

National Aeronautics and Space Administration

High-End Computing Capability

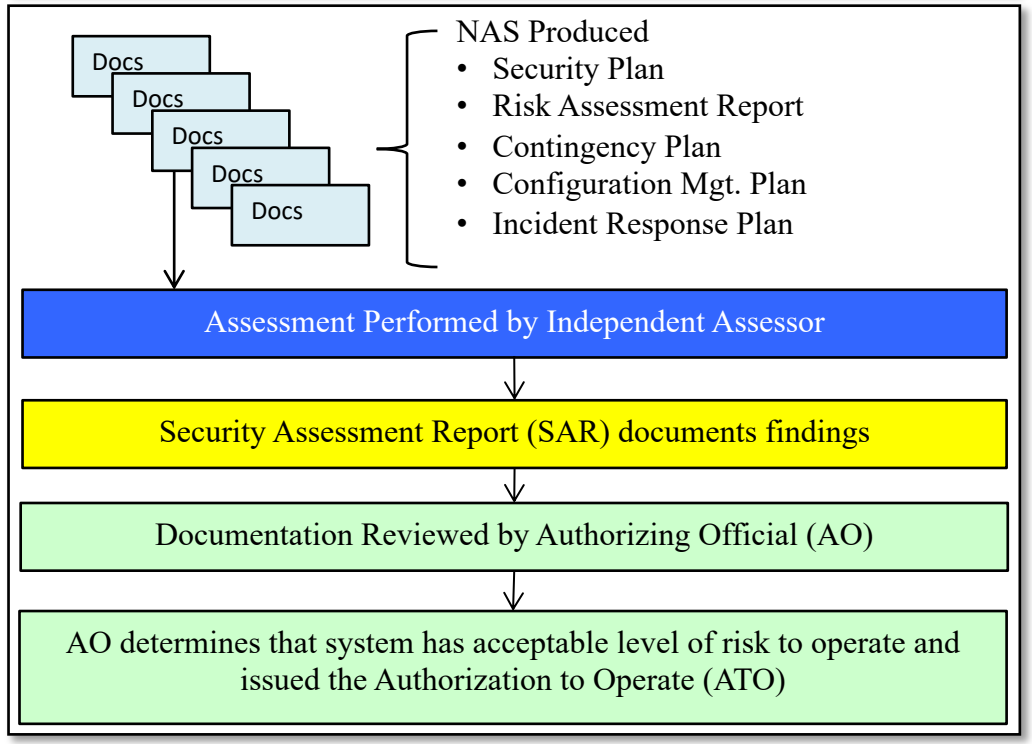
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December 10, 2023

Security Team Obtains Authorization to Operate

- The NAS/HECC Security team completed updating the NAS Systems Environment (NSE) System Security Plan (SSP) with inputs from other HECC support groups. A completed package was submitted for a full Security Controls Assessment (SCA).
  - The SCA was performed by the Office of the Chief Information Officer (OCIO) Enterprise Assessment Services (EAS) team in alignment with newly standardized agency requirements.
  - EAS evaluated the information assurance posture of NSE facilities, systems, and operations, including HECC systems, with agency requirements.
  - The NAS/HECC Security team also engaged the OCIO Cybersecurity Posture Assessment Services team to conduct a penetration test of NSE systems.
- All findings were addressed and briefed to David Korsmeyer, deputy center director (acting) of NASA's Ames Research Center, who is the authorizing official for NSE.
- Based on an analysis of the Security Assessment Report, the authorizing official issued an Authorization to Operate (ATO). The ATO allows NSE and HECC operations for another year, in compliance with agency security requirements.

IMPACT: Reauthorization of the NAS security plan allows HECC systems to continue operating for another year, providing critical supercomputing resources to NASA missions, programs, and projects.



Flow chart outlining the evaluation and approval process leading to receiving an Authorization to Operate.

HECC Begins Early Access Testing for Cabeus

- The deployment of NASA's new 512-GPU cluster, called Cabeus, is almost complete. The system is now available to a small group of users for early access testing.
- The Cabeus cluster is comprised of 128 GPU nodes. Each GPU node has the following components:
  - Two AMD 7763 processors with 64 cores each, 2.45 gigahertz.
  - Eight 32-gigabyte (GB) DIMMs totaling 256 GB of memory.
  - One Nvidia HGX A100 80GB, four-GPU air-cooled board.
- Select users will be allowed to run test jobs on Cabeus to determine how best to optimize their workflow.
- Early access testing will continue for about two weeks. HECC teams plan to release the system to all users on December 19, 2023.

IMPACT: The new Cabeus cluster is a significant GPU-optimized addition to NASA's supercomputing resources, helping to meet the agency's ever-growing need for high-end computing.



Photo of the new Cabeus cluster located at the NASA Advanced Supercomputing facility. *Don Story, NASA/Ames*

Science Powered by NASA High-End Computing on Display at SC23

- HECC staff across various teams planned and produced NASA's exhibit at the International Conference for High-Performance Computing, Networking, Storage, and Analysis (SC23) held in Denver, Colorado November 12–16, 2023.
- This marks the 35th year that NASA has exhibited at the annual conference, which welcomed over 14,000 attendees from the HPC community across academia, industry, and government organizations.
- The booth showcased 42 in-person and virtual presentations enabled by supercomputing resources and services provided by HECC and the NASA Center for Climate Simulation, representing scientists and researchers from six NASA centers, as well as university and industry collaborators.
- Working with agency and vendor partners, a wide array of high-resolution images and videos of science and engineering simulations—many created by the HECC Visualization team—were shown on in the booth's two presentation theaters.
- The Publications and Tools teams worked with presenters to develop booth displays and several center-level feature stories, in addition to the NASA@SC23 website and printed promotional material—especially the return of the highly-requested luggage tags, which attendees lined up to collect throughout the conference.

IMPACT: The annual Supercomputing Conference provides a highly visible public platform to showcase the agency's science and engineering programs supported by NASA high-end computing resources.

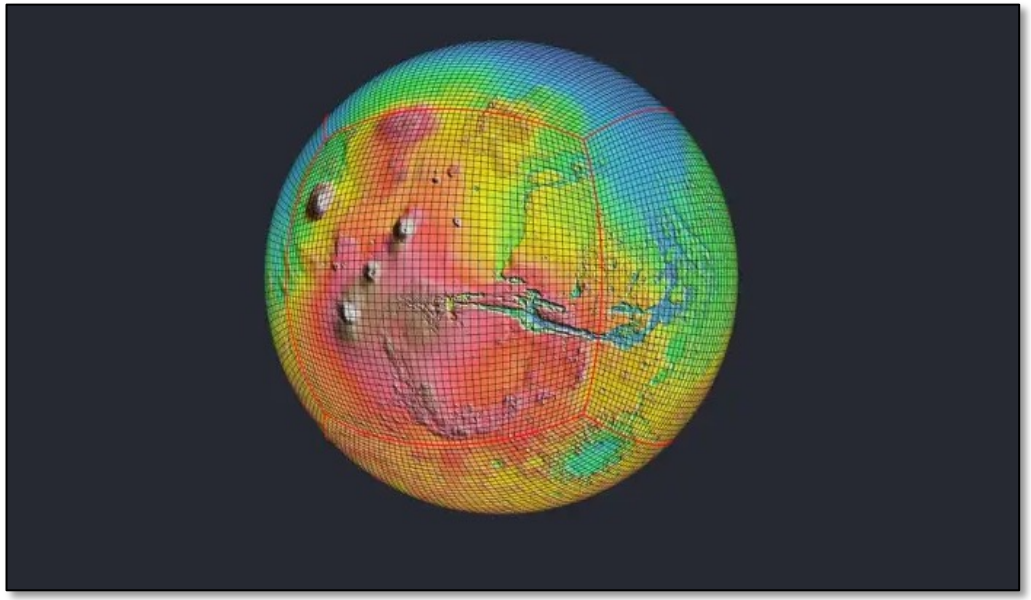


The SC23 exhibit support team and presenters representing all mission directorates provided thousands of conference attendees with a memorable NASA experience.

Cloud Computing Support For the Mars Climate Modeling Workshop

- The Mars Climate Modeling Center (MCMC) at NASA Ames held a successful three-day virtual workshop, November 13–15.
  - The MCMC ported the NOAA Geophysical Fluid Dynamics Laboratory cubed-sphere dynamical core to create a Mars Global Climate Model (GCM). The Mars GCM source code was recently open-sourced and placed on GitHub.
- The HECC Cloud team provisioned 33 dynamic compute clusters on Amazon Web Services (AWS) to help facilitate the workshop, with 33 participants attending.
  - In preparation for the workshop, the MCMC team created a set of tutorials that introduce the science community to the open-source modeling system
  - The compute clusters were provisioned one day prior to the workshop, which illustrates the ability to deploy compute systems in the cloud rapidly.
  - Participants could work through the tutorials on the compute systems, build codes, and run compute jobs with a similar look and feel to the on-prem HECC environment.
- Upon completion of the workshop, all clusters were immediately decommissioned, which illustrates the ability to rapidly stand-down compute systems in the cloud to maintain cost-efficiency.
- Due to the dynamic nature of the compute infrastructure used for the workshop, overall compute costs were minimal.

IMPACT: Cloud computing can play a pivotal role in achieving NASA's open-source science objectives by cost-effectively facilitating community engagement and broadening the reach of the agency's scientific work.

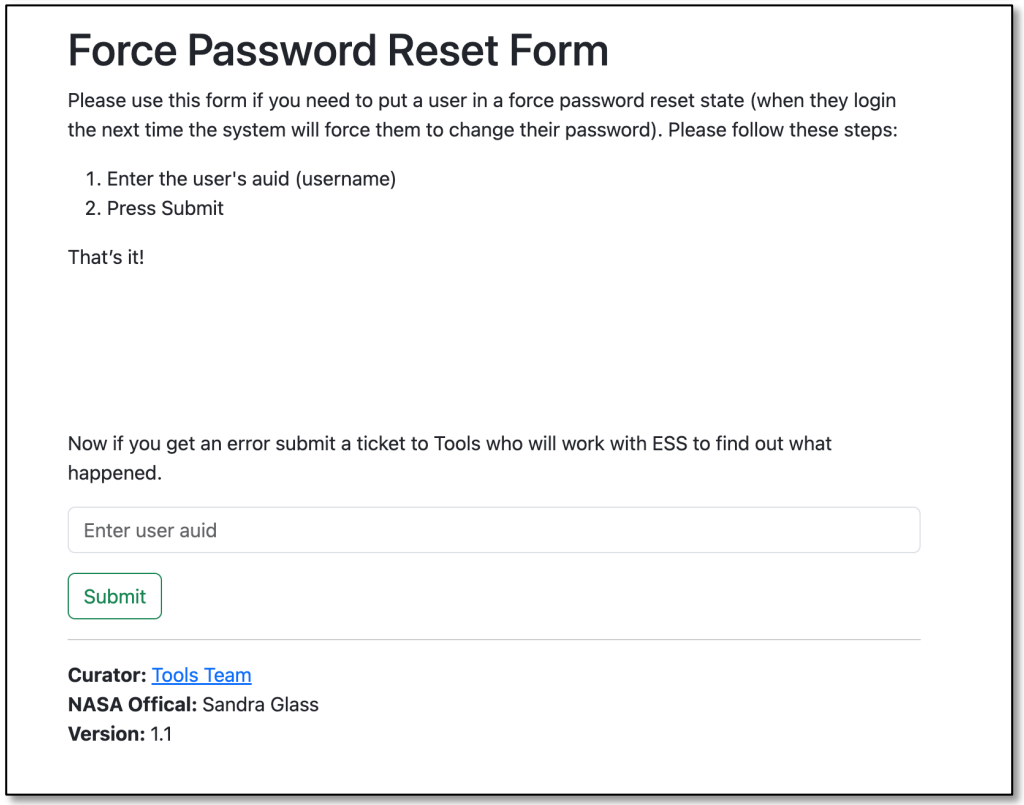


Example visualization from the Mars modeling system.
Mars Climate Modeling Group

Force Password Reset App Saves User, Staff Time

- The HECC Tools team developed and deployed a new web-based application that enables Control Room staff to put a user's account status in a "forced password change state" when users have forgotten their password or are getting their first password set during their HECC account creation.
  - The app will force the user to change their password the next time they log in to HECC systems.
  - Previously, users would have to wait up to 24 hours before they could change their password to one of their choosing.
- The Tools team worked closely with the Systems team to build a custom script with the web application that handles the connection and modification of the Lightweight Directory Protocol (LDAP) record to put a user account into a forced password state.
- Both SSL and SSH were used to ensure that all communications are encrypted.
  - The web application was written using the Python Django web framework.
- The new process saves time for LDAP Team during changes.
  - Previously if a user could not wait the required 24 hours, an account expert would have to perform manual steps to put a user account into a "forced password change state."
  - This saves about one hour a month of the LDAP Team's time.

IMPACT: Providing HECC Control Room staff with the ability to force users to change their password right away after a password reset saves frustration for users and time for staff.

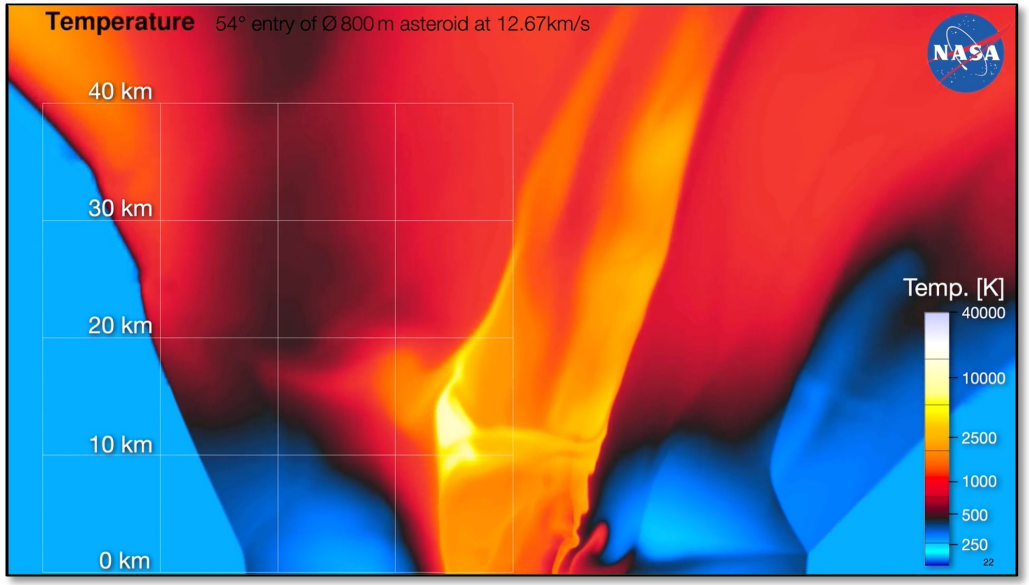


Screenshot of the new web form used to force a password reset.

Blast Wave Modeling of Large Asteroid Impacts*

- Researchers at NASA Ames simulated blast propagation and Earth's atmospheric response to entry of hypothetical asteroid PDC 2023 from both the hot entry and impact of this large, 800-meter diameter, imaginary asteroid.
  - The entry and impact releases over 10 gigatons of energy into the atmosphere and on the ground near the impact site.
  - Ground footprints of maximum overpressure and wind speed are also captured for this large 3D unsteady simulation.
- They selected this project to deliberately stress-test the simulation codes used in planetary defense by choosing an unusually large hypothetical object to identify gaps in their modeling technology or defense coordination efforts.
- Their results show regions of blast overpressure footprint and peak wind velocities surrounding the impact region, and indicate a potential for triggering tsunamis far from the point of impact.
- Asteroid impact simulations are among the most challenging unsteady problems to compute. Simulations were done using NASA's Cart3D simulation code on 16,000 Cascade Lake cores of HECC's Aitken supercomputer, taking roughly 12 hours to complete.

IMPACT: HECC supercomputing resources and highly scalable simulation tools are the keys to these simulations, characterized by extremely fine grids and a large numbers of iterations.



Video showing the entry, impact, and blast evolution through the first 20 minutes after impact of the hypothetical asteroid PDC 2023. The colors show temperature, where blue tones indicate cooler temperatures. *Michael Aftosmis, NASA/Ames*

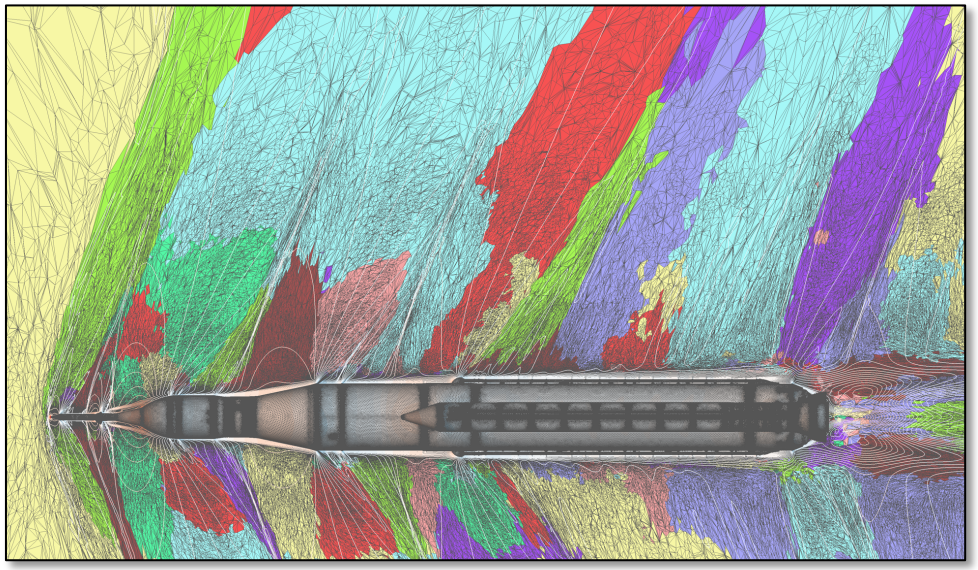
** HECC provided supercomputing resources and services in support of this work.*

NASA Supercomputing in the Artemis Program*

- Groups from across NASA are using HECC resources for computational fluid dynamics (CFD) modeling in support of all aspects of the Artemis Program, including the Orion capsule, the Space Launch System (SLS), and Exploration Ground Systems (EGS).
  - The aerodynamics, heating, and acoustics of vehicle ascent and descent phases are the primary focus of Artemis-related supercomputing efforts.
  - These phases are difficult to model and challenging to test, and it takes many groups at multiple NASA centers to understand them sufficiently to ensure safety and mission success.
- All of the CFD simulations needed to build aerodynamic databases for the Orion, SLS, and EGS programs were run on the Pleiades, Electra, and Aitken supercomputers, often using NASA-developed CFD codes like LAVA, Cart3D, FUN3D, and OVERFLOW.
- The resulting data informs trajectory simulations and criteria for the day of launch, giving mission planners an unprecedented amount of data to make decisions on mission safety.
- For the Artemis I mission, scale-resolving simulations of the SLS rocket on the launch tower were integral in the classification of ground wind loads, which were crucial in the decision to leave the rocket on the launch pad during Hurricane Nicole.

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

IMPACT: Thousands of computational fluid dynamics (CFD) simulations run on HECC systems are used to provide mission planners an unprecedented amount of data to make decisions about mission safety.



