National Aeronautics and
Space Administration

HIGH-END COMPUTING CAPABILITY PORTFOLIO

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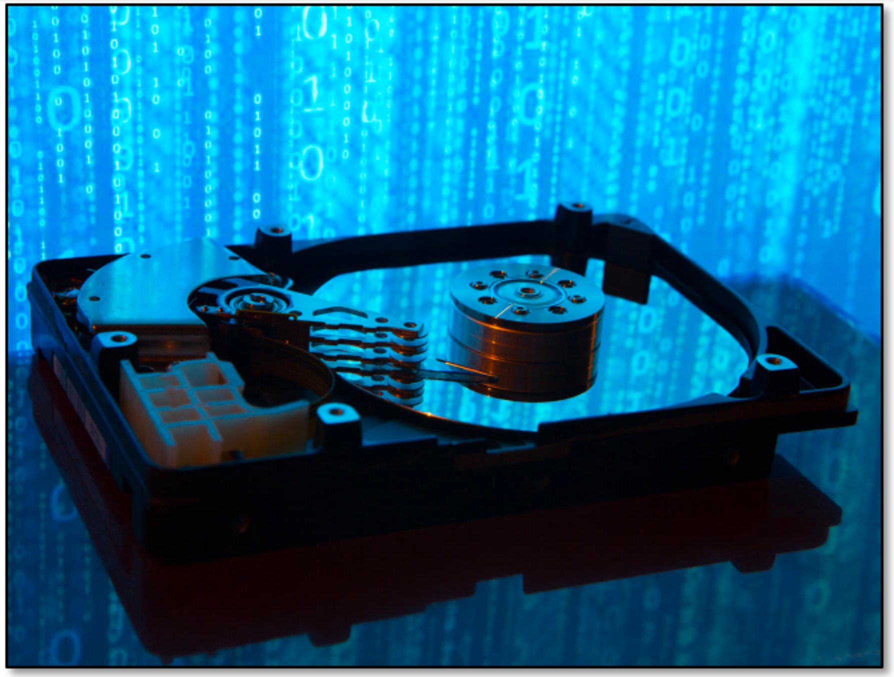
NASA Advanced Supercomputing Division

July 10, 2020

RFP Issued for Significant Data Storage Expansion

- Accelerating user requirements for additional storage, along with aging hardware, necessitate expanding HECC's current filesystem capacity and performance capabilities to match those of the growing computational demands.
  - Currently, there is a mix of Lustre and BeeGFS filesystems deployed at the NAS facility, totaling 44 petabytes (PB) of data.
- The storage expansion RFP, issued on June 24, seeks to add approximately:
  - 17 PB of spinning disk.
  - 150 terabytes (TB) of solid-state drive (SSD)-based storage.
- The SSD storage will be specialized and targeted for specific codes that perform poorly on large parallel filesystems. Typically, these codes require high metadata operation or issue small I/O sizes.
- This is the first major SSD purchase for HECC. Increased storage capabilities will enable NAS users to take advantage of next-generation technologies.

IMPACT: The additional storage will increase the space available for supercomputing output by 38% and will add SSD capabilities that will increase performance by at least 10x in situations where storage is the primary bottleneck.

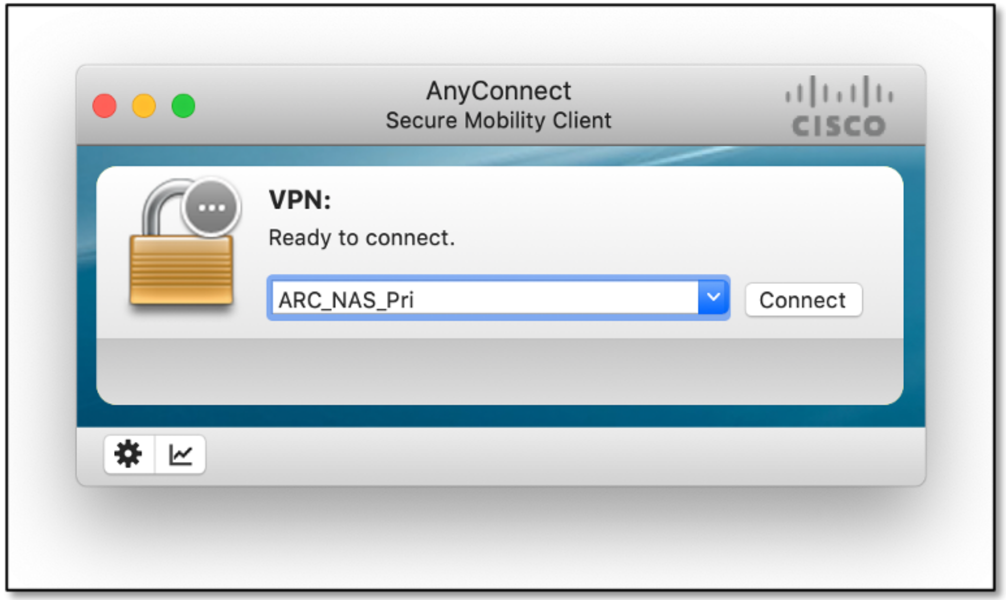


The HECC storage expansion will include approximately 17 petabytes of spinning disk.

HECC Implements NAS Profiles on Agency VPN Service

- To improve the telework experience for remote NAS users, the HECC Networks, Security, and Engineering Servers and Services (ESS) groups worked with NASA Integrated Communication Services (NICS) engineers at NASA Marshall to implement new NAS profiles in the agency VPN service.
  - New profiles combine access to NAS resources (such as license servers) available through legacy NAS VPN, and agency resources (such as email) available through Ames Teleworker profiles.
  - The primary and secondary profile choices are: ARC_NAS_Pri (via agency VPN server at Ames) or ARC_NAS_Sec (via an agency VPN server at NASA Johnson). Both have identical access to NAS and agency resources.
- NAS profiles have been deployed on ESS-supported Macs and are now available in Cisco AnyConnect. Users are encouraged to try them immediately.
- Existing NAS VPN users already have access to NAS profiles; new VPN users request access via NAMS—listed in NAMS as "AGCY VPN ARC NAS."
- The old NAS VPN will be decommissioned; all remote access to NAS resources will then be through these new profiles.

IMPACT: Having a single VPN connection enabling remote access to both NAS and agency resources gives staff working from home a one-stop-shop for accessing NAS and agency resources, removing the time-consuming and inconvenient process of having to switch from one VPN to another multiple times per day.



The primary NAS Virtual Private Network profile (ARC_NAS_Pri) selected in the Cisco AnyConnect client.

Tools Team Releases myNAS Allocator Edition

- The HECC Tools team extended the existing myNAS platform with a new version intended for allocators and other supercomputing stakeholders within NASA's mission directorates. The website (portal.nas.nasa.gov) provides these stakeholders with near-real-time insights into the way mission directorates, programs, and individual projects are using HECC resources.
- Several new features were introduced in this release, including:
  - An enhanced GID allocation and usage page. Data can be filtered by mission and program, with totals for allocations and usage automatically calculated. Filtered datasets are downloadable in Excel, PDF, and CSV formats.
  - SBU burn rate bar charts, which show the current running and queued computational workload in SBUs per hour, broken down by mission directorate.
  - Charts showing mission directorate usage as a percentage of target for each major resource. The percentage for the current day is updated every 10 minutes. A zoomable sparkline chart shows this data for each of the last 365 days.
  - A home page widget showing the top software applications currently running on each supercomputer, ranked by number of cores in use.

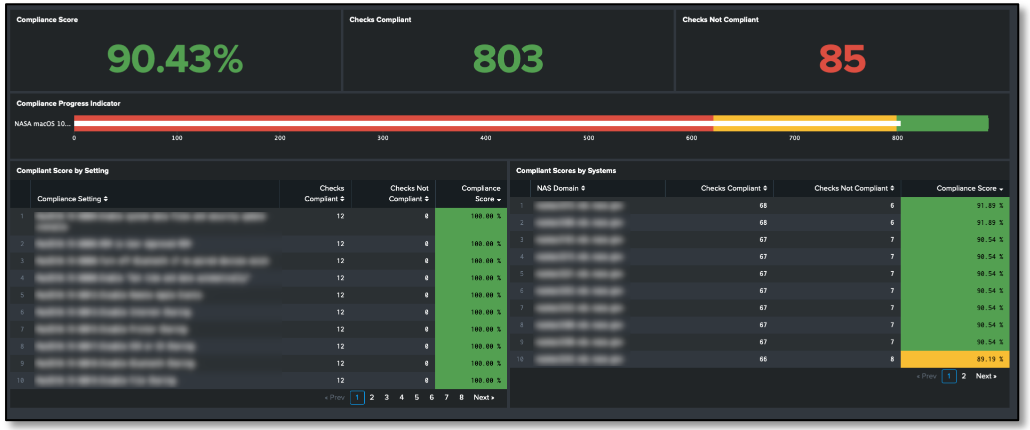
IMPACT: The myNAS Allocator Edition provides mission directorate stakeholders with visibility into current use of HECC resources, as well as insight into long-term trends.

This myNAS screenshot shows the numbers of running and queued jobs for each resource across the top. Below that are bar charts showing the current SBU burn rates for running and queued jobs. Hovering over a bar brings up the breakdown in SBUs/hour for each mission directorate. The scale shows the total SBUs/hour for running and queued jobs, along with the current capacity of the resources.

Security Team Deploys New Compliance Reporting Tool

- HECC security experts deployed a new reporting tool to monitor and report compliance status of HECC IT resources, with agency security configuration specifications.
- Using the tool, HECC security analysts can quickly:
  - Determine IT resources that are not in compliance.
  - Identify which compliance settings are not correctly set.
  - Report on compliance status.
- HECC is already benefiting from using the tool—several IT compliance issues were identified and corrected.
- Future work will include automatic notification to system owners and administrators of compliance issues.

IMPACT: The tool allows the HECC Security Team to work with system administrators to quickly remediate issues, ensuring IT resources are compliant.

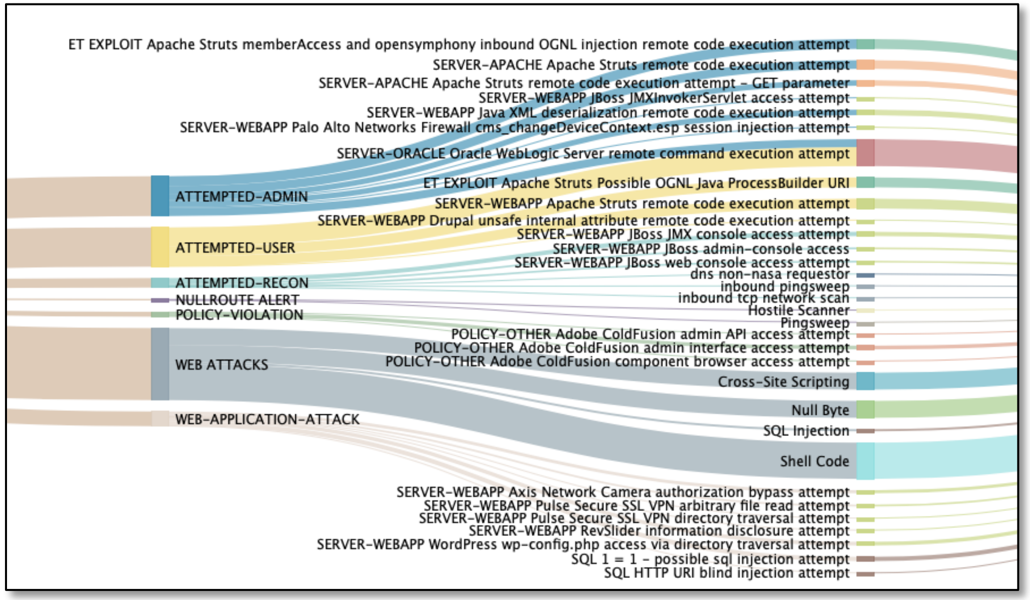


This bullet graph generated from the new compliance reporting tool shows compliance status (white bar) in relation to compliance performance (red, yellow, and green bars).

New Capabilities Improve Security Monitoring System

- HECC security experts continue to improve the HECC security monitoring systems. New and improved capabilities include:
  - A new common information model for analyzing, grouping, and correlating attacks and suspicious activities that improves analysis, alerting, and reporting.
  - Improved detection of reconnaissance activity (pre-attack probes).
  - Improved detection of suspicious Domain Name System activity that may indicate data exfiltration by an insider threat.
  - Improved detection of domain name spoofing using a homograph attack, to help prevent phishing attacks.
- The continued improvements and addition of new capabilities enhance the HECC Security team's abilities to monitor IT resources for signs of malicious activity such as compromise, insider threat, malware, and advanced persistent threats (APT).

IMPACT: New capabilities provide security analysts with the needed tools to identify threats in order to provide better security for HECC resources and agency data.

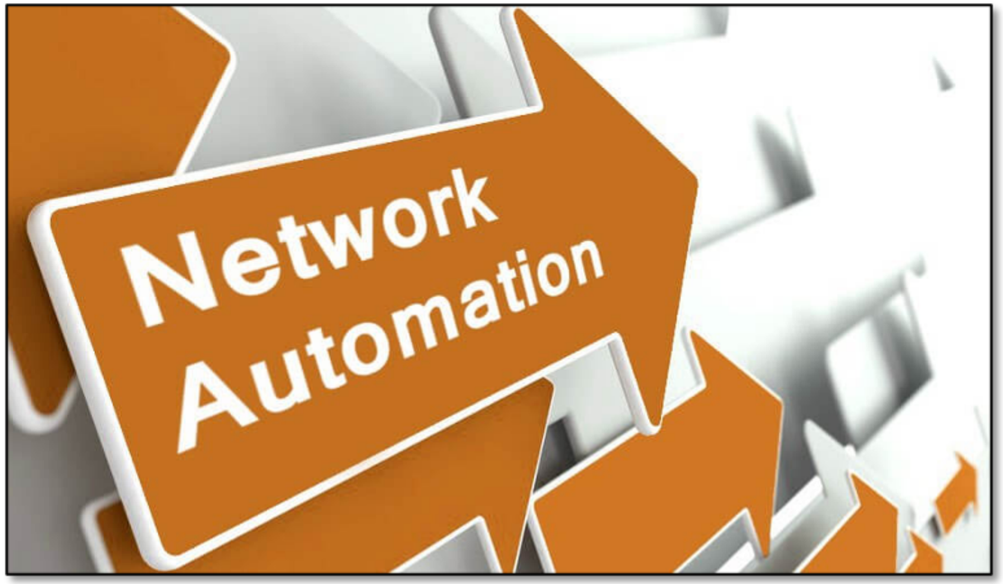


Sankey diagram from the NAS Situational Awareness System showing attack activity from a single attacker targeting several systems.

Networks Team Automates Operational Tasks

- HECC experts implemented automation tools to improve several networks operations tasks. Benefits include:
  - The reduction of manual actions improves the productivity of the network engineers.
  - Efficiency is improved, making tasks easier to complete with augmented capabilities.
  - Accuracy is improved because the automated tasks are less prone to errors.
- The Networks team collaborated with the Tools team to automate various repetitive and manual network processes, including:
  - Daily backup of networks equipment configurations.
  - Search of MAC addresses across NASLAN. Previously, searches were manual and limited to the switch that the network engineer was logged in to.

IMPACT: Automating network tasks increases staff productivity, improves network administration efficiency, and reduces configuration errors, while also reducing administrative overhead.



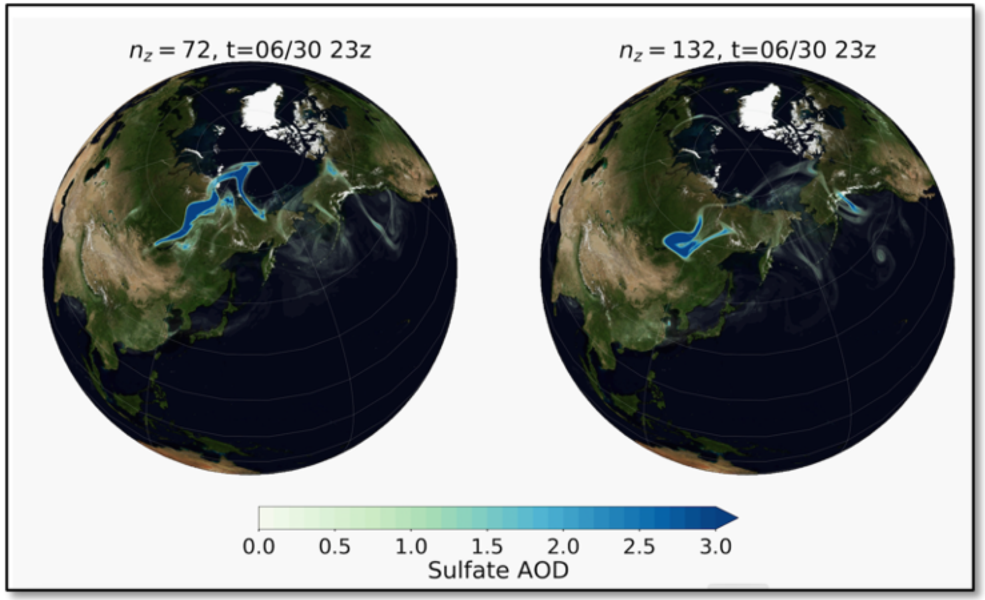
Network automation implemented in collaboration with the HECC Tools team provides simple scripting tools that both enhance the capabilities of operational tasks and improve the efficiency of the network engineers.

Simulating Air Quality and Volcanic Plumes with GEOS CCM

- Researchers at NASA Goddard ran the agency's Goddard Earth Observing System (GEOS) Chemistry Climate Model (CCM) on Pleiades to examine how changing the resolution of an atmospheric model affects simulation results, with the goal of improving predictions of air quality and the impacts of volcanic eruptions on surface temperature.
  - The scientists conducted two simulations—one with 72 vertical model levels (the standard configuration for GEOS) and another with 132 levels—in order to investigate how increasing the resolution of the model's vertical mesh would affect the simulated transfer of constituents between the stratosphere and the troposphere.
  - The simulated stratospheric intrusion and volcanic plume events were both characterized by the exchange of material, such as ozone and volcanic aerosols, between the stratosphere and troposphere, making the simulations especially sensitive to the model's vertical resolution.
- Results showed that increasing the vertical resolution of the model allows for more detailed representation of the atmosphere's vertical structure, particularly at the interface region between the stratosphere and troposphere. The simulations lay the groundwork for increasing the complexity and resolution of GEOS models.

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

IMPACT: Improving simulation accuracy will enable scientists to better interpret NASA satellite observations of real events in Earth's atmosphere and make better air quality forecasts.



Two different realizations from the last day of a GEOS model simulation of a volcanic aerosol plume produced by the Raikoke volcano on the Kuril Islands, Russia, showing the different transport of the plume in each simulation. Left: 72-vertical-level resolution. Right: 132-level resolution. *Peter Colarco, NASA/Goddard*

Analysis for NASA's Quadcopter Urban Air Taxi Concept

- To support the agency's vision for Advanced Air Mobility (AAM), aerospace engineers at NASA Ames ran simulations to develop and validate advanced high-fidelity CFD tools for use in the rotorcraft design process.
- Recent work studied the performance for a six-passenger quadcopter. The Ames team analyzed rotor-rotor and rotor-airframe interactions, which resulted in a new design with the rear rotors placed above the front rotors, reducing the interactions while keeping a compact configuration.
  - The quadcopter and surrounding air were modeled using hundreds of millions of grid points with overset volume grids.
  - The flow was solved using NASA's OVERFLOW CFD code, a high-order accurate Navier-Stokes solver.
  - The rotorcraft trim and rotor blade motions were predicted with the comprehensive rotorcraft code, CAMRAD II.
  - The final solution is obtained by loosely coupling OVERFLOW and CAMRAD II.
- Only with powerful supercomputers such as Pleiades and Electra can such a complex simulation be solved in just a few days.

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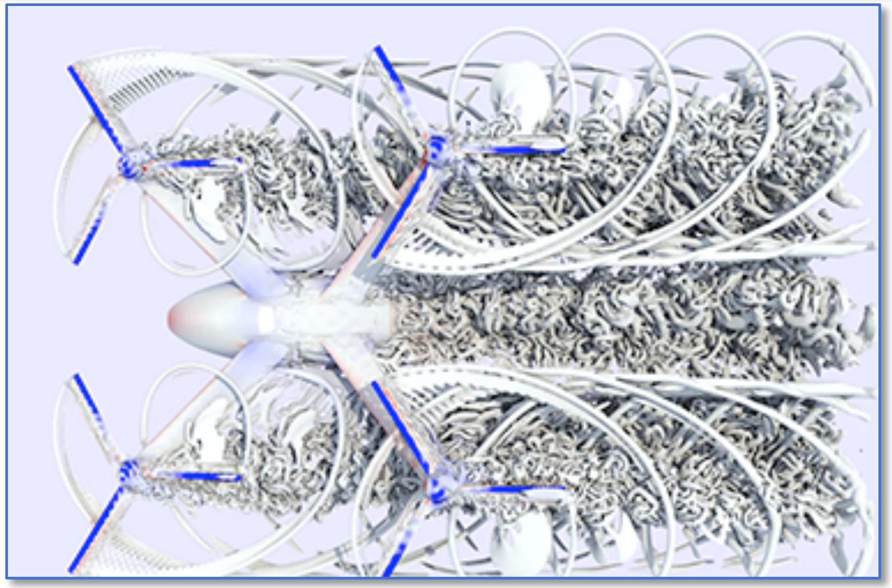
IMPACT: Advanced CFD tools, combined with the CAMRAD II code and HECC's powerful supercomputers, assist in the rotorcraft design process for future multi-rotor advanced air mobility vehicles.



