

National Aeronautics and Space Administration

High-End Computing Capability

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Selected Monthly Accomplishments

- **Improving Efficiency**
  - Updated the Special Access website to reduce the amount of data displayed in the manager approver workflow. With this change, reviewers can see a short summary of the justification for access and click to see an expanded view—saving time and stress trying to read justifications. The previous version made it difficult to read the contents when two or more requests were in the queue.
- **Improving System Stability**
  - Formed an operational working group to identify problems related to failed jobs, investigate root causes, plan and implement solutions (or propose projects), and provide updates via the HECC weekly report.
  - Tools and Systems team members worked closely to fix the data pipeline that produces the system utilization for Pleiades, Electra, and Aitken that appears in the daily System Status email. Updated internal documentation on the pipeline.
  - A safety audit was conducted May 2 and May 7 with auditors from NASA Ames Code Q. The auditors were extremely detailed in their walkthroughs and noted that our facilities are "in great shape."
  - A new 50-kilowatt uninterruptible power supply (UPS) was installed in Building N258 on May 14. The UPS provides battery backup for life safety equipment such as the fire alarm/suppression system, access control, emergency lighting, and doomsday box.
- **Improving User Experience**
  - Configured the PBS reservation capability, which is now standard for cloud projects with dynamic compute systems in Amazon Web Services. The reservation capability allows users and/or groups to "hold onto" large node sets, reducing the need for nodes to spin up on a per-job basis, which can take significant time when jobs are running.
  - Added Cabeus node information to the Node Status (https://monitoring.nas.nasa.gov/nodes_status/) and Node Utilization Dashboard (https://monitoring.nas.nasa.gov/dashboard/) websites.

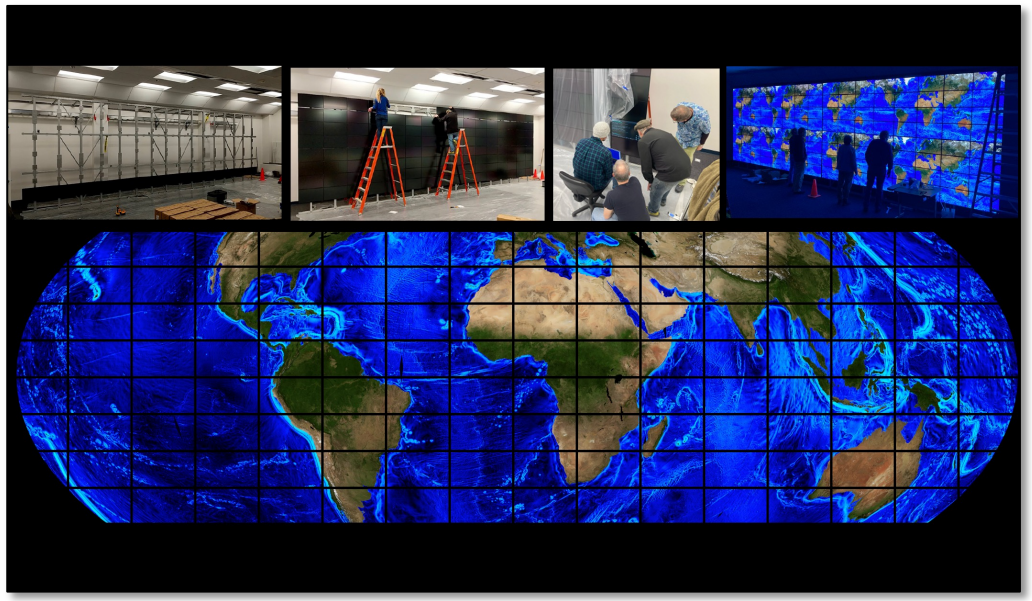
Selected Monthly Accomplishments (Cont.)

- **Next-Generation hyperwall**
  - Set the supply air temperature for Air Handler 2 at 65° F, so the supply air is 65° and the building heats up that air. The temperature in the hyperwall room has held steady at 69° - 70°. Will continue to monitor to see if this adjustment continues to work through the summer. See slide 6 for details on the hyperwall unveiling.
- **Support Open Science**
  - Deployed a new dataset named “NEX downscaled climate projection.” The new dataset contains daily, monthly, and annual downscaled Coupled Models Intercomparison Project phase 6 (CMIP6) projections over the conterminous United States at 30-arcsecond horizontal resolution for maximum temperature, minimum temperature, precipitation, and vapor pressure. Also added the dataset to the THREDDS server, which allows users to view inside the dataset data files (netCDF format) while on the site instead of having to downloading them locally.
- **Outreach and Collaboration**
  - Published a new feature story on the NAS Division website: Defending the Planet: How NASA Supercomputers Capture Hypothetical Asteroid Impacts. The story was promoted on HEC social media accounts.

New hyperwall Capabilities Unveiled

- This month, HECC's Visualization and Data Analysis and Facilities teams unveiled the fourth generation hyperwall (internally named hyperwall4) display environment at an informal ribbon-cutting ceremony.
  - hyperwall4 is a powerful, 128-node compute cluster equipped with modern HPC technology: 256 24-core Intel Xeon Platinum 8268 processors, 128 NVIDIA Quadro RTX 6000 GPUs, and a 1.8 petabyte BeeGFS filesystem built on the hyperwall SSDs—tightly woven into the HECC supercomputing infrastructure via InfiniBand. The 128 nodes are connected via 4 miles of optical video cables to 128 27-inch 4K monitors, which form the 8x16, 1-billion-pixel, hyperwall display environment.
  - The state-of-the-art, fully integrated compute cluster allows for real-time/near-real-time data processing, generation, and streaming. The display environment has consistently proven to be a powerful instrument for scientists and engineers to interactively and collaboratively explore and analyze their large, multidimensional datasets.
- While work remains before hyperwall4 is fully operational, the ribbon-cutting ceremony gave Ames Center management and local NAS Division staff the opportunity to see the culmination of extensive work over the last year.
  - The Visualization and Data Analysis team presented their latest efforts, including: streaming and visualizing performance monitoring data; visualizing the latest observational data from the Geostationary Operational Environmental Satellites –R Series (GOES-R) and Solar Dynamics Observatory (SDO); generating billion-pixel visualizations of CFD simulations of turbine flow and supersonic retropropulsion; and displaying, at native resolution, recently released altimetry data from the Surface Water Ocean Topography (SWOT) mission.

IMPACT: The new hyperwall will serve as a primary instrument for HECC scientists and engineers to interactively and collaboratively explore and analyze the next generation of large, multidimensional datasets.

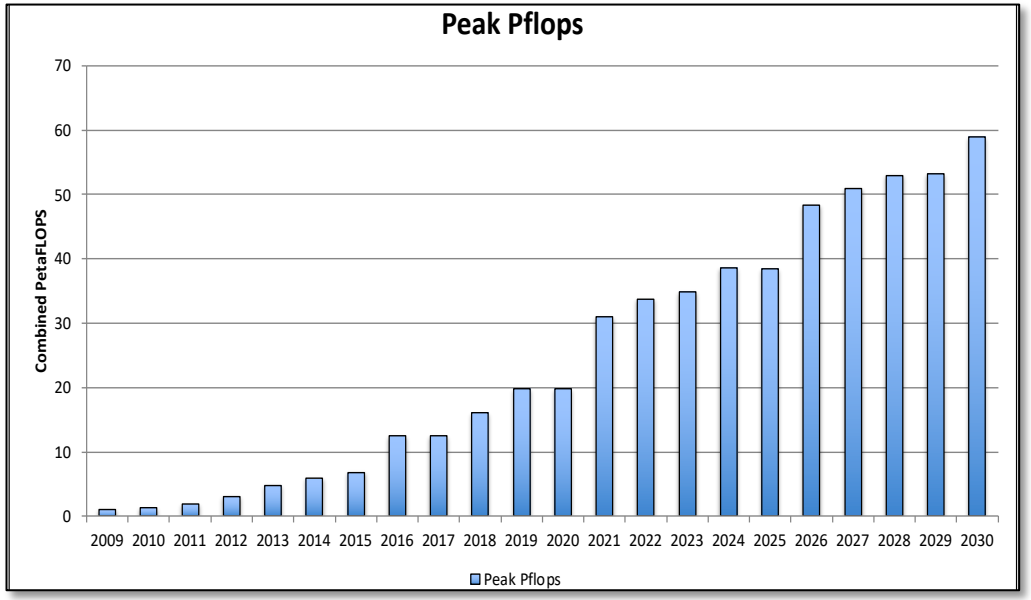


Top: Different stages of deploying the hyperwall4 display environment. Bottom: hyperwall visualization of recently released altimetry data from the Surface Water Ocean Topography mission, shown here at 650-meter resolution at the equator and 61,000 pixels across on the hyperwall.
HECC Visualization & Data Analysis Team/NASA Ames

HECC Hosts Two Virtual User Meetings

- HECC hosted two virtual user meetings in May 2024 to provide an overview of the HECC portfolio component and promote the services, resources, and capabilities available.
  - The meetings are an opportunity to introduce users to HECC support staff, answer questions, and gather feedback/requirements.
  - Some topics of interest included migrating codes to new hardware/GPUs, transitioning from Pleiades, reservations, usability of the Pleiades front ends, and the AWS cloud.
  - This year also included an overview of proposed plans to decommission end-of-life systems and procure new CPU and GPU resources.
- The meetings were well attended with an average of 68 participants (52 users) and an average attendance time of 2 hours and 20 minutes. Although there were fewer participants than the previous virtual meetings, there was more discussion and engagement.
- These virtual meetings allow HECC to reach a much wider user base.
- Presentation slides will be made available on the HECC website.

IMPACT: User outreach is critical to ensuring that scientists and engineers get the most out of their allocations on HECC resources.



Graph presented during the HECC overview depicts historic and predicted compute growth in peak flops based on current budget/plans. *William Thigpen, NASA Ames Research Center*

MSF Compute Module Getting Close to Installation

- The permit for the installation of Compute Module 2 at the NASA Ames Modular Supercomputing Facility (MSF) was approved by the Ames Permit Board on May 23, 2024.
  - The design documentation for the module's installation was reviewed by experts in 15 different disciplines at Ames to confirm that the module meets federal, state, and local requirements, and adheres to the California Building Code.
  - The module received its California Insignia certifying that it was manufactured in compliance with the California Code of Regulations Title 25.
- Compute Module 2 shipped from the Avail Infrastructure Solutions factory in Maryland on May 30, 2024. The module is scheduled to arrive at Ames on June 10, 2024.
  - The module ships in two halves as an oversize load, each one almost 16 feet wide. Transporting the module requires special permits and the roadways limit times for transporting the module. The trip across country requires 12 days.
  - The module's halves are scheduled to be lifted into place by a crane and anchored to the concrete pad at R&D099 starting on June 11, 2024. The module infrastructure (transformer, cooler, and pumps) will then be lifted into place.
- Compute Module 2 will house the Milan expansion of the Aitken supercomputer and the next-generation compute cluster. The new module can house 24 compute racks and provide 3 megawatts of power, more than doubling the current capacity.

IMPACT: Compute Module 2 will more than double the computational capacity of the Modular Supercomputing Facility, significantly expanding the HECC resources available to scientists and engineers working on NASA projects and mission.



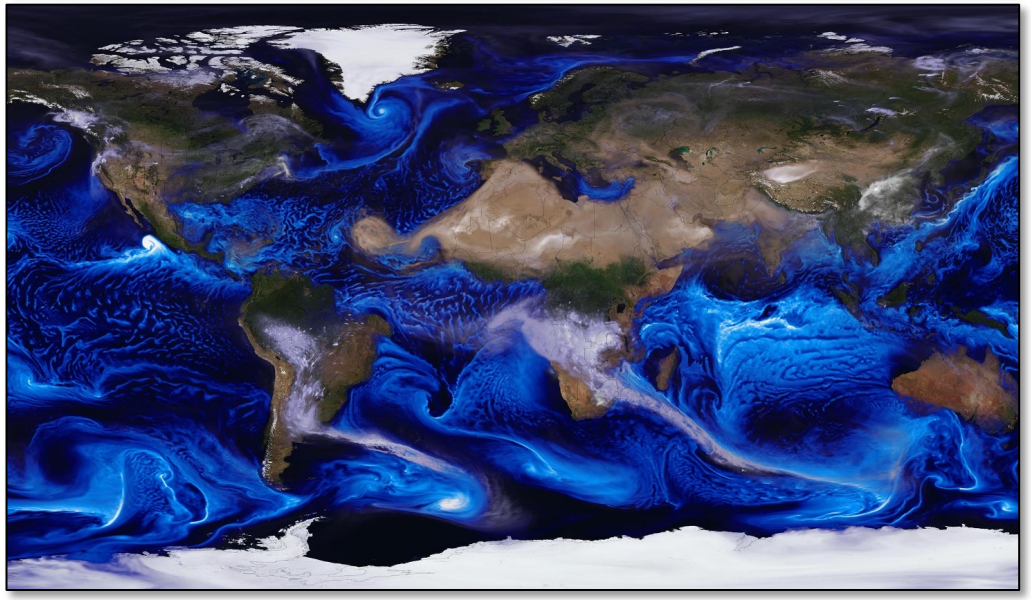
Compute Module 2 (north half) loaded on a trailer just before leaving the Avail Infrastructure Solutions factory in Maryland.
Anthony Innerarity/Avail Infrastructure Solutions

HECC Supercomputer Usage Sets New Normalized Record

- In May, the combined usage of HECC supercomputers set a new normalized record of 17,514,953 Standard Billing Units (SBUs*).
- The usage by 385 of NASA's science and engineering groups exceeded the previous normalized record of 17,418,475 SBUs set in April 2024 by 96,478 SBUs.
- The record was achieved in great part by the Science Mission Directorate Foundational Modeling group use of GPUs and supporting many high-resolution simulations with the Goddard Earth Observing System (GEOS) for future observing system development. These simulations approach 1.5 kilometers globally, and focus has been placed on extreme events and storm-scale processes in these simulations.
- Usage of Aitken, Pleiades, Electra, Endeavour, and Cabeus contributed to this record. The new record is greatly attributed to the Aitken Rome nodes, with 128 cores per node.
- The top 10 projects' usage ranged between 401,178 and 2,382,649 SBUs, and together accounted for over 46% of the total usage.
- The HECC Project continues to evaluate and plan resources to address the future requirements of NASA's users.

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

IMPACT: The increased capacity of HECC systems and expert support to help users optimize their run capacities provide mission directorates with more resources to accomplish their goals and objectives.

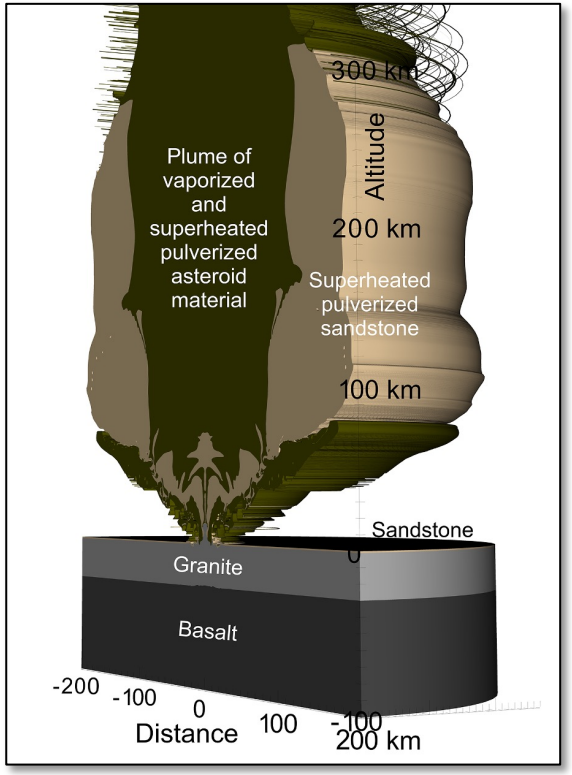


Snapshot of forecasted aerosol optical depth from the GEOS model at 12-kilometer horizontal resolution, with blue plumes representing sea salt; white, carbon; and brown, dust. Features visible are dust plumes streaming from the Sahara into the Atlantic, carbon emissions from fires in Africa, and cyclones traced by sea salt in the Pacific.
William Putman, NASA/Goddard

Simulating Kilometer-Size Asteroid Impacts on Earth*

- As part of NASA's work to develop the means to protect Earth from such dangerous asteroids, engineers at NASA Ames, collaborating with partners at USGS, ran simulations on HECC systems to investigate hypothetical kilometer- or mile-wide-size asteroids that would have the potential to devastate an entire country.
- Simulation results show the extent of damage from the hypothetical asteroid impact and help improve the accuracy of impact predictions. One surprising finding was that the blast wave alone can cause tsunami waves around the globe even if the asteroid doesn't hit an ocean.
  - Using observations from the 2022 Hunga-Tonga volcano eruption, the team found that the blast wave from the impact of such a large asteroid can be channeled by the atmosphere and decay less slowly than smaller explosions.
- Simulations and observations from the 1994 Shoemaker-Levy-9 comet both show that hot gas plumes can rise above the atmosphere and collapse back down to form a layer of hot gas that can bake the land below over a much larger area than just the hot plume from a smaller impact.
- The team will also run simulations to compare how the damage changes with impact location, as future mitigation methods may allow the impact location to be changed to less populated areas.

IMPACT: Results from these simulations will be used to suggest areas for evacuation to U.S. and international agencies and estimate the cost of damage.



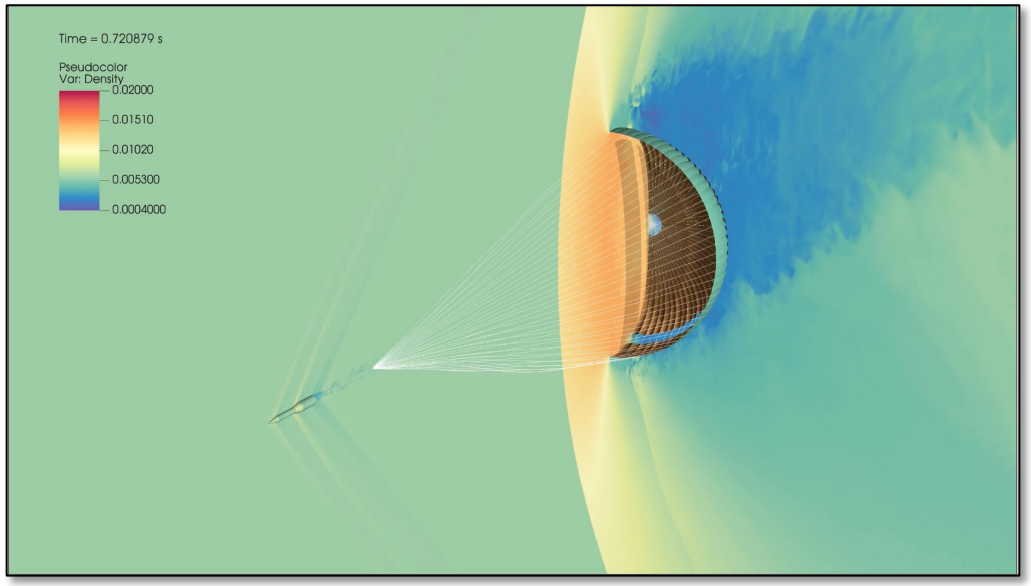
Cross-section showing the impact of a hypothetical kilometer-size asteroid, vaporizing the asteroid and some of the ground, and excavating a crater 10 km deep. Much more ground material is liberated than the mass of the asteroid. Vaporized, melted, and hot pulverized material is ejected into space. The plume expands greatly in the upper atmosphere, forming a cloud of hot material that extends hundreds of kilometers. *Darrel Robertson, NASA/Ames*

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

Simulating Supersonic Parachutes for EDL*

- NASA's Entry Systems Modeling project funds research and development toward the capability to simulate the complex physics surrounding supersonic parachutes that will by used for several upcoming missions: Mars Sample Return, DaVinci (Venus), and Dragonfly (Titan).
- The Launch, Ascent, and Vehicle Aerodynamics (LAVA) team at NASA Ames is developing such a capability within the LAVA multi-physics simulation software.
  - The team uses fluid-structure interaction (FSI) simulations of the Advanced Supersonic Parachute Inflation Research Experiment (ASPIRE)'s third flight test (SR03, conducted in the upper Earth atmosphere in 2018) and compares simulation predictions to the flight test measurements to validate this new capability.
  - The team found that by incorporating the whole system's deceleration, there was a 12% drop In the predicted force the parachute exerts on the payload. They were able to obtain better agreement with flight measurements, demonstrating the importance of modeling the system's deceleration for supersonic parachute inflation.
- The LAVA team is improving the LAVA FSI tool by adding physics-based models to enhance its accuracy, and by optimizing its runtime efficiency, so the tool can be used to inform future interplanetary robotic missions.

IMPACT: Once validated, the simulation tool will be leveraged to reduce upcoming missions' parachute-related risks by complementing other data and models in the design process.



