

National Aeronautics and Space Administration

High-End Computing Capability

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Significant Accomplishments: Current & Future

Current

- Data Portal Enhancements Improve Visualization Team's Active Collaboration Projects
- HCI II Provides Redundancy for Key HECC Systems
- Compute Module 2 Construction Underway
- User Services Releases Survey Results and Recommendations
- Finding a Signal from Earth-Like Planets in Stellar Noise
- Simulating Capsule Free-Flight for Planetary EDL

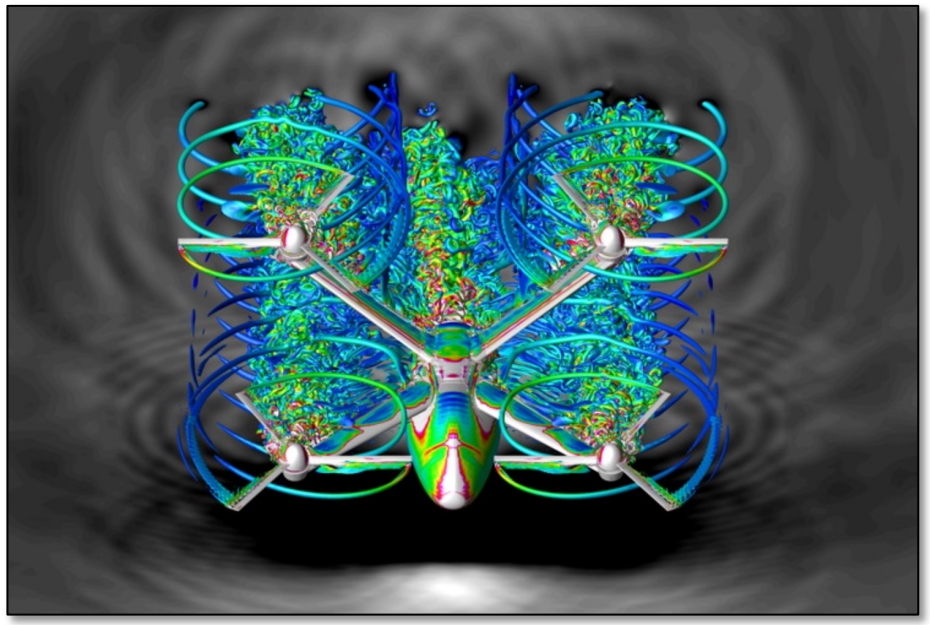
Future

- 100 Gbps network connectivity
- Shift Large Transfer Performance Improvements
- Hot Pool Migration
- DDN Issues Resolution

Data Portal Enhancements Improve Visualization Team's Active Collaboration Projects

- The HECC Data Portal and Engineering Systems Services (ESS) teams made several changes to the NAS Visualization Team Data Portal to address system stability issues.
  - Outages caused by maintenance or high loads on infrastructure in the HECC enclave (such as nobackup filesystems and re-exporters) caused problems with the stability and usability of the data portal—sometimes during active collaboration with external partners.
  - Although migrating data to the export1 filesystem alleviated the majority of outages, the infrastructure was still susceptible to outages for maintenance.
- The Data Portal and ESS teams created a virtual storage area network (VSAN) storage space on the Hyper Converged Infrastructure (HCI) that mounts onto data portal production hosts.
  - Most of the Visualization team's data has been copied into this storage space.
  - Active backup service on data portal's control node performs routine backups of the instance of the Viz team's data on export1 to VSAN storage space.
- A new service implemented on data portal production servers continuously checks whether the Network File System mount to the dedicated fileserver is working, and automatically switches to the VSAN as needed, eliminating downtime and reducing human intervention to keep the service up 99.9% of the time (except during complete power shutdowns and widespread infrastructure outages).

IMPACT: The enhancements to the data portal via the Hyper Converged Infrastructure storage space ensure data availability when collaborating with users in real time.



Screenshot from the Visualization Team Data Portal showing the flow of a NASA quadcopter concept for urban air mobility (UAM). *Timothy Sandstrom, Patricia Ventura Diaz, NASA/Ames*

HCI II Provides Redundancy for Key HECC Support Systems

- The ESS team installed a second Hyper Converged Infrastructure (HCI II) cluster in building N233A and brought it into production on January 19, 2024.
- The new cluster augments an existing HCI cluster in the main NAS facility (building N258).
- The new cluster also has Site Recovery Management from VMware. This software enables administrators to set up replication for virtual machines, which facilitates the ability to move virtual machines of particular importance between the two clusters for redundancy and failover.
- Services critical to HECC to be supported on the redundant HCI I and II cluster pair include: PBS job accounting and reporting, Data Portal, Nagios monitoring, and software license management.

IMPACT: The new Hyper Converged Infrastructure system enables the failover of key HECC systems to N233A to ensure system redundancy and service resilience.



The new Hyper Converged Infrastructure II installed in building N233A at NASA's Ames Research Center. *Michael Latiolais, NASA/Ames*

Compute Module 2 Construction Underway

- The second compute module for the Modular Supercomputing Facility (MSF) at NASA Ames is now under construction. Compute Module 2 will support the expansion of the Aitken supercomputer.
- Module designer and manufacturer Avail Infrastructure Solutions is fabricating the steel modular building in their Maryland factory.
  - Module fabrication began at the beginning of December 2023 and is expected to complete in March 2024.
  - In addition to fabricating the steel building, Avail will integrate the electrical, cooling, fire, and control systems into the building before shipping to California.
  - The module, which is fabricated in two halves, will ship to California via semi-trailer truck. Because the module is subject highway transport restrictions for oversized loads, shipping is expected to take nearly two weeks.
- Avail will set the modular building at the MSF site with a crane in April 2024. Complete integration of the module and infrastructure plus commissioning is projected to complete in June 2024.
- The Aitken expansion into Compute Module 2 will begin with the relocation of the four HPE Apollo Milan racks currently installed in Building N258. Module 2 will ultimately house 24 compute racks.

IMPACT: Compute Module 2 supports the expansion of the Aitken supercomputer, providing space for hosting additional computing resources for the HECC user community.



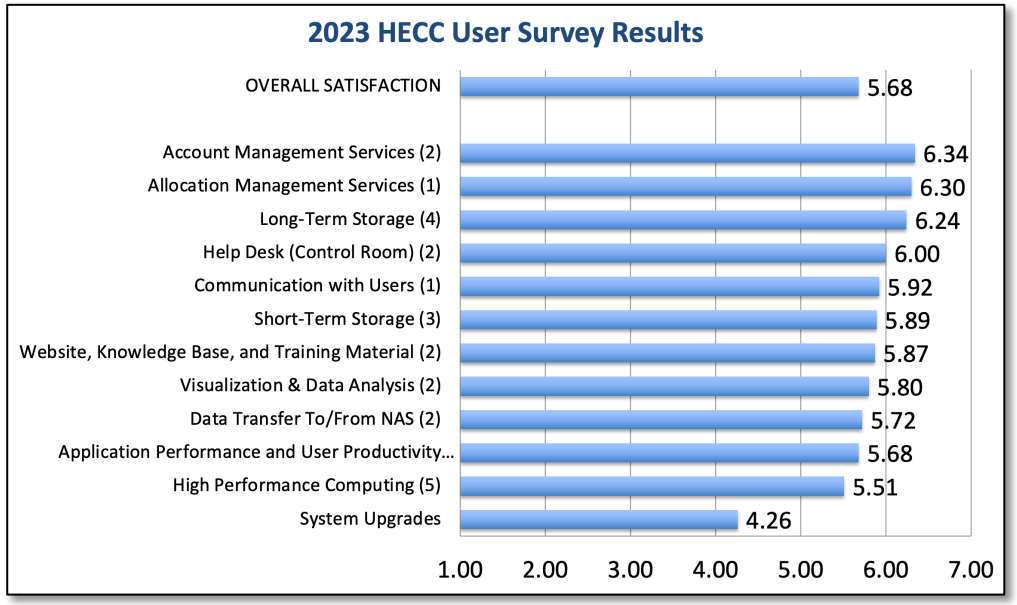
One half of Compute Module 2 is being constructed in the Avail Infrastructure Solutions factory. *Anthony Innerarity/Avail Infrastructure Solutions*

User Services Releases Survey Results and Recommendations

- The 2023 user survey results were released to NAS/HECC management, the HEC Board of Advisors and to user community. The survey identifies areas for improvement, year-to-year trends, and user satisfaction across each of HECC's service areas. This information is used to produce a list of recommendations and completed actions to date for HECC management to inform strategic planning decisions.
- 223 users answered at least one question; with a response rate (users who completed the survey) of 11.3% of the total userbase.
  - The survey consisted of both quantitative and qualitative questions.
  - User demographics were well represented (years as a user, location, mission directorate supported).
- Support continues to stand out among the aspects of HECC services users find outstanding, followed by hardware/high-performance computing, and the website/training/knowledge base.
- Four areas of opportunity for improvement were identified: system stability, downtime, job turnaround, and support*.
  - Recommendations included: increasing cluster independence, consolidating work for scheduled downtimes, evaluating the job scheduler, and establishing formal service level agreements for tickets.

* Survey results indicated polarized experiences with support, not exclusive to Tier I/Control Room. Some experiences were outstanding, while others noted significant room for improvement.

IMPACT: User surveys play a key role in measuring and tracking user satisfaction, identifying trends, and informing management decisions.



The 2023 HECC User Survey scores by service area on a 7-point. scale. The number in parentheses denotes the number of questions asked.

Finding a Signal from Earth-Like Planets in Stellar Noise *

- One of the most promising methods for detecting Earth-size exoplanets orbiting their parent stars in the habitable zone is to measure variations of a star's radial velocity, caused by orbiting planets.
- Research scientists at NASA Ames are addressing a challenge to improve the detection rate of these planets by enabling technology to retrieve planetary signals from significantly stronger background noise produced by their parent stars.
- For the first time, the researchers reconstructed the dynamics of the entire stellar surface with a high degree of realism.
  - This demonstrates that regions on the periphery of the stellar disk can contribute significantly to disk-integrated radial velocity disturbances.
  - The project describes star-specific surface disturbances, called “stellar jitter,” using the NASA Ames StellarBox code to model the dynamics of target stars.
  - The researchers developed 3D radiative hydrodynamic models of several solar-type stars to investigate the origin and properties of stellar jitter.
- The scientists obtained synthetic observations for six target stars being used as a testbed to develop new capabilities to detect Earth-like planets and understand the limitations and uncertainties in observations and methods.

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

IMPACT: Enabled by HECC resources, this work facilitates the development of noise reduction procedures to retrieve planetary signals and explore how different areas on the stellar surface contribute to observed radial velocity variations.



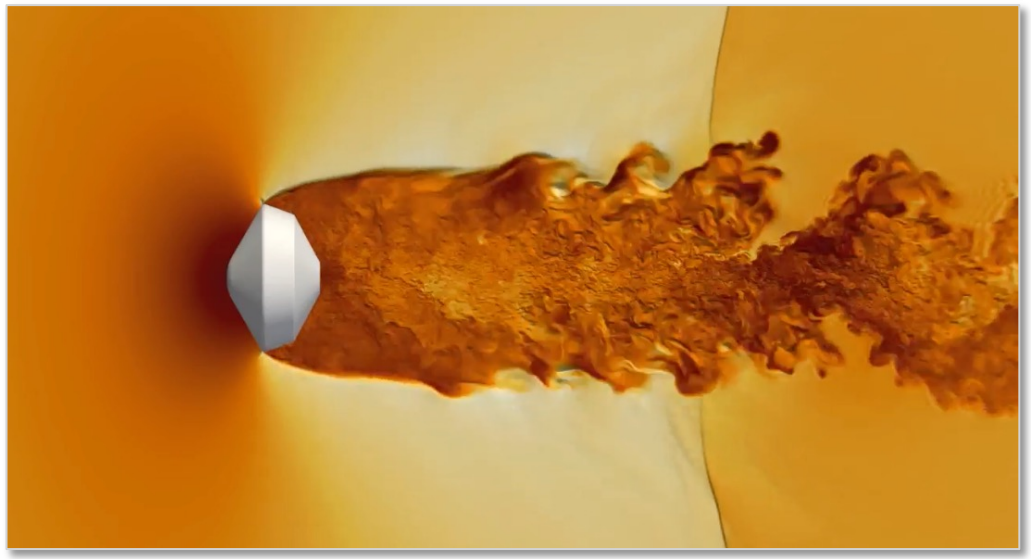
Animation showing the reconstructed continuum intensity surface dynamics of star HD209458 using 3D radiative hydrodynamics simulations run on NASA’s Aitken and Electra supercomputers.
Irina N. Kitiashvili, Timothy Sandstrom, NASA/Ames

Simulating Capsule Free-Flight for Planetary EDL *

- NASA designs capsules to survive the intense conditions of entering a planetary atmosphere at hypersonic speeds, protecting their payloads from the high temperatures encountered early in the entry flight trajectory. However, the capsules can encounter dynamic instabilities as they are slowed down by aerodynamic drag.
- To quantify and understand these instabilities, researchers at NASA Ames used the agency's Pleiades and Electra supercomputers to simulate the free-flight conditions of capsules during the full trajectory of planetary entry. The simulations were conducted as part of the NASA Entry Systems Modeling (ESM) Project.
  - These complex simulations involve coupling an existing computational fluid dynamics solver (US3D) to a trajectory code and allowing an object to rigidly rotate about a center-of-gravity in response to aerodynamic forces.
  - This enables a full six-degrees-of-freedom simulation of free-flying objects, which are used by researchers at NASA Ames to analyze the flight dynamics of capsules and identify any risks these instabilities may pose during the later stage of the flight trajectory.
  - Results compare well to ballistic range data and complement experimental methods for assessing the dynamic stability of these high-speed vehicles.
- As a next step, a simplified approach that uses reduced degrees-of-freedom simulations is being investigated to reduce computational cost.

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IMPACT: The simulations enable mapping of the entry vehicle dynamics for the full flight trajectory and are being used for dynamic analysis for flagship NASA planetary exploration missions, including the Artemis Program and the upcoming Dragonfly mission to Saturn's largest moon, Titan.



Free-flight simulation showing the speed of aerodynamic flow around a planetary entry vehicle and how the vehicle's motion is affected by it. The simulation was run on supercomputers at the NASA Advanced Supercomputing facility. *Eric Stern, NASA/Ames*

Papers

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  - "**Aerodynamic Assessment of a 70 deg Spherecone at 0 deg Angle of Attack Flying Hypersonically in the Mars Atmosphere**," D. Fawley, et al. * https://arc.aiaa.org/doi/abs/10.2514/6.2024-1822
  - "**Analysis of e-VTOL Rotor Noise Predictions**," M. Marques Goncalves, V. Golubev, A. Lyrintzis. * https://arc.aiaa.org/doi/abs/10.2514/6.2024-2809
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Papers (cont.)

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Papers (cont.)

- **AIAA SciTech 2024 Forum** (cont.)
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Papers (cont.)

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Papers (cont.)

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Presentations

- **AIAA SciTech 2024 Forum**, Orlando, FL, January 8-12, 2024.
  - "**Validation of SLS Ascent CFD Surface Pressure Databases Using Artemis I Flight Data**," J. Meeroff, D. Dalle, S. Rogers, A. Burkhead, D. Schauerhamer, J. Diaz. *
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  - "**Deep Neural Network Based Convergence Classification for Computational Fluid Dynamics**," J. Diaz, D. Dalle, P. Papadopoulos. *
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Presentations (cont.)

- **AIAA SciTech 2024 Forum** (cont.)
  - "**Simulating Transonic Buffet Aerodynamics for the Boeing Transonic Truss-Braced Wing Aircraft**," O. Browne, D. Maldonado, J. Housman, J. Duensing, W. Milholen. *
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  - "**Anisotropic Mach Cone Aligned Mesh Adaptation for Low Boom Simulations**," C. Ashby, J. Housman, J. Duensing. *
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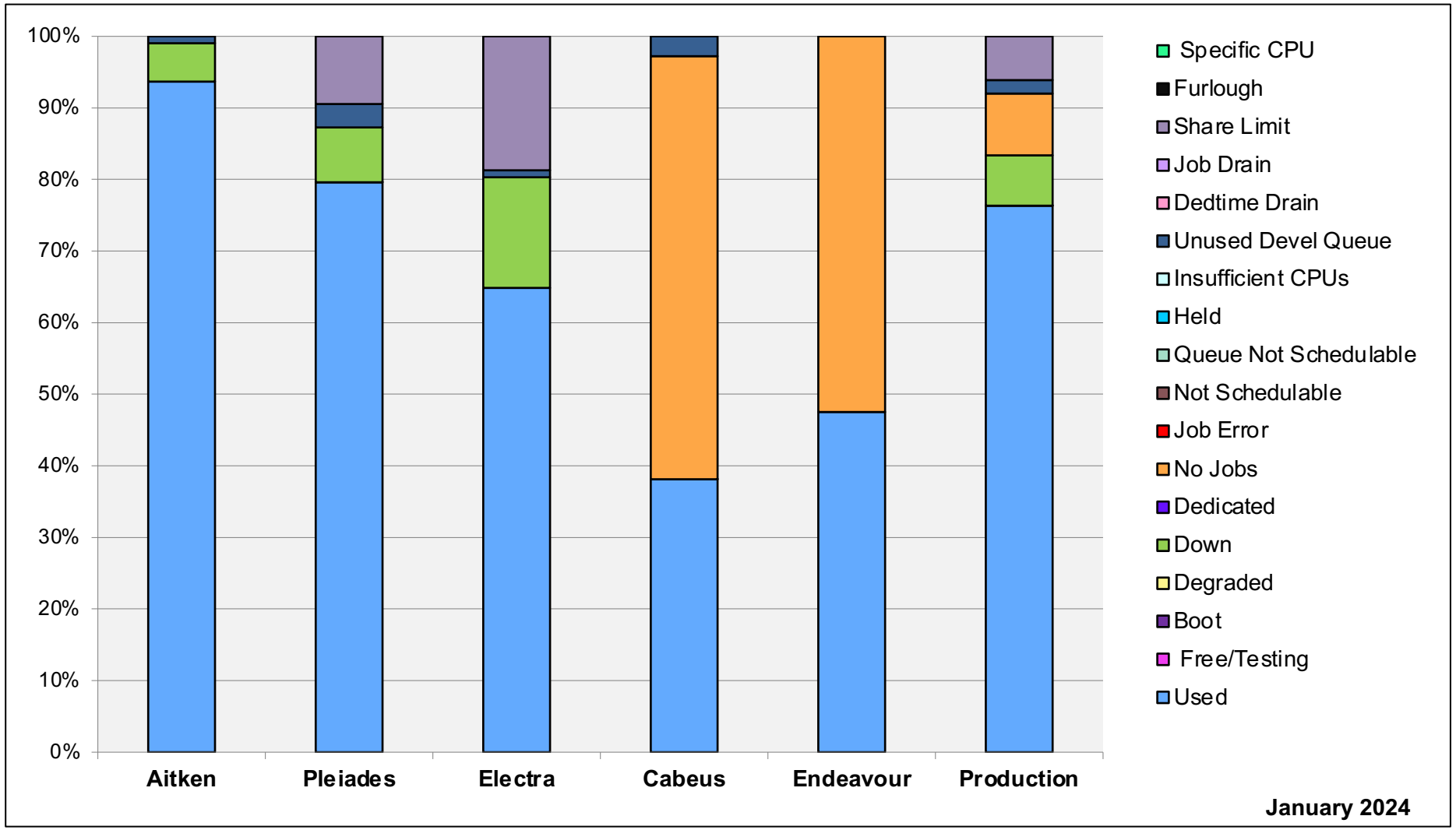
News and Events

