National Aeronautics and
Space Administration

HIGH-END COMPUTING CAPABILITY PORTFOLIO

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September 10, 2020

Facility Upgrades to Aitken Module in Progress

- Facility upgrades to the Aitken module are underway in preparation for the new Apollo 9000 compute installation in mid-September.
- The module's electrical and cooling capacity is being upgraded to accommodate the increased demands of the new computers.
- The electrical power distribution is being upsized to handle an additional 100 kilowatts required by the Apollo 9000 above the original design of the HPE 8600 computers.
  - Existing 60-amp circuit breakers in two distribution panels are being replaced with new 100-amp circuit breakers.
  - Existing 6-gauge cabling to the compute racks is being replaced with new 4-gauge cabling.
- The Cooling Water Distribution unit is being re-piped, as the Apollo 9000 eliminates the cooling fan racks used in the HPE 8600s.
  - The existing cooling water piping is being removed and replaced with
    4-inch piping to supply the single Cooling Distribution Unit in the Apollo 9000 design.

IMPACT: Upgrades to the Modular Supercomputing Facility provide facility space and power to support new computer resources for NASA mission projects.

The current module housing the Aitken supercomputer at Ames Research Center. Facility upgrades to electrical power and cooling capacity will support new computing resources being installed in September 2020. *Derek Shaw, NASA/Ames*

Endeavour Replacement Vendor Selection Completed

- With the Endeavor supercomputer reaching its end-of-life, a replacement system required procurement before the end of calendar year 2020.
  - Endeavour was installed in 2013 to replace the Columbia supercomputer as a large shared-memory resource.
- Responses to the Request For Proposal were evaluated by a team of HECC systems experts, and Hewlett Packard Enterprise (HPE) was selected as the winner.
- HECC will purchase two HPE Superdome Flex systems. Each system will have:
  - 32-socket Intel Xeon 8280 (28-core, 2.7 gigahertz) with 6 terabytes of memory.
  - NUMAlink 8 interconnect (13.33 gigabytes per second of bidirectional peak payload bandwidth).
  - Theoretical peak of 77.414 teraflops.

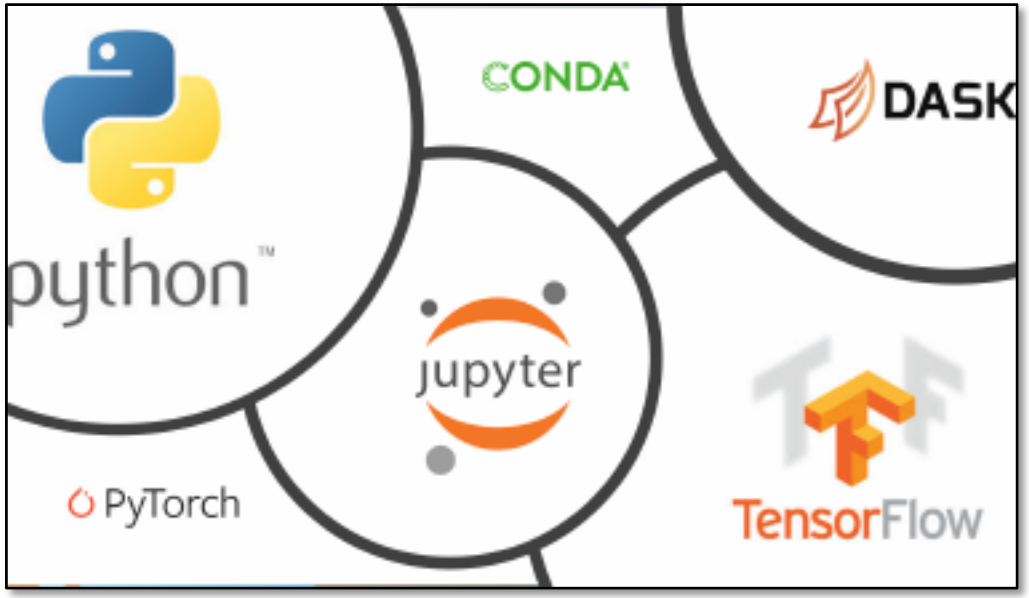
IMPACT: Scientific code that benefits from large shared-memory systems will continue to be supported by HECC with 384% more theoretical compute, 100% more memory than the Endeavour supercomputer, and nearly 100% increase in interconnect speeds.

The HPE Superdome Flex Server. *Image courtesy HPE*

HECC Holds User Training Sessions for Data Science

- Over the last several months, the Data Science team conducted three training sessions, including a webinar to provide an overview of software, environments, and tools available to HECC users; topics included:
  - Data science conda environments, which can be used to provide, or be customized to create, a project-specific software environment.
  - Web user interfaces, such as Jupyter Lab, which allow for graphical presentation and manipulation of data and easier data sharing; TensorFlow, for deep learning on GPU nodes; and Dask, a distributed programming tool on CPU nodes.
  - Core services offered by the team; and past pilot projects such as Solar Cell Materials and Prediction with Gas Chemical sensors.
  - 62 users attended the webinar, which is available in the webinars archive.
- The Data Science team also hosted two NVIDIA training sessions attended by 183 users:
  - The Machine Learning (ML) bootcamp and Introduction to Deep Learning (DL) sessions were an introduction to these topics covering:
    - The ML hands-on bootcamp covered the basics of using the NVIDIA Rapids framework. Attendance was limited to 50 users; 150 users responded to request attendance.
    - The DL training covered an introduction to neural networks/deep learning, optimizers, hyperparameters, and artificial intelligence for computational fluid dynamics.

IMPACT: HECC training sessions are designed to familiarize researchers with the software tools available to allow them to apply data science practices in modeling scientific data for NASA programs and projects.