Video of a fluid-structure interaction simulation of the third ASPIRE flight test, showing density on the cut plane, payload, and parachute surface to highlight bow shock and low density in the wake. *Francois Cadieux, Michael Barad, NASA/Ames*

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Papers

- "**The Stagger Code for Accurate and Efficient, Radiation-Coupled MHD Simulations**," R. Stein, A. Nordlund, R. Collet, R. Trampedach, arXiv:2405.02483 [astro-ph.IM], May 3, 2024. *
  https://arxiv.org/abs/2405.02483
- "**Process Intensification Applied to Biojet Production Through ATJ Process**," E. Sánchez-Ramírez, et al., chapter from *Contributions of Chemical Engineering to Sustainability*, pp. 293-328, published online May 3, 2024. *
  https://link.springer.com/chapter/10.1007/978-3-031-55594-7_10
- "**Molecular Dynamics Simulations of Microstructural Effects on Austenite-Martensite Interfaces in NiTi**," G. Plummer, M. Mendelev, J. Lawson, Extended Abstracts from the International Conference on Shape Memory and Superelastic Technologies, presented in Cascais, Portugal, May 6-10, 2024. *
  https://dl.asminternational.org/shape-memory/proceedings/SMST2024/84840/78/31828
- "**Accurate Infrared Line Lists for 20 Isotopologues of CS_2 at Room Temperature**," X. Huang, et al., *The Astrophysical Journal Supplement Series*, vol. 272, no. 1, May 8, 2024. *
  https://iopscience.iop.org/article/10.3847/1538-4365/ad3809
- "**On the Formation of Trapped Electron Radiation Belts at Ganymede**," L. Liuzzo, et al., *Geophysical Research Letters,* vol. 515, issue 10, May 10, 2024. *
  https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024GL109058
- "**CFD Evaluation of Radial Airflow Lean Direct Injectors for Commercial Supersonics Technology**," K. Ajmani, J. Moder, presented at the Spring Technical Meeting of the Central States Section of the Combustion Institute, Cleveland, OH, May 12-14, 2024. *
  https://ntrs.nasa.gov/citations/20240005602

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Papers (cont.)

- "**Early Results from the HUMDRUM Survey: A Small, Earth-Mass Planet Orbits TOI-1450A**," M. Brady, et al., arXiv:2405.10400 [astro-ph.EP], May 16, 2024. *
  https://arxiv.org/abs/2405.10400
- "**Star-Spot Activity, Orbital Obliquity, Transmission Spectrum, Physical Properties, and Transit Time Variations of the HATS-2 Planetary System**," F. Biagiotti, et al., *Astronomy & Astrophysics*, vol. 685, published online May 17, 2024. *
  https://www.aanda.org/articles/aa/abs/2024/05/aa47872-23/aa47872-23.html
- "**Effect of Nb Solutes on the Kolbe Mechanism for Microtwinning in Ni-based Superalloys**," V. Borovikov, et al., *International Journal of Plasticity*, vol. 178, May 18, 2024. *
  https://www.sciencedirect.com/science/article/abs/pii/S0749641924001311
- "**GJ 238 b: A 0.57 Earth Radius Planet Orbiting an M2.5 Dwarf Star at 15.2 pc**," E. Tey, et al., *The Astronomical Journal*, vol. 167, no. 6, May 24, 2024. *
  https://iopscience.iop.org/article/10.3847/1538-3881/ad3df1/meta
- "**A New Dynamic Slip Approach for Wall-Modeled Large Eddy Simulations in a Consistent Discontinuous Galerkin Framework**," P. Raje, K. Duraisamy, arXiv:2405.15899 [physics.flu-dyn], May 24, 2024. *
  https://arxiv.org/abs/2405.15899
- "**Heliophysics and Space Weather Information Architecture and Innovative Solutions: Current Status and Ways Forward**," A. Masson, et al., *Advances in Space Research*, published online May 28, 2024. *
  https://www.sciencedirect.com/science/article/pii/S0273117724004939

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Papers (cont.)

- "**The GAPS Programme at TNG. LVII. TOI_5076b: A Warm Sub-Neptune Planet Orbiting a Thin-to-Thick-Disk Transition Star in a Wide Binary System**," M. Montalto, et al., arXiv:2405.18950 [astro-ph.EP], May 29, 2024. *
  https://arxiv.org/abs/2405.18950
- "**Surface and Sub-Surface Kinetic Energy Wavenumber-Frequency Spectra in Global Ocean Models and Observations**," J. Ansong, et al., *Journal of Geophysical Research: Oceans*, vol. 129, issue 6, published online May 30, 2024. *
  https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023JC020480
- **30th AIAA/CEAS Aeroacoustics Conference**, Rome, Italy, June 4-7, 2024 (published online May 30, 2024).
  - "**Effects of Flight on Turbulence Statistics and Noise Sources in a Round Turbulent Jet**," S. Leib, B. Heberling, J. Bridges. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3412
  - "**High-Fidelity Simulations of Vertiport Ground Effects on eVTOL Rotor Noise**," M. Marques Goncalves, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3333
  - "**Fan Noise Predictions of the NASA Source Diagnostic Test Using Unsteady Simulations with LAVA Part II – Tonal and Broadband Noise Assessment**," L. Santos Fernandes, J. Housman, G.-D. Stich, J. Duensing. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3228
  - "**Aeroacoustic Computations of a Transonic Truss-Braced Wing Aircraft: Part 1 - Aerodynamic and Airframe Nosie Simulations**," R. Ferris, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3058
  - "**Aeroacoustic Computations of a Transonic Truss-Braced Wing Aircraft: Part 2 – Acoustic Signature and Noise Source Identification**," P. Ravetta, M. Khorrami, R. Ferris. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3059
  - "**Noise Prediction of Multi-Stream Internally Mixed Jets with External and Internal Pligs using Large-Eddy Simulation**," G.-D. Stich, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2024-3377

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Presentations

- "**Tiltwing Transition Flight Analysis Using High-Fidelity CFD**," D. Garcia Perez, presented at the Vertical Flight Society's 80th Annual Forum & Technology Display, held in Montreal, Quebec May 7-9, 2024.
- "**Using Long-Short Term Memory Models to Predict Solar Active Regions Emergence**," S. Kasapis, presented as part of the Software for the NASA Mission Directorate Workshop, held in Washington D.C. and virtually May 7-9, 2024.
- "**CAPE – Computational Aerosciences Productivity & Execution**," D. Dalle, presented at the NASA/CREATE-AV Technical Interchange Meeting, held virtually May 21-22, 2024.

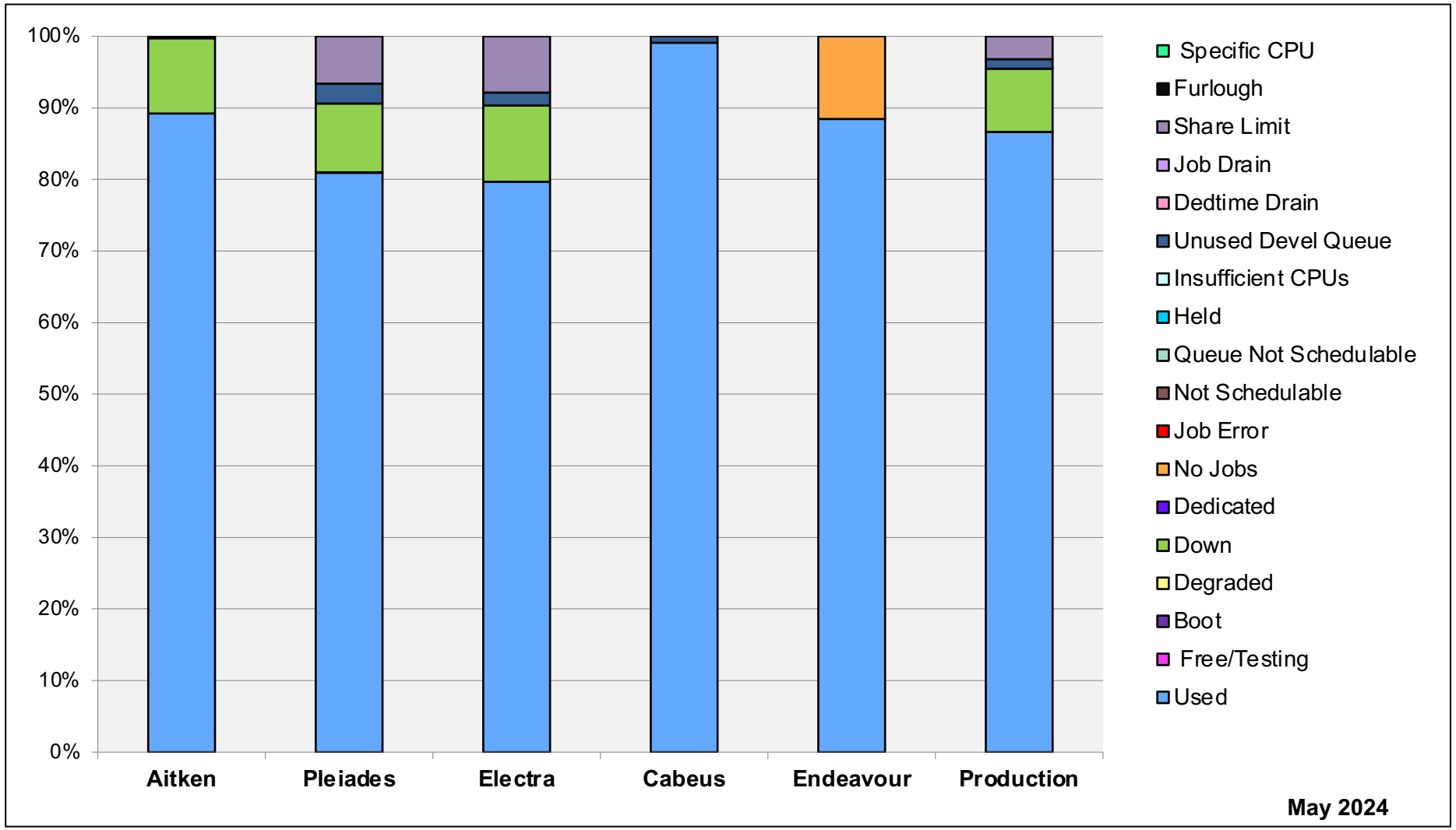
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News and Events

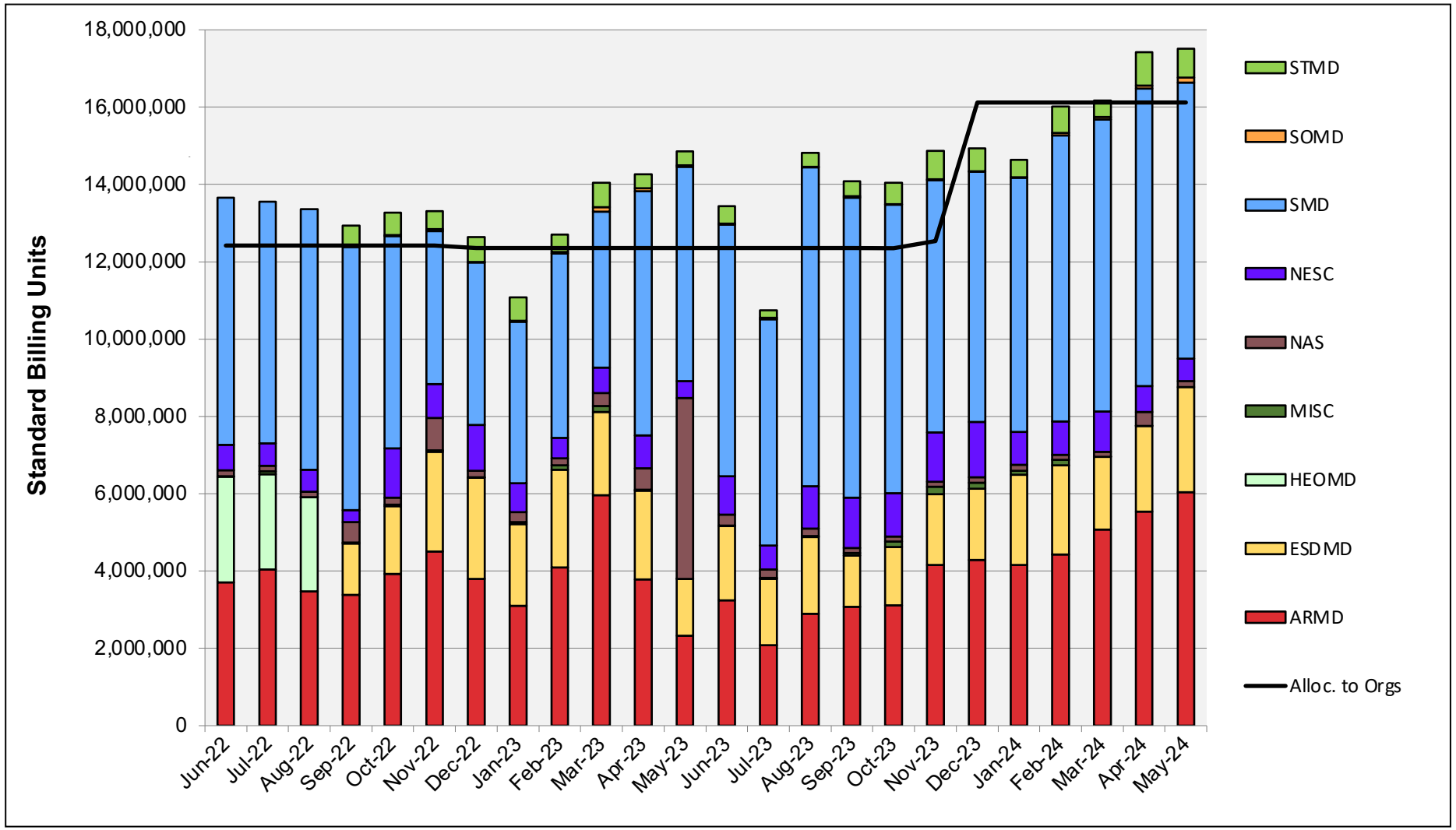
- **2024 Total Solar Eclipse: Prediction vs. Reality**, *NASA Science*, May 2, 2024 – Before a total solar eclipse crossed North America on April 2, 2024, scientists at Predictive Science In. of San Diego aimed to foresee what the Sun's outer atmosphere, the corona, would look like during totality using simulations on agency supercomputers.
  https://science.nasa.gov/image-article/2024-total-solar-eclipse-prediction-vs-reality/
- **Defending the Planet: How NASA Supercomputers Capture Hypothetical Asteroid Impacts**, *NASA Advanced Supercomputing Division*, May 7, 2024 – Supporting the NASA Planetary Defense Coordination Office, scientists in the NASA Advanced Supercomputing (NAS) Division's Computational Aerosciences Branch have kept their eyes close to Earth recently—focusing on what might occur if our planet should someday get hit by an asteroid, and what we might be able to do to mitigate the damage.
  https://www.nas.nasa.gov/pubs/stories/2024/feature_how_NASA_supercomputers_capture_hypothetical_asteroid_impacts.html
- **Sun's Magnetic Field Originates Surprisingly Close to the Surface**, *Northwestern University*, May 22, 2024 – After running a series of complex calculations on a NASA supercomputer, researcher's new finding addresses a 400-year-old mystery once explored by Galileo.
  https://news.northwestern.edu/stories/2024/05/suns-magnetic-field-originates-surprisingly-close-to-the-surface/
- **NASA and IBM Research Apply AI to Weather and Climate**, *NASA EarthData*, May 22, 2024 – A collaboration involving NASA and IBM Research has led to the development of a new artificial intelligence foundation model for weather and climate.
  https://www.earthdata.nasa.gov/learn/blog/nasa-ibm-weather-climate-foundation-model

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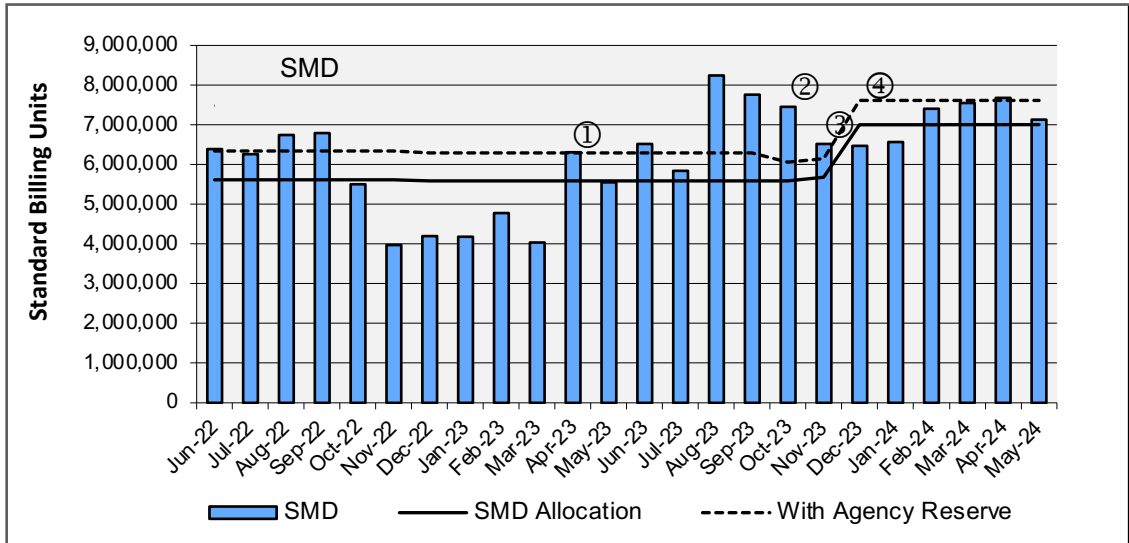
HECC Utilization

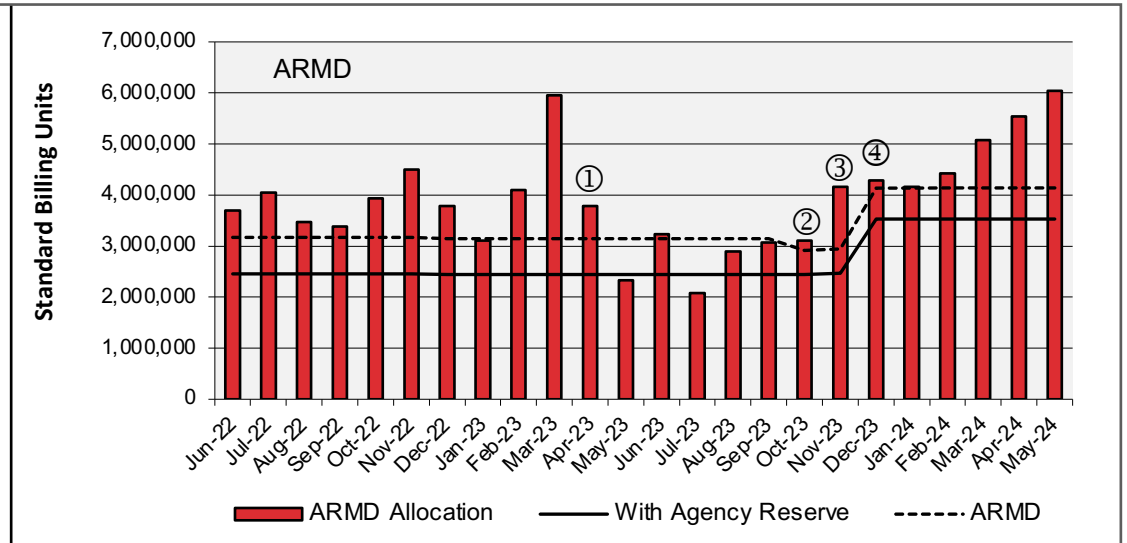


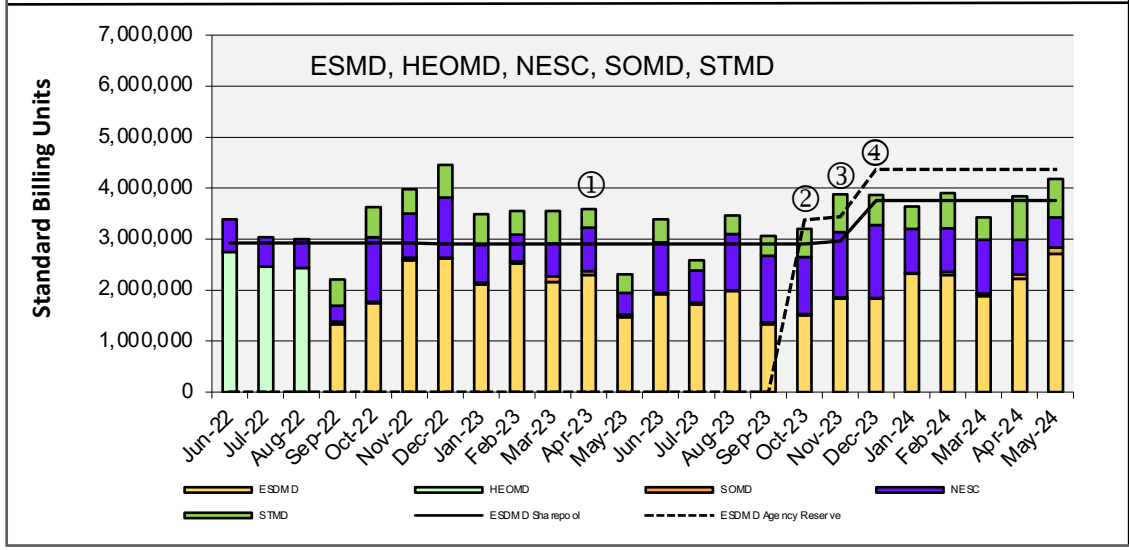
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