- **TESS Researchers Discover Six-Planet System Using New Algorithms**, *NASA Advanced Supercomputing Division*, January 16, 2024—An international group of scientists have recently uncovered a remarkable system of six exoplanets from data collected by NASA's Transiting Exoplanet Survey Satellite (TESS). Their years of planetary detective work—which began with light curve processing on the Pleiades supercomputer at the NASA Advanced Supercomputing (NAS) facility—was detailed in a paper published in Nature. https://www.nas.nasa.gov/pubs/stories/2024/feature_TESS_researchers_discover_six-planet_system.html

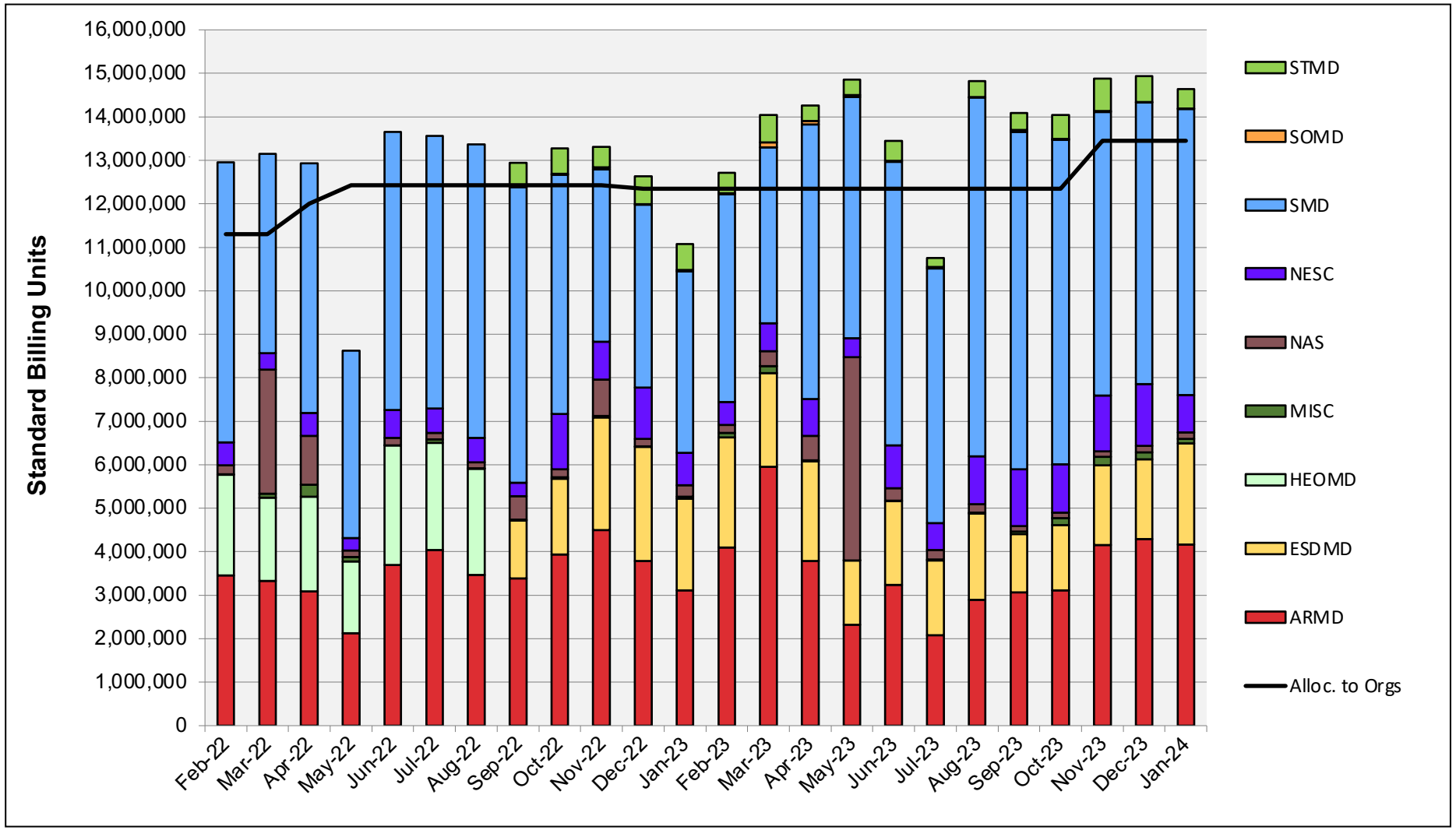
News and Events: Social Media

- **X-59 Rollout Ceremony**
  - NASA Supercomputing: Facebook 27 reactions, 10 shares.
  - NASA Advanced Supercomputing: X/Twitter 157 likes, 42 shares.

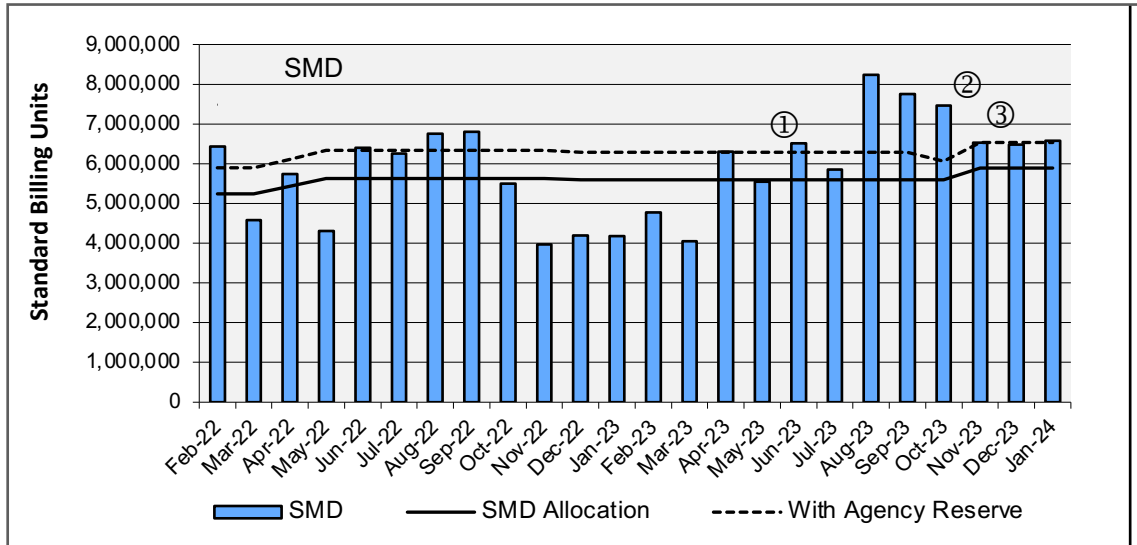
HECC Utilization

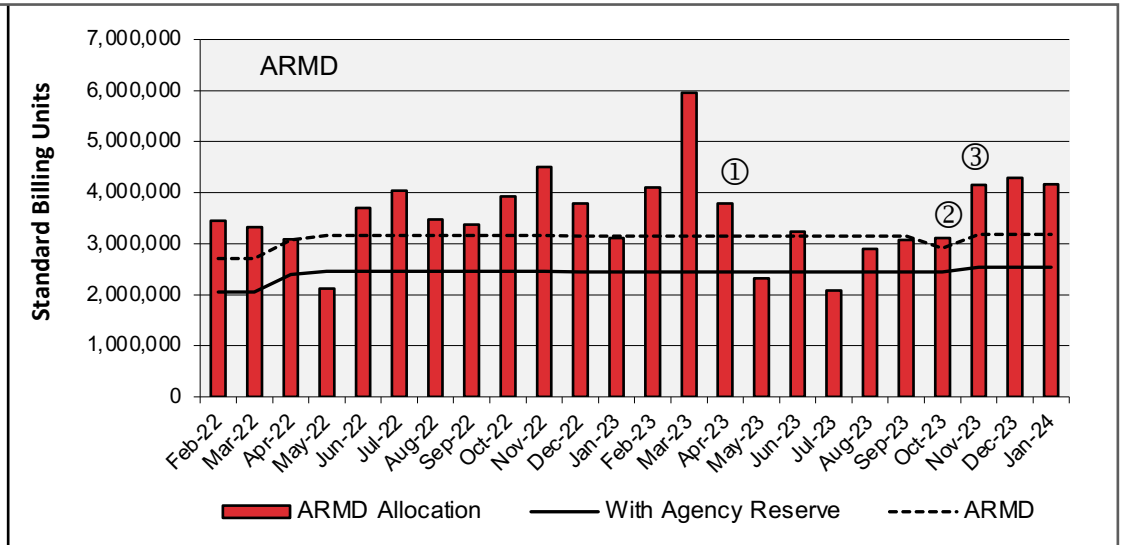


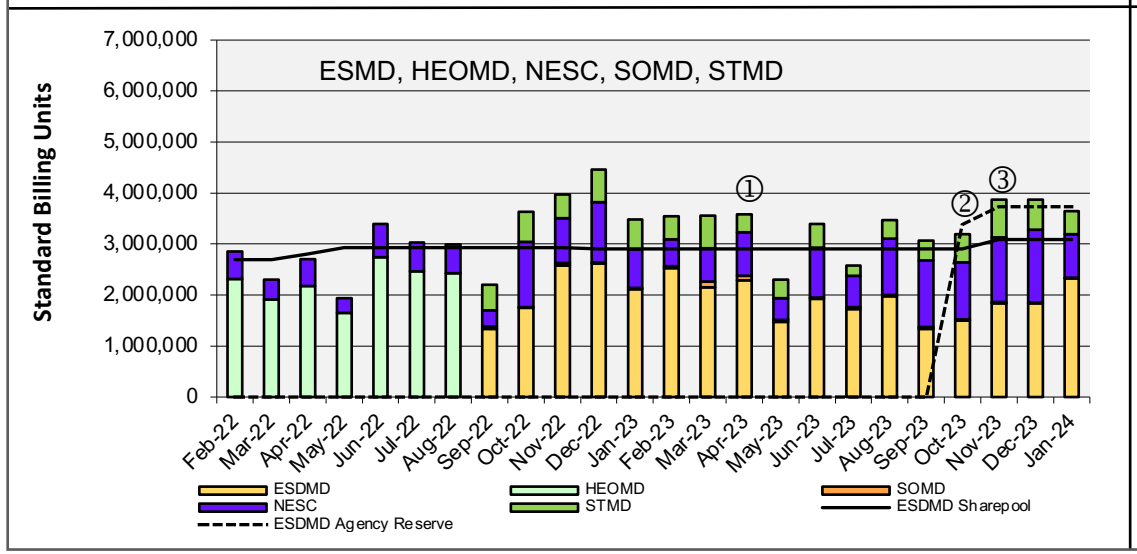
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month





