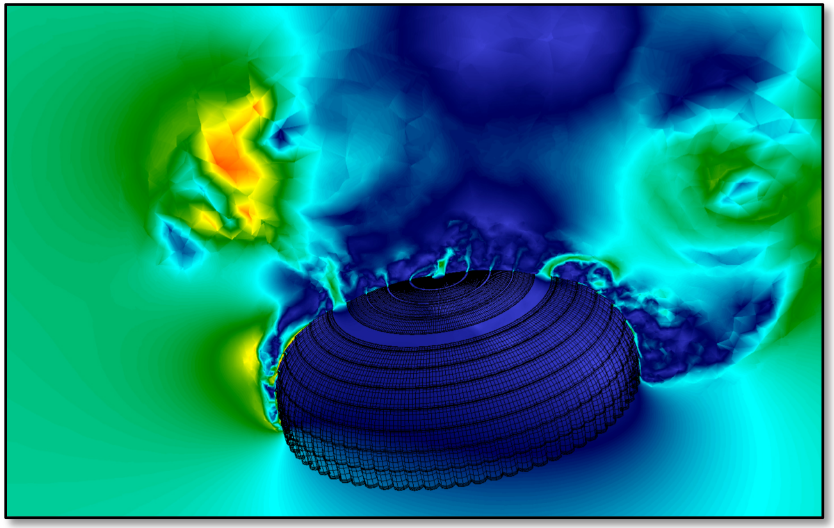
POC: Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, ASRC

** 1 SBU represents the work that can be done in 1 hour on a Pleiades Broadwell 28-core node.*

HECC Supercomputer Usage Sets New Record in May 2019

- In May, the combined usage of HECC supercomputers set a new monthly record of 10,313,760 SBUs*.
- The usage by 364 of NASA's science and engineering groups exceeded the previous record of 8,660,336 SBUs set in March 2019 by 19%.
- The record was achieved in great part by the Transformative Tools and Technologies group using computational fluid dynamics (CFD) simulations for the Revolutionary Computational Aerosciences project.
- Usage of Pleiades, Electra, Merope, and Endeavour contributed to this record.
- The top 10 projects used between 192,231 and 889,596 SBUs and together accounted for over 34% of the total usage.
- HECC continues to evaluate and plan resources to address the future requirements of NASA's users.

Mission Impact: The increased capacity of HECC systems, and working with users to optimize their runs, provides mission directorates with more resources to accomplish their goals and objectives.



This visualization is an example of the computed velocity on a slice through a deployed Orion parachute. Areas of high speed are colored red; low-speed areas are blue. Bright yellow-orange areas represent a high-vorticity structure that squeezes through one of the gaps in the parachute. *Laslo Diosady, NASA/Ames*

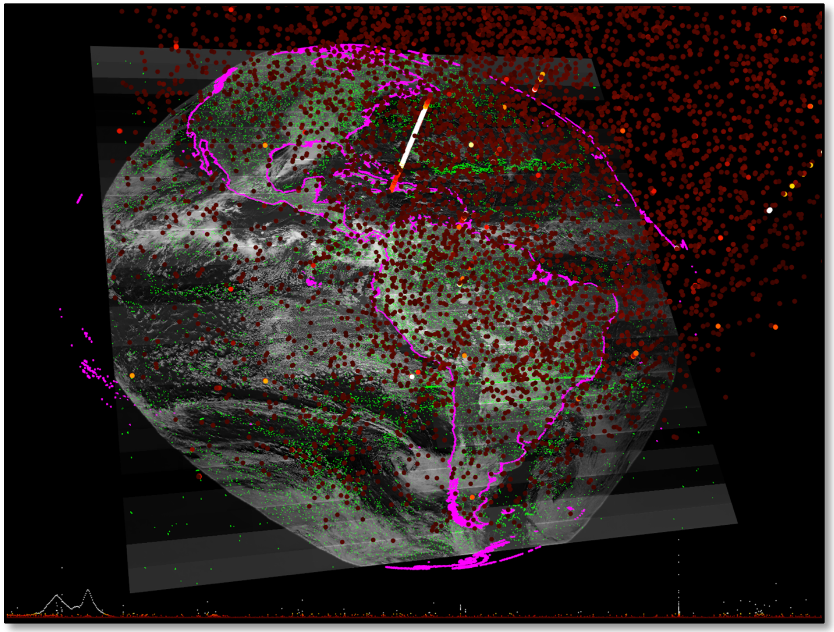
POC: Blaise Hartman, blaise.hartman@nasa.gov, (650)-604-2539, NASA Advanced Supercomputing Division

** 1 SBU represents the work that can be done in 1 hour on a Pleiades Broadwell 28-core node.*

Collaboration on Live Data Feed for Detection of Bolide Meteors

- HECC's Visualization and Data Analysis team, working with several organizations, established a 24x7 live data feed from the Geosynchronous Lightning Mapper (GLM), designed for mapping lightning flashes over vast geographic regions, to better understand asteroid events.
  - Using an event-driven framework, data are received on the hyperwall, inside the NAS facility's secure enclave—usually within 20 seconds of detection by sensors in geosynchronous orbit (at an altitude of 22,200 miles).
  - Immediately on receipt, the data are live-streamed through analytics software developed by the NAS visualization experts, and are also archived to disk.
- In the first weeks of operation, the hyperwall-based system detected numerous bolides (bright airburst meteors)—many visible from both GOES-East and GOES-West, which allows stereo reconstructions of flight tracks—within seconds of their bright disintegrations high in the atmosphere.
- The online data analytics pipeline is now learning to distinguish events caused by bolides from lightning events (the primary targets of the GLM) and other instrumental readings.

Mission Impact: This work supports the goals of NASA's Asteroid Threat Assessment Program and Planetary Defense Coordination Office, for real-time detection and dissemination of information about airburst events.



Screenshot from an analytics utility on the NAS hyperwall, which is learning to distinguish signals produced by bright airburst meteors from those produced by lightning, and from large amounts of instrumental noise.

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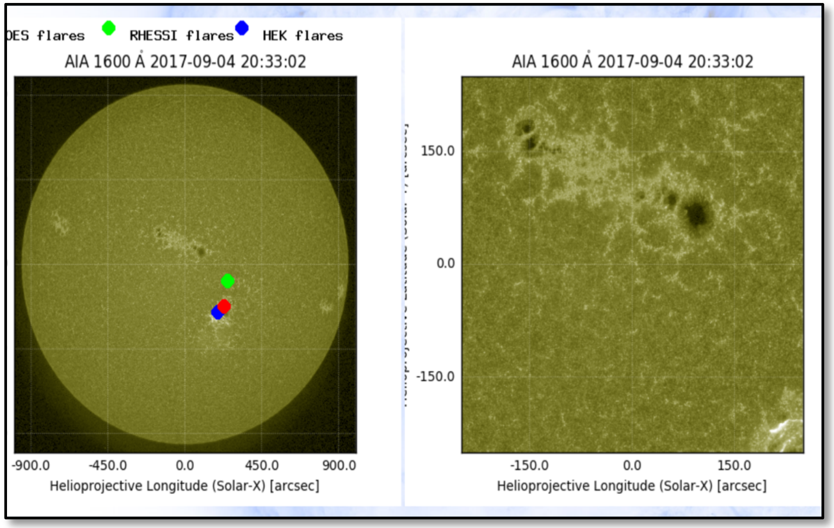
Big Data Team Adds New Filters to the Heliophysics Portal

- HECC's Big Data team, in collaboration with New Jersey Institute of Technology (NJIT), added additional sources of flare-related events into the Interactive Multi-Instrument Database of Solar Flares. The data sources include:
  - Records of coronal mass ejections (CMEs) and solar energetic particles (SEPs) from the Space Weather Database Of Notifications, Knowledge, Information (DONKI); implemented at NASA's Community Coordinated Modeling Center.
  - Records of solar proton events affecting the Earth environment from the NOAA Space Environment Services Center.
- The team added the a new capability to search and filter the flares accompanied with SEP events to the query page.
- They also added data cross-checking with the NJIT researchers to upgrade the database tables and ensure there is no missing data.
- Follow-on work will include adding new solar related datasets.

** Visit the Heliophysics data portal at:* https://helioportal.nas.nasa.gov/

Mission Impact: The Heliophysics Portal is a preprocessed metadata repository enabling fast search and automatic identification of all recorded flares sharing a specified set of characteristics, features, and parameters.



Screenshot from the Heliophysics Portal showing solar flares from the GOES, RHESSI and HEK instrument filters.

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Application Experts Improve Performance of Finite Element Solver Kernel by 85%

- The Applications Performance and Productivity (APP) team improved the performance of the kernel of NASA's open-source FEMERA code by 85%. This high-performance finite element solver is implemented in C++ and uses OpenMP in a domain decomposition-based parallelization approach.
  - The target of this work was a mini-solver that represents the computational characteristics of the full code.
  - The APP optimization work is part of an educational effort with NASA Langley to examine their codes and report back to them on the techniques used.
- In collaboration with David Wagner and other Langley scientists, the APP team achieved a 1.85-fold speedup through:
  - Memory restructuring to reduce cross-NUMA traffic.
  - Rewriting of critical loops using vector intrinsics.
  - Flattening of complex C++ data structures.
  - Additional improvements using OpenMP directives.
- The joint Langley-HECC team also participated in a hackathon to transform the code base to employ GPUs effectively. The focus of Brookathon 2019 was using new features of OpenMP to coordinate computations between CPUs and GPUs. During the event, the team produced a baseline GPU-parallel version of the code using OpenMP 4.5.

Mission Impact: Training users in techniques to achieve faster performance in physics-based modeling and simulation codes helps ensure that NASA will be able to meet its future computational requirements.

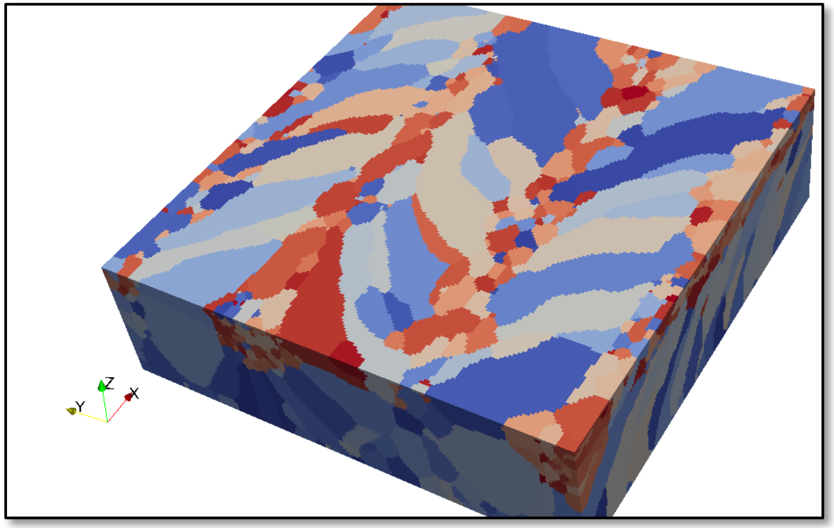


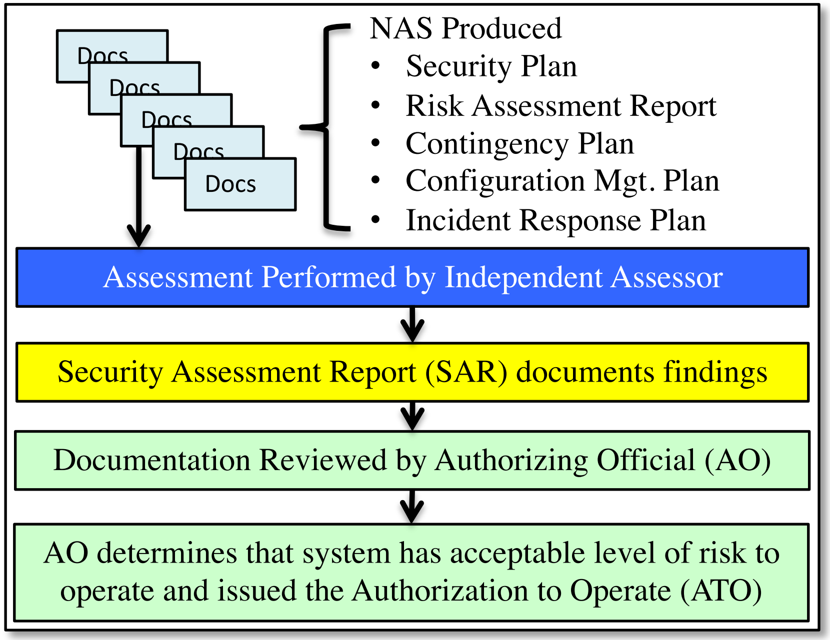
Image showing an additive process simulation using a cubic material, employing quadratic tetrahedrons, 1,766 grains, 24 million multiple degrees of freedom, and a non-linear crystal plasticity model—one of the applications motivating the development of a high-finite element solver.

POCs: Gabriele Jost, gabriele.jost@nasa.gov , NASA Advanced Supercomputing (NAS) Division, Supersmith; Daniel Kokron, daniel.s.kokron@nasa.gov, NAS Division, Redline Performance Solutions

Annual Security Assessment Completed for Continued HECC Authorization to Operate

- On May 28, 2019, the HECC Security team successfully presented NAS's security plan to the NASA Ames Deputy Center Director, who is the authorizing official (AO) for the security plan that includes the HECC systems. The AO indicated that the security plan is acceptable, and the Authorization to Operate (ATO) for all NAS facility systems is forthcoming.
- The approved ATO is the final step in the annual security assessment required of all NASA systems.
- The annual assessment must be conducted by an independent assessor who evaluates the compliance of the facilities, systems, and operations under the NAS Supercomputing Storage and Support Systems (NS4) security plan that covers the NAS Division systems, including HECC systems.
- The ATO ensures the continued operation of HECC systems, in compliance with NASA security requirements.

Mission Impact: The Authorization to Operate allows HECC supercomputers and support systems to continue to be available for NASA programs and projects; and the independent assessment provides an important confirmation as to the security compliance of HECC systems.



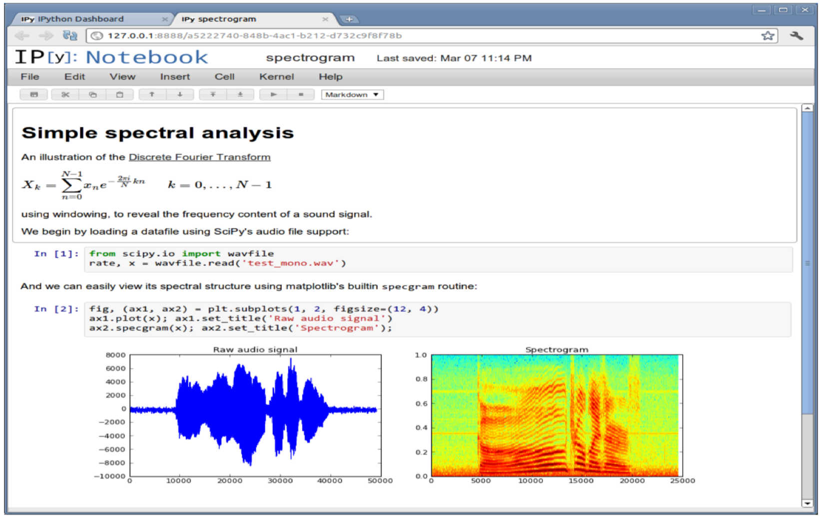
Flow chart outlines the evaluation and approval process leading to receiving an Authorization to Operate (ATO).

POC: Derek G Shaw, derek.g.shaw@nasa.gov, (650)604-4229, NASA Advanced Supercomputing Division

Security Protections Implemented for Jupyter Collaboration Tools

- HECC engineers implemented security controls for Jupyter applications to run on multi-user systems like Pleiades and Electra.
- Jupyter Notebook and Jupyter Lab enable users to interactively explore science data, but by default do not meet HECC security requirements.
- Systems engineers evaluated and implemented a set of configuration modifications on HECC resources enforcing security, including:
  - Password protecting Jupyter notebooks.
  - Setting correct permissions, using encryption for the connection
  - Setting up the use of a dedicated node for running Jupyter.
- HECC developed a local modification in the Jupyter Notebook code for the handling of localhost with IPv6, to make it easier for users to implement recommended settings.

Mission Impact: HECC provides security best practices for open source tools like Jupyter Notebooks to enable collaboration among HECC users and their peers in a secure manner.



Because the Jupyter Notebook application has access to all of a users' files, HECC experts developed best practices to reduce the risk that any user's Jupyter session can be taken over maliciously.

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Data Migration to Latest Generation Tape Technology Adds Capacity, Saves Money

- HECC engineers recently completed the transparent migration of data to the latest generation LTO-8 tape drive that reads LTO-7 and LTO-8M media, providing more storage capacity for a three-fold reduction in cost per terabyte.
- The migration process involved reading, copying, and verifying all data from 61,000 tapes (126 petabytes) on to two copies of LTO-7/8M media—all done in the background to minimize impact on users—and took 32 months to complete.
- LTO-8 tape drives provide twice the read/write performance of the previous generation tapes and faster access time for user data.
- To help with the migration process, Spectra Logic, the tape library vendor, provided an additional ten LTO-7 tape drives to expedite the migration.

Mission Impact: Migration to the latest tape technology provides six times the capacity of the older generation media, and enables HECC to provide higher capacity storage to NASA-sponsored scientists and engineers.

The NASA Advanced Supercomputing (NAS) facility has six Spectra Logic TFinity tape libraries: three are located in the primary NAS facility and three are located in a secondary facility. A copy of all data is written to each location to minimize the risk of data loss.

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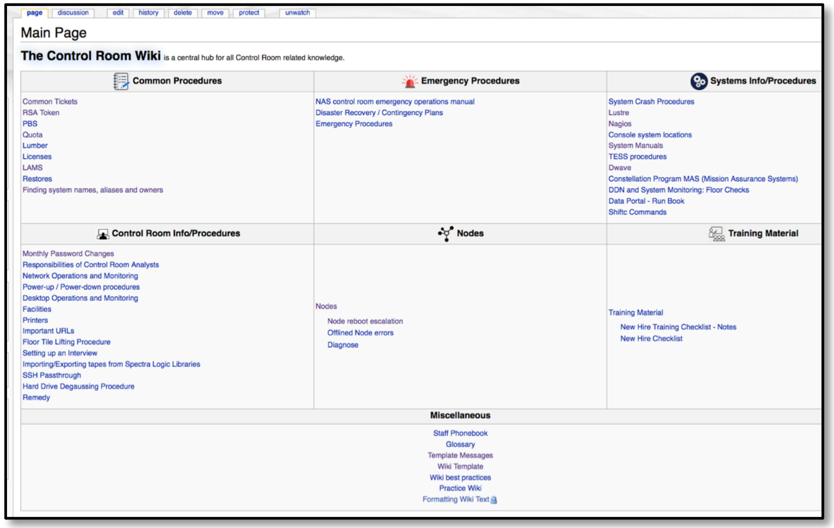
HECC Control Room Completes Major Procedure Updates to Improve Documentation and Workflow

- HECC Control Room (CR) staff reorganized and updated their CR wiki, which serves as a central knowledge base for all CR-related information.
  - Referenced multiple times daily by CR staff.
  - Documents information ranging from daily procedures to disaster plans.
- The new CR wiki improves the old wiki with:
  - Updated, verified, and complete information.
  - Topics organized logically.
  - Standardized formatting and writing style.
  - Aggregated information (512 pages down to about 250 pages).
  - Procedures for future wiki expansion and maintenance.
- The new CR wiki is now being updated as systems/procedures change.
- Future work is focused on integrating the CR wiki with monitoring systems and other knowledge bases.