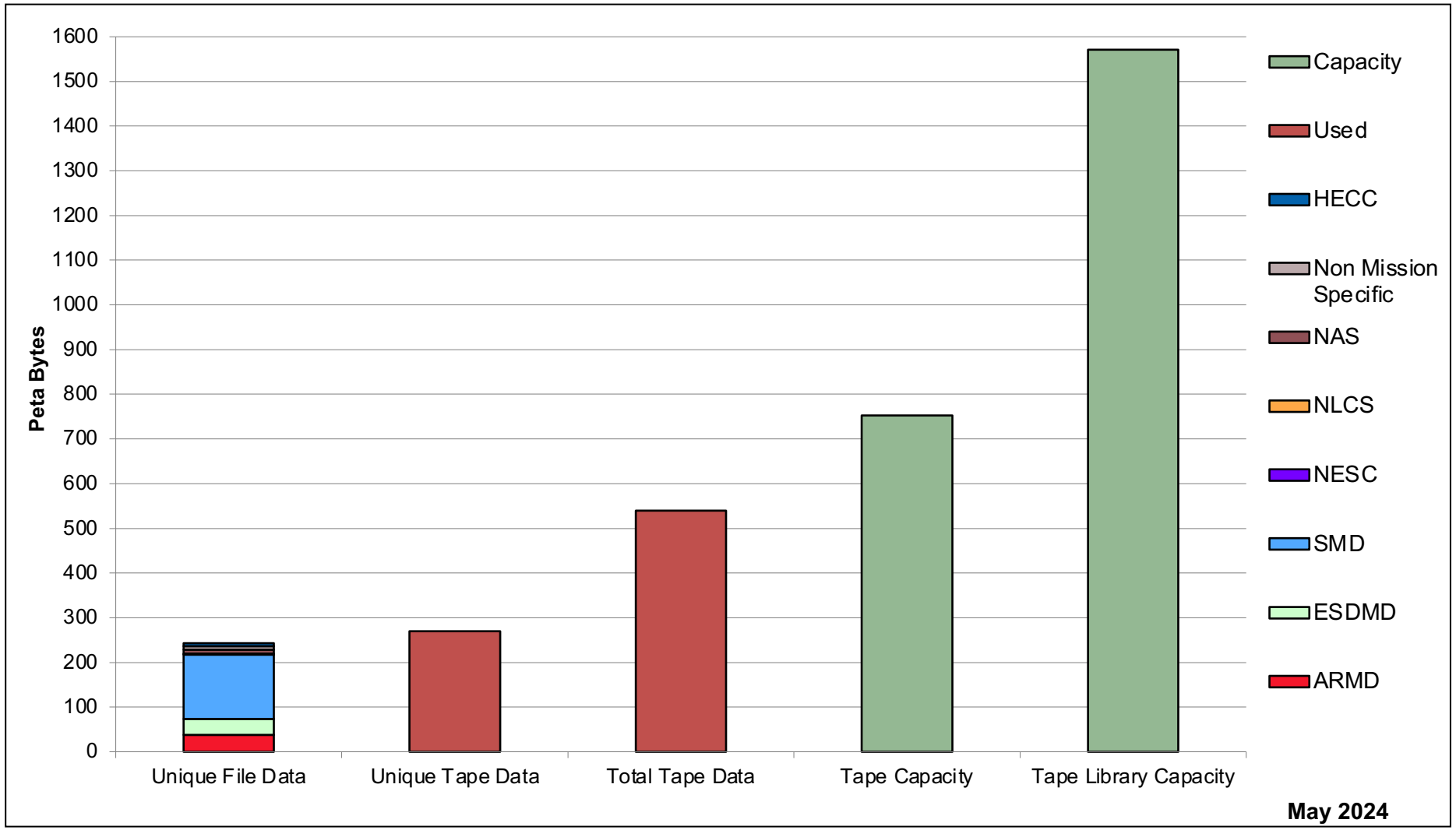
① 4 Rome Apollo Racks added to Aitken

② 4 Rome Apollo Racks added to Aitken

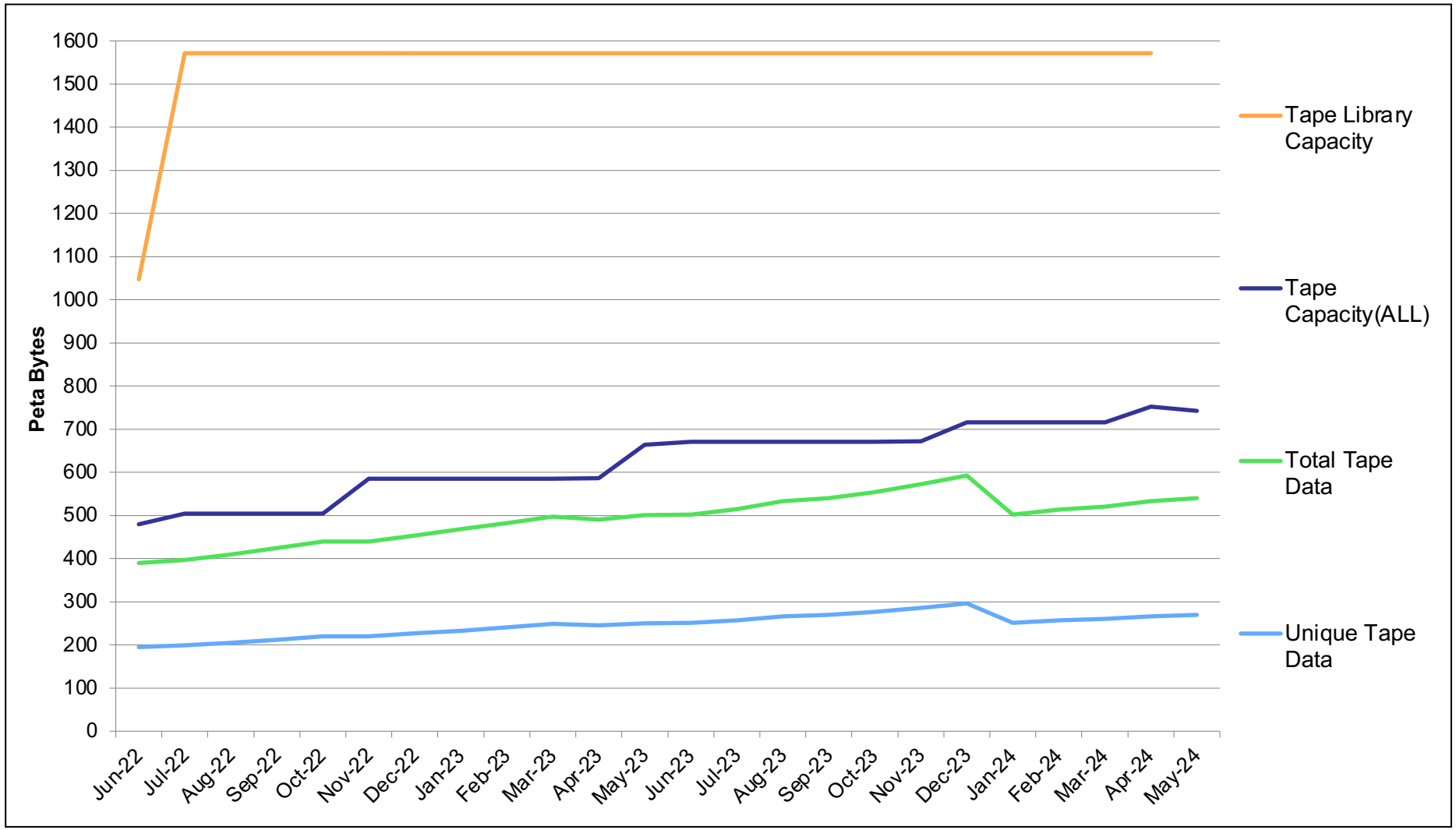
③ Cabeus v100 nodes added

④ Cabeus Milan a100 nodes added

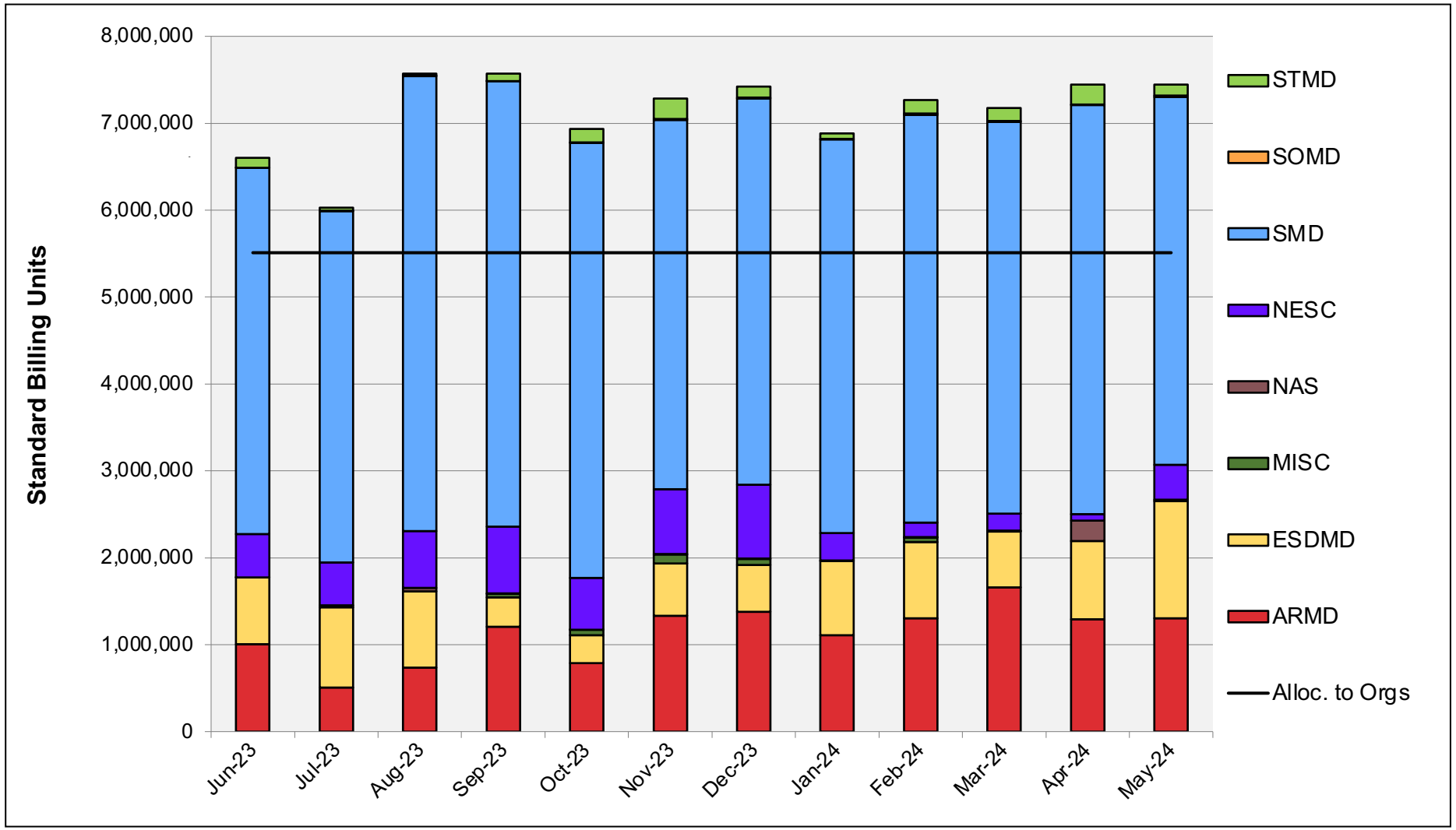
Tape Archive Status



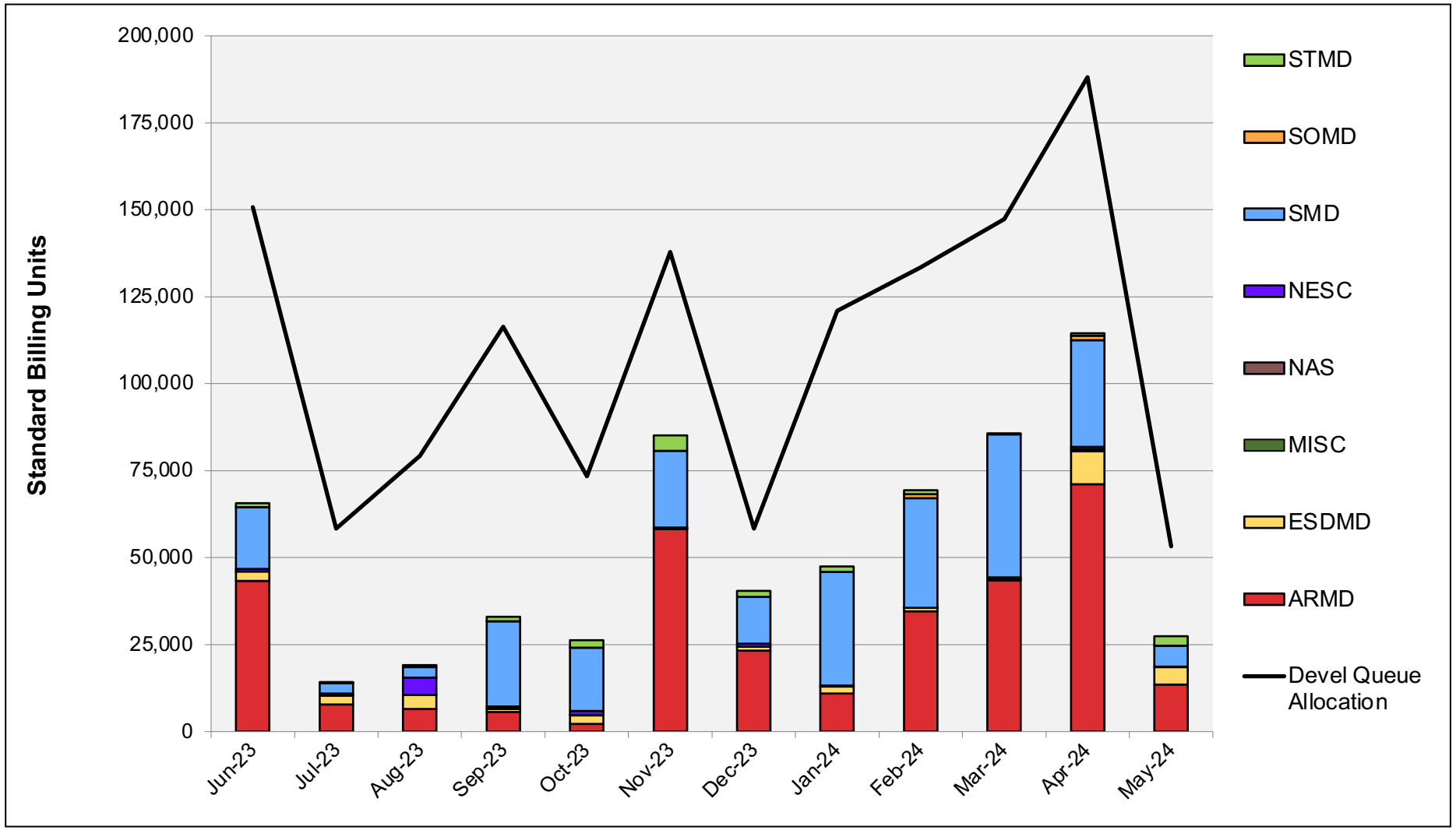
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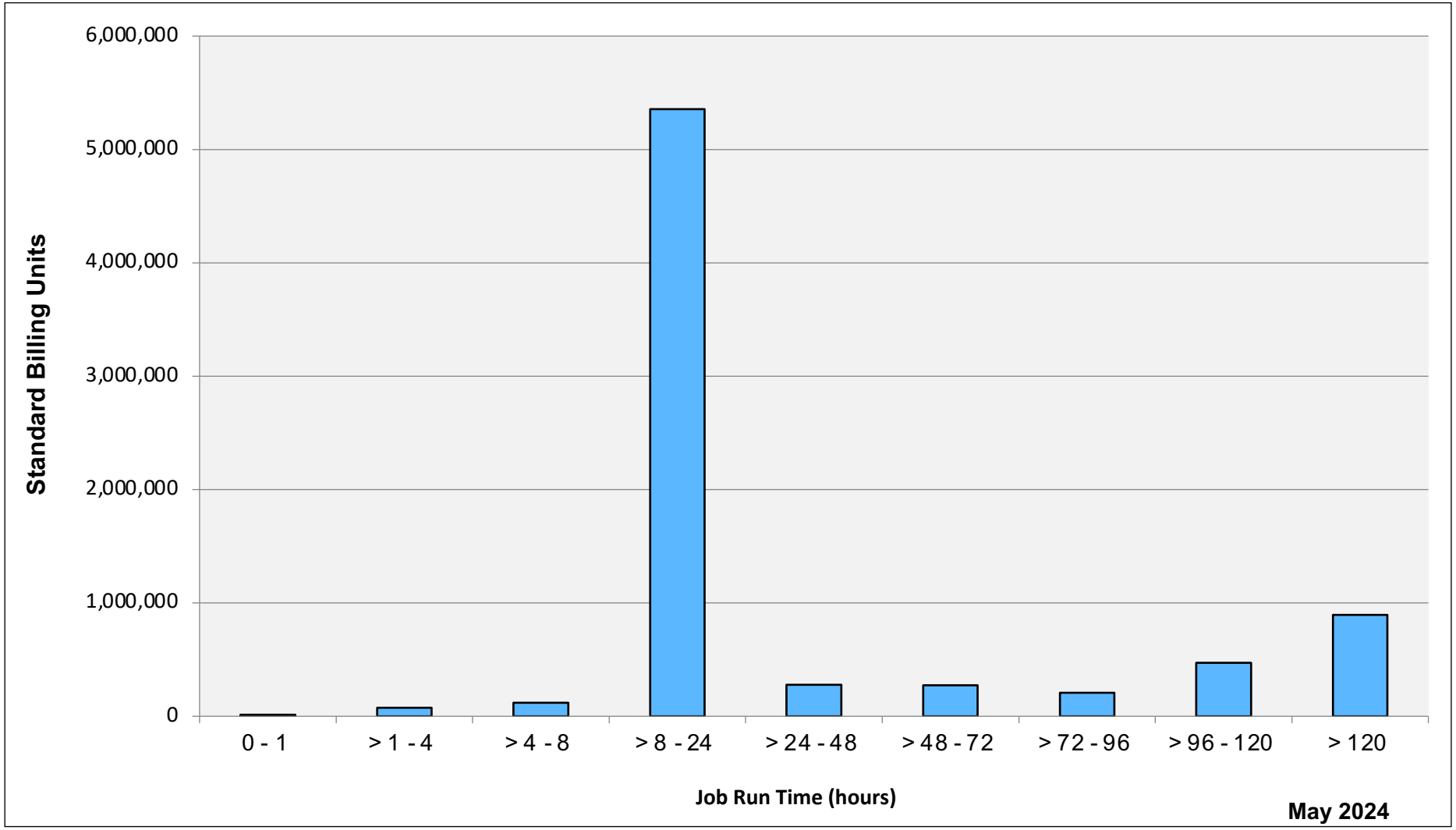
Aitken: SBUs Reported, Normalized to 30-Day Month