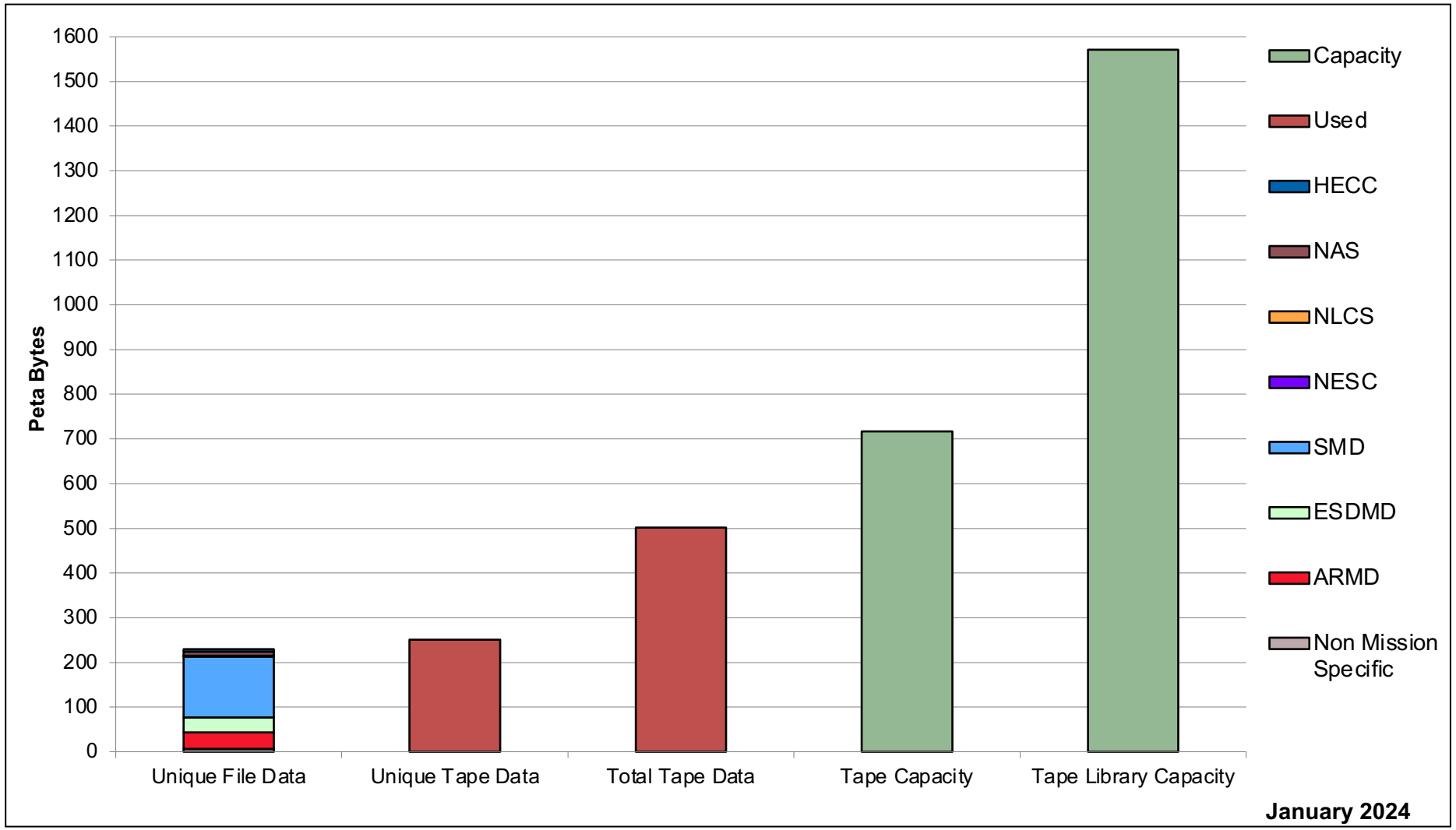


① 4 Rome Apollo Racks added to Aitken

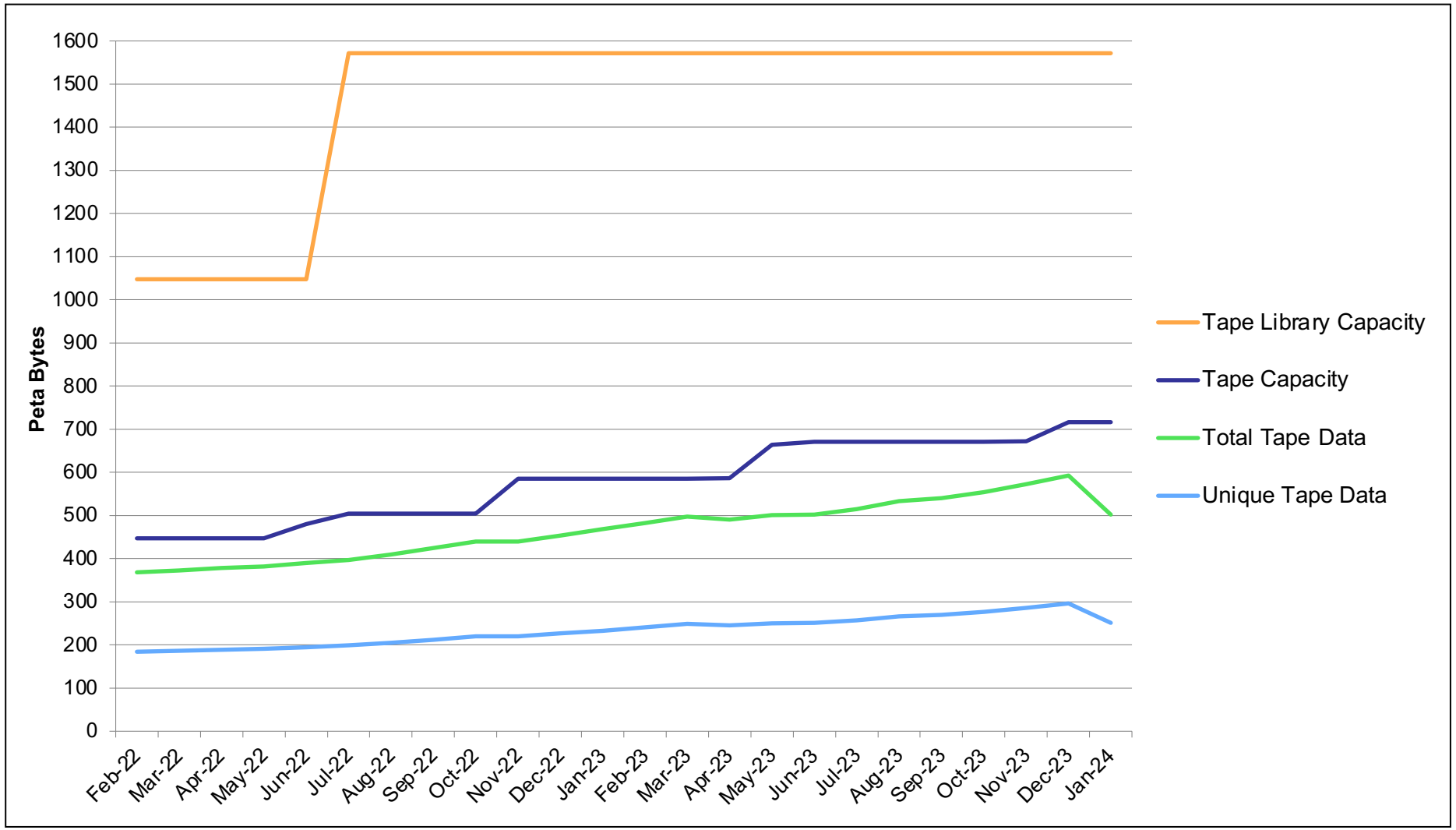
② 4 Rome Apollo Racks added to Aitken

③ Cabeus v100 nodes added

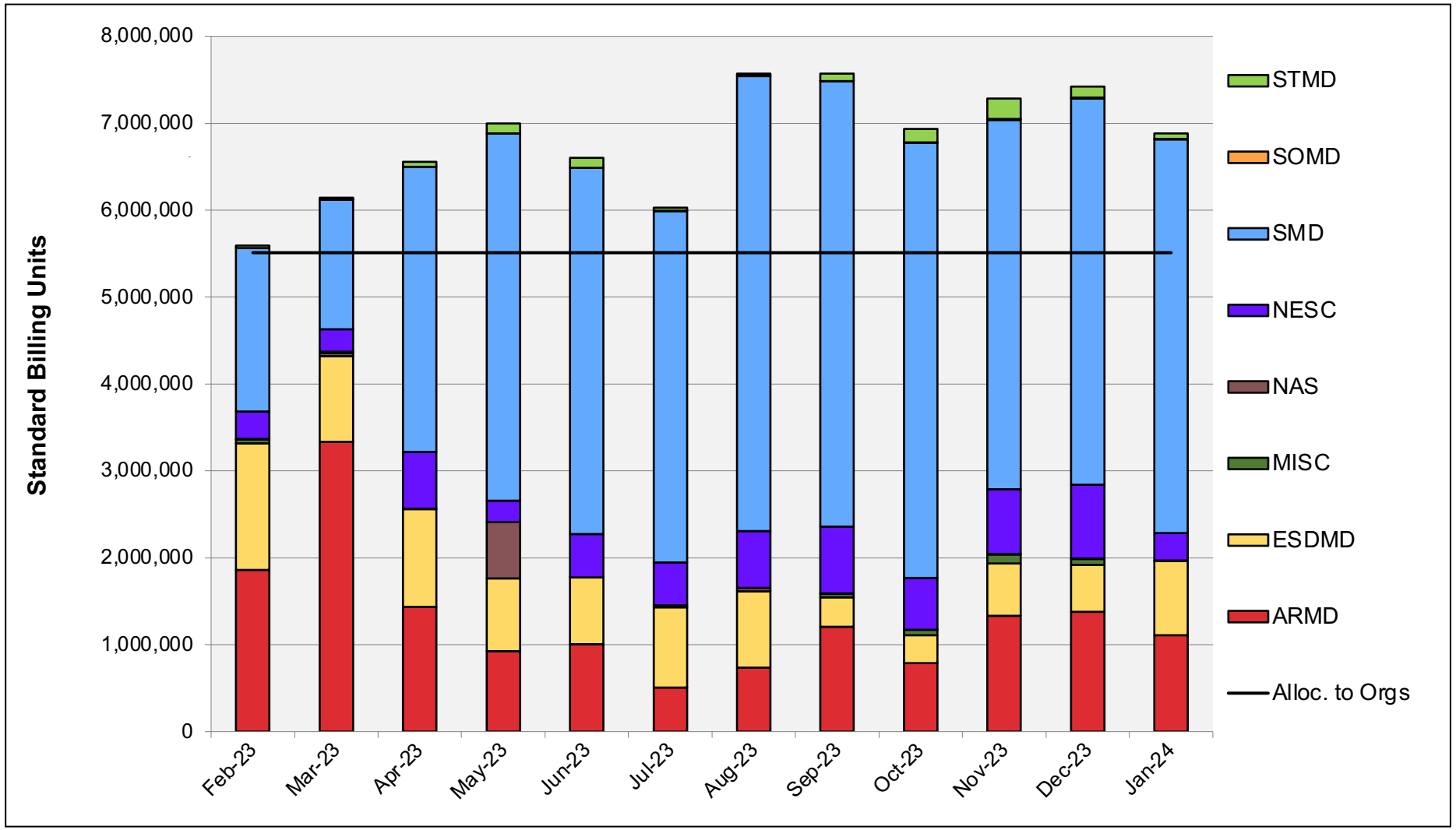
Tape Archive Status



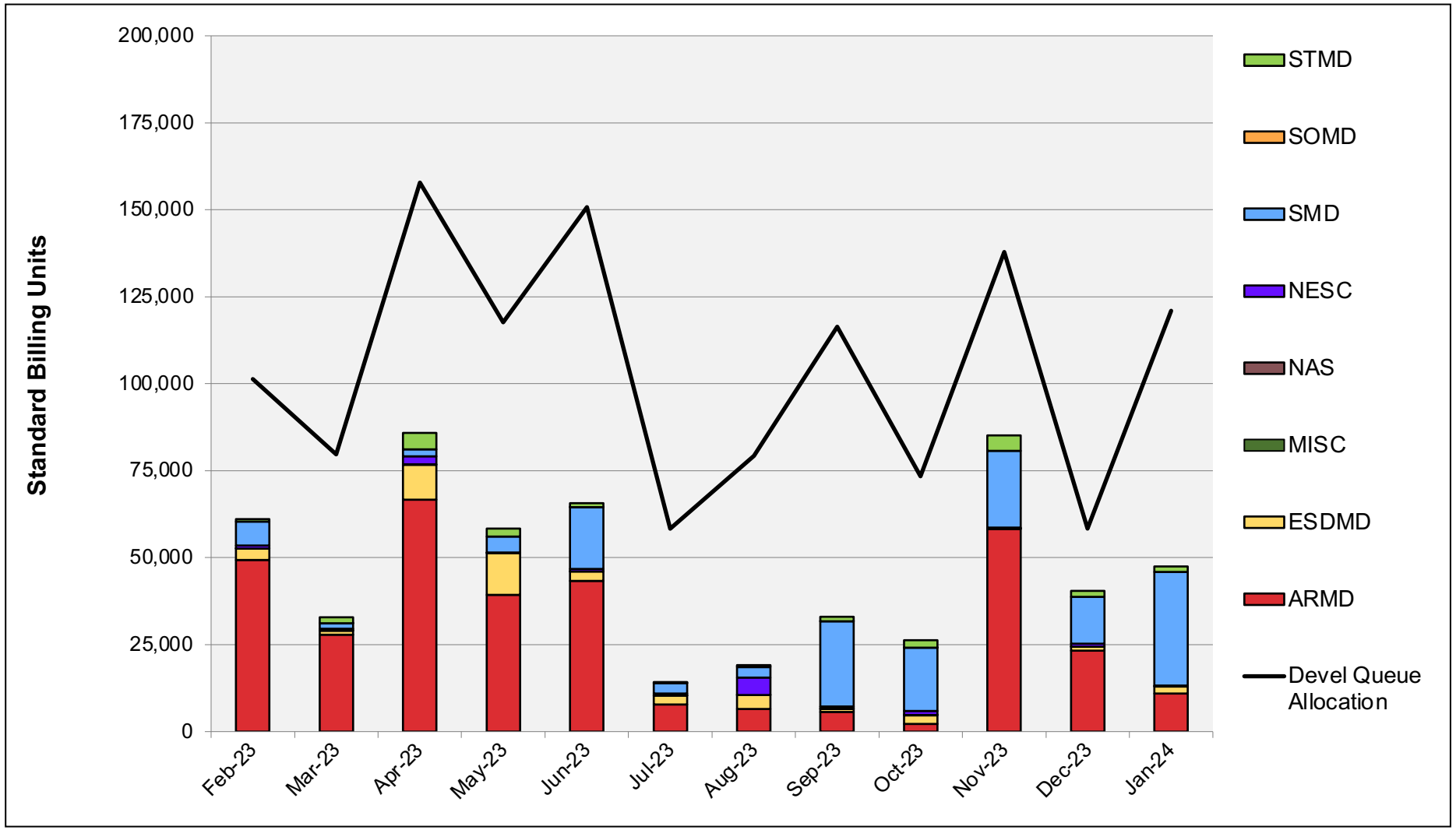
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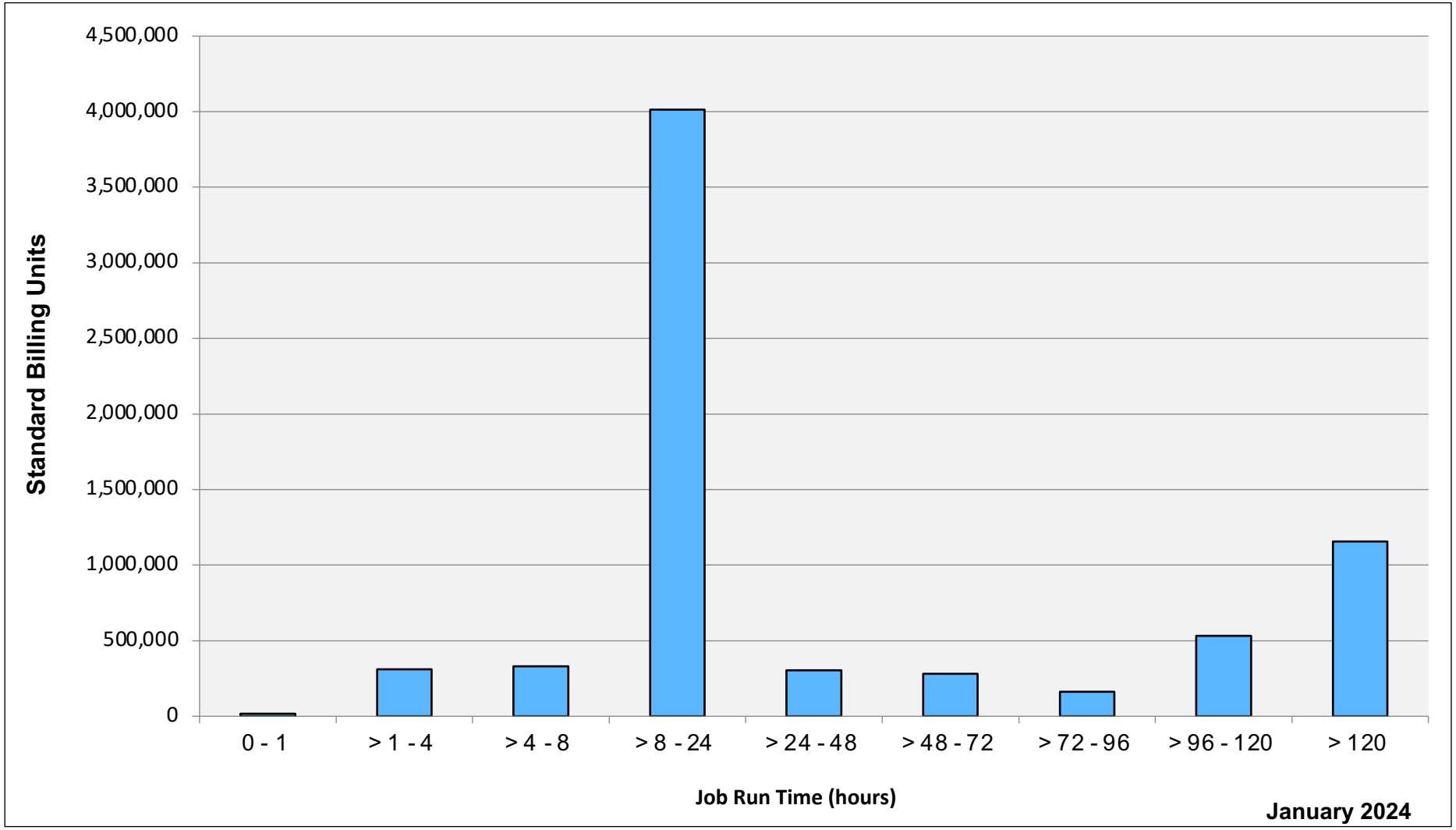
Aitken: SBUs Reported, Normalized to 30-Day Month



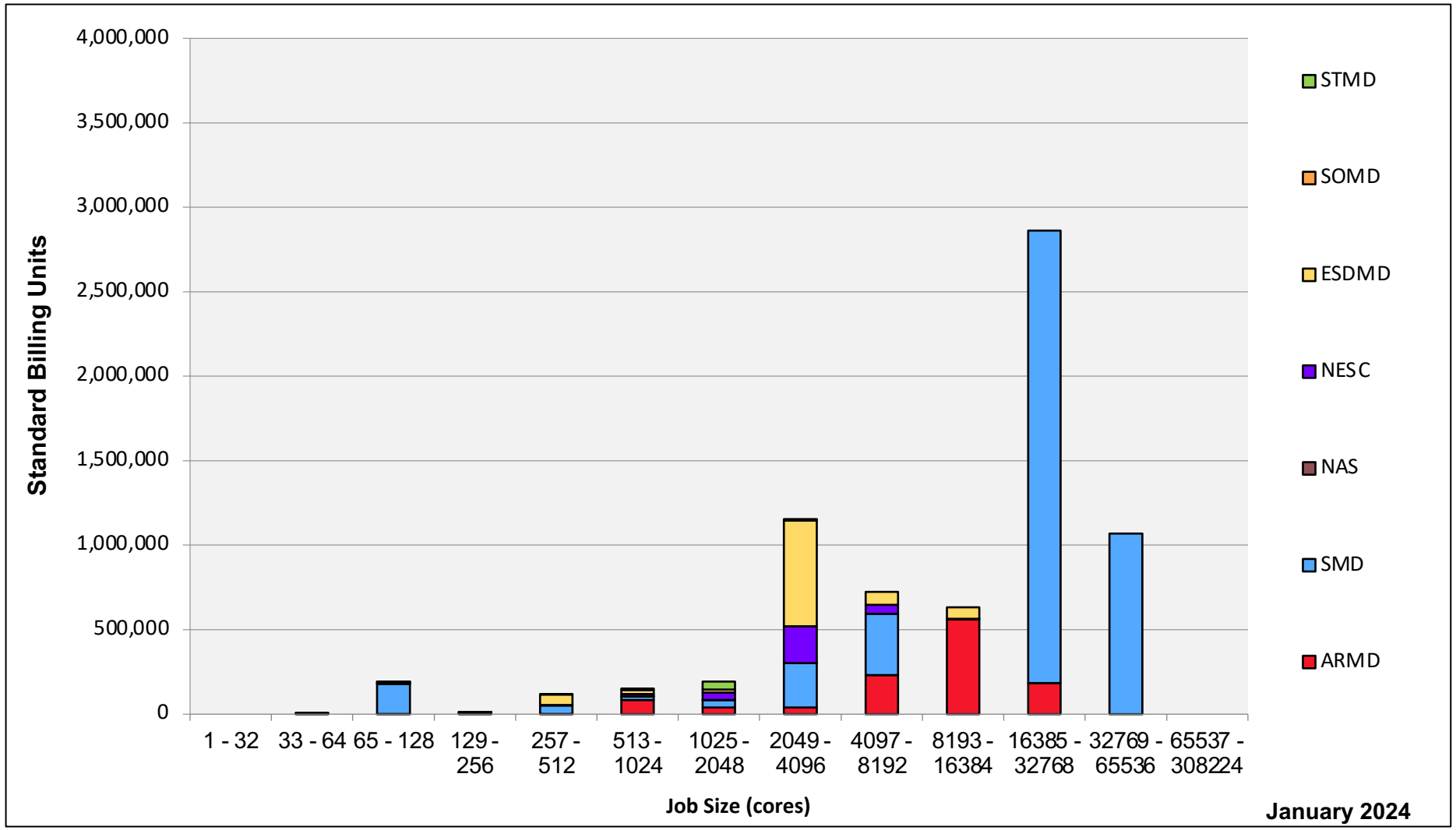
Aitken: Devel Queue Utilization



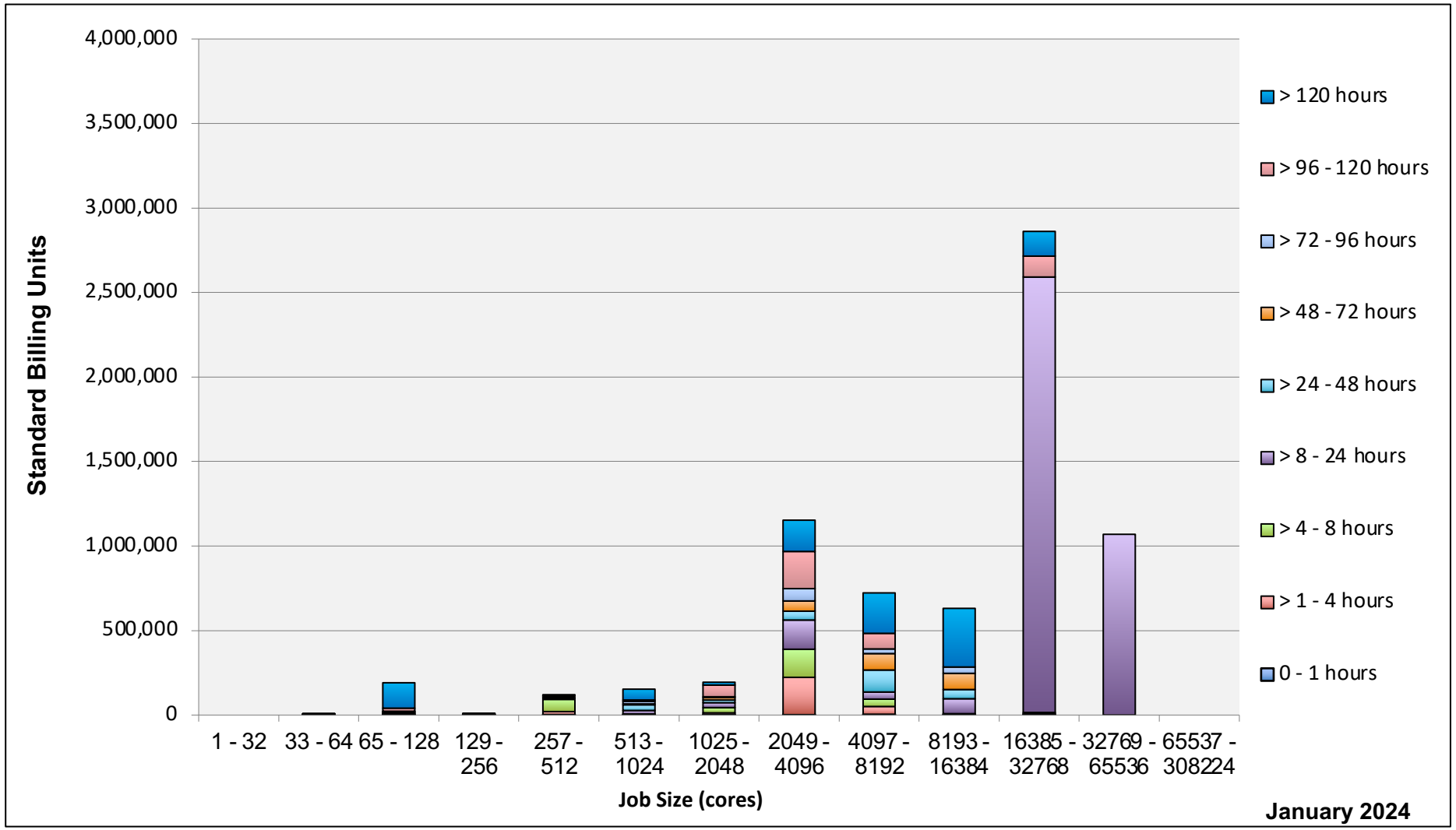
Aitken: Monthly Utilization by Job Length