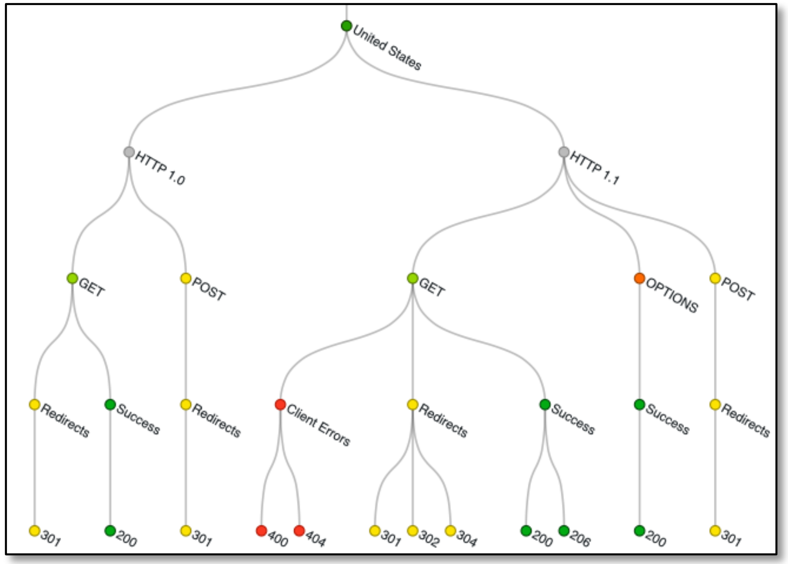


Data Science user training sessions held over the past several months were heavily attended, and several users requested training material. All users expressed interest in future training offerings. The HECC Data Science team presented the capabilities of various software tools to assist with artificial intelligence and machine learning-related projects to further NASA's mission.

New Visualization Capability Improves HECC Security Monitoring System

- HECC security experts continue to improve the security monitoring systems with a new interactive dendrogram visualization capability to create a visual overview of activity.
- The dendrogram is a tree diagram used for displaying hierarchical data.
  - Useful for providing path information of various activities.
  - Allows security analysts to dynamically display up to eight levels of hierarchical data.
- Currently, the interactive dendrogram visualizes activities for elevated privilege use, web server activity, SSH login activity, and vulnerability analytics.
- Future work will include adding drilldown capabilities and adding more activities to visualize.

IMPACT: The interactive dendrogram visualization provides HECC security analyst with a new visualization tool needed to identify threats in order to provide better security for HECC resources.

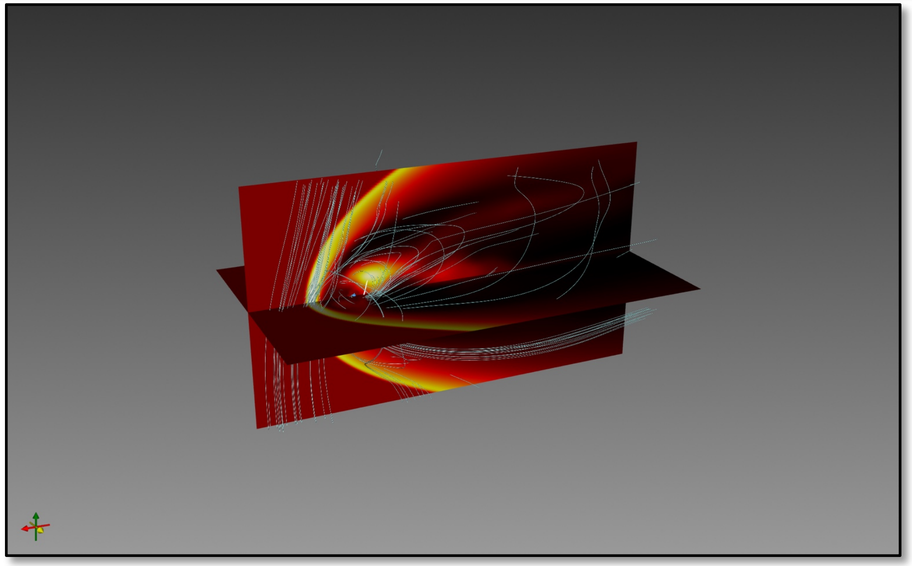


Sanitized dendrogram from the HECC security monitoring system showing a hierarchical breakdown of web server activity.
Derek Shaw, NASA/Ames

Innovative Modeling of Planetary Solar Wind Interactions*

- Researchers at Princeton University performed unique global simulations of interactions between the solar wind and planetary magnetospheres, including Mercury, Earth, Uranus, and Ganymede.
- The team developed a novel, multi-moment multifluid model containing key electron physics that are essential for reproducing and interpreting the observations.
  - The model is essential for capturing the electron physics associated with collisionless magnetic reconnection in a planet's magnetosphere. Simulation results revealed highly dynamic responses of the planetary magnetospheres to varying external conditions.
  - The simulations alleviate limited in situ measurements captured by NASA observatories, allow interpretation measurements in a 3D context, and distinguish temporal from spatial fluctuations.
- Given the significant impact of stellar winds on exoplanets residing within close-in habitable zones of M dwarfs, the investigation of the solar wind interaction with planets under extreme space weather conditions may have important implications for studying (exo)planetary habitability.

IMPACT: Investigations of solar wind interactions with planets (including Earth) enhance the science returns of NASA missions such as MESSENGER to Mercury, Magnetospheric Multiscale around Earth, the Voyager flyby past Uranus, and the Galileo flybys of Ganymede.



View of the Uranian magnetosphere from a ten-moment multifluid simulation. The solar wind carries interplanetary magnetic field lines (green streamlines). Yellow contours show ion number density in unit per cubic centimeter. The boundary in ion density at left marks the bow shock due to fast-moving solar wind flow. *Chuanfei Dong, Liang Wang, Princeton University.*