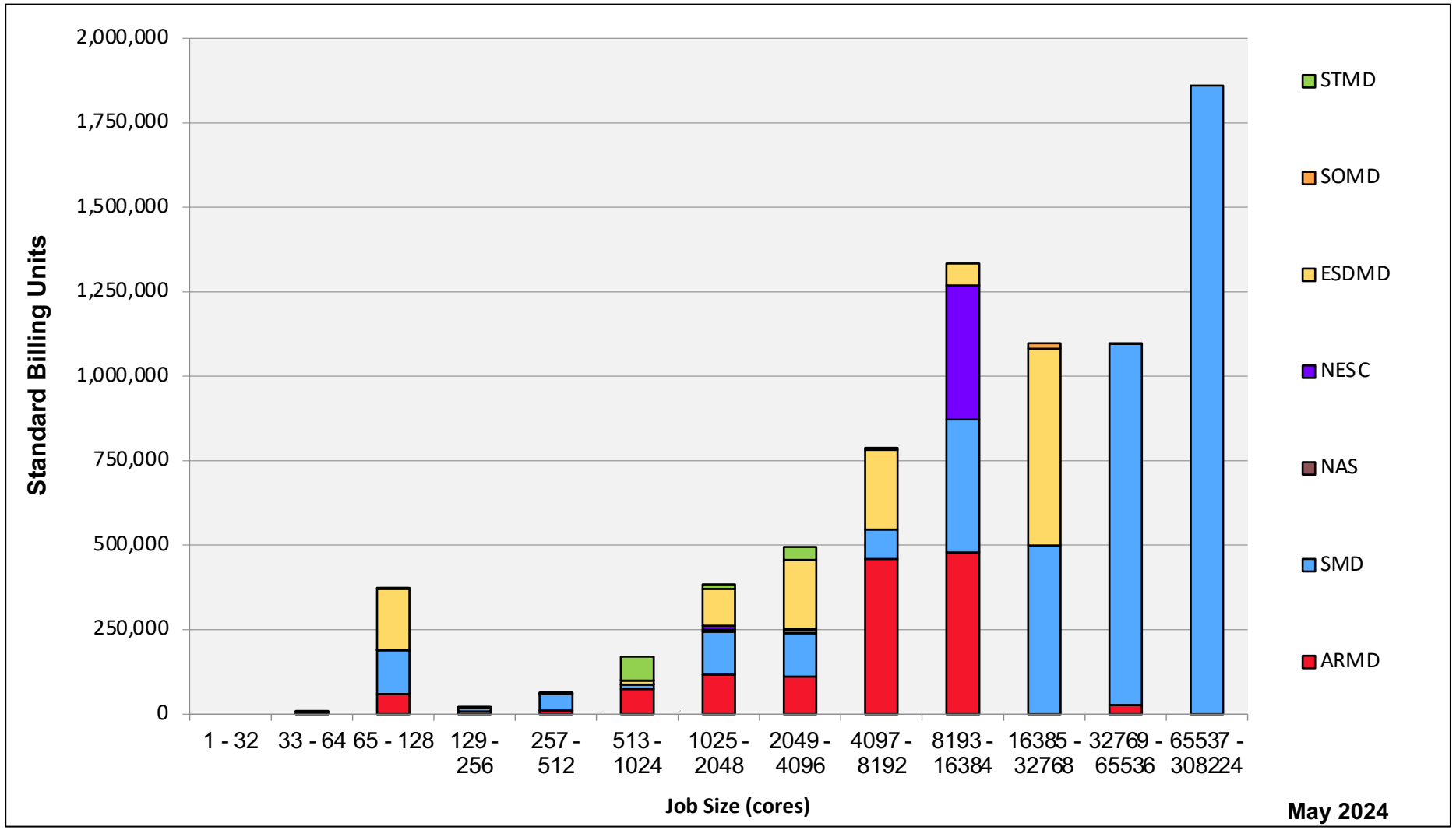
Aitken: Devel Queue Utilization



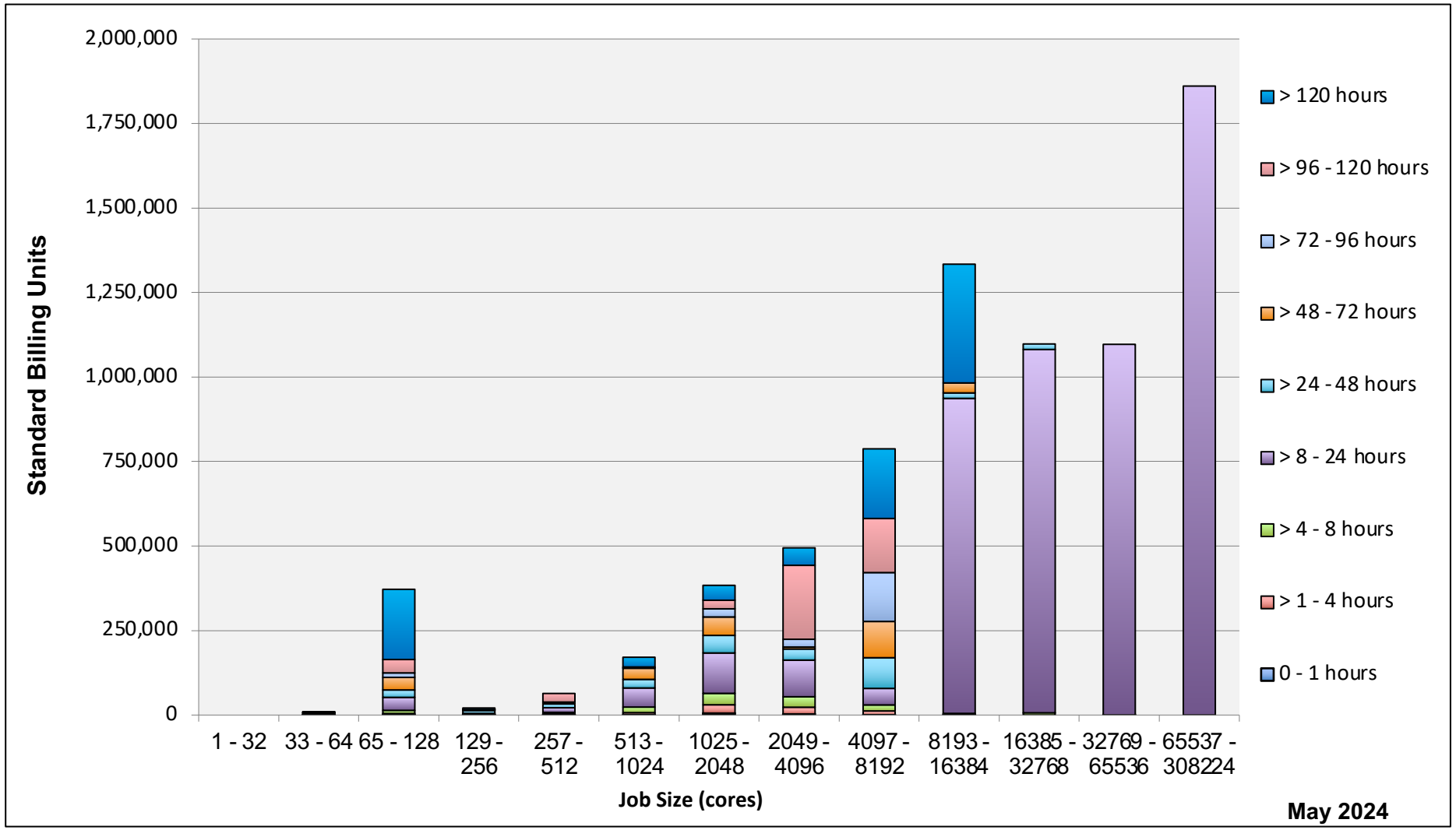
Aitken: Monthly Utilization by Job Length



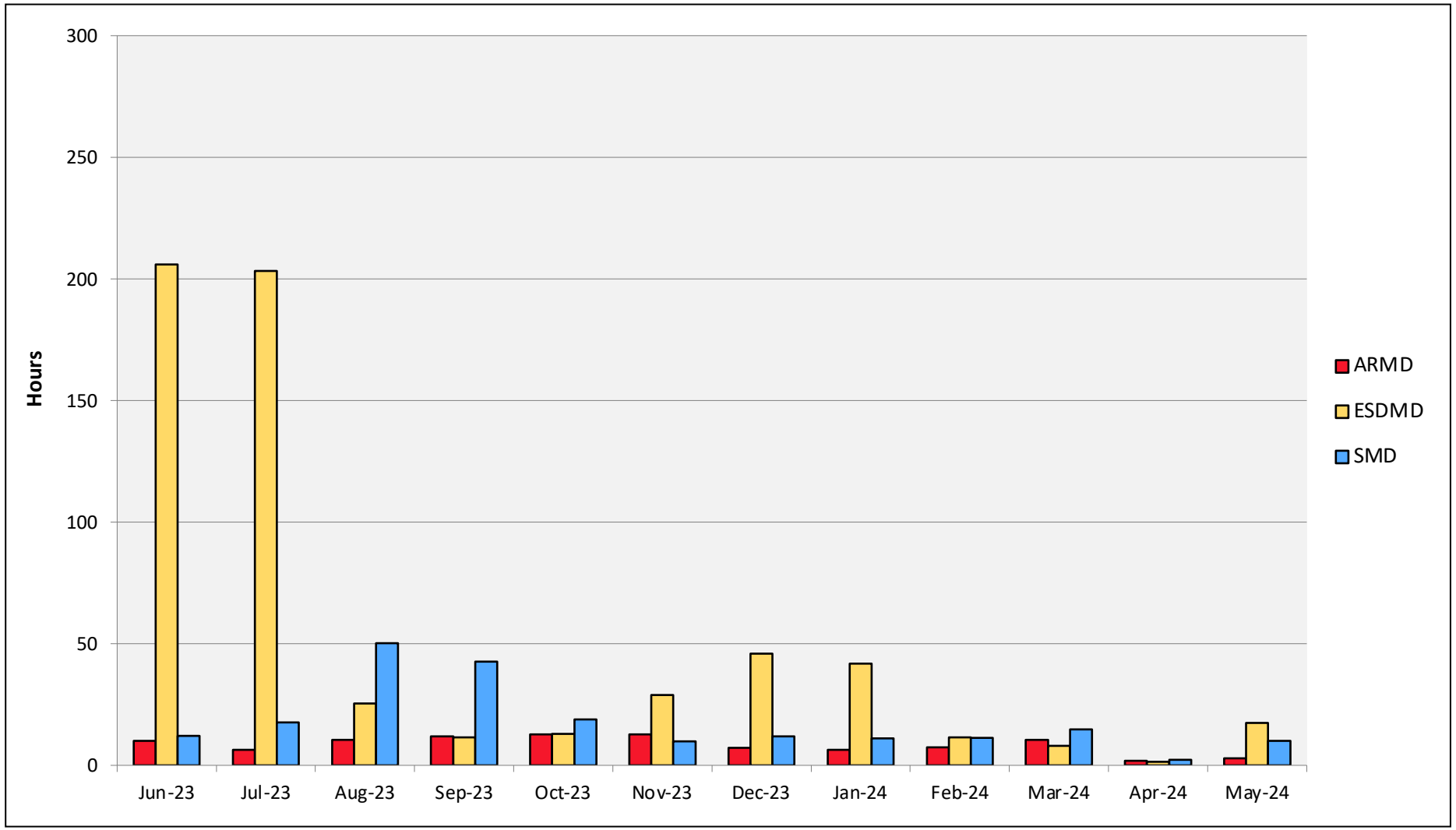
Aitken: Monthly Utilization by Job Size



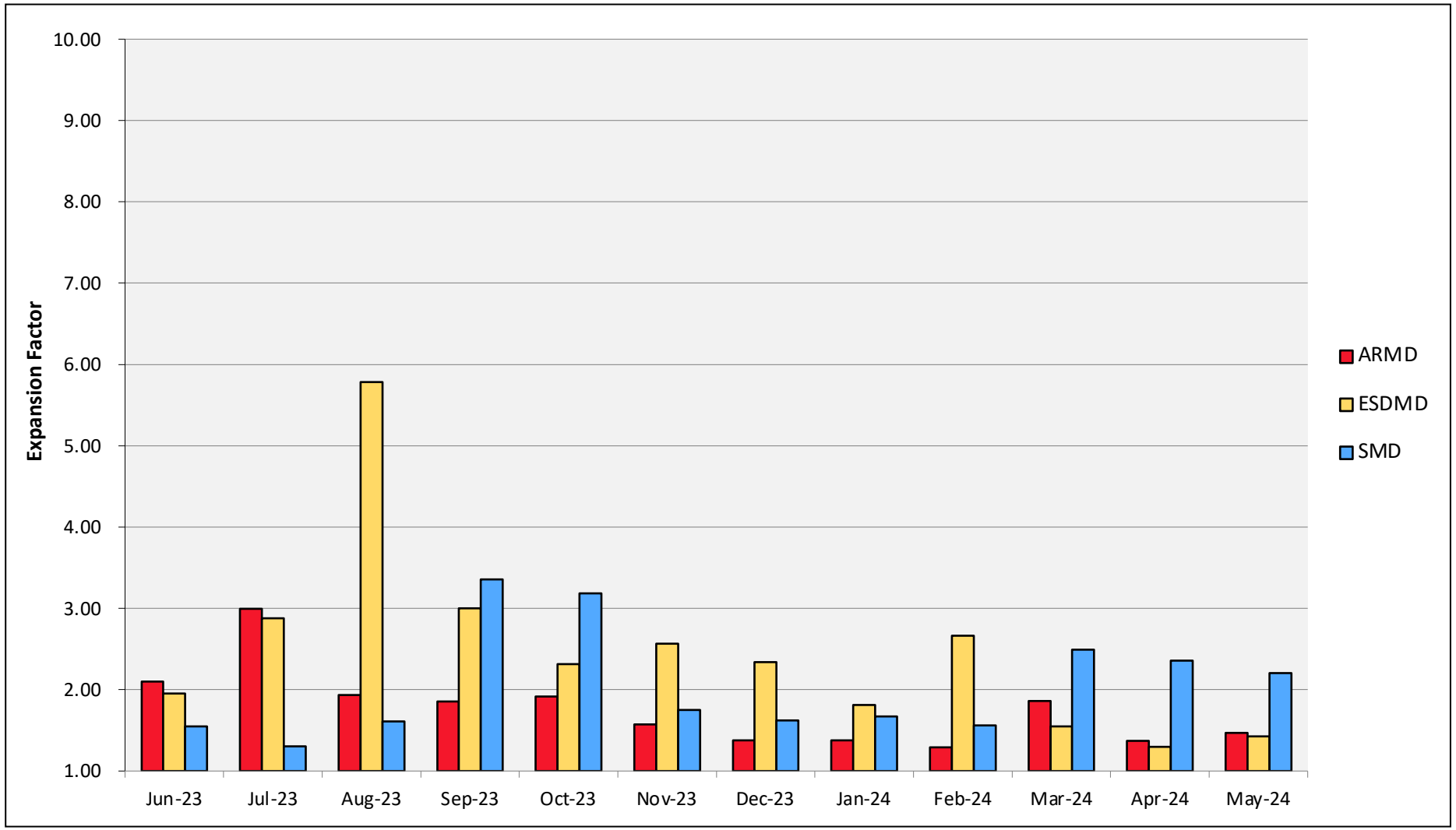
Aitken: Monthly Utilization by Size and Length



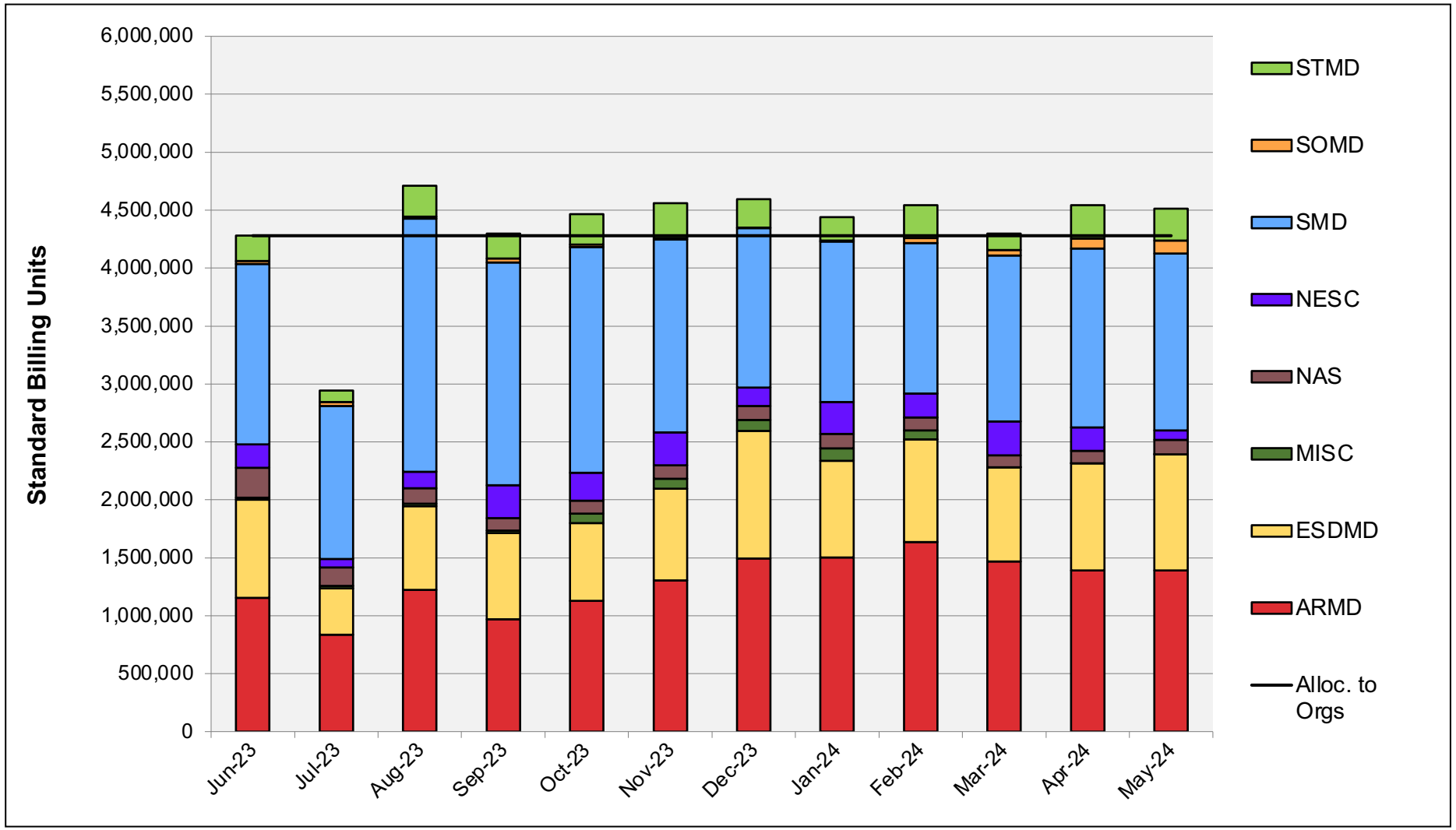
Aitken: Average Time to Clear All Jobs



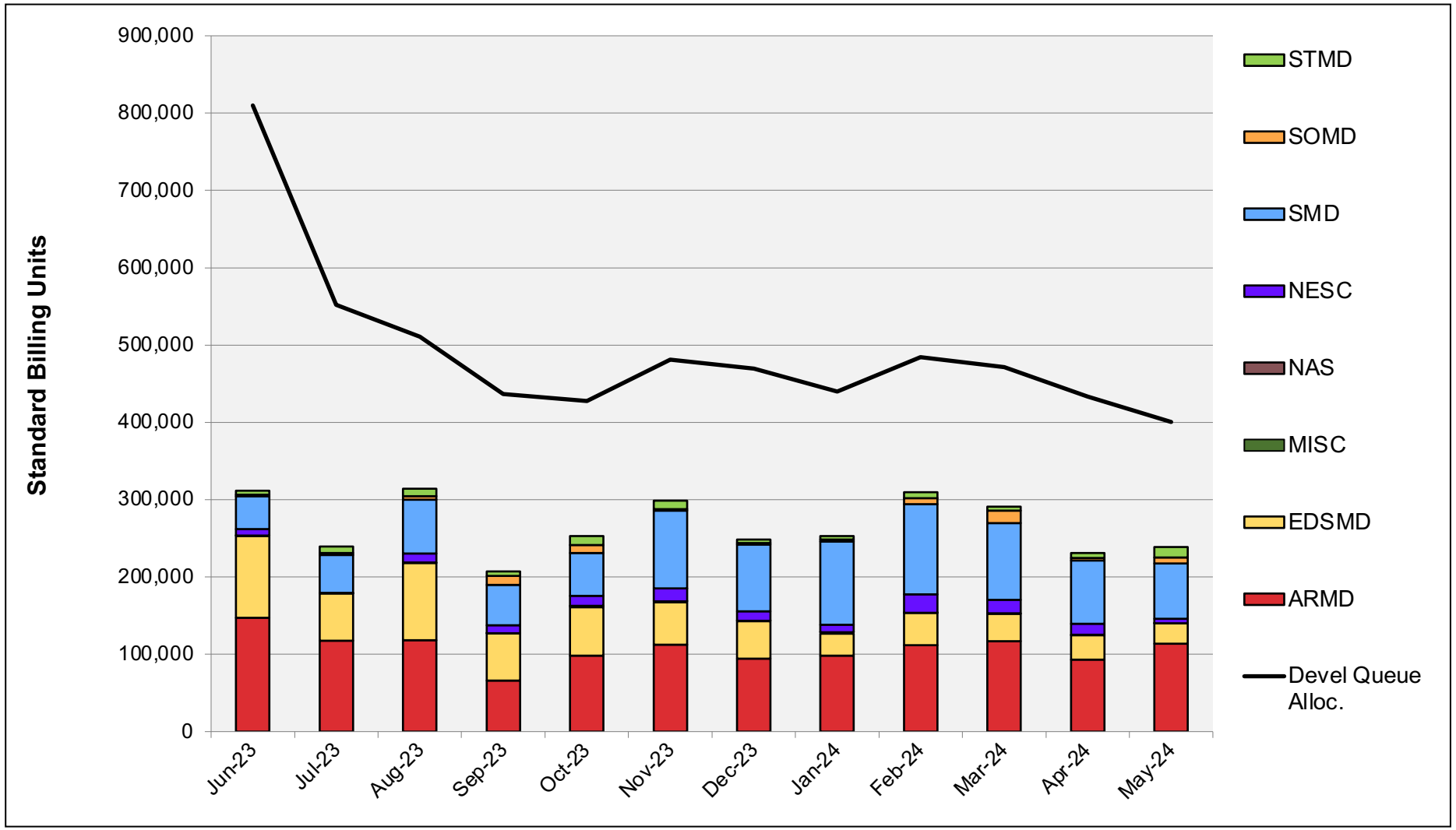
Aitken: Average Expansion Factor



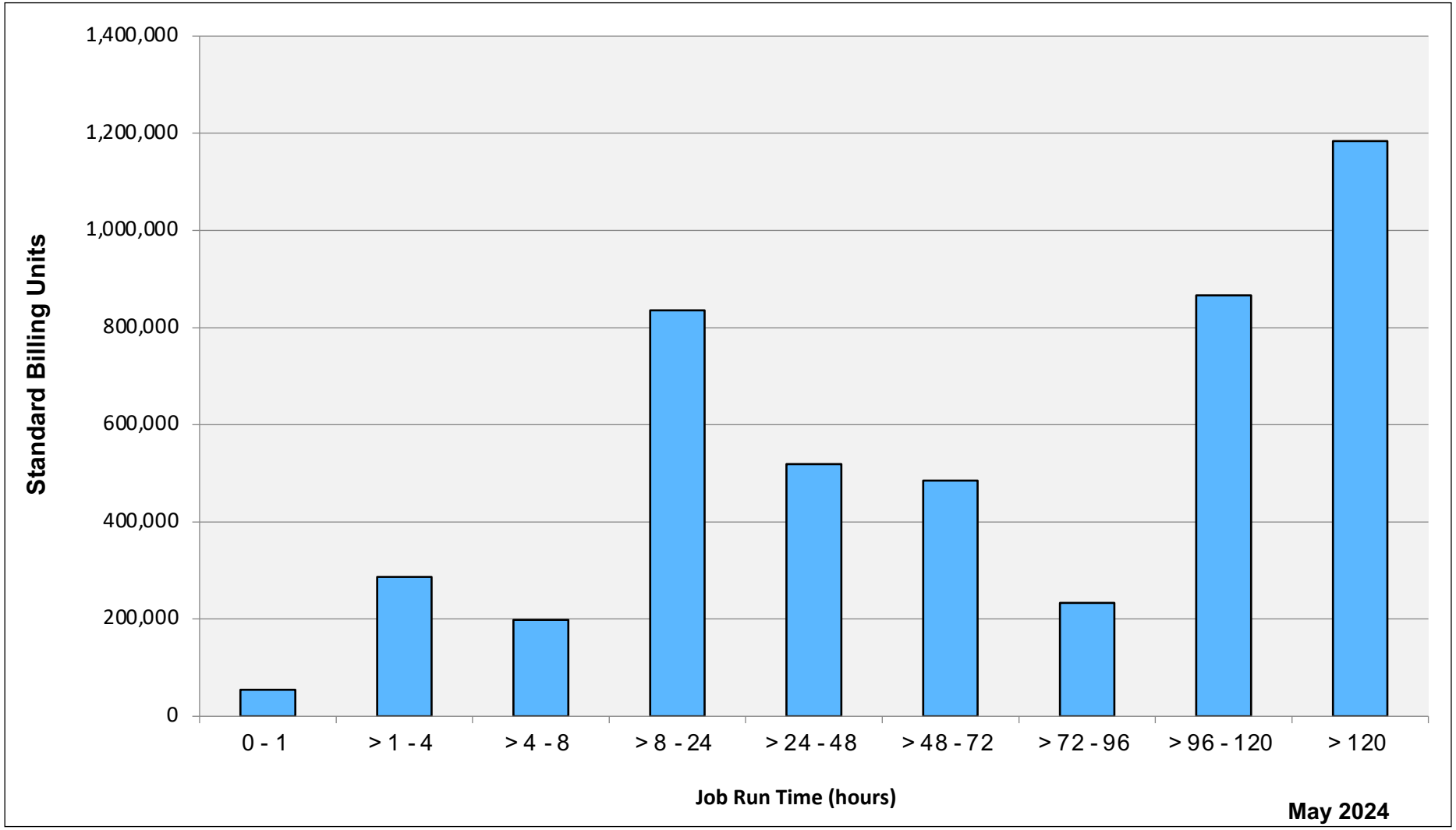
Pleiades: SBUs Reported, Normalized to 30-Day Month