Mission Impact: Improvements to the HECC Control Room procedures and documentation results in a more efficient workflow when assisting users; and in smoother facility operations.



Snapshot of the reworked, easier-to-navigate homepage of the NASA Advanced Supercomputing facility's Control Room wiki.
(View in Slide Show mode and click image for full scale.)

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ESS Team Completes Deployment of macOS 10.13 High Sierra

- The HECC Engineering Servers and Services (ESS) team completed the deployment of macOS 10.13 (High Sierra) to 220 Macs used by staff at the NAS facility.
- The ESS team began the rollout in July 2018, after NASA Ames IT Security approved the ESS High Sierra OS build.
- Deployment of High Sierra included:
  - Developed a custom build process to address recent Apple hardware restrictions that prevent standard imaging practices.
  - Automated the implementation of NASA IT security benchmarks.
  - Integrated smartcard support with Centrify initially; and later, changed to Apple native Personal Identity Verification (PIV).
- Improving on the custom build process from High Sierra, ESS staff developed a NASA approved macOS 10.14 Mojave build, and are beginning the user deployment phase.

Mission Impact: HECC's deployment of macOS 10.13 (High Sierra) with smart card authentication enhances system security and enables users to take advantage of the latest Apple software and hardware features.

With HECC's completion of the High Sierra deployment, its successor, macOS 10.14 Mojave, was developed, approved and is being deployed.

POCs: Ted Bohrer, ted.bohrer@nasa.gov, NASA Advanced Supercomputing (NAS) Division, nLogic;
Ed Garcia, edmund.a.garcia@nasa.gov, NAS Division, ASRC

Raspberry Pi Cluster Provides Simple Demonstration of HECC Compute Environment

- HECC Control Room analysts created an eight-node Raspberry Pi cluster configured with an environment similar to Pleiades to better understand the HECC environment. This was complemented by generating extensive self-led exercises for training new Control Room staff.
- The project included planning and building the 24-compute core system configured with MPI and PBS scheduling, similar to the HECC environment.
- The team also installed a 2D, smoothed particle hydrodynamics code (TinySPH) to successfully demonstrate distributed computing.
- The project was designed for training but proved a great mobile educational outreach tool for conferences. The Raspberry Pi Cluster was demonstrated at the Bay Area Maker's Faire (see slide 16) which resulted in invitations to present at the Apollo 50th Anniversary on the Mall and the Tennessee STEAM festival.

Mission Impact: Innovative projects such as the Raspberry Pi cluster support continuous improvement training for HECC Control Room staff and provide an excellent tool for NASA outreach opportunities.

The Raspberry Pi Cluster was called out as a factor in the NASA Booth being awarded the Editor's Choice ribbon at the Bay Area Maker's Faire 2019. *Blaise Hartman, NASA/Ames*

POC: Blaise Hartman, blaise.hartman@nasa.gov, (650)-604-2539
NASA Advanced Supercomputing Division

HECC Presents in the NASA Booth at Maker Faire Bay Area

- HECC team members participated in the NASA Ames booth at Maker Faire Bay Area May 17–19. Among the HPC activities:
  - Demonstrated distributed computing via a compute cluster made of 8 Raspberry Pi systems (see slide 14).
  - Engaged with attendees to inform them about the role of HPC in scientific discovery and engineering achievements for NASA programs.
  - Distributed visually appealing postcards representing simulations run on HECC systems.
- About 200,000 people attended the event, with a conservative estimate of more than 25,000 people attending the live demonstrations at the NASA booth.
- The NASA exhibit was presented the Maker's Faire Editor's Choice award, with a statement that the Raspberry Pi cluster simplified a complex idea (distributed computing/ supercomputing) in a way the general public could understand.

Mission Impact: Maker Faire provided a highly visible outreach platform to showcase the agency's high-end computing capability to the general public.

Comedian, producer, and writer Conan O'Brien and his family attended one of the demonstrations by HECC support staff member Mike Hartman.
Blaise Hartman, NASA/Ames

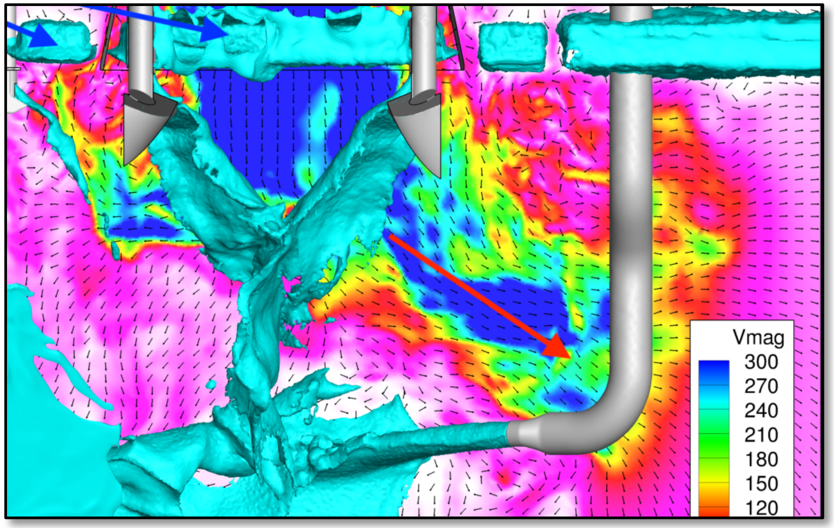
POC: Blaise Hartman, blaise.hartman@nasa.gov, (650)-604-2539, NASA Advanced Supercomputing Division

Simulating NASA's Ignition Overpressure and Sound Suppression System*

- Researchers at NASA Marshall successfully ran computational fluid dynamics (CFD) simulations on Pleiades to accurately model and predict the complex environment around NASA's mobile launcher during ignition, for the first time.
  - Using their CFD flow solver Loci/CHEM, the researchers modeled the Ignition Overpressure and Sound Suppression (IOP/SS) water system used to quiet acoustic energy loading during solid rocket booster (SRB) ignition.
  - During the Space Shuttle Program, the IOP/SS system used 350,000 gallons of water in 41 seconds; the system was designed through empirical analysis and scale-model testing, as simulating this environment using CFD tools was not possible.
  - The Loci/CHEM simulations predicted the correct timing of water plume mist that exits out the top of the system, and the peak pressures inside the exhaust holes.
  - Results also showed that SRB plume deflection from the IOP/SS water was the cause of high wall pressures on the south wall of the mobile launcher, which had been observed during space shuttle launches but the cause was unknown.
- Loci/CHEM is now being applied to the Space Launch System (SLS) redesigned launcher.

** HECC provided supercomputing resources and services in support of this work.*

Mission Impact: Building on the success of these simulations, engineers can use CFD to model the new mobile launcher and IOP/SS system that will be used for NASA's Space Launch System, aiding and speeding design of the new launch environment.



Results of CFD simulations showing the velocity magnitude along the center of the solid rocket booster (SRB). Water surface is shown as a cyan isosurface. In this image, the plume has reached the center water location; high-velocity gas propagates into the drift hole. *Jared Gudenkauf, NASA/Marshall*

POCs: Jeff West, jeffrey.s.west@nasa.gov, (256) 544-6309, NASA Marshall Space Flight Center (MSFC); Andrew Weaver, andrew.b.weaver@nasa.gov, MSFC, ESSCA

HECC Facility Hosts Several Visitors and Tours in May 2019

- HECC hosted 13 tour groups in May; guests learned about the agency-wide missions being supported by HECC assets, and also viewed the D-Wave 2000Q quantum system. Visitors this month included:
  - A group of NASA staff participating in the NASA Space Environment Test Management Office face-to-face meeting at Ames.
  - Senior management from the SLAC National Accelerator Laboratory and personnel working in SLAC's computing, exoplanets, and astrobiology areas, and detectors and sensors organizations, visited at the invitation of Ames Center Director Eugene Tu.
  - NASA Headquarters' Strategic Workforce Planning Team.
  - Jim Wulff, Deputy Regional Administrator, Occupational Safety and Health Administration.
  - A research group at the Australian Department of Defense.
  - Hale Reynolds, Chief Executive Officer of Spot Technologies.
  - A group of engineers from the Guild of Electrical Engineering from Aalto University in Helsinki, Finland.
  - A large group of NASA Ames spring interns.

Piyush Mehrotra, NASA Advanced Supercomputing Division Chief, presents slides to senior managers from the SLAC National Accelerator Laboratory. Ames Director Eugene Tu is at far right in the front row.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division

Papers

- "**A Hybridizable Discontinuous Galerkin Method for Both Thin and 3D Nonlinear Elastic Structures**," S. Terrana, N. Nguyen, J. Bonet, J. Peraire, Computer Methods in Applied Mechanics and Engineering, vol. 352, published online April 30, 2019. *
https://www.sciencedirect.com/science/article/pii/S0045782519302324
- "**Establishing the Quantum Supremacy Frontier with a 281 Pflop/s Simulation**," B. Villalonga, et al., arXiv:1905.00444 [quant-ph], May 1, 2019. *
https://arxiv.org/abs/1905.00444
- "**SPECTRUM: Synthetic Spectra Calculations for Global Space Plasma Modeling**," J. Szente, et al., The Astrophysical Journal Supplement Series, vol. 242, no.1, May 1, 2019. *
https://iopscience.iop.org/article/10.3847/1538-4365/ab16d0/meta
- "**The Transiting Multi-planet System HD15337: Two Nearly Equal-mass Planets Straddling the Radius Gap**," D. Gandolfi, et al., The Astrophysical Journal Letters, vol. 876, no. 2, May 6, 2019. *
https://iopscience.iop.org/article/10.3847/2041-8213/ab17d9/meta
- "**Discovery of the First Earth-Sized Planets Orbiting a Star Other than Our Sun in the Kepler-20 System**," G. Torres, F. Fressin, New Astronomy Review, vol. 83, published online May 13, 2019. *
https://www.sciencedirect.com/science/article/pii/S1387647318300617

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**Densely-Packed Bundles of Collapsed Carbon Nanotubes: Atomistic and Mesoscopic Distinct Element Method Modeling**," G. Drozdov, et al., Carbon (Elsevier), published online May 16, 2019. *
https://www.sciencedirect.com/science/article/pii/S0008622319305056
- "**Enabling Immediate Access to Earth Science Models Through Cloud Computing: Application to the GEOS-Chem Model**," J. Zhuang, et al., Bulletin of the American Meteorological Society (BAMS), published online May 17, 2019. *
https://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-18-0243.1
- "**Active Control of Supersonic Transport Aeroelastic Oscillations Using High-Fidelity Equations**," G. Guruswamy, IFAC Journal of Systems and Control, vol. 8, published online May 20, 2019. *
https://www.sciencedirect.com/science/article/pii/S2468601818301573
- "**Dedalus: A Flexible Framework for Numerical Simulations with Spectral Methods**," K. Burns, et al., arXiv:1905.10388 [astro-ph.IM], May 24, 2019. *
https://arxiv.org/abs/1905.10388

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- **25th AIAA/CEAS Aeroacoustics Conference**, Delft, The Netherlands, May 20-23, 2019.
  - "**Simulation-Based Assessment of a Full-Scale Installed Quiet Landing Gear**," B. Duda, R. Ferris, M. Khorrami. * https://arc.aiaa.org/doi/pdf/10.2514/6.2019-2476
  - "**Assessment of Aeroacoustic Simulations of the High-Lift Common Research Model**," D. Lockard, M. O'Connell, V. Vasta, M. Choudhari. * https://arc.aiaa.org/doi/pdf/10.2514/6.2019-2460
  - "**Measured and Simulated Acoustic Signature of a Full-Scale Aircraft with Airframe Noise Reduction Technology Installed**," M. Khorrami, P. Ravetta, D. Lockard, B. Duda, R. Ferris. * https://arc.aiaa.org/doi/pdf/10.2514/6.2019-2477
  - "**Hybrid RANS/LES Simulation of Jet Surface Interaction Noise**," G.-D. Stich, J. Housman, J. Kocheemoolayil, C. Kiris, J. Bridges, C. Brown. * https://arc.aiaa.org/doi/pdf/10.2514/6.2019-2475
  - "**Propeller Noise Predictions Using the Lattice Boltzmann Method**," J. Kocheemoolayil, G. Stich, M. Barad, C. Kiris. * https://arc.aiaa.org/doi/pdf/10.2514/6.2019-2661

** HECC provided supercomputing resources and services in support of this work*

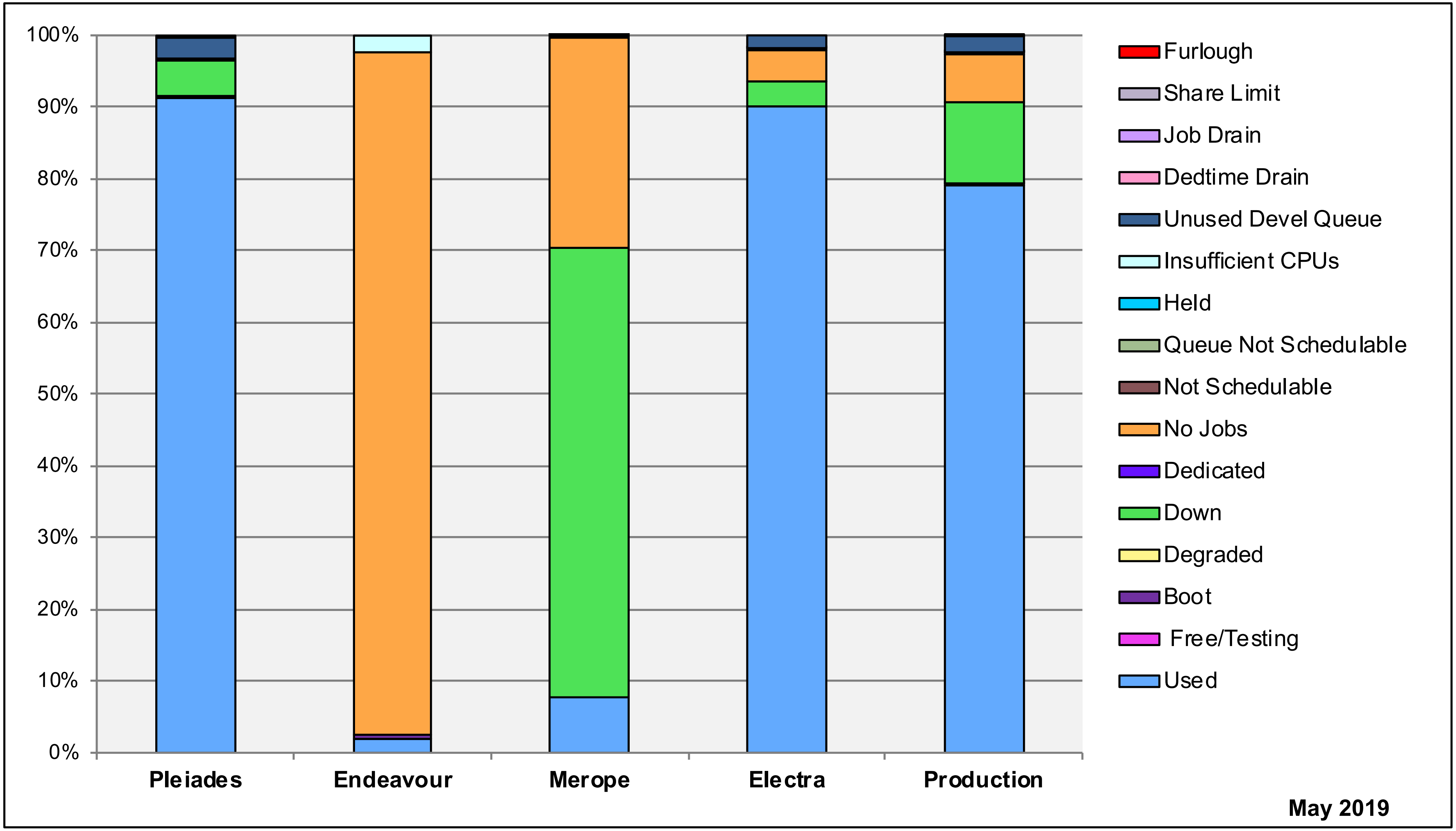
News and Events

- **Don't Panic: Scientists are Practicing for a Killer Asteroid Impact**, *The Washington Post*, May 3, 2019—NAS Division researcher Lorien Wheeler modeled millions of potential impact scenarios for a tabletop exercise exploring possible damage by a fictional asteroid, at the International Academy of Astronautics' Planetary Defense Conference April 29–May 3, 2019 in College Park, Maryland. https://www.washingtonpost.com/science/2019/05/03/dont-panic-scientists-are-practicing-killer-asteroid-impact/?utm_term=.84e1282feb0e
- **Hammering Away at the Dynamic Stall Problem to Build Better Rotorcraft**, *NAS Feature*, May 23, 2019—Continuous advances in NASA's modeling and simulation tools, along with the Electra supercomputer, help rotorcraft design engineers build safer, more efficient aircraft in less time and for less money. https://www.nas.nasa.gov/publications/articles/feature_rotorcraft_bvi_chaderjian.html