Mesh cutaway of a Space Launch System (SLS) ascent simulation. The colored regions show the partitioning done by the CFD software to efficiently solve this complex problem on a large parallel HPC system. Overlaid are contour lines of the Mach numbers, showing how all resources come together to produce a flow field solution. The vehicle is colored by pressure (red is high and blue is low). *Derek Dalle, NASA/Ames*

Papers

- "**Theory of Magnetic Switchbacks Fully Supported by Parker Solar Probe Observations**," G. Toth, et al., *The Astrophysical Journal*, vol. 957, no. 2, published online November 3, 2023. *
https://iopscience.iop.org/article/10.3847/1538-4357/acfd91/meta
- "**CORHEL-CME: An Interactive Tool for Modeling Solar Eruptions**," J. Linker, et al., arXiv:2311.03586 [astro-ph.SR], November 6, 2023.*
https://arxiv.org/abs/2311.03596
- "**Accreting Neutron Stars in 3D GRMHD Simulations: Jets, Magnetic Polarity, and the Interchange Slingshot**," K. Parfrey, A. Tchekhovskoy, arXiv:2311.04291 [astro-ph.HE], November 7, 2023. *
https://arxiv.org/abs/2311.04291
- "**Environment Matters: Predicted Differences in the Stellar Mass—Halo Mass Relation and History of Star Formation for Dwarf Galaxies**," C. Christensen, et al., arXiv:2311.04975 [astro-ph.GA], November 8, 2023. *
https://arxiv.org/abs/2311.04975
- "**Grid Topology for Time-Accurate Deployment Simulation of 2D Parachutes by Using Navier-Stokes Equations**," G. Guruswamy, *Aerospace Science and Technology*, vol. 142, Part B, published online November 11, 2023. *
https://www.sciencedirect.com/science/article/abs/pii/S1270963823006107
- "**Giant Outer Transiting Exoplanet Mass (GOT 'EM) Survey. III. Recovery and Confirmation of a Temperate, Mildly Eccentric, Single-Transit Jupiter Orbiting TOI-2010**," C. Mann, et al., *The Astronomical Journal*, vol. 166, no. 6, November 13, 2023. *
https://iopscience.iop.org/article/10.3847/1538-3881/ad00bc/meta

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

Papers (cont.)

- "**Confinement of the Solar Tachocline by a Non-Axisymmetric Dynamo**," L. Matilsky, et al., arXiv:2211.10202 [astro-ph.SR], Nov. 16, 2023. * https://arxiv.org/abs/2311.10202
- "**The GAPS Programme at TNG L—TOI-4515 b: An Eccentric Warm Jupiter Orbiting a 1.2 Gyr-old G-Star**," I. Carleo, et al., arXiv:2311.11903 [astro-ph.EP], November 20, 2023. * https://arxiv.org/abs/2311.11903
- "**Stable Vortex Particle Method Formulation for Meshless Large-Eddy Simulation**," E. Alvarez, A. Ning, *AIAA Journal of Aeronautics and Astronautics*, published online November 20, 2023. * https://arc.aiaa.org/doi/full/10.2514/1.J063045
- "**Wall-Modeled Large-Eddy Simulation of Turbulent Boundary Layer with Spatially Varying Pressure Gradients**," I. Hayat, G. Park, *AIAA Journal of Aeronautics and Astronautics*, published online November 21, 2023. * https://arc.aiaa.org/doi/full/10.2514/1.J063336
- "**The SOPHIE Search for Northern Extrasolar Planets-XIX. A System Including a Cold Sub-Neptune Potentially Transiting a V=6.5 Star HD88986**," N. Heidari, et al., arXiv:2311.13513 [astro-ph.EP], November 22, 2023. * https://arxiv.org/abs/2311.13513
- "**Three Warm Jupiters around Solar-Analog Stars Detected with TESS**," J. Eberhardt, et al., *The Astronomical Journal*, vol. 166, no. 6, published online November 29, 2023. * https://iopscience.iop.org/article/10.3847/1538-3881/ad06bc/meta

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

Papers (cont.)

- "**Exponential Acceleration of Macroscopic Quantum Tunneling in a Floquet Ising Model**," G. Grattan, et al., arXiv:2311.17814 [cond-mat.str-el], November 29, 2023. *
  https://arxiv.org/abs/2311.17814
- "**A Resonant Sextuplet of Sub-Neptunes Transiting the Bright Star HD110067**," Luque, R., Osborn, H.P., Leleu, A. et al. A resonant sextuplet of sub-Neptunes transiting the bright star HD 110067. *Nature* 623, 932–937 (2023).
  https://doi.org/10.1038/s41586-023-06692-3

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Presentations

- **2023 Supercomputing Conference**, Denver, Colorado, November 13–16, 2023.
  - ”**Computational Study of a Small Ducted Propeller**,” J. Jensen, J. Duensing. https://www.nas.nasa.gov/SC23/research/project1.html
  - “**Automated Voronoi Meshing for High-Fidelity Aerodynamic Simulations**,” V. Sousa. https://www.nas.nasa.gov/SC23/research/project2.html
  - “**Simulating an Iced Wing Aerodynamic Performance Predictions**,” D. Craig Penner. https://www.nas.nasa.gov/SC23/research/project3.html
  - “**Modeling Aerodynamic and Acoustic Fields Around Turbofan Engines**,” L. Fernandes. https://www.nas.nasa.gov/SC23/research/project4.html
  - ”**Scale-Resolving Methods for Jet Aeroacoustic Predictions**,” G.-D. Stich. https://www.nas.nasa.gov/SC23/research/project5.html
  - “**Simulating Air Taxi Safety: NASA’s Quadcopter in Ground Effect**,” P. Ventura Diaz. https://www.nas.nasa.gov/SC23/research/project6.html
  - “**Simulating Supersonic Parachute Inflation for Atmospheric Entry**,” F. Cadieux. https://www.nas.nasa.gov/SC23/research/project11.html
  - “**Launch Pad Rocket Plume Simulations Supporting NASA’s Artemis Missions**,” M. Barad. https://www.nas.nasa.gov/SC23/research/project12.html
  - “**NASA’s Use of Supercomputing in the Artemis Program**,” J. Meeroff, D. Dalle. https://www.nas.nasa.gov/SC23/research/project13.html
  - “**High-Fidelity Blast Wave Modeling of Large Asteroid Impacts**,” M. Aftosmis. https://www.nas.nasa.gov/SC23/research/project18.html

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Presentations (cont.)

- **2023 Supercomputing Conference** (cont.)
  - "**Parallel Mesh Adaptation for Unsteady Asteroid Blast Simulations**," W. Spurlock. https://www.nas.nasa.gov/SC23/research/project20.html
  - "**Simulating Kilometer-Size Asteroid Impacts on Earth**," D. Robertson. https://www.nas.nasa.gov/SC23/research/project25.html
  - "**Toward Energy Efficient High-End Computing**," W. Thigpen. https://www.nas.nasa.gov/SC23/research/project26.html
  - "**Artificial Intelligence/Machine Learning in HPC Environments**," S. Ranjan, T. Norman. https://www.nas.nasa.gov/SC23/research/project29.html
  - "**How to Find a Signal from Earth-like Planets in Stellar Noise**," I. Kitiashvili. https://www.nas.nasa.gov/SC23/research/project40.html
  - "**Predicting the Appearance of Sunspots on the Solar Surface Using Machine Learning**," S. Kasapis. https://www.nas.nasa.gov/SC23/research/project41.html

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News and Events

- **How NASA is Driving Efficiency with Modular Data Centers**, *Scientific Computing World*, November 3, 2023—NASA High-End Computing Capabilities Project Manager Bill Thigpen shares how NASA is driving efficiency with modular data centers, as part of the Breakthrough collection of interviews with Scientific Computing World.
  https://www.scientific-computing.com/article/breakthroughs-2023-how-nasa-driving-efficiency-modular-data-centres
- **Five Ways NASA Supercomputing Takes Missions from Concept to Reality**, *NASA,* November 13, 2023—NASA high-end computing plays a key role in taking many agency missions from concept to application in the real world. From increasing accuracy of global weather forecasts to parachute design tests for landing spacecraft, our supercomputing resources and experts are driving science and engineering advances for the benefit of humanity.
  https://www.nasa.gov/general/five-ways-nasa-supercomputing-takes-missions-from-concept-to-reality/
  - **Five Ways NASA Supercomputing Takes Missions from Concept to Reality**, *Phys.Org*, November 14, 2023.
    https://phys.org/news/2023-11-ways-nasa-supercomputing-missions-concept.html
- **Modeling Turbofan Engines to Understand Aircraft Noise**, *NASA*, November 15, 2023—Using the Pleaides supercomputer at NAS, researchers have developed software that can model different aircraft engine configurations in a more timely and economic manner to better understand the causes of aircraft engine noise.
  https://www.nasa.gov/centers-and-facilities/ames/modeling-turbofan-engines-to-understand-aircraft-noise/
- **Unlocking Insights into Asteroid Impact Risks: SETI Institute Leverages Weather Satellite Data and AI**, *SETI Institute*, November 16, 2023—Scientists with SETI, with partners at NASA, Sandia National Labs, and UC Berkeley, have developed a machine-learning algorithm to assess the risk of very large meteors in Earth's atmosphere.
  https://www.seti.org/unlocking-insights-asteroid-impact-risks-seti-institute-leverages-weather-satellite-data-and-ai

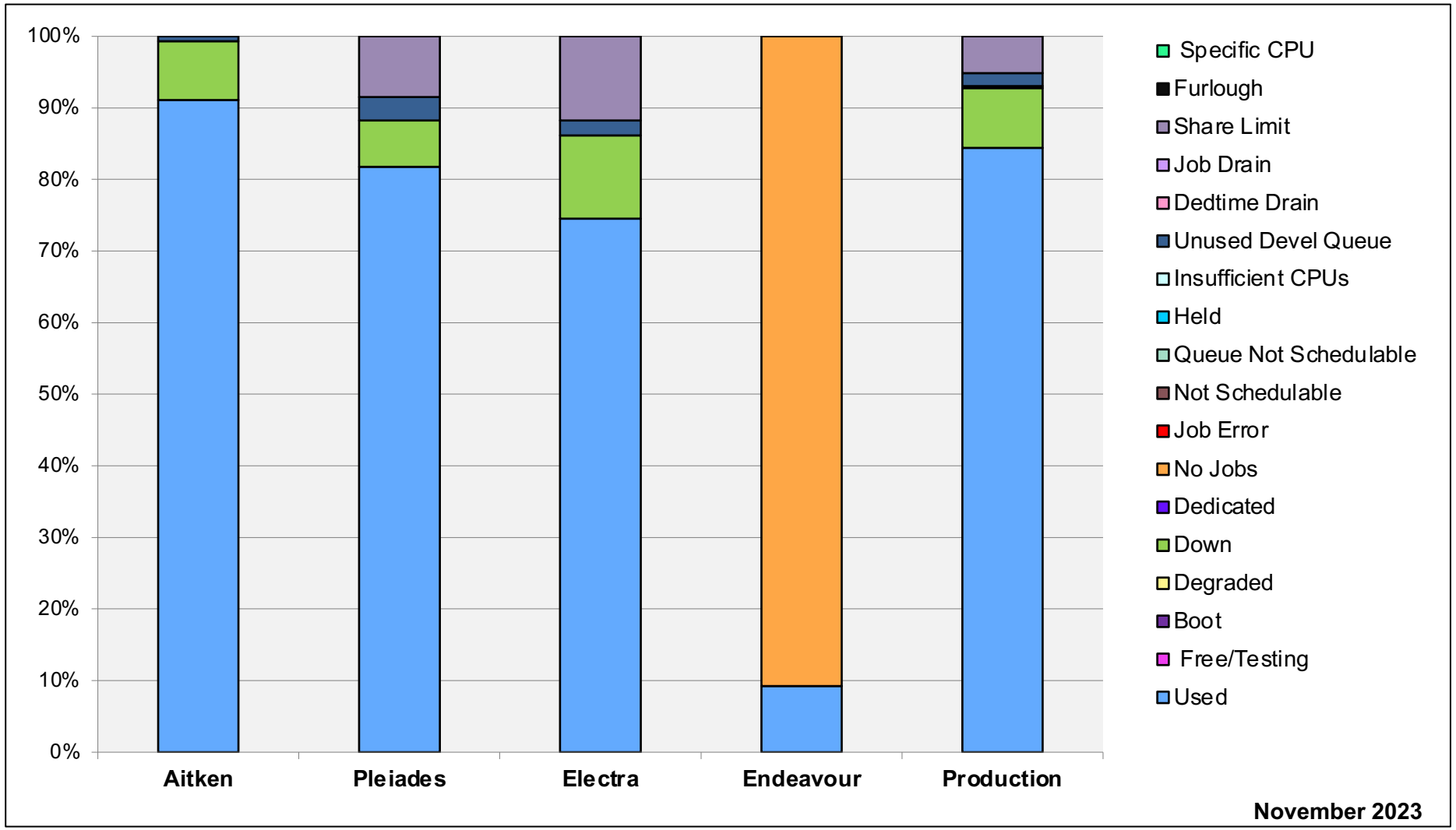
News and Events (cont.)

- **Rocket Exhaust on the Moon: NASA Supercomputers Reveal Surface Effects**, *NASA*, November 14, 2023—Researchers at NASA's Marshall Space Flight Center ran simulations on high-end computing systems at NAS to help lander system engineers better understand how future spacecraft engine plumes will interact with the Moon's surface.
  https://www.nasa.gov/general/rocket-exhaust-on-the-moon-nasa-supercomputers-reveal-surface-effects/
  - **NASA Supercomputers Show How Apollo 12 Landing Kicked up Moon Dust**, *Space.com*, November 15, 2023.
    https://www.space.com/nasa-supercomputer-apollo-12-moon-landing-video
  - **NASA Geeks Code New Tricks to Model Rocket Plumes and Avoid Lunar Dust-Up**, *The Register*, November 16, 2023.
    https://www.theregister.com/2023/11/16/nasa_lander_plume_simulations/
  - **Watch NASA's Supercomputer Simulation of the Apollo 12 Lunar Landing**, *Popular Science*, November 17, 2023.
    https://www.popsci.com/technology/nasa-lunar-landing-simulation/
  - **Simulating How Moon Landings Will Kick Up Dust**, *Universe Today*, November 21, 2023.
    https://www.universetoday.com/164360/simulating-how-moon-landings-will-kick-up-dust/
- **Discovery Alert: Watch the Synchronized Dance of a 6-Planet System**, *NASA,* November 29, 2023—An international team of researchers led by Rafael Luque, University of Chicago, published a paper in *Nature* on the discovery of six planets that orbit their central star in a rhythmic beat, a rare case of an "in sync" gravitational lockstep that could offer deep insight into planet formation and evolution. NAS provided the high-performance computing resources required for the Transiting Exoplanet Survey Satellite (TESS) science data pipeline.
  https://exoplanets.nasa.gov/news/1771/discovery-alert-watch-the-synchronized-dance-of-a-6-planet-system/
  - Major media coverage including the New York Times, Washington Post, Wall Street Journal, CNN, BBC, and many international news organizations.

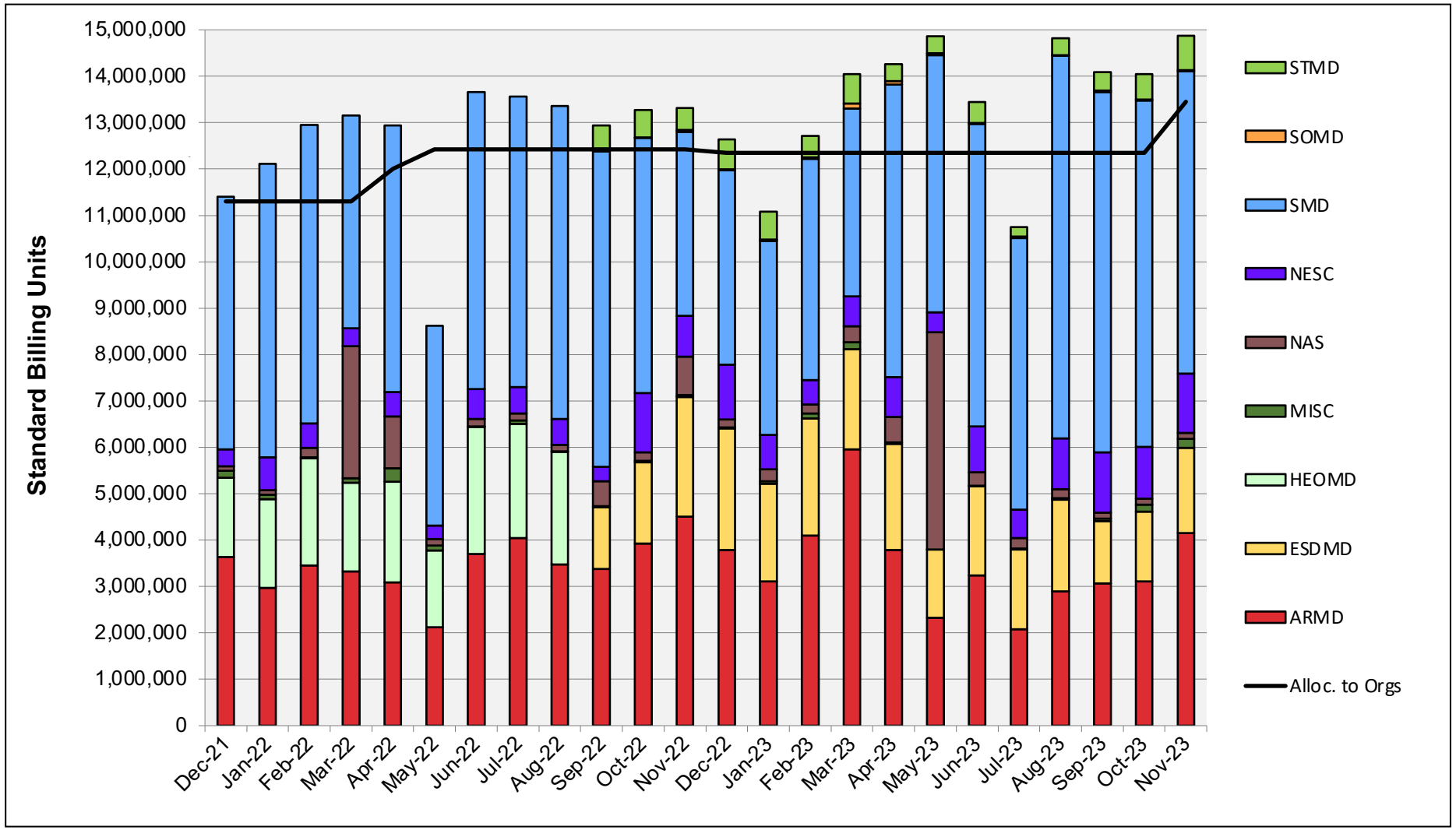
News and Events: Social Media

- **NASA@SC23 Coverage**
  - SC23 Event posts from NASA Supercomputing
    - Announcement: Facebook 17 likes, 4 shares; X 5 reposts, 11 likes.
    - Building: X 3 reposts, 21 likes.
    - Opening Gala: X 2 reposts, 13 likes.
    - Job Fair: X 3 reposts, 5 likes.
  - "Five Ways…" Feature
    - NASA Ames: Facebook 93 likes, 36 shares; X 55 reposts, 253 likes.
    - NASA Supercomputing: Facebook 11 likes, 5 shares; X 2 reposts, 11 likes.
    - NASA Earth: Facebook 626 likes, 49 shares; X 19 reposts, 114 likes.
    - NASA Earth Data: X 3 reposts, 13 likes.
  - Apollo Plume Simulation Feature
    - NASA Ames: Facebook 134 likes, 29 shares; X 86 reposts, 510 likes.
    - NASA Supercomputing: Facebook 4 likes, 2 shares;
    - Popular Science: Facebook ; X 6 likes.
  - Aircraft Engine Design Feature
    - NASA Ames: Facebook ; X 216 reposts, 1.2k likes.
    - NASA Aeronautics: Facebook 10k likes, 907 shares; X 33 reposts, 133 likes.
    - Interesting Engineering: X 156 reposts, 650 likes; LinkedIn 958 likes; YouTube 230 likes.