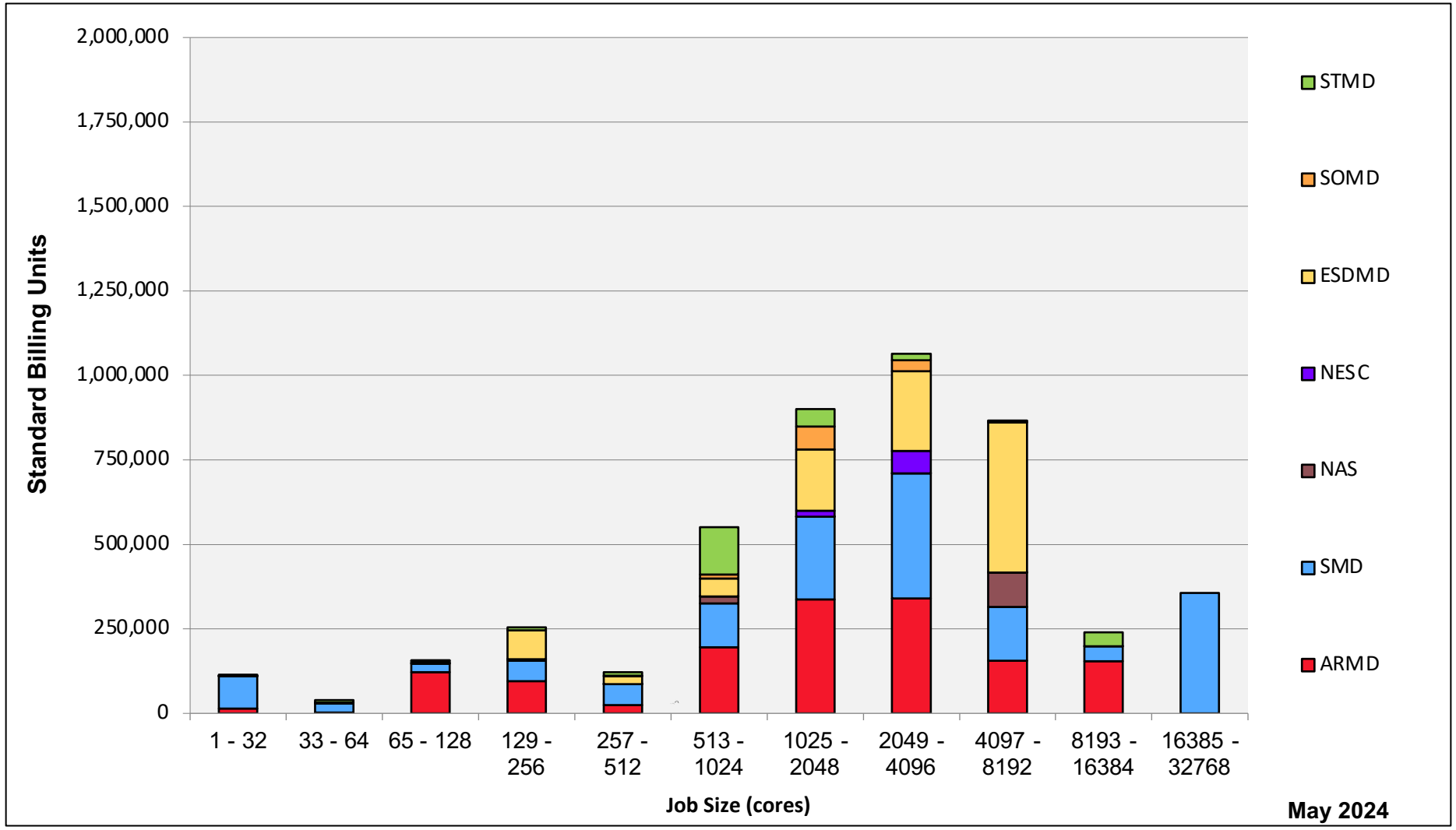
Pleiades: Devel Queue Utilization



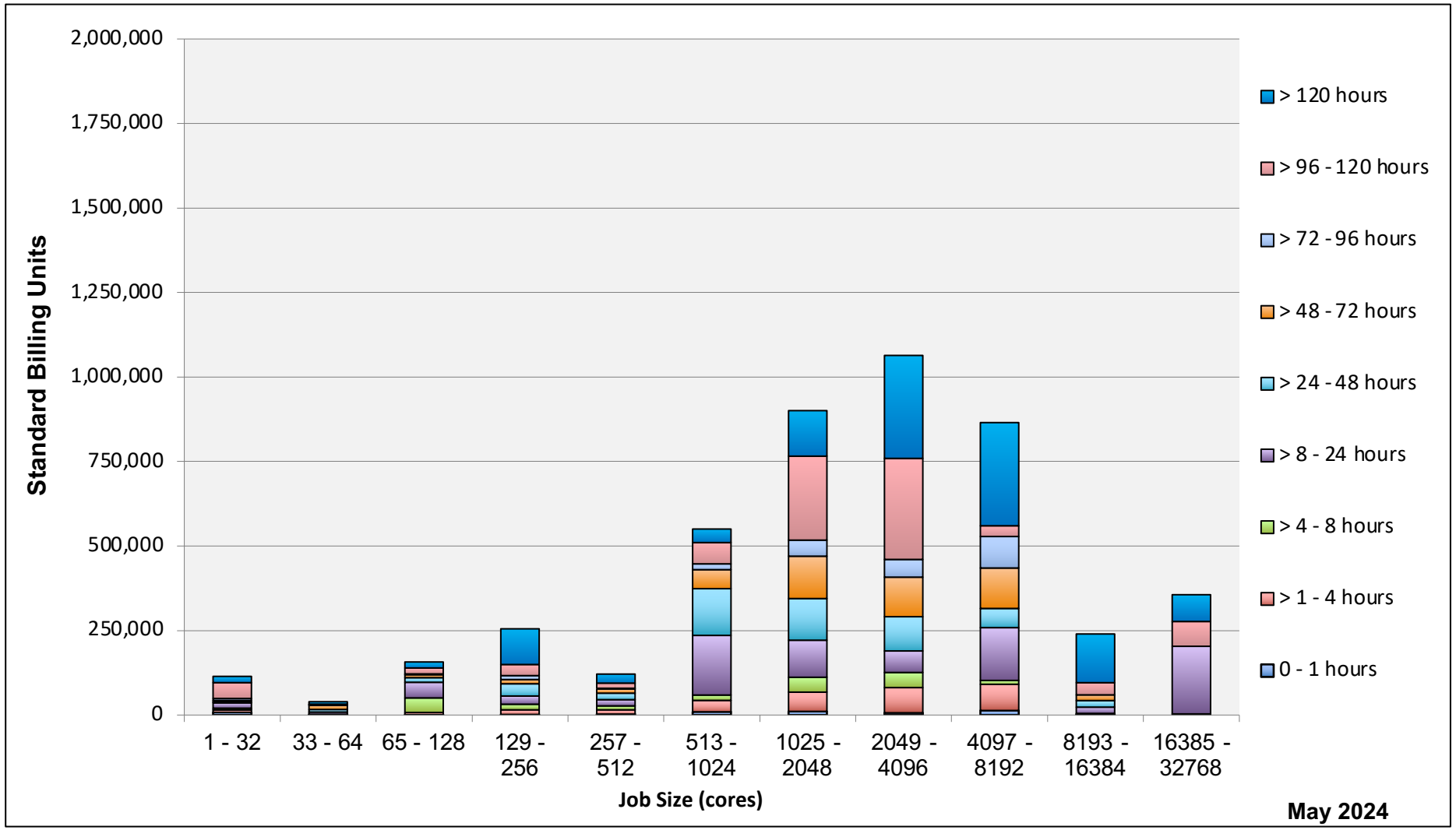
Pleiades: Monthly Utilization by Job Length



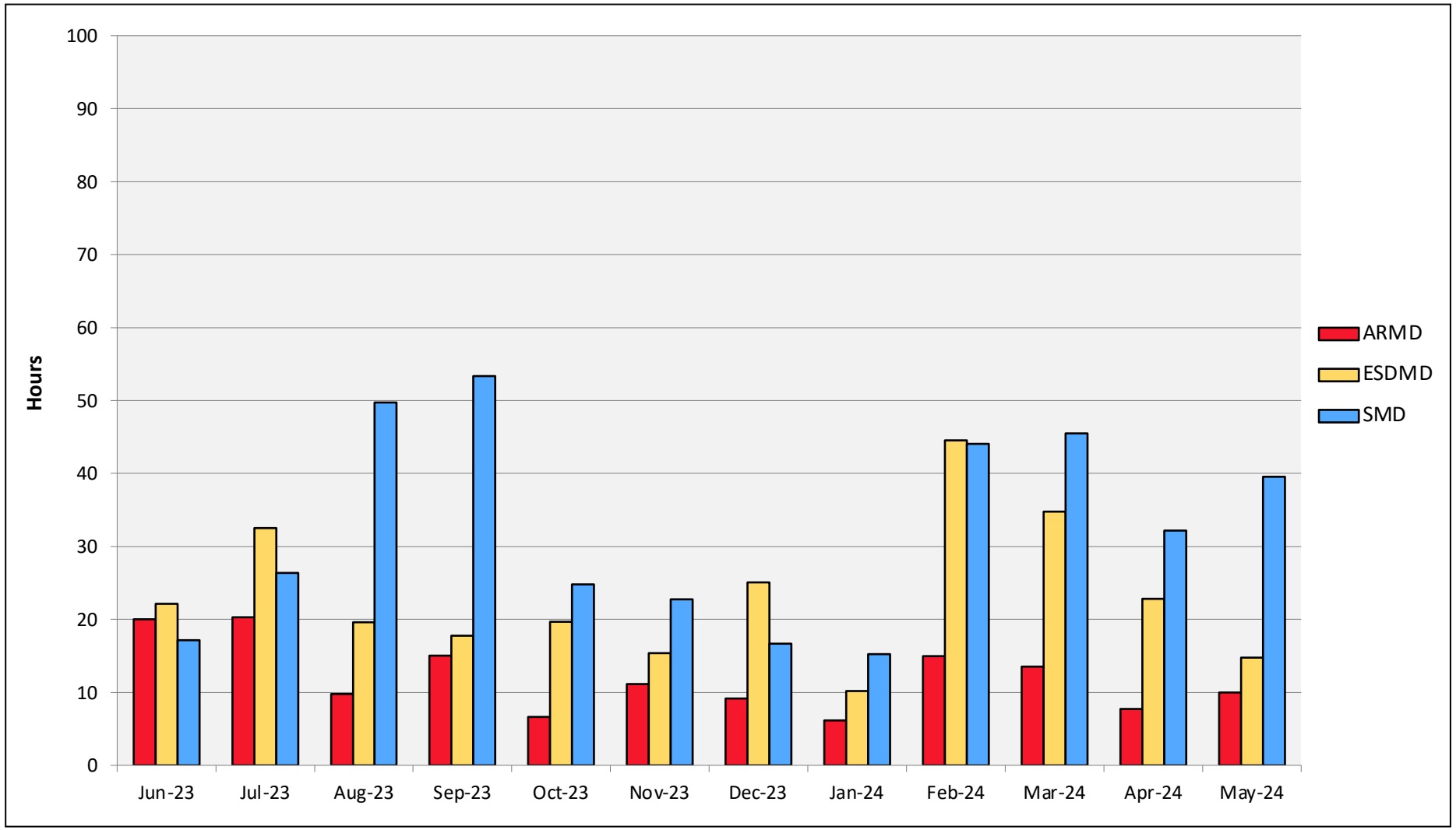
Pleiades: Monthly Utilization by Job Size



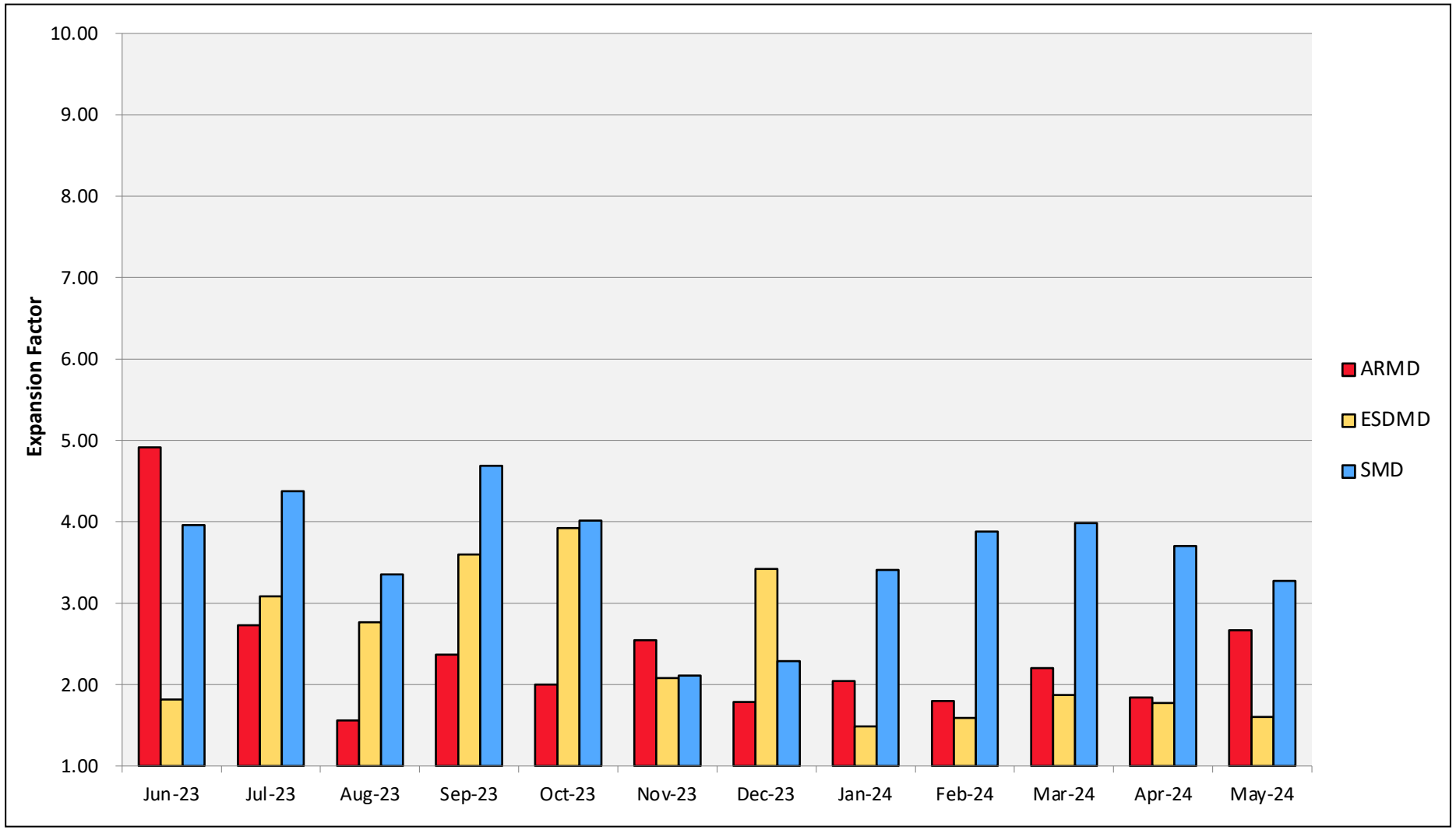
Pleiades: Monthly Utilization by Size and Length



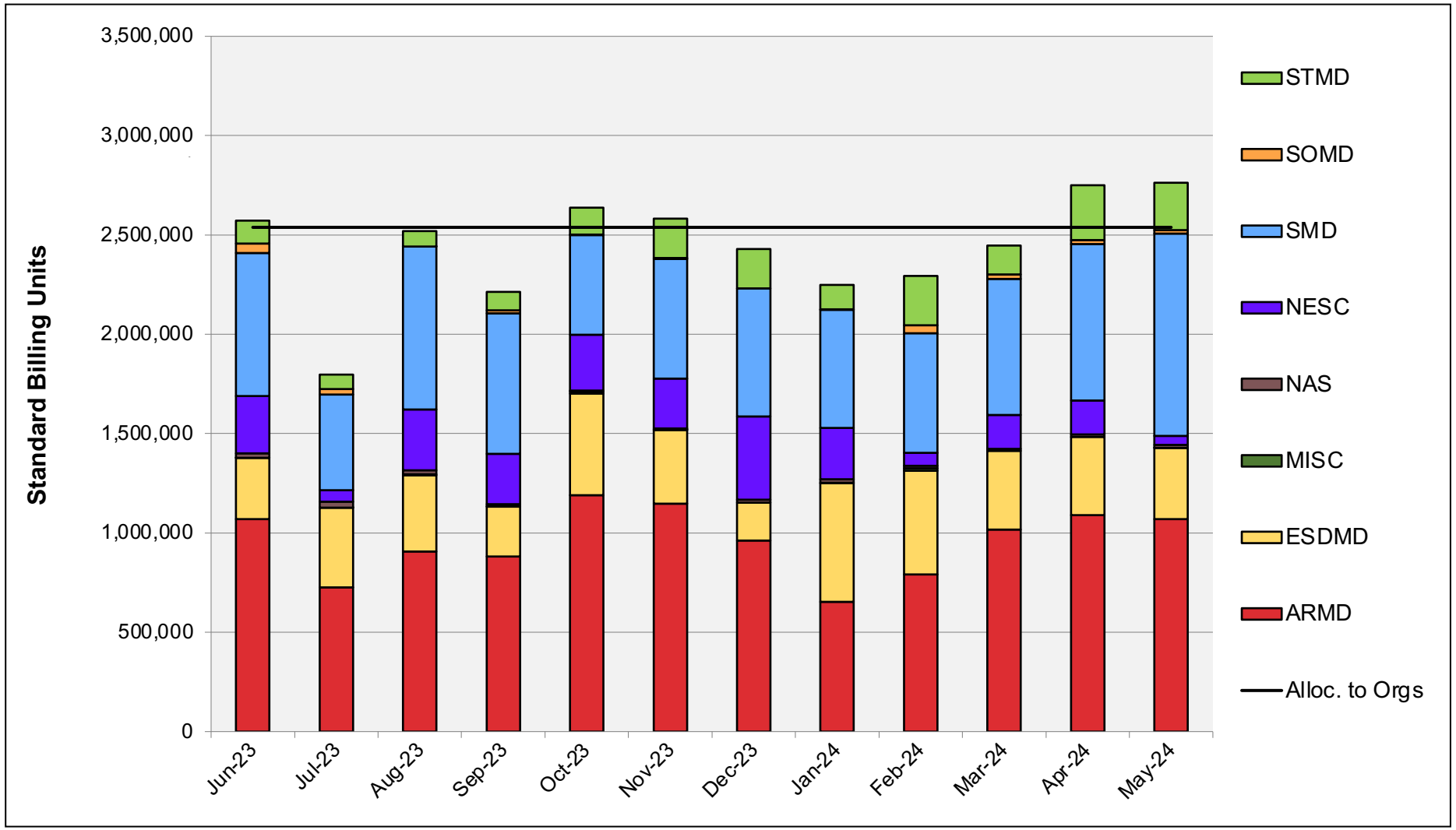
Pleiades: Average Time to Clear All Jobs