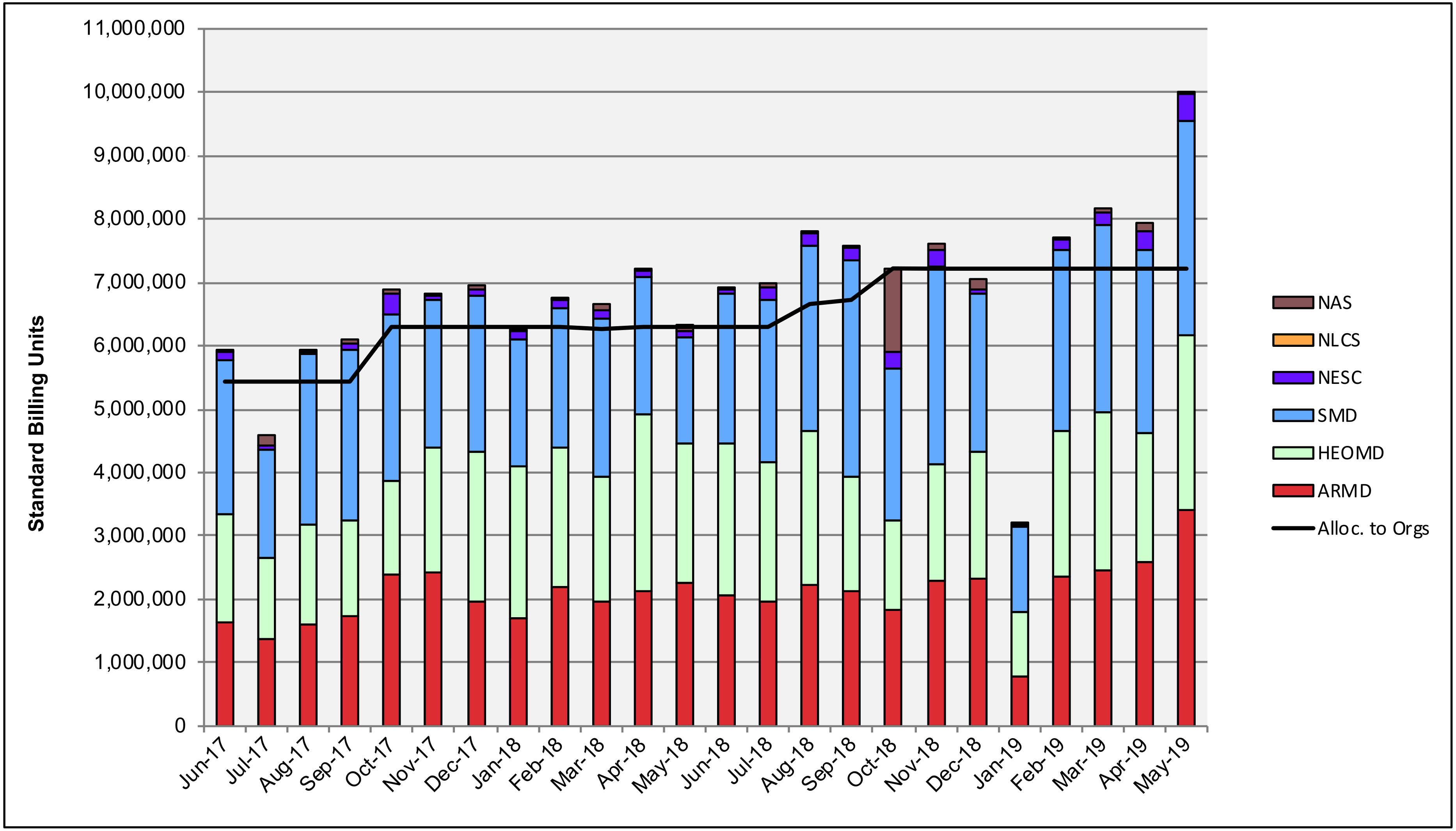
News and Events: Social Media

- **Top Posts from NAS**
  - Rotorcraft Feature Story:
    - Twitter: 2 retweets, 11 likes
    - Facebook: 759 users reached, 140 engagements
  - Participation in NASA's #Planetary Defense Campaign:
    - Twitter: 6 retweets, 17 likes
    - Twitter: 3 retweets, 8 likes
  - Participation in #MFBA19 (Maker Faire Bay Area):
    - Twitter: 3 retweets, 3 likes
    - Twitter: 8 retweets, 16 likes

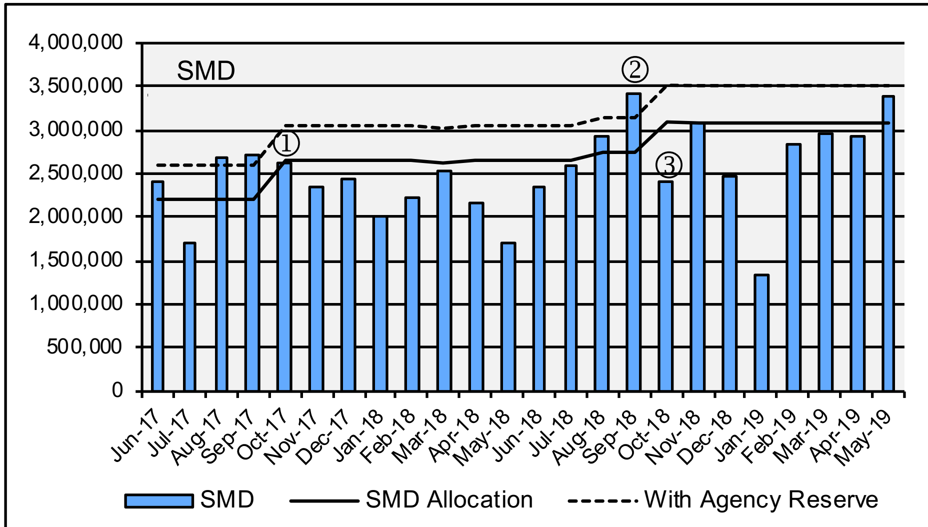
HECC Utilization

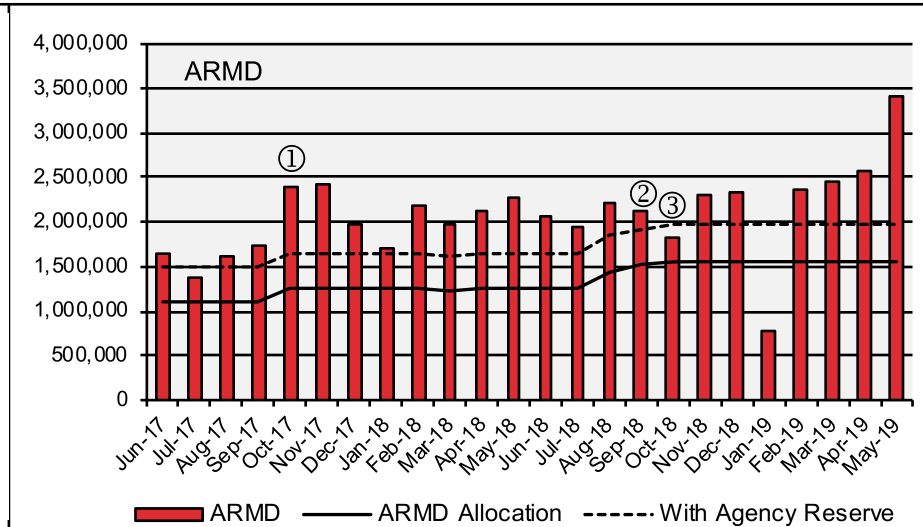


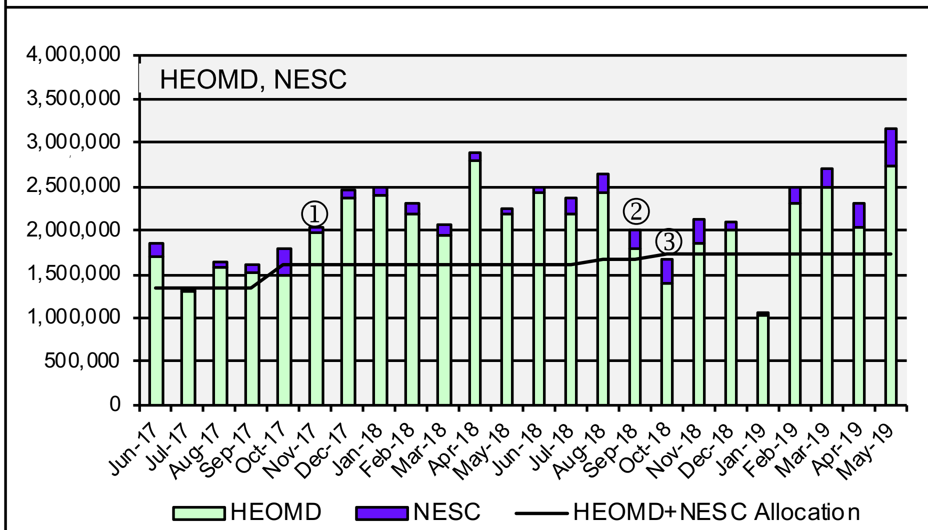
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month





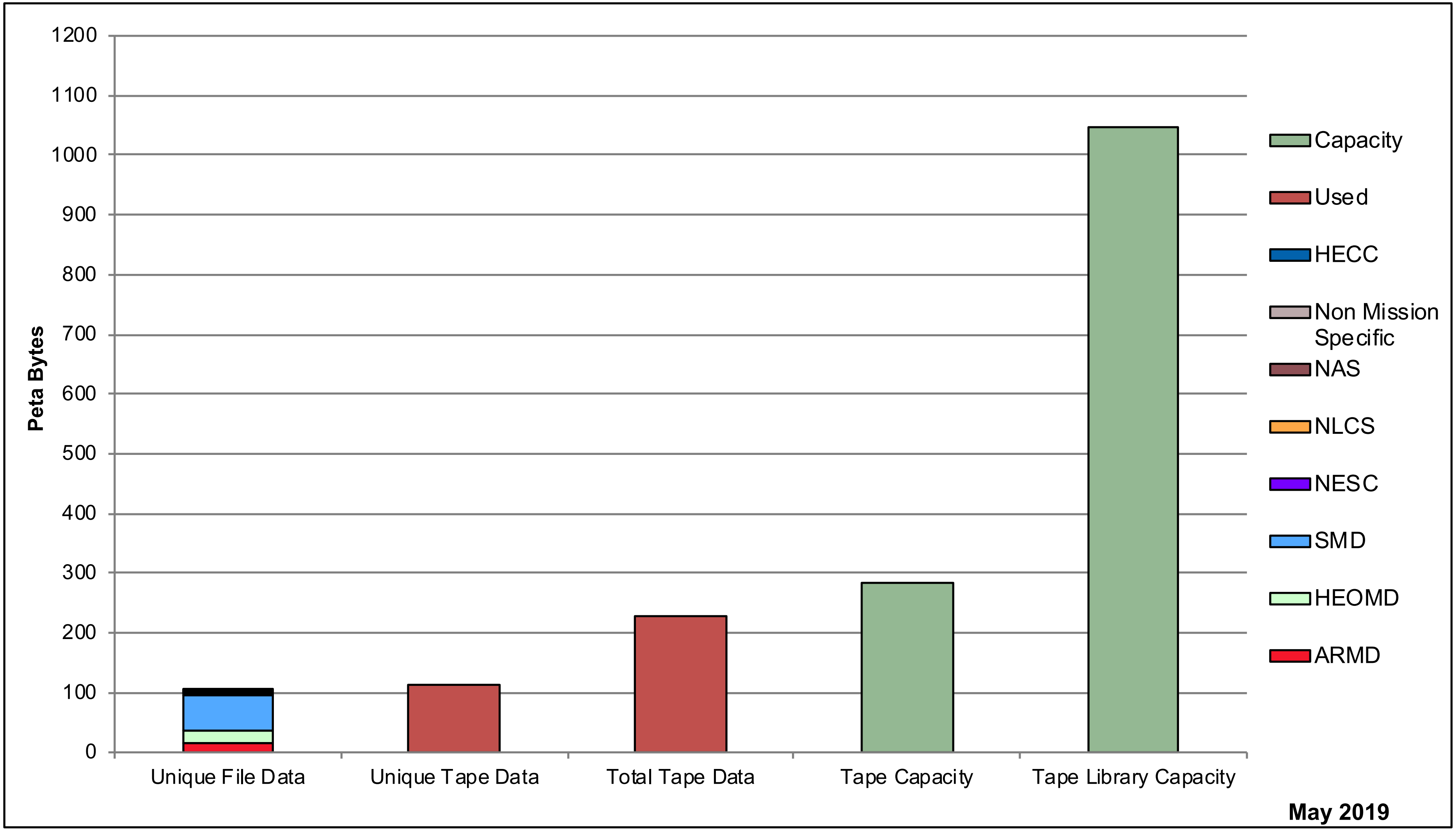


① 4 Skylake E cells (16 D Rack Equivalence) added to Electra

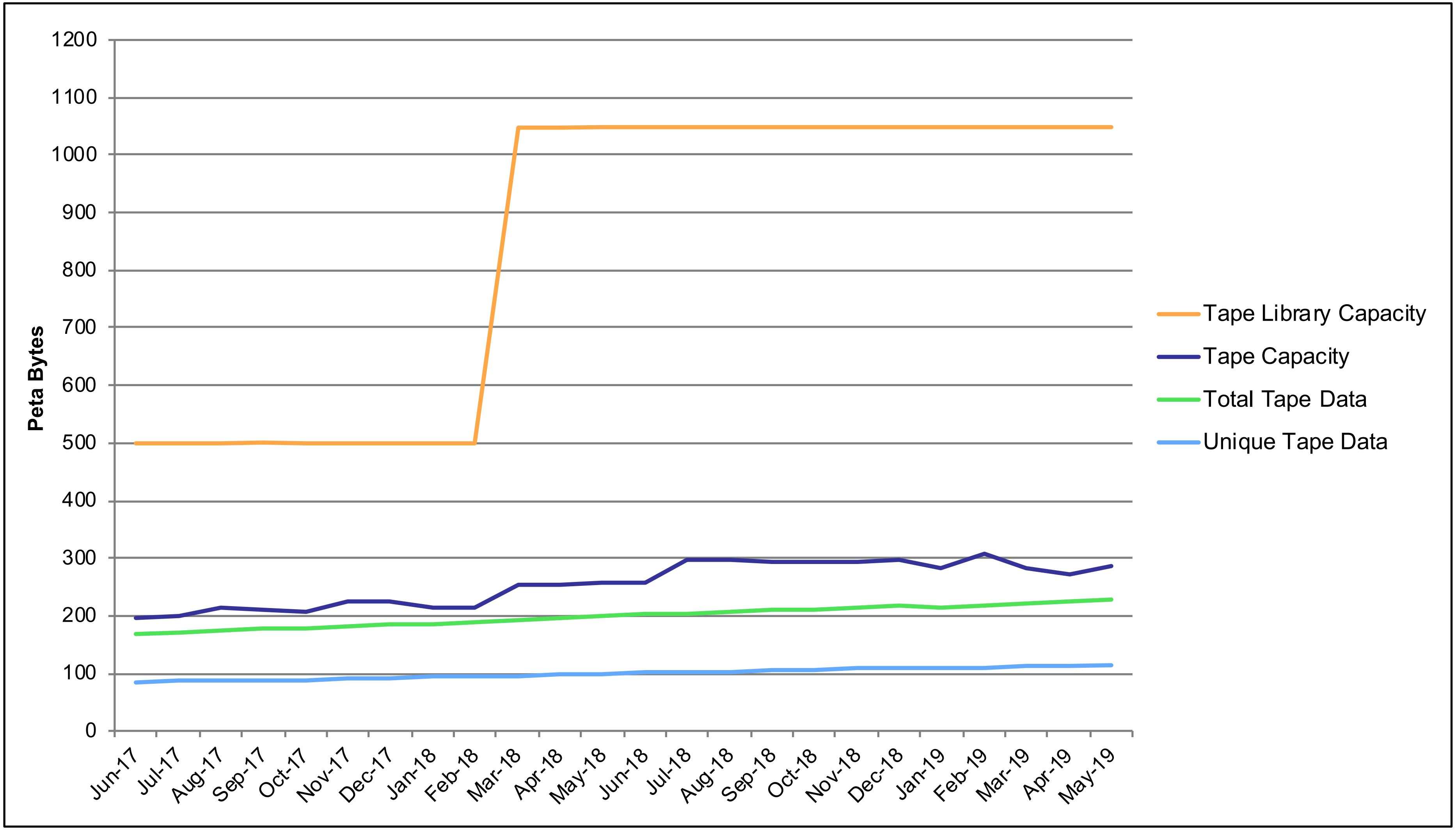
② 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to ARMD