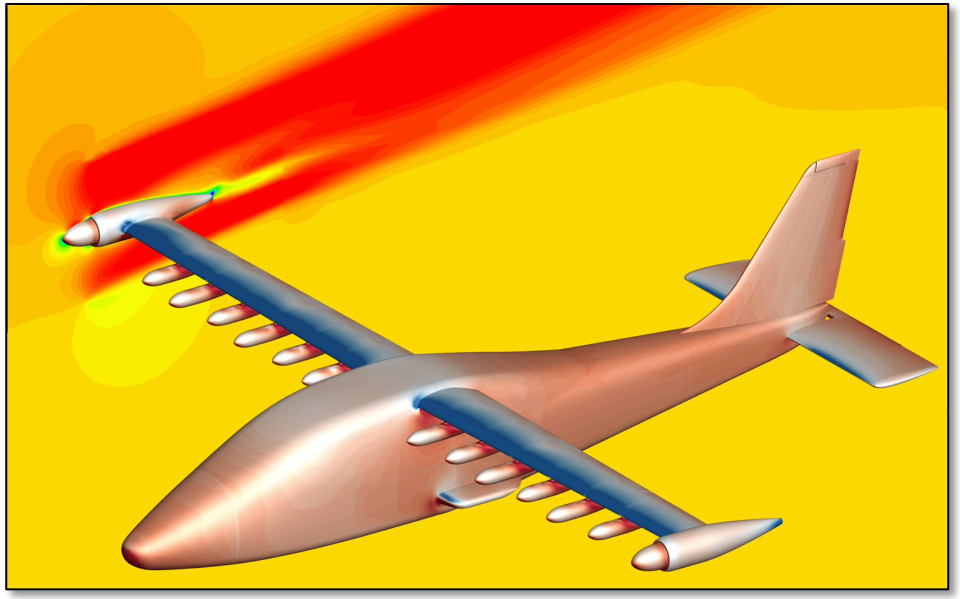
** HECC provided supercomputing resources and services in support of this work.*

Building an Aerodynamic Database for the X-57 Maxwell*

- Researchers at NASA Langley and NASA Ames ran simulations on Pleiades to create a computational fluid dynamics (CFD) database for the X-57 "Maxwell" aircraft, NASA's first all-electric X-Plane.
  - The primary goal of this effort was to develop an accurate model of the X-57 aerodynamic performance and stability characteristics to implement in the aircraft flight simulator.
  - The X-57 contains six high-lift propellers across each wing, providing distributed propulsion during takeoff and landing; and two cruise propellers at the wing tips, the primary source of thrust during cruise.
  - The team produced databases for each of the propulsion settings and compared the effects to the corresponding no-power case. Accurately predicting the impacts of propulsion ensures the flight simulator will perform in a manner consistent with actual flight.
- The simulations that were run to develop the database allowed engineers to conduct preliminary airworthiness evaluations of the airplane, as well as conduct some pilot training for the various configurations. The CFD results are critical since there is little experimental data on the vehicle's aerodynamics and no experimental data on the high-lift system.

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

IMPACT: Developing an accurate model of the X-57's aerodynamic performance and stability characteristics is facilitating airworthiness evaluations and pilot training at NASA's Armstrong Flight Research Center.



Using actuator zones—a method to replicate the propulsion effects of moving propellers—balances computational cost and accuracy. In this simulation of the X-57 "Maxwell" aircraft, pressure is shown on the aircraft surface and streamwise velocity is shown on the planar slice for selected cruise propeller settings (blue = low pressure or velocity; red = high). *Jared Duensing, NASA/Ames*

Papers

- “**TESS Reveals a Short-Period Sub-Neptune Sibling (HD 86226c) to a Known Long-Period Giant Planet**,” J. Teske, et al., The Astronomical Journal, vol. 160, no. 2, August 3, 2020. *
  https://iopscience.iop.org/article/10.3847/1538-3881/ab9f95/meta
- “**Toward a Practical Method for Hypersonic Transition Prediction Based on Stability Correlations**,” P. Paredes, et al., AIAA Journal, August 3, 2020. *
  https://arc.aiaa.org/doi/full/10.2514/1.J059407
- “**Arepo-MCRT: Monte Carlo Radiation Hydrodynamics on a Moving Mesh**,” A. Smith, et al., arXiv:2008.01750 [astro-ph.GA], August 4, 2020. *
  https://arxiv.org/abs/2008.01750
- “**Single-Hemisphere Dynamos in M-Dwarf Stars**,” B. Brown, et al., arXiv:2008-02362 [astro-ph.SR], August 5, 2020. *
  https://arxiv.org/abs/2008.02362
- “**Unsupervised Anomaly Detection in Flight Data Using Convolutional Variation Auto-Encoder**,” M. Memarzadeh, et al., Aerospace, vol. 7, August 8, 2020. *
  https://www.mdpi.com/2226-4310/7/8/115
- “**A Study of the Internal Aerodynamics of the Concorde Inlet**,” J. Slater, AIAA Propulsion and Energy 2020 Forum, published online August 17, 2020. *
  https://arc.aiaa.org/doi/abs/10.2514/6.2020-3770

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

Papers (cont.)

- “**RDE Nozzle Computational Design Methodology Development and Application**,” K. Miki, D. Paxson, D. Perkins, S. Youngster, AIAA Propulsion and Energy 2020 Forum, published online August 17, 2020. *
  https://arc.aiaa.org/doi/abs/10.2514/6.2020-3872
- “**Aerodynamic Behavior of a Coupled Boundary Layer Ingesting Inlet – Distortion Tolerant Fan**,” G. Heinlein, J. Chen, M. Bakhle, AIAA Propulsion and Energy 2020 Forum, published online August 17, 2020. *
  https://arc.aiaa.org/doi/abs/10.2514/6.2020-3780
- “**Computational Study of Modeling Fully-coupled Combustor-Turbine Interactions by the Open National Combustion Code (OpenNCC)**,” K. Miki, C. Wey, J. Moder, AIAA Propulsion and Energy 2020 Forum, published online August 17, 2020. *
  https://arc.aiaa.org/doi/abs/10.2514/6.2020-3689
- “**High-Frequency Submesoscale Motions Enhance the Upward Vertical Heat Transport in the Global Ocean**,” Z. Su, et al., Journal of Geophysical Research: Oceans, August 18, 2020. *
  https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020JC016544
- “**Carbon Oxidation in Turbulent Premixed Jet Flames: A Comparative Experimental and Numerical Study of Ethylene, n-heptane, and Toluene**,” D. Pineda, et al., Combustion and Flame, vol. 221, August 21, 2020. *
  https://www.sciencedirect.com/science/article/abs/pii/S0010218020303230

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

Papers (cont.)