Visualization of NASA's quadcopter concept for advanced air mobility showing the complex flow motions and interactions of the rotor wakes. Q-criterion iso-surfaces are colored by pressure (red is high, blue is low). Multiple rear rotor placements were simulated, finding an improvement in rotor power by increasing the vertical separation between front and rear rotors in forward flight. *Tim Sandstrom, NASA/Ames*

Papers

- "**Deflection Driven Evolution of Asteroid Impact Risk Under Large Uncertainties**," C. Rumpf, et al., Acta Astronautica, published online June 1, 2020. *
  https://www.sciencedirect.com/science/article/abs/pii/S009457652030309X
- "**OSSOS XX: The Meaning of Kuiper Belt Colors**," D. Nesvorny, et al., arXiv:2006.01806 [astro-ph.EP], June 2, 2020. *
  https://arxiv.org/abs/2006.01806
- "**Deep Rotating Convection Generates the Polar Hexagon on Saturn**," R. Yadav, J. Bloxham, Proceedings of the National Academy of Sciences (PNAS), June 23, 2020. *
  https://www.pnas.org/content/117/25/13991.short
- "**GEOM: Energy-Annotated Molecular Conformations for Property Prediction and Molecular Generation**," S. Axelrod, R. Gomez-Bombarelli, arXiv:2006.05531 [physics.comp-ph], June 9, 2020. *
  https://arxiv.org/abs/2006.05531
- "**Diffuse Ionized Gas in Simulations of Multiphase, Star-Forming Galactic Disks**," E. Kado-Fong, et al., arXiv:2006.06697 [astro-ph.GA], June 11, 2020. *
  https://arxiv.org/abs/2006.06697
- "**Opacity Driven Convection and Variability in Accretion Disks Around Supermassive Black Holes**," Y.-F. Jiang, O. Blaes, arXiv:2006.08657 [astro-ph.HE], June 15, 2020. *
  https://arxiv.org/abs/2006.08657

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

Papers (cont.)

- **AIAA Aviation Forum**, June 15–19, 2020.
  - "**UNS3D Simulations for the Third Sonic Boom Prediction Workshop Part I: Biconvex 9x7 Shock Plume Interaction Model**," J. Kassing, F. Carpenter, P. Cizmas. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2732
  - "**UNS3D Simulations for the Third Sonic Boom Prediction Workshop Part II: C608 Low-Boom Flight Demonstrator**," F. Carpenter, P. Cizmas. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2733
  - "**Axisymmetric Turbulent Shockwave Boundary Layer Interaction at Mach 2.5**," J.-P. Mosele, A. Gross, J. Slater. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-3010
  - "**System-Level Impact of Propulsive Uncertainties for Low-Boom Aircraft Concepts**," B. Phillips, C. Heath. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2730
  - "**Inlet Vortex Generator Design for the X-59 Low Boom Flight Demonstrator**," B. Heberling. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2757
  - "**A Multi-Fidelity Approach to Predicting Rotor Aerodynamic Interactions**," O. Pinti, R. Niemiec, A. Oberai, F. Gandhi. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2796
  - "**Streak Instability Analysis on BOLT Configuration**," F. Li, M. Choudhari, P. Paredes. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-3028
  - "**Shape Optimization of Vortex Generators to Control Mack Mode Amplification**," C. Pederson, P. Paredes, M. Choudhari, B. Yx Zhou, B. Diskin. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2963

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Papers (cont.)

- **AIAA Aviation Forum**, June 15–19, 2020 (cont.)
  - "**Recent Improvements to the LAURA and HARA Codes**," K. Thompson, C. Johnston, B. Hollis, V. Lessard. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-3030
  - "**Simulation of a Turbulent Flow Subjected to Favorable and Adverse Pressure Gradients**," A. Uzun, M. Malik. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-3061
- "**TIC 278956474: Two Close Binaries in One Young Quadruple System, Identified by TESS**," P. Rowden, et al., arXiv:2006.08979 [astro-ph.SR], June 16, 2020. *
  https://arxiv.org/abs/2006.08979
- "**Self-Sustaining Sound in Collisionless, High-Beta Plasma**," W. Kunz, J. Squire, A. Schokochihin, E. Quataert, arXiv:2006.08940 [astro-ph.HE], June 16, 2020. *
  https://arxiv.org/abs/2006.08940
- "**Energetic Electron Acceleration by Ion-scale Magnetic Islands in Turbulent Magnetic Reconnection: Particle-in-Cell Simulations and ARTEMIS Observations**," A. Lu, et al., The Astrophysical Journal, vol. 896, no. 6, June 17, 2020. *
  https://iopscience.iop.org/article/10.3847/1538-4357/ab908e/meta
- "**The TESS Phase Curve of KELT-1b Suggests a High Dayside Albedo**," T. Beatty, et al., arXiv:2006.10292 [astro-ph.EP], June 18, 2020. *
  https://arxiv.org/abs/2006.10292

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Papers (cont.)

- "**Marine Nitrous Oxide Emissions from Three Eastern Boundary Upwelling Systems Inferred from Atmospheric Observations**," A. Ganesan, et al., Geophysical Research Letters, published online June 20, 2020. *
https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020GL087822
- "**ADflow: An Open-Source Computational Fluid Dynamics Solver for Aerodynamic and Multidisciplinary Optimization**," C. Mader, G. Kenway, A. Yildirim, J. Martins, Aerospace Information Systems (article ahead of print), published online June 21, 2020. *
https://arc.aiaa.org/doi/full/10.2514/1.I010796
- "**TOI 694 b and TIC 220568520 b: Two Low-Mass Companions Near the Hydrogen Burning Mass Limit Orbiting Sun-like Stars**," I. Mireles, et al., arXiv:2006.14019 [astro-ph.EP], June 24, 2020. *
https://arxiv.org/abs/2006.14019

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Presentations

- **AIAA Aviation Forum**, June 15–19, 2020.
  - “**Mesh Effects on Flow Solutions for a 2D Multi-Element Airfoil Using Structured Overset Methods**,” A. Chuen, W. Chan. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-3222
  - “**Scale Revolving Simulations of the NASA Juncture Flow Model Using the LAVA Solver**,” A. Ghate, J. Housman, G.-D. Stich, G. Kenway, C. Kiris. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2020-2735
  - “**Simulation of HyMETS Flowfield Around Baby-SPRITE Entry Probe**,” P. Ventura Diaz, S. Yoon, F. Panerai, N. Mansour. *
    https://pdfs.semanticscholar.org/d5be/02442c073d74cd060fe22da64b1f333a627c.pdf

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News and Events

- **A New Galactic Center Adventure in Virtual Reality**, *NASA Press Release*, June 2, 2020—By combining data from telescopes with supercomputer simulations and virtual reality, a new visualization allows you to experience 500 years of cosmic evolution around the supermassive black hole at the center of the Milky Way. The simulations were run on supercomputing resources located at the NASA Advanced Supercomputing facility. *
  https://www.nasa.gov/mission_pages/chandra/news/a-new-galactic-center-adventure-in-virtual-reality.html

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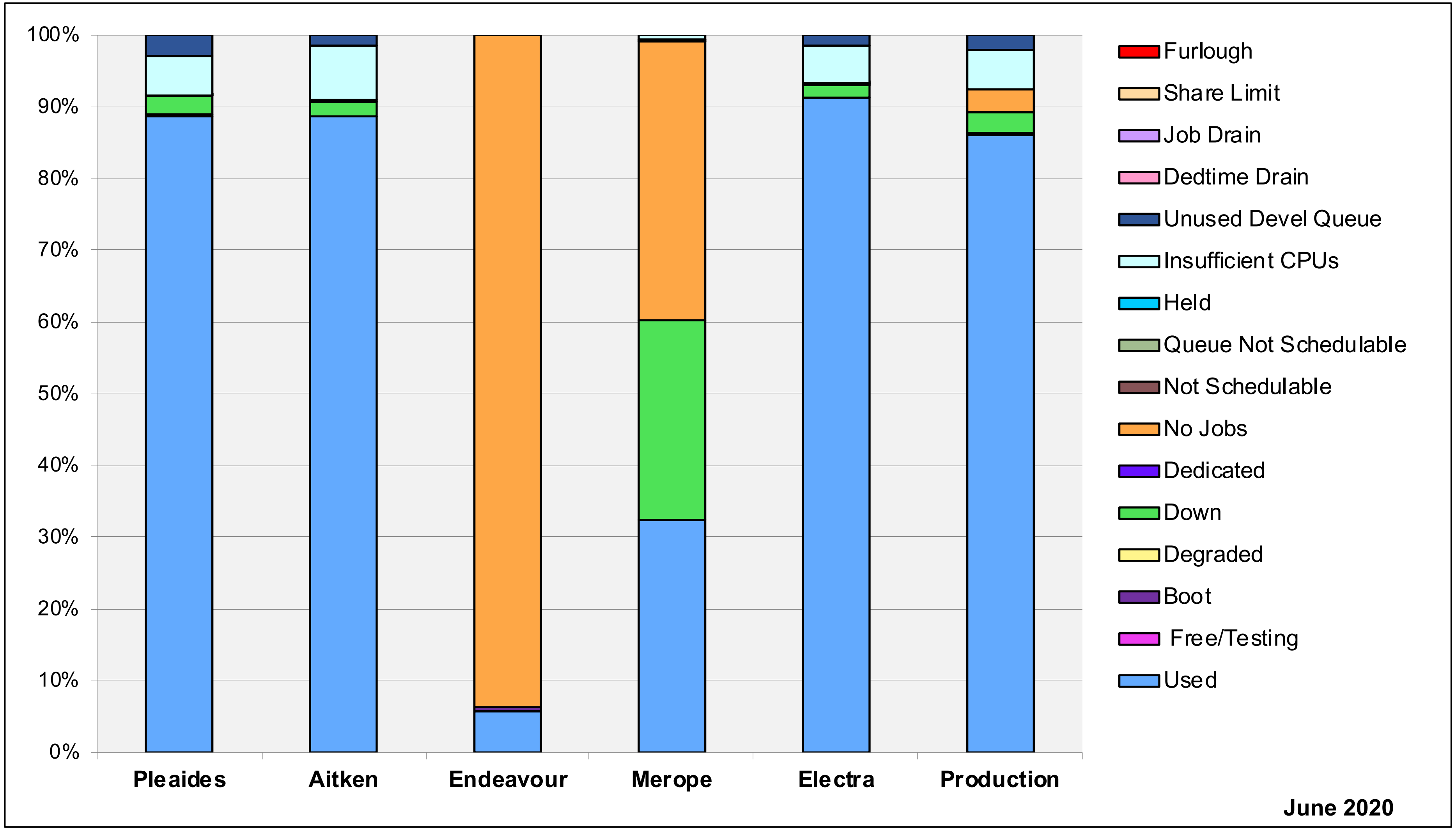
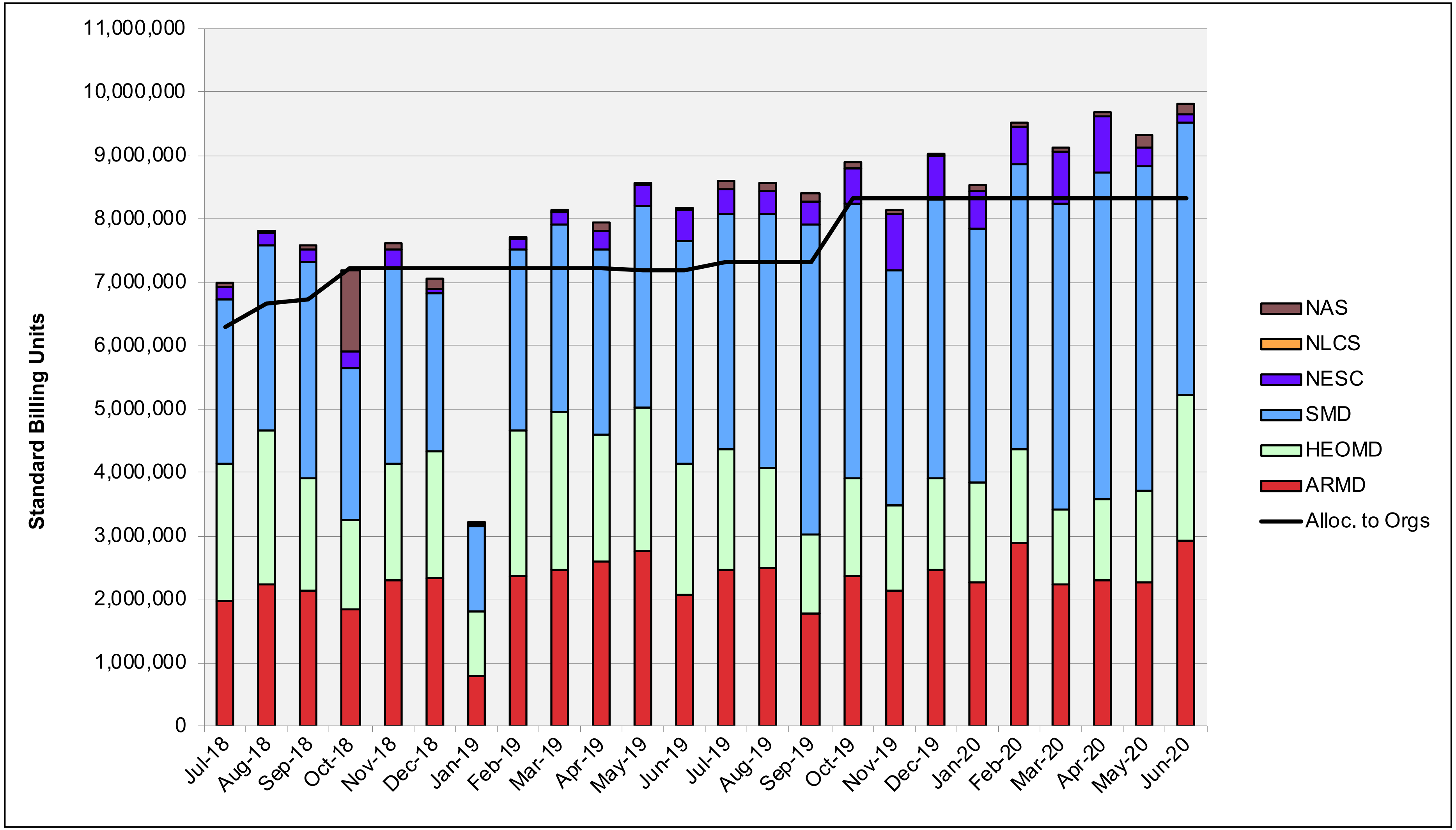
News and Events: Social Media

- **Coverage of NAS Stories**
  - NAS joins COVID-19 Consortium:
    - NASA Supercomputing: Facebook 426 users reached, 334 engagements, 14 likes, 43 shares.
    - NAS: Twitter 6 retweets, 16 favorites.
  - New VR Experience from Chandra, using NAS resources:
    - NASA Supercomputing: Facebook 300 users reached, 24 engagements, 15 likes, 3 shares.
    - NAS: Twitter 4 retweets, 8 favorites.
  - NASA Response to COVID-19, including supercomputing:
    - NASA Supercomputing: Twitter 2 retweets, 5 likes; Facebook 106 users reached, 4 engagements, 2 likes.

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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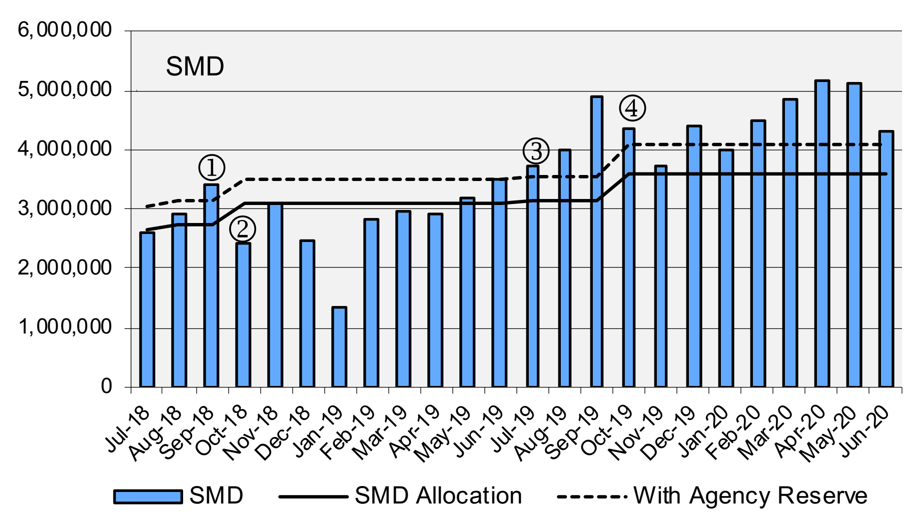
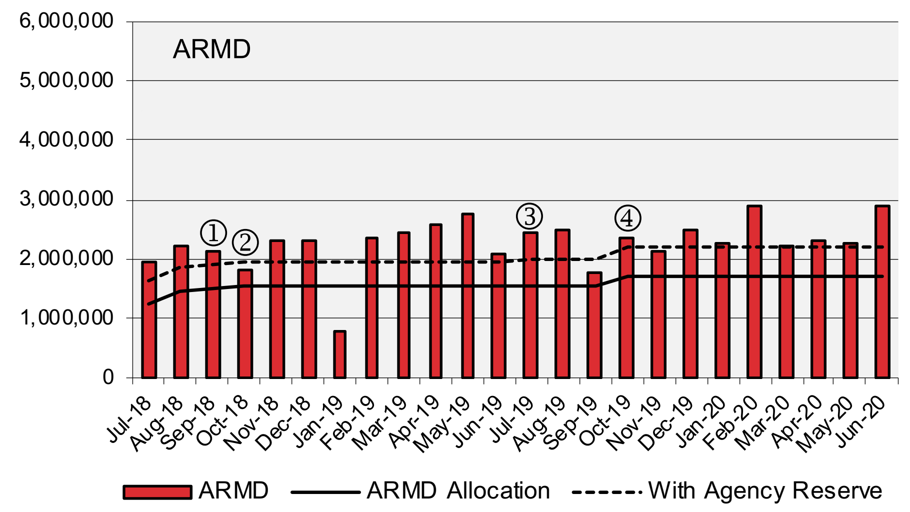
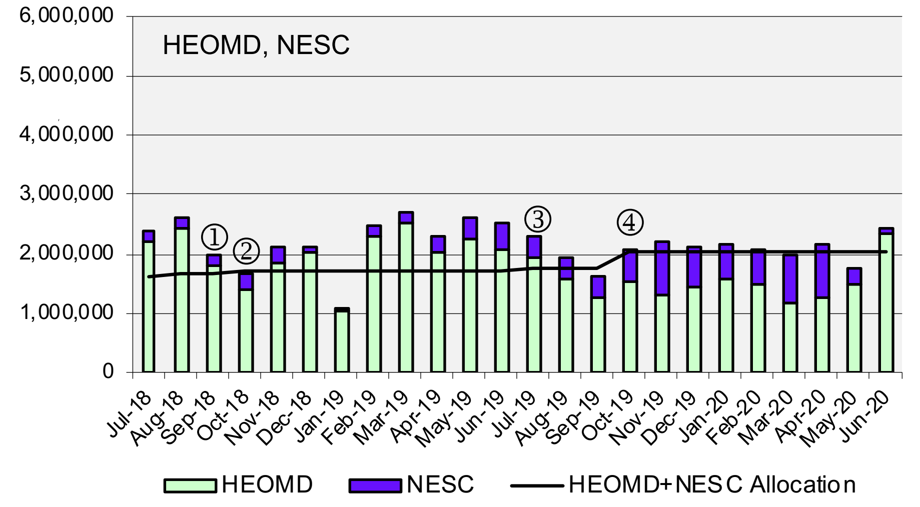