③ 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to SMD

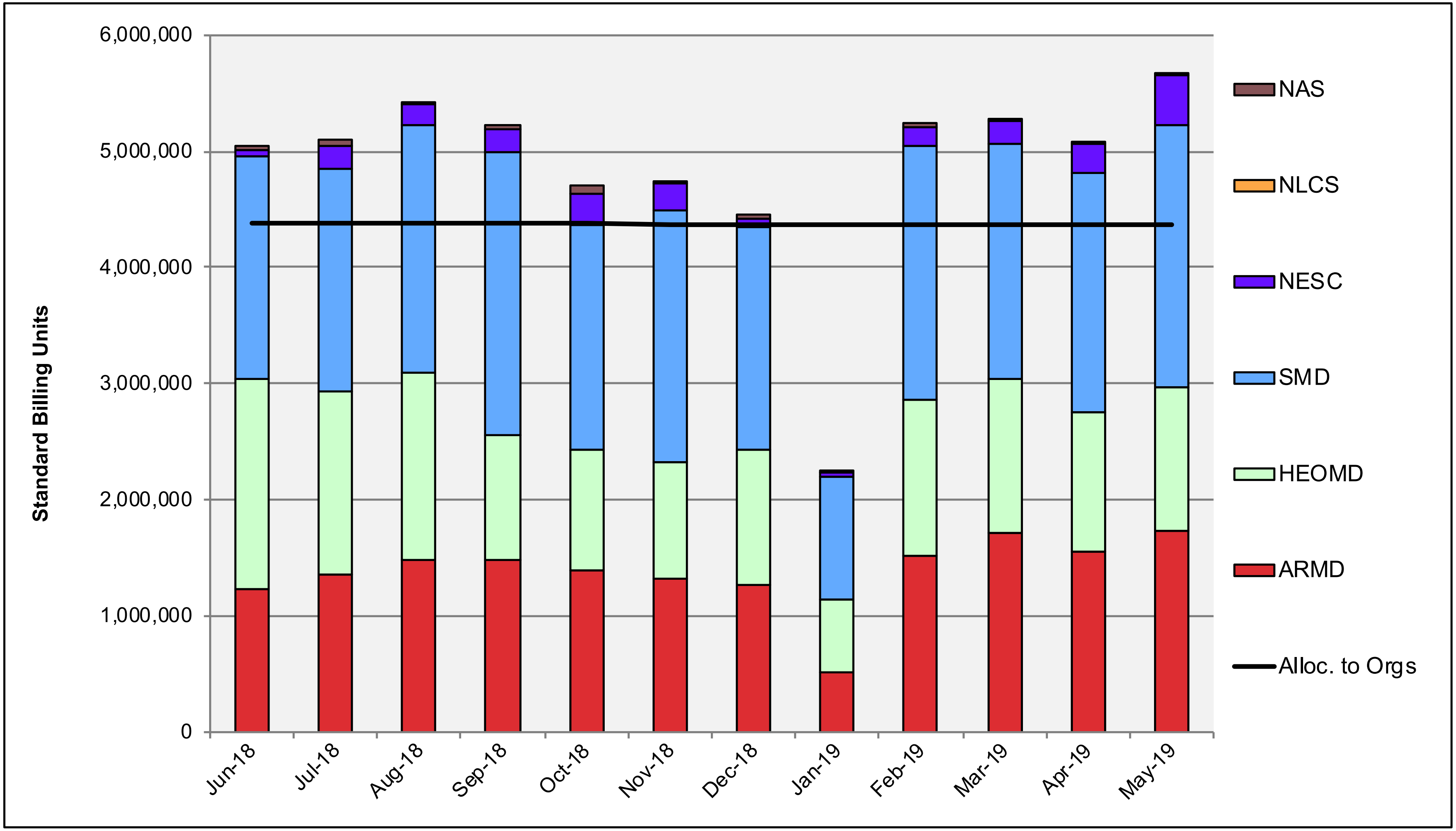
Tape Archive Status



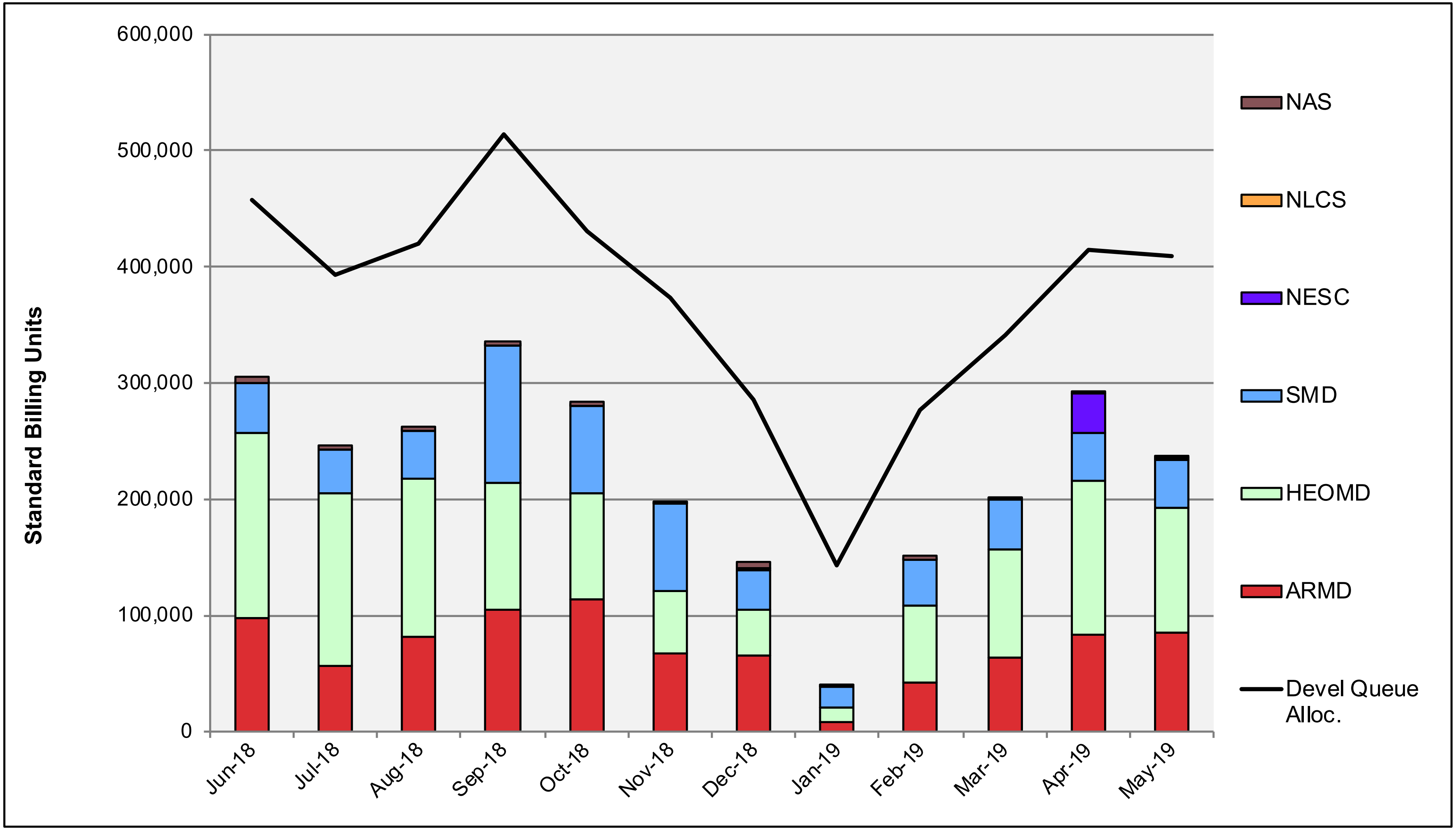
Tape Archive Status



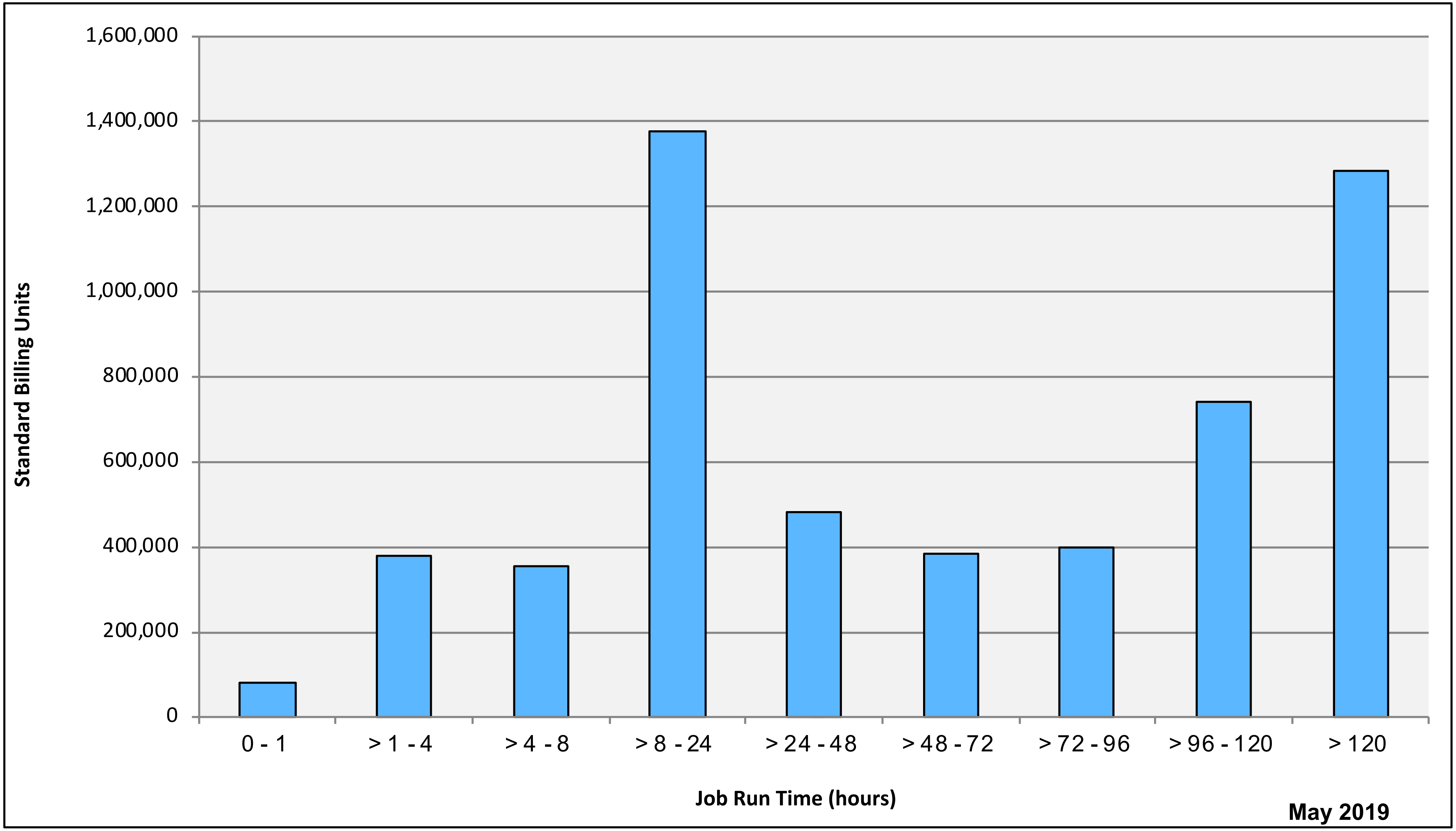
Pleiades: SBUs Reported, Normalized to 30-Day Month



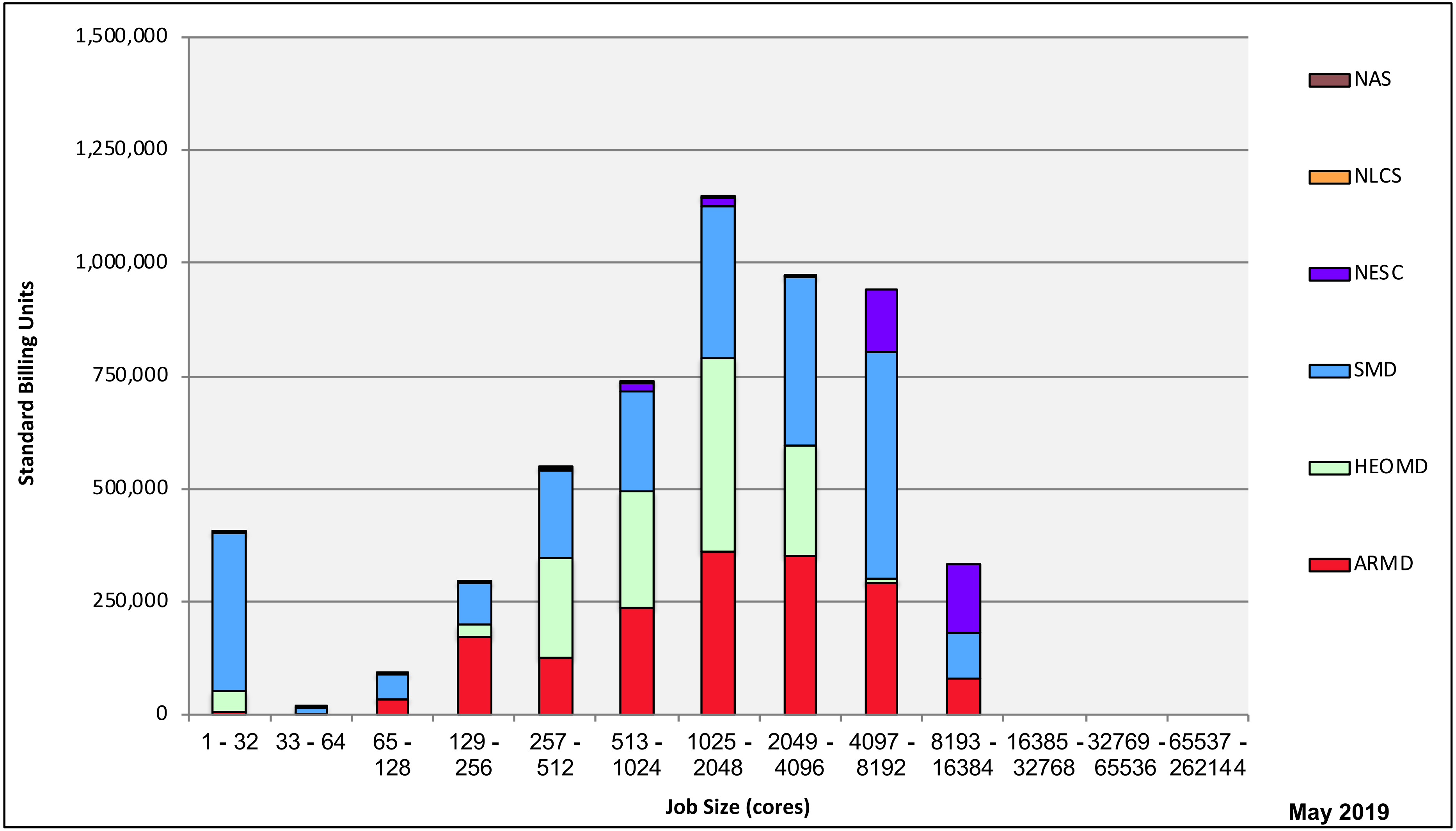
Pleiades: Devel Queue Utilization



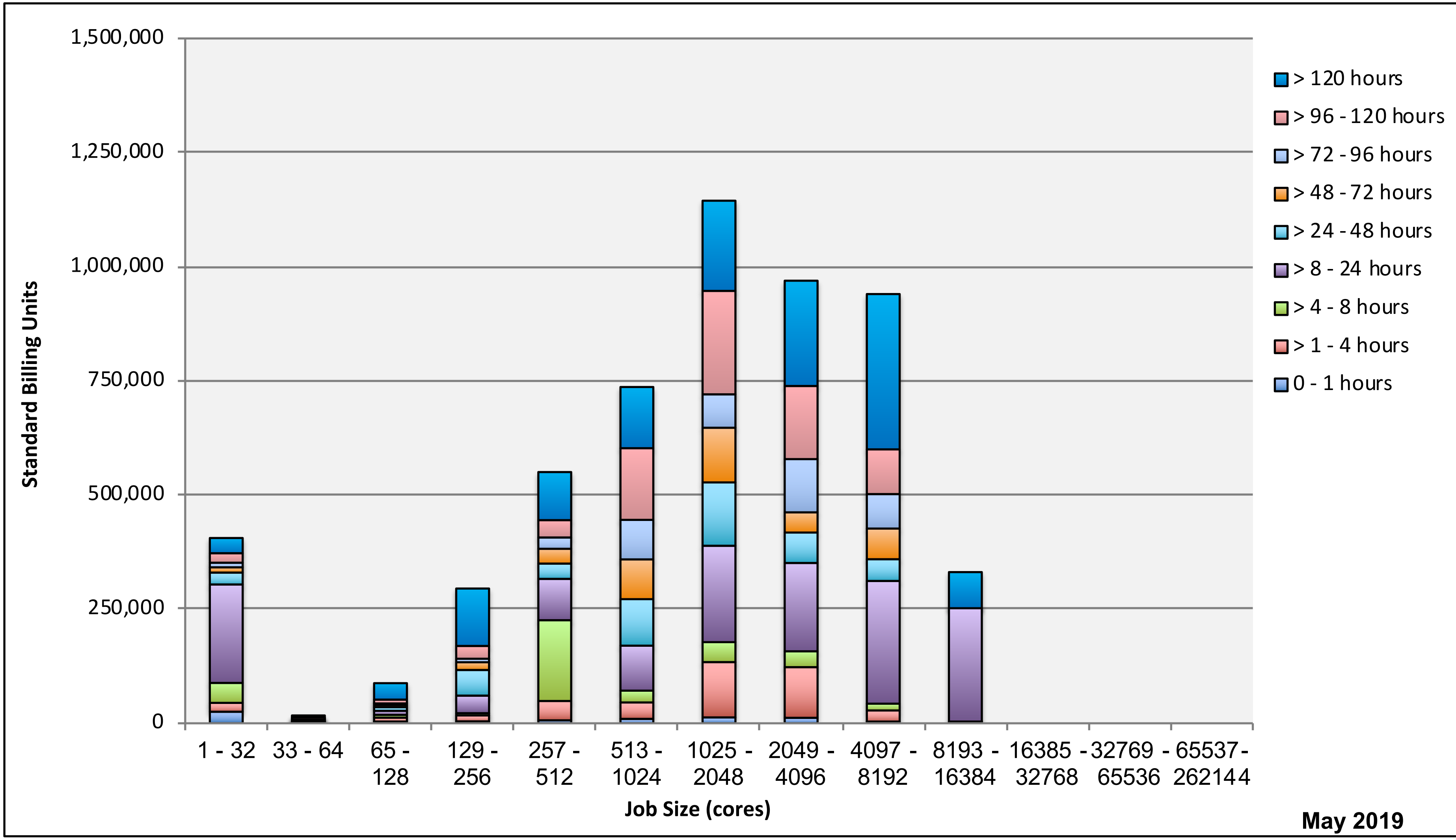
Pleiades:
Monthly Utilization by Job Length



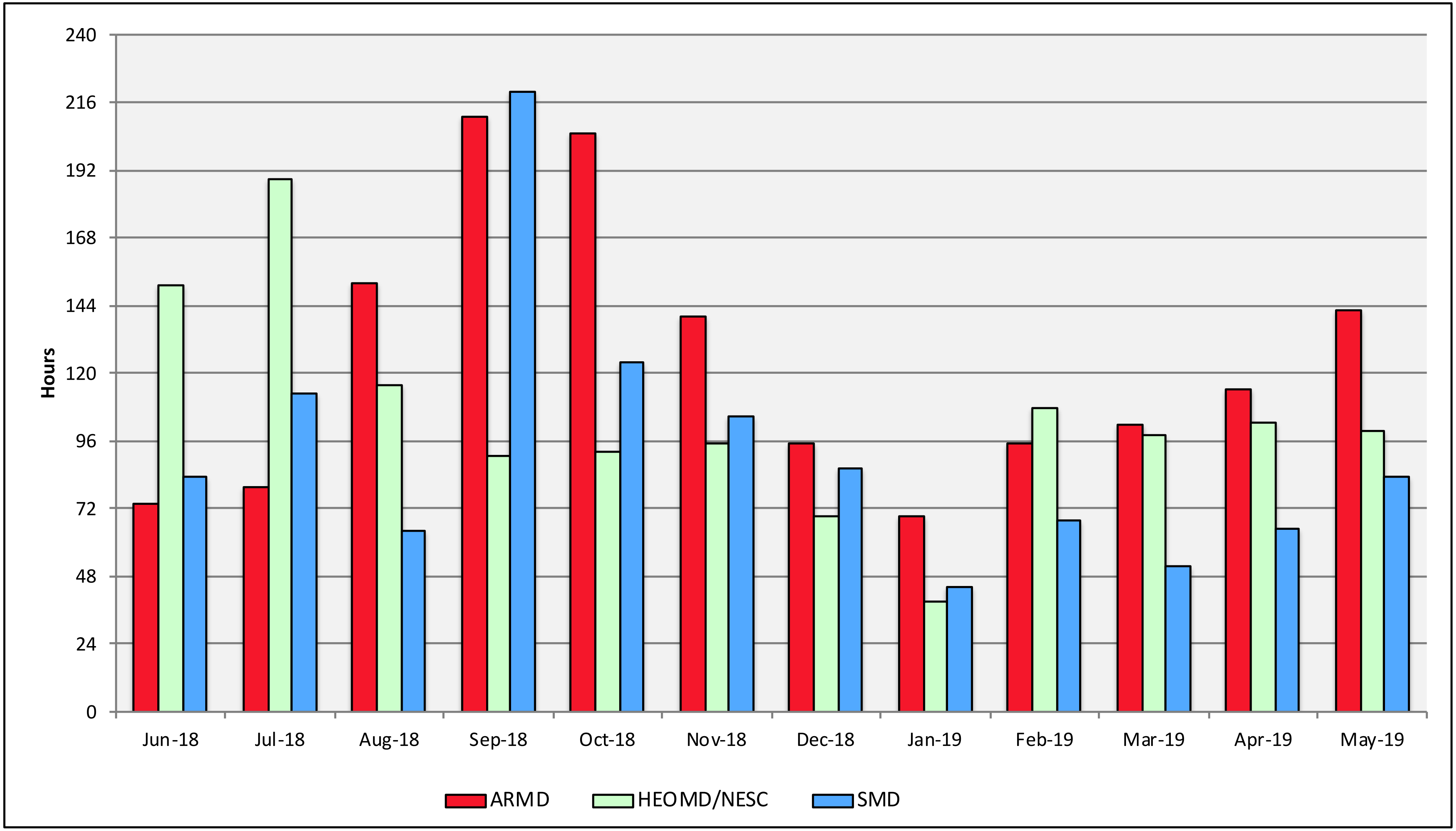
Pleiades: Monthly Utilization by Size and Mission