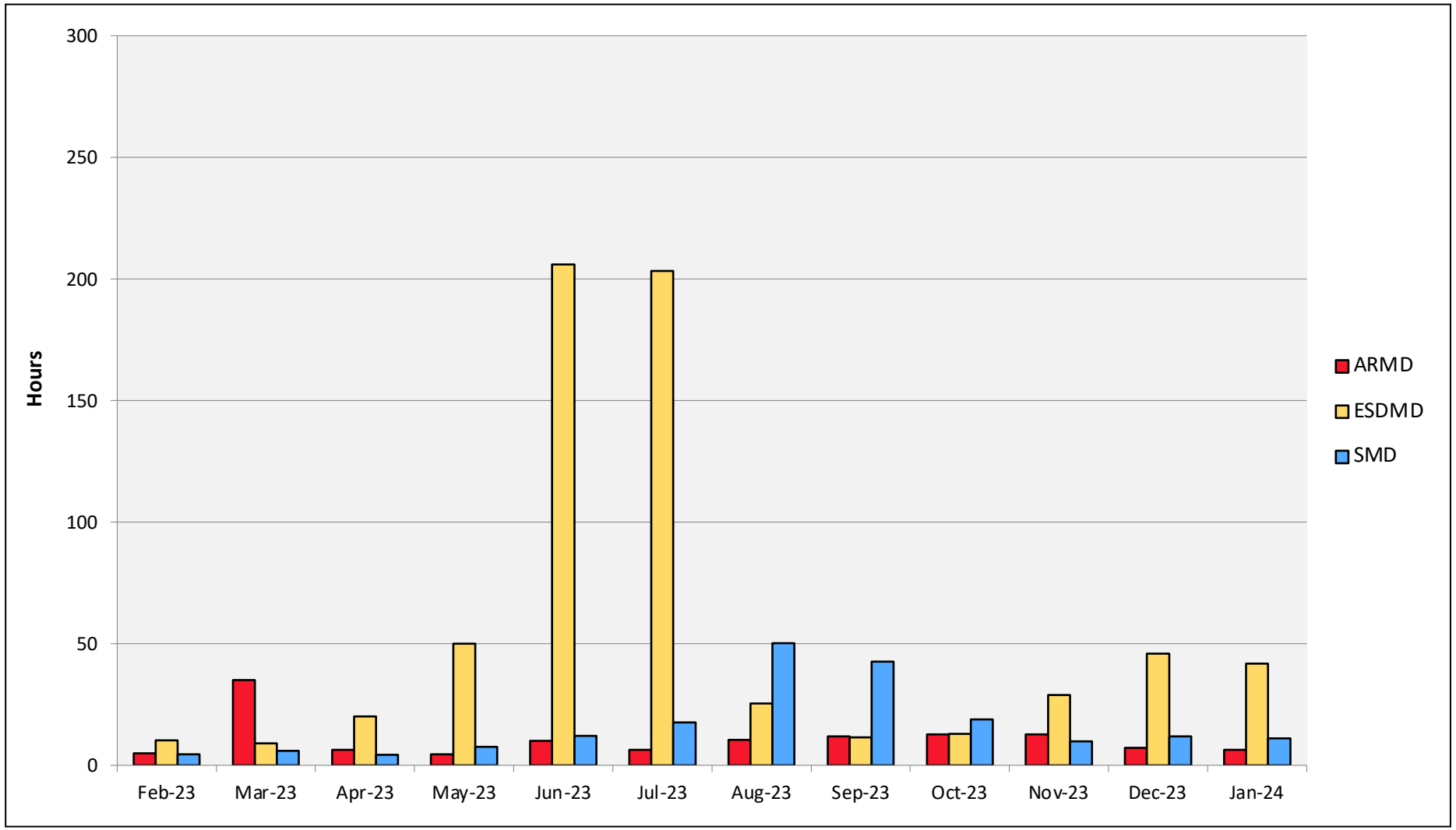
Aitken: Monthly Utilization by Job Size



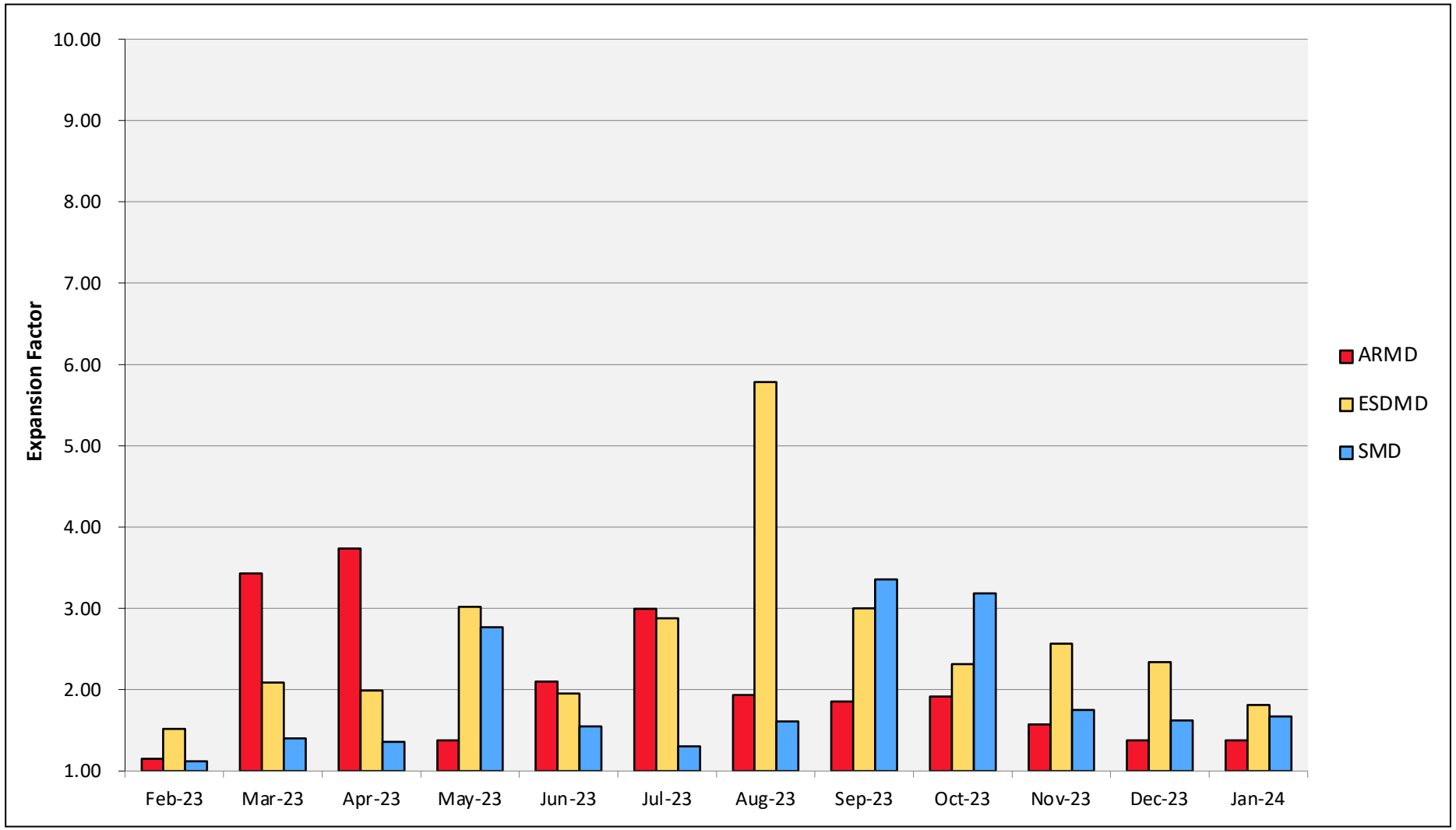
Aitken: Monthly Utilization by Size and Length



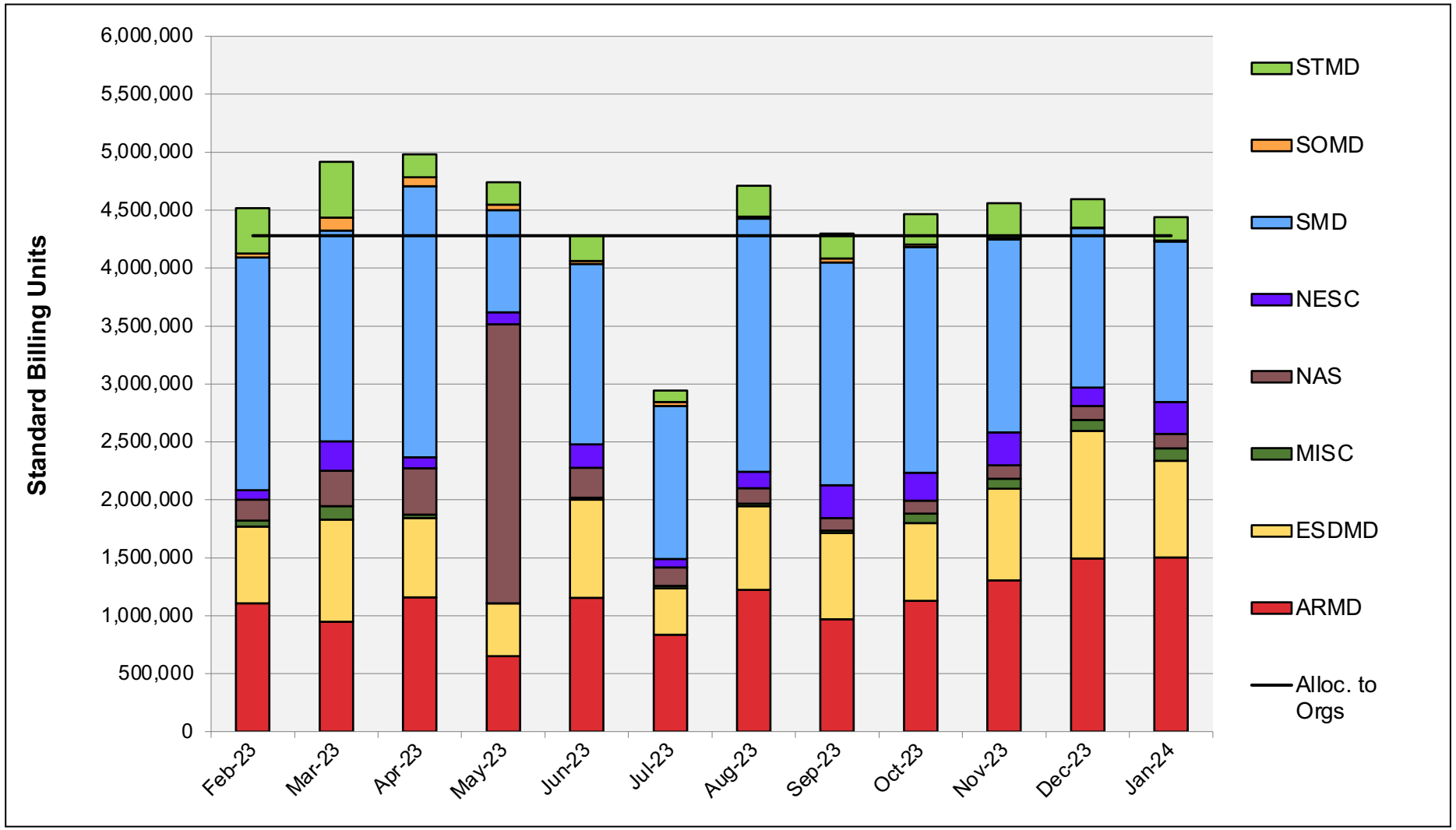
Aitken: Average Time to Clear All Jobs



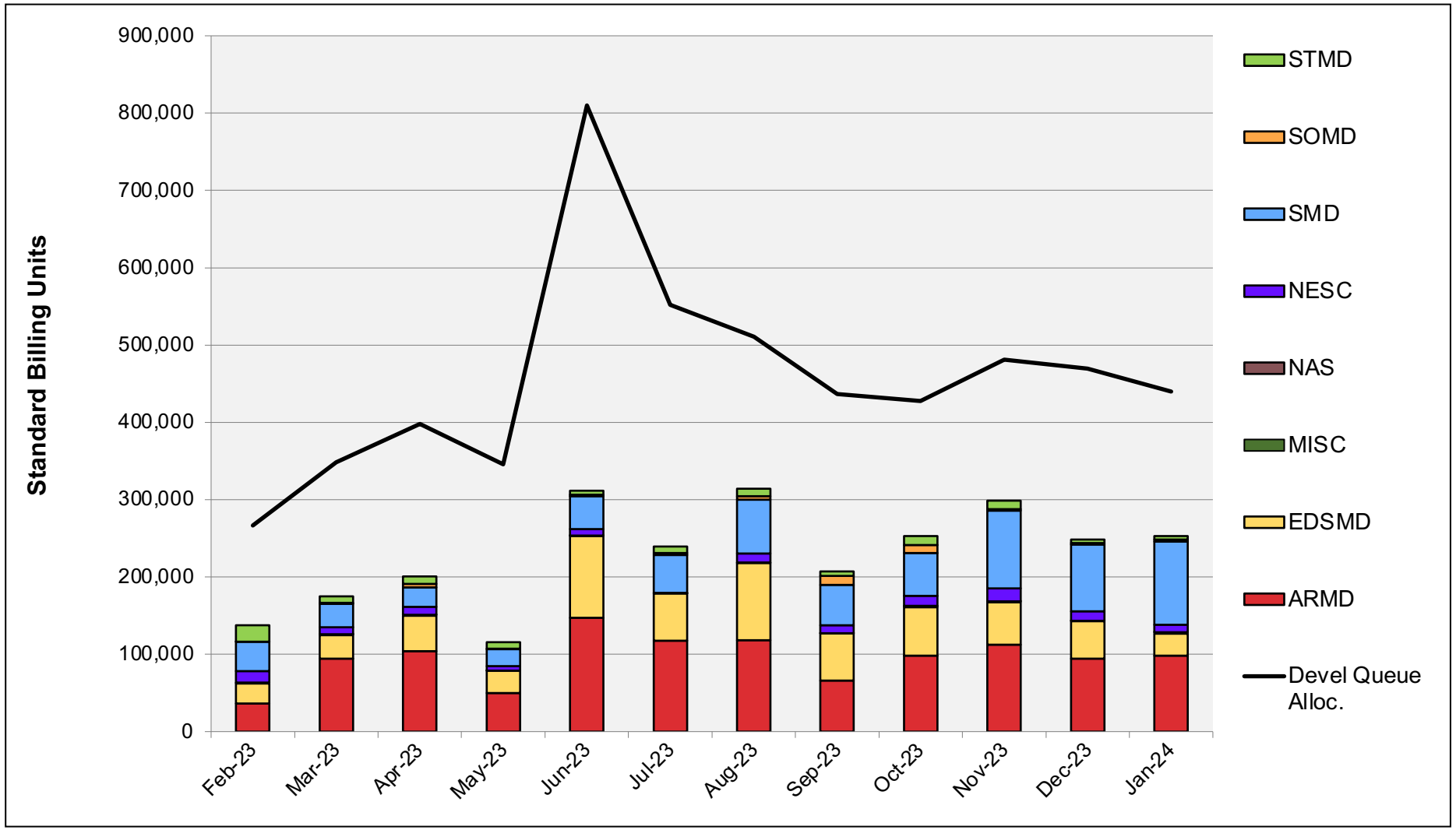
Aitken: Average Expansion Factor



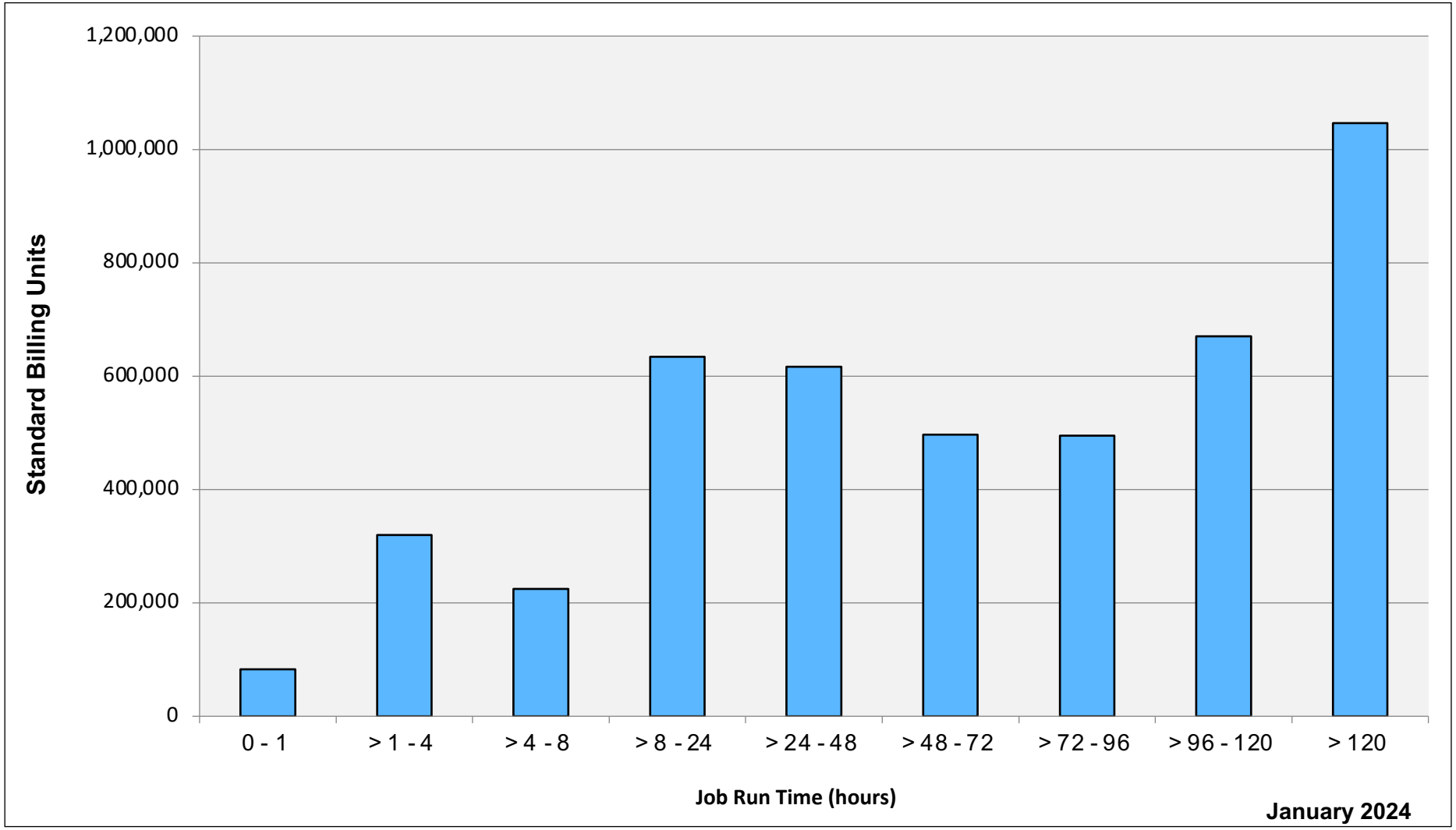
Pleiades: SBUs Reported, Normalized to 30-Day Month