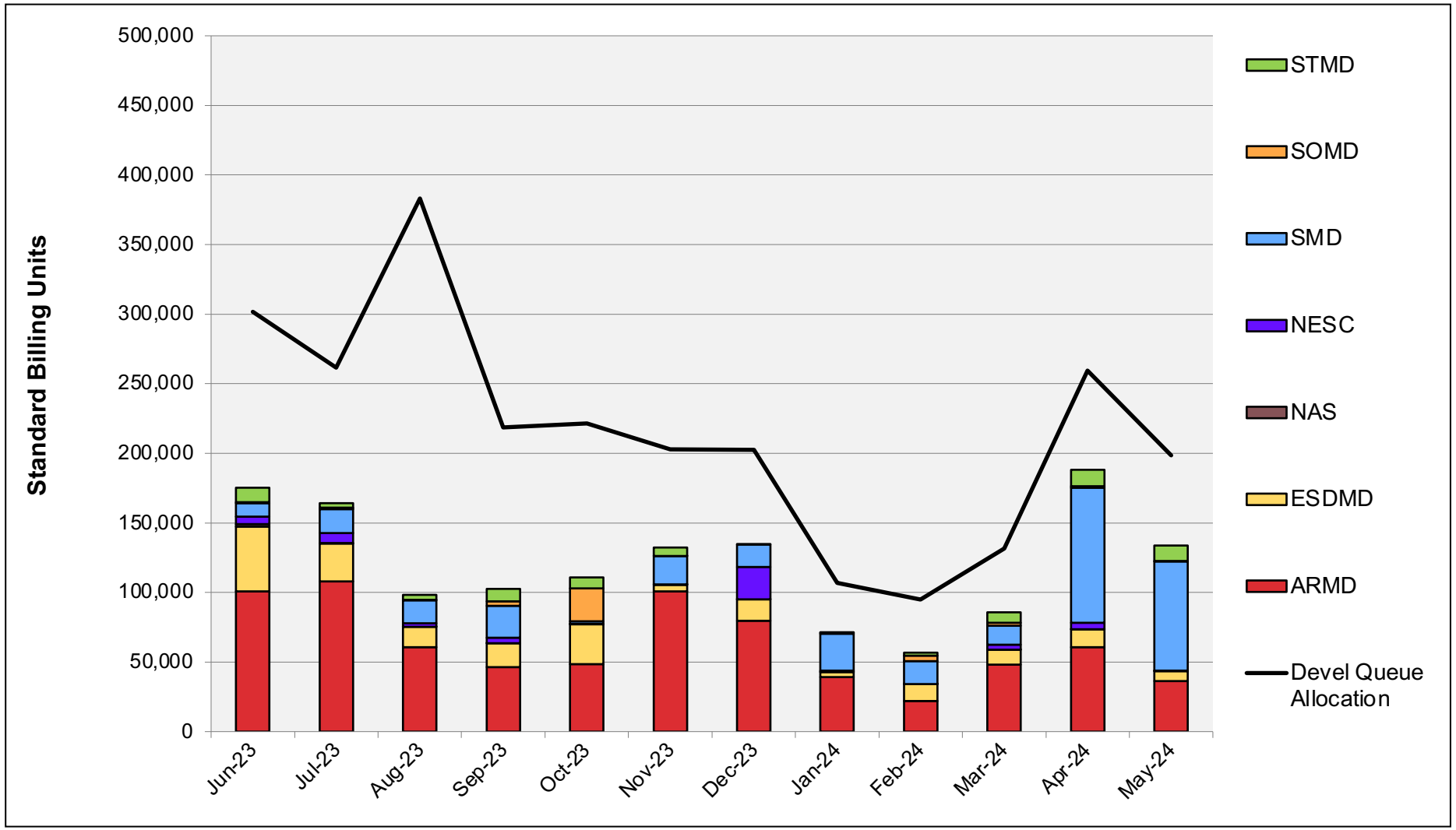
Pleiades: Average Expansion Factor



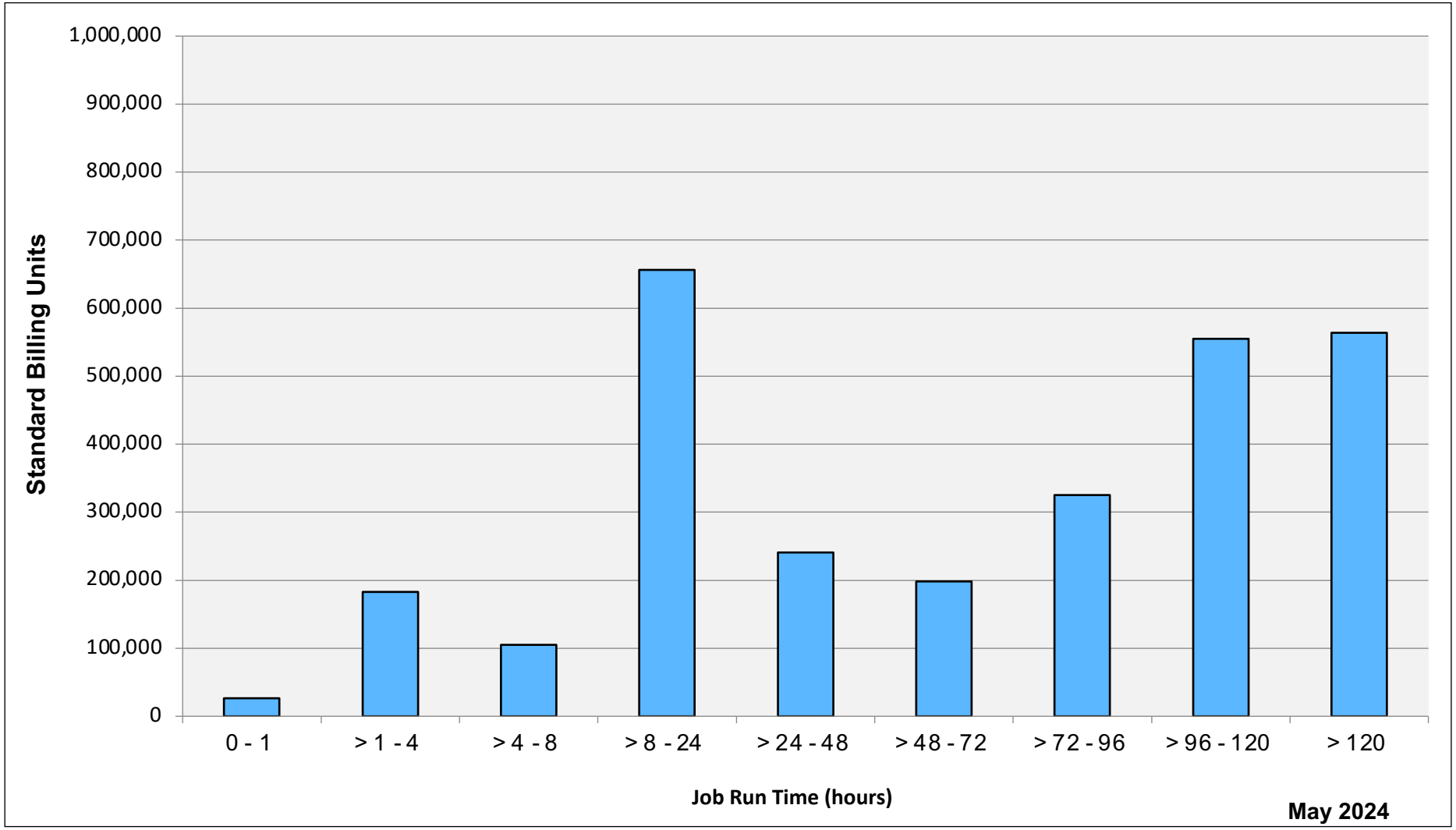
Electra: SBUs Reported, Normalized to 30-Day Month



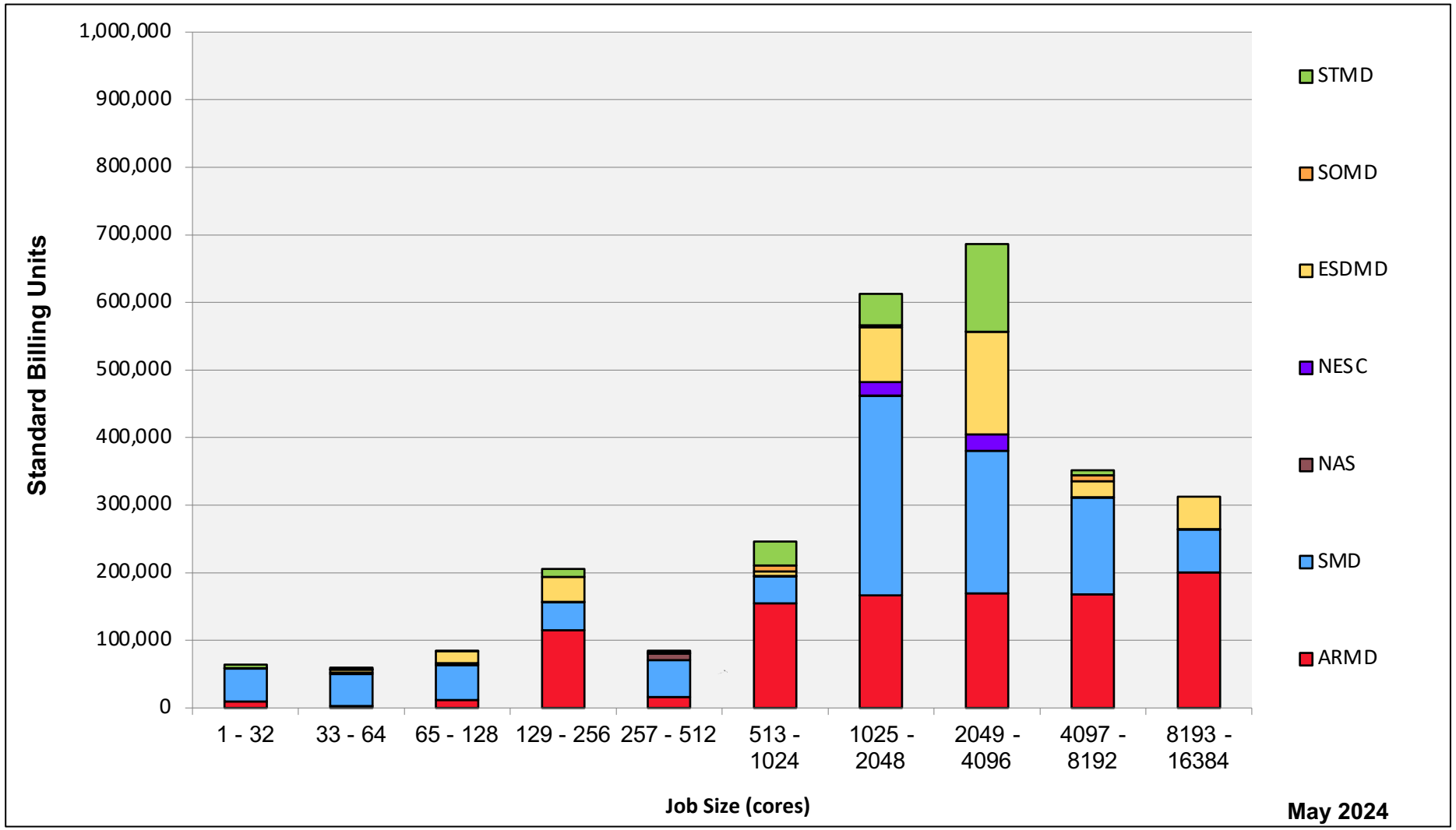
Electra: Devel Queue Utilization



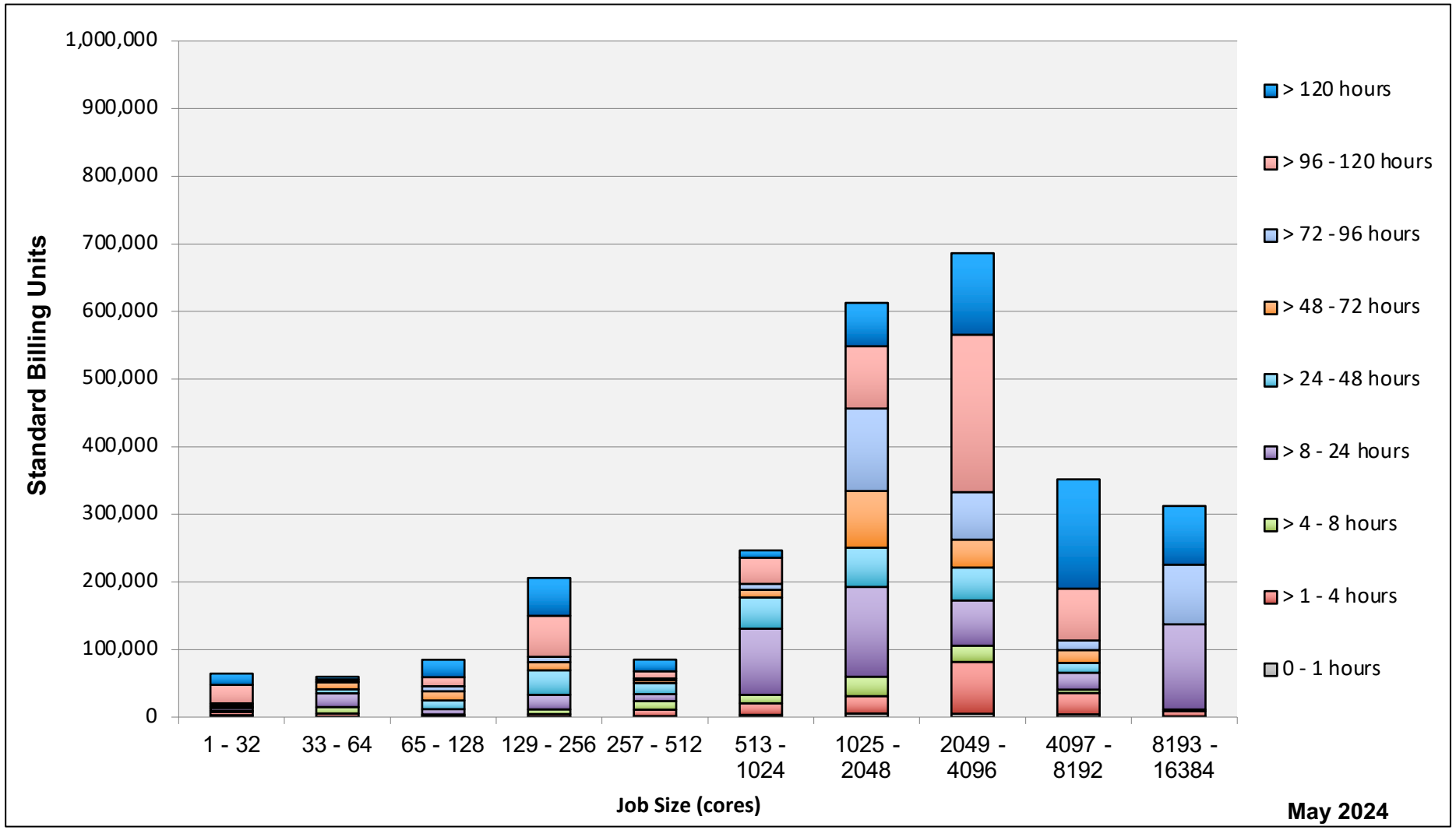
Electra: Monthly Utilization by Job Length



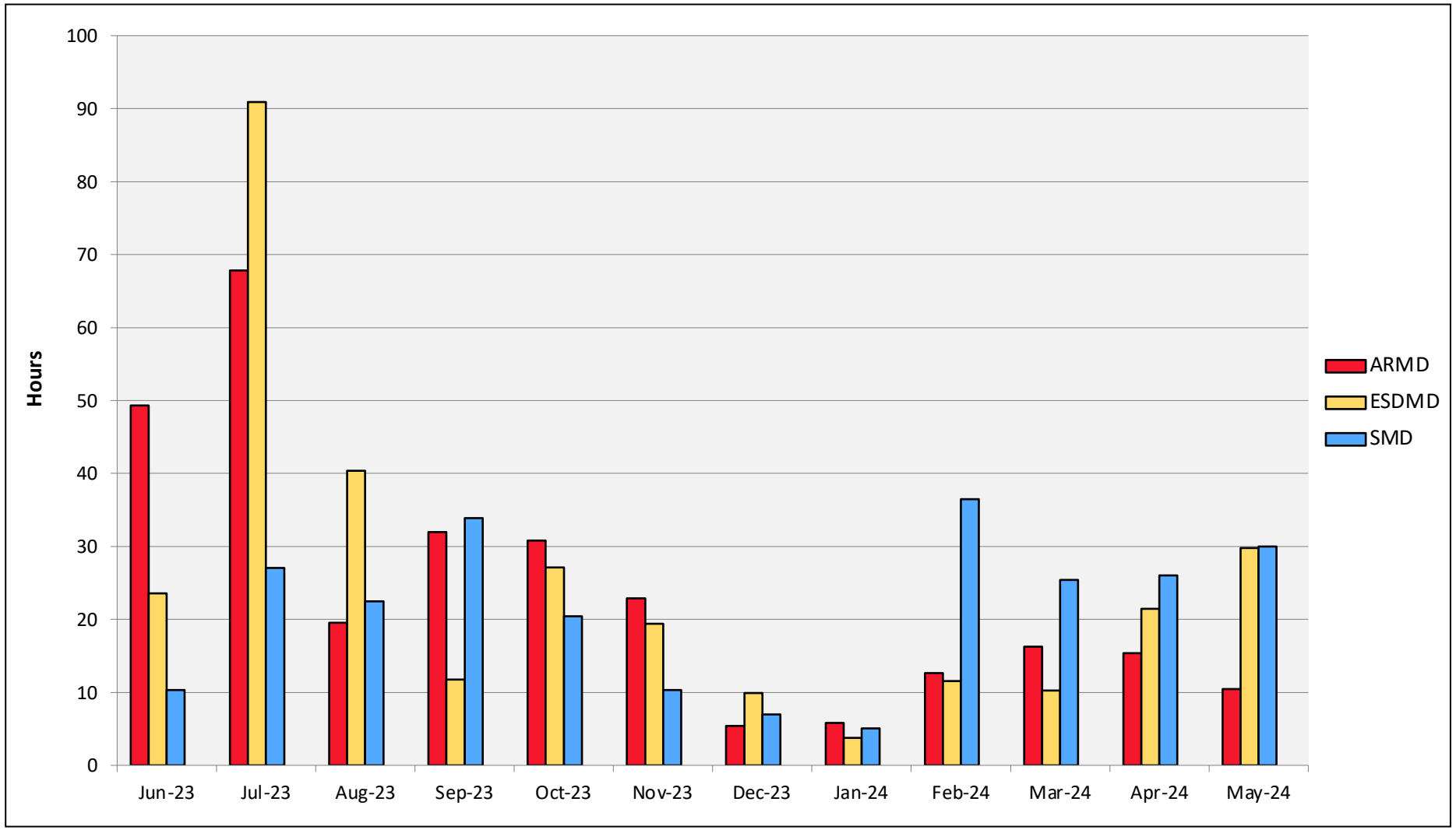
Electra: Monthly Utilization by Job Size



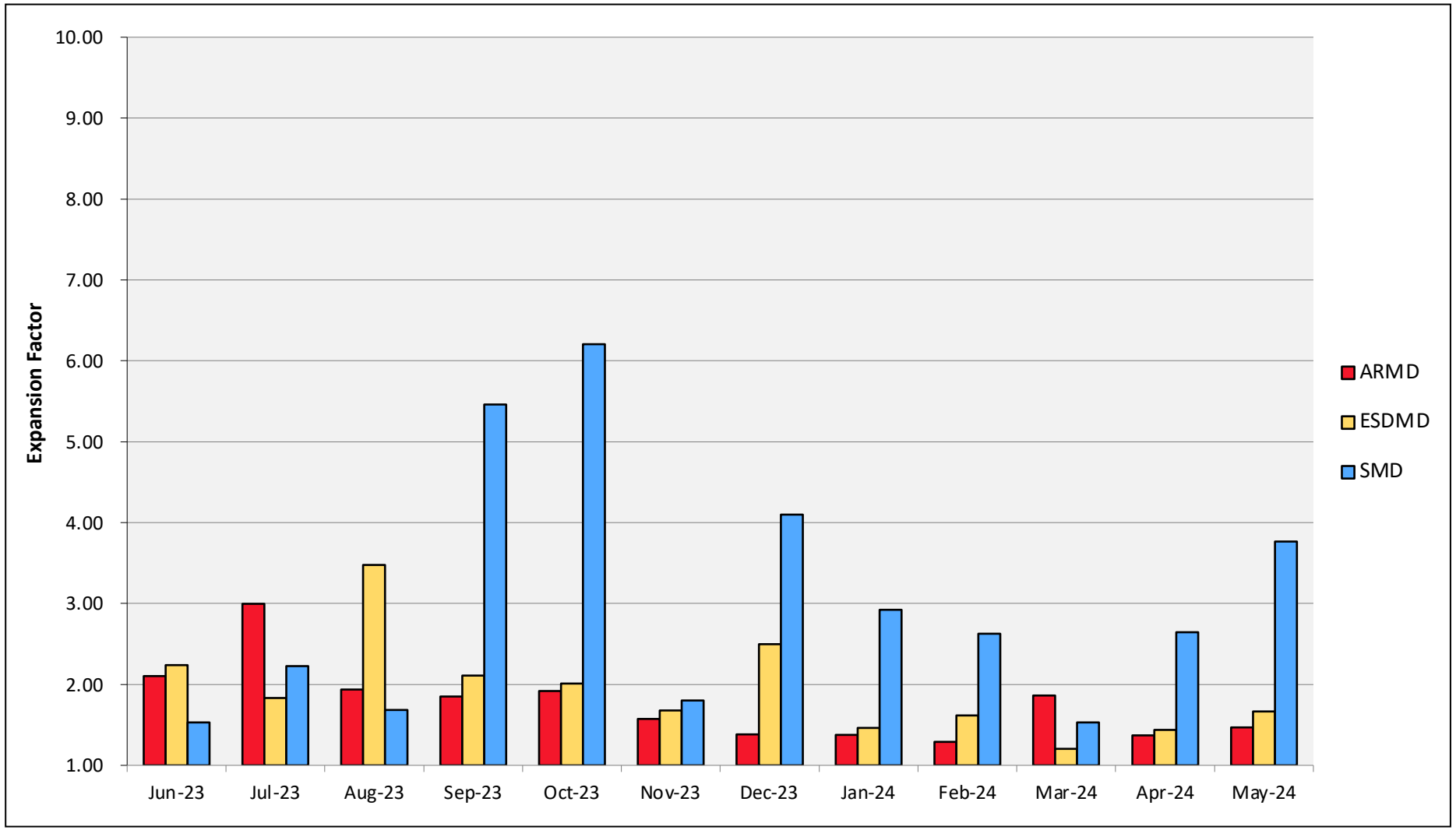
Electra: Monthly Utilization by Size and Length