- "**Impacts of Lower Thermospheric Atomic Oxygen on Thermospheric Dynamics and Composition Using the Global Ionosphere Thermosphere Model**," G. Malhotra, et al., Journal of Geophysical Research: Space Physics, August 21, 2020. *
https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020JA027877
- "**Ultra-Faint Dwarfs in a Milky Way Context: Introducing the Mint Condition DC Justice League Simulations**," E. Applebaum, et al., arXiv:2008.11207 [astro-ph.GA], August 25, 2020. *
https://arxiv.org/abs/2008.11207
- "**TOI-824 b: A New Planet on the Lower Edge of the Hot Neptune Desert**," J. Burt, et al., arXiv:2008.11732 [astro-ph.EP], August 26, 2020. *
https://arxiv.org/abs/2008.11732
- "**OVI Traces Photoionized Streams with Collisionally Ionized Boundaries in Cosmological Simulations of *z*~1 Massive Galaxies**," C. Strawn, et al., arXiv:2008.11863 [astro-ph.GA], August 27, 2020. *
https://arxiv.org/abs/2008.11863
- "**Anisotropic Analysis of Fibrous and Woven Materials Part 2: Computation of Effective Conductivity**," F. Semeraro, Computational Materials Science, vol. 186, published online August 29, 2020. *
https://www.sciencedirect.com/science/article/pii/S092702562030447X

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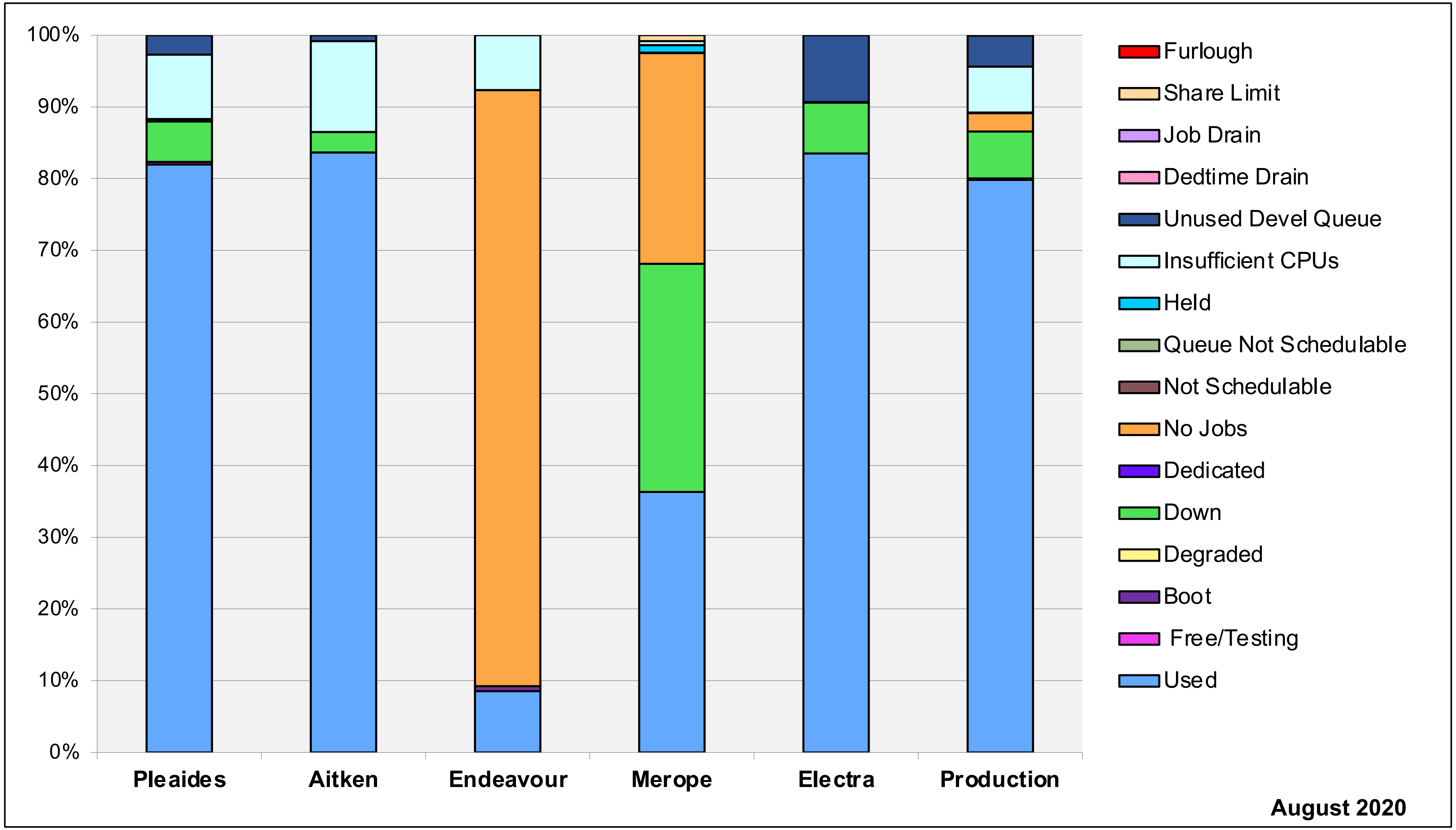
News & Events

- **NASA Is Developing an All-Electric X-57 X-Plane: A Cleaner Way to Fly**, *NASA Image of the Day*, August 19, 2020–In celebration of National Aviation Day, the agency highlighted modeling and simulation work on the X-57 all-electric aircraft, performed on the systems at the NASA Advanced Supercomputing (NAS) facility. These simulations help the design team analyze the concept aircraft's stability and flight-worthiness, and also allows them to create an accurate model of performance for the flight simulator.
  https://www.nasa.gov/image-feature/nasa-is-developing-an-all-electric-x-57-x-plane-a-cleaner-way-to-fly
  - **NASA's Pleiades Renders an All-Electric Airplane**, *HPCwire*, August 21, 2020. https://www.hpcwire.com/2020/08/21/nasas-pleiades-renders-an-all-electric-airplane/