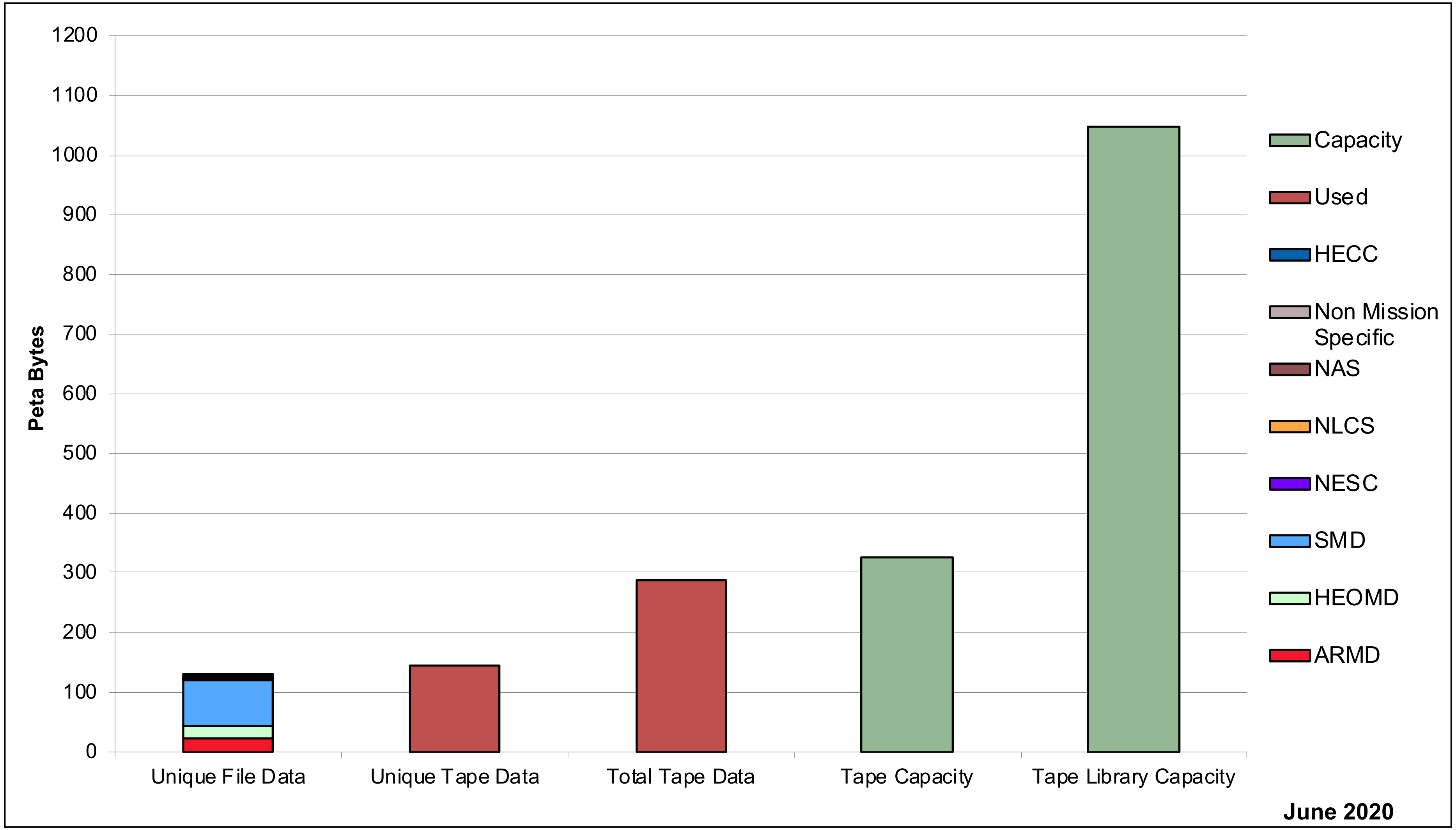
① 4 Skylake E cells (16 D Rack Equivalence) added to Electra

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

④ Skylake Tesla GPU V100 Nodes installed

Tape Archive Status



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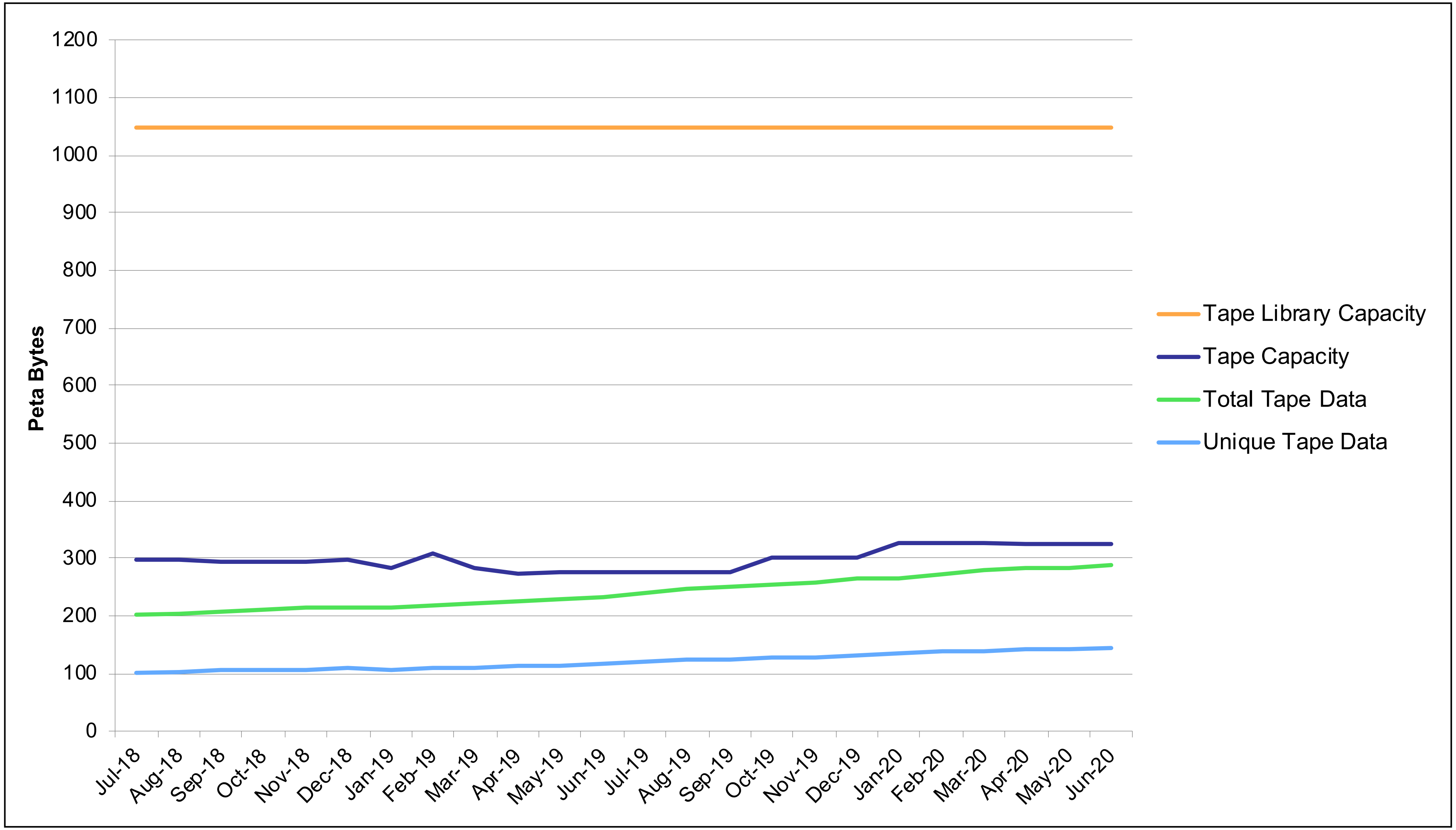
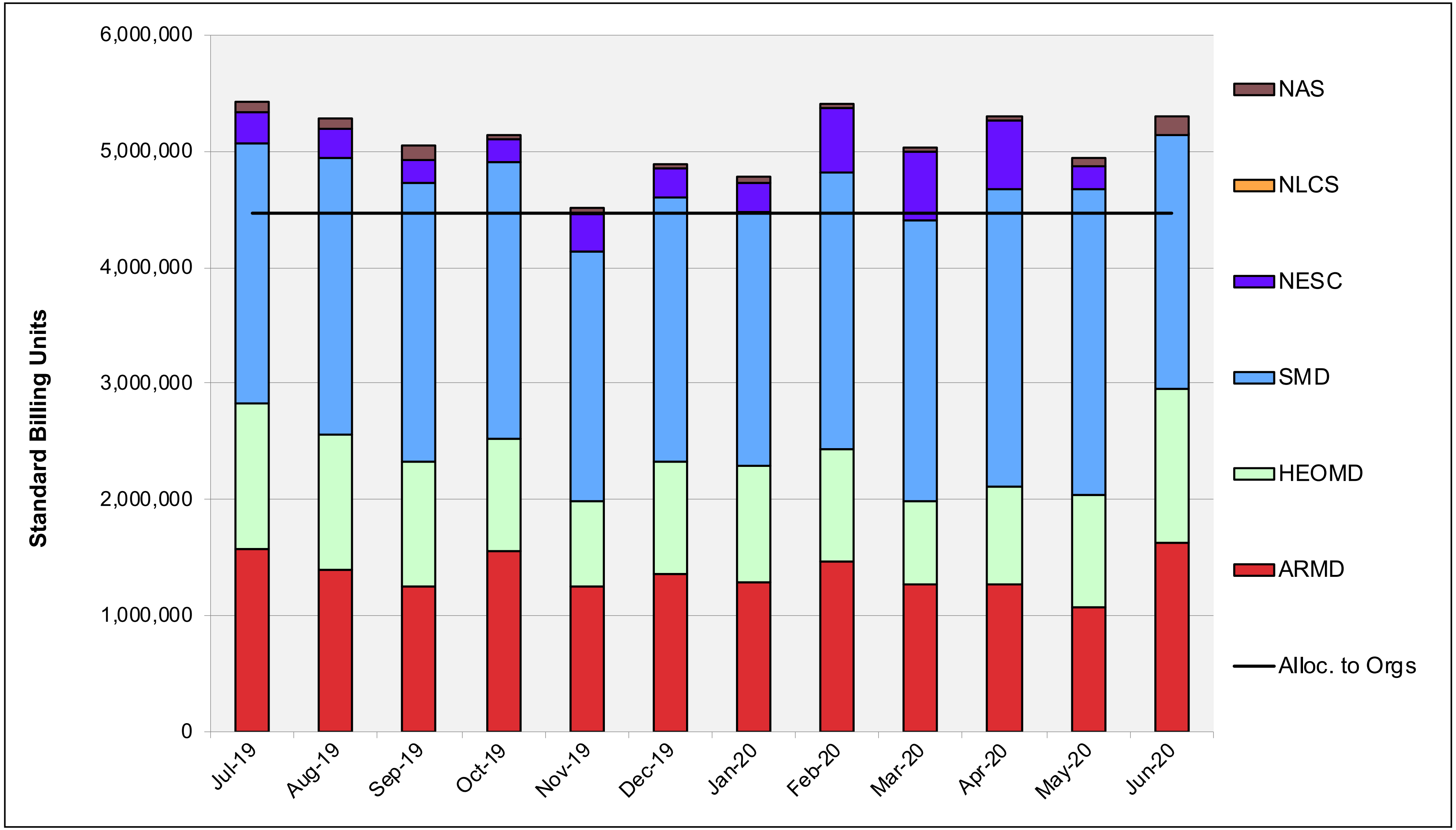
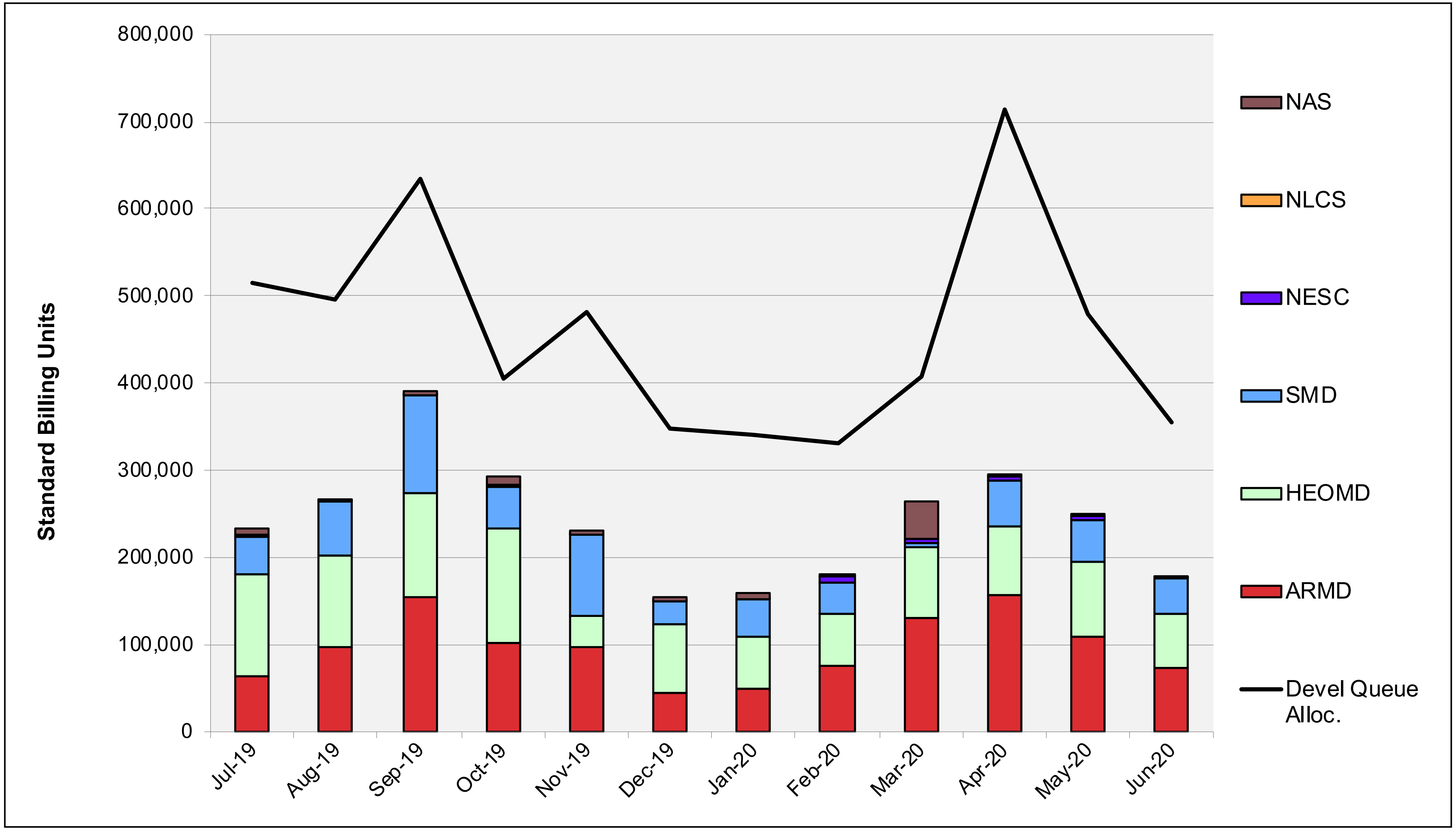


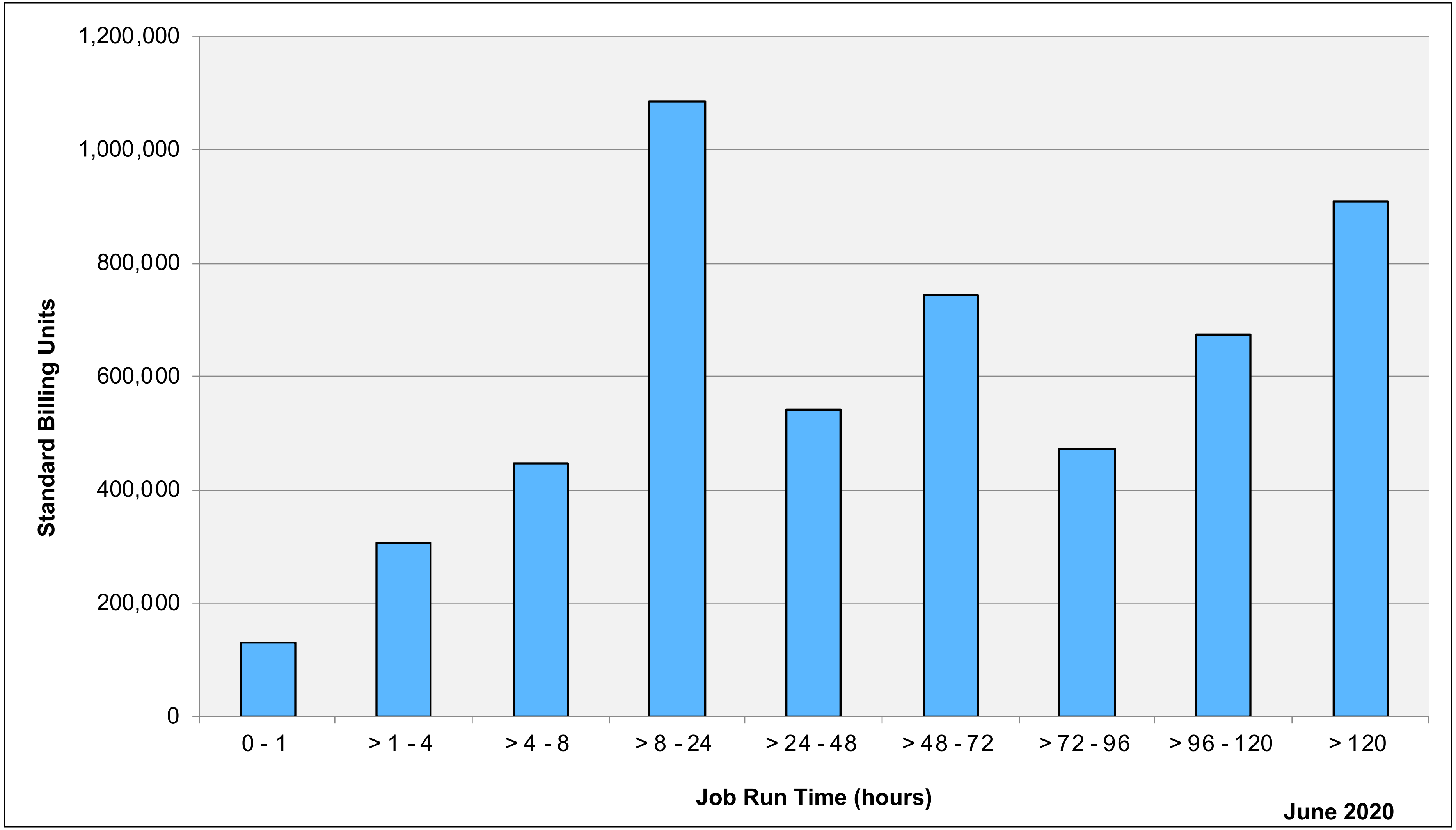
Pleiades: SBUs Reported, Normalized to 30-Day Month