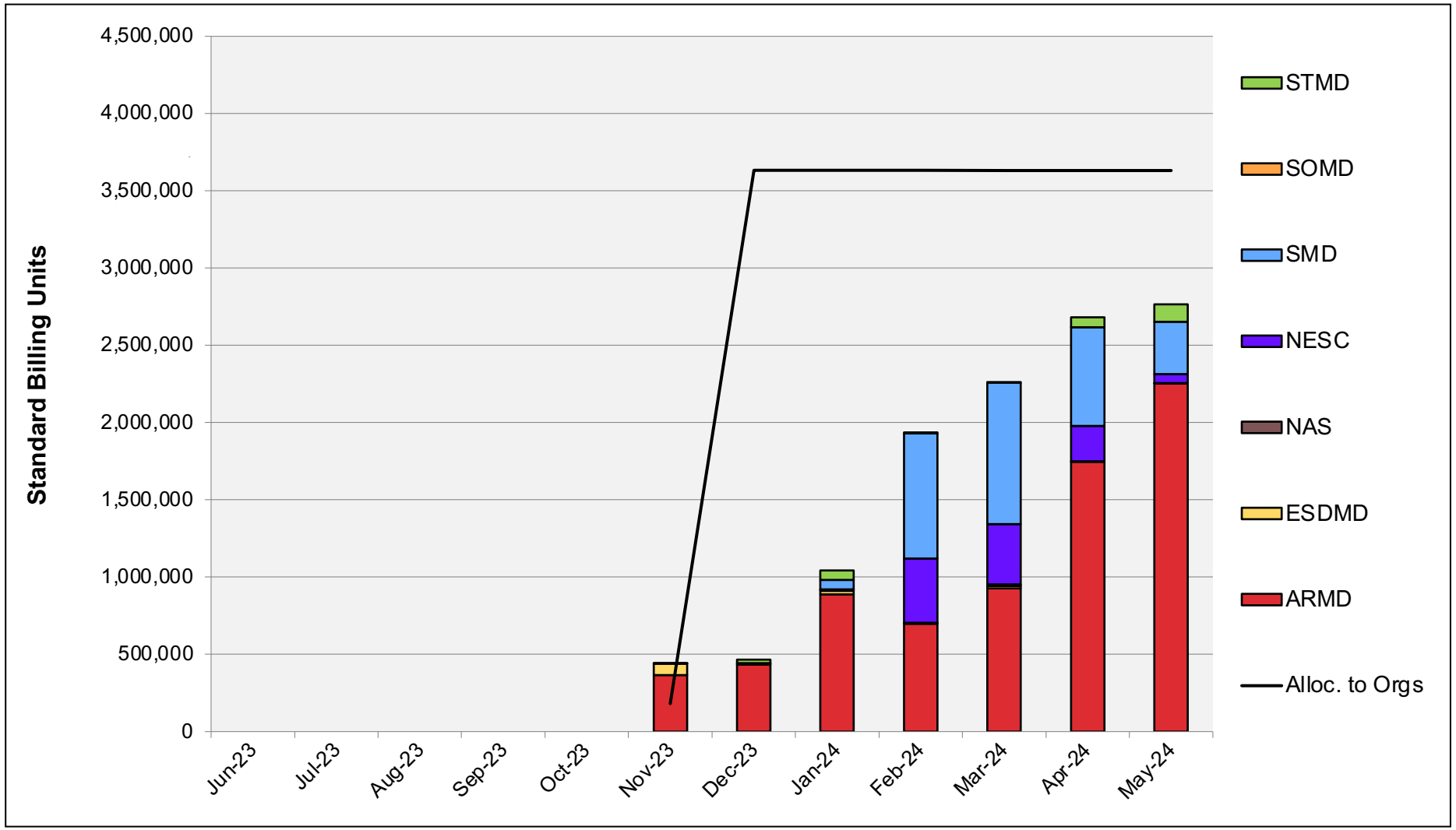
Electra: Average Time to Clear All Jobs



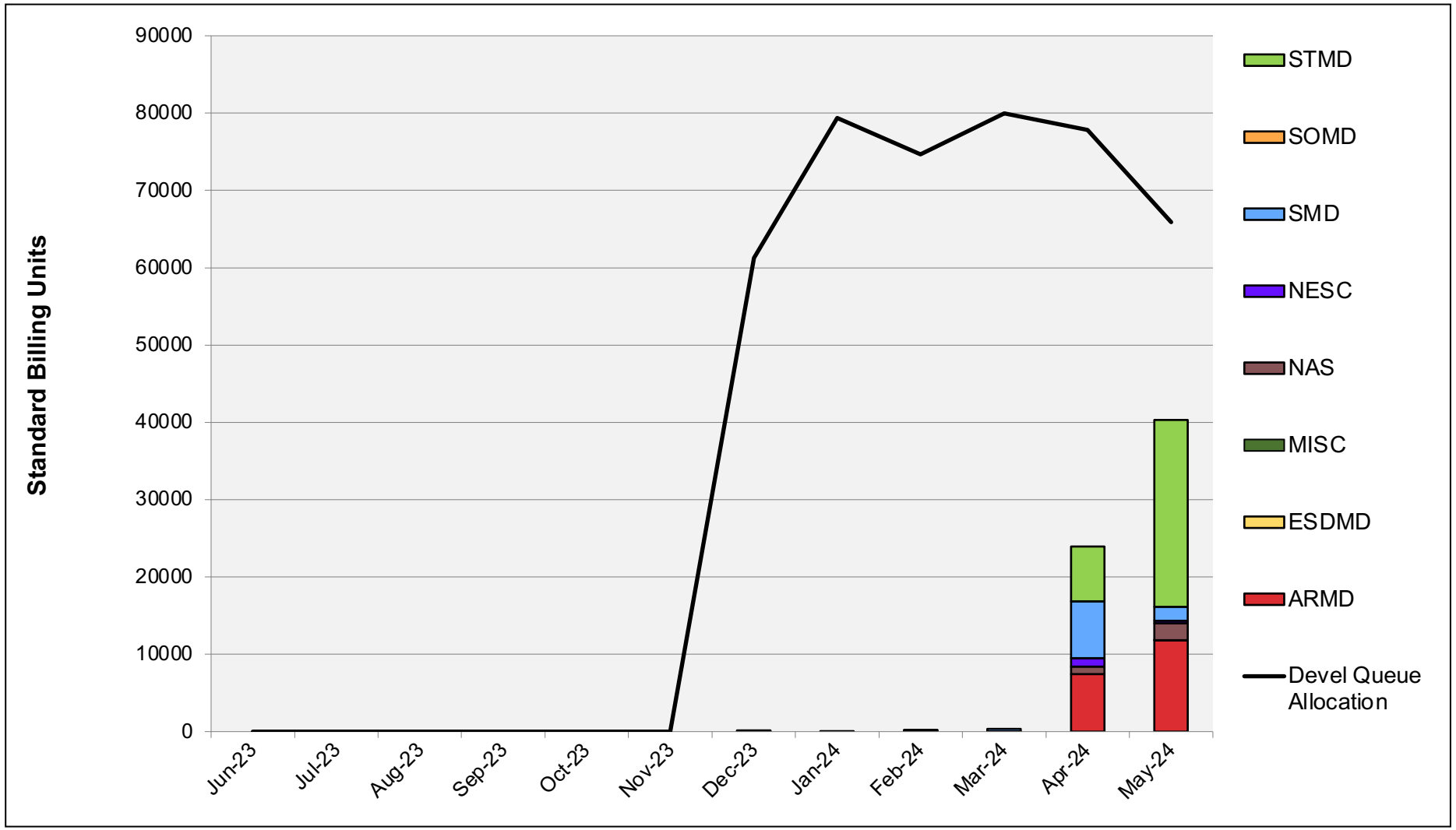
Electra: Average Expansion Factor



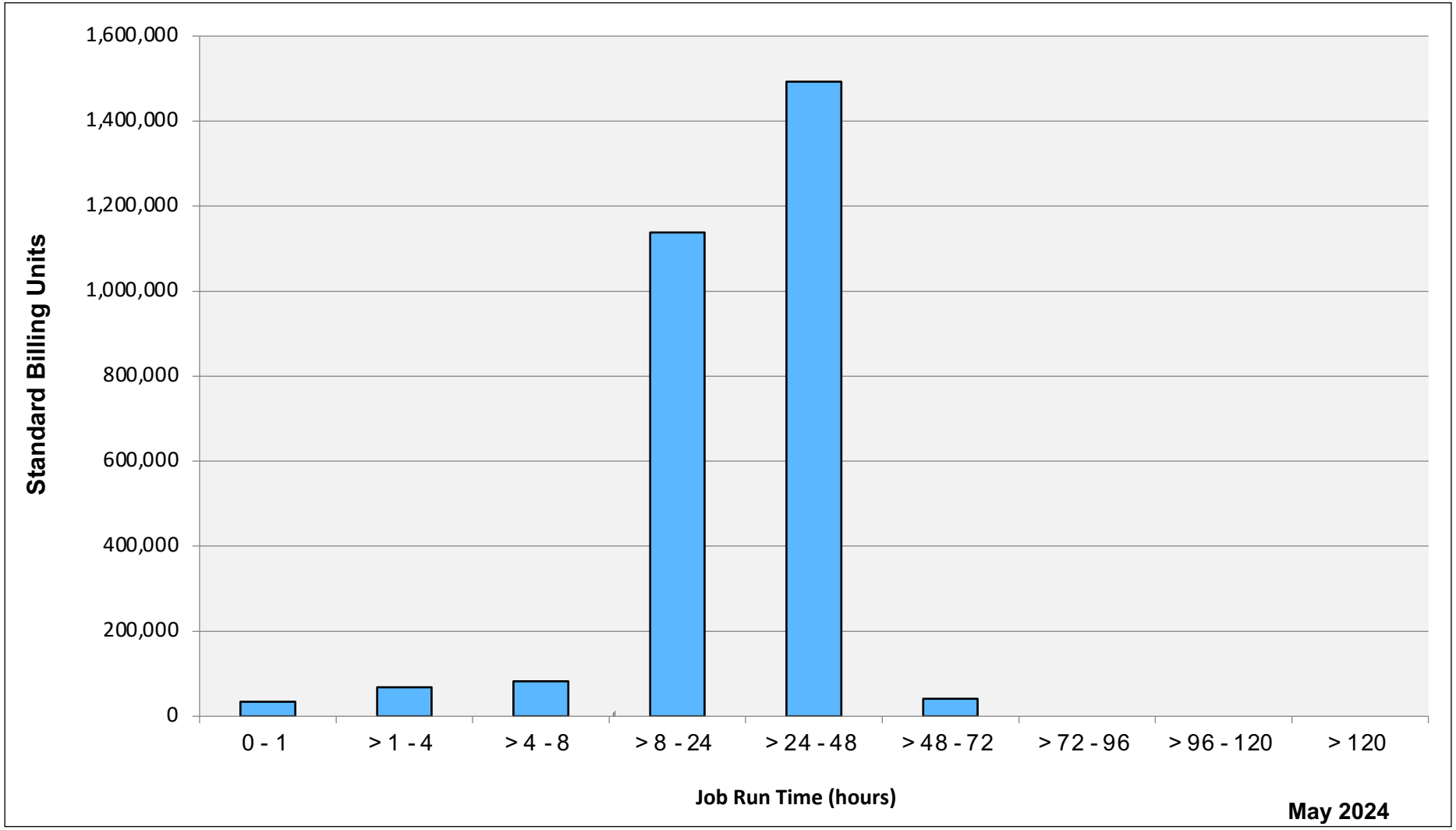
Cabeus: SBUs Reported, Normalized to 30-Day Month



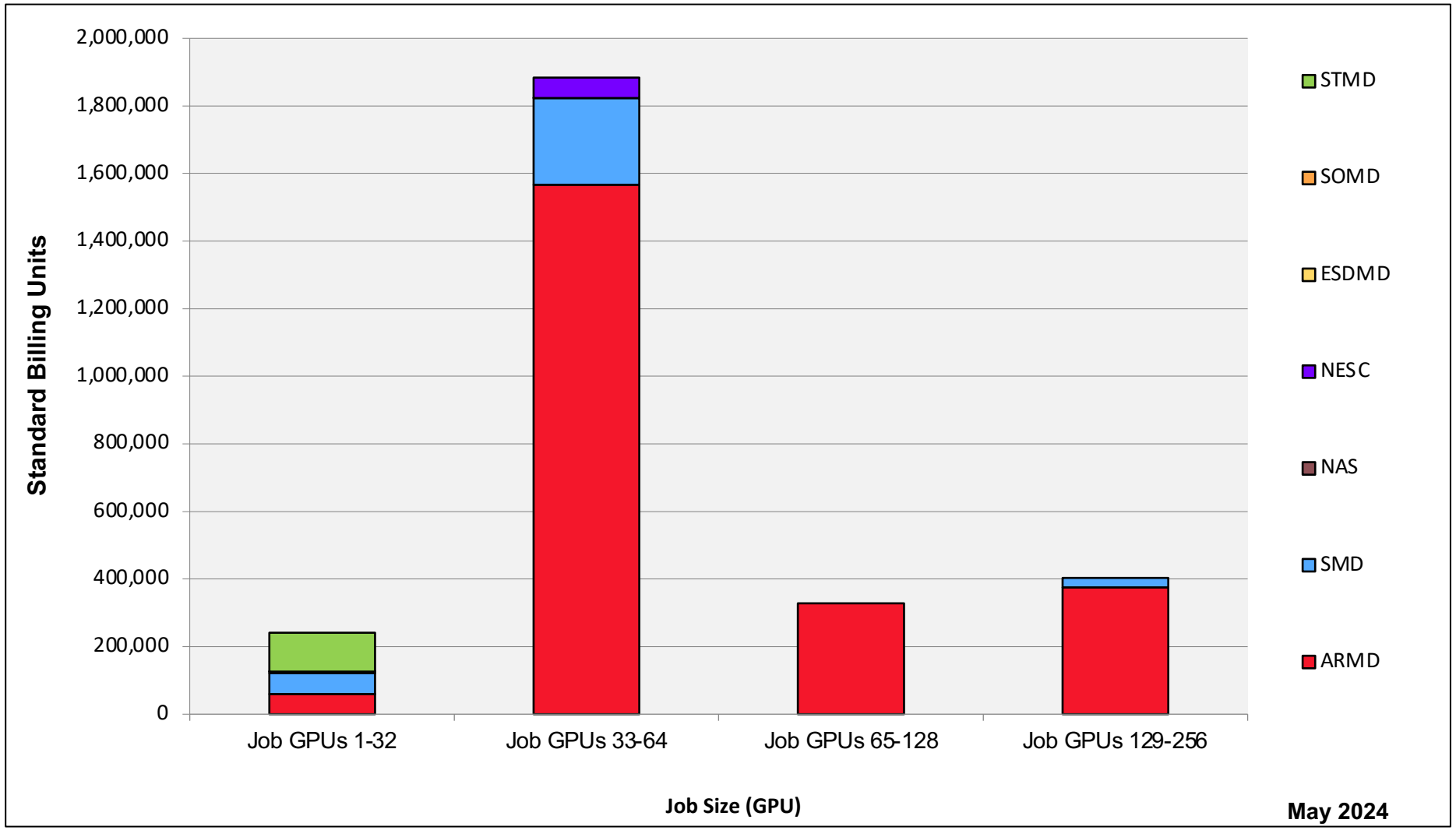
Cabeus: Devel Queue Utilization



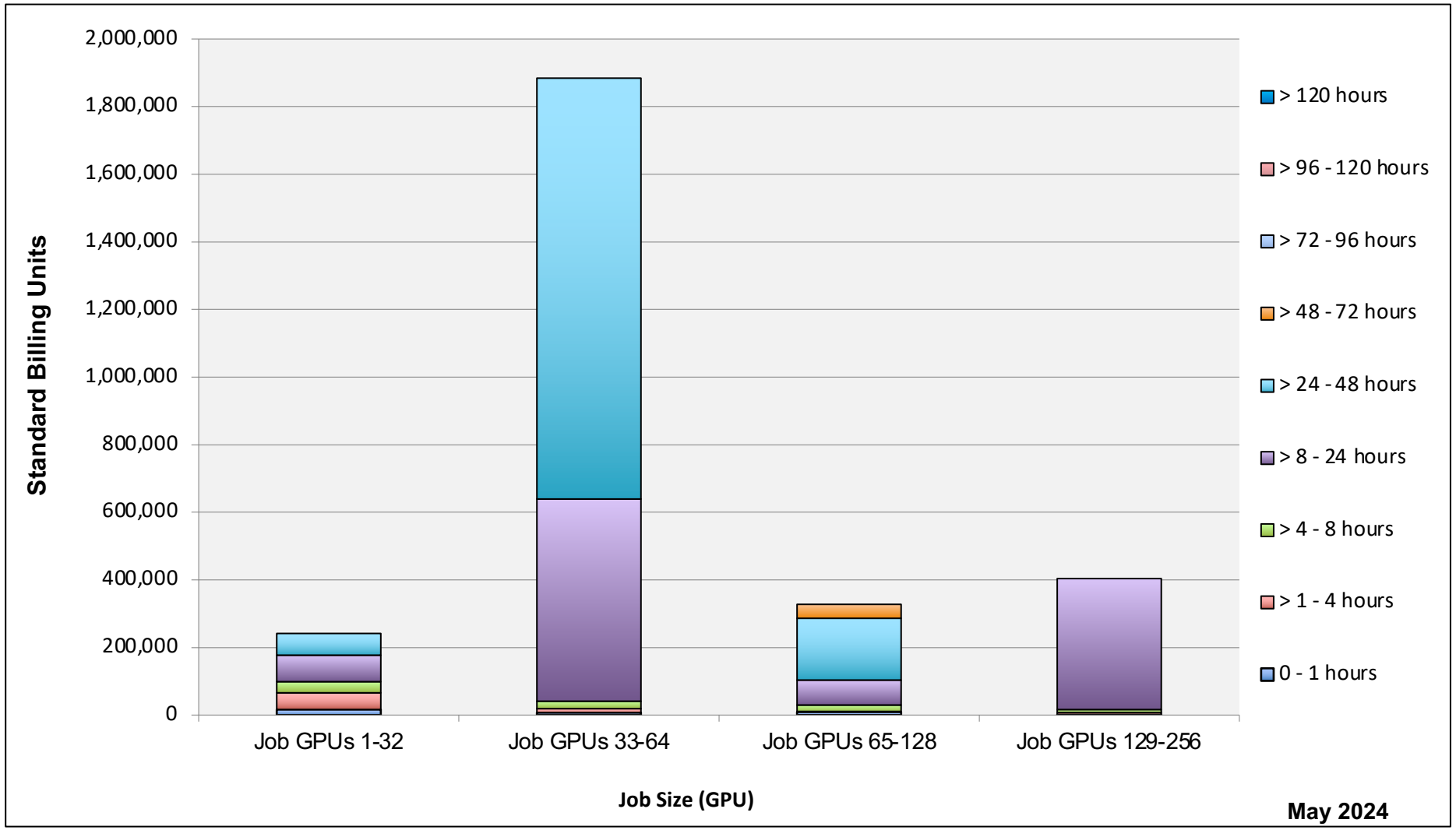
Cabeus: Monthly Utilization by Job Length