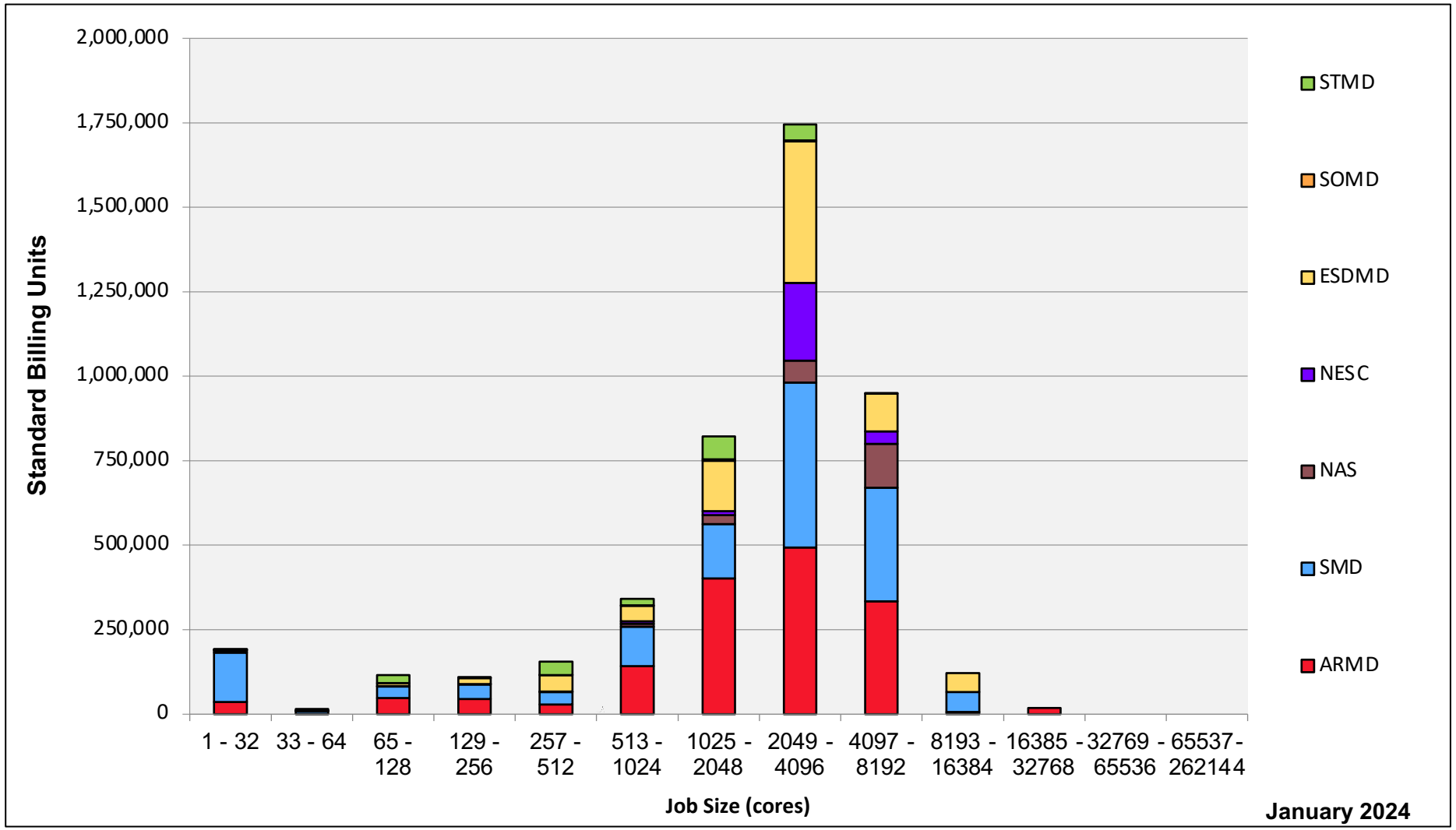
Pleiades: Devel Queue Utilization



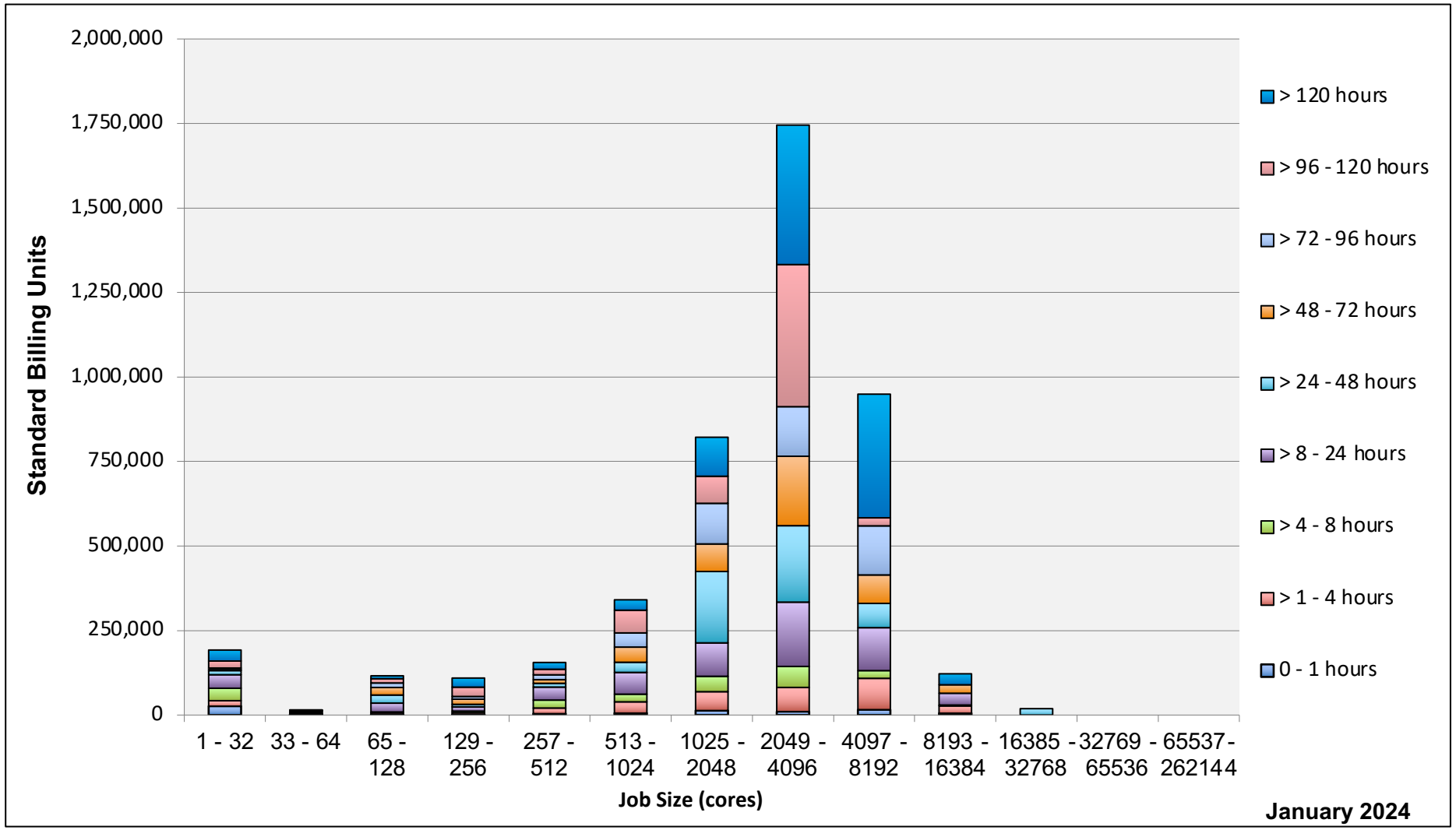
Pleiades: Monthly Utilization by Job Length



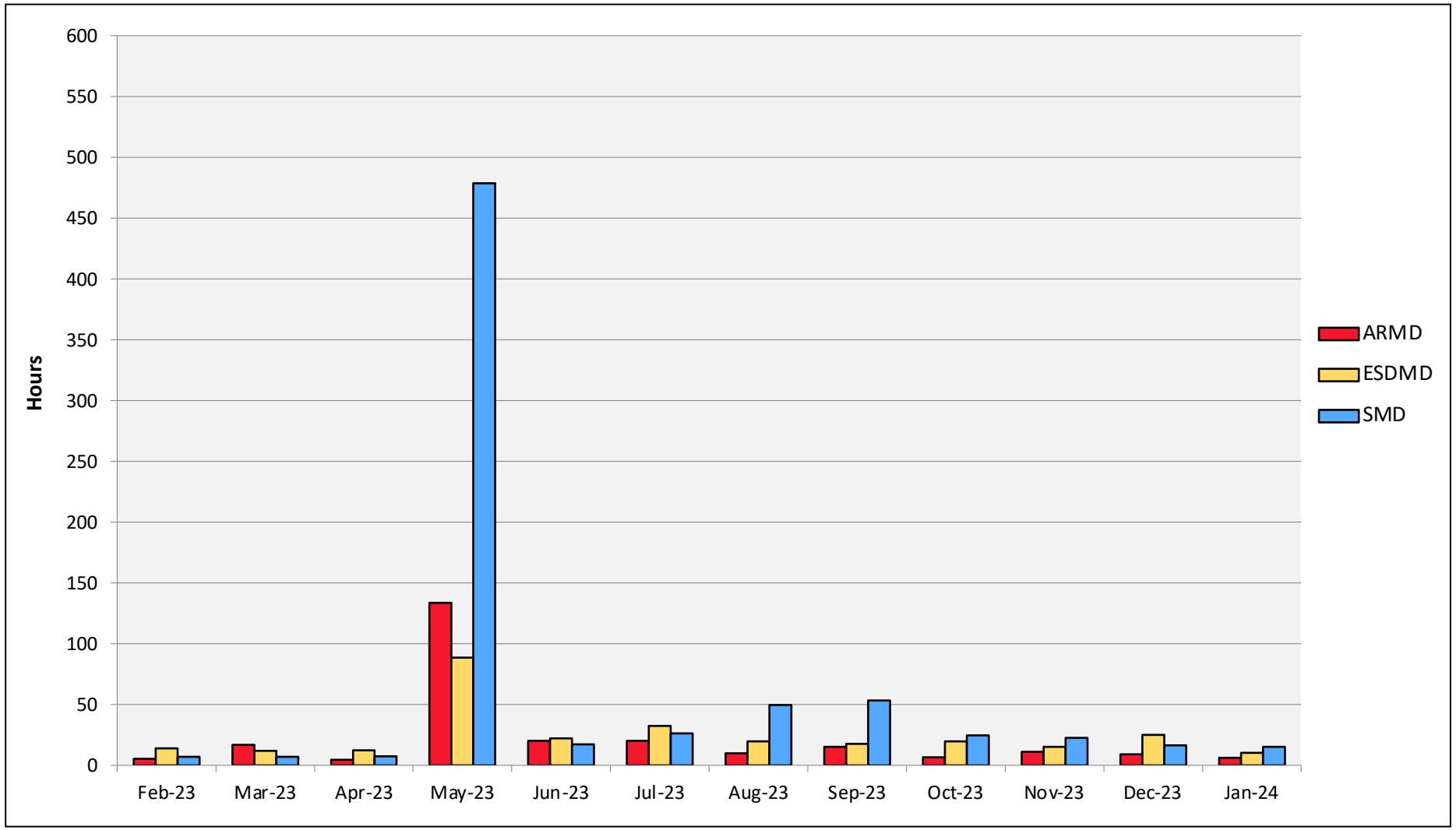
Pleiades: Monthly Utilization by Job Size



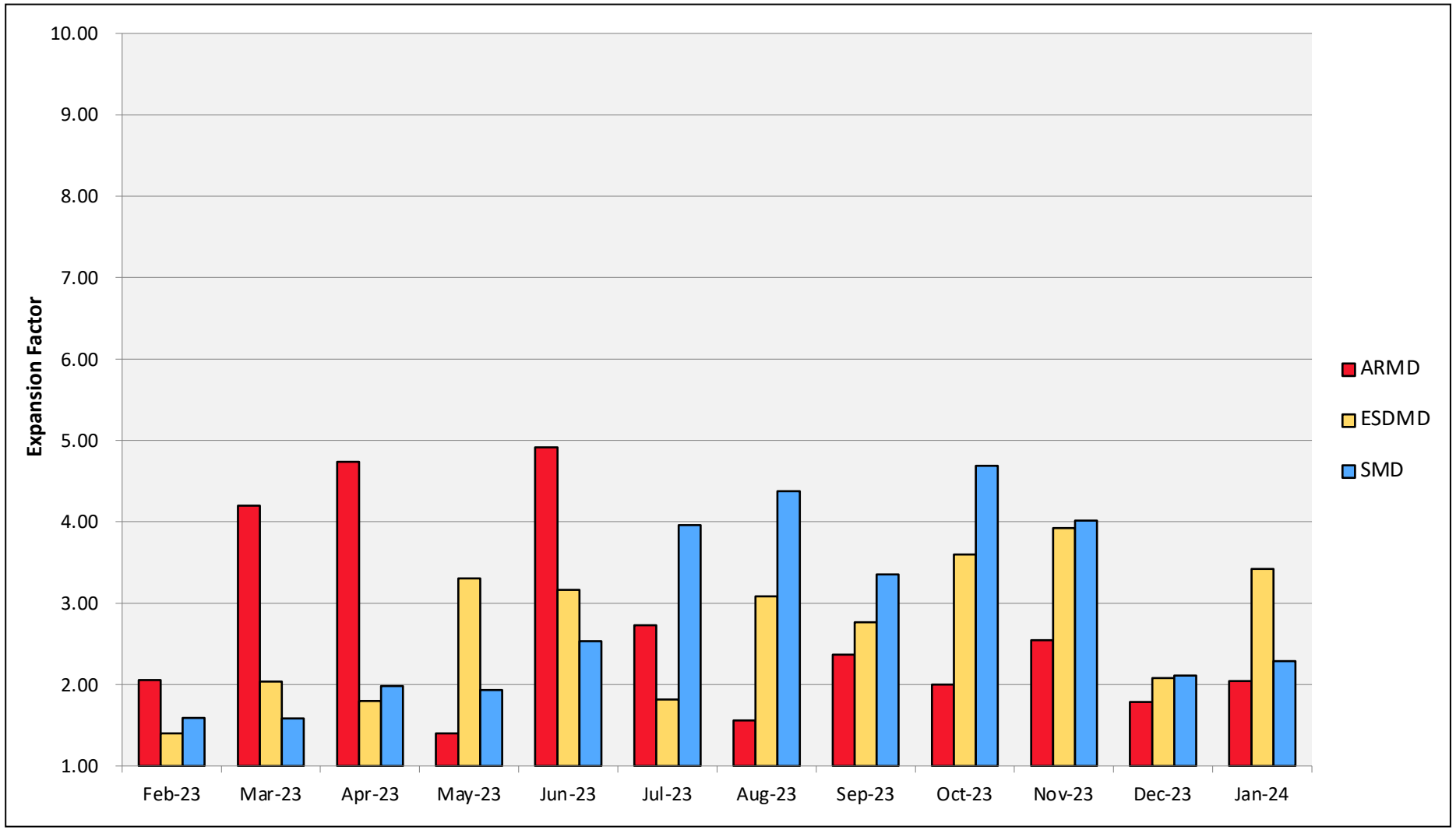
Pleiades: Monthly Utilization by Size and Length



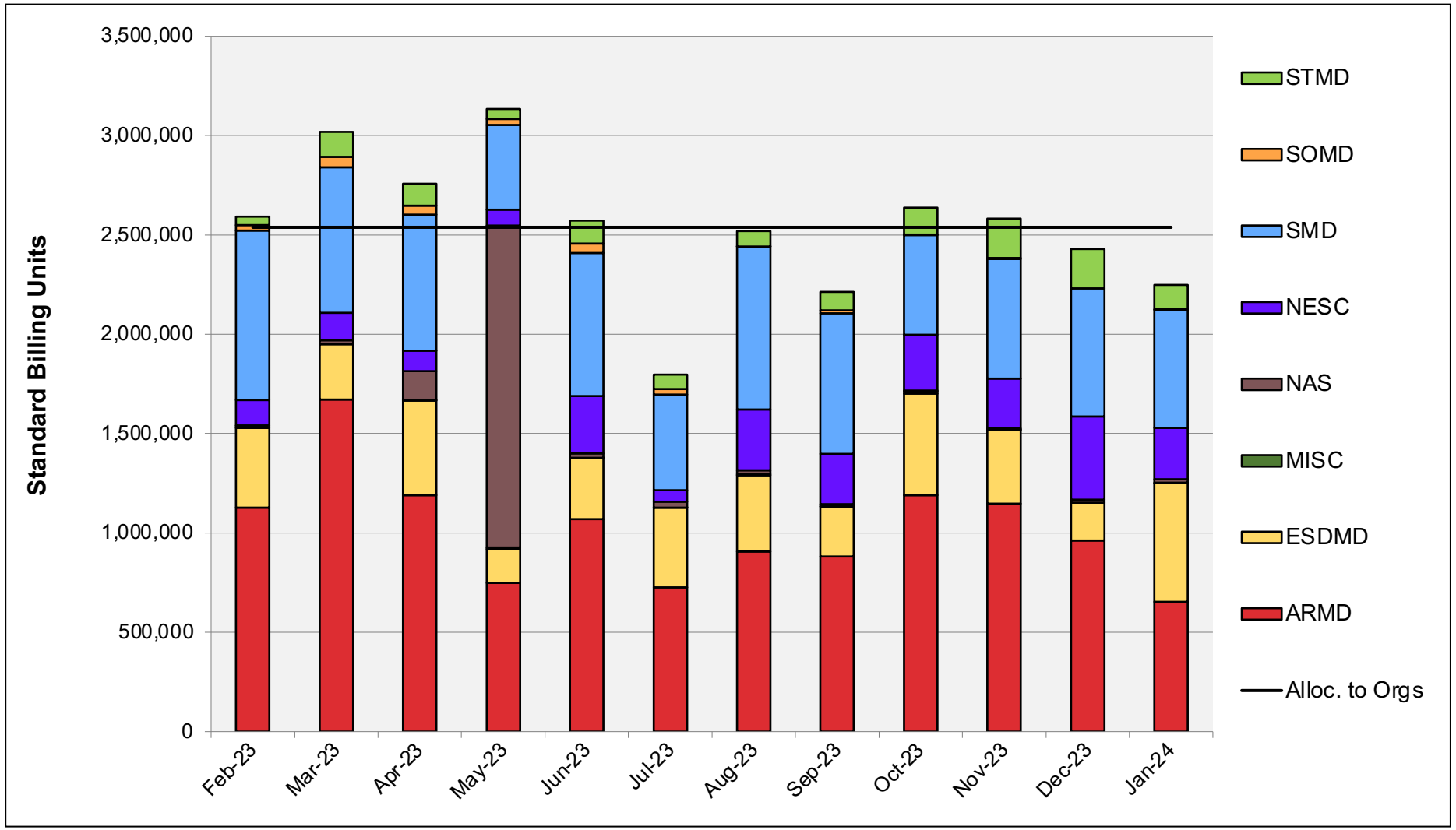
Pleiades: Average Time to Clear All Jobs