Pleiades: Devel Queue Utilization



Pleiades: Monthly Utilization by Job Length



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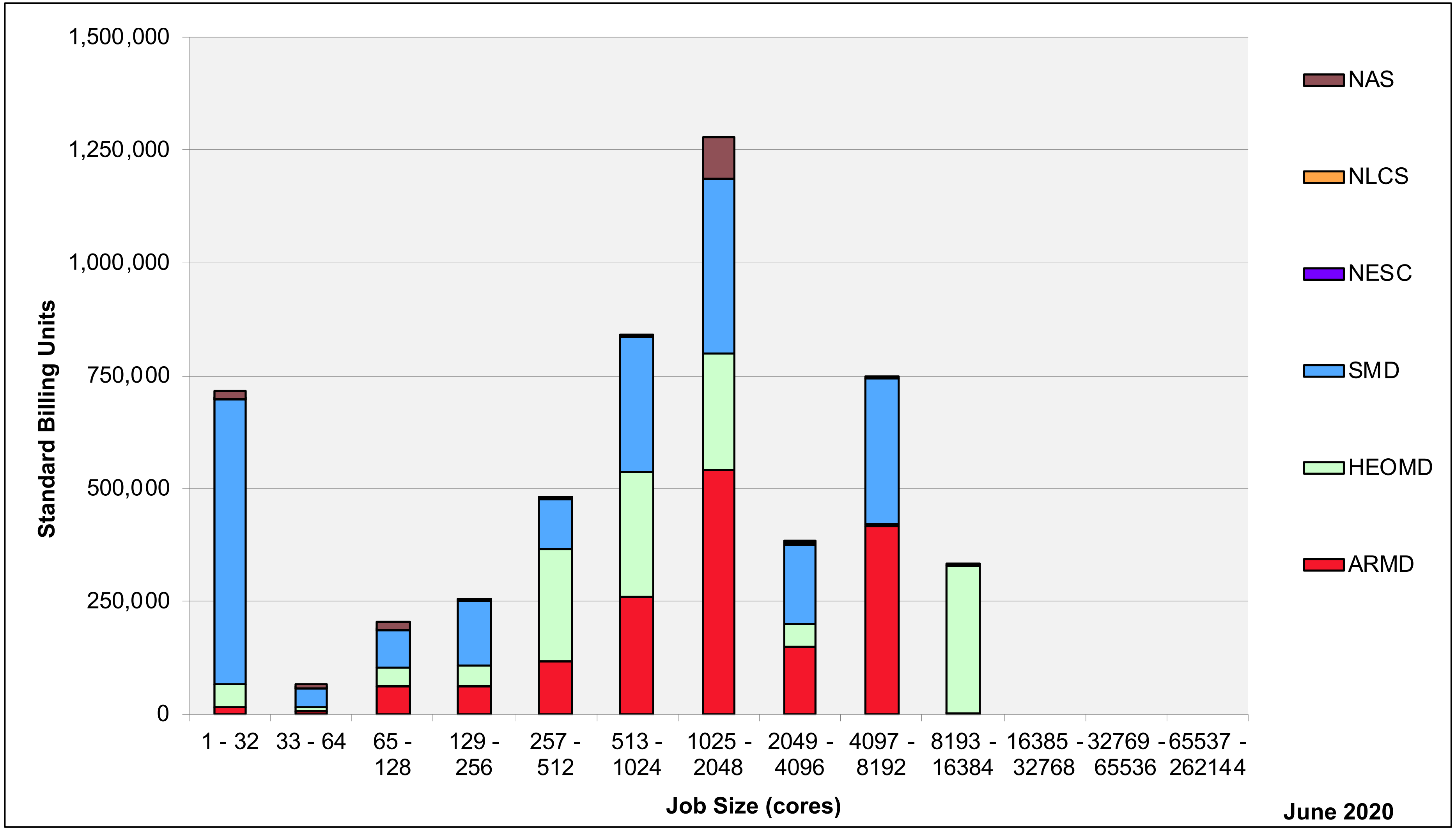
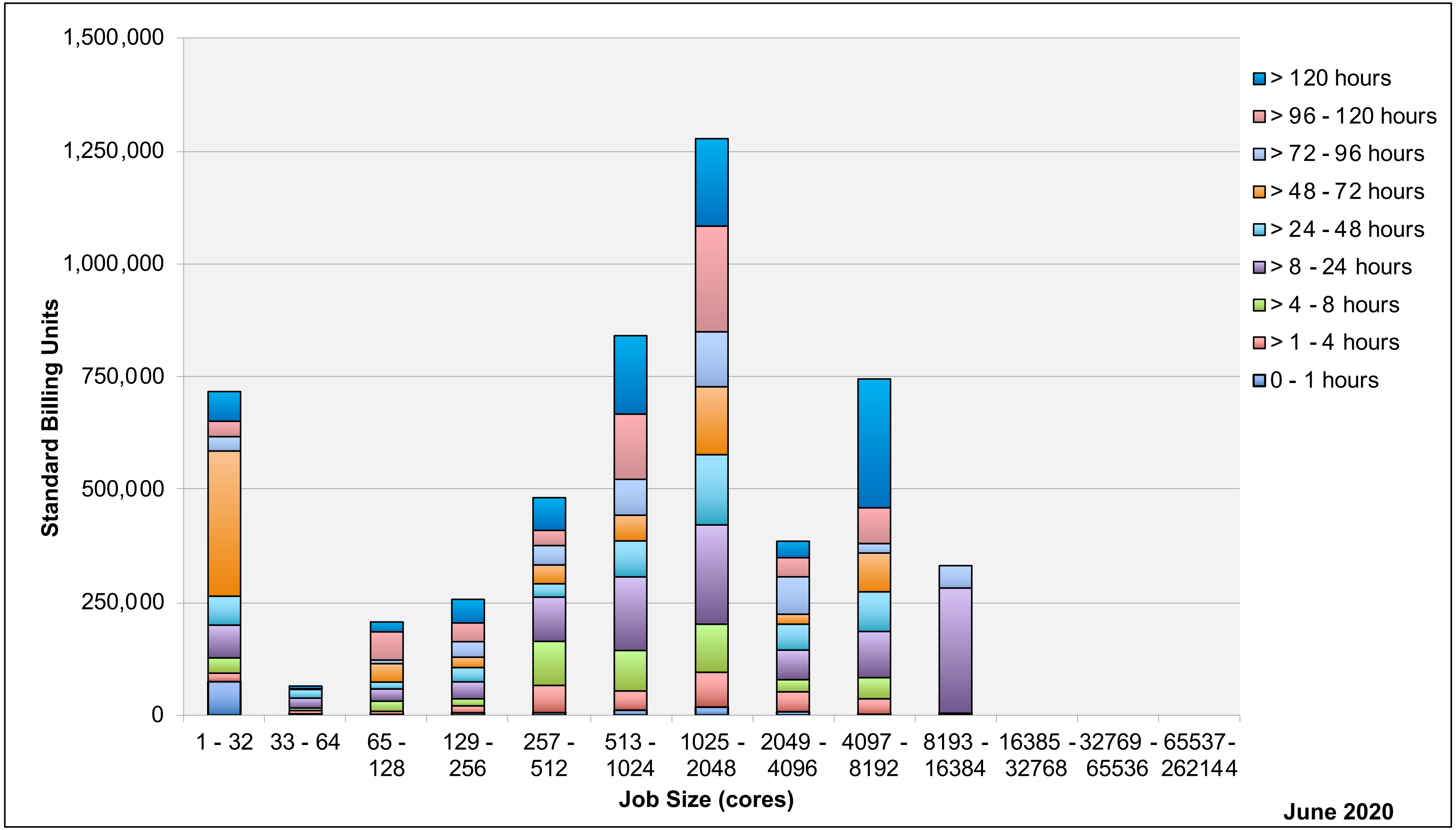
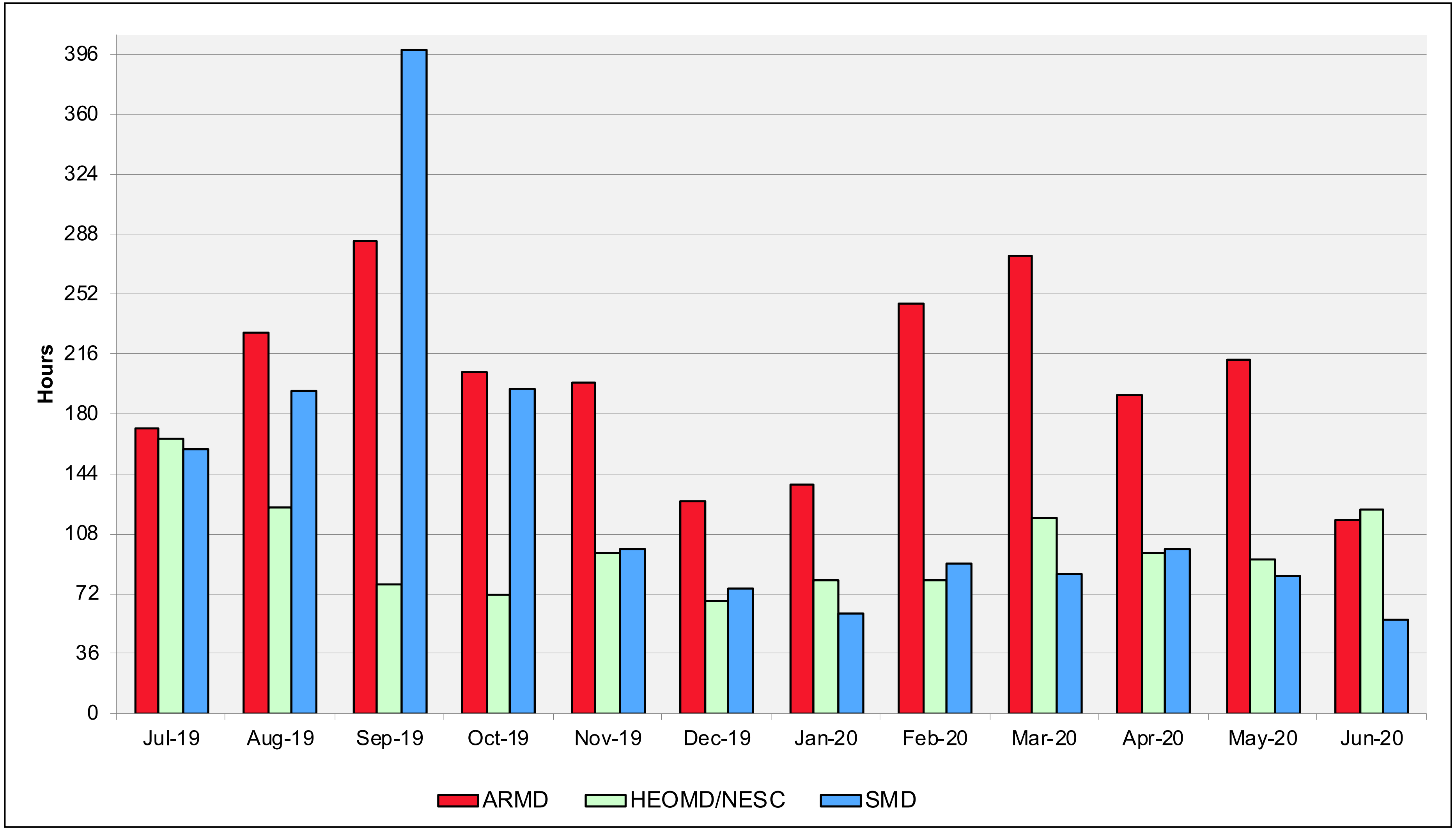


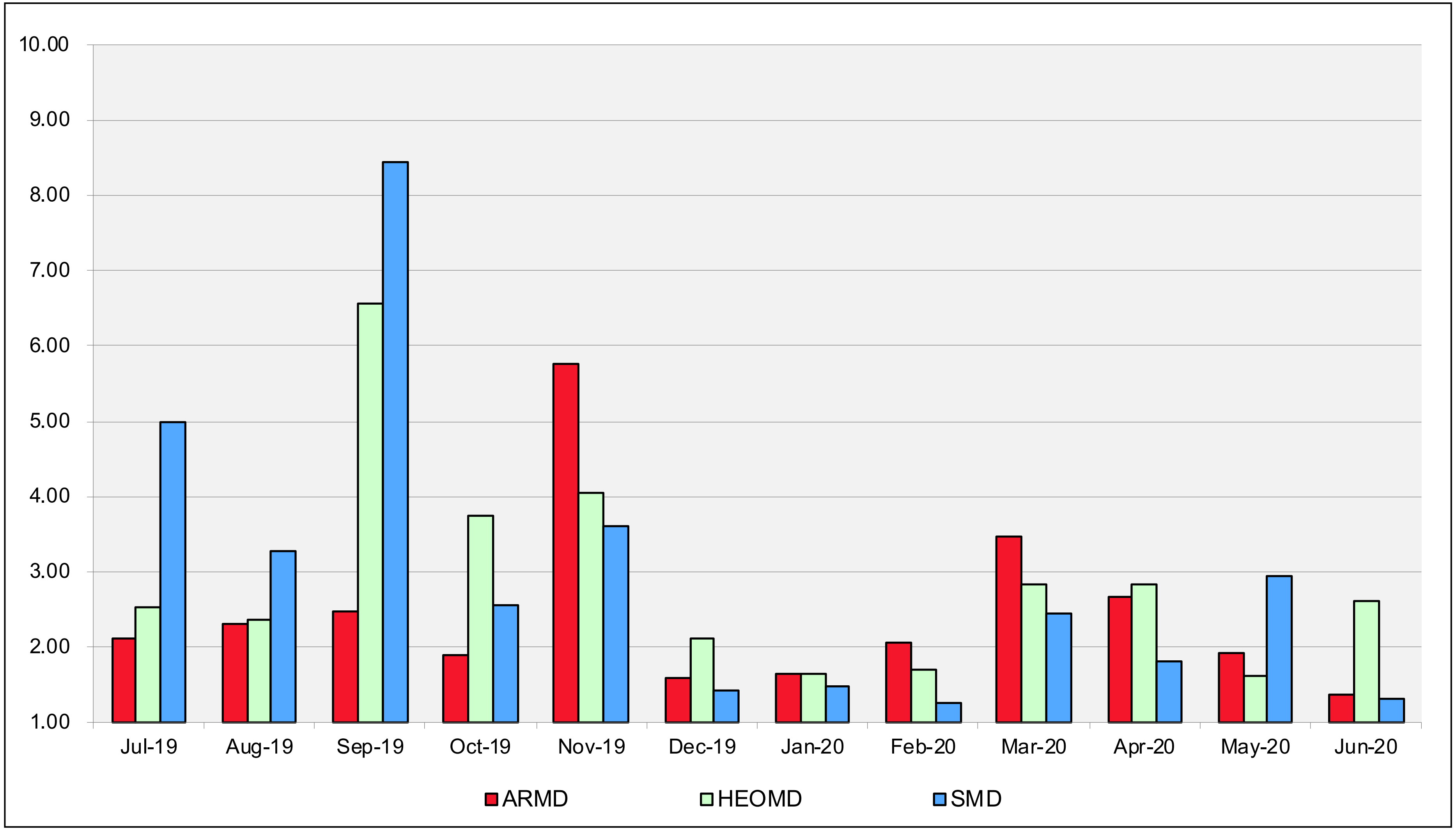
Pleiades: Monthly Utilization by Size and Length



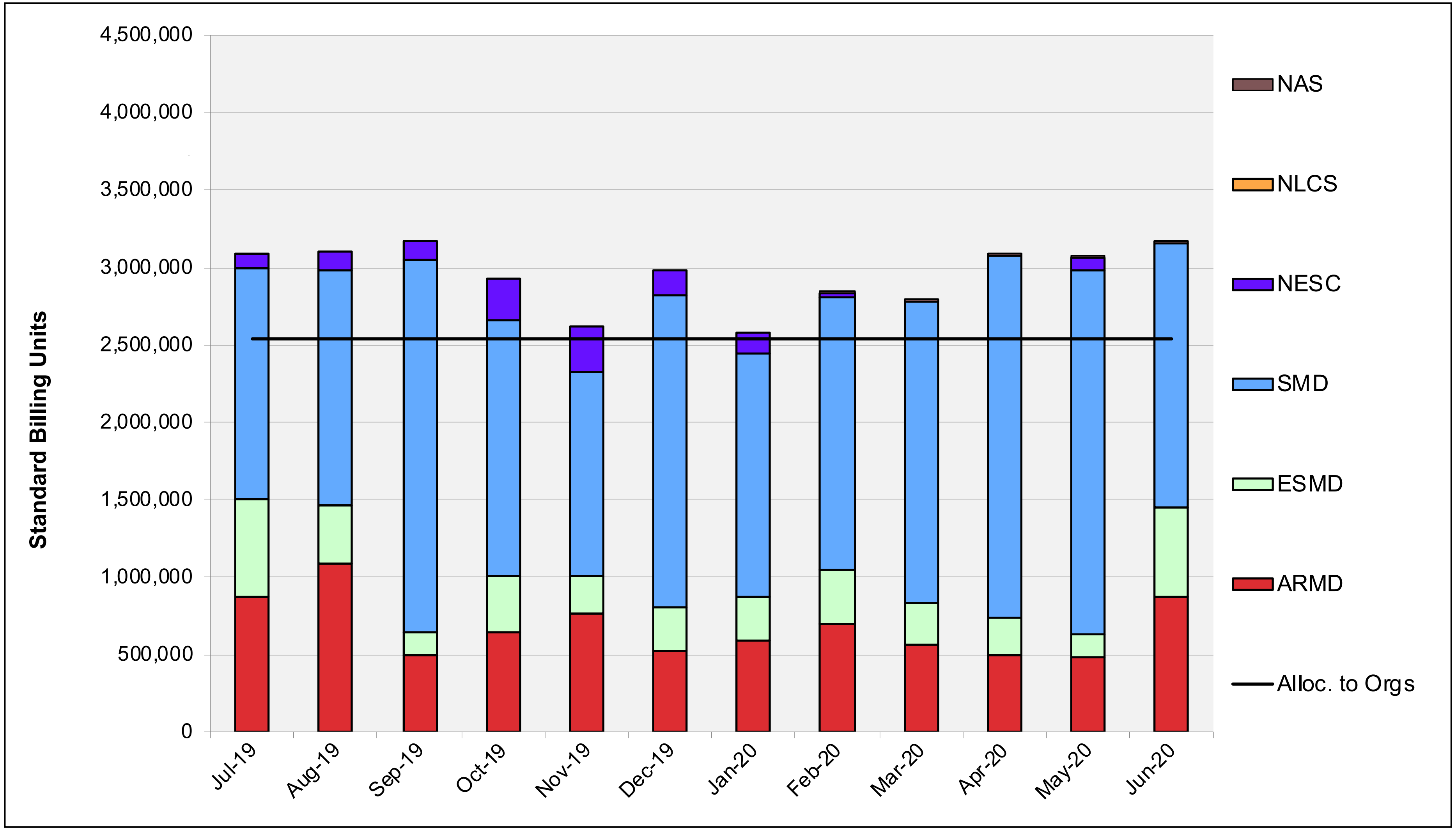
Pleiades: Average Time to Clear All Jobs



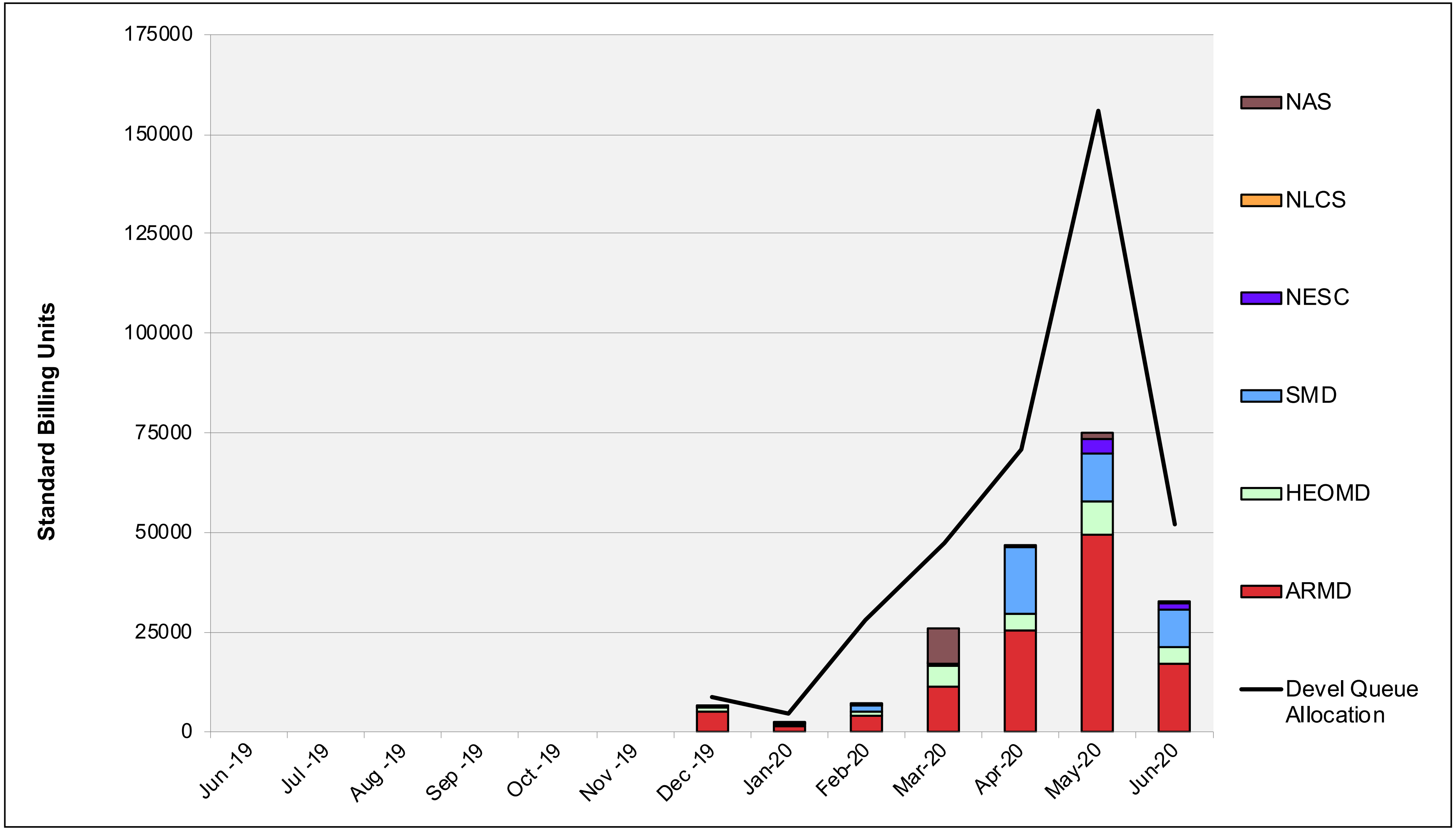
Pleiades: Average Expansion Factor



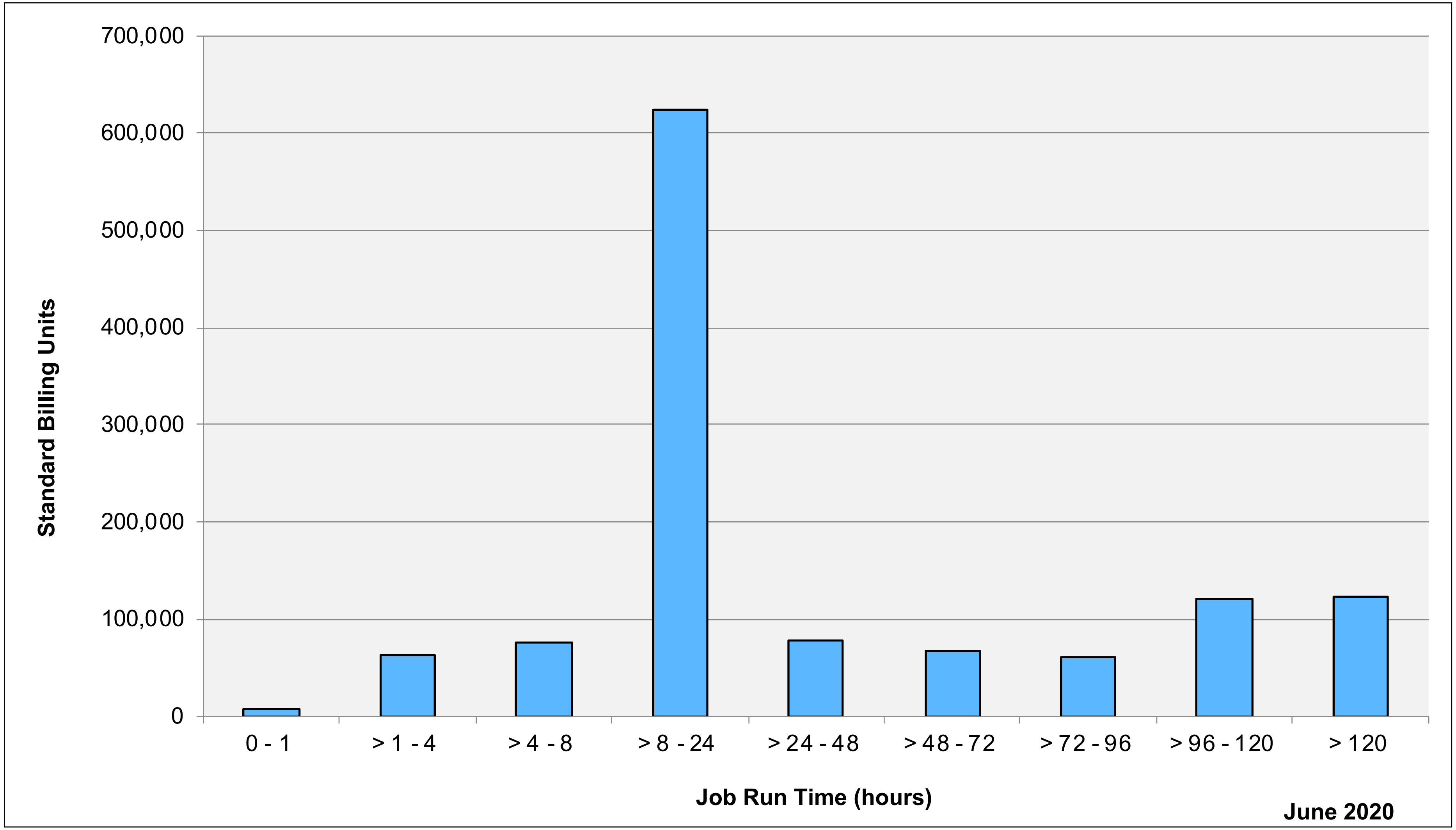
Aitken: SBUs Reported, Normalized to 30-Day Month