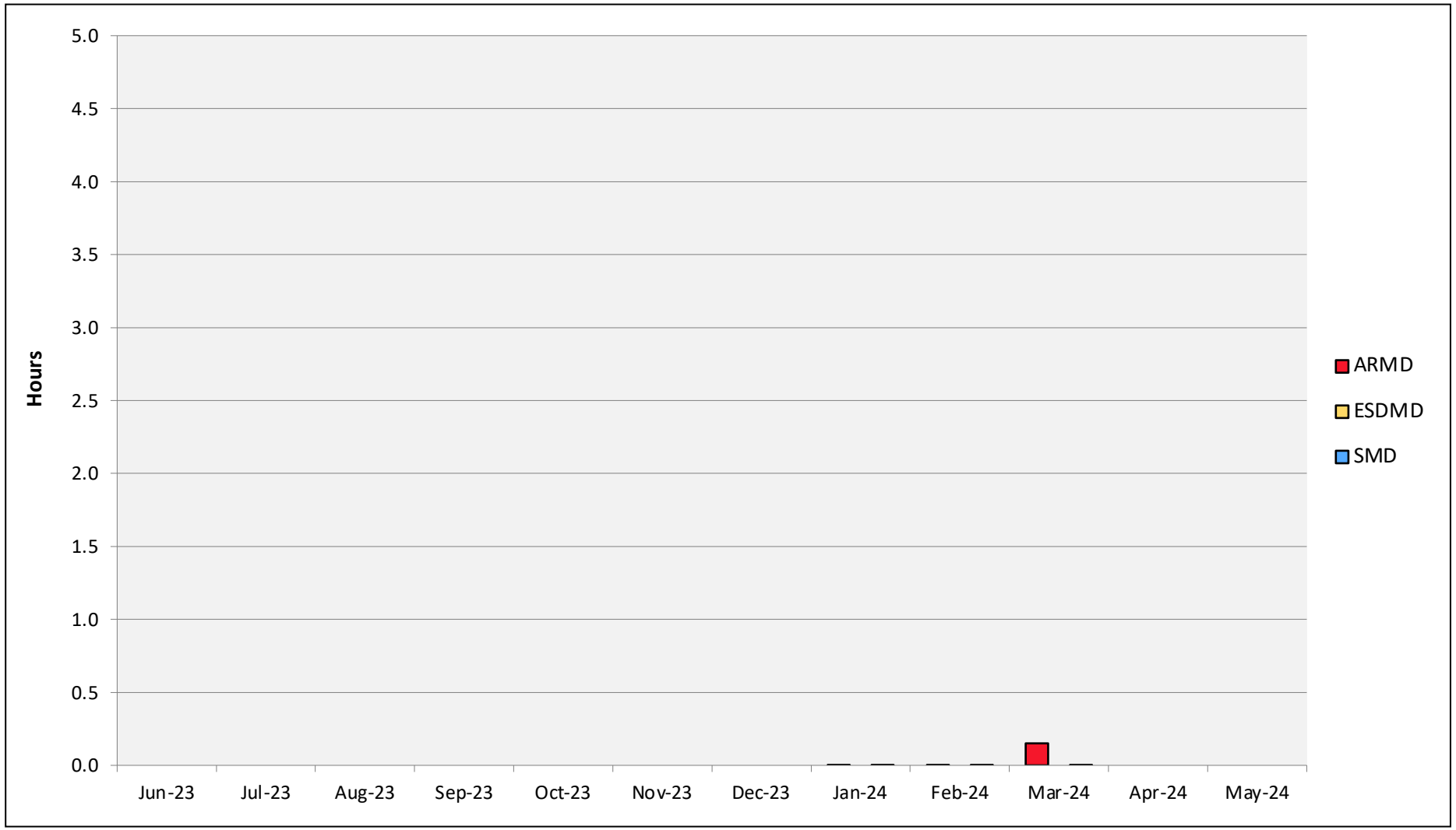
Cabeus: Monthly Utilization by Job Size



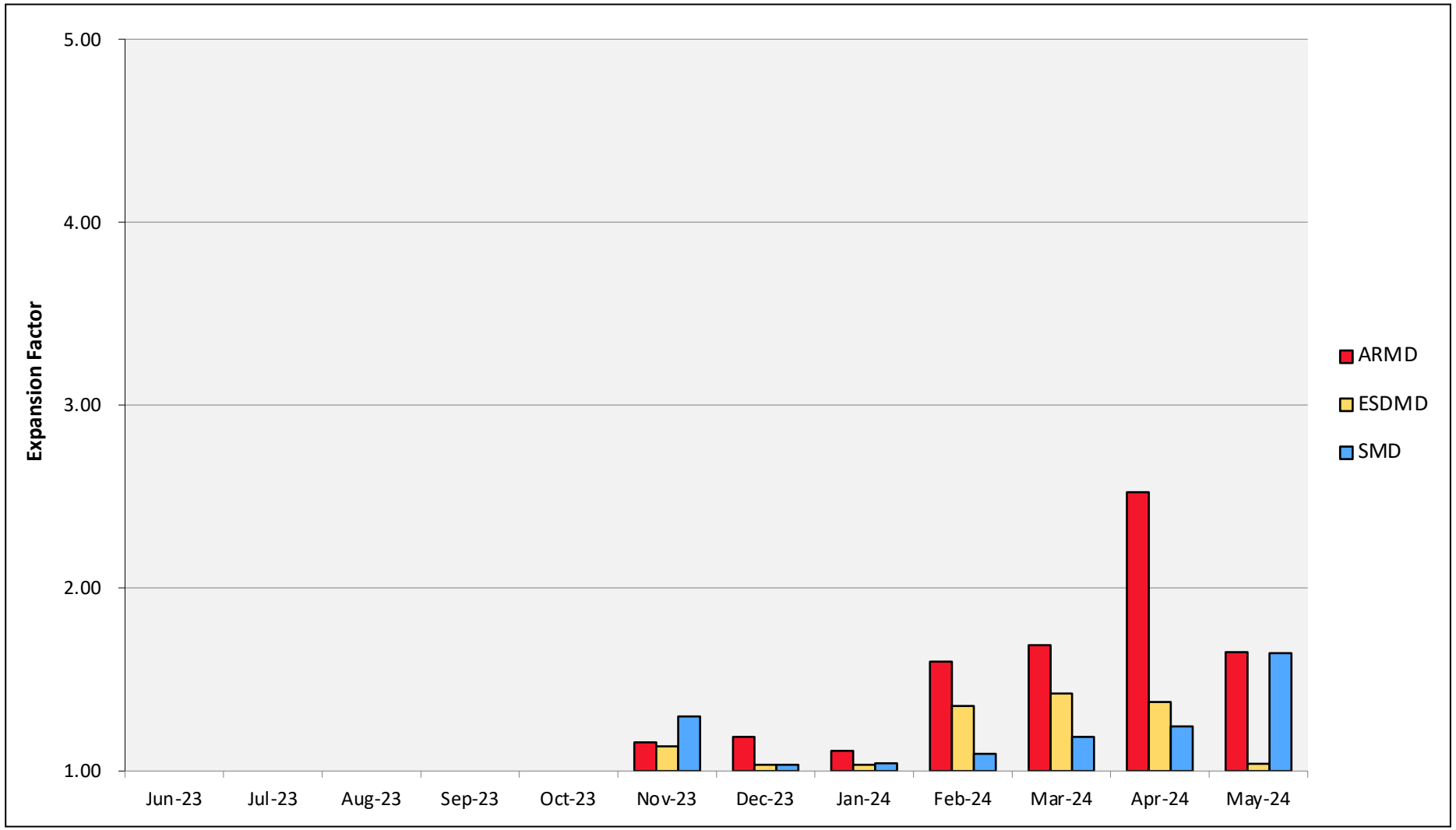
Cabeus: Monthly Utilization by Size and Length



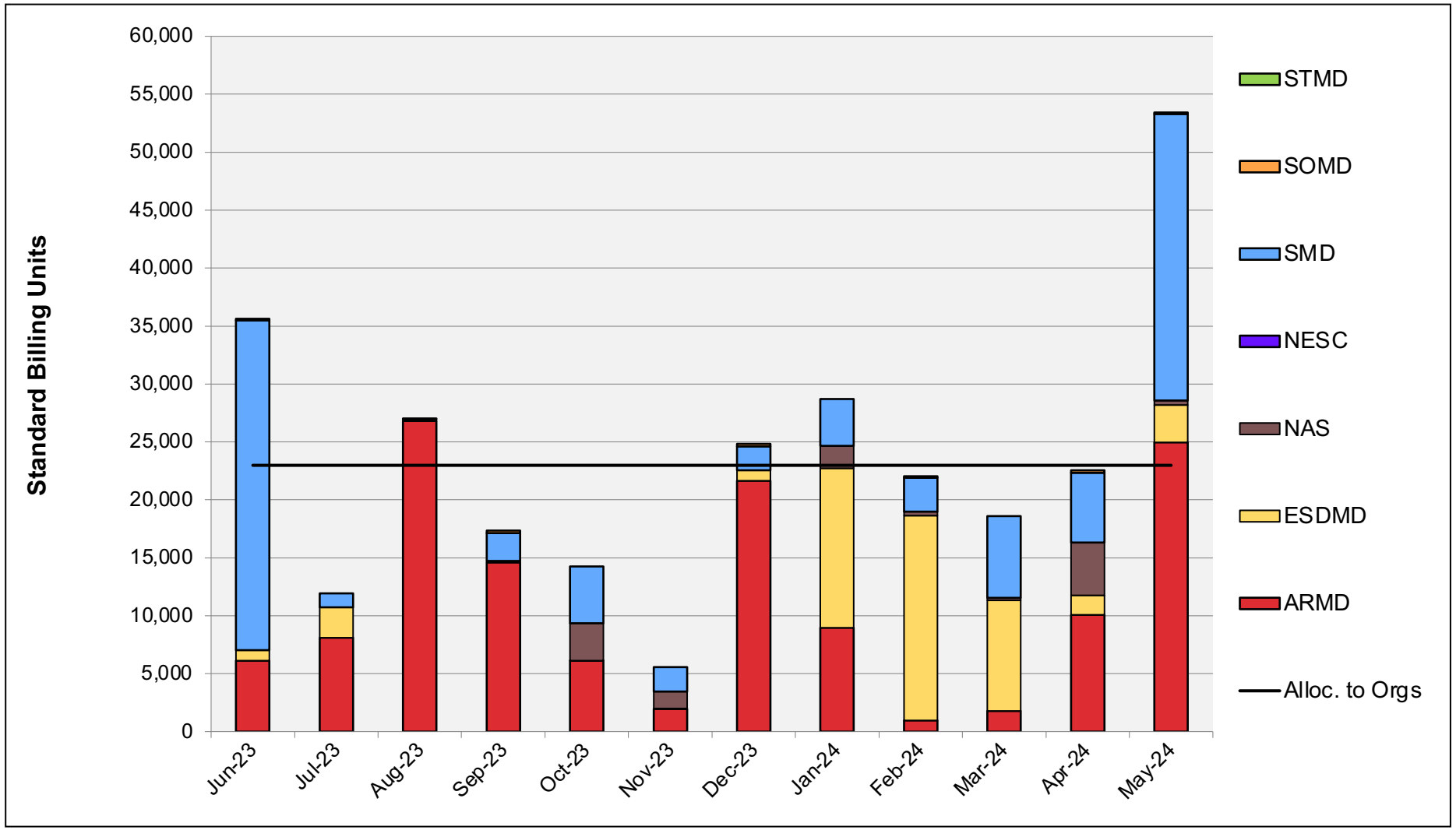
Cabeus: Average Time to Clear All Jobs



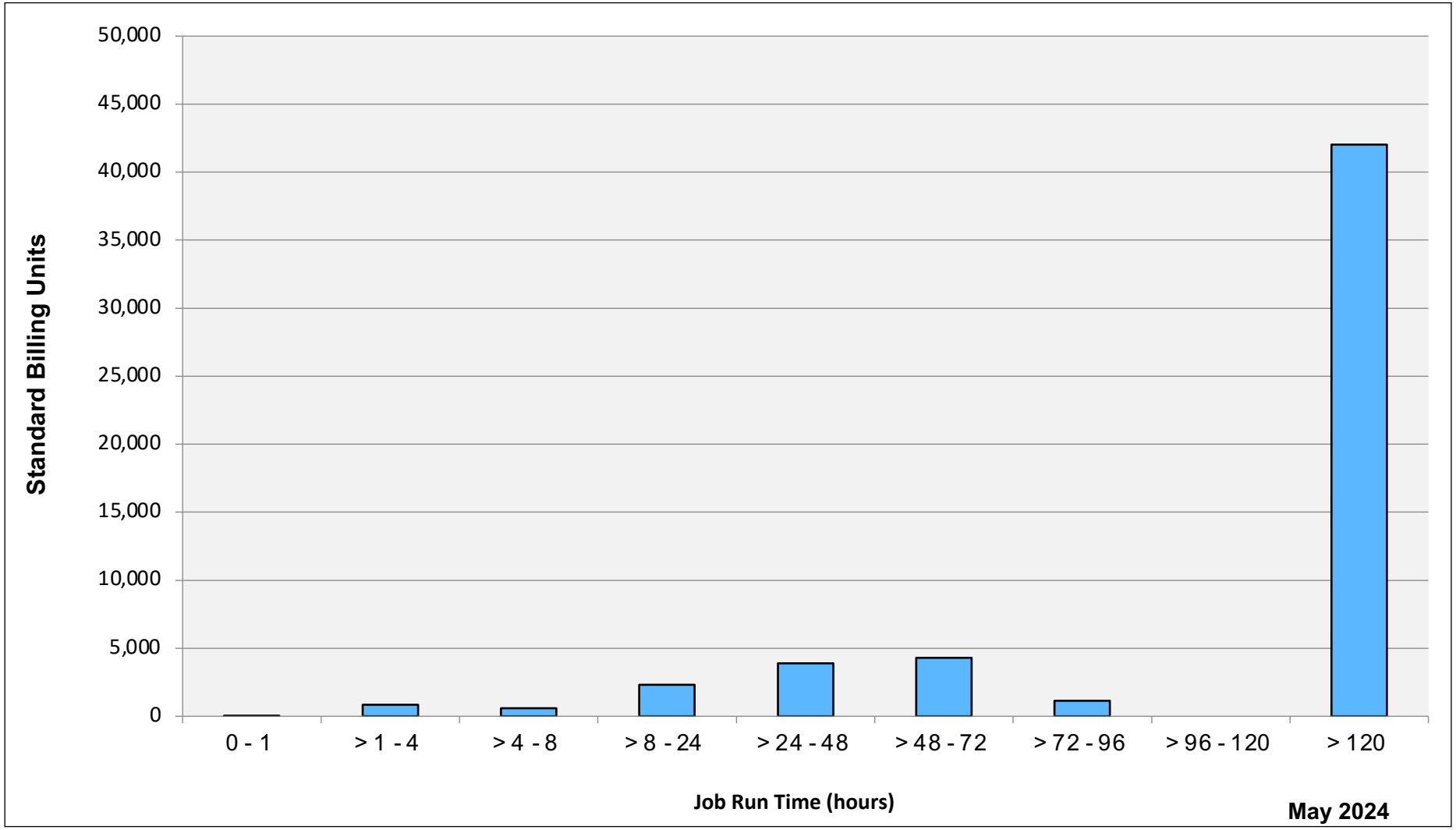
Cabeus: Average Expansion Factor



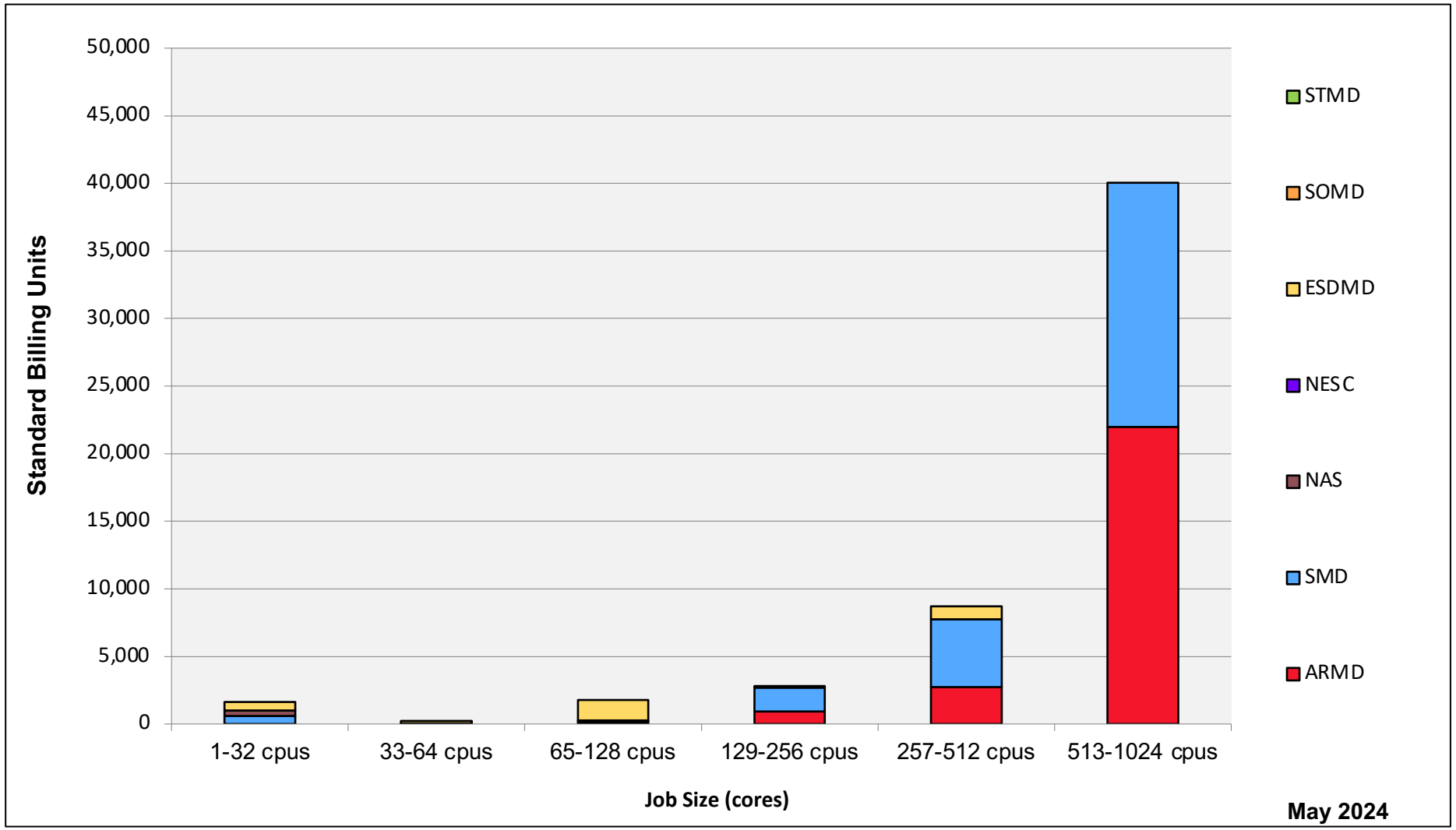
Endeavour: SBUs Reported, Normalized to 30-Day Month



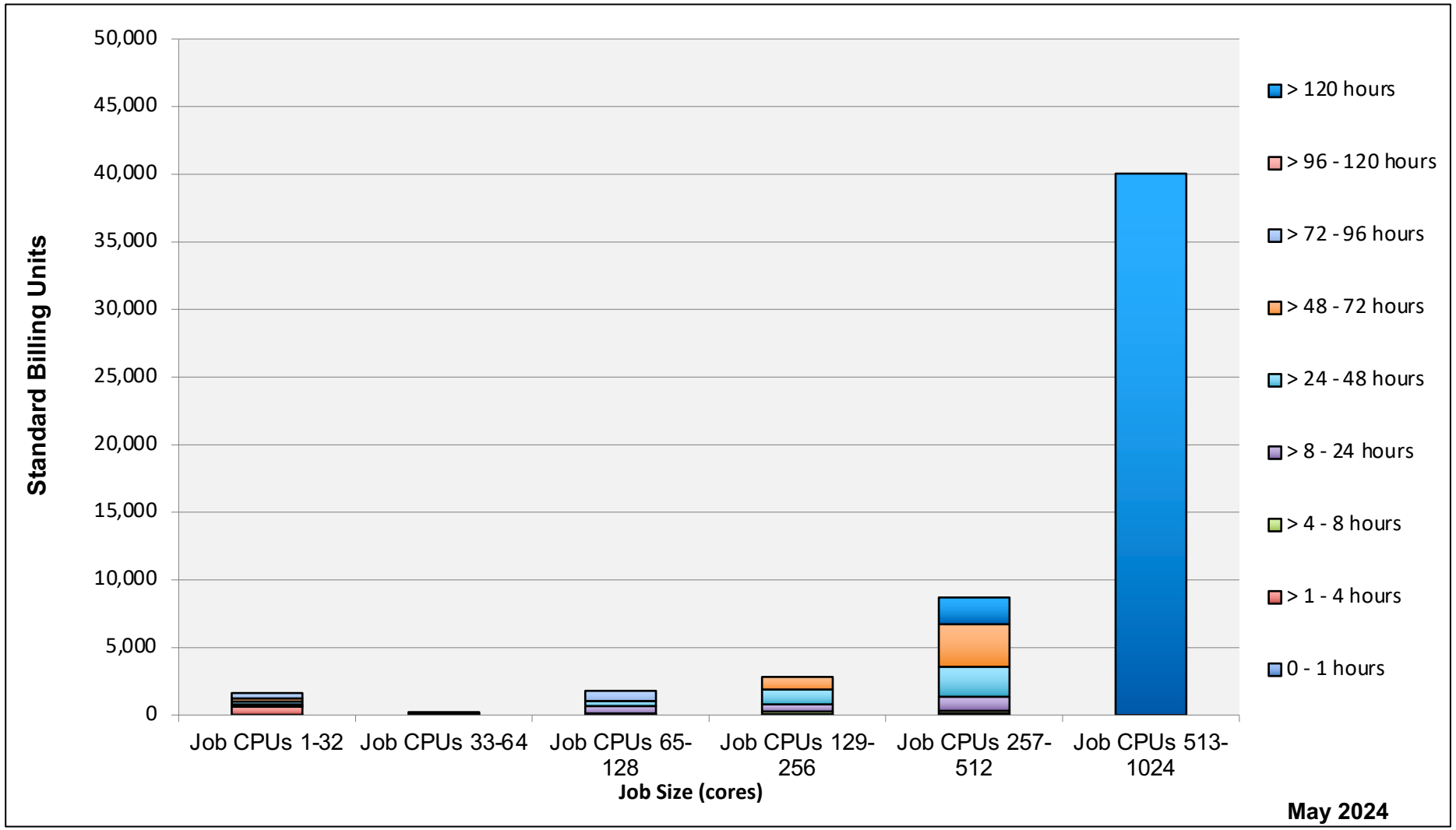
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor