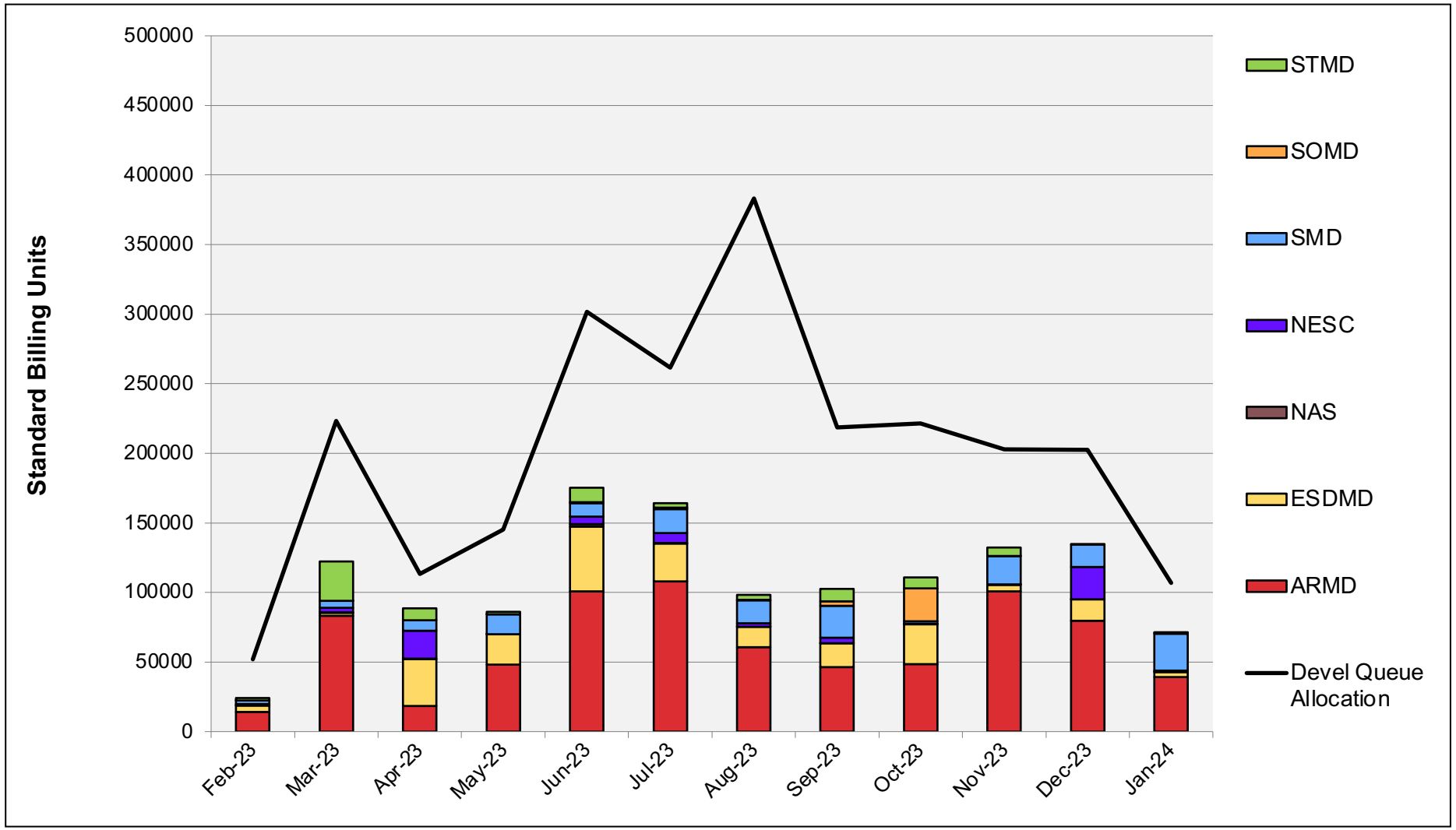
Pleiades: Average Expansion Factor



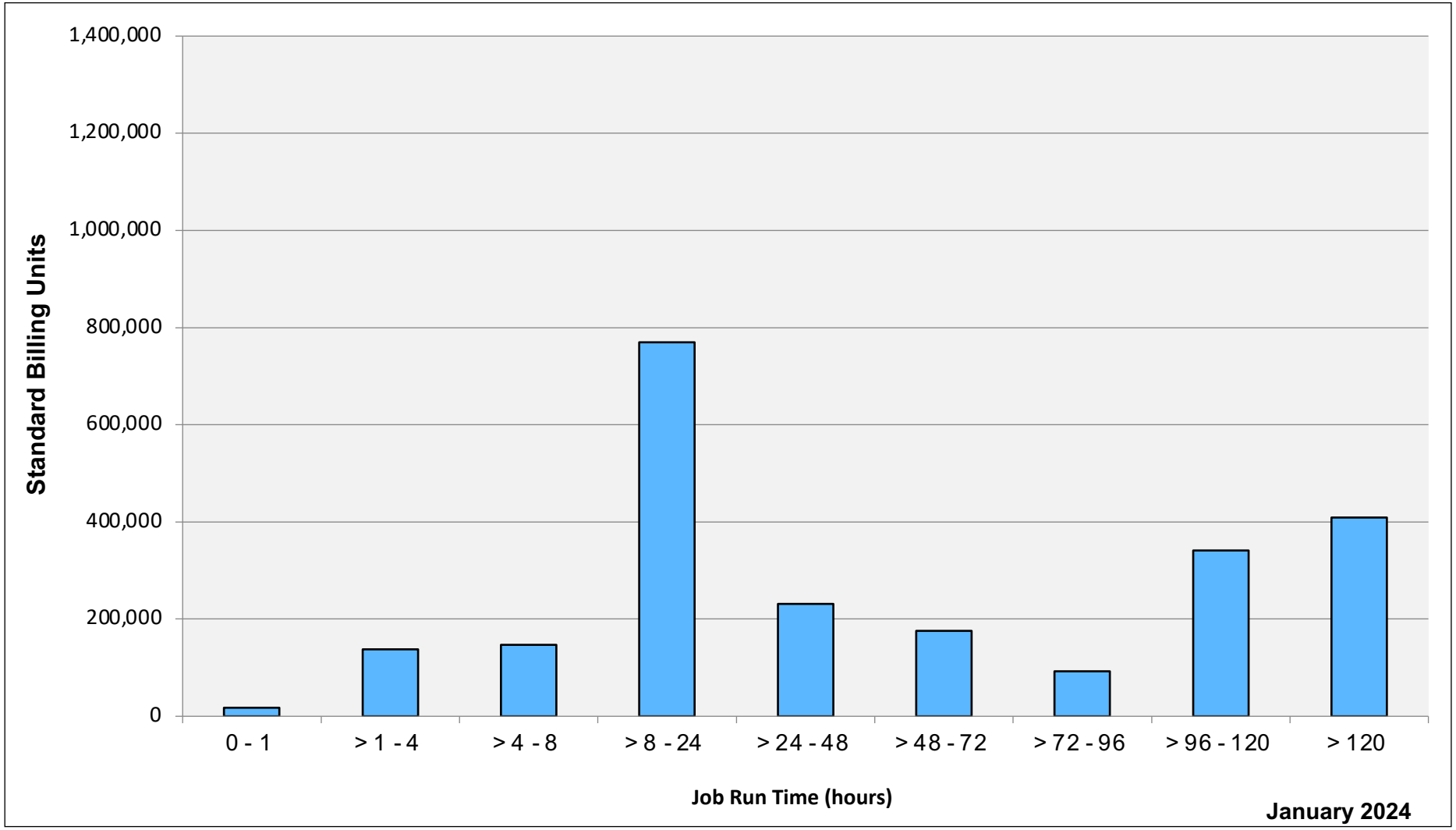
Electra: SBUs Reported, Normalized to 30-Day Month



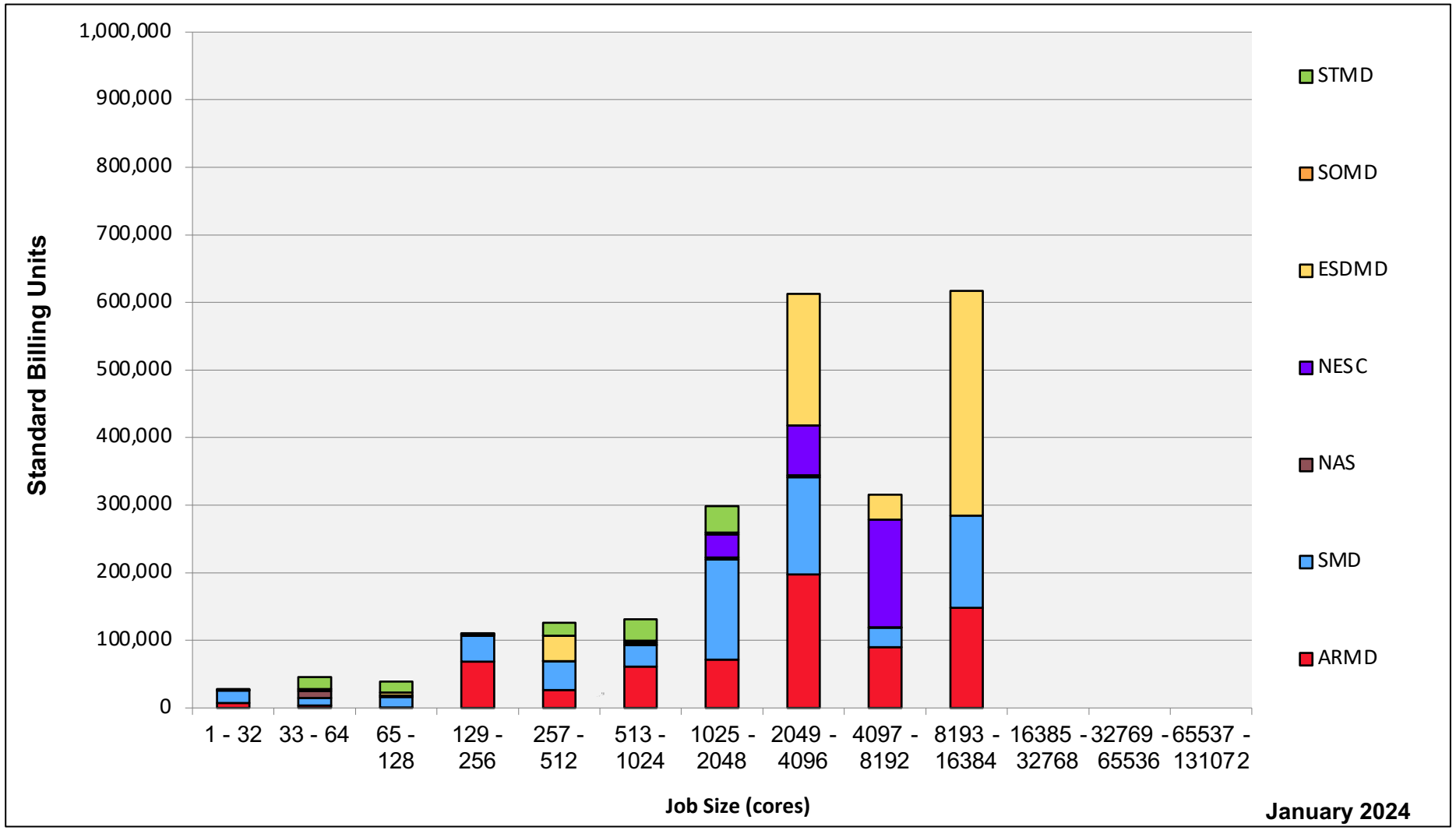
Electra: Devel Queue Utilization



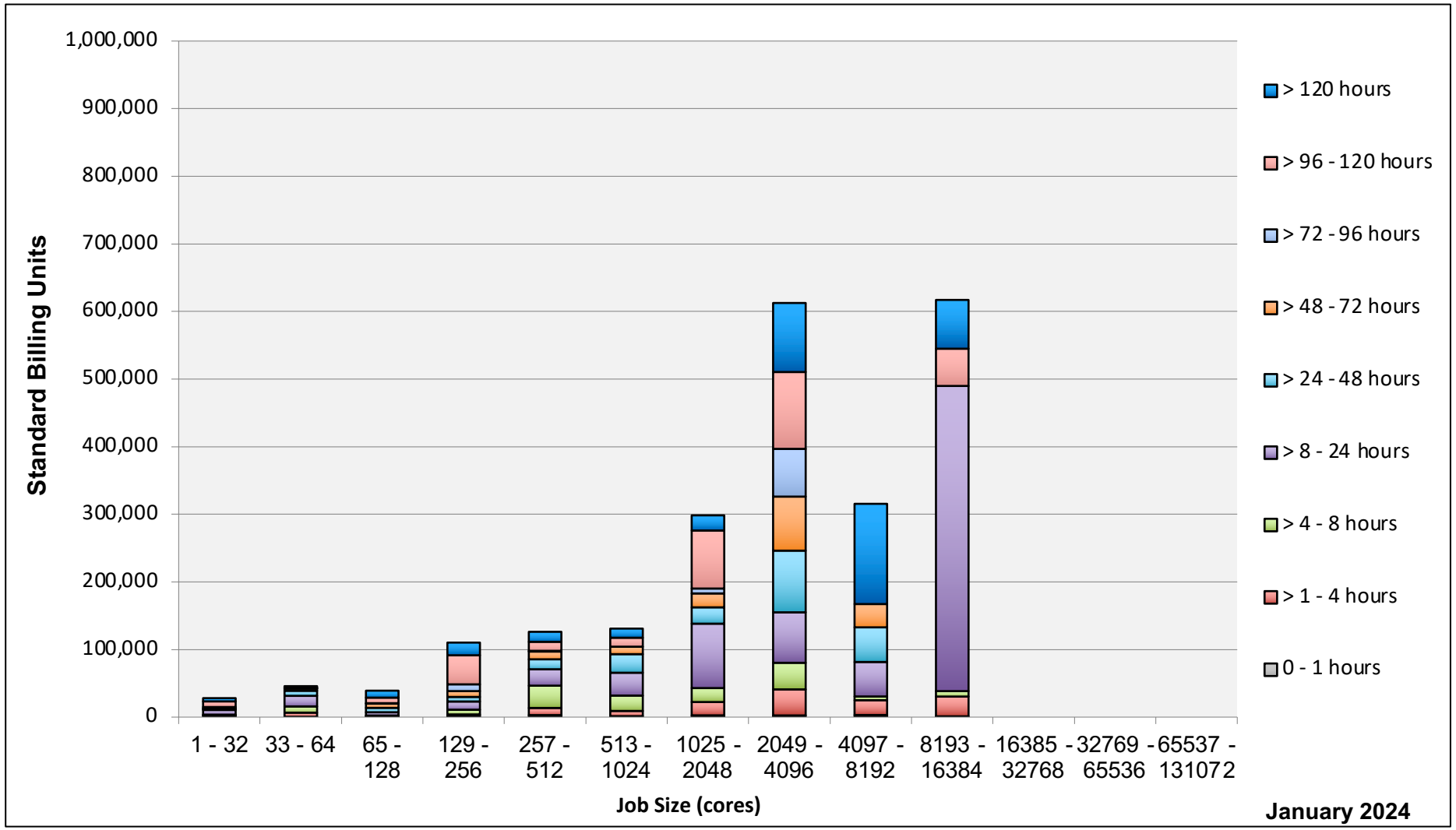
Electra: Monthly Utilization by Job Length



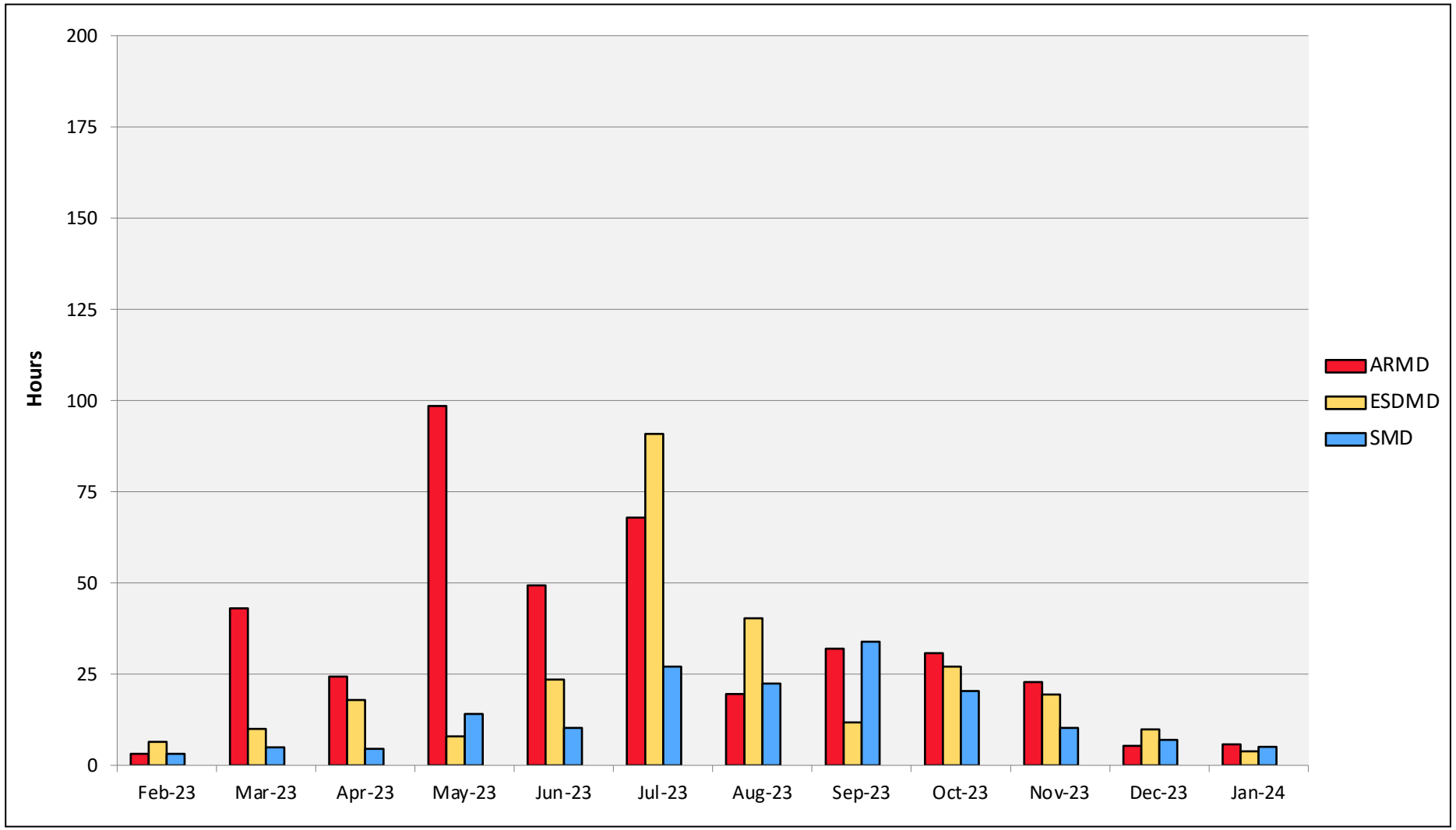
Electra: Monthly Utilization by Job Size