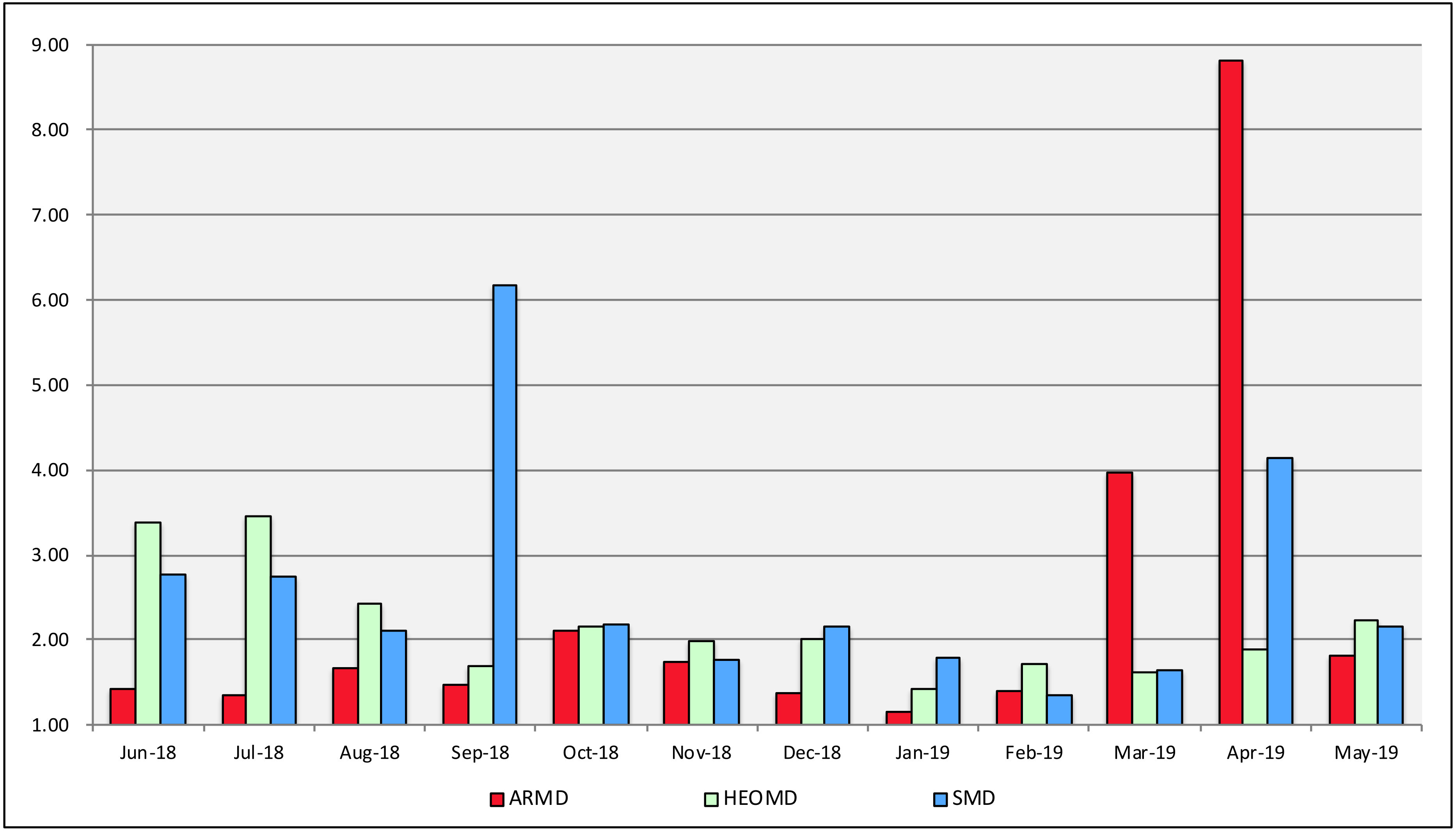
Pleiades:
Monthly Utilization by Size and Length



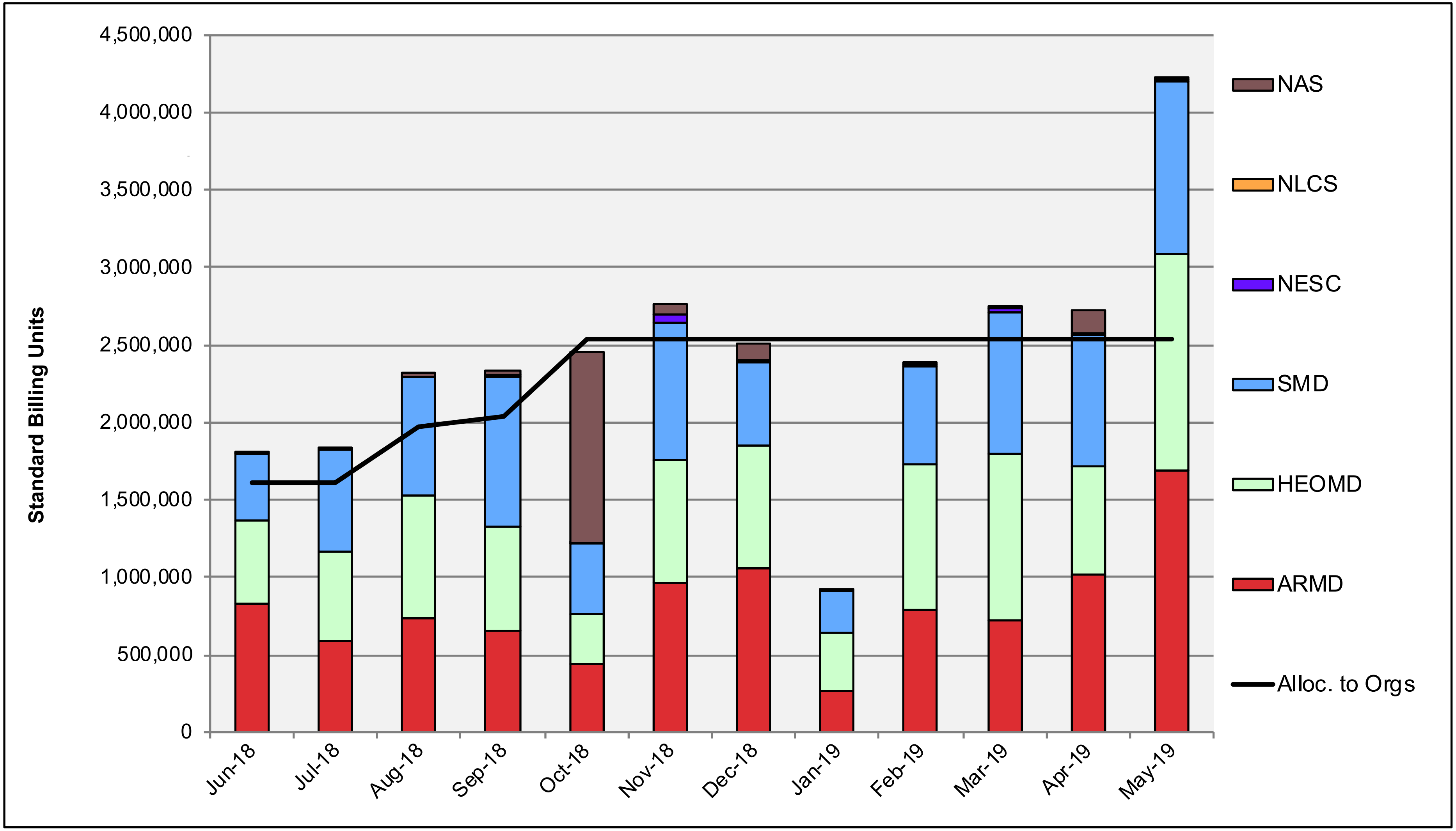
Pleiades: Average Time to Clear All Jobs



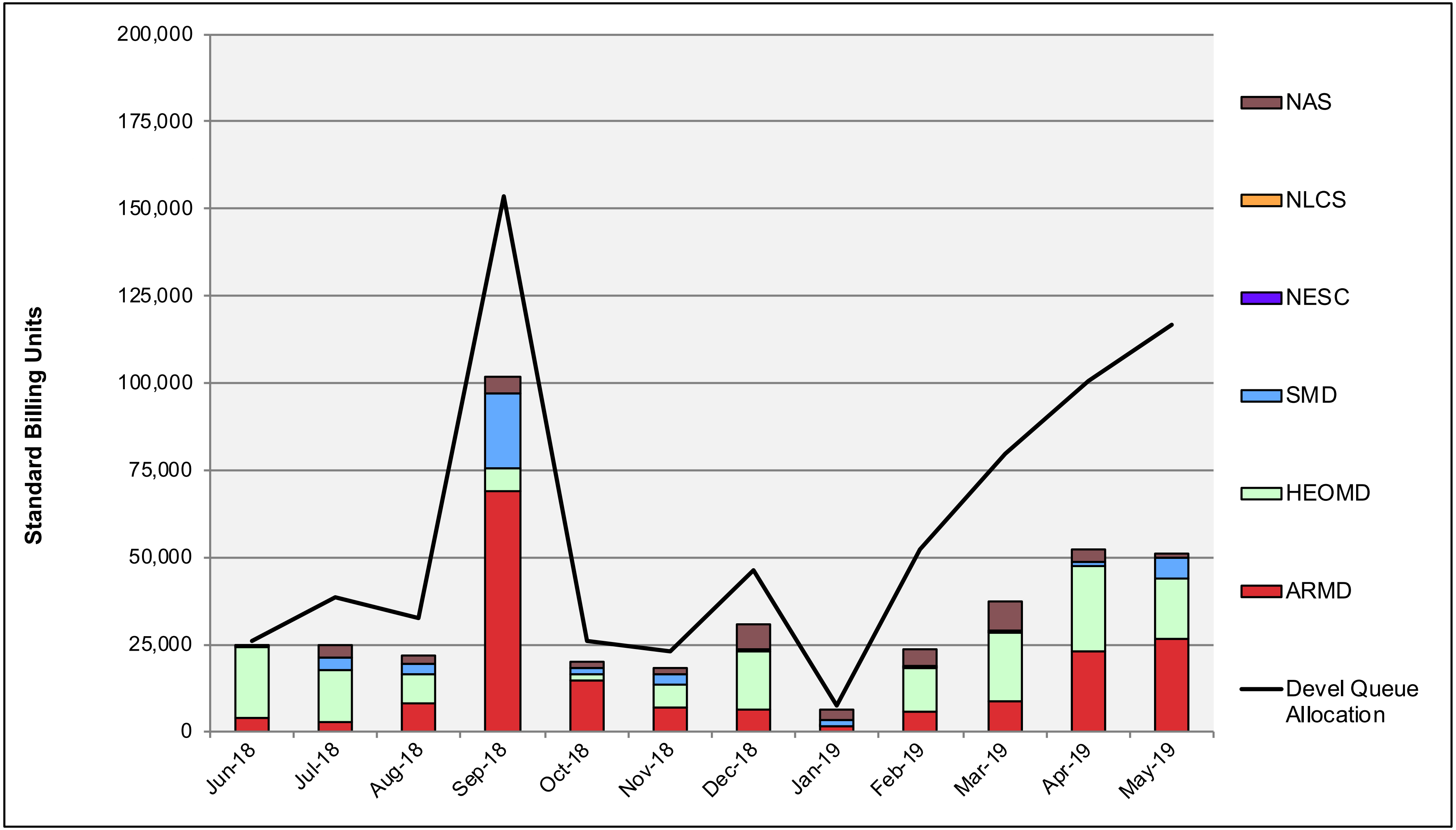
Pleiades: Average Expansion Factor



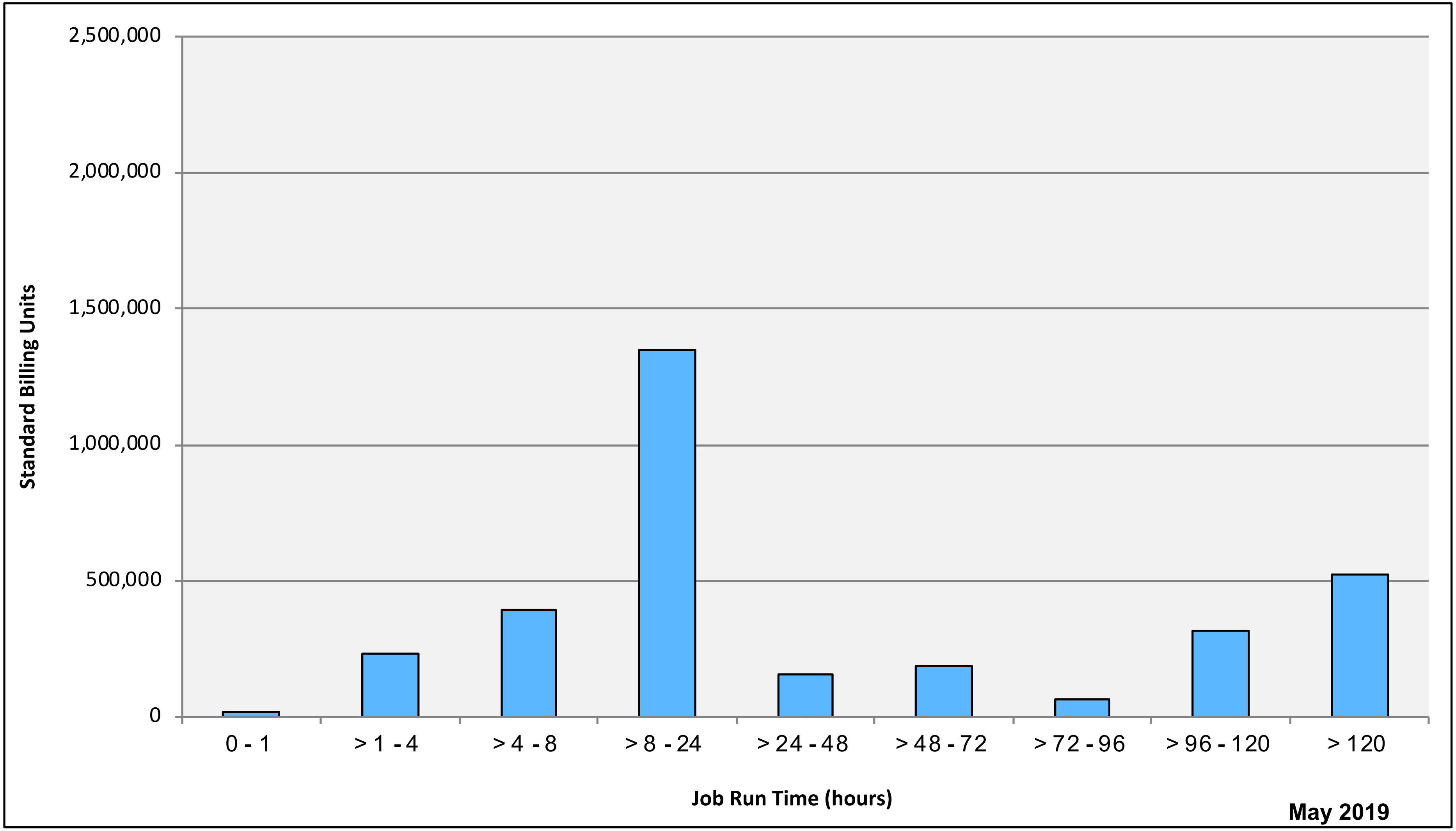
Electra: SBUs Reported, Normalized to 30-Day Month