Aitken: Devel Queue Utilization



Aitken: Monthly Utilization by Job Length



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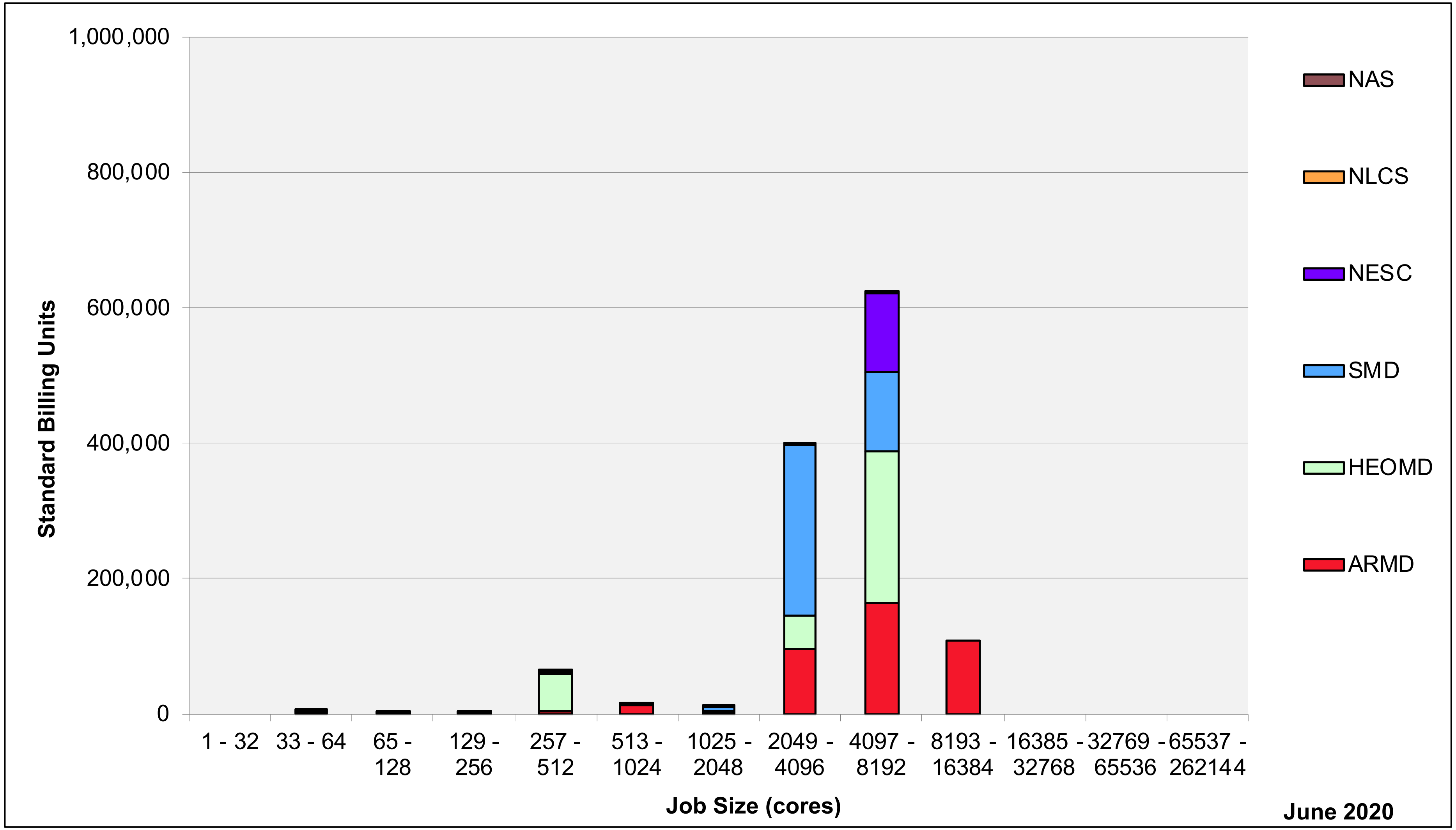
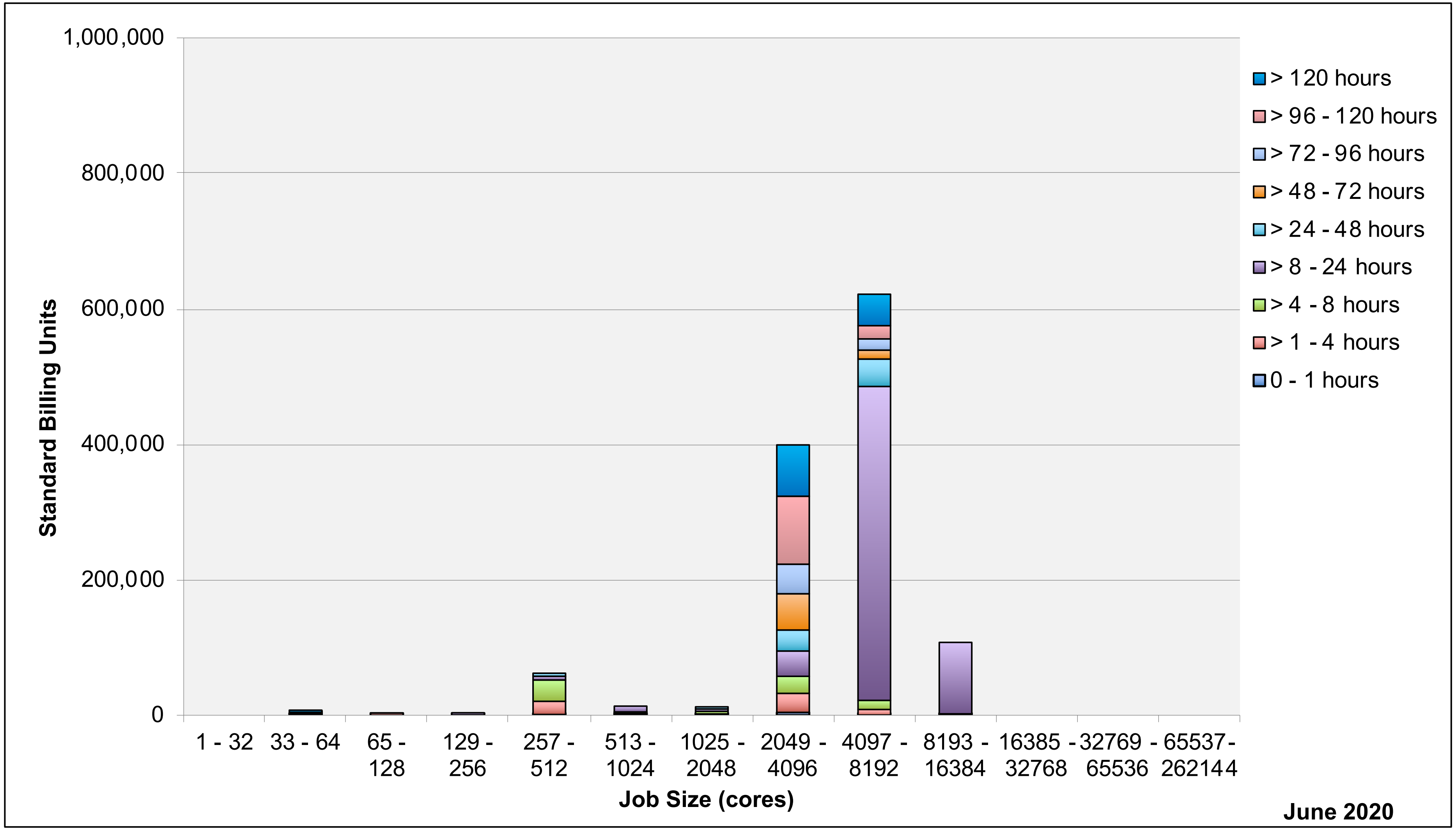


Aitken: Monthly Utilization by Size and Length



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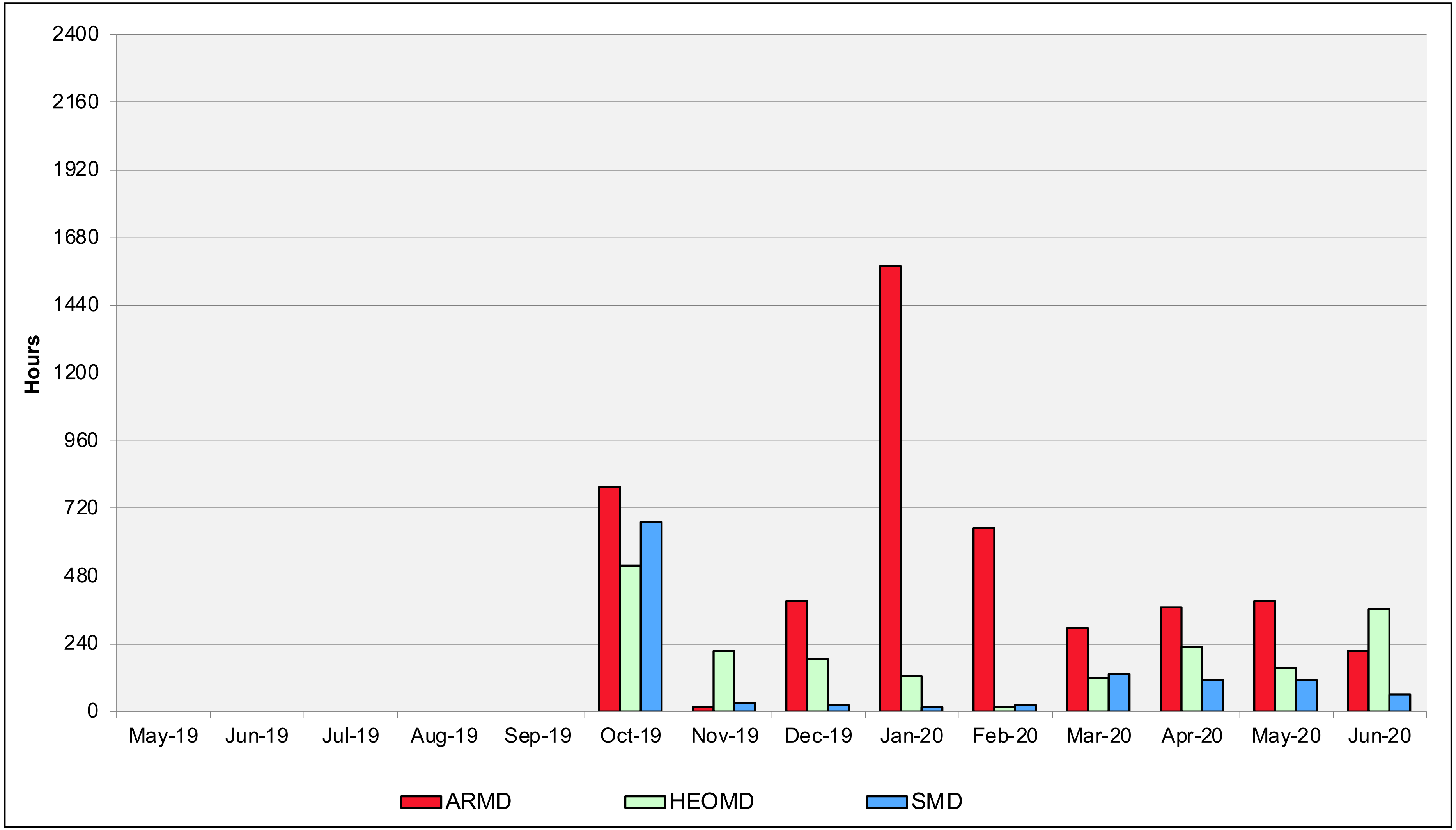
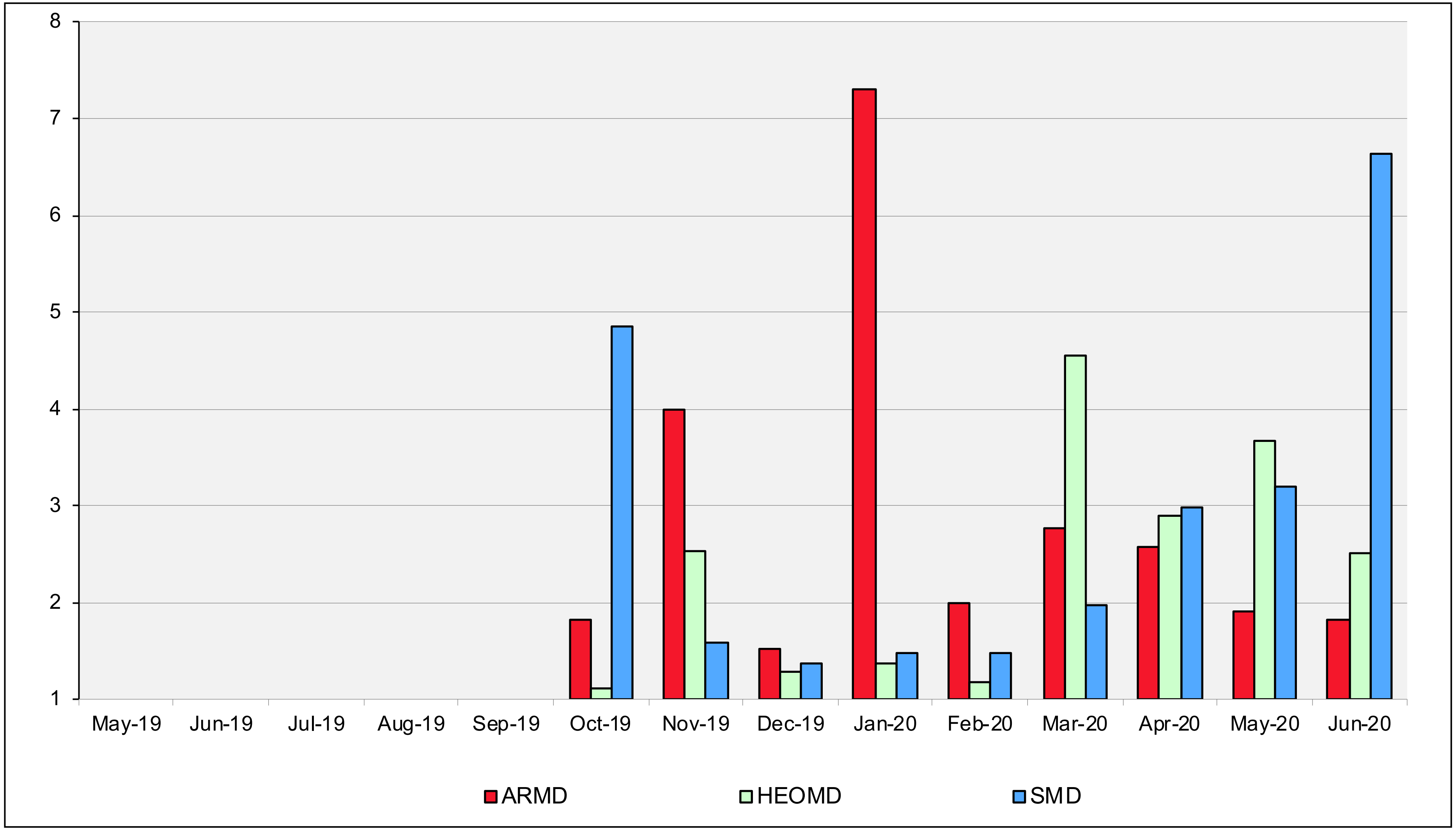
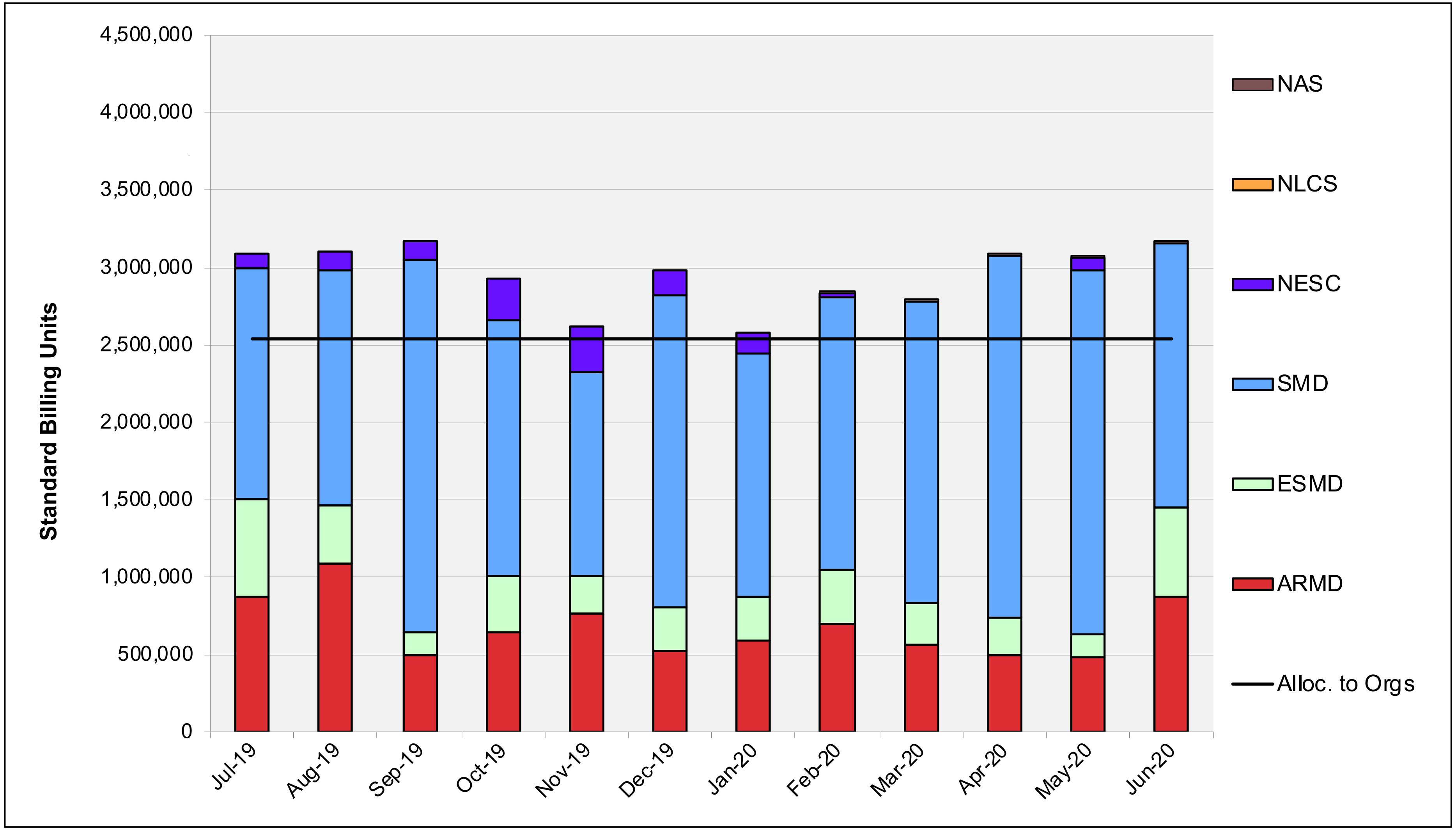