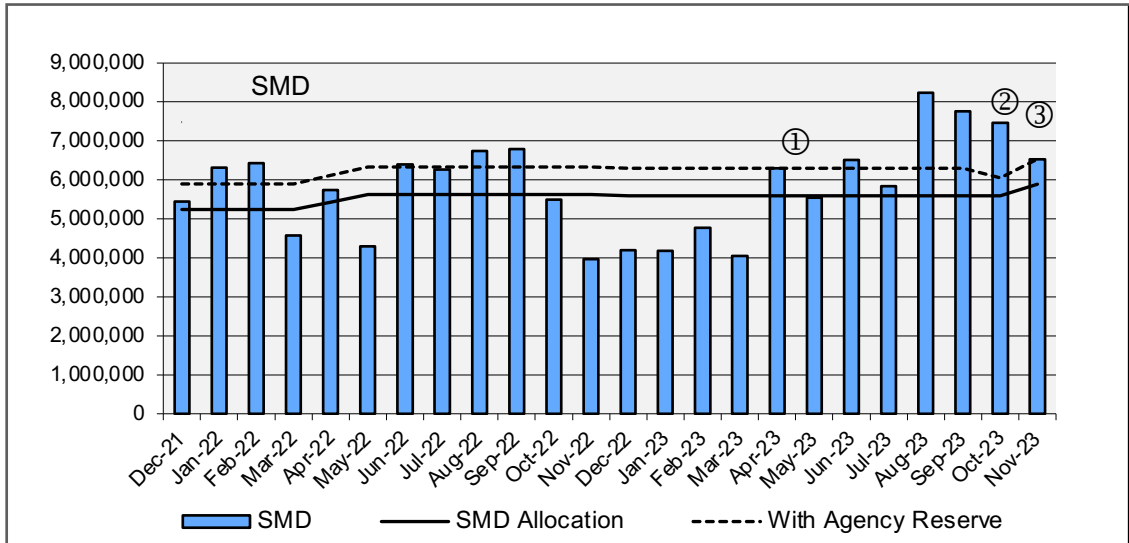
HECC Utilization

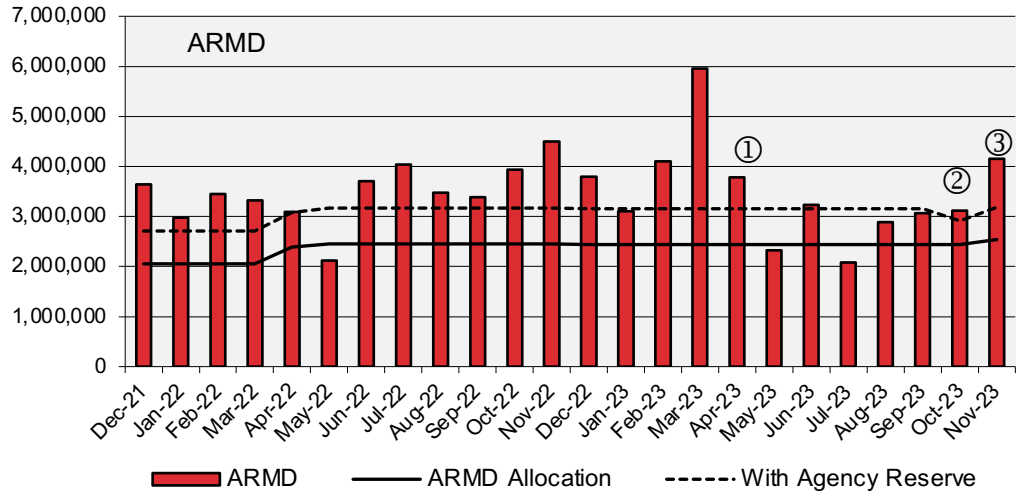


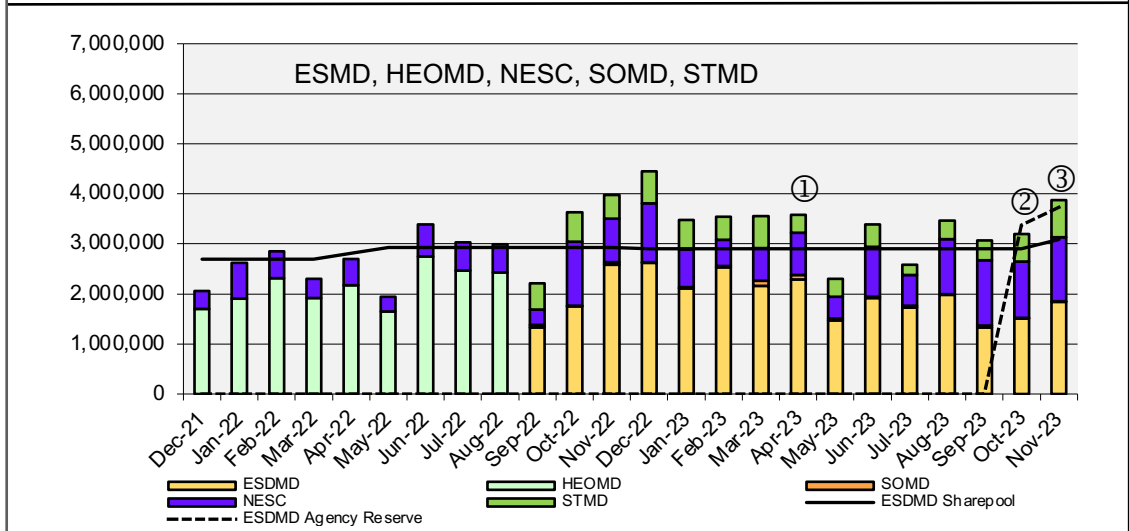
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month