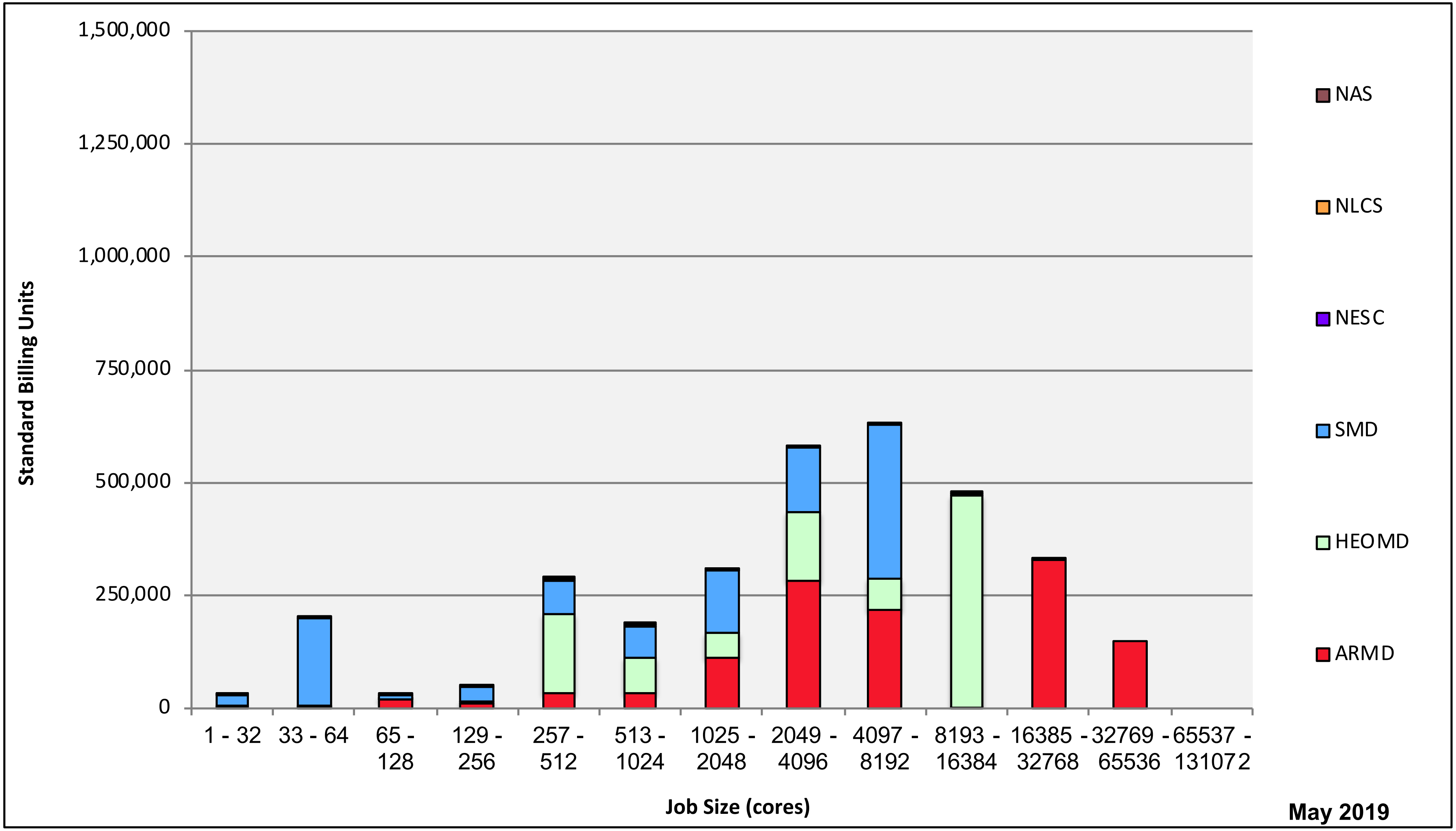
Electra:
Devel Queue Utilization



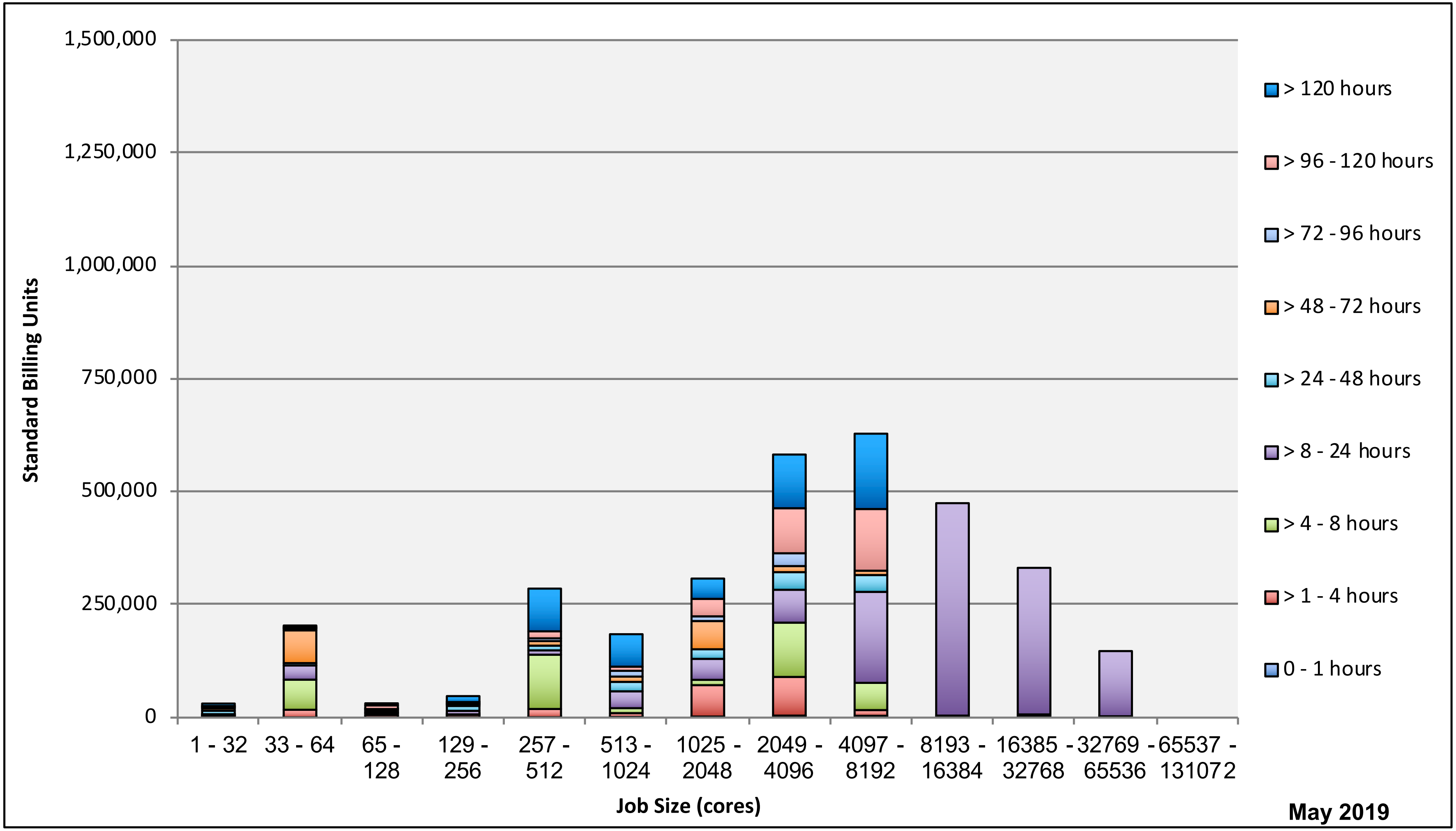
Electra: Monthly Utilization by Job Length



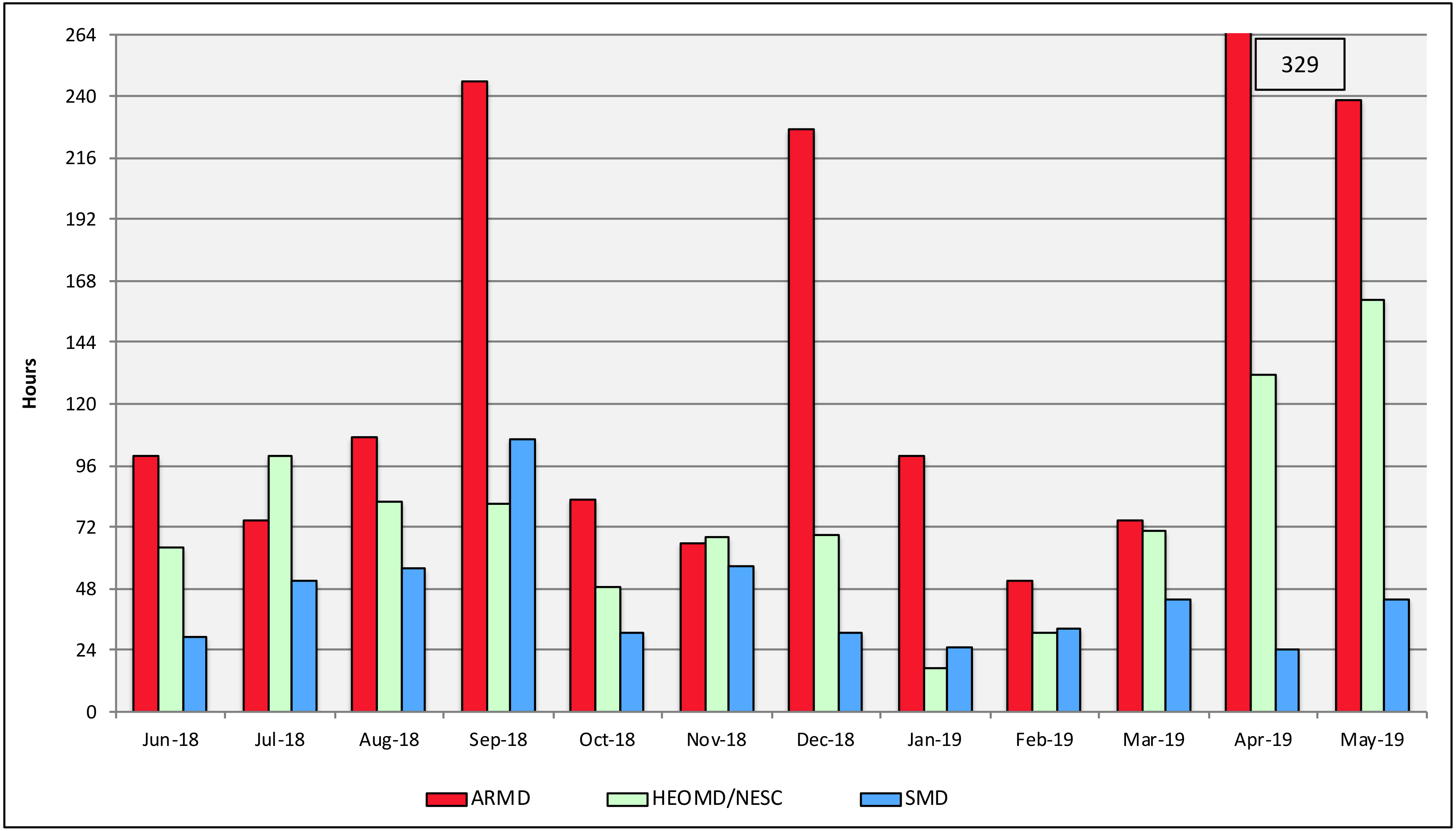
Electra: Monthly Utilization by Size and Mission



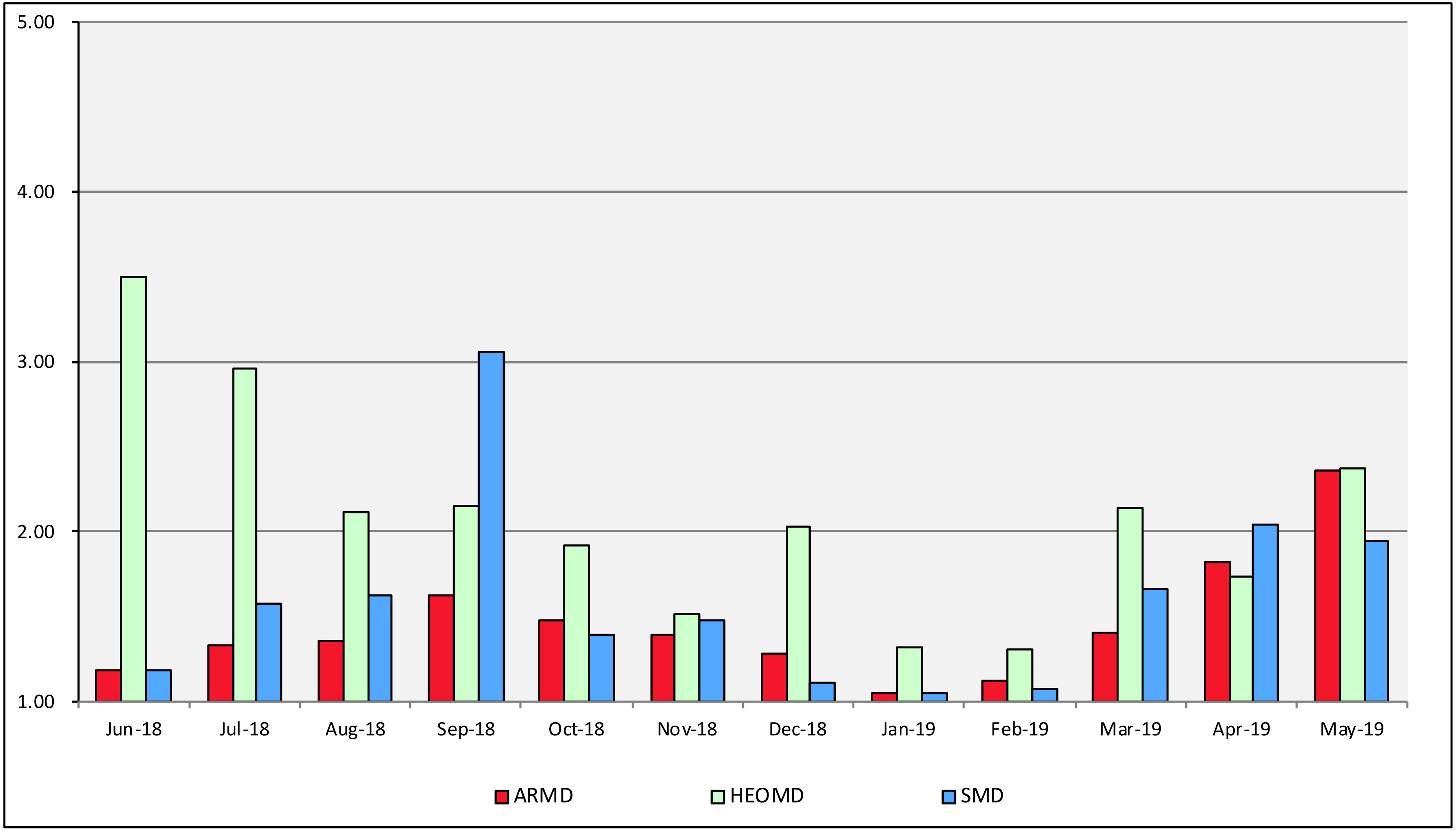
Electra:
Monthly Utilization by Size and Length