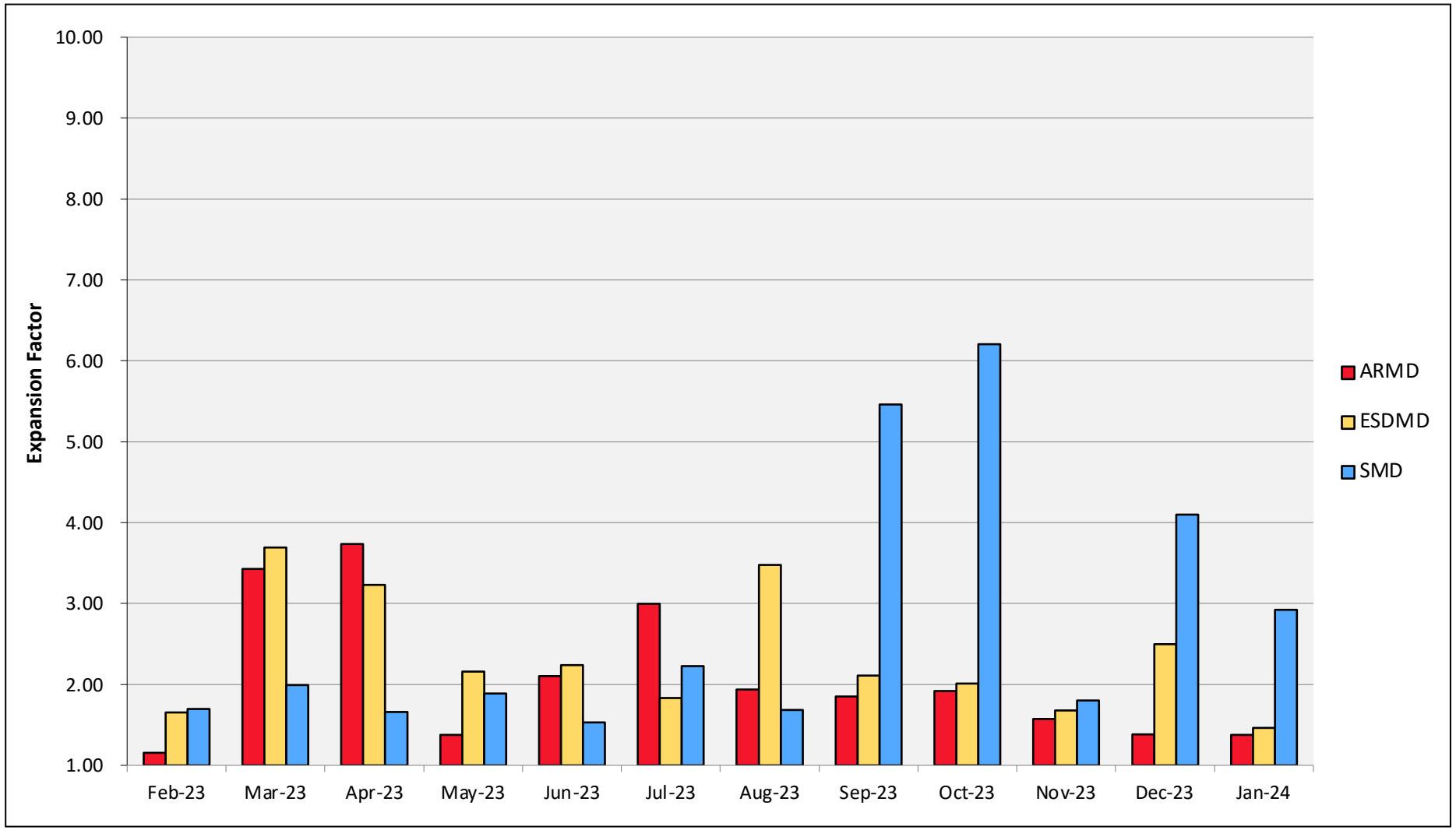
Electra: Monthly Utilization by Size and Length



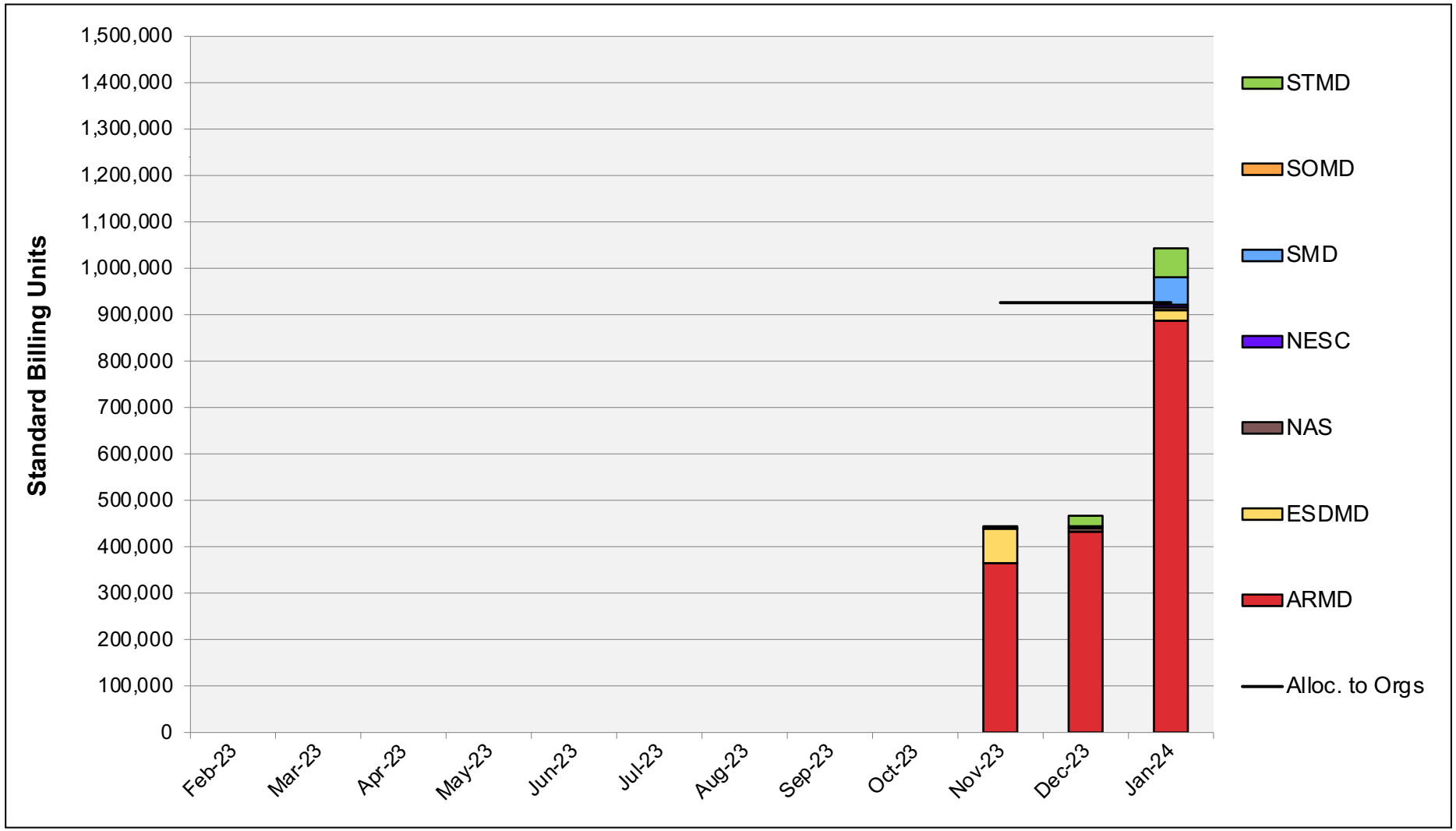
Electra: Average Time to Clear All Jobs



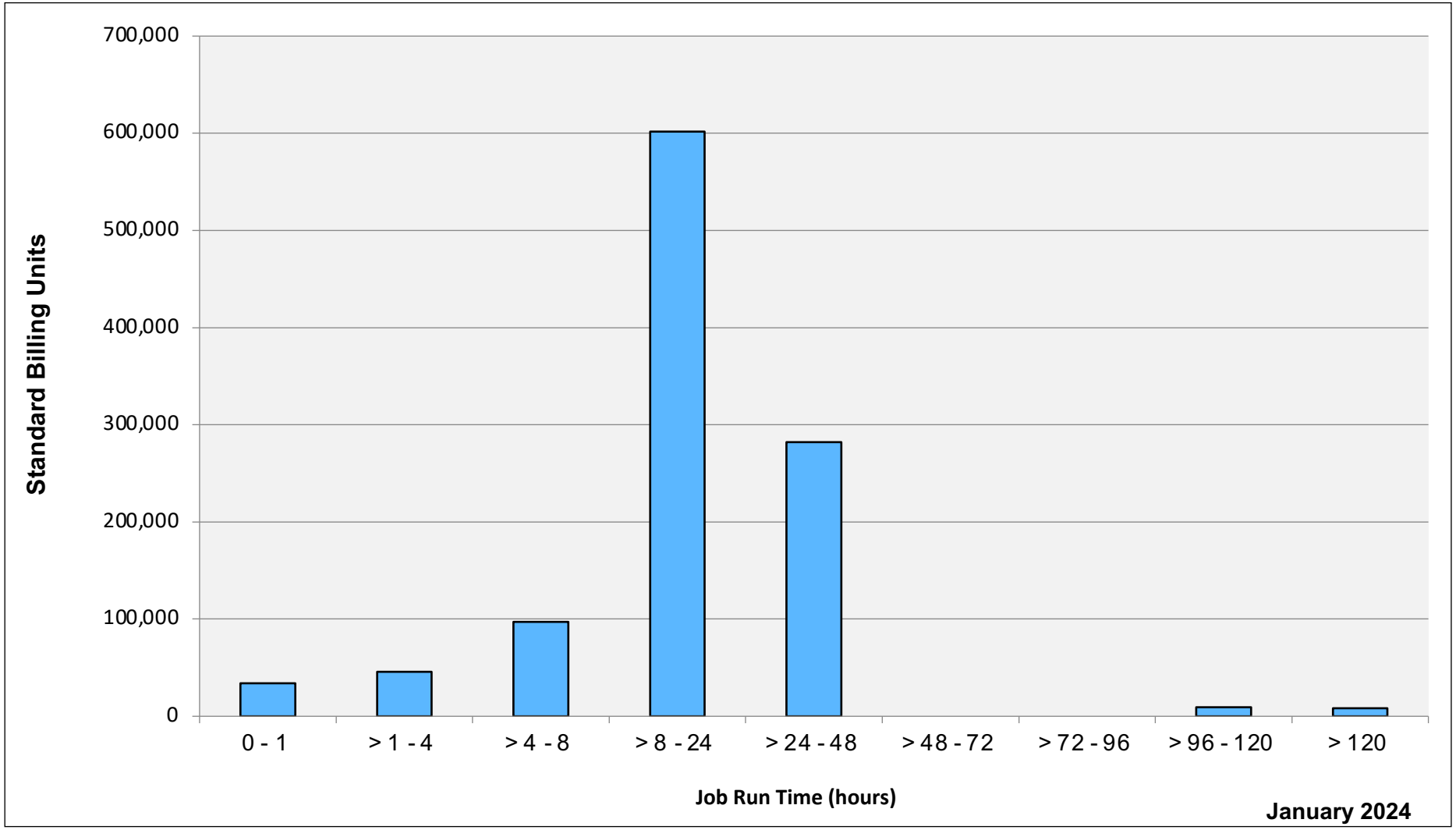
Electra: Average Expansion Factor



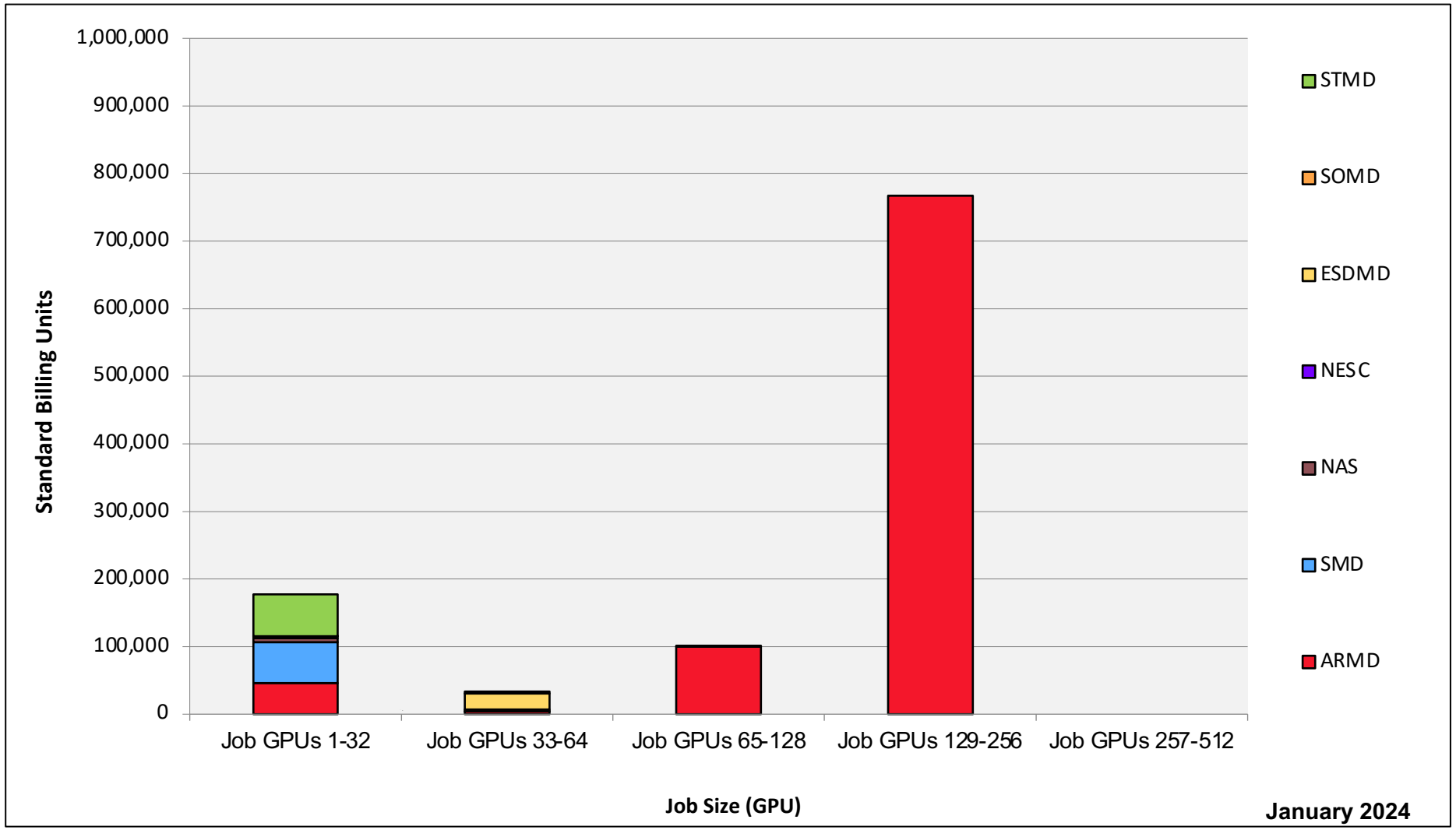
Cabeus: SBUs Reported, Normalized to 30-Day Month



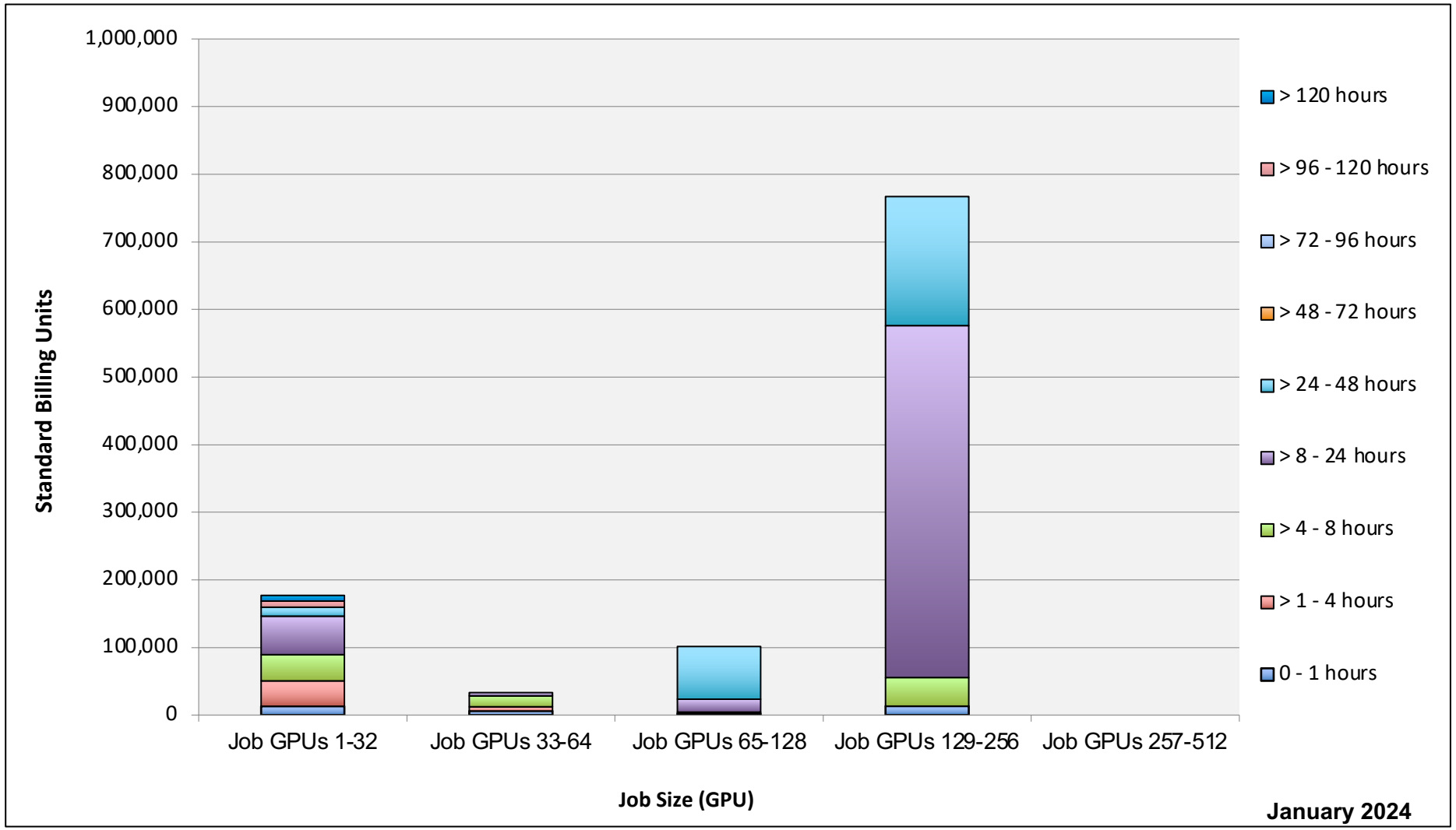
Cabeus: Monthly Utilization by Job Length