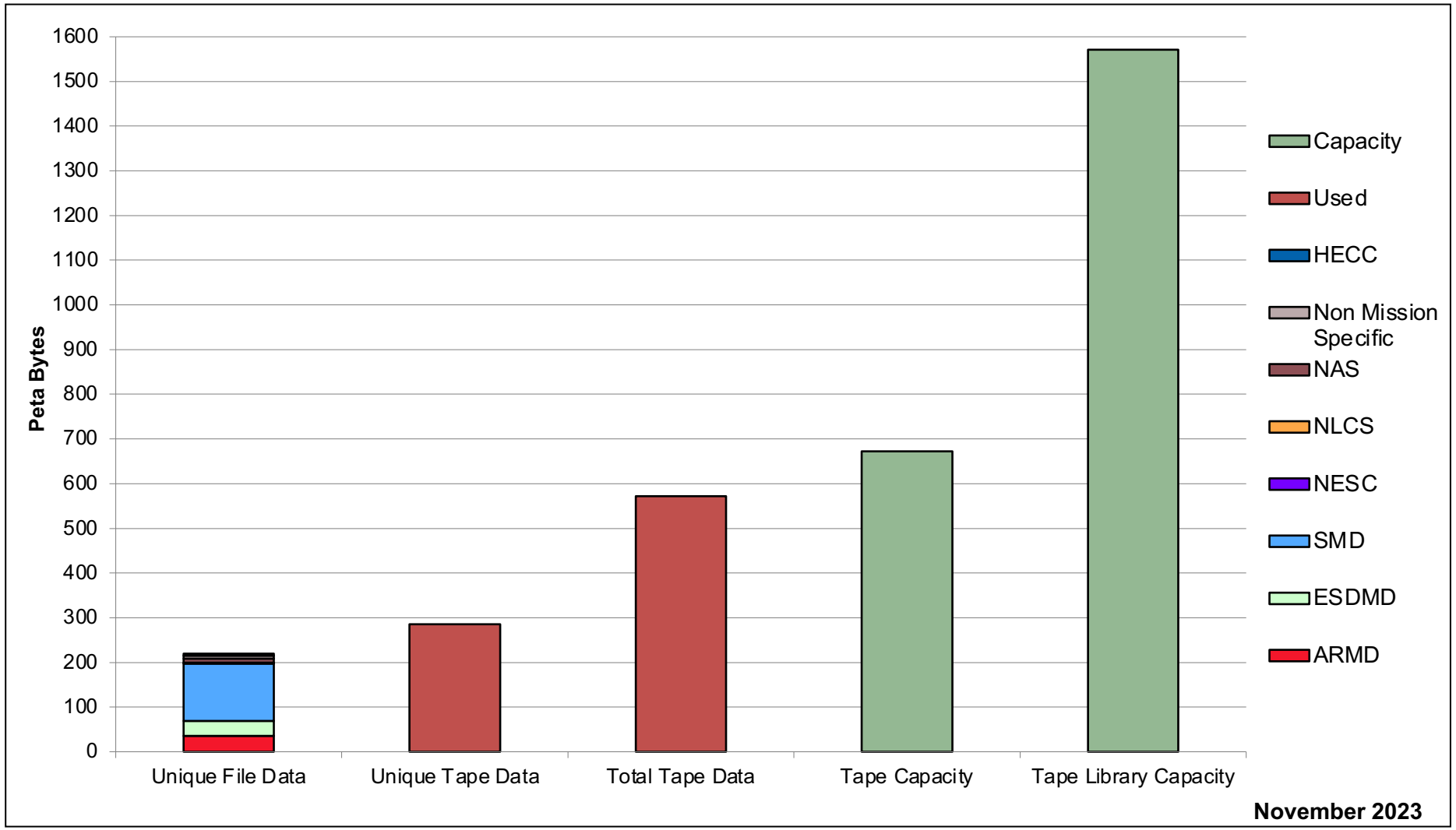


① 4 Rome Apollo Racks added to Aitken

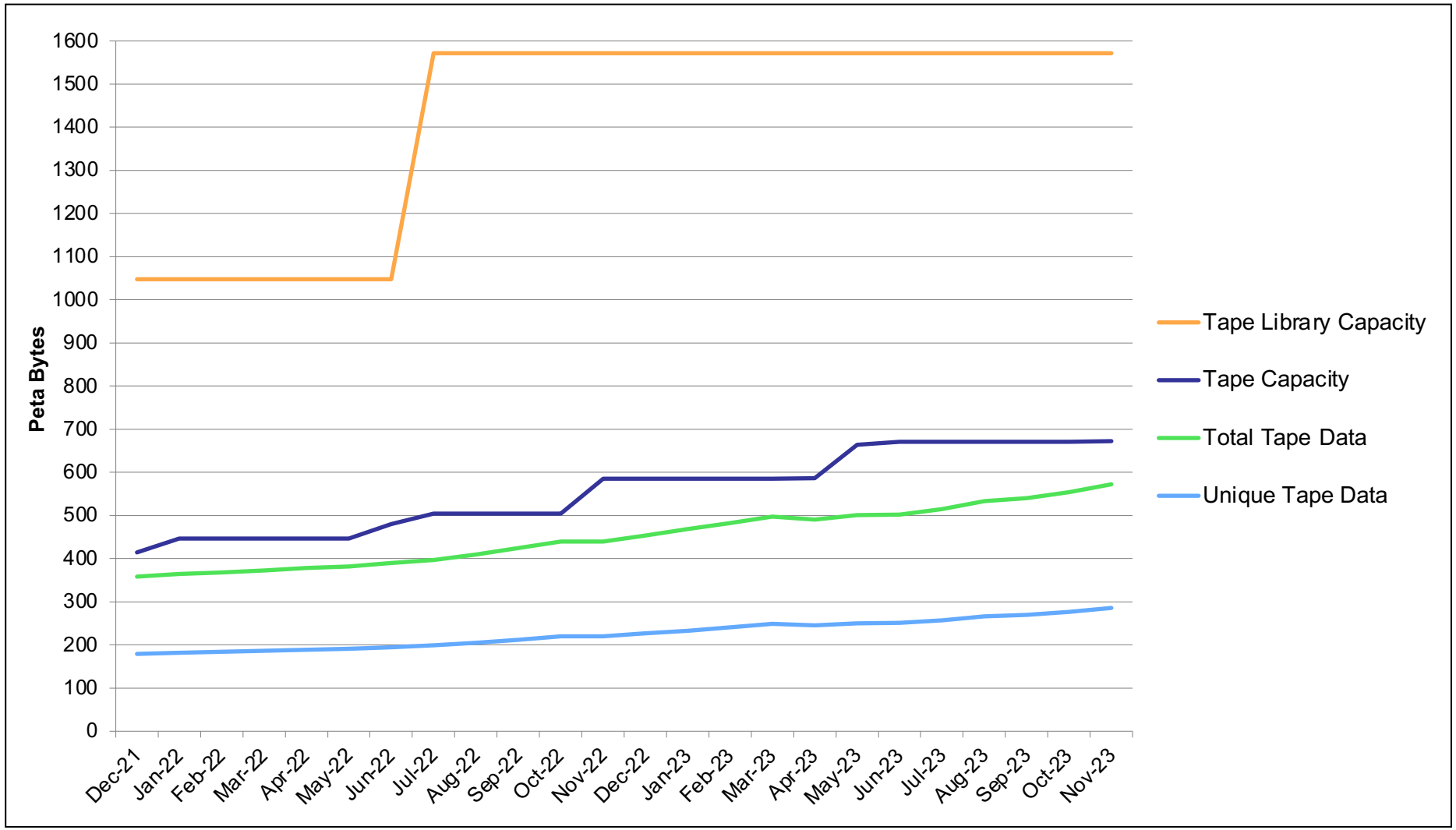
② 4 Rome Apollo Racks added to Aitken

③ Cabeus v100 nodes added

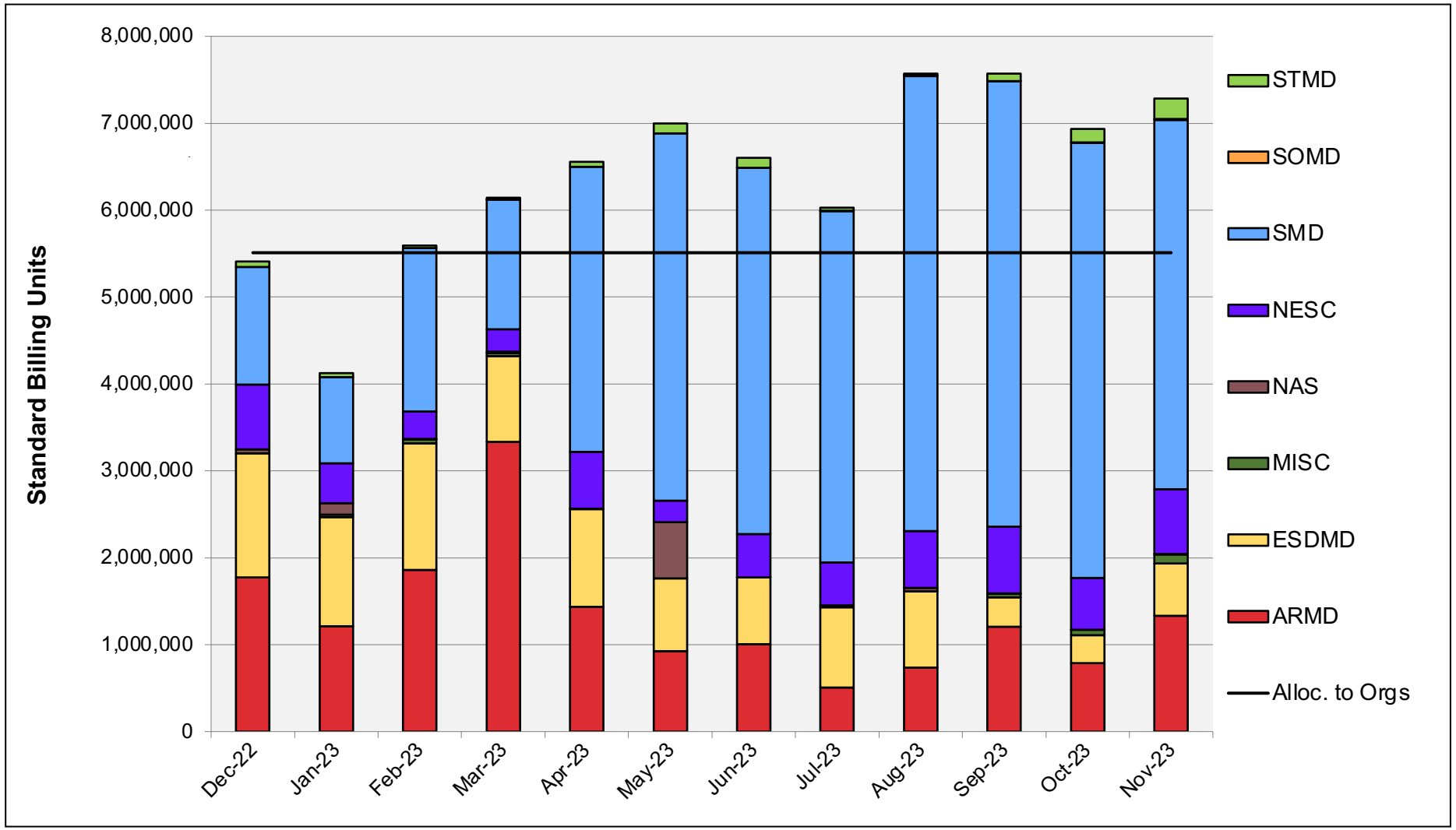
Tape Archive Status



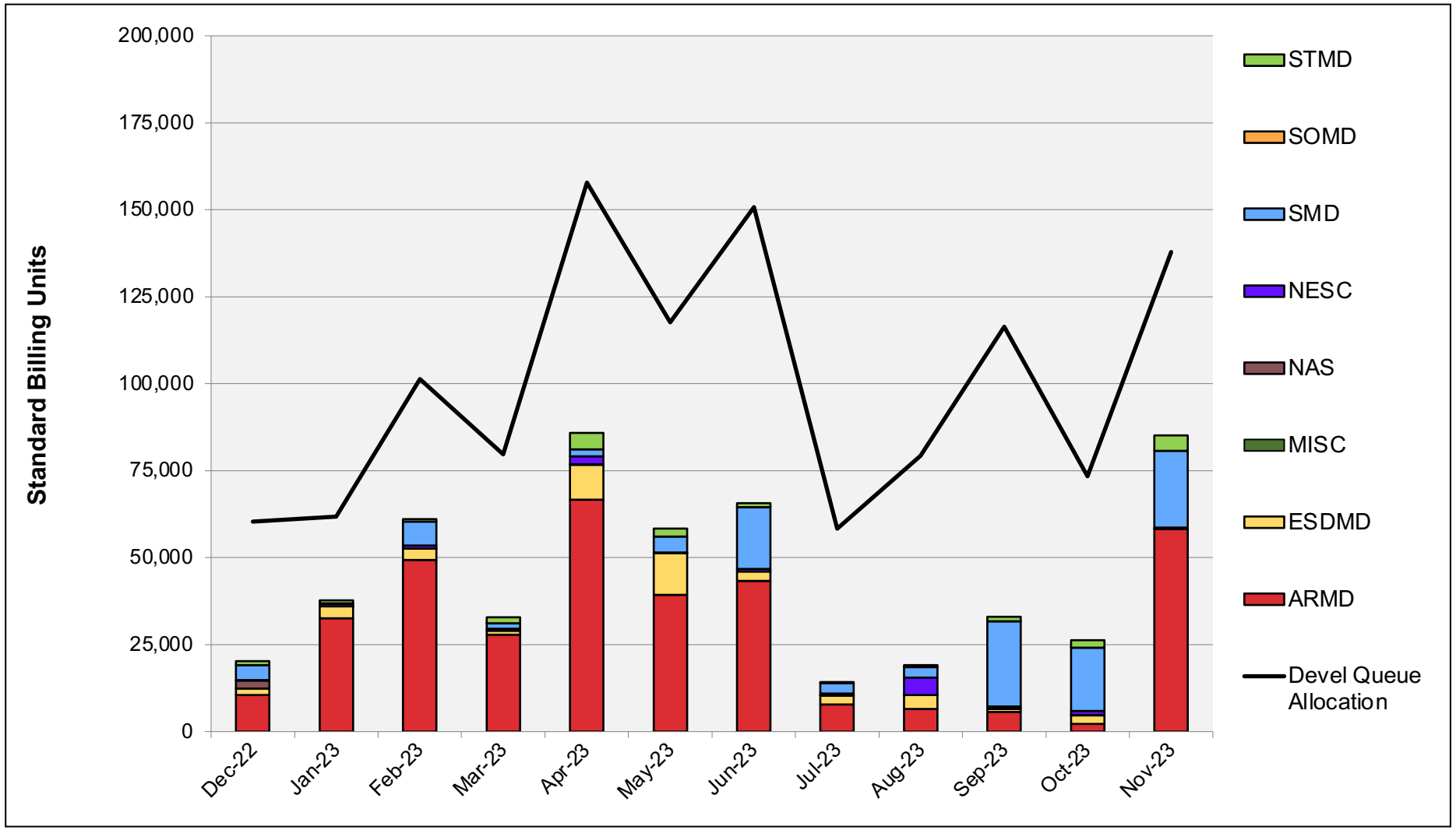
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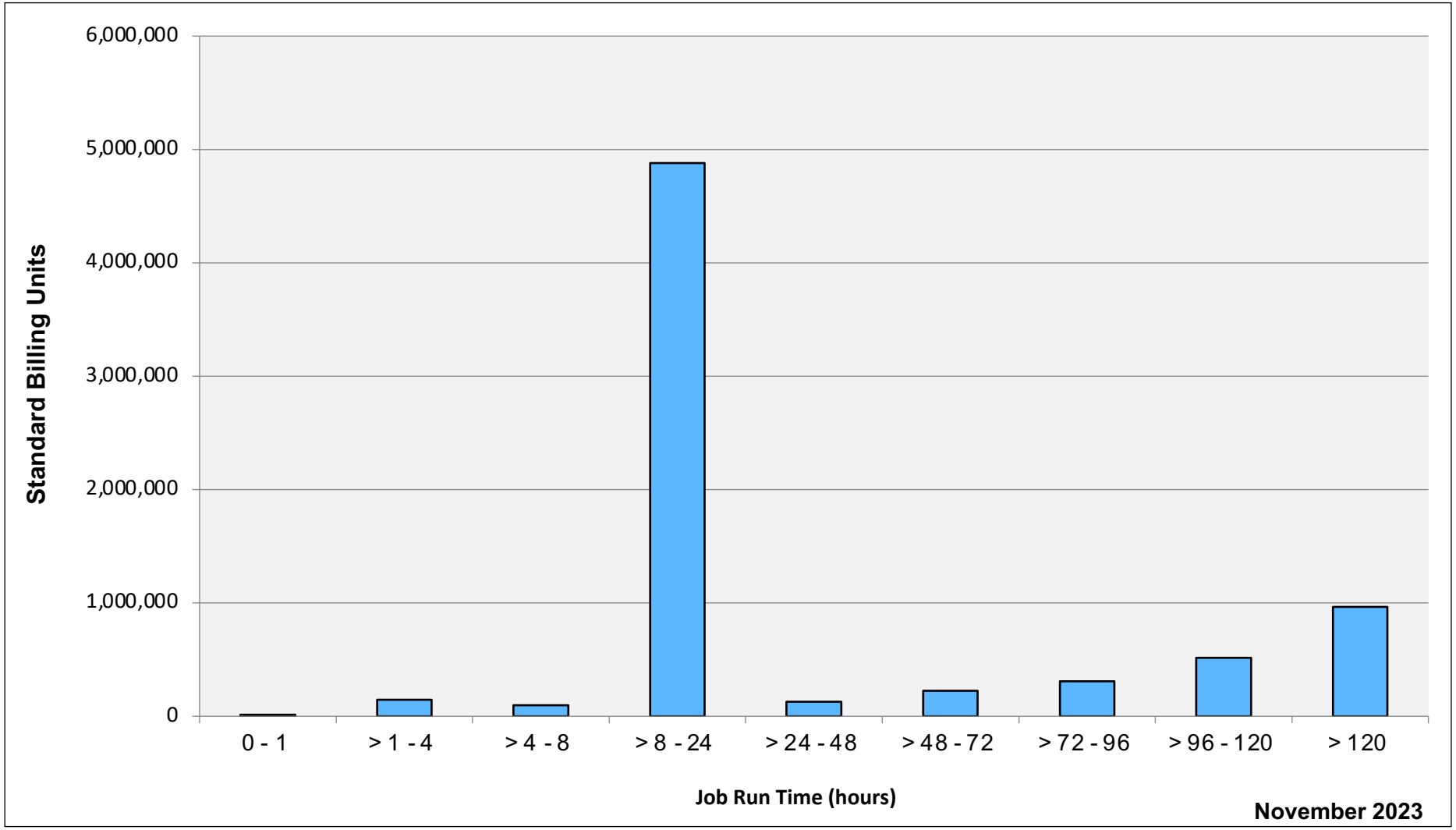
Aitken: SBUs Reported, Normalized to 30-Day Month



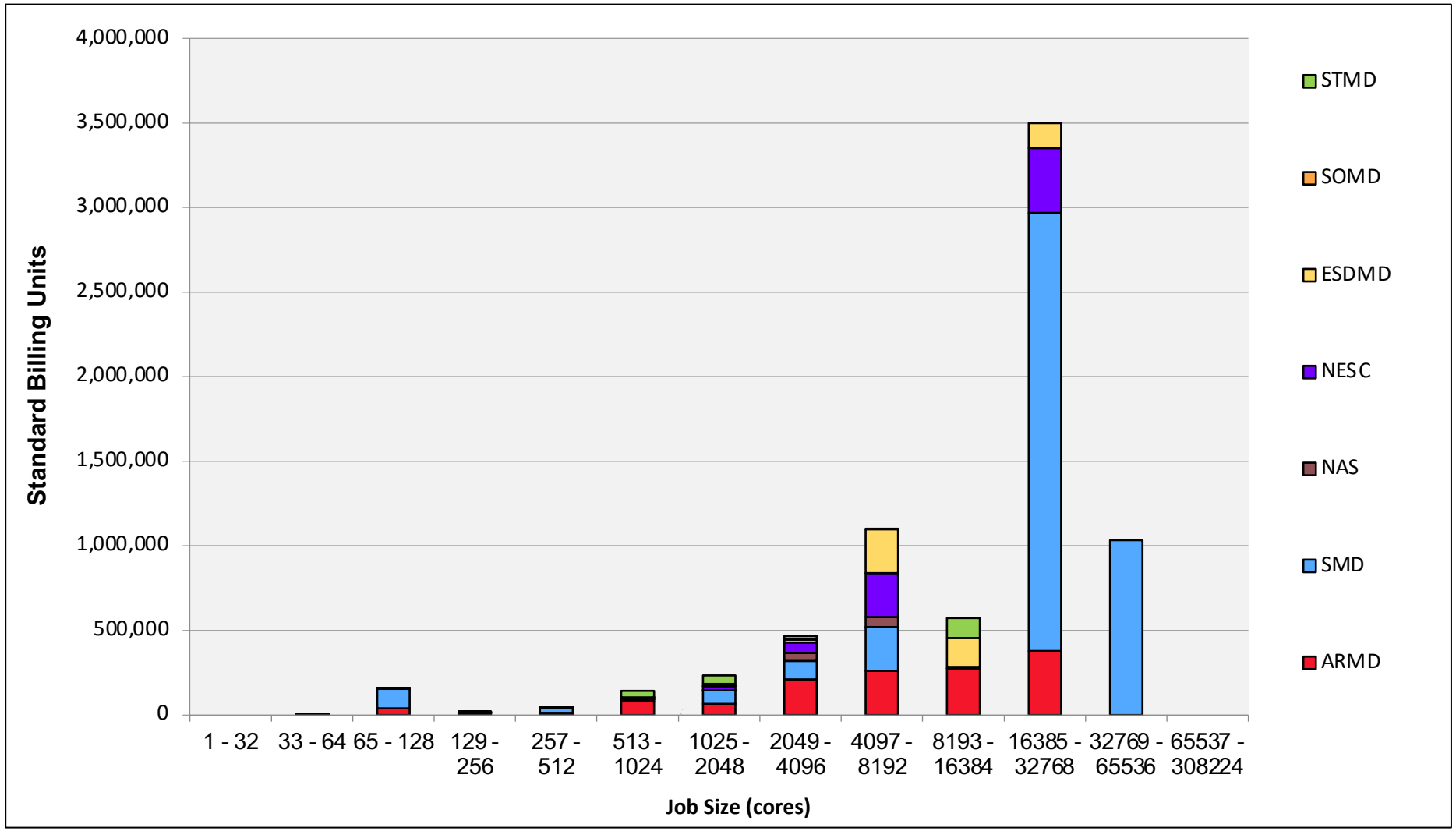
Aitken: Devel Queue Utilization



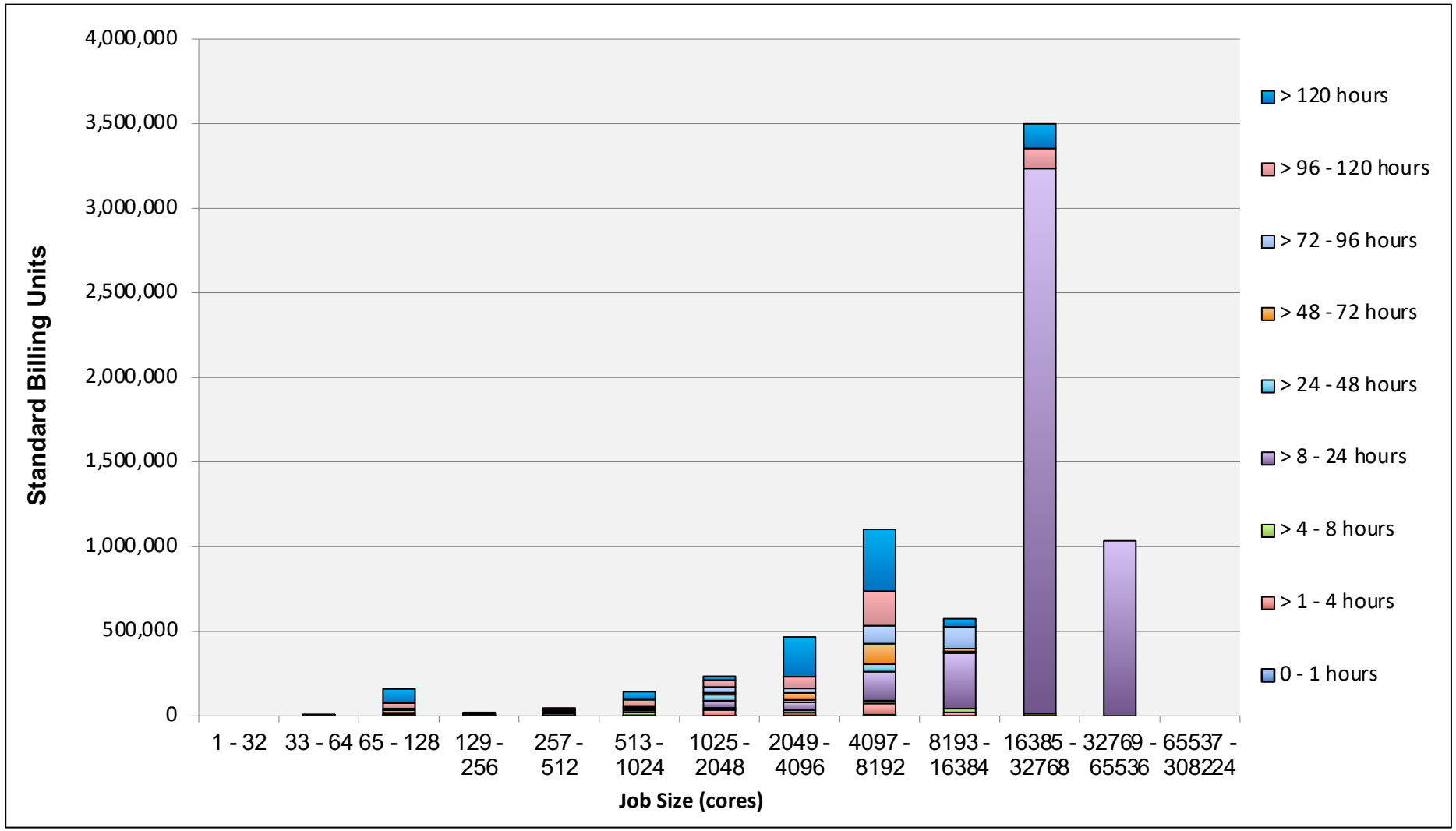
Aitken: Monthly Utilization by Job Length



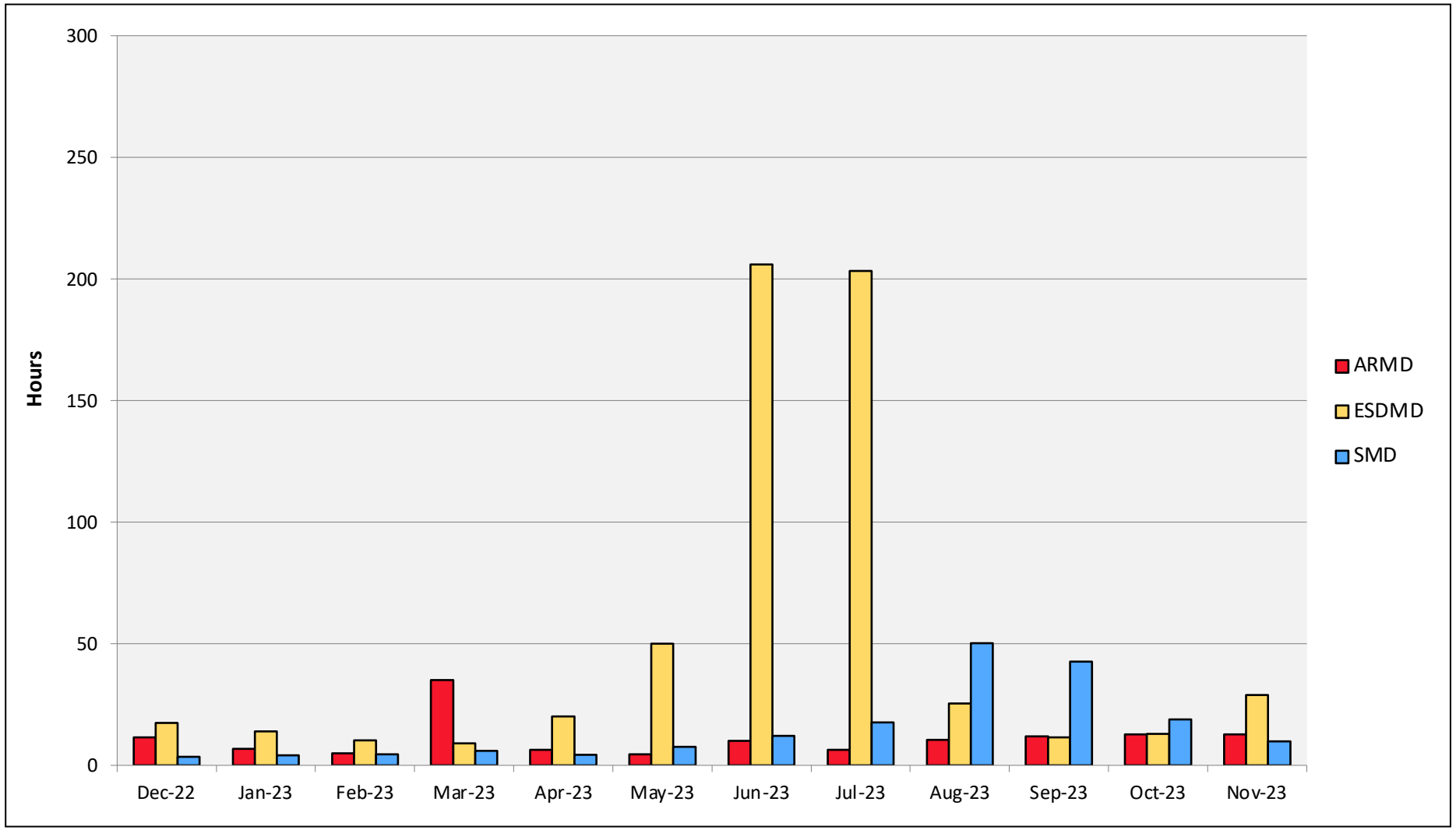
Aitken: Monthly Utilization by Job Size



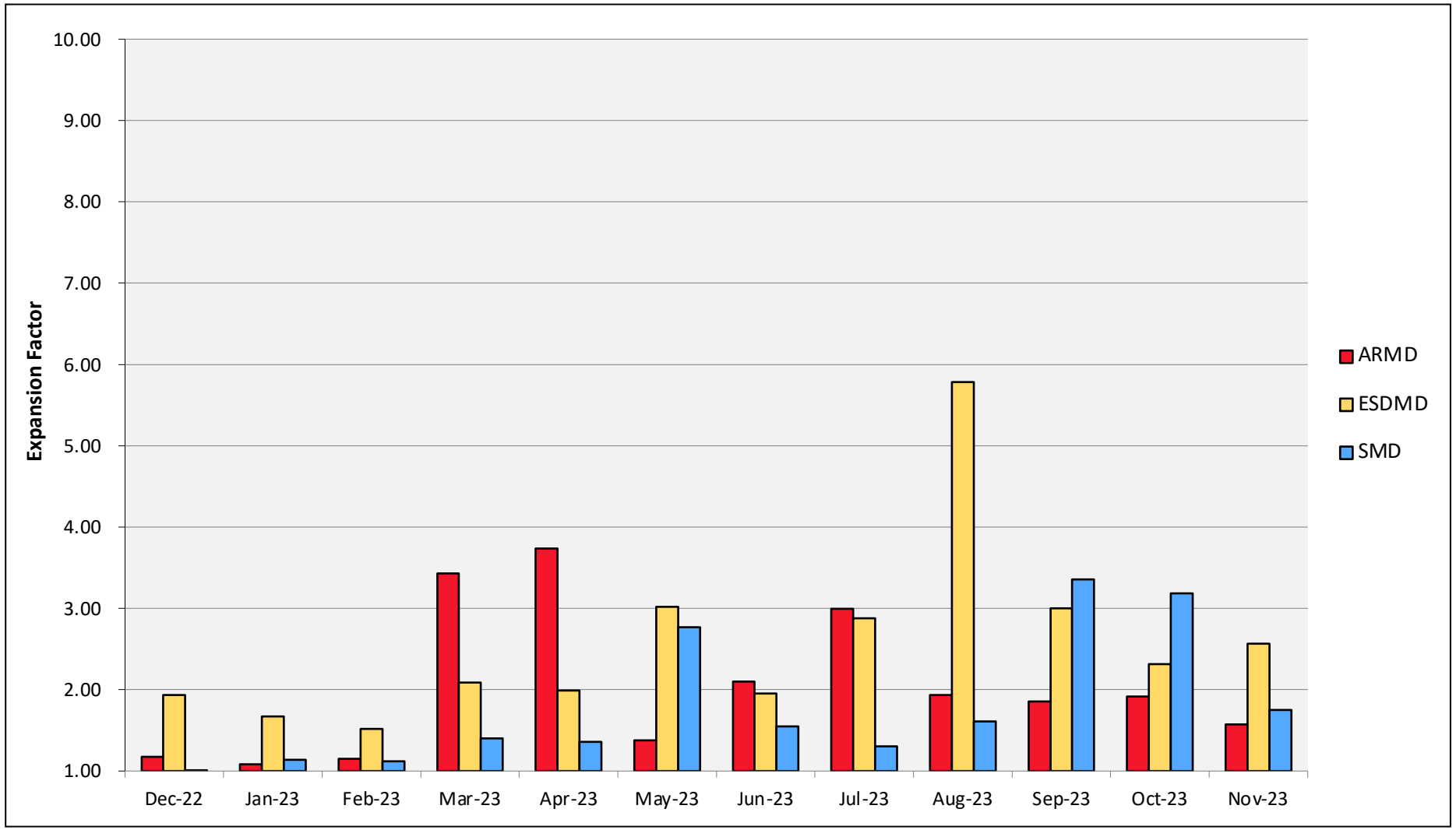
Aitken: Monthly Utilization by Size and Length