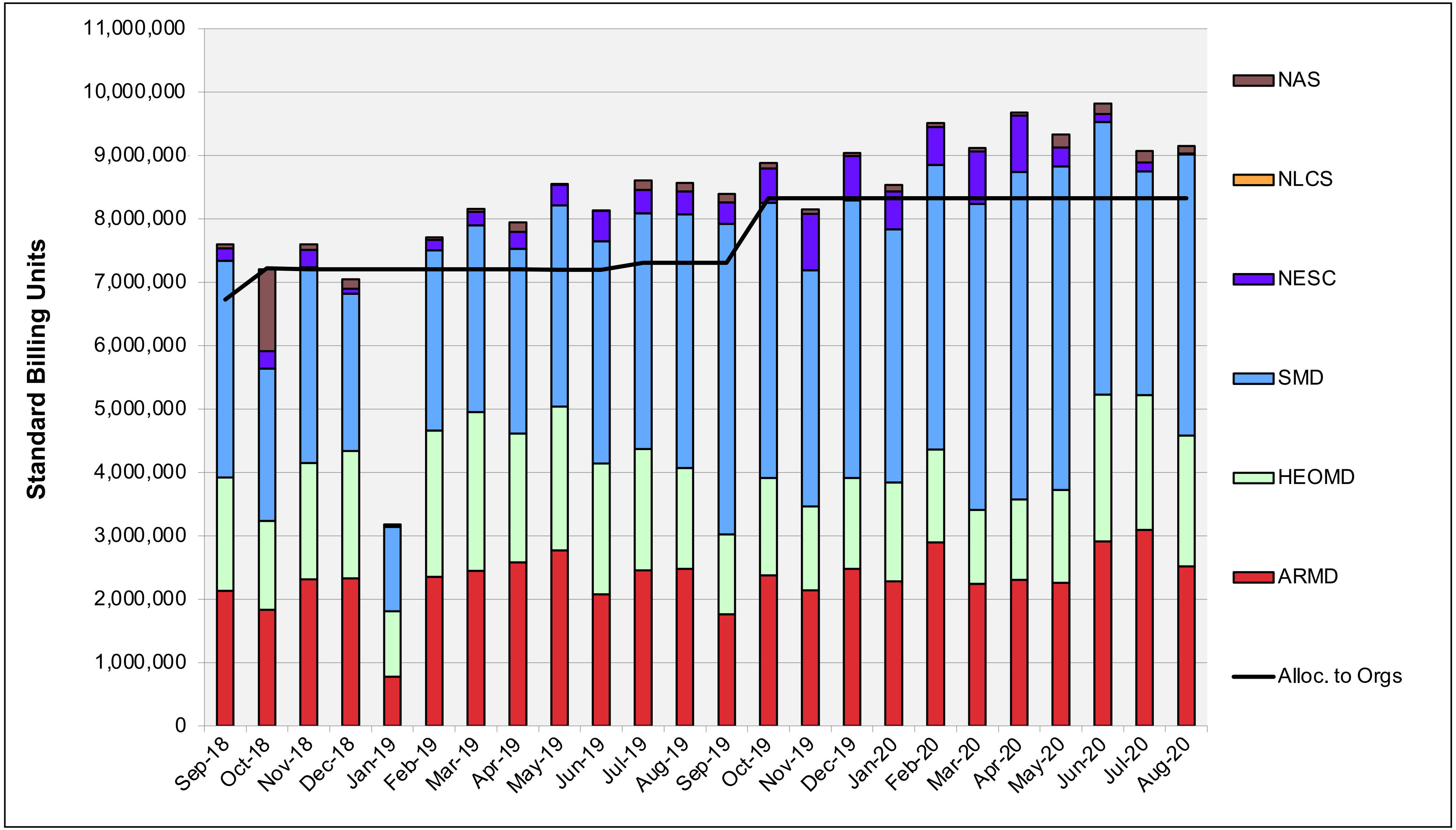
Social Media

- **Coverage of NAS Stories**
  - #NationalAviationDay coverage of X-57 simulation:
    - NAS: Twitter 7 retweets, 16 likes (combined)
    - NASA Supercomputing: Facebook 218 users reached, 14 engagements, 9 likes