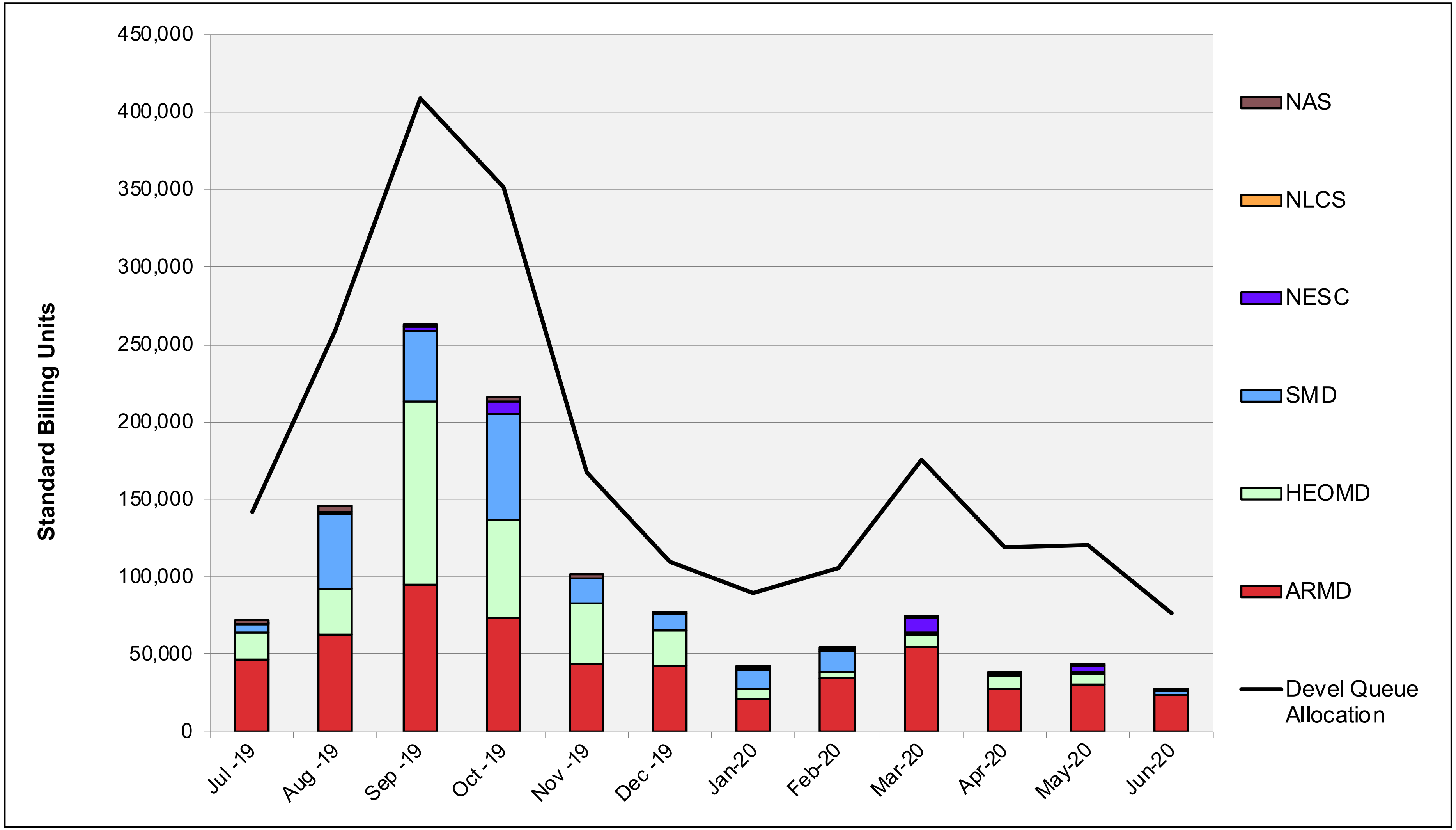
Aitken: Average Expansion Factor



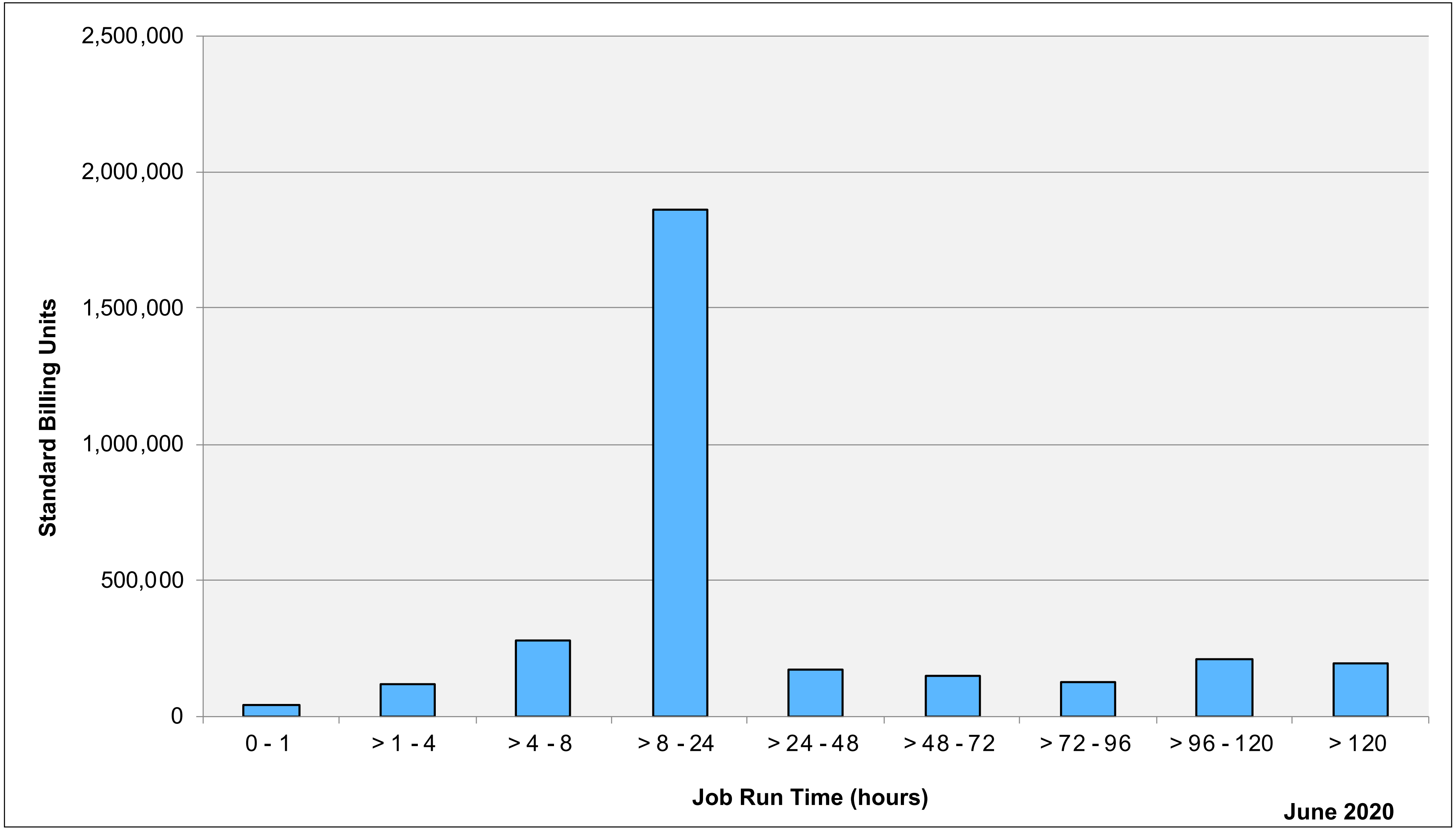
Electra: SBUs Reported, Normalized to 30-Day Month



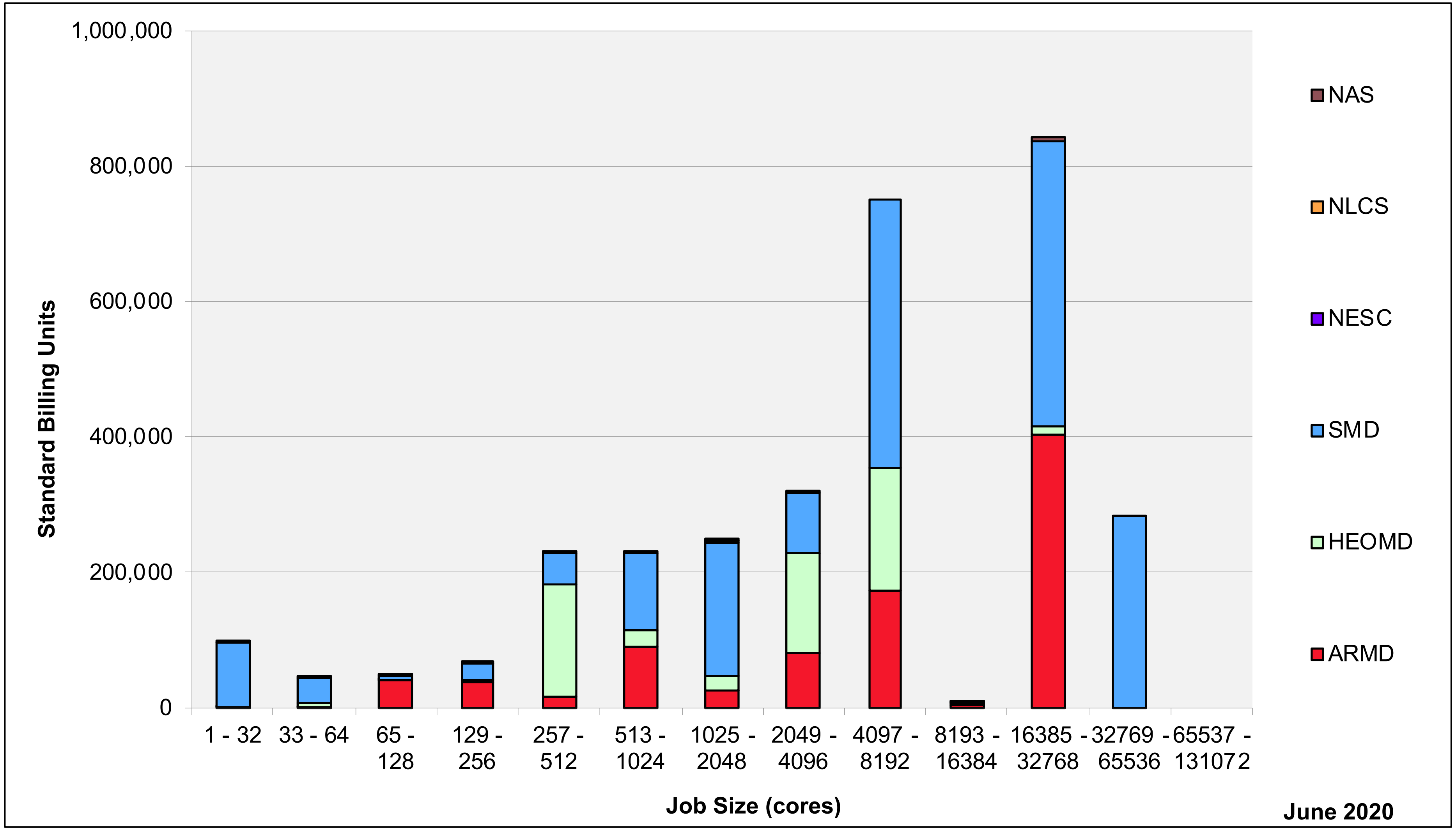
Electra: Devel Queue Utilization



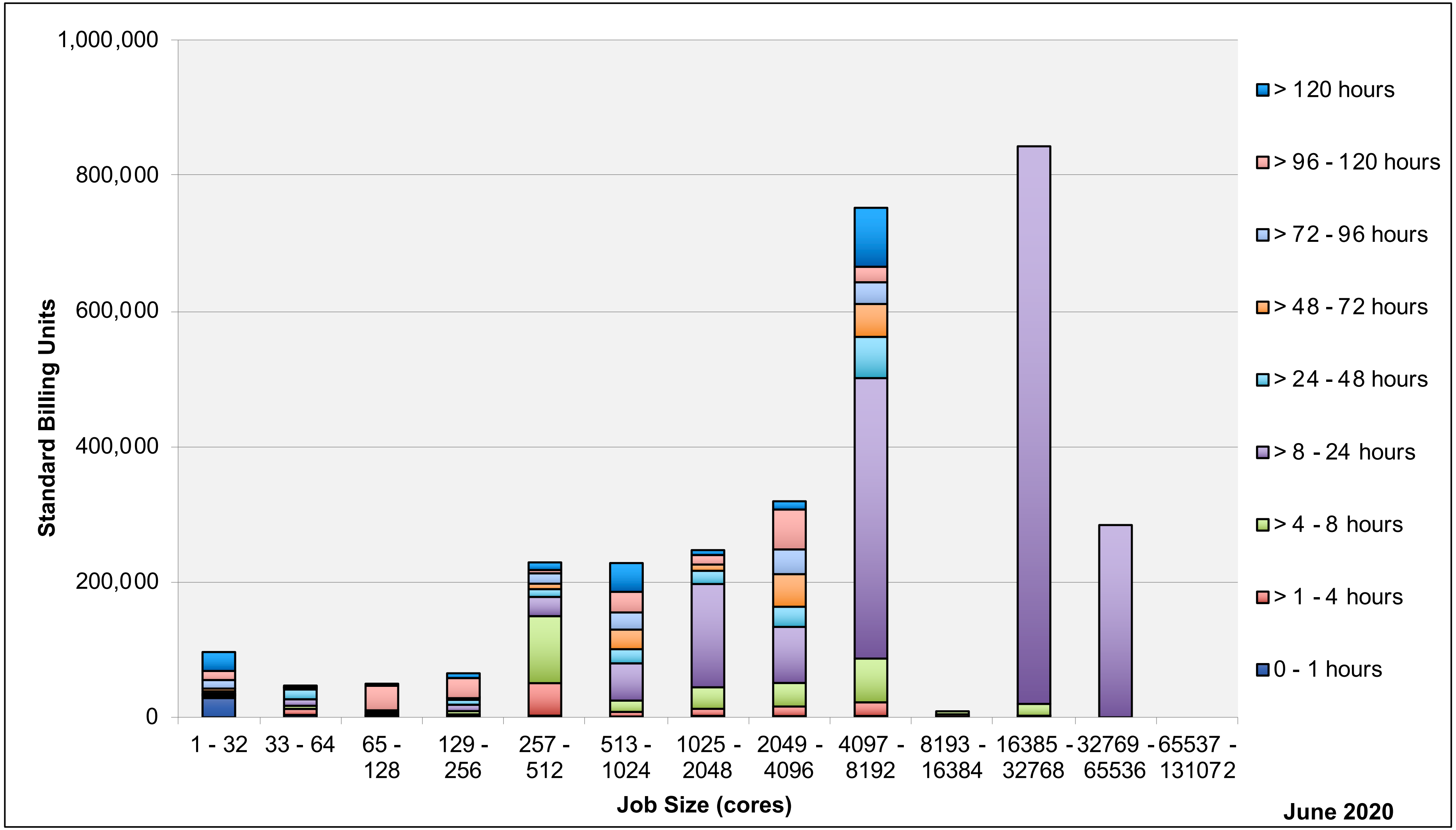
Electra: Monthly Utilization by Job Length



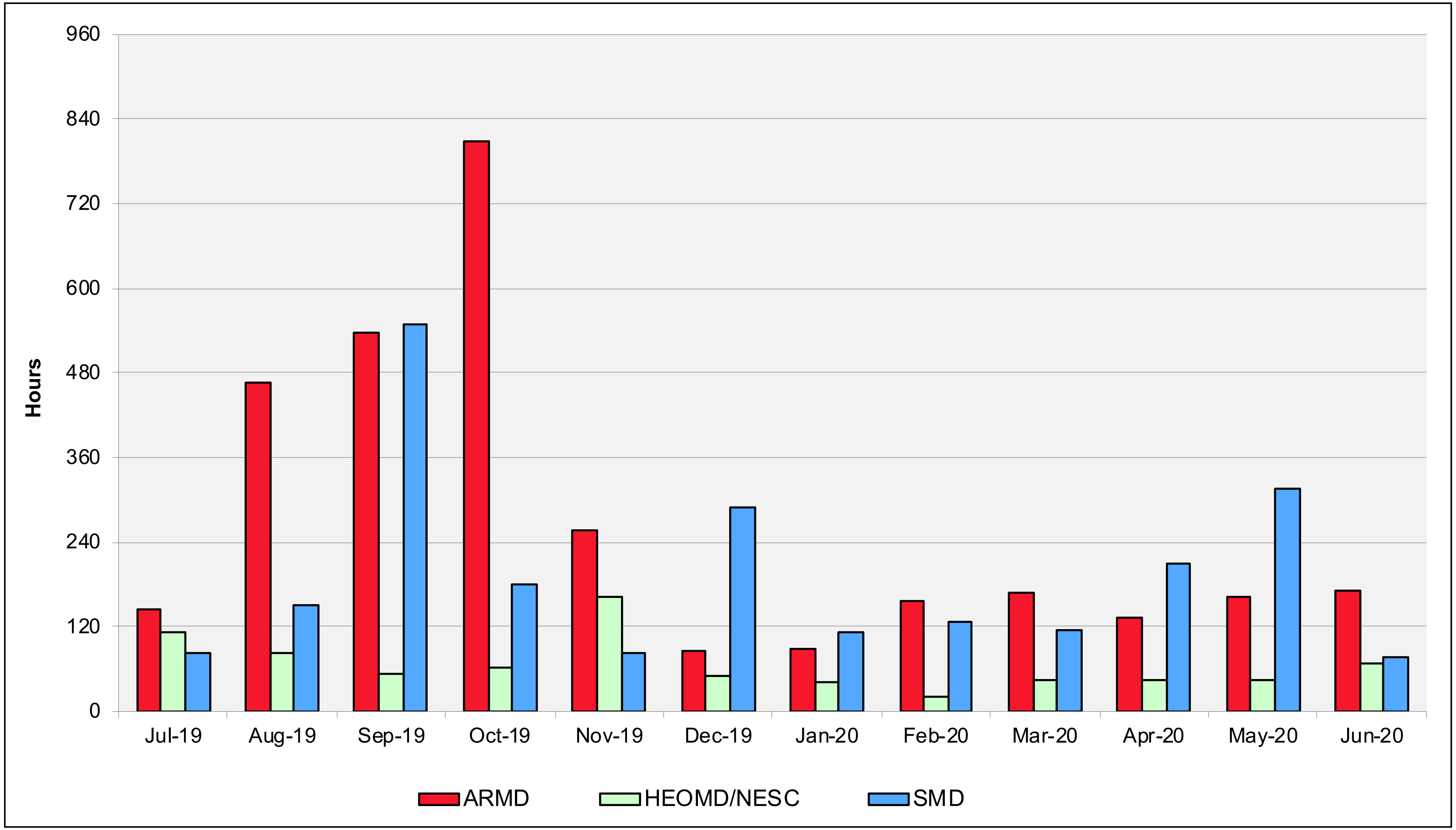
Electra: Monthly Utilization by Job Length



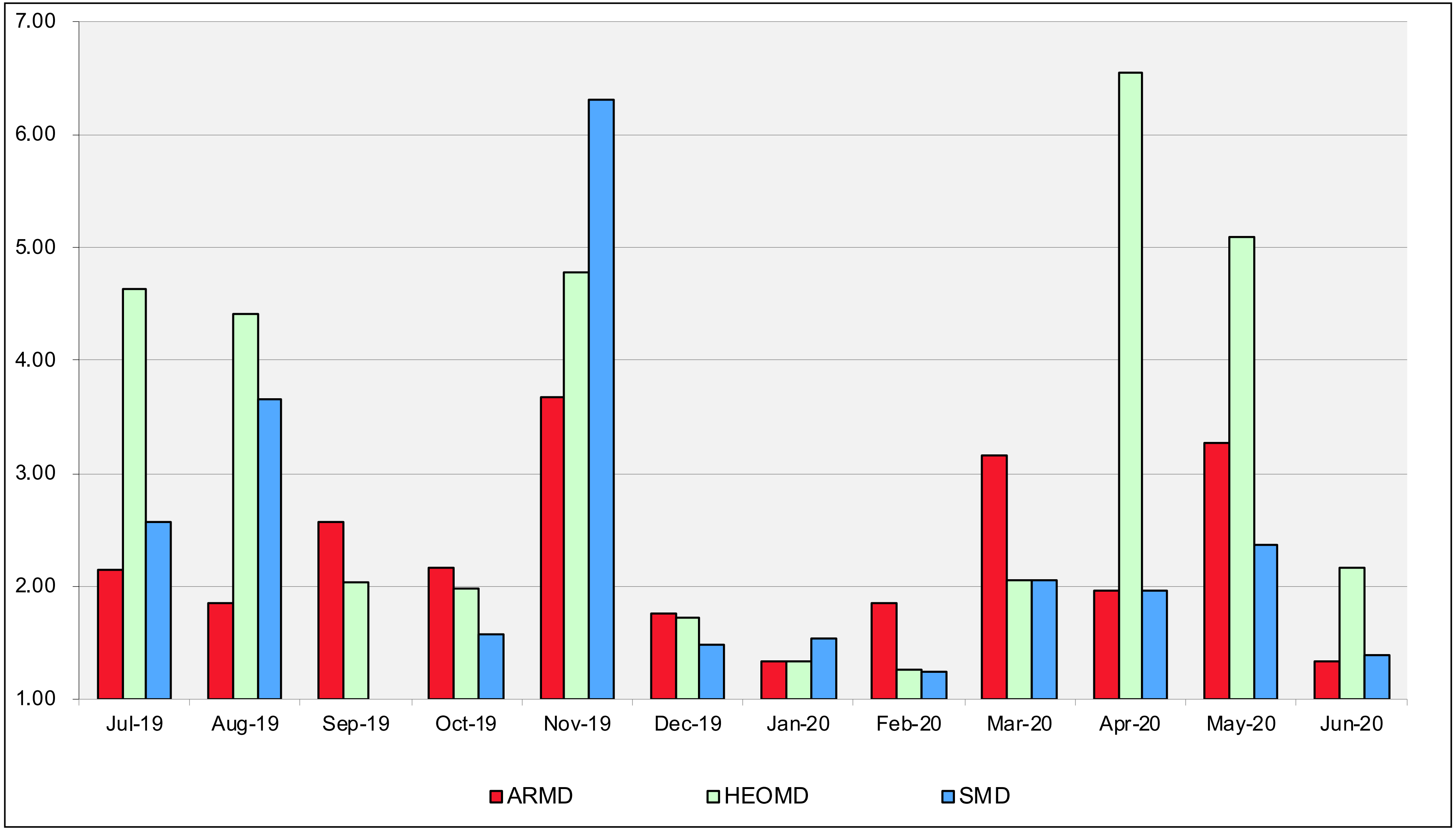
Electra: Monthly Utilization by Size and Length