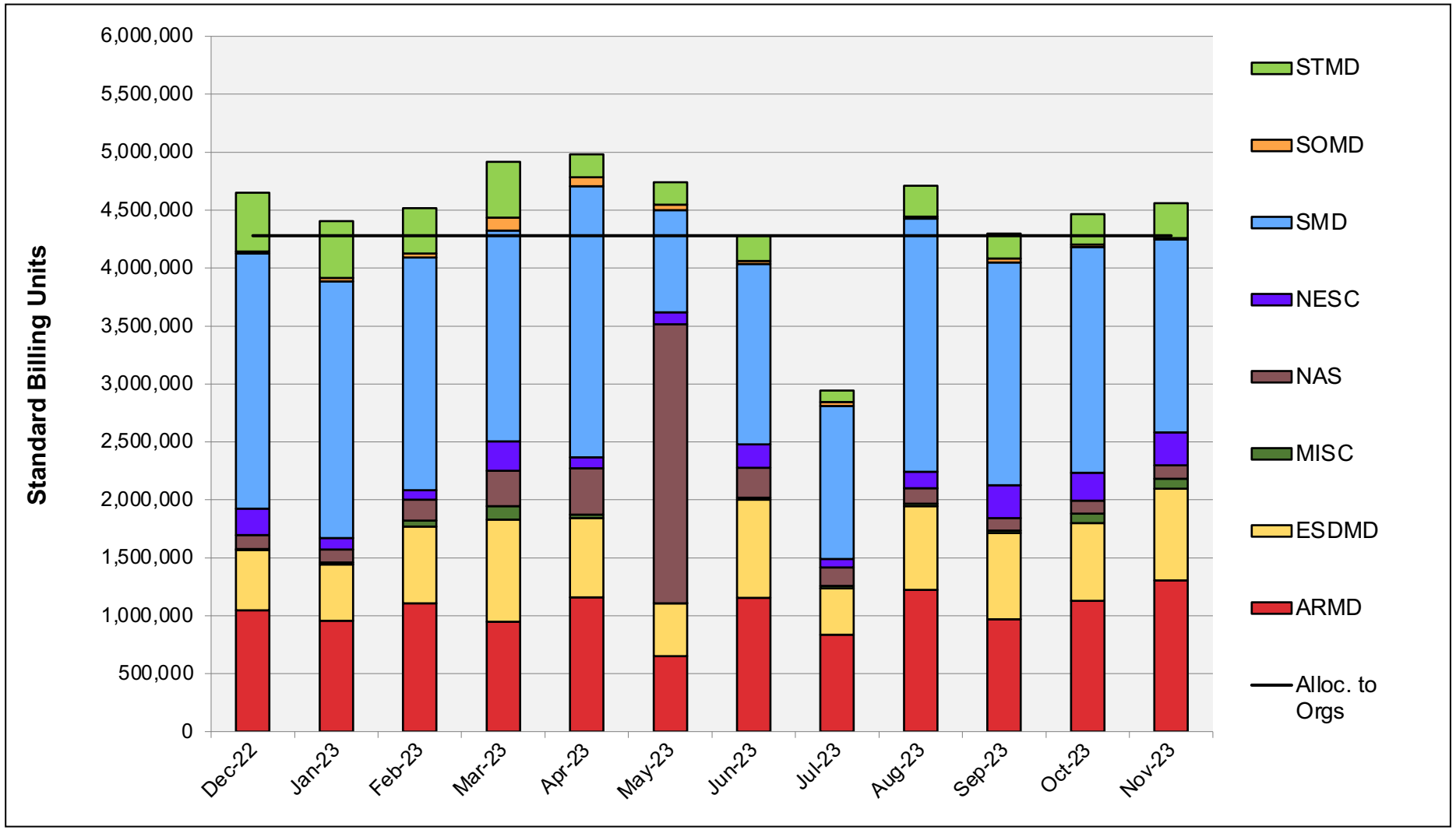
Aitken: Average Time to Clear All Jobs



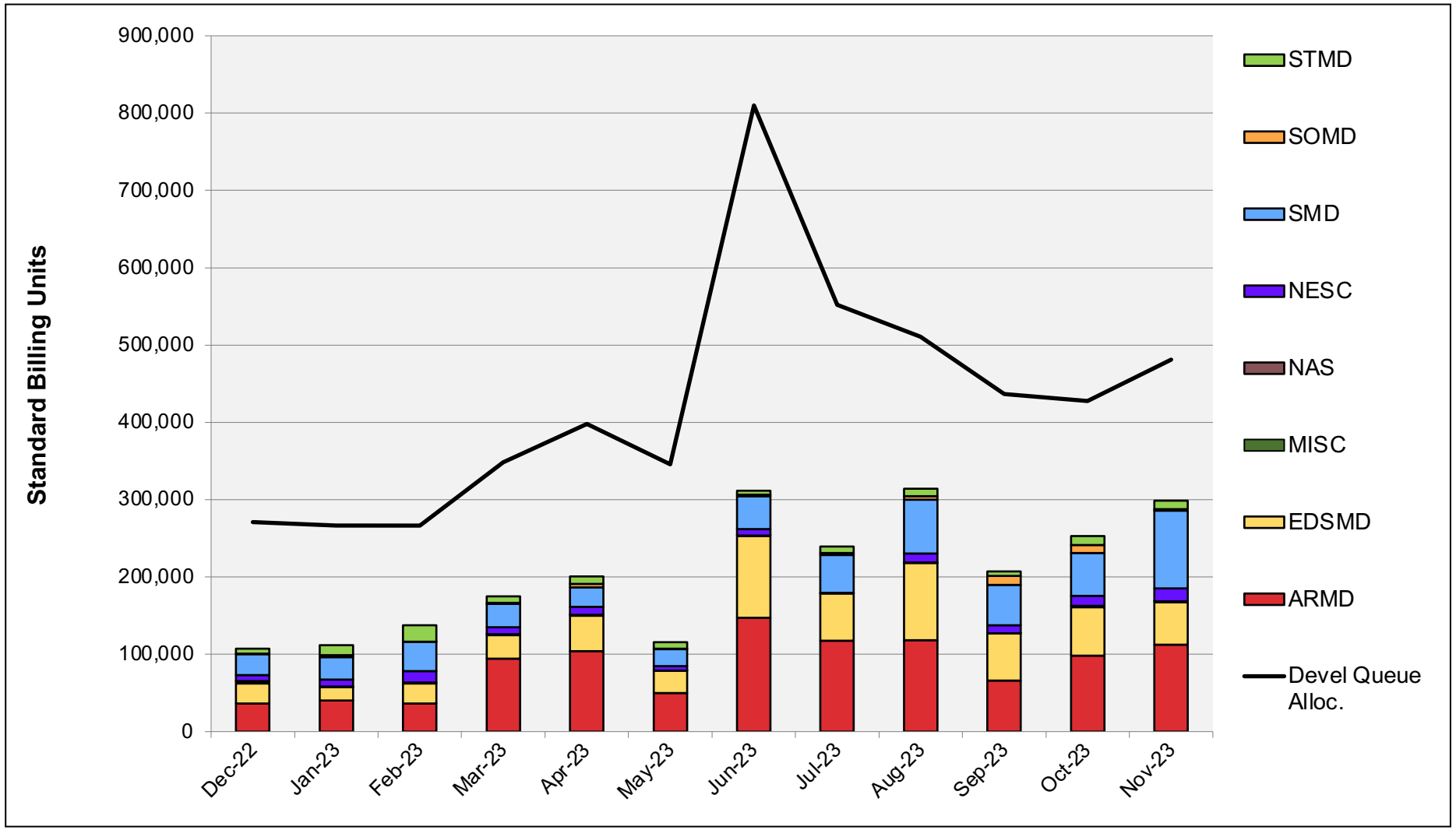
Aitken: Average Expansion Factor



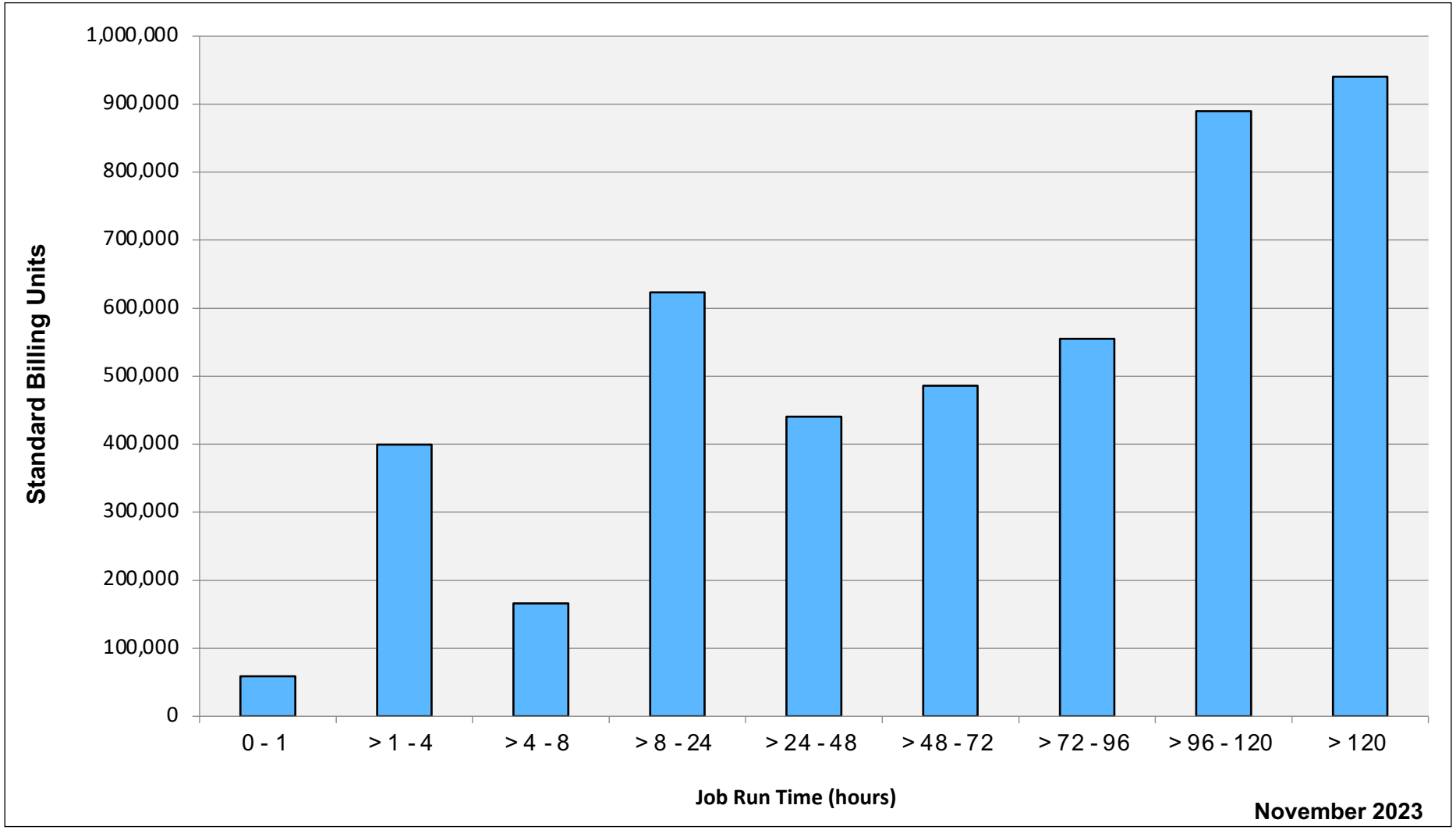
Pleiades: SBUs Reported, Normalized to 30-Day Month



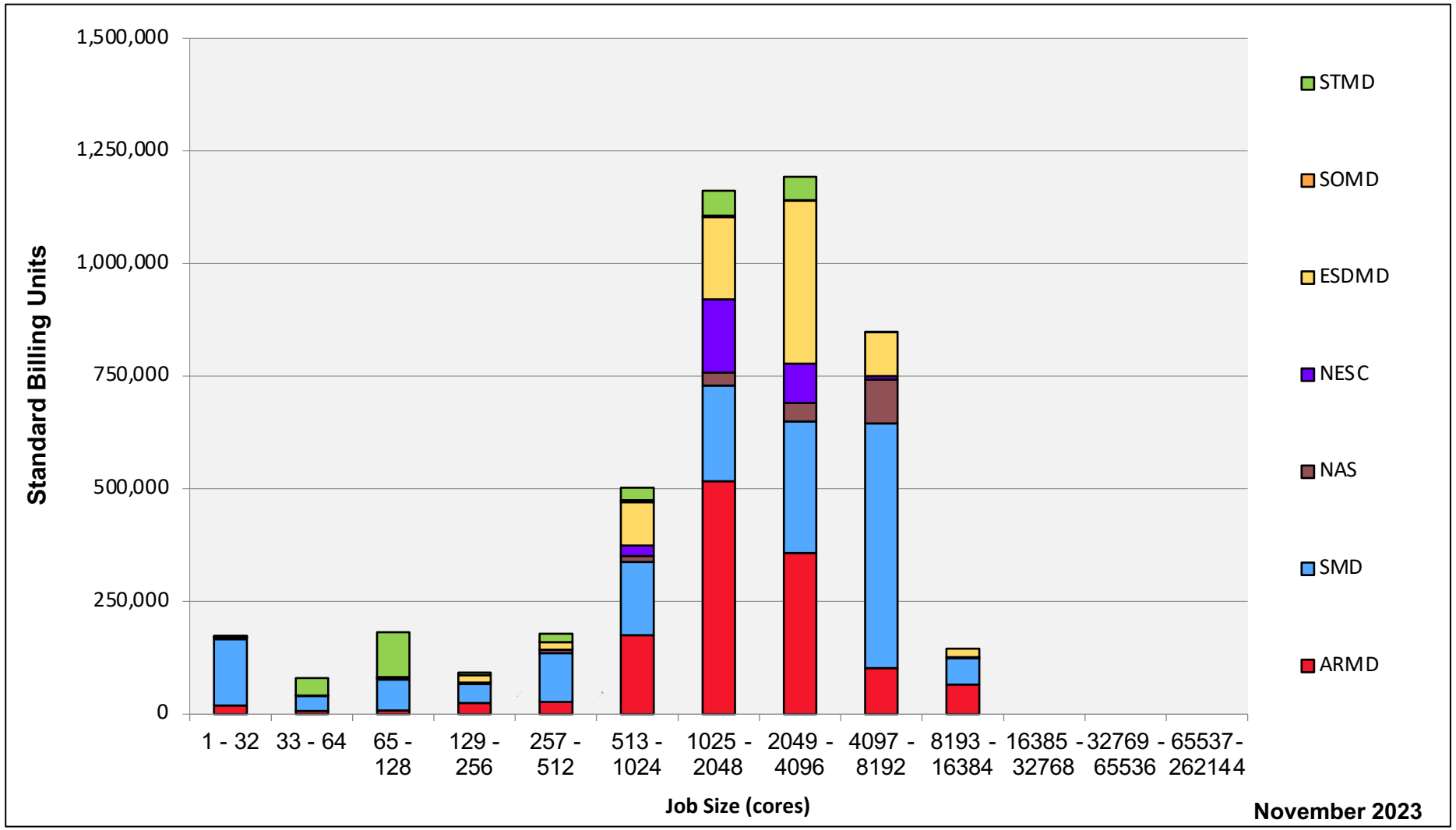
Pleiades: Devel Queue Utilization



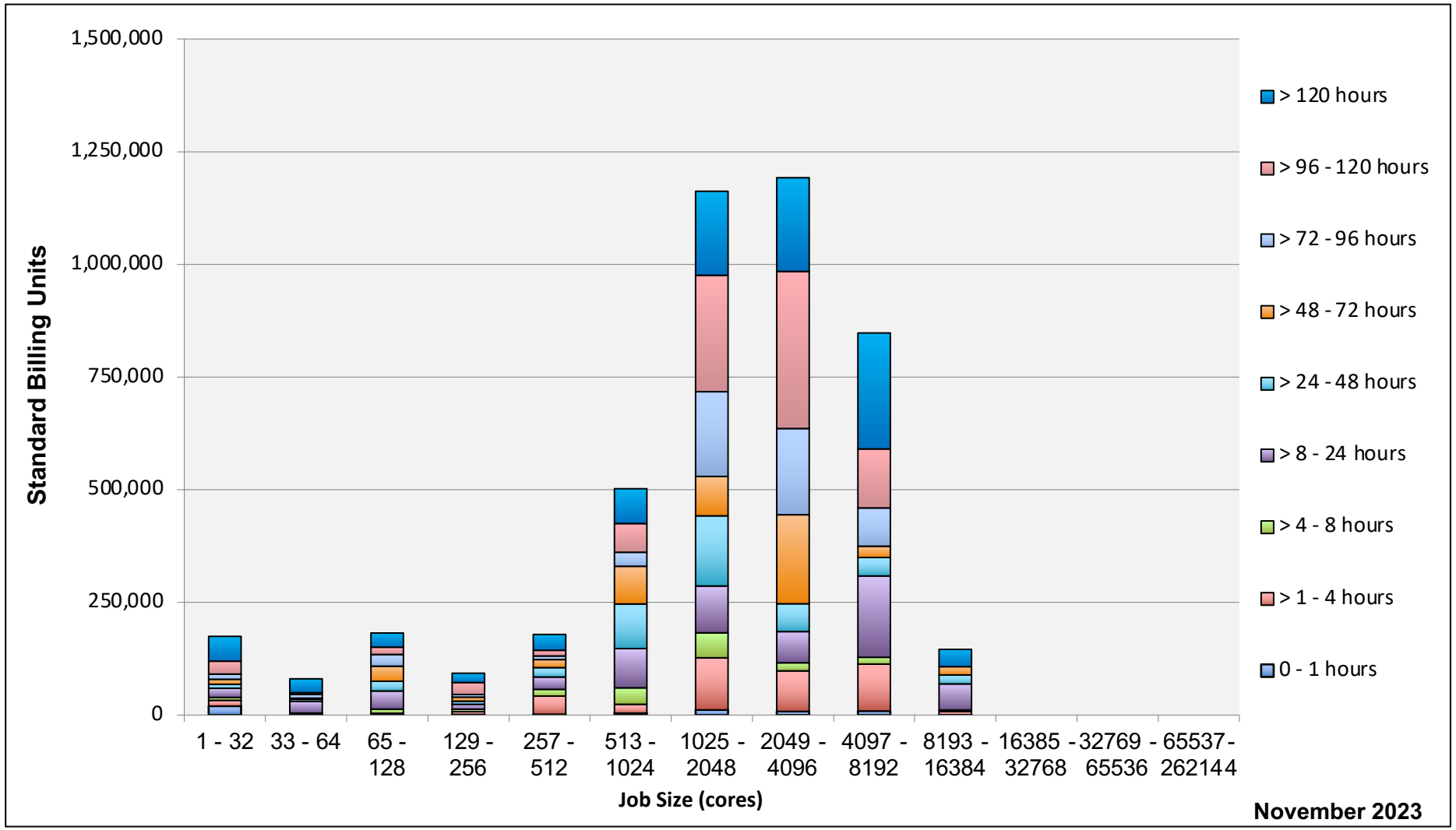
Pleiades: Monthly Utilization by Job Length