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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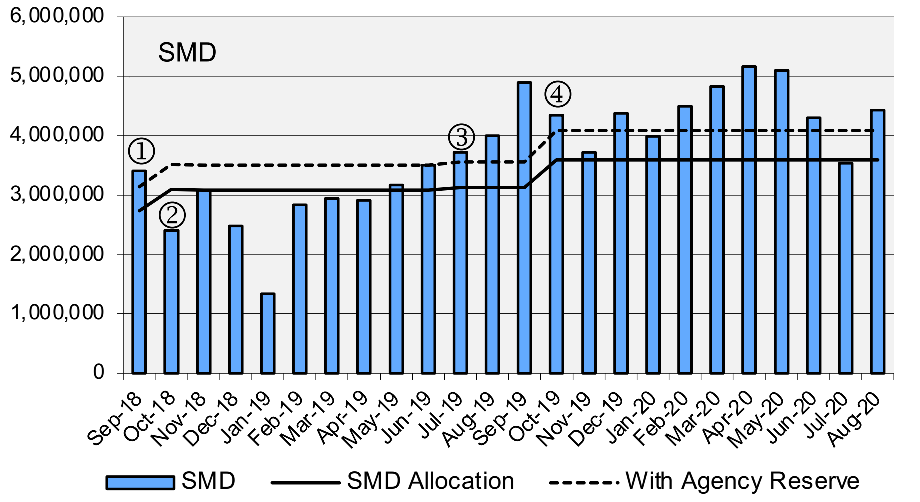
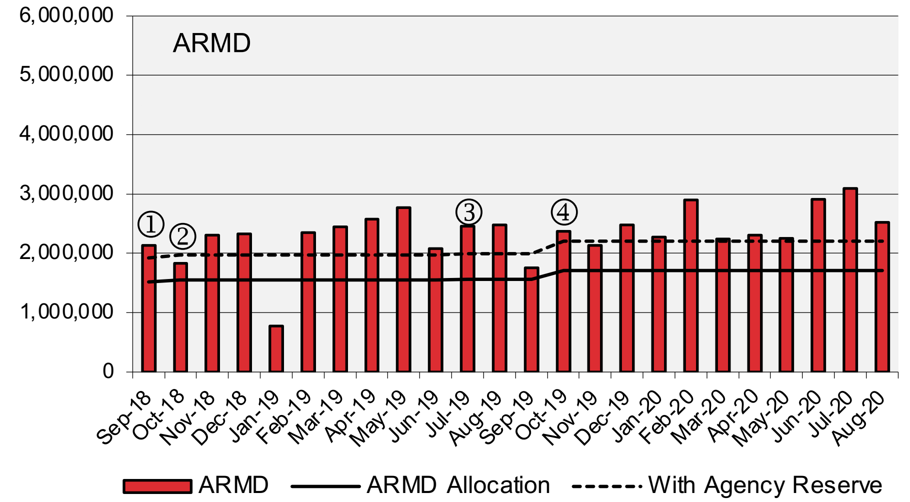
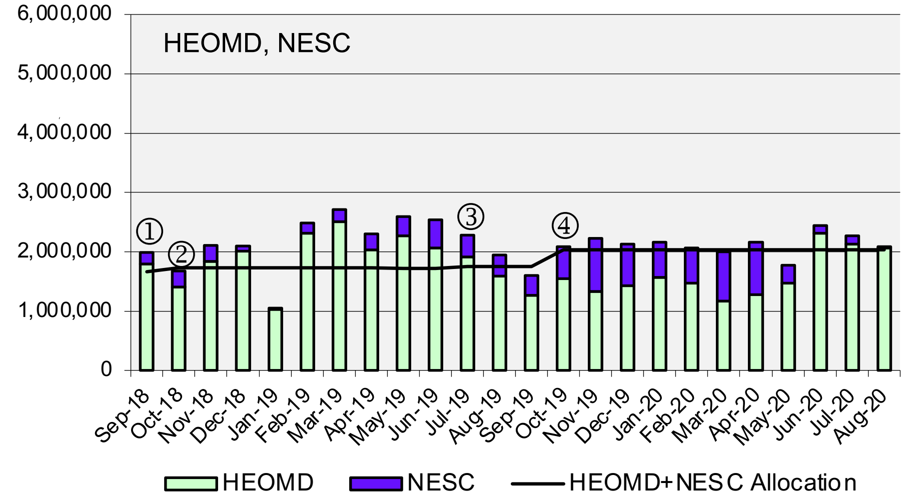






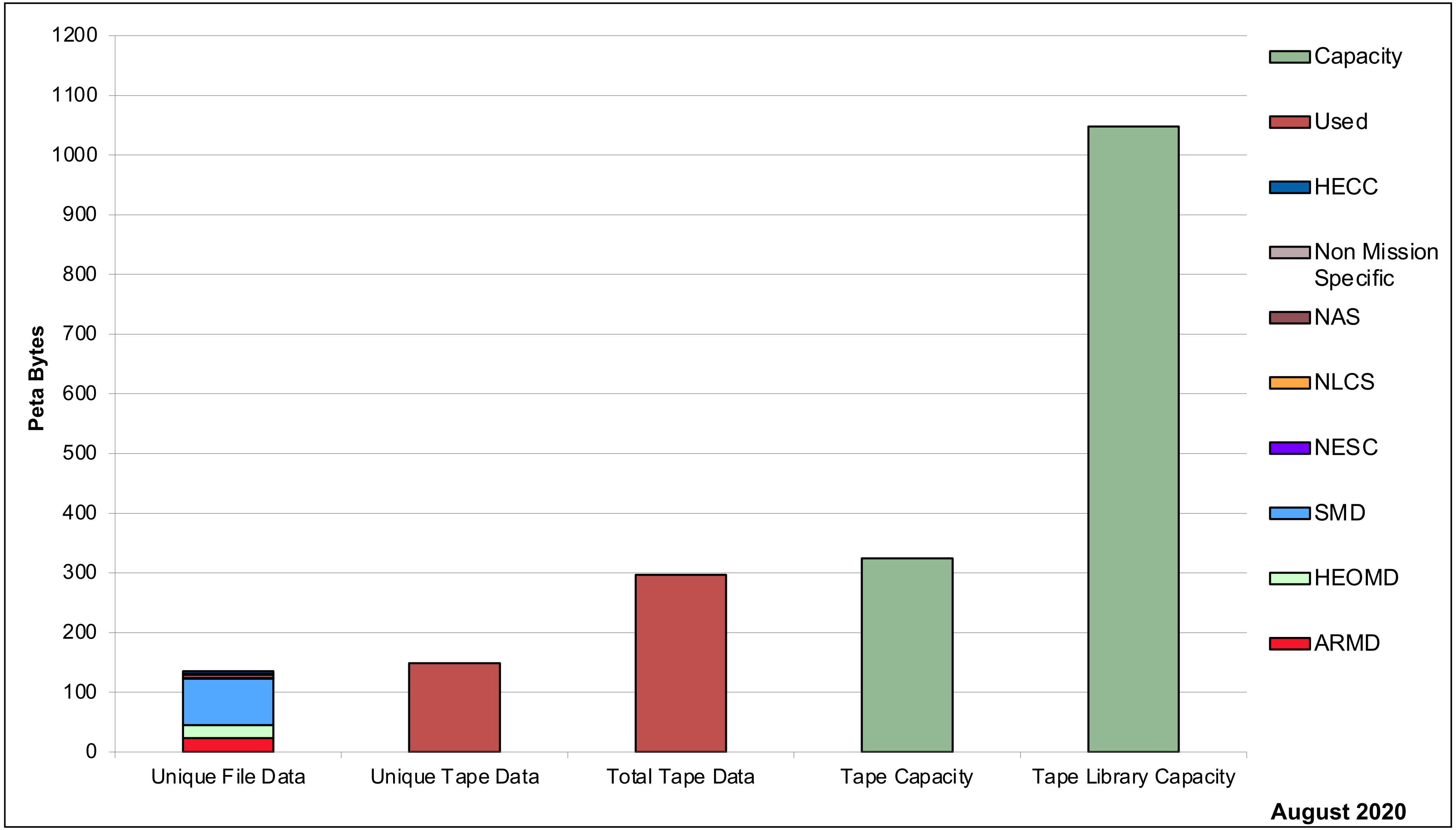
① 4 Skylake E cells (16 D Rack Equivalence) added to Electra