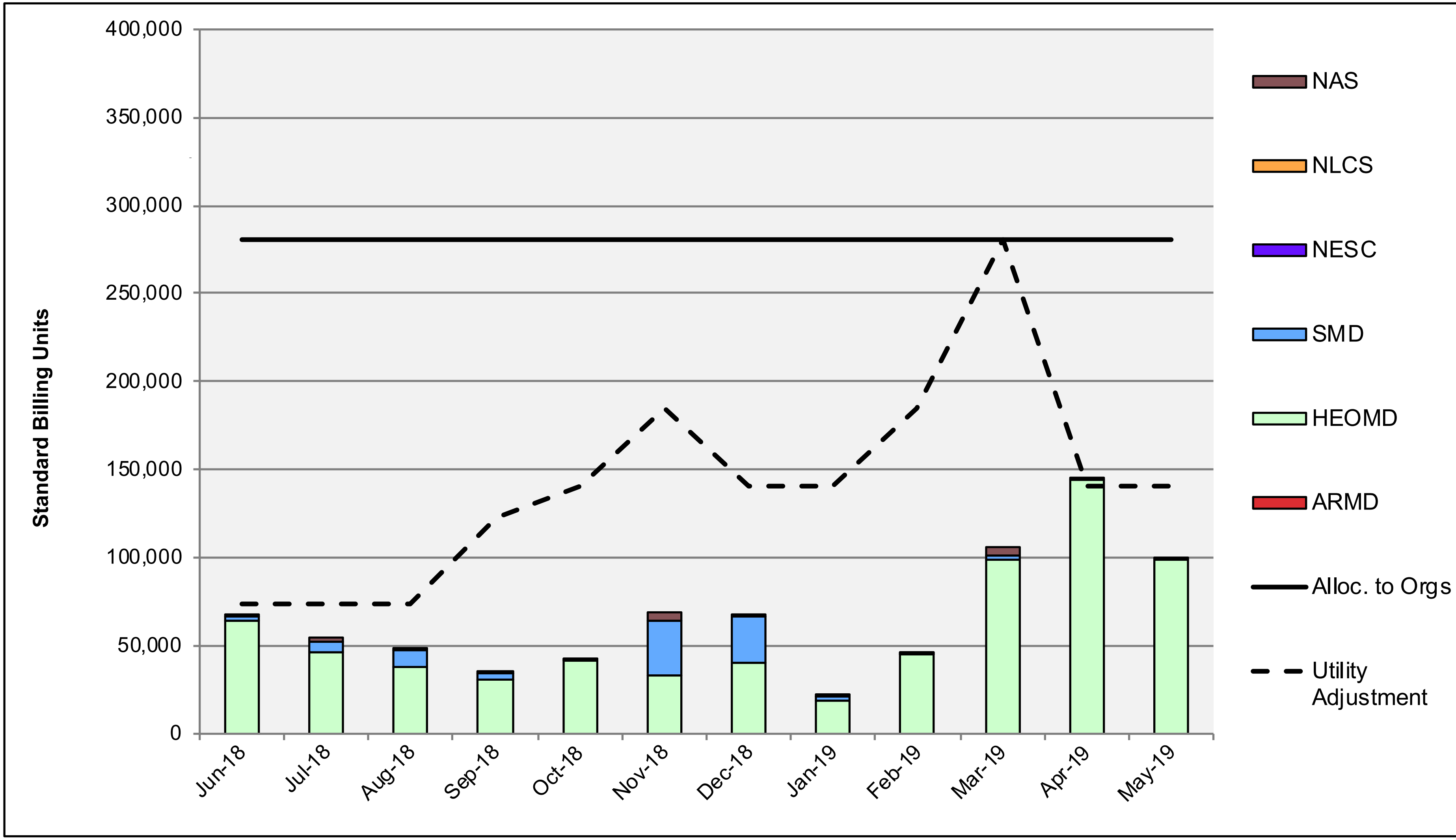
Electra: Average Time to Clear All Jobs



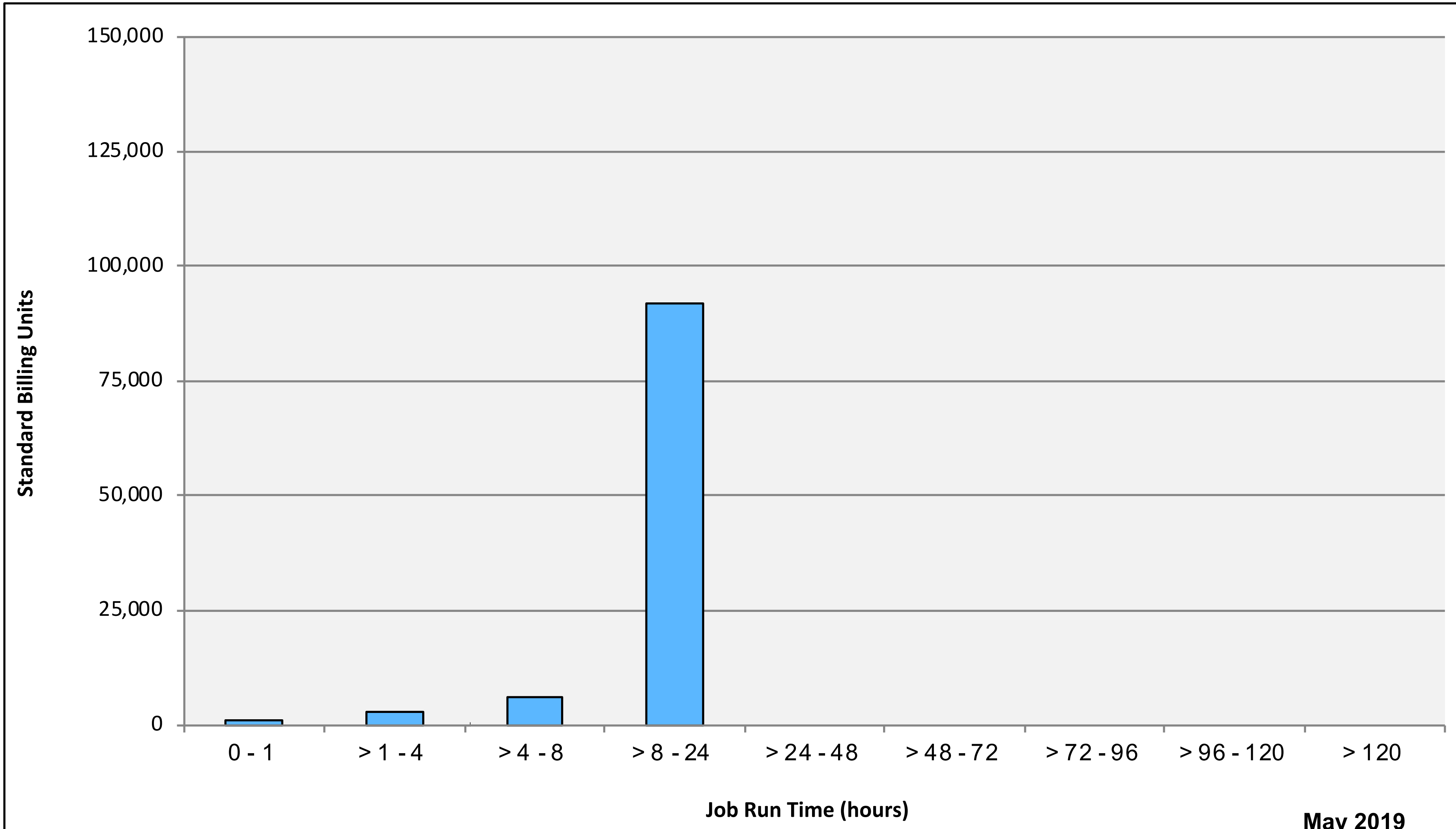
Electra: Average Expansion Factor



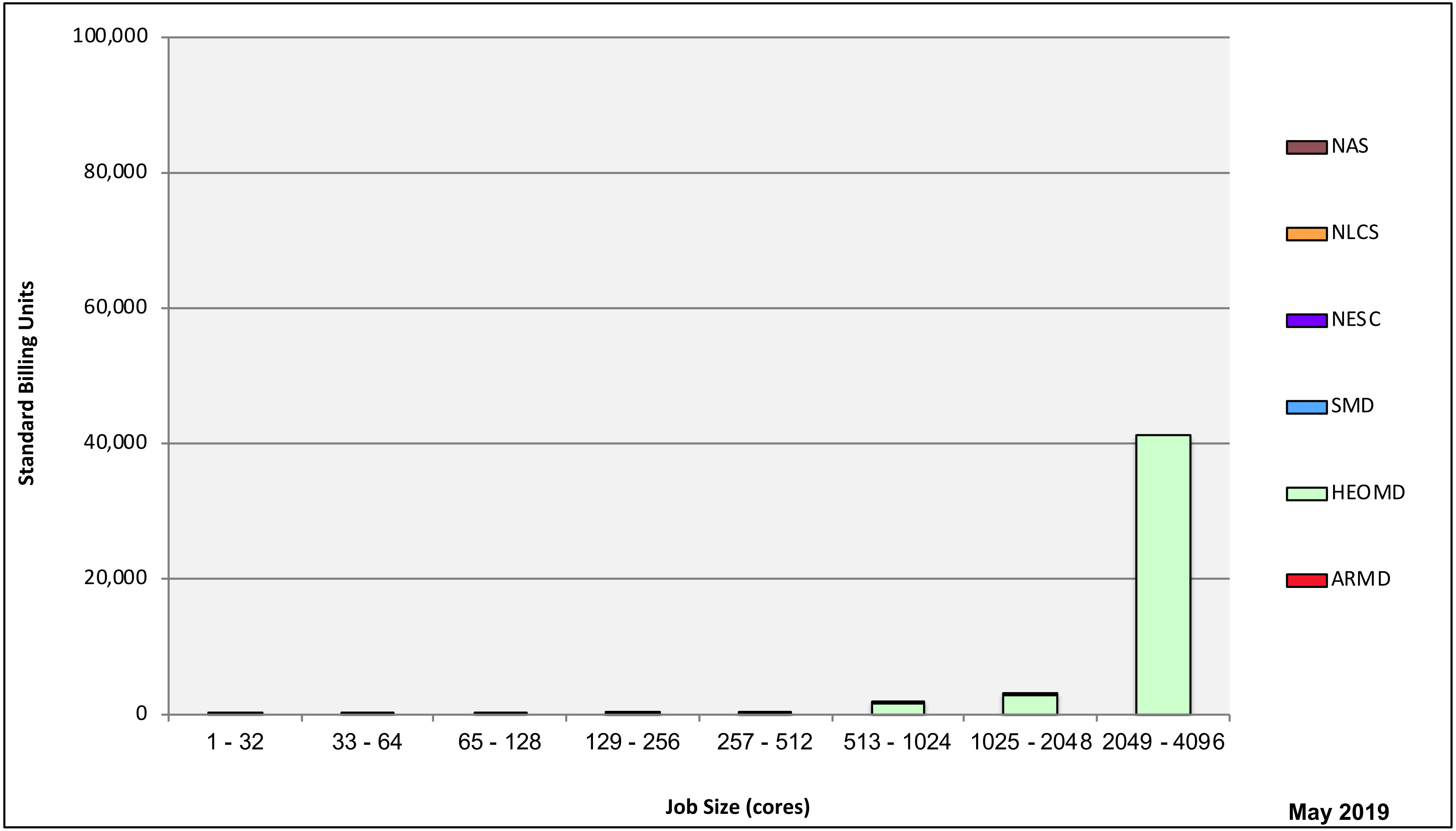
Merope:
SBUs Reported, Normalized to 30-Day Month



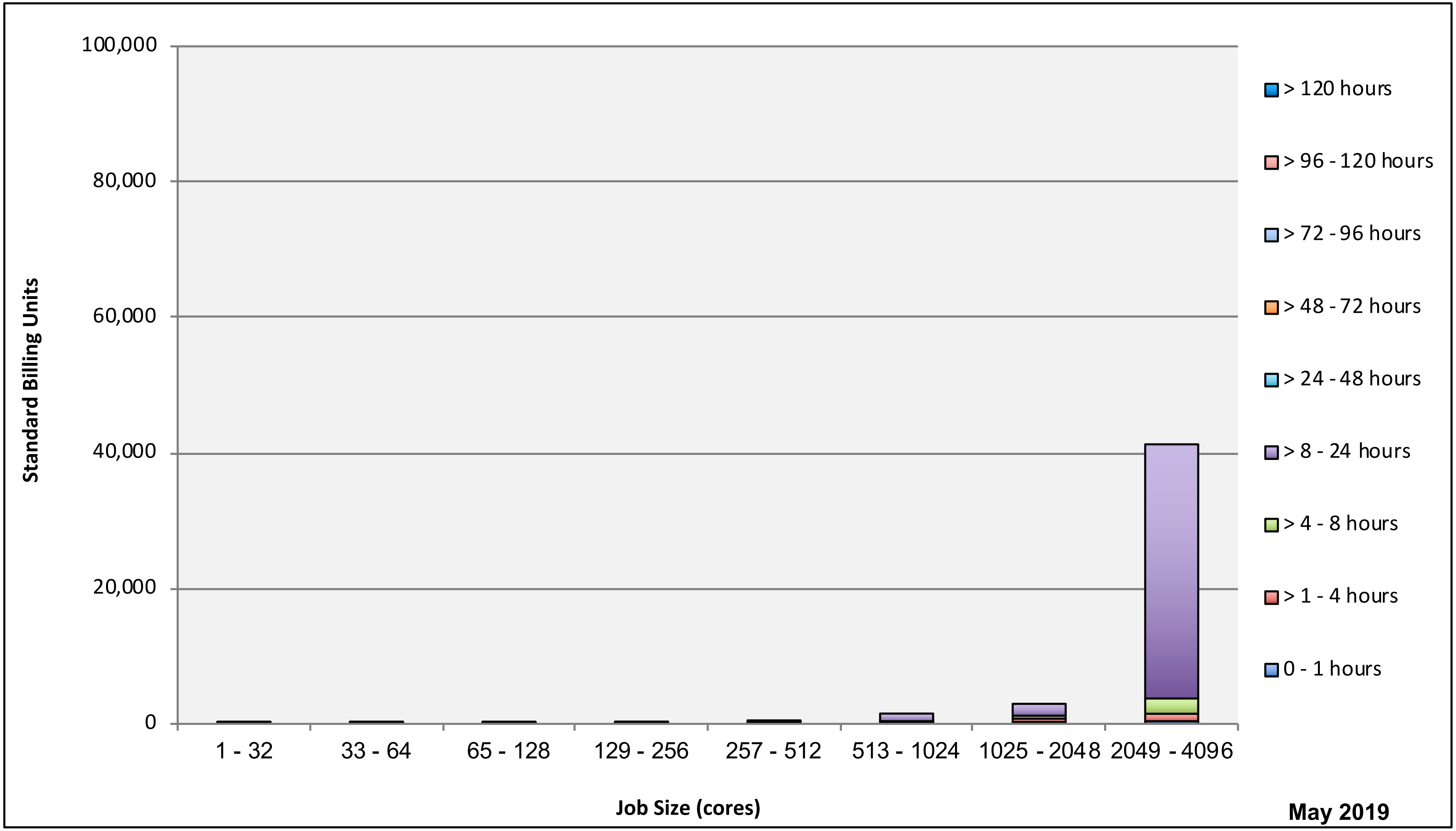
Merope: Monthly Utilization by Job Length



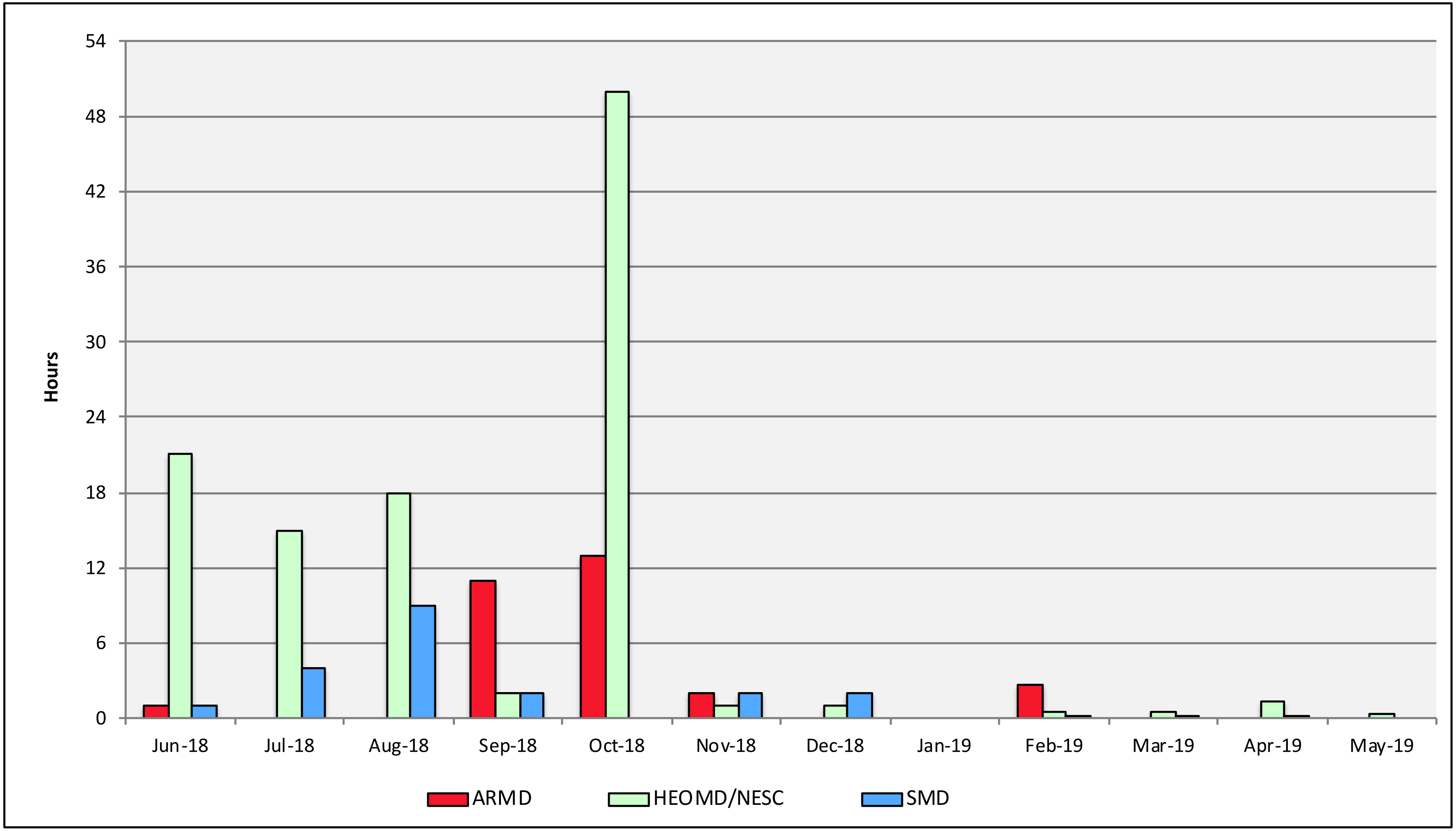
Merope:
Monthly Utilization by Size and Mission



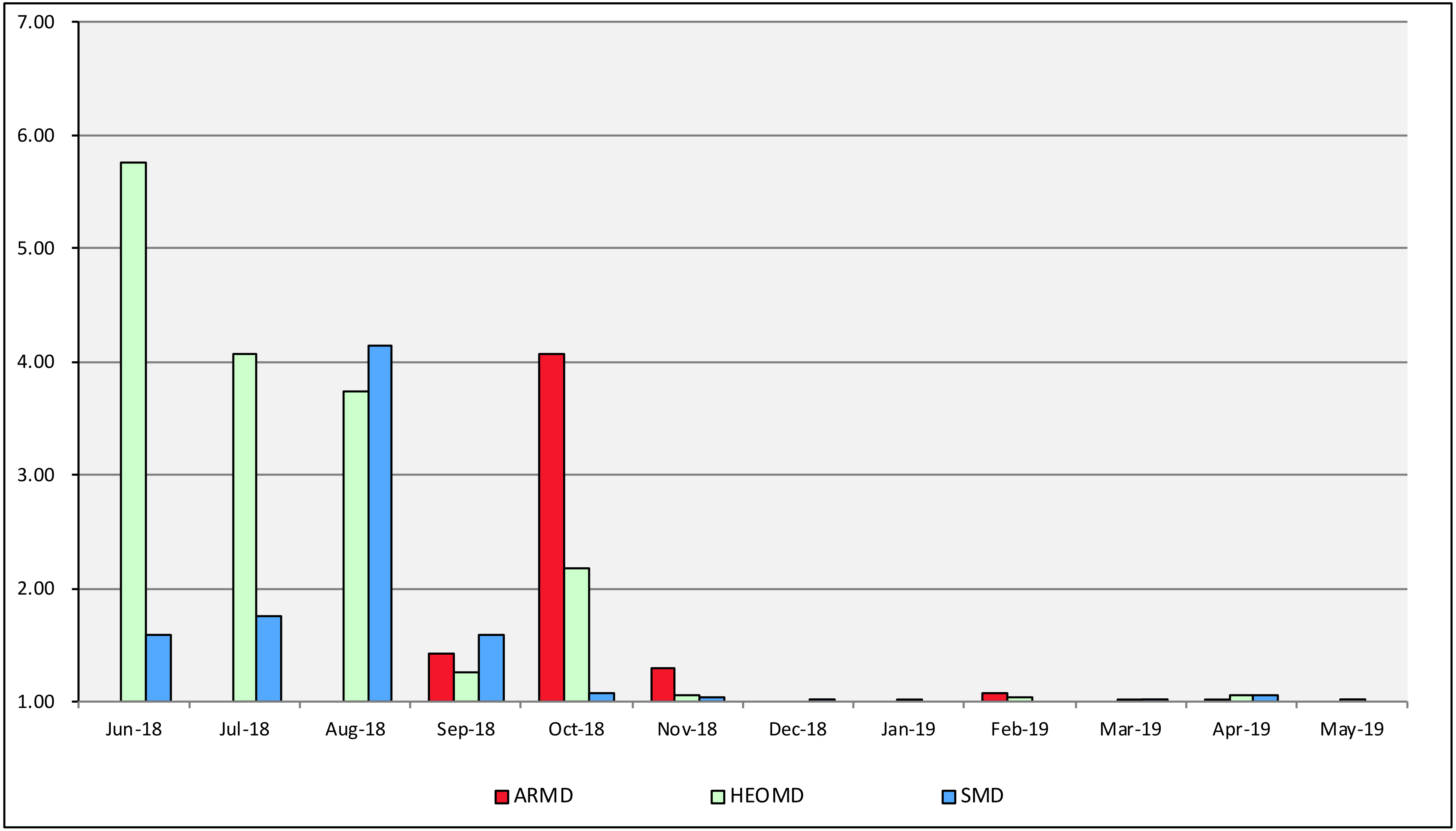
Merope:
Monthly Utilization by Size and Length