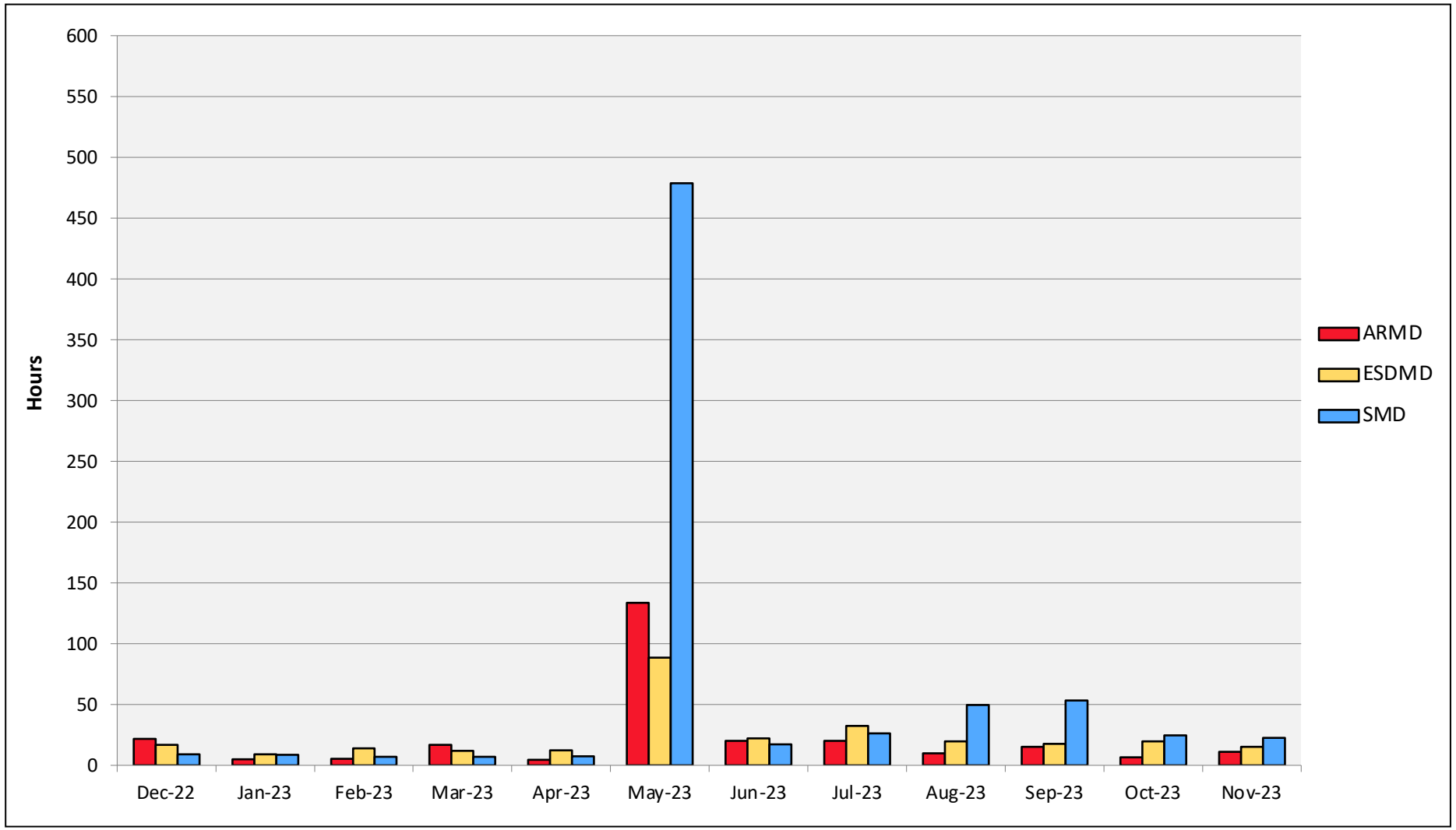
Pleiades: Monthly Utilization by Job Size



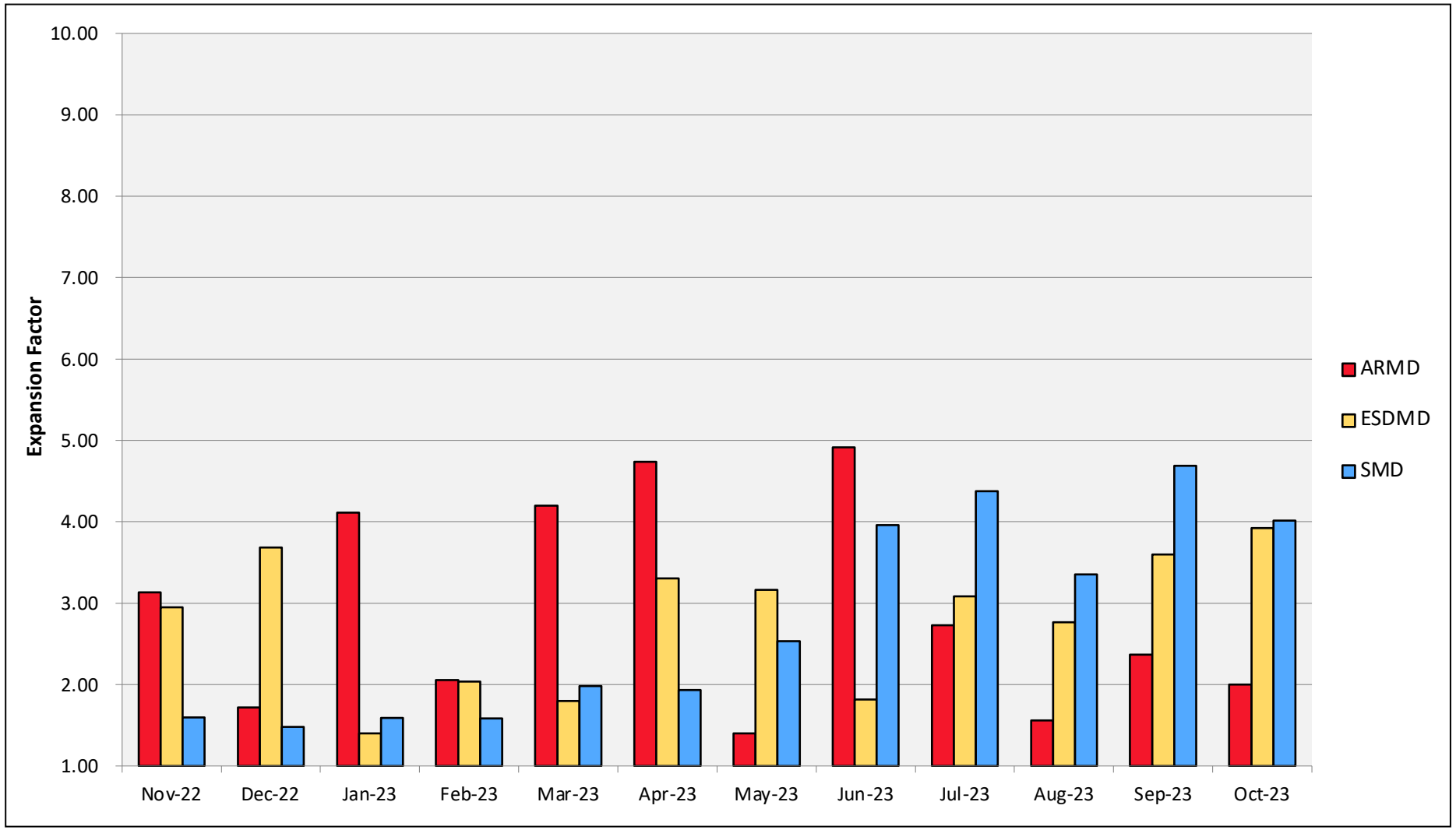
Pleiades: Monthly Utilization by Size and Length



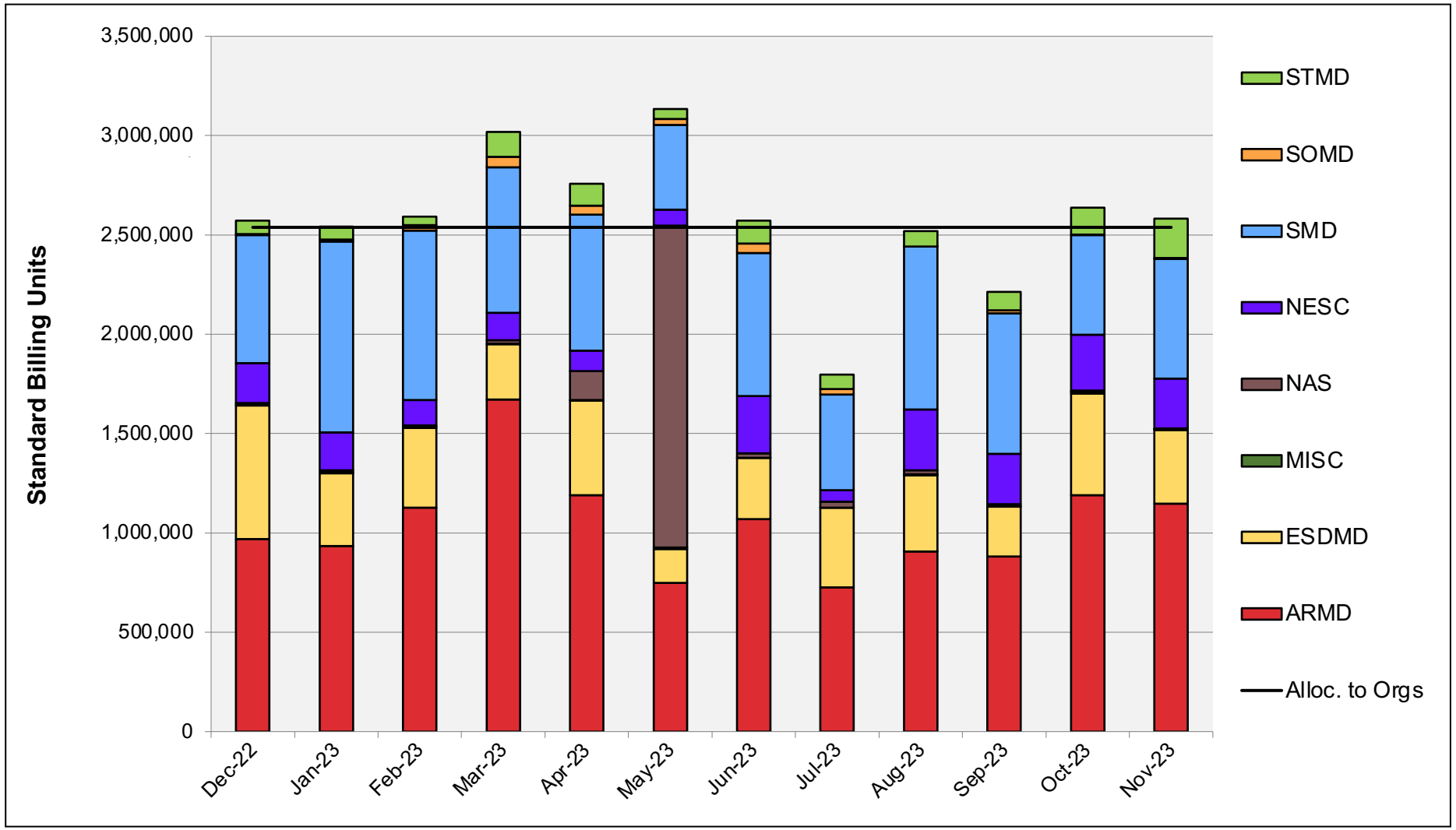
Pleiades: Average Time to Clear All Jobs



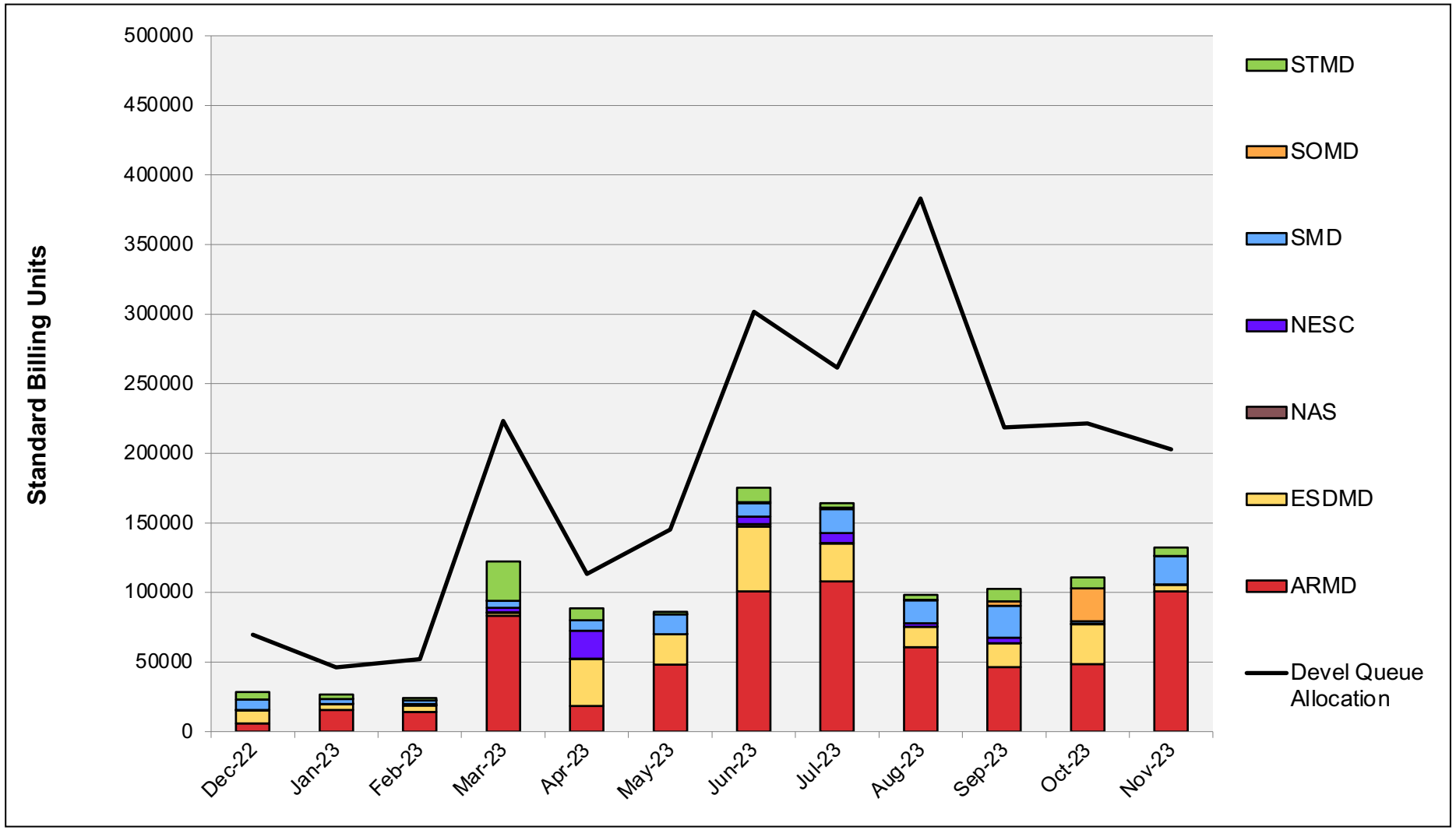
Pleiades: Average Expansion Factor



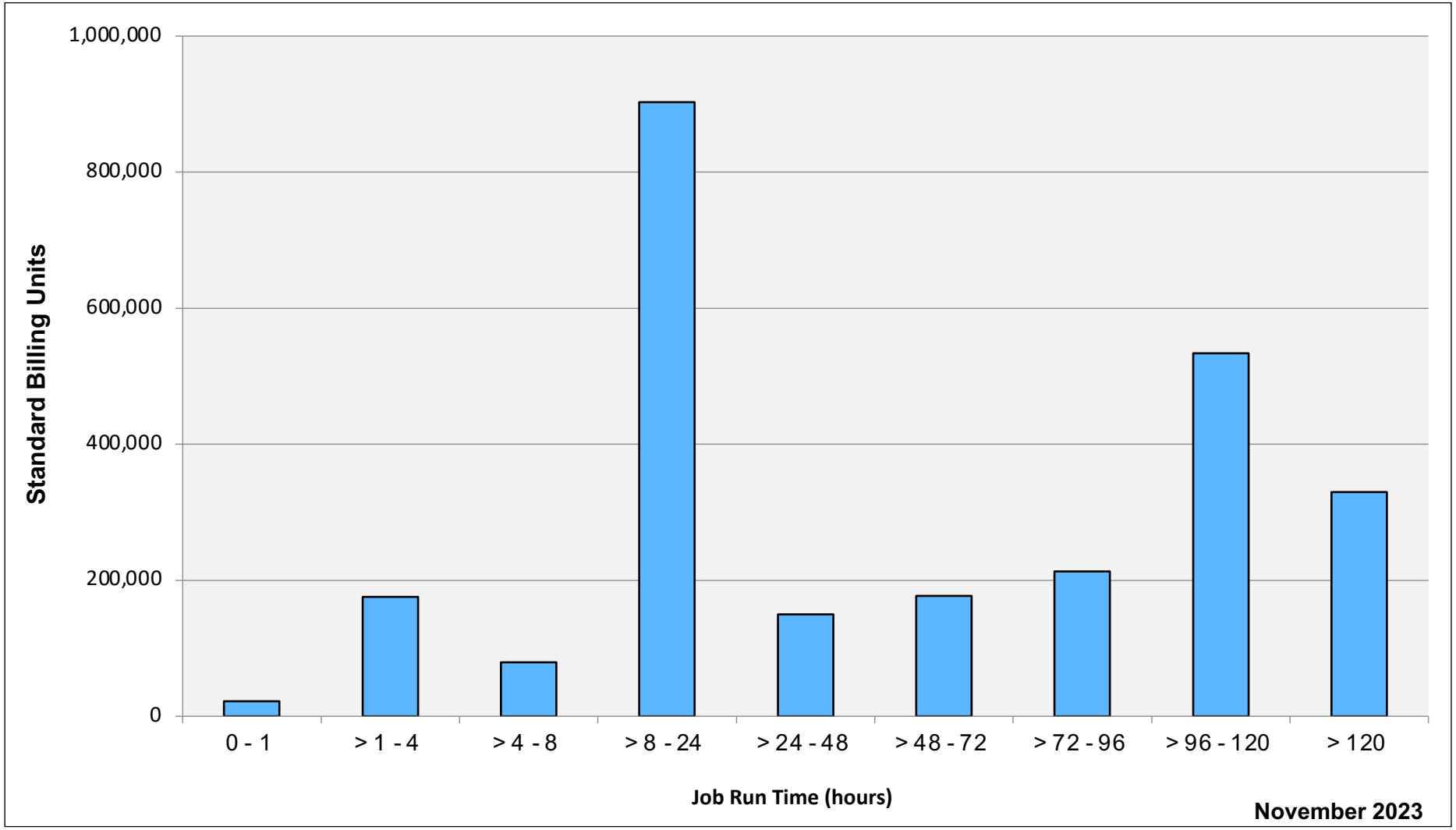
Electra: SBUs Reported, Normalized to 30-Day Month