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

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

④ Skylake Tesla GPU V100 Nodes installed

Tape Archive Status



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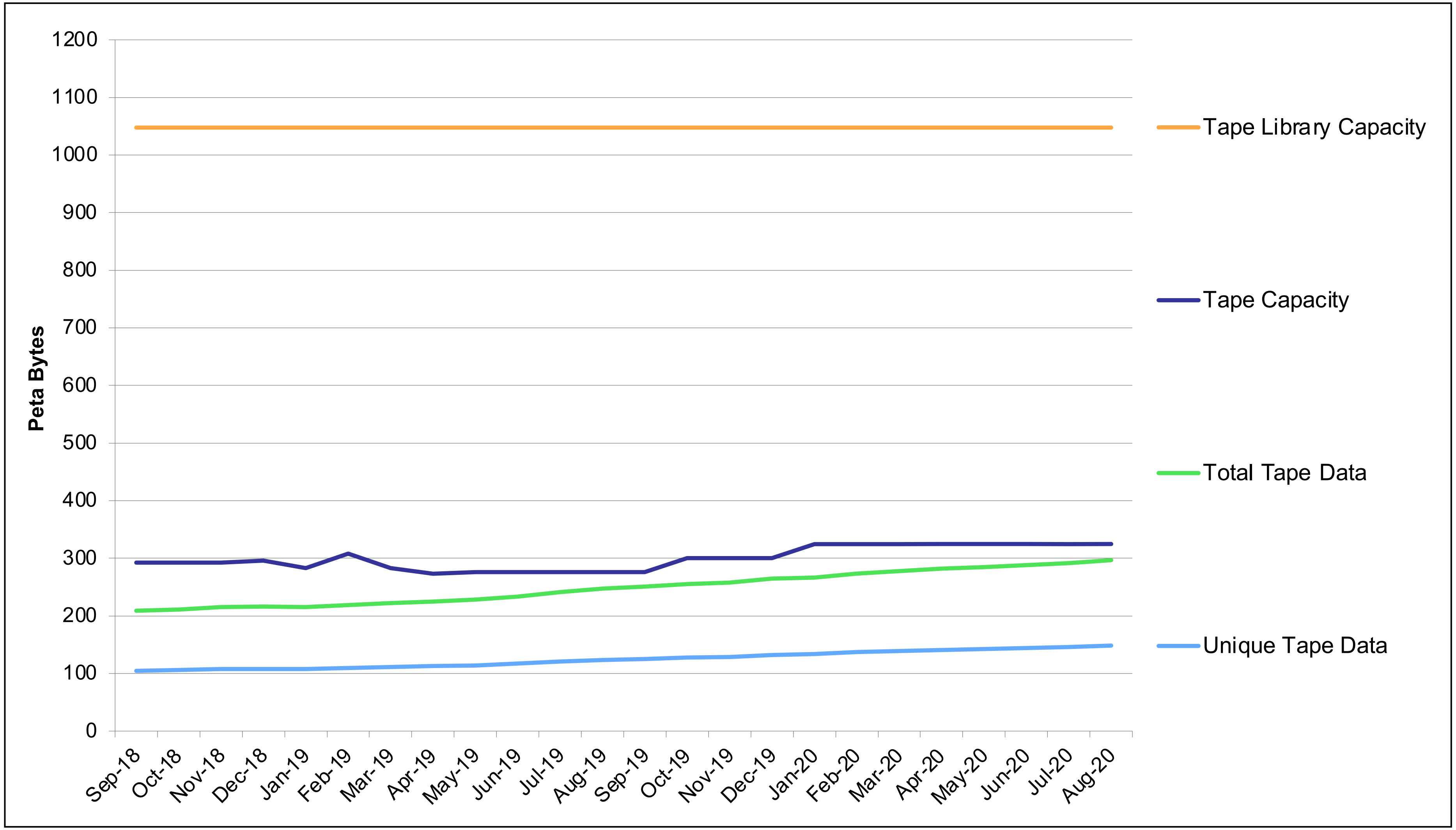
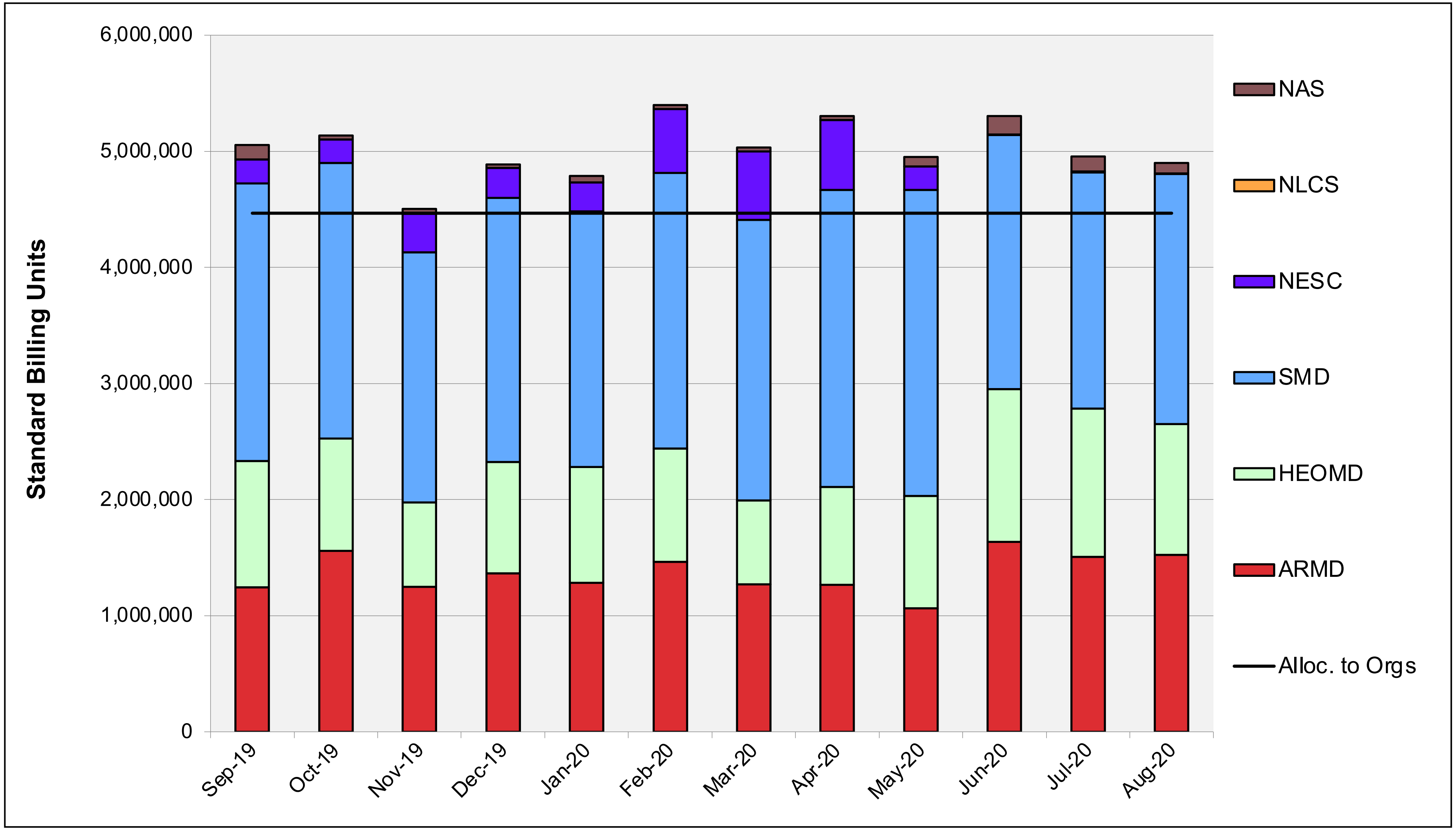
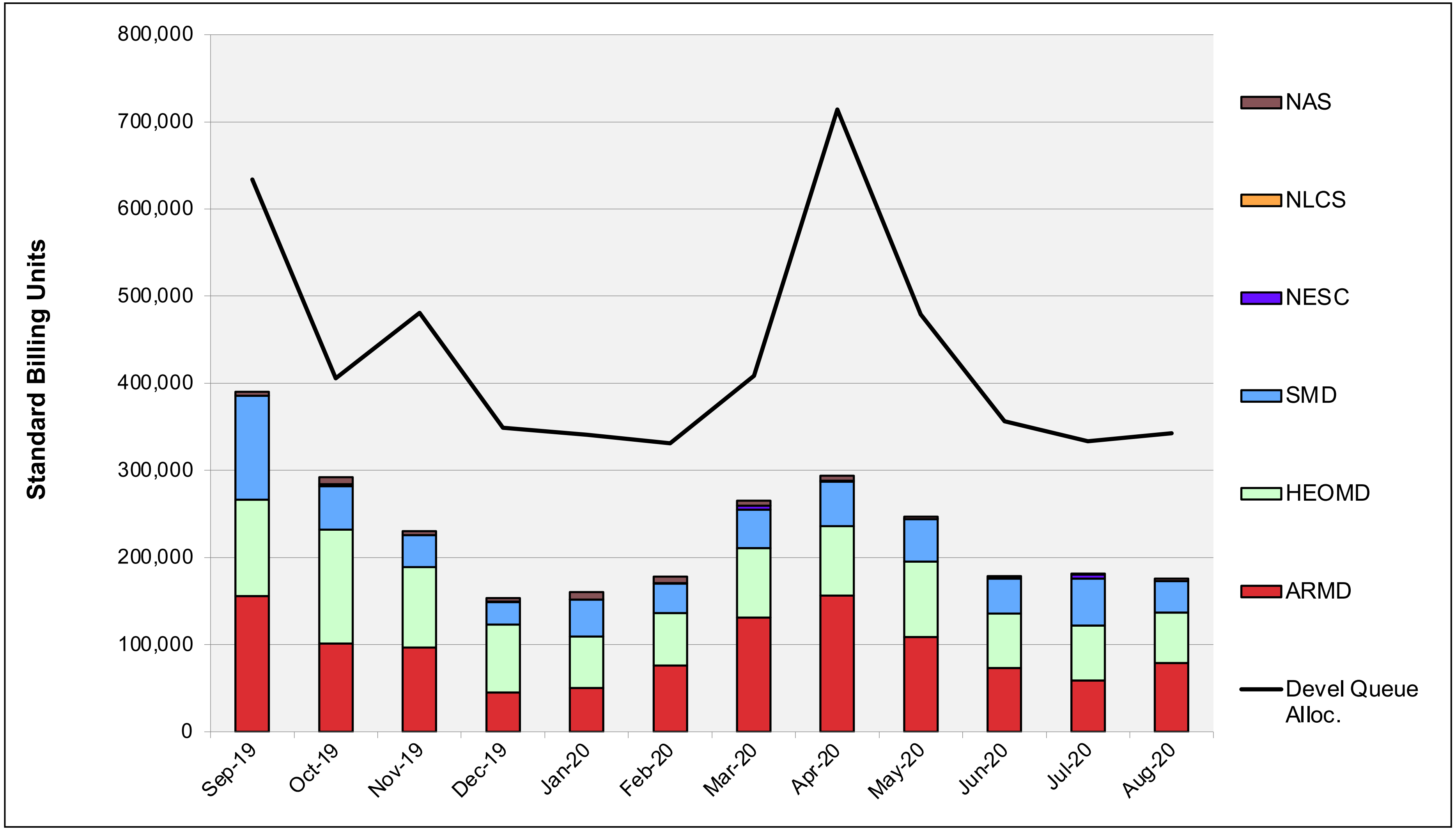