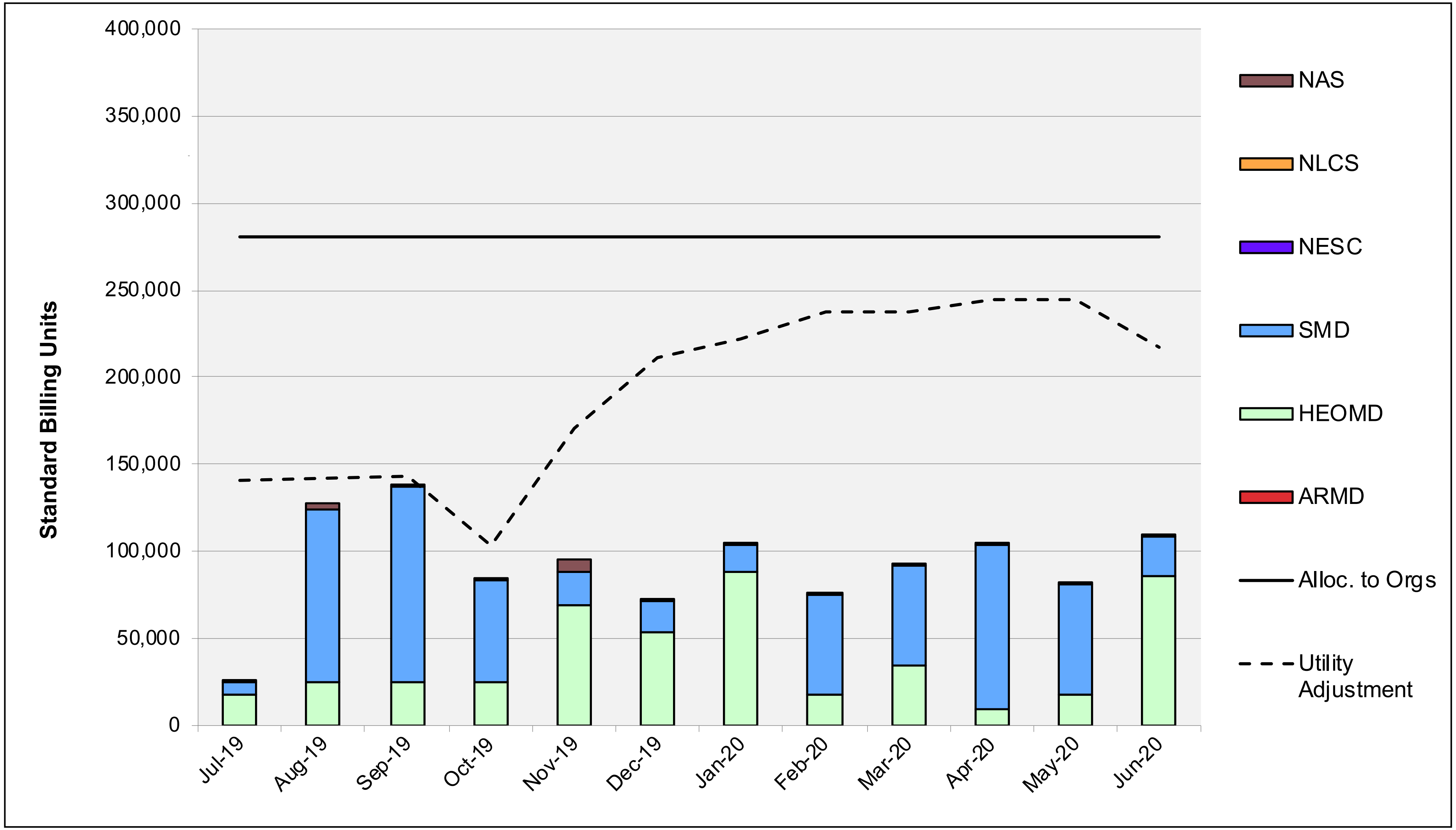
Electra: Average Time to Clear All Jobs



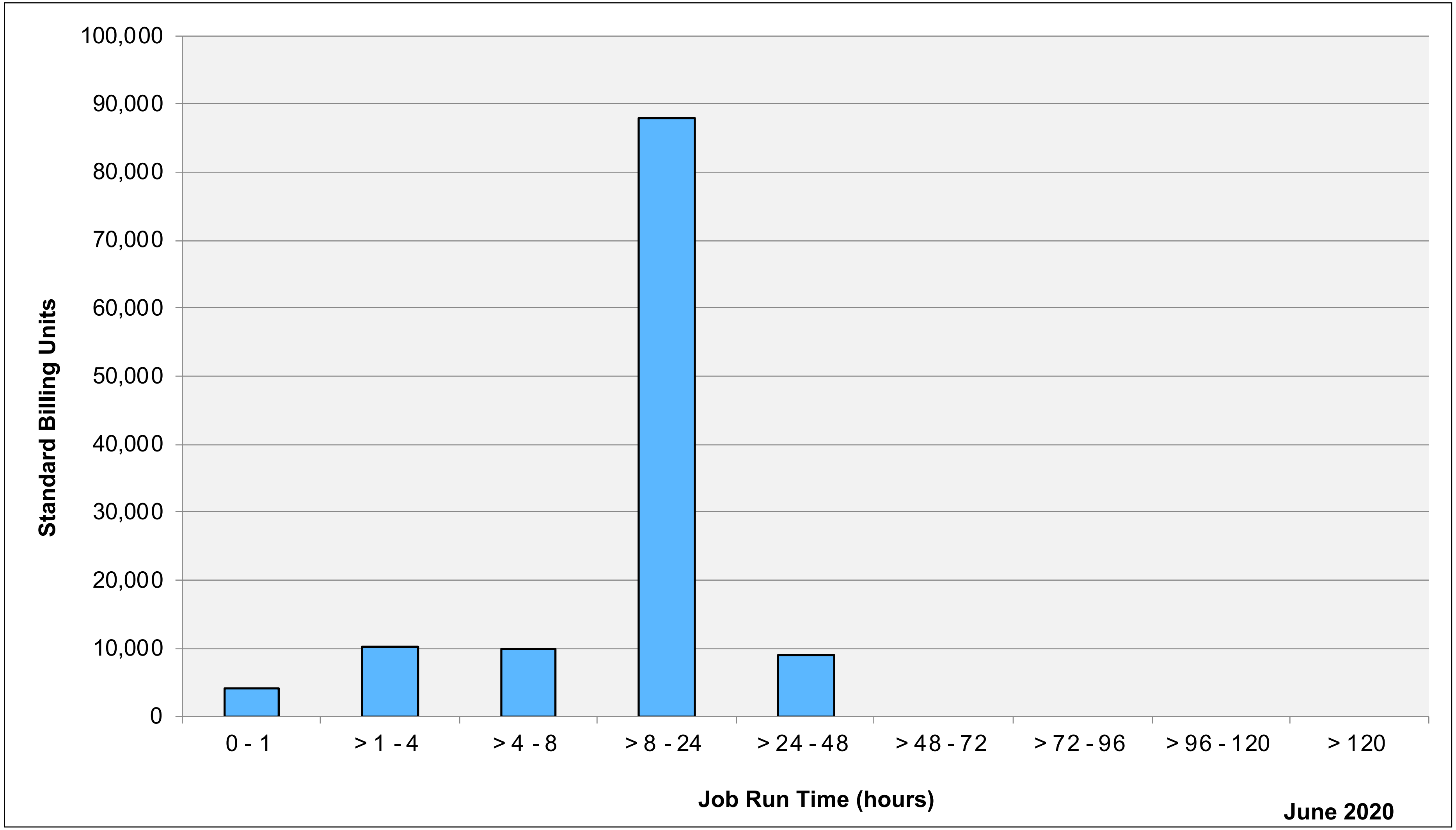
Electra: Average Expansion Factor



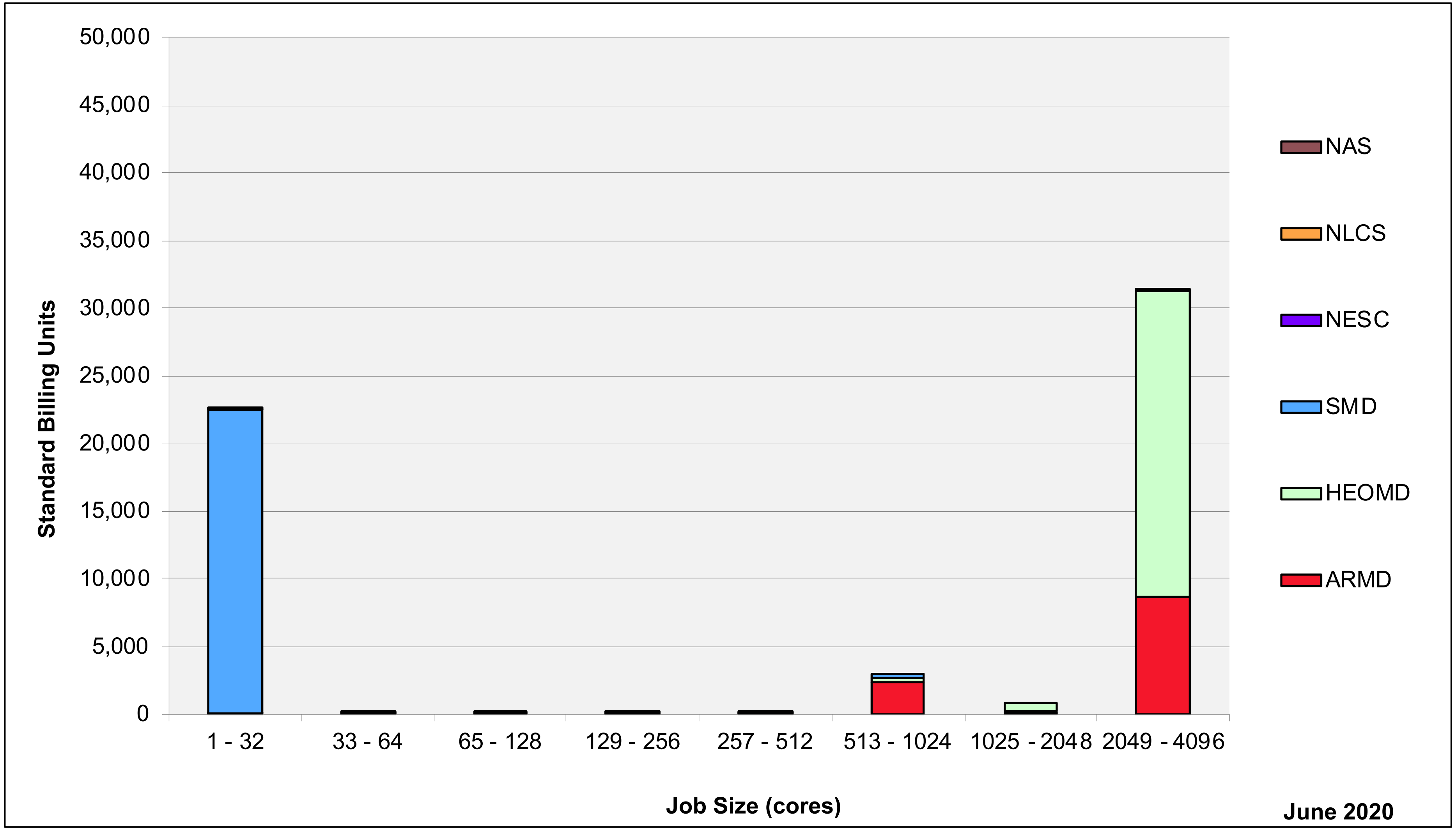
Merope: SBUs Reported, Normalized to 30-Day Month



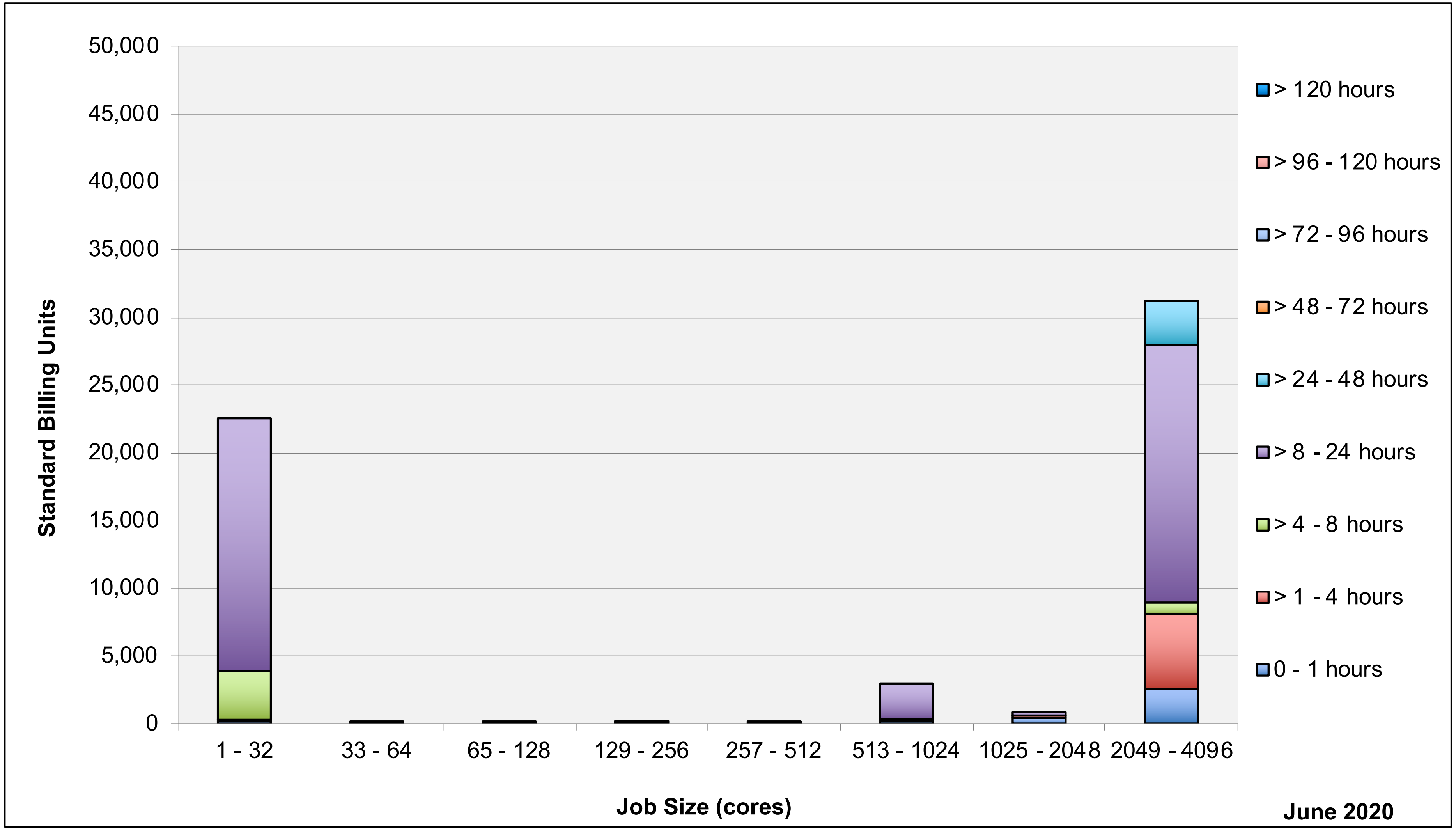
Merope: Monthly Utilization by Job Length



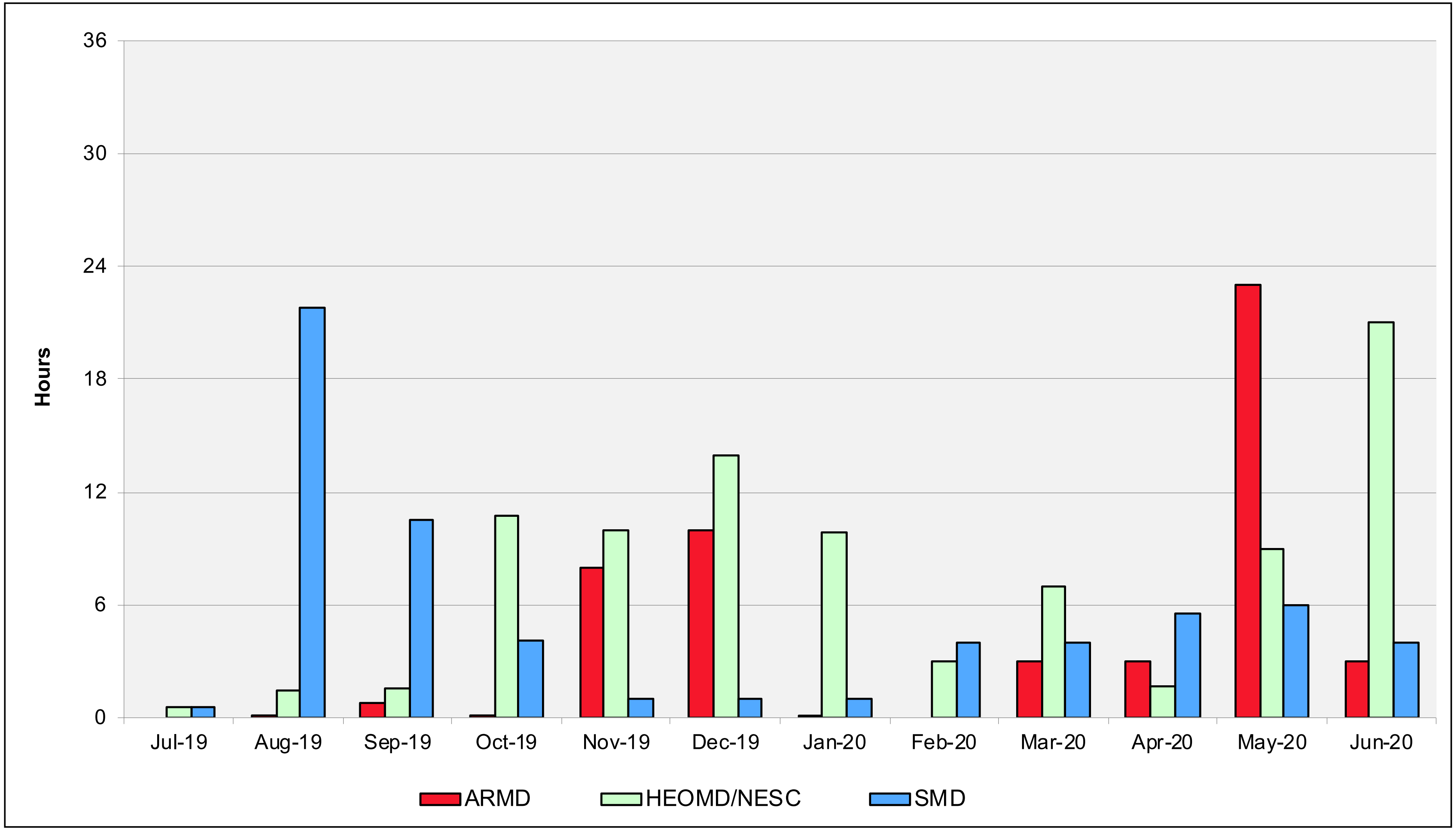
Merope: Monthly Utilization by Job Length



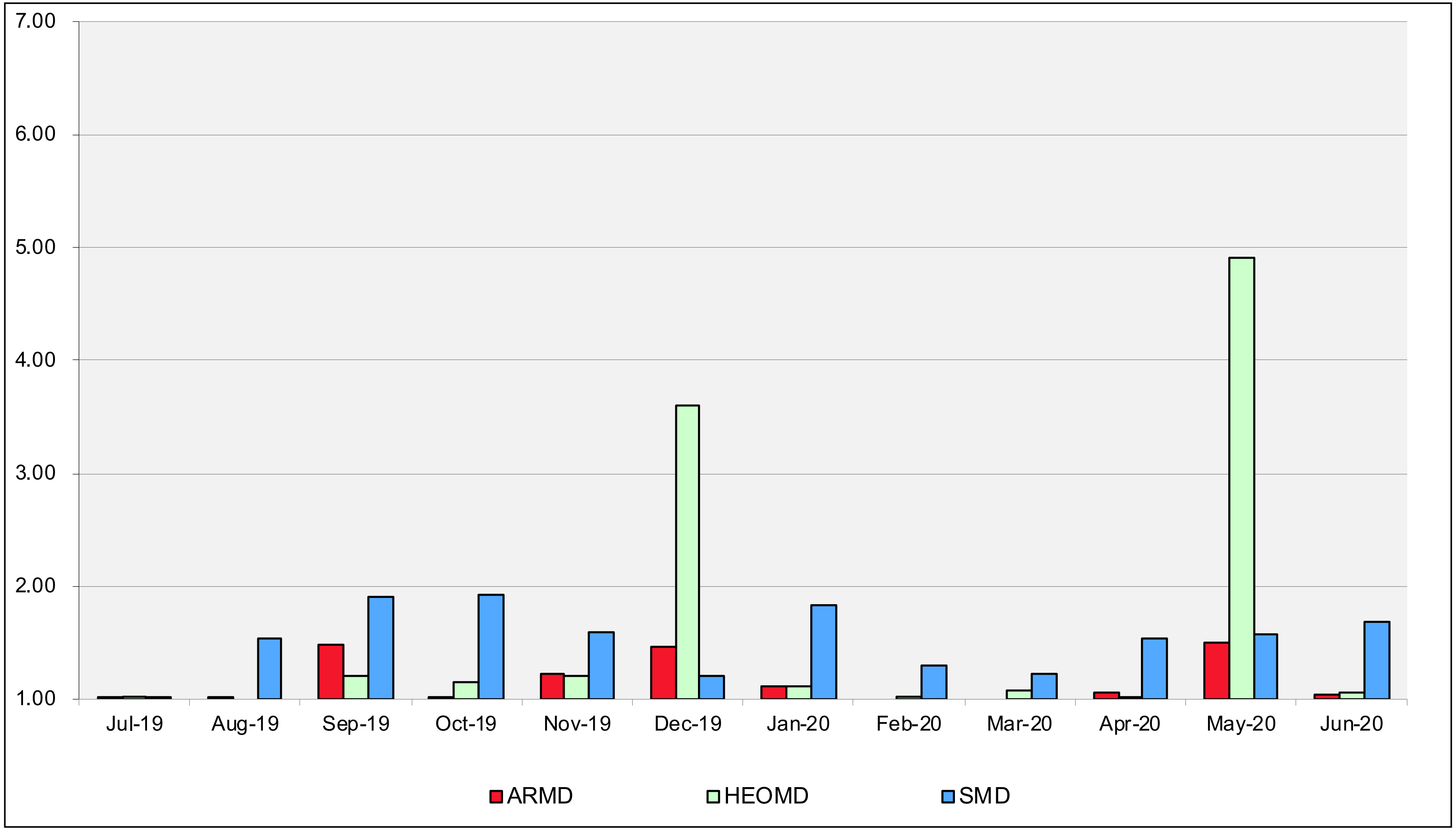
Merope: Monthly Utilization by Size and Length



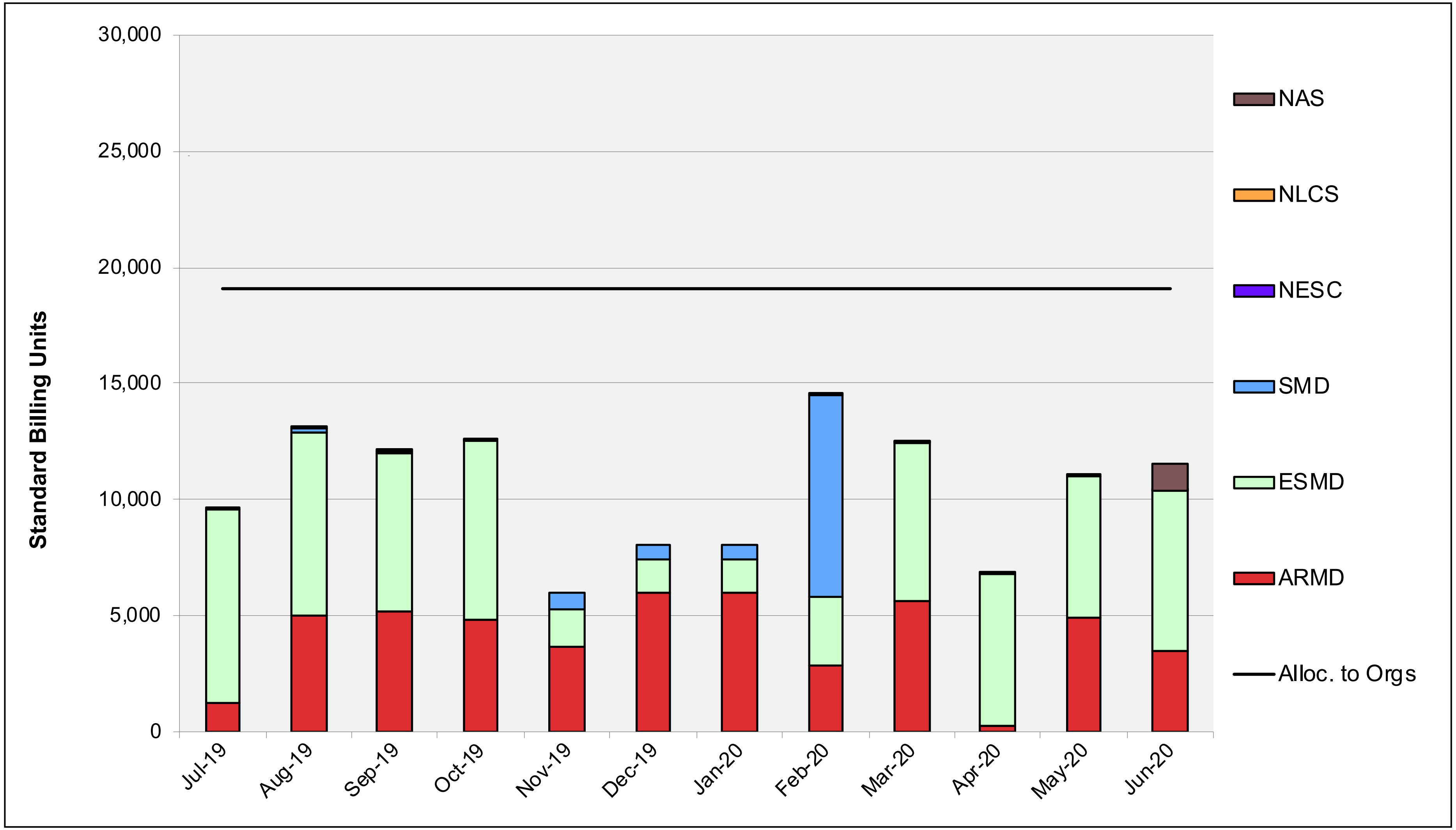
Merope: Average Time to Clear All Jobs



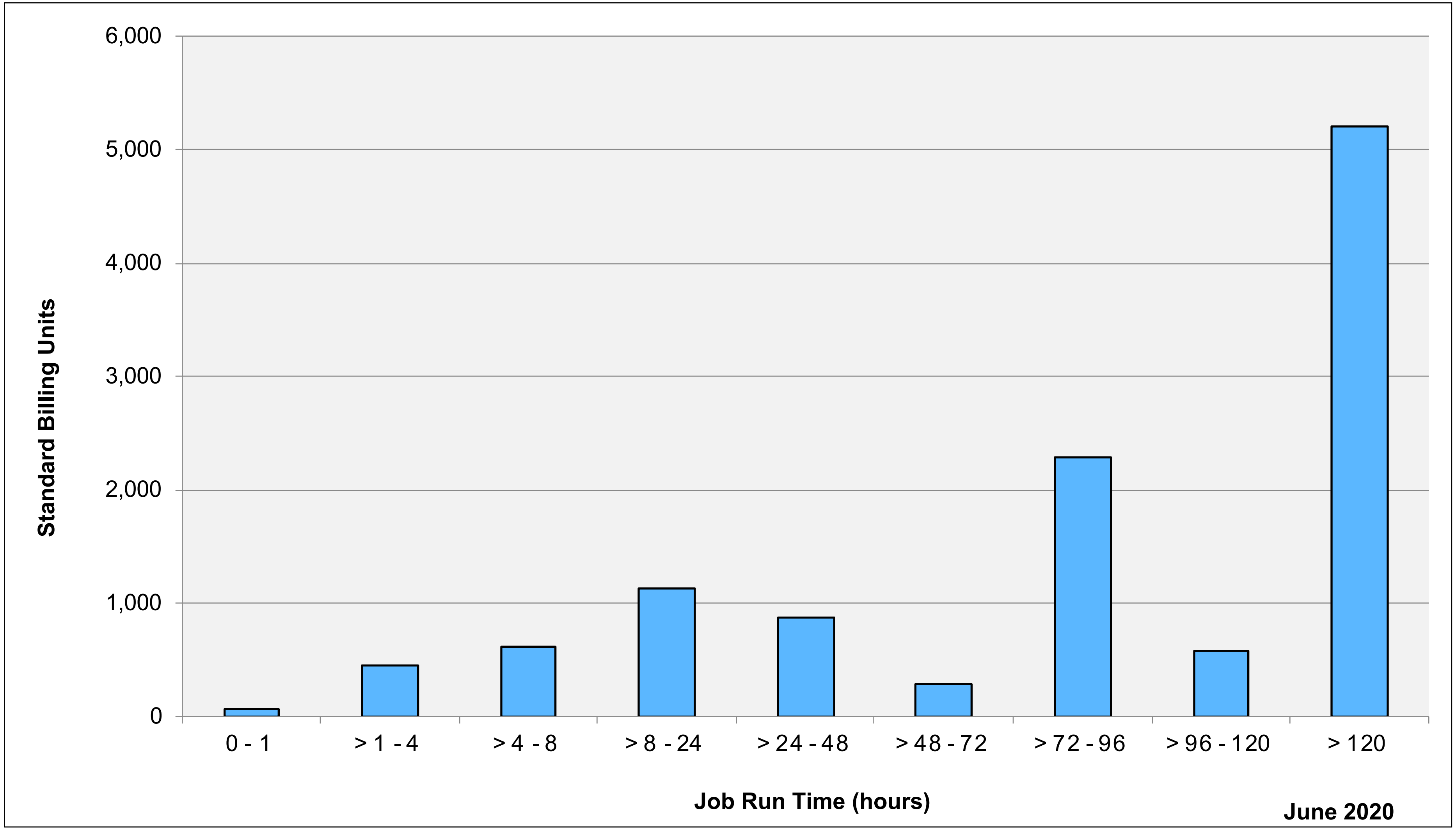
Merope: Average Expansion Factor



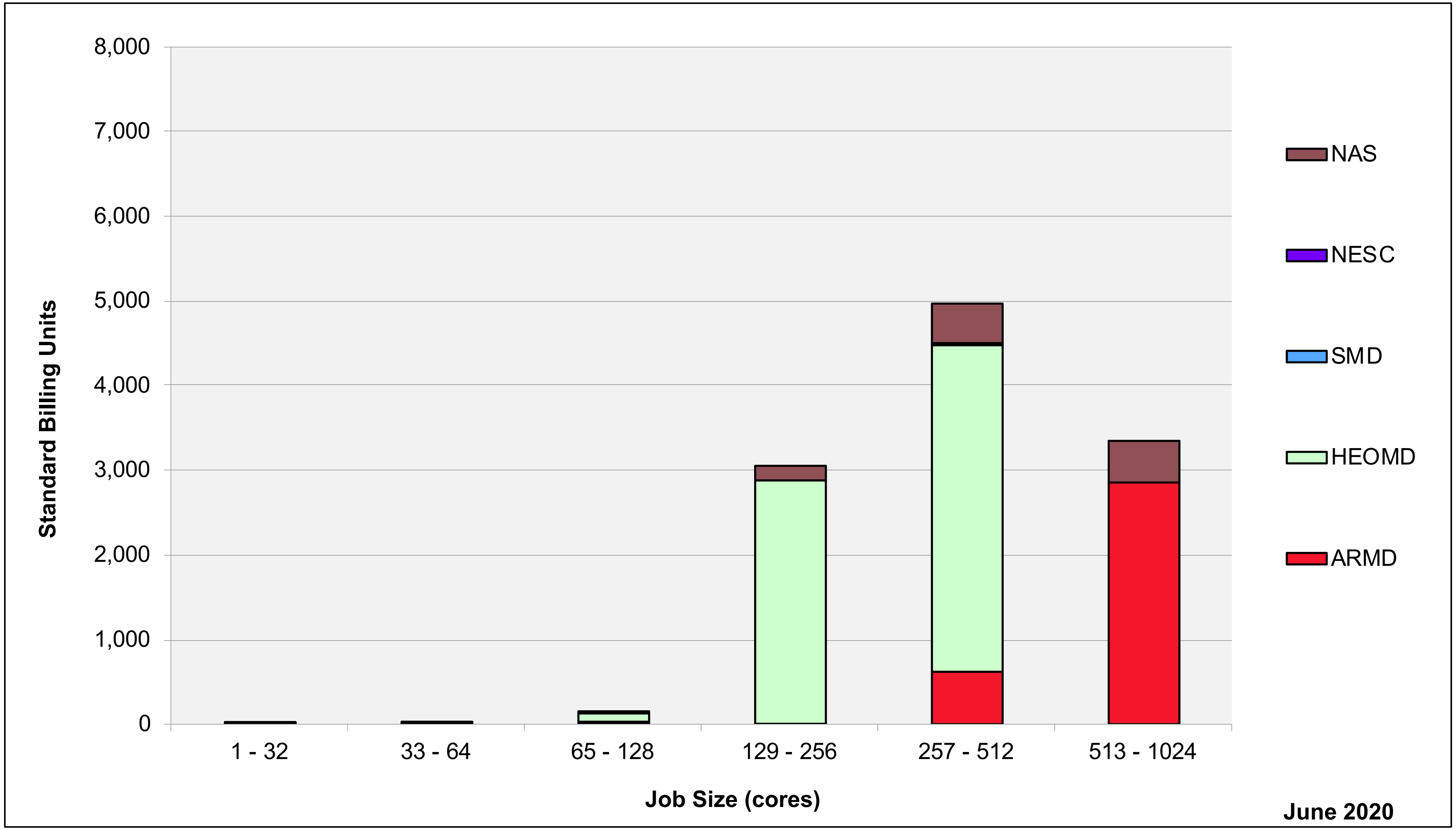
Endeavour: SBUs Reported, Normalized to 30-Day Month



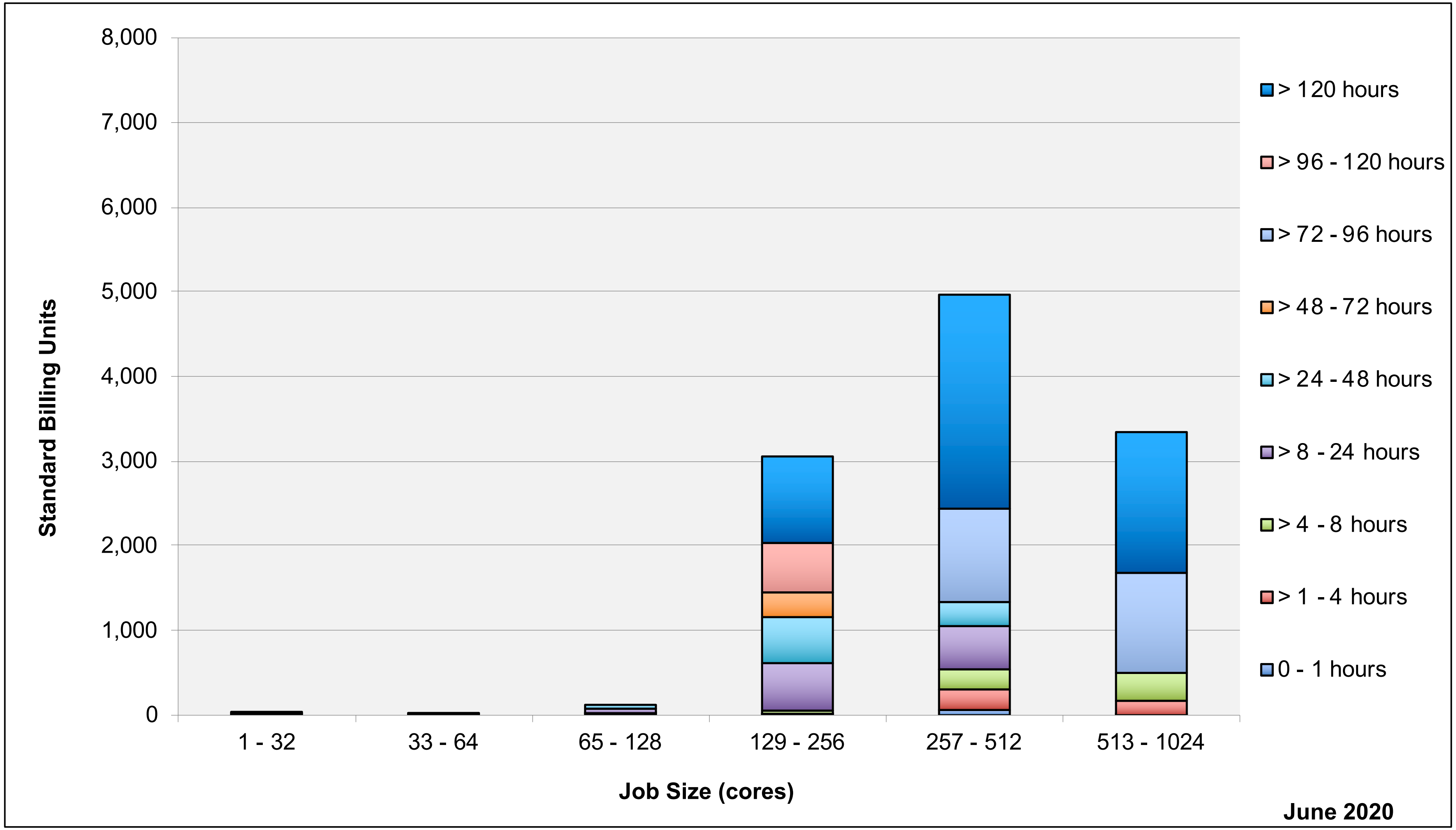
Endeavour: Monthly Utilization by Job Length



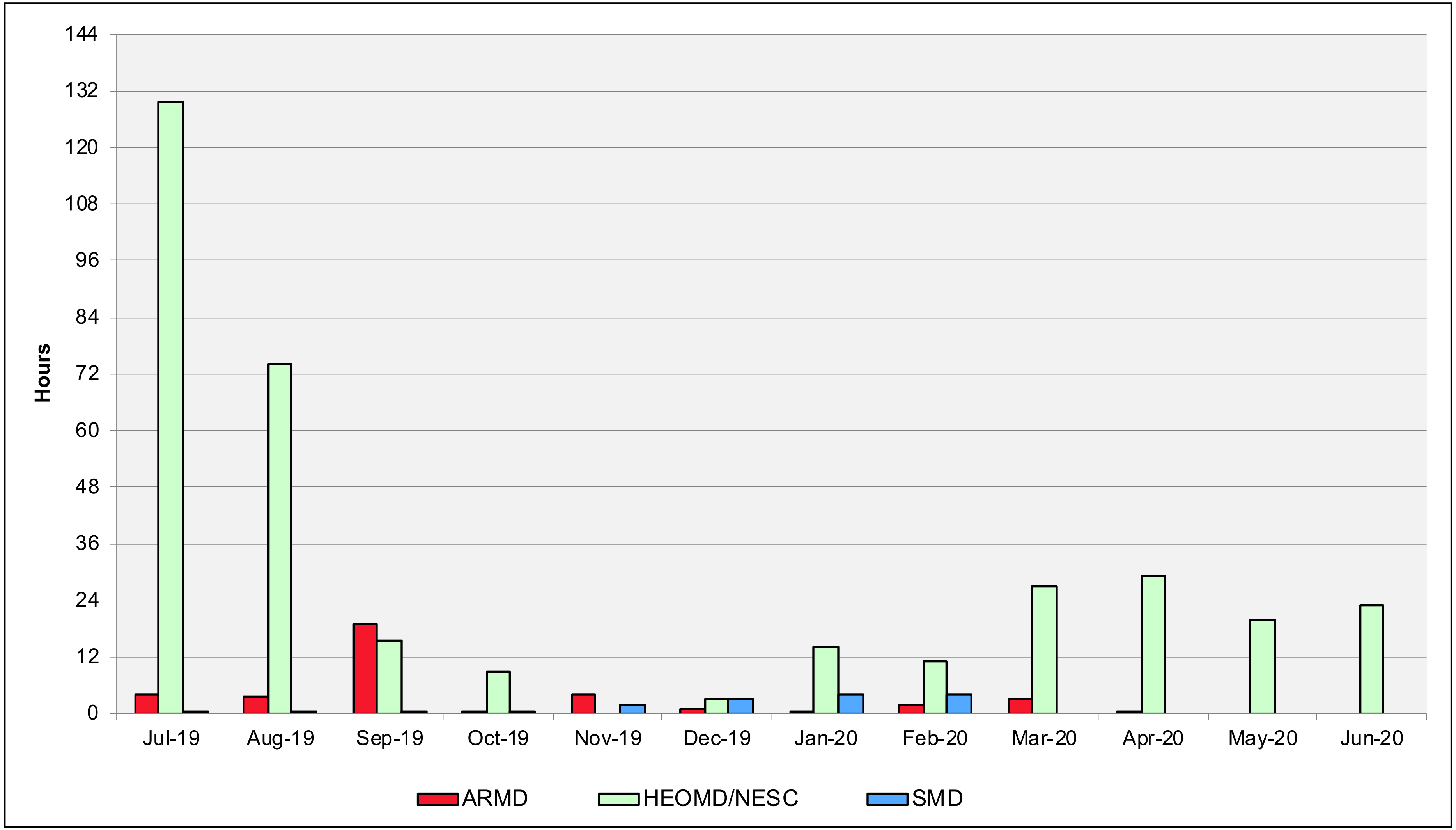
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Time to Clear All Jobs



Endeavour: Average Expansion Factor