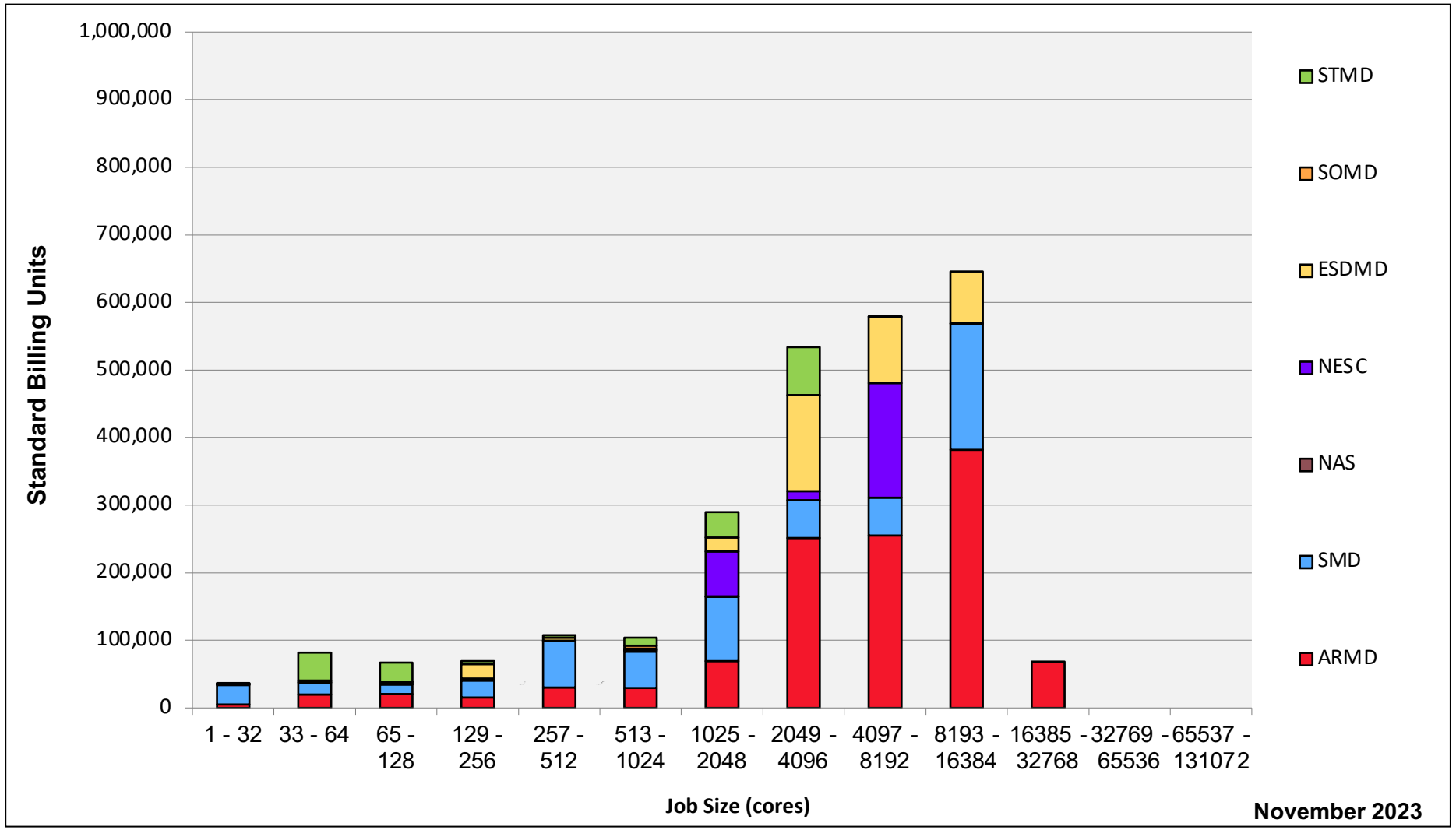
Electra: Devel Queue Utilization



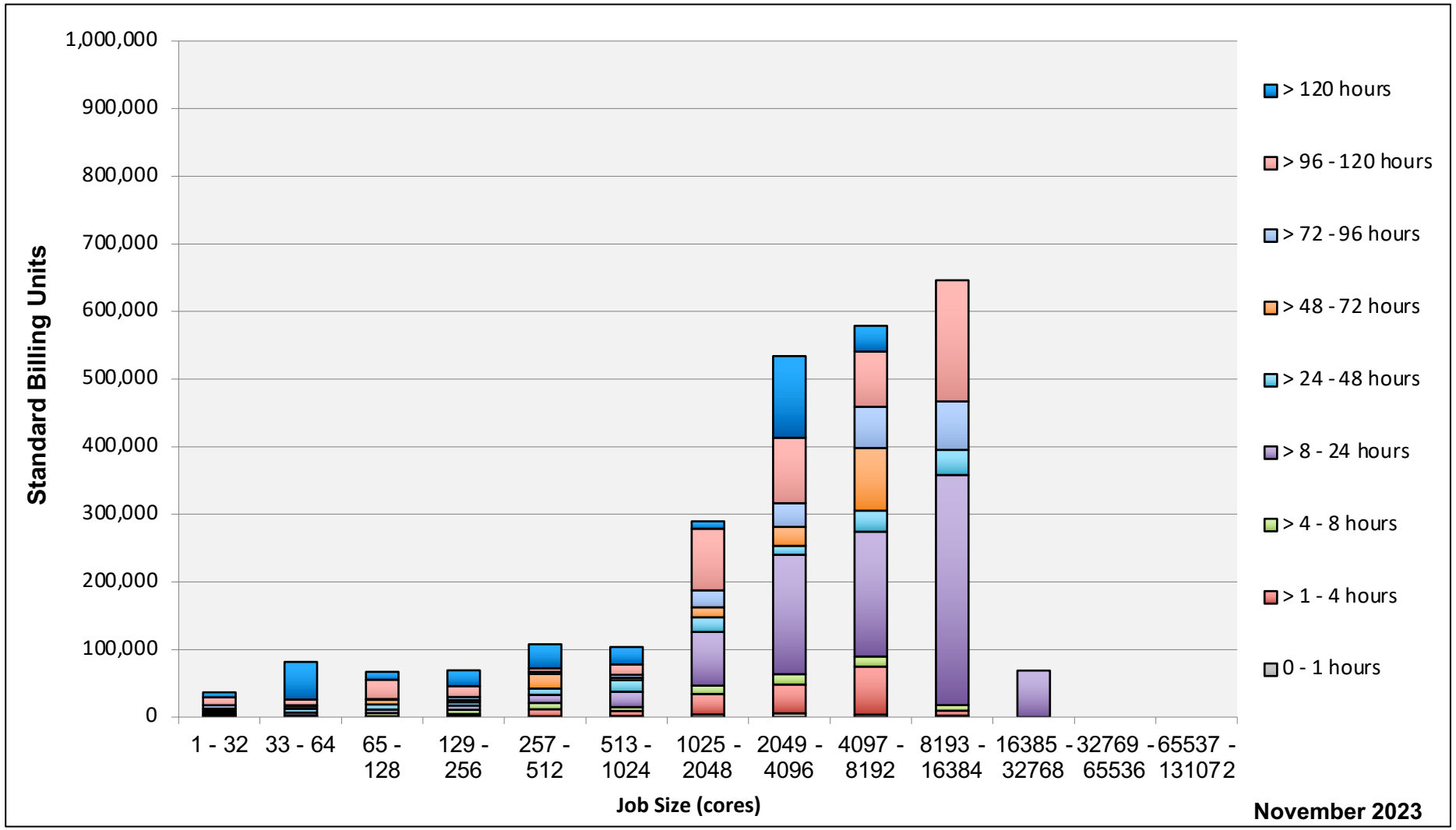
Electra: Monthly Utilization by Job Length



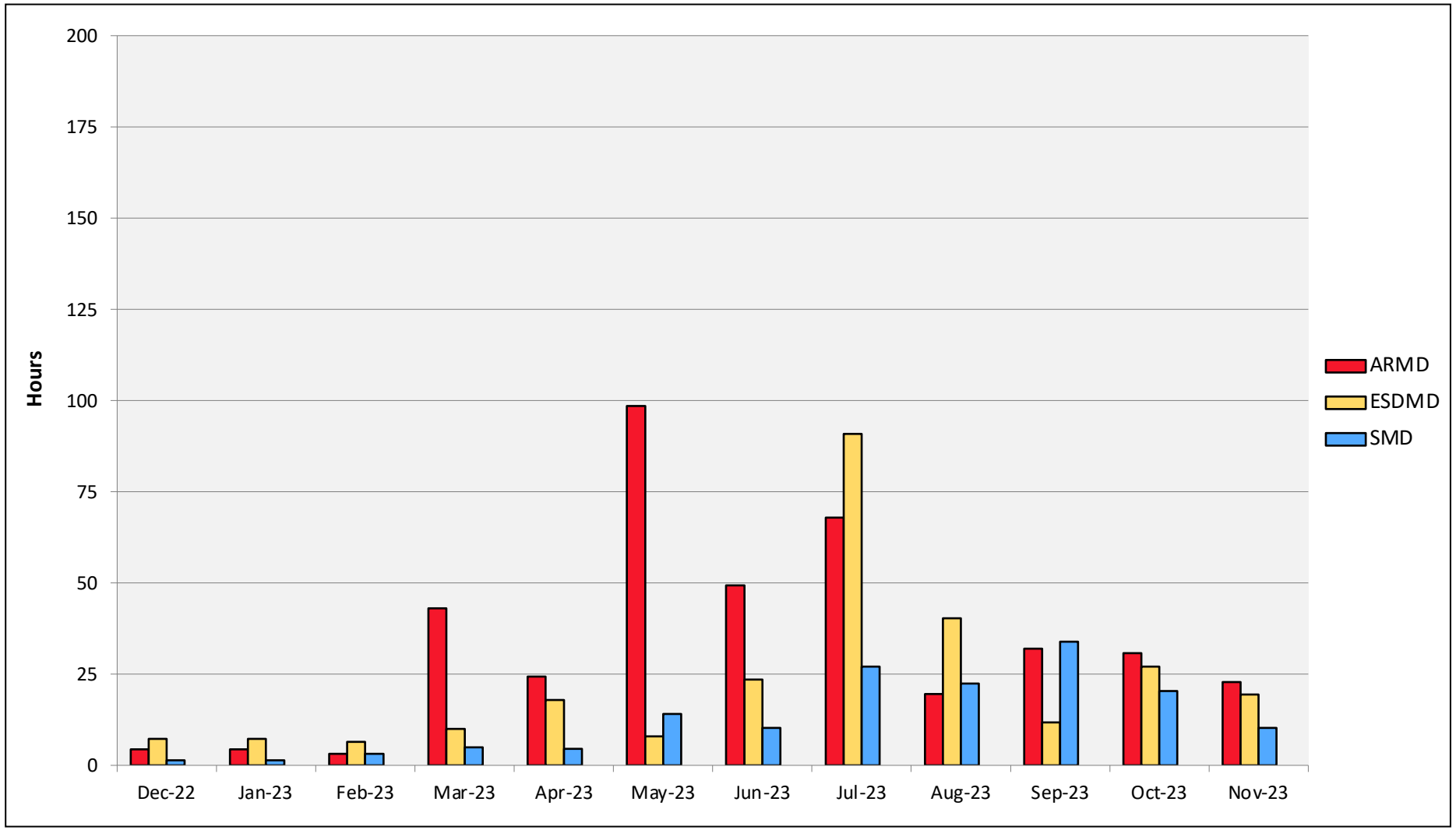
Electra: Monthly Utilization by Job Size



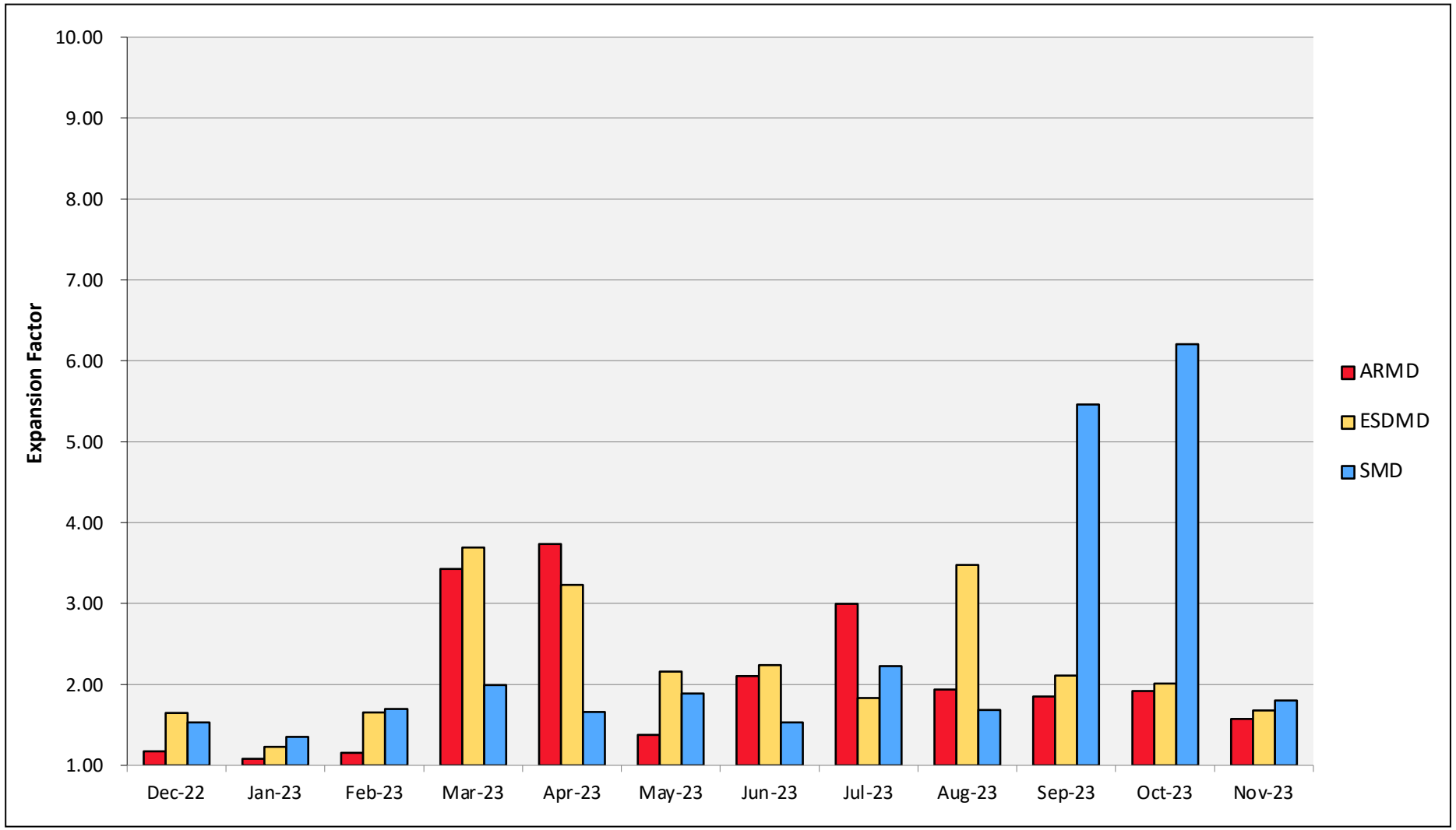
Electra: Monthly Utilization by Size and Length