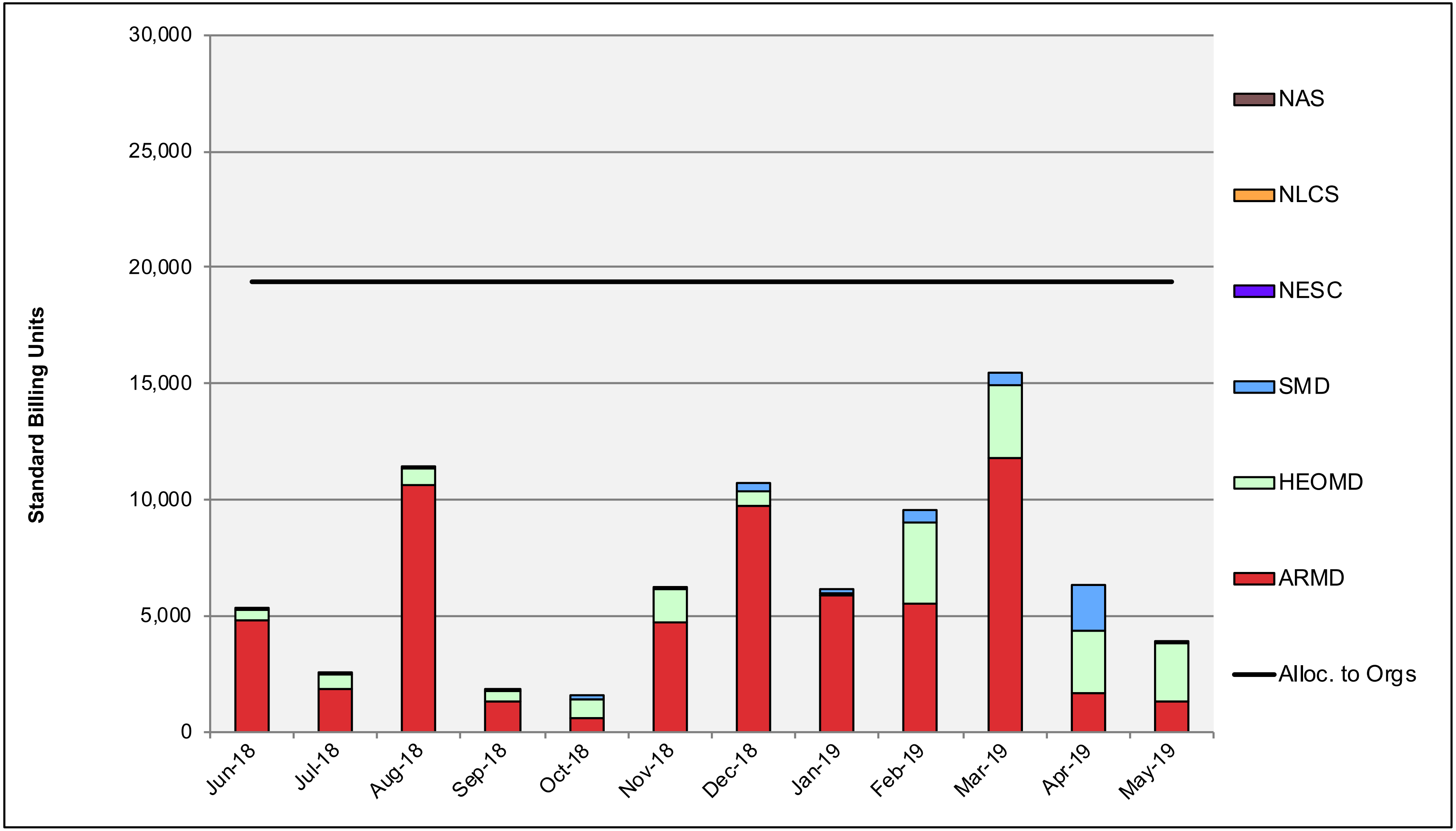
Merope: Average Time to Clear All Jobs



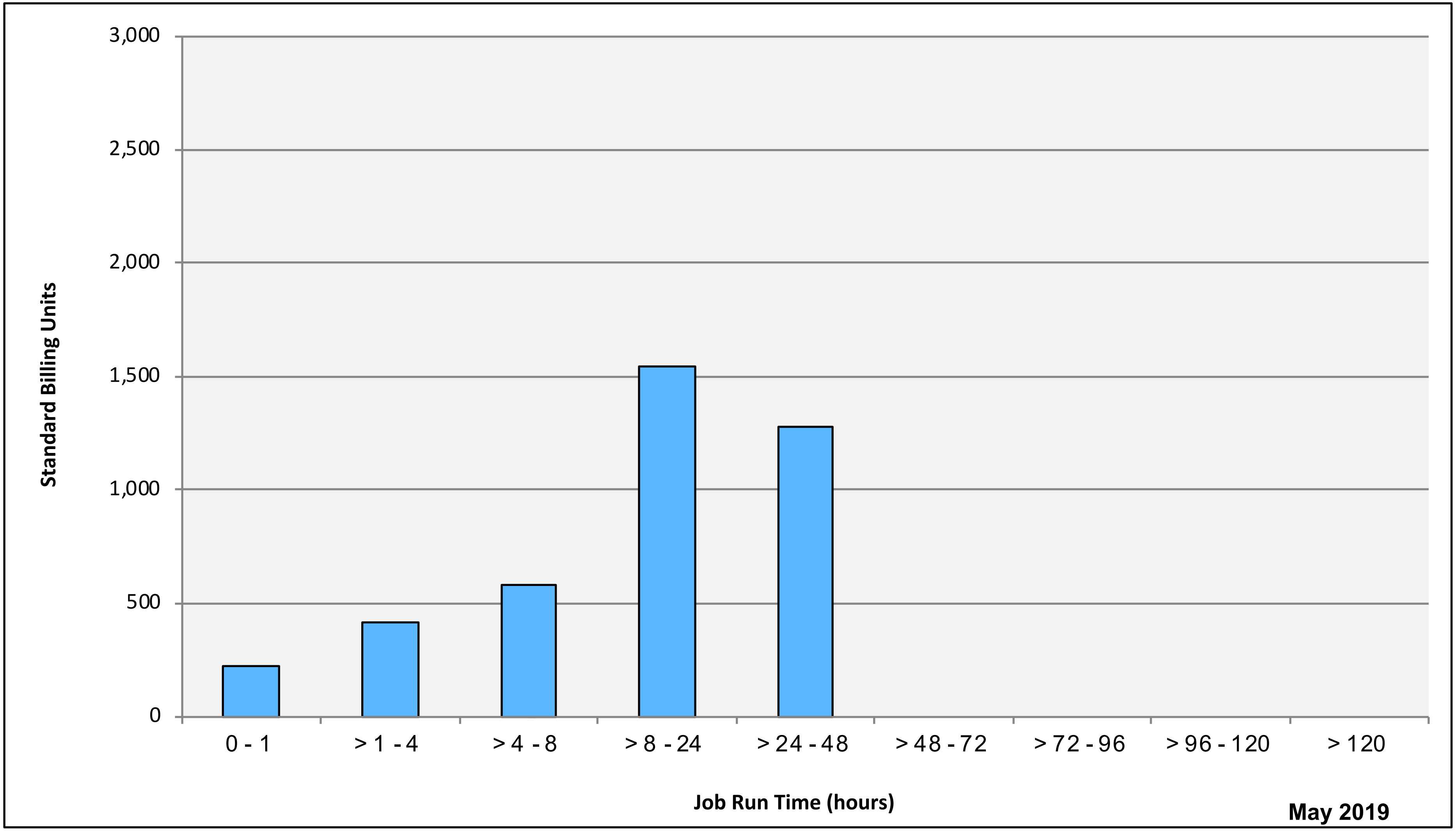
Merope: Average Expansion Factor



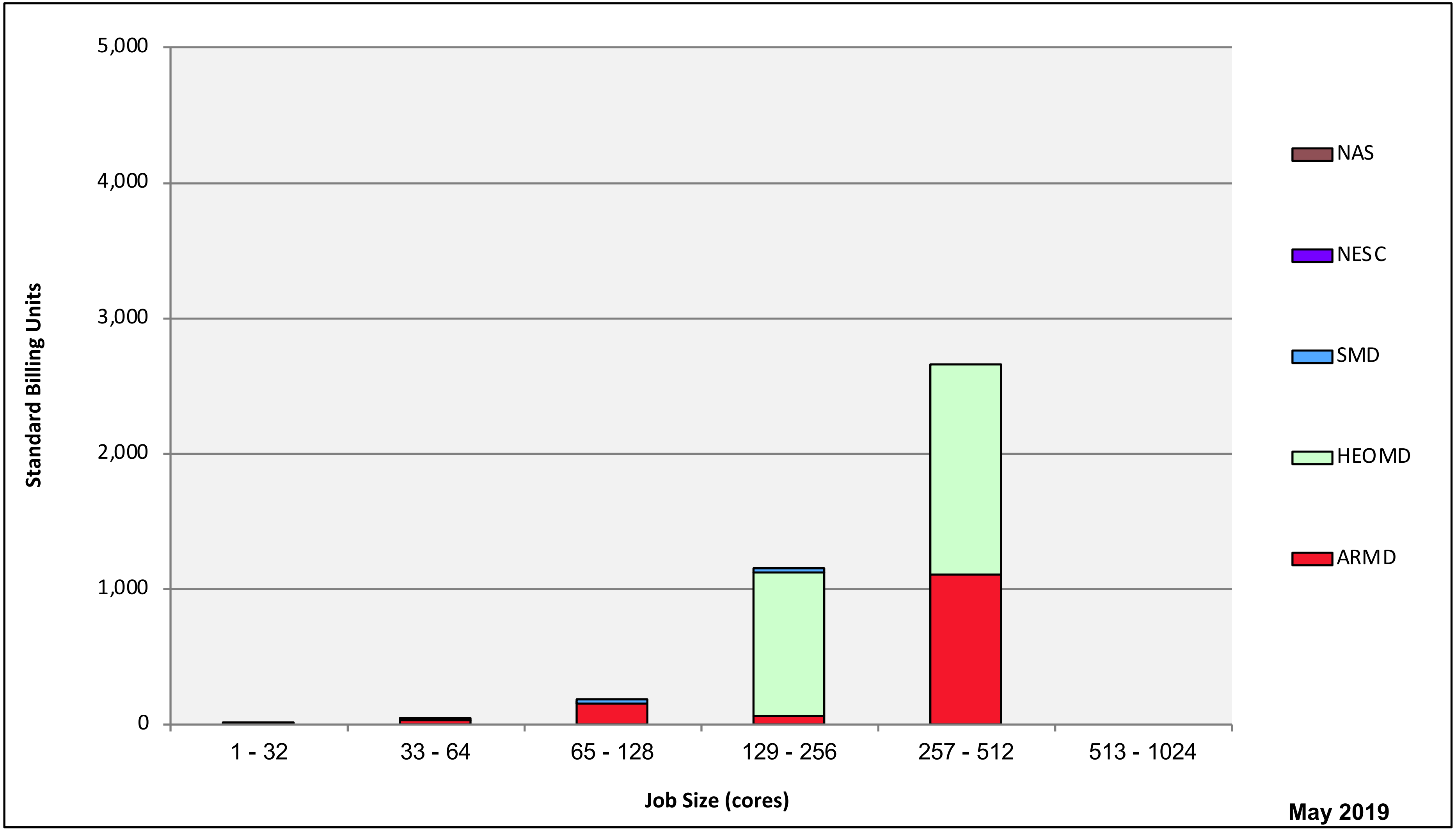
Endeavour: SBUs Reported, Normalized to 30-Day Month



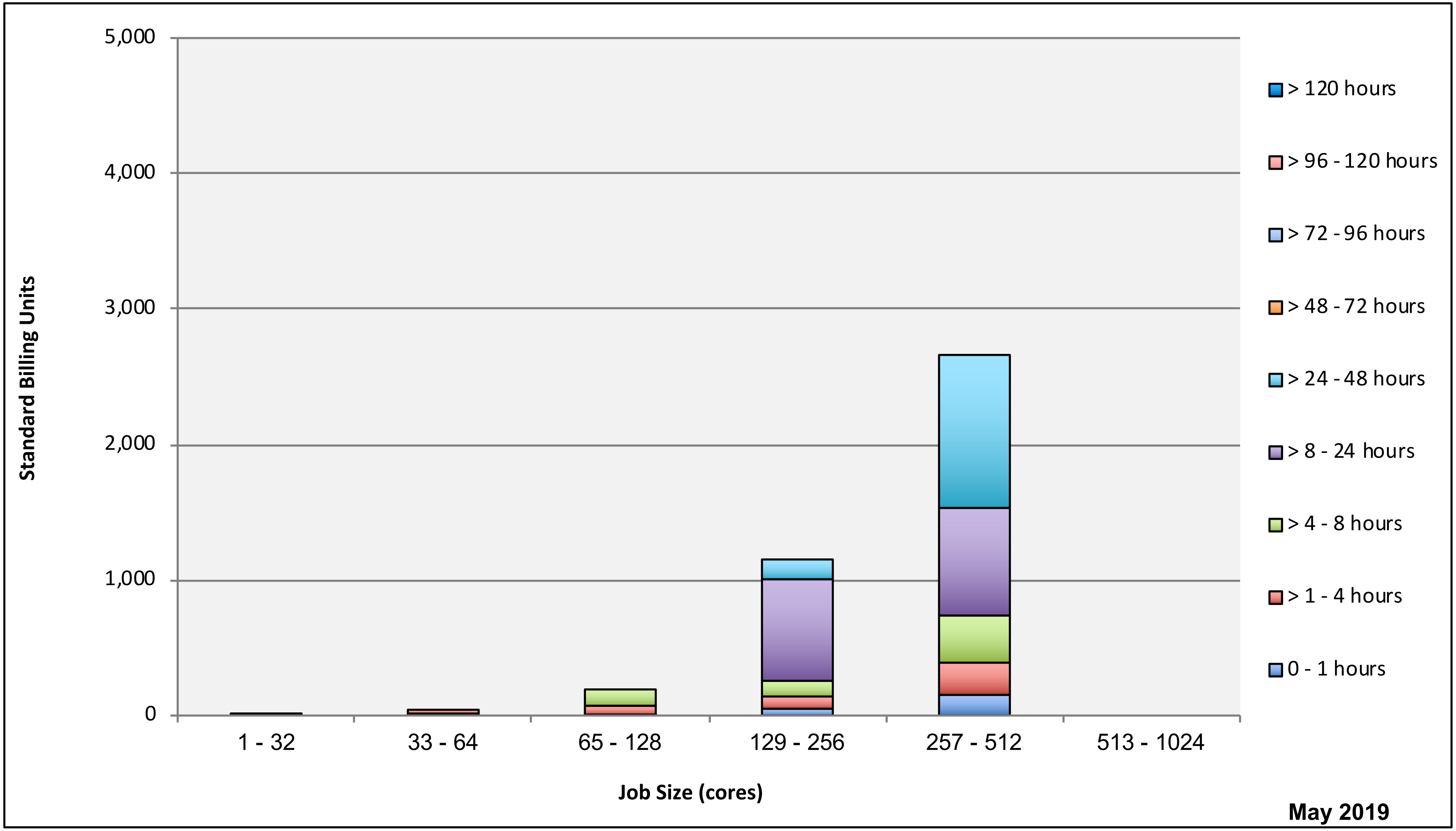
Endeavour: Monthly Utilization by Job Length



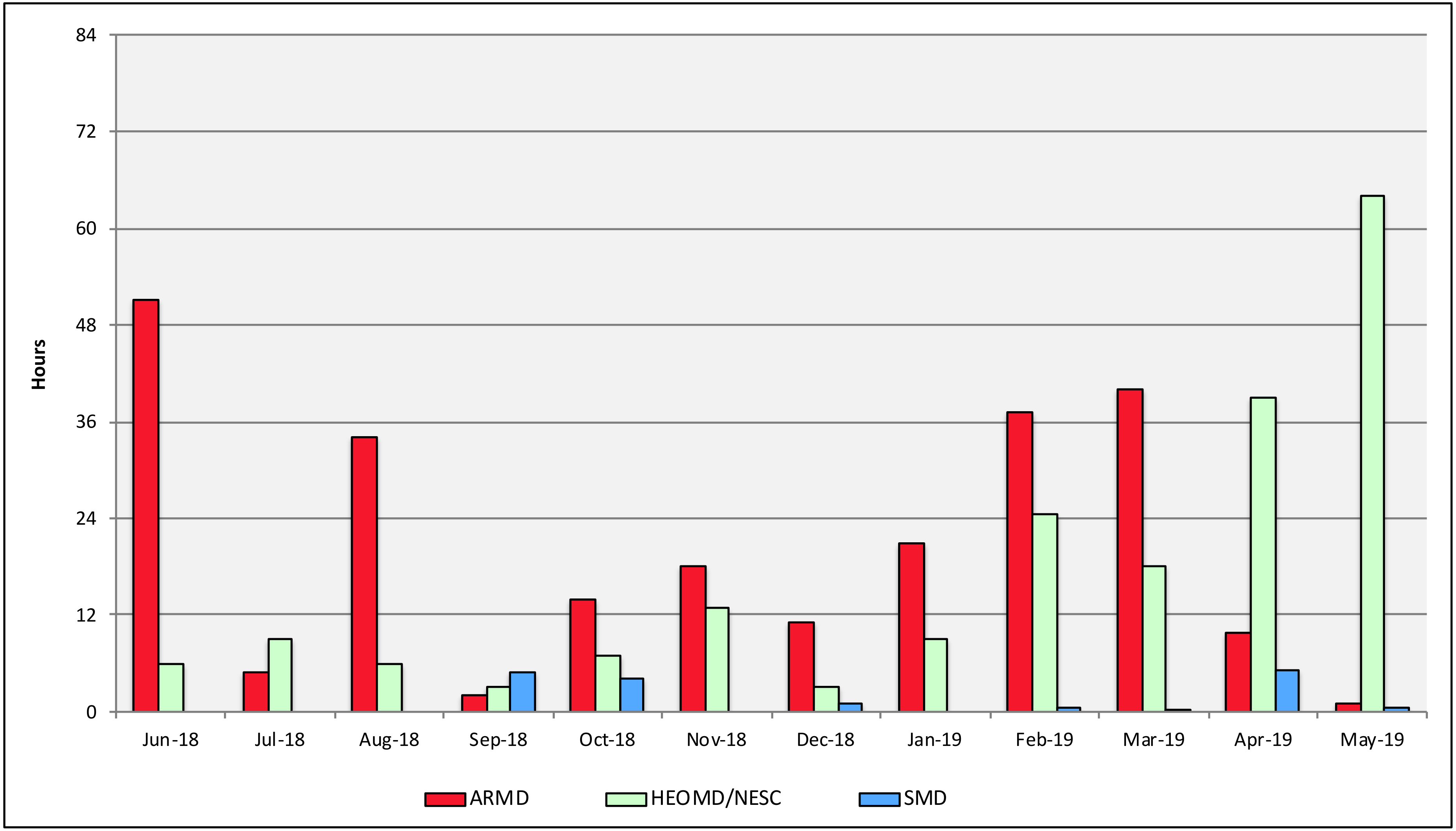
Endeavour:
Monthly Utilization by Size and Mission



Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs



Endeavour: Average Expansion Factor