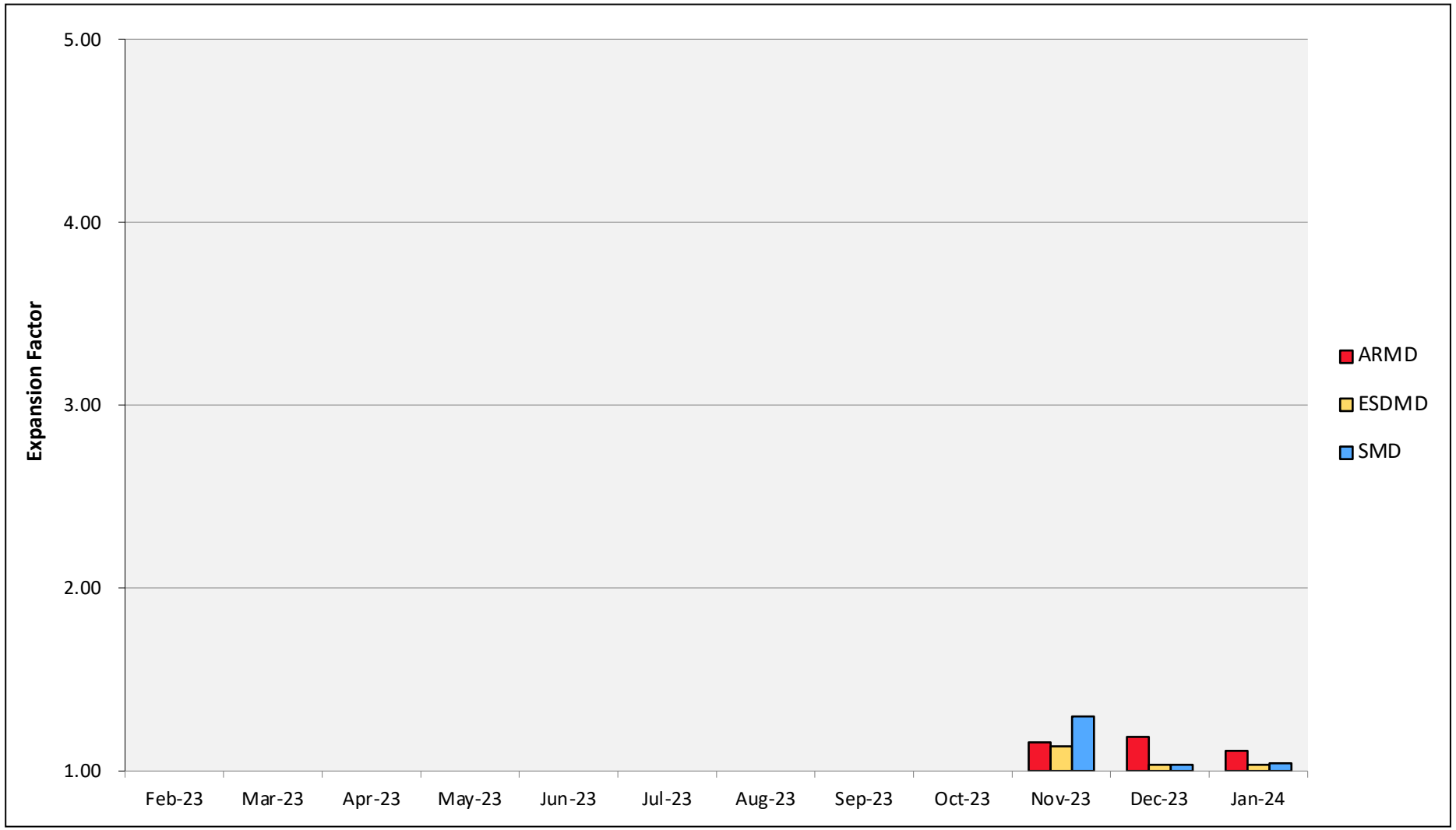
Cabeus: Monthly Utilization by Job Size



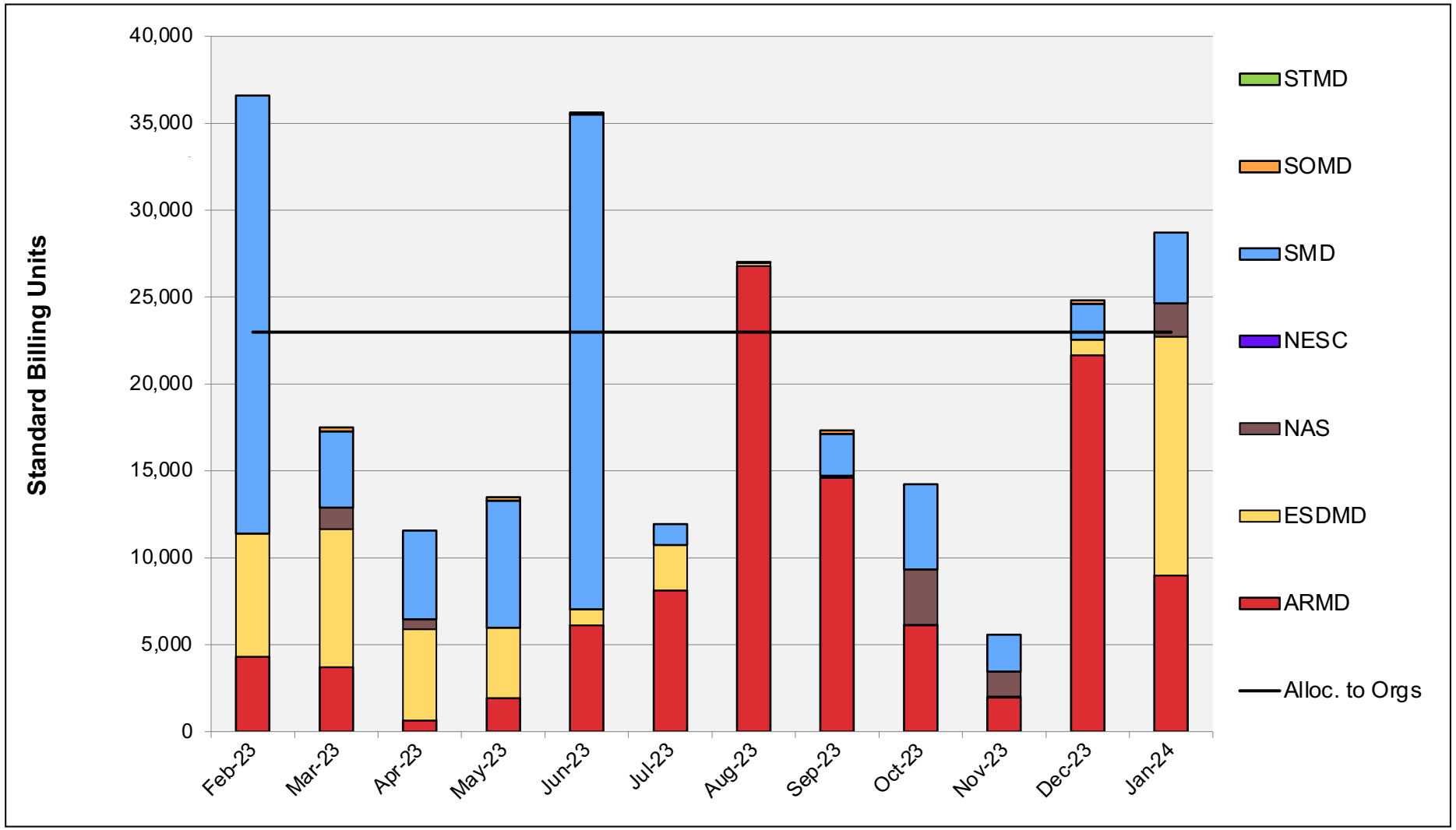
Cabeus: Monthly Utilization by Size and Length



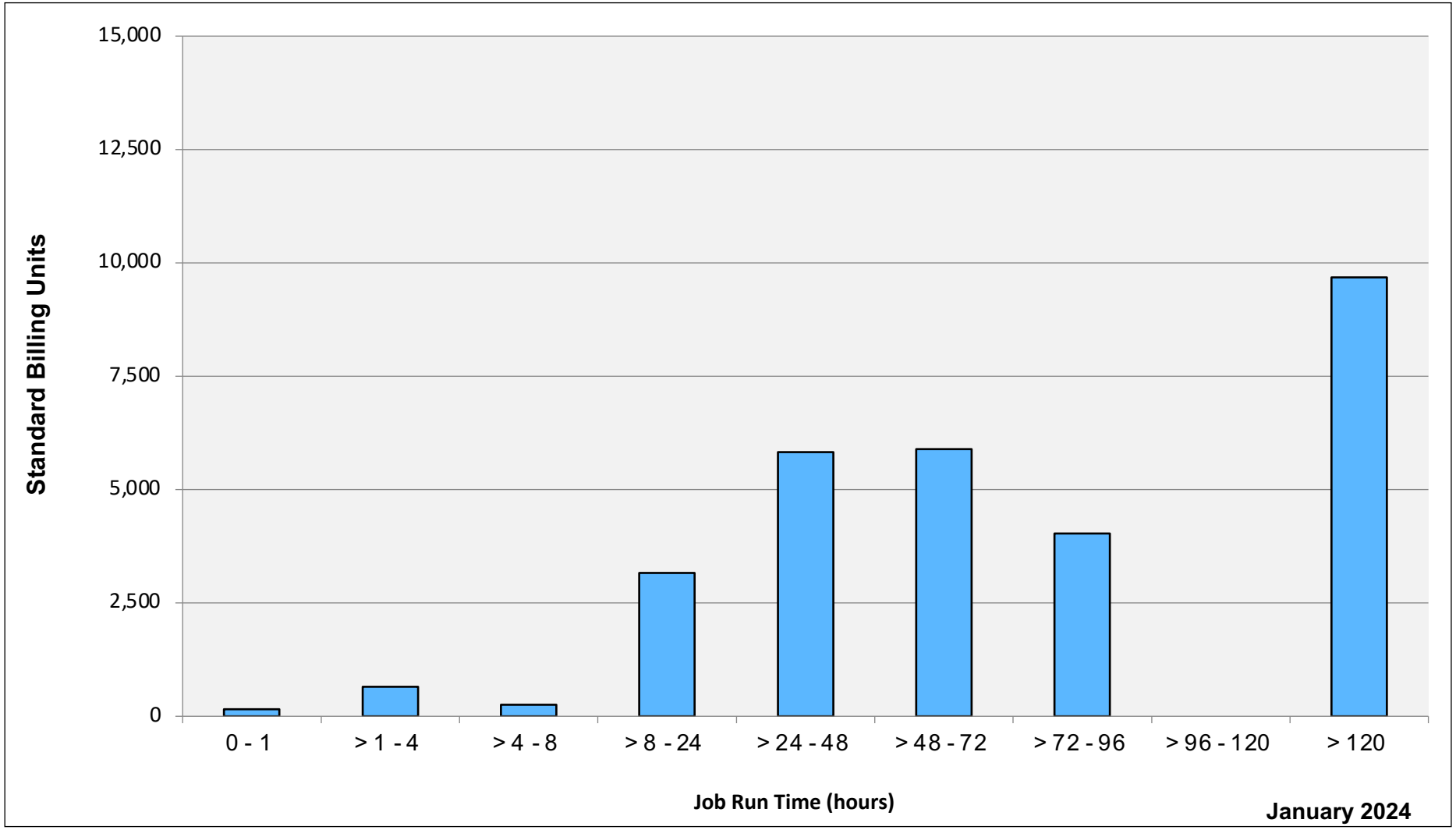
Cabeus: Average Expansion Factor



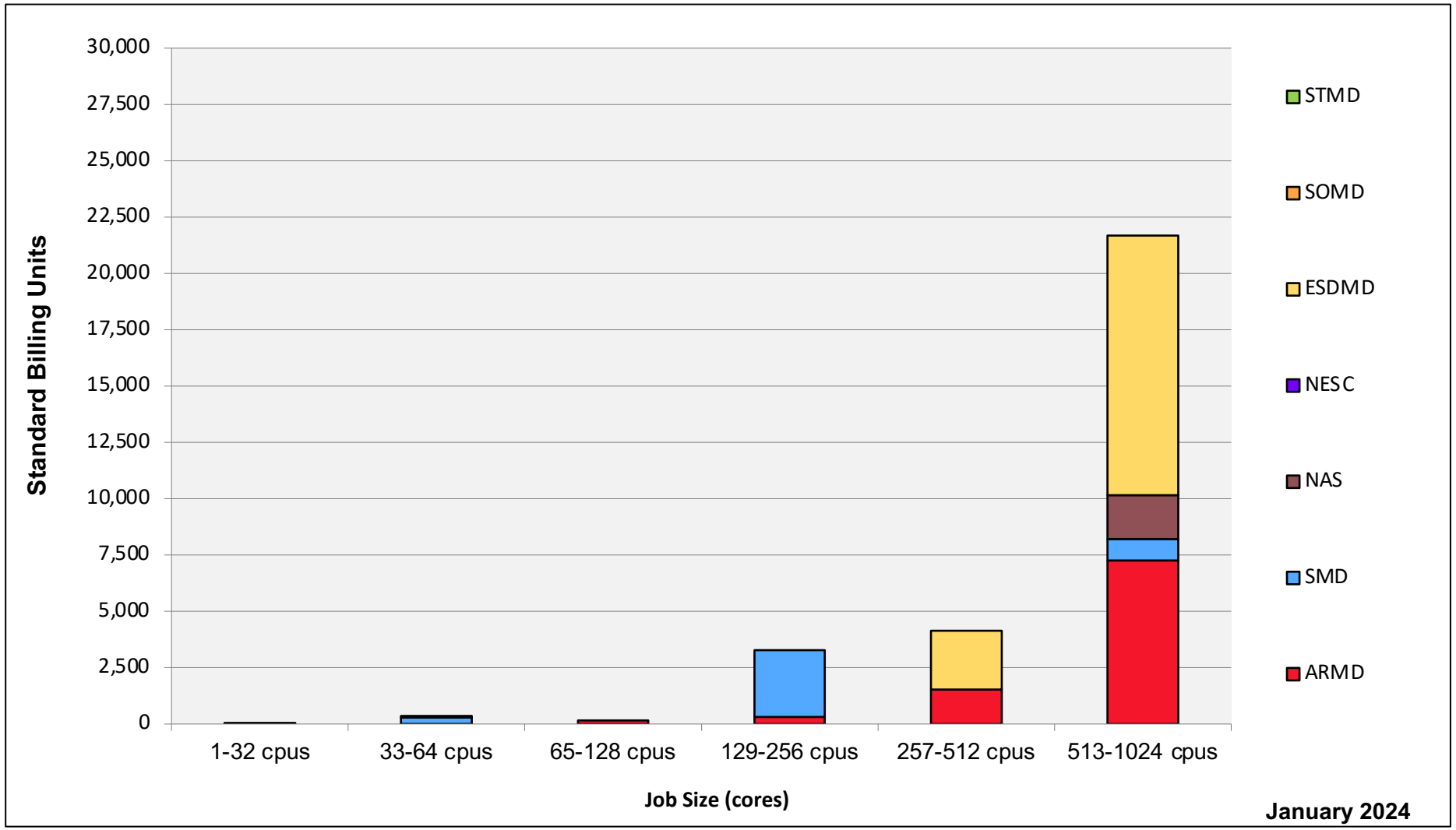
Endeavour: SBUs Reported, Normalized to 30-Day Month



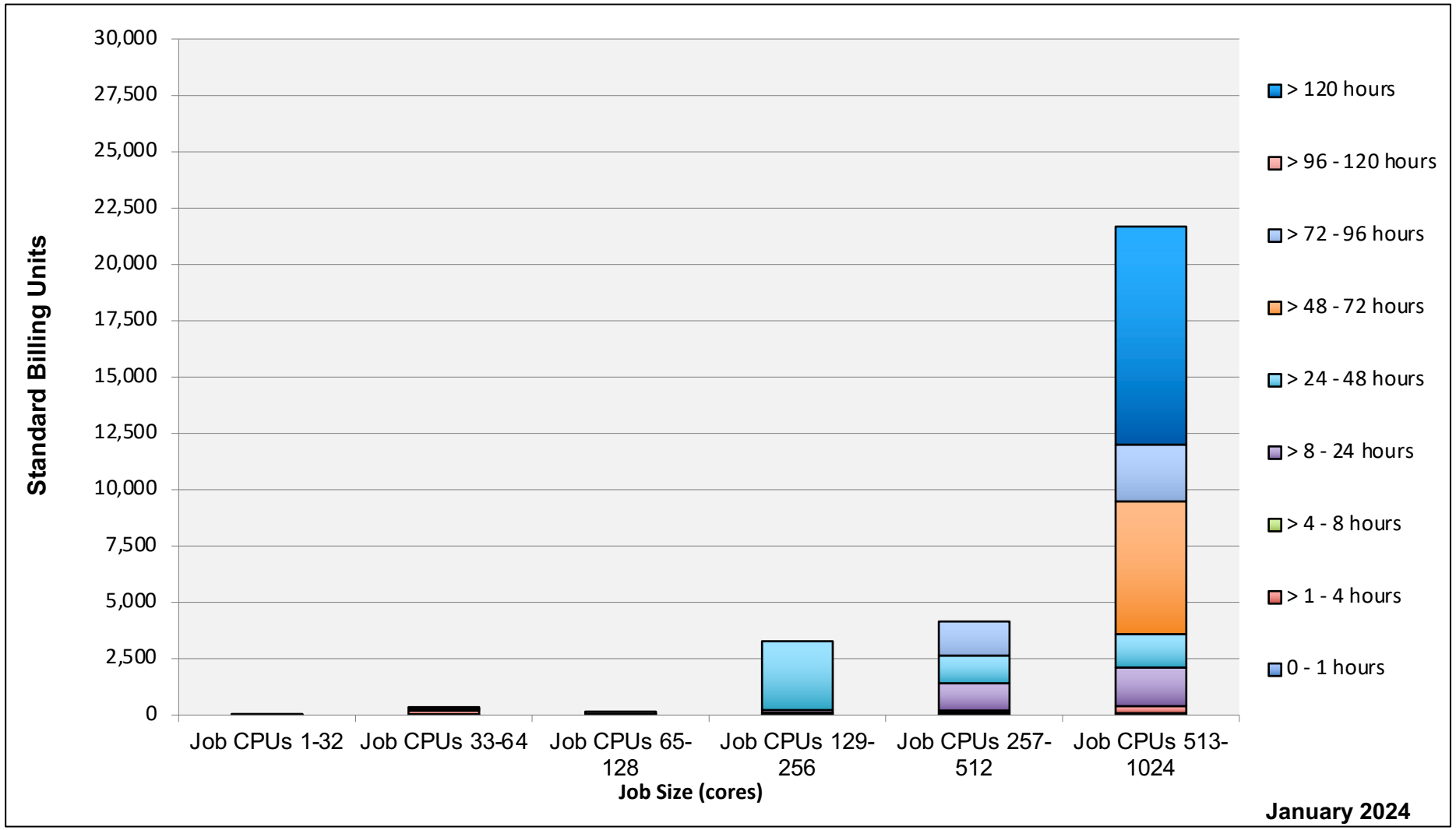
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor