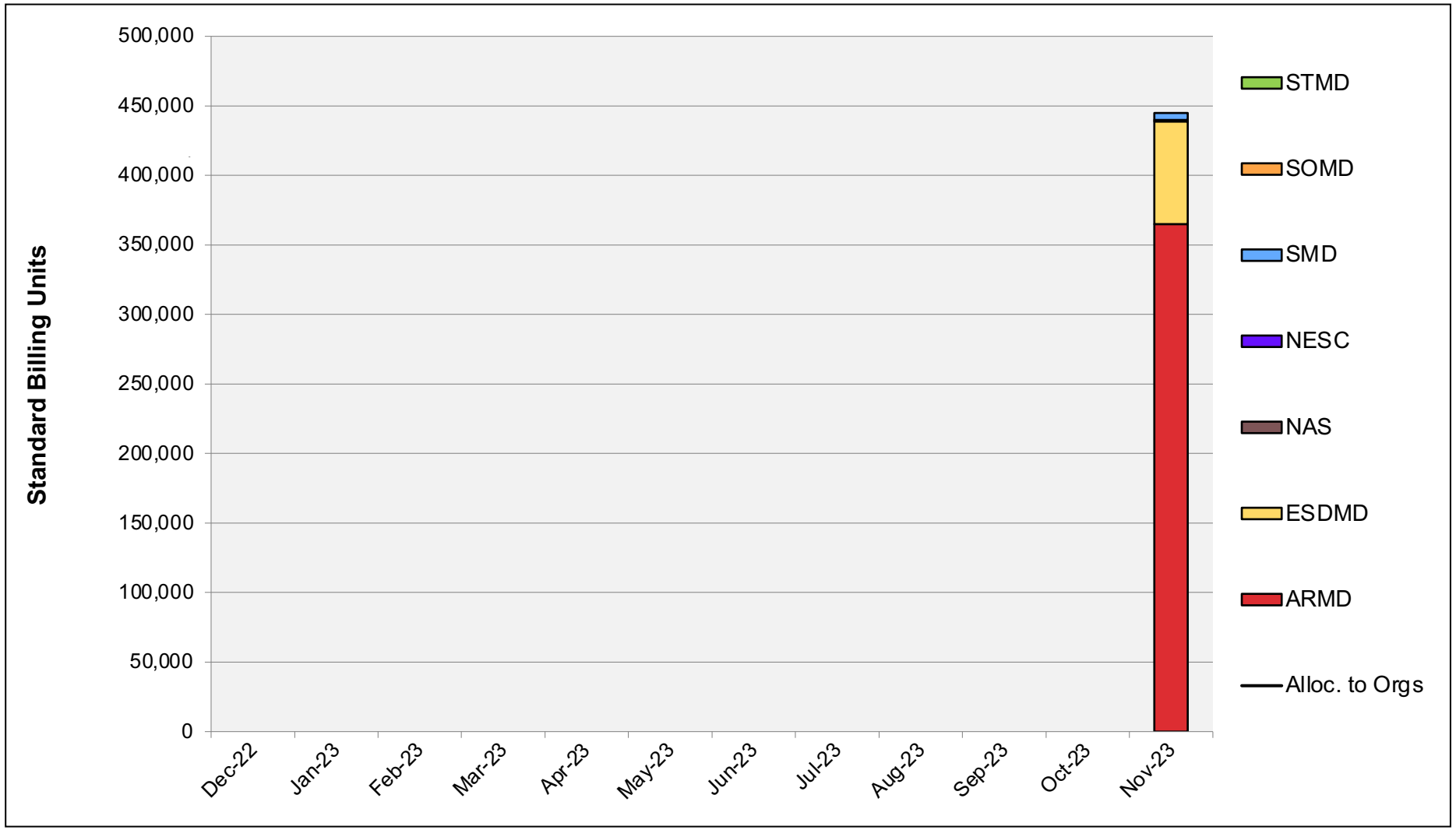
Electra: Average Time to Clear All Jobs



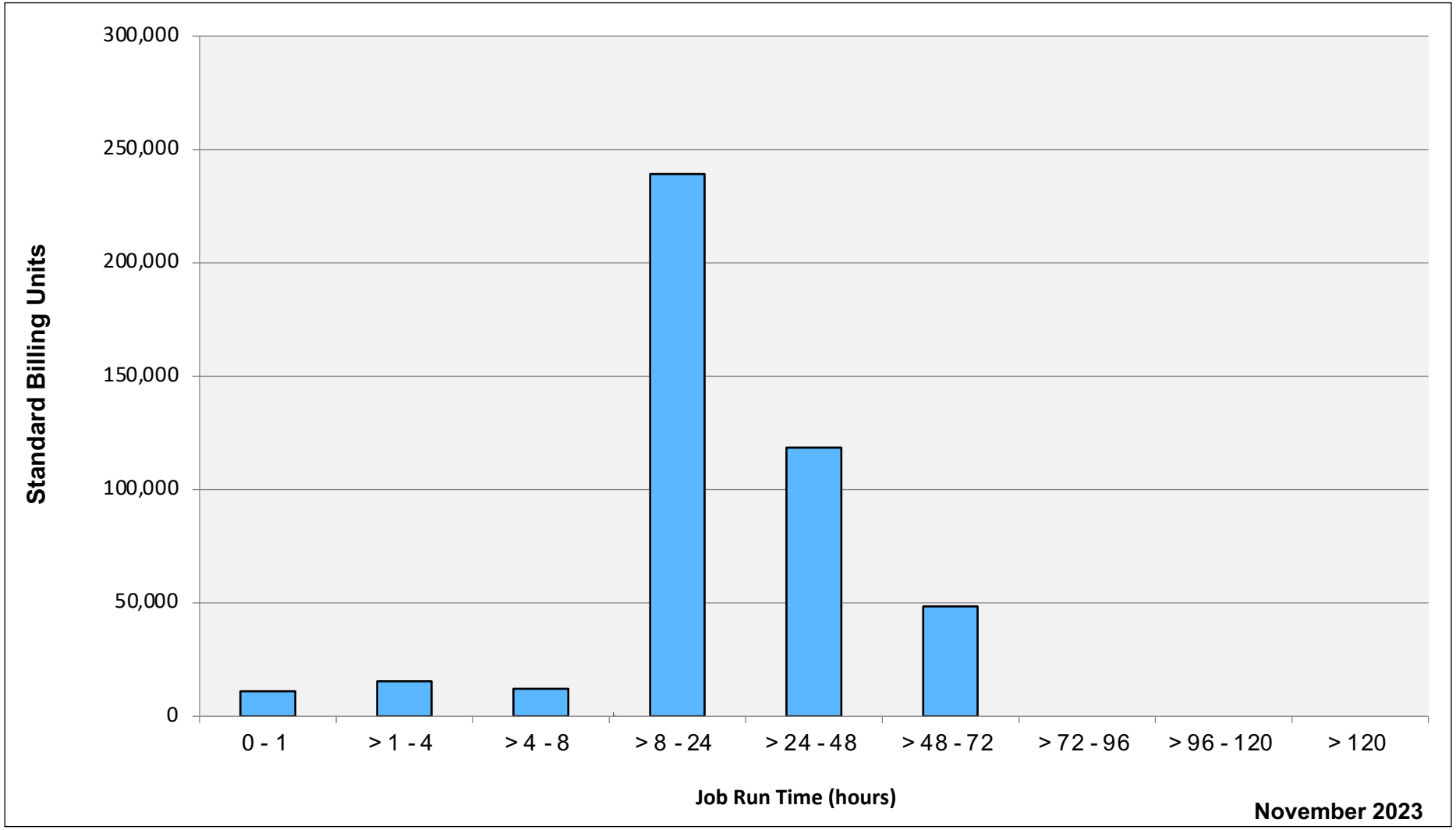
Electra: Average Expansion Factor



Cabeus: SBUs Reported, Normalized to 30-Day Month



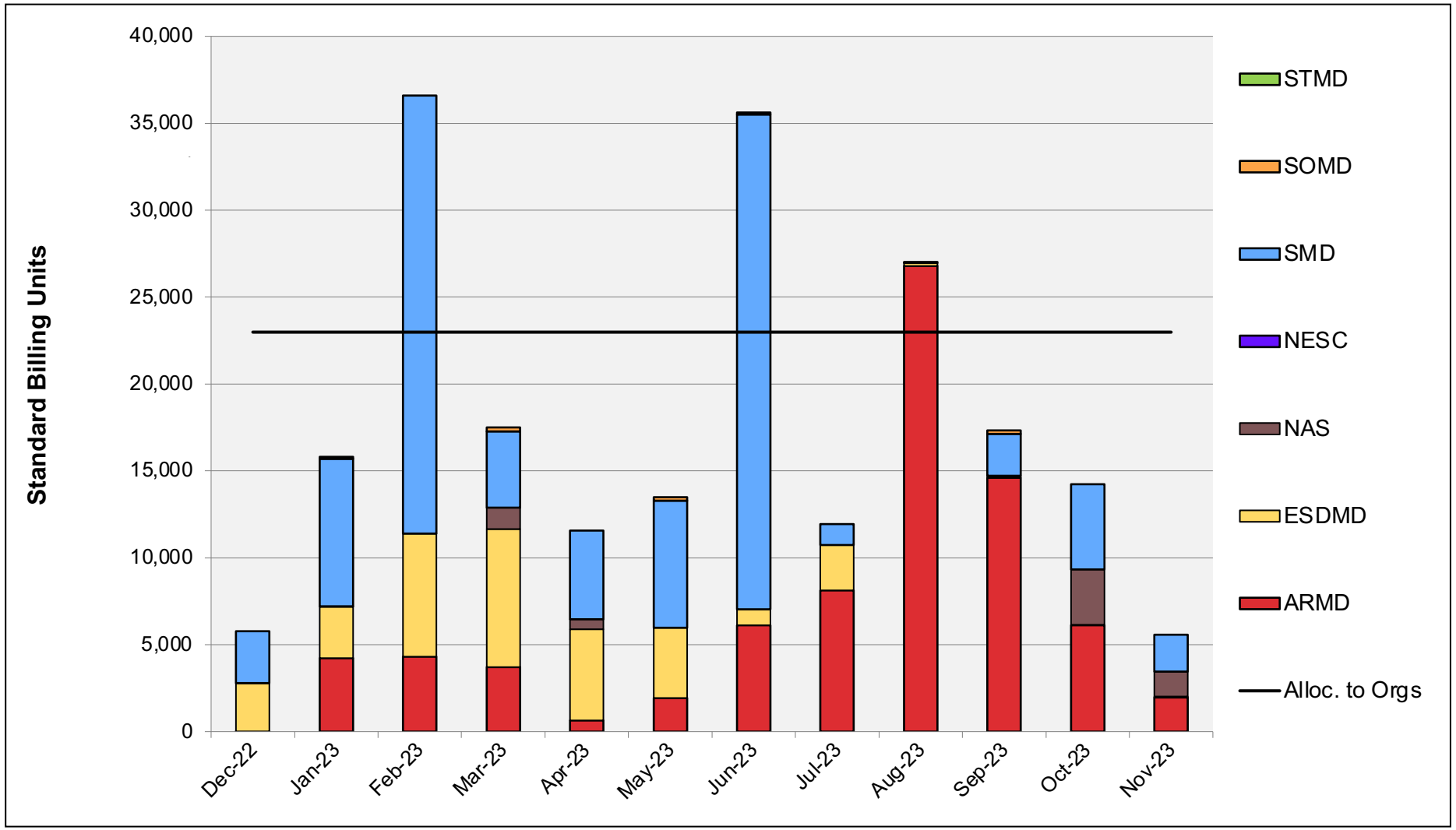
Cabeus: Monthly Utilization by Job Length



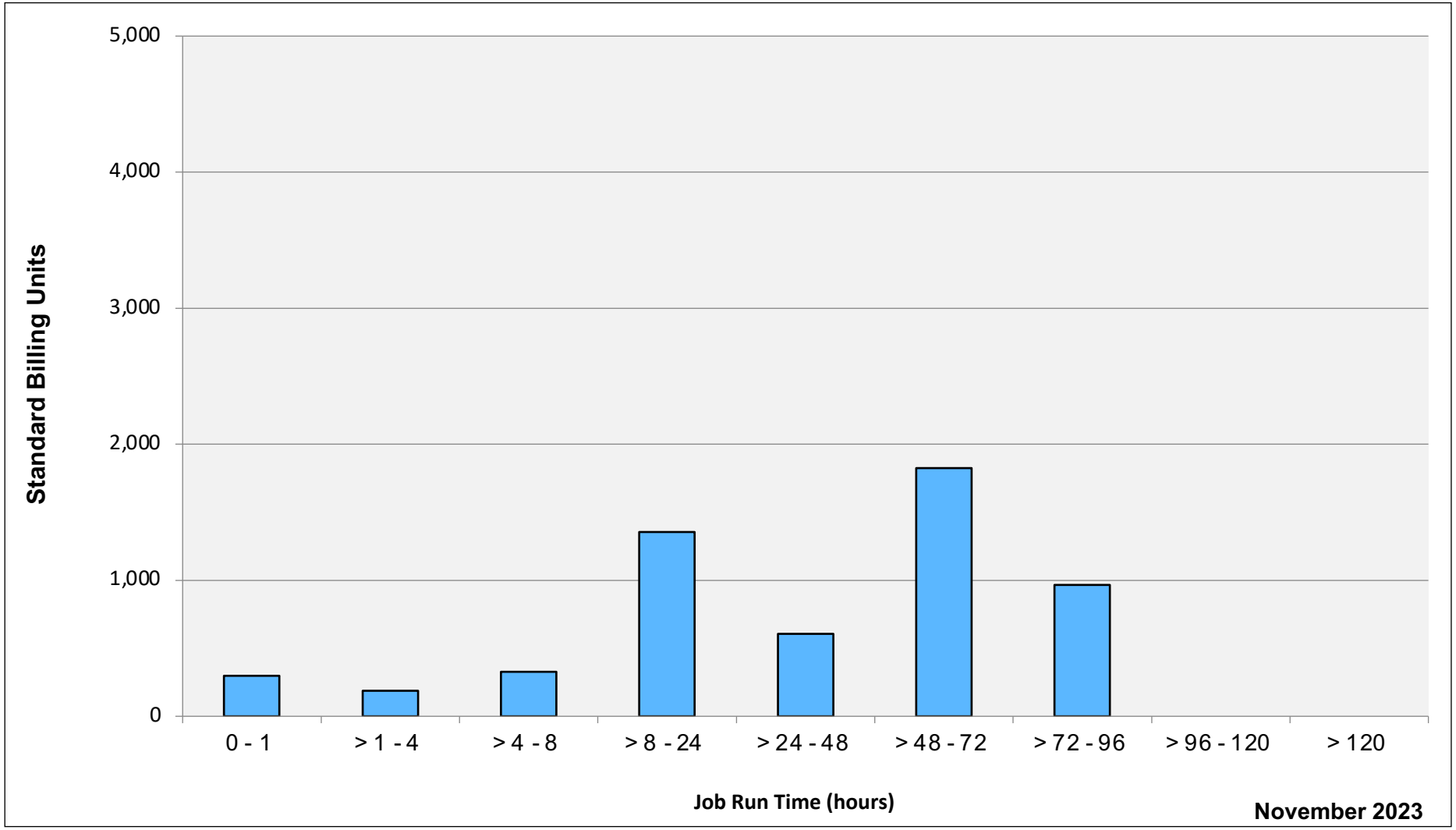
Cabeus: Average Expansion Factor



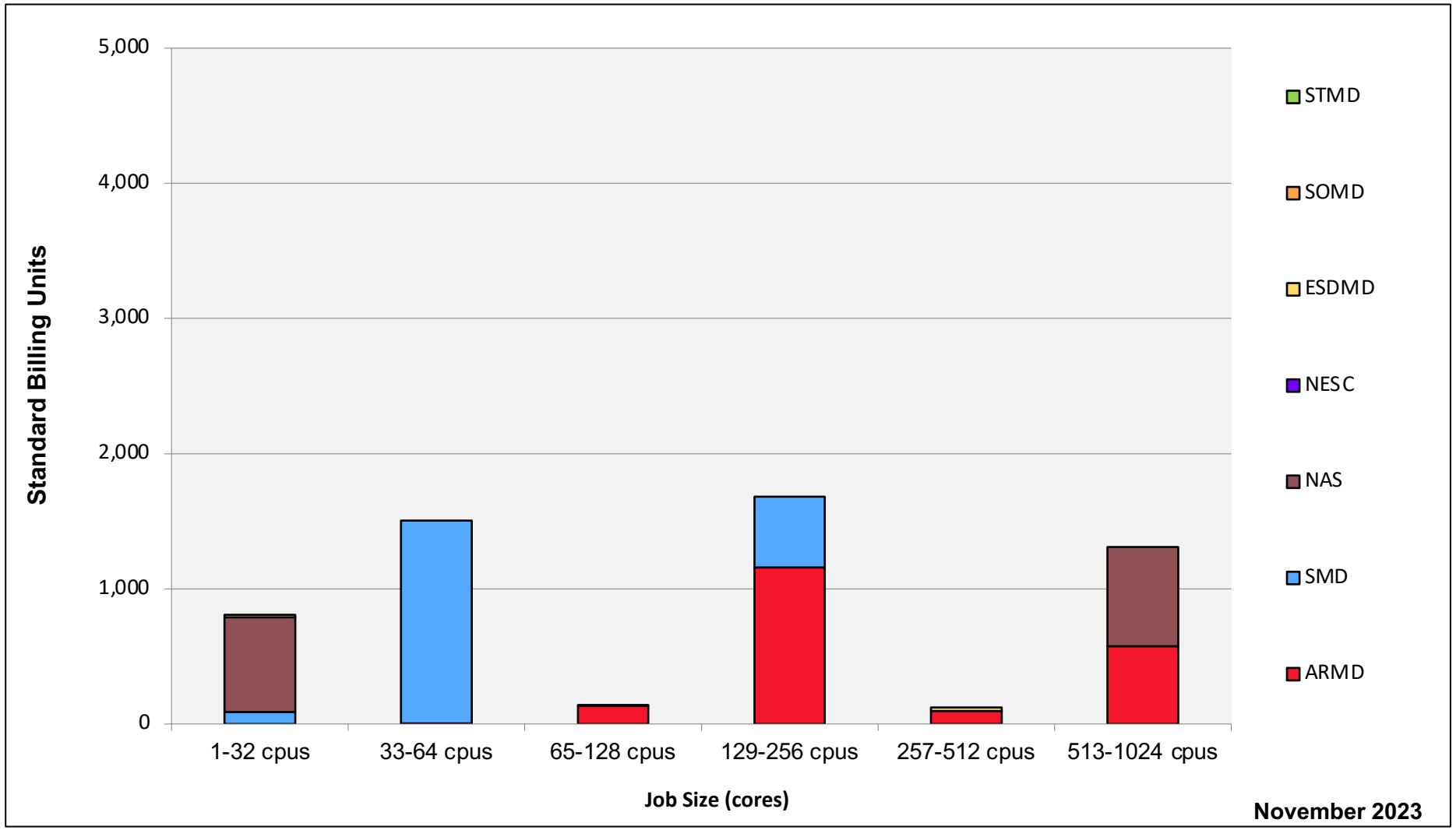
Endeavour: SBUs Reported, Normalized to 30-Day Month



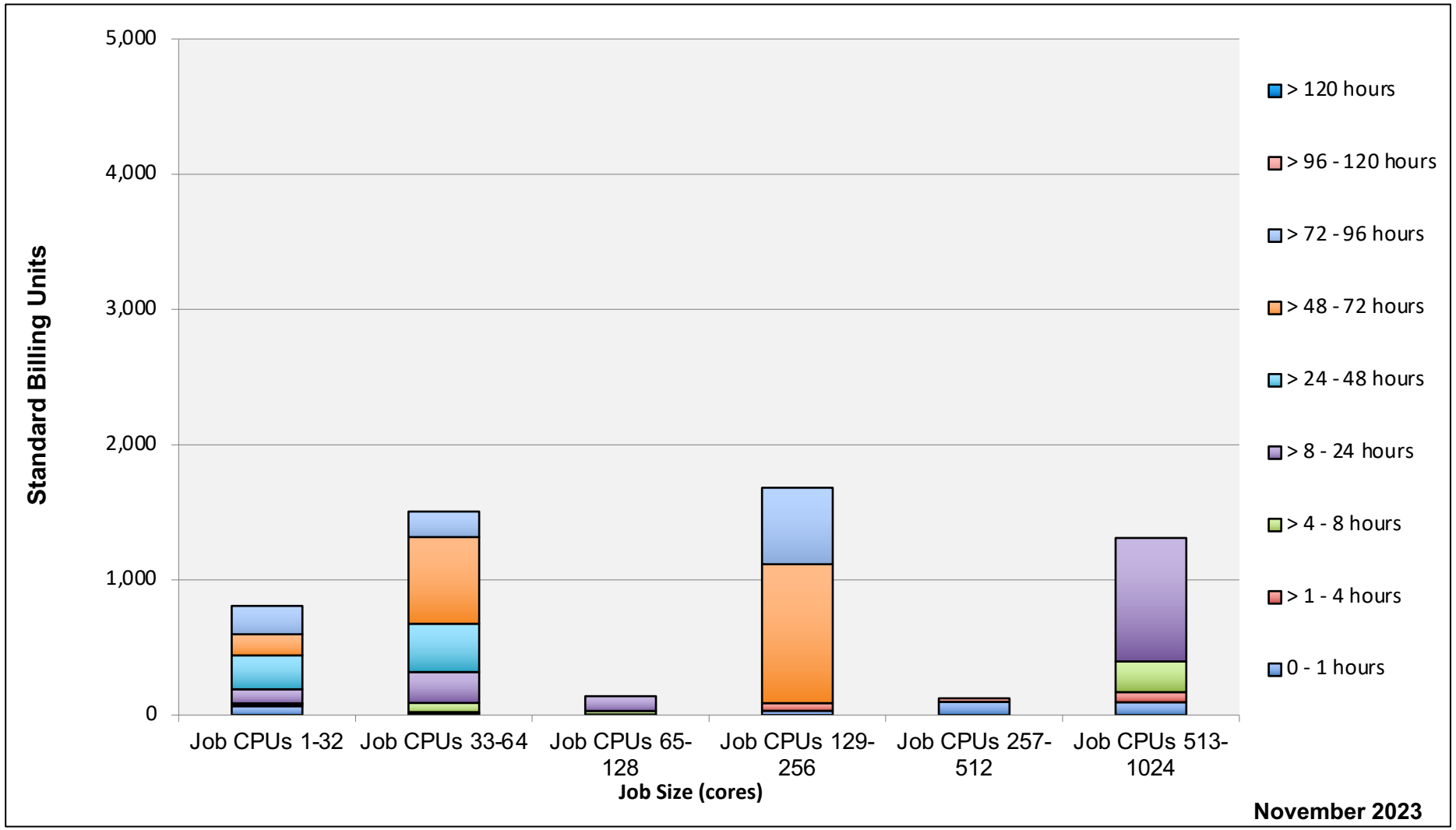
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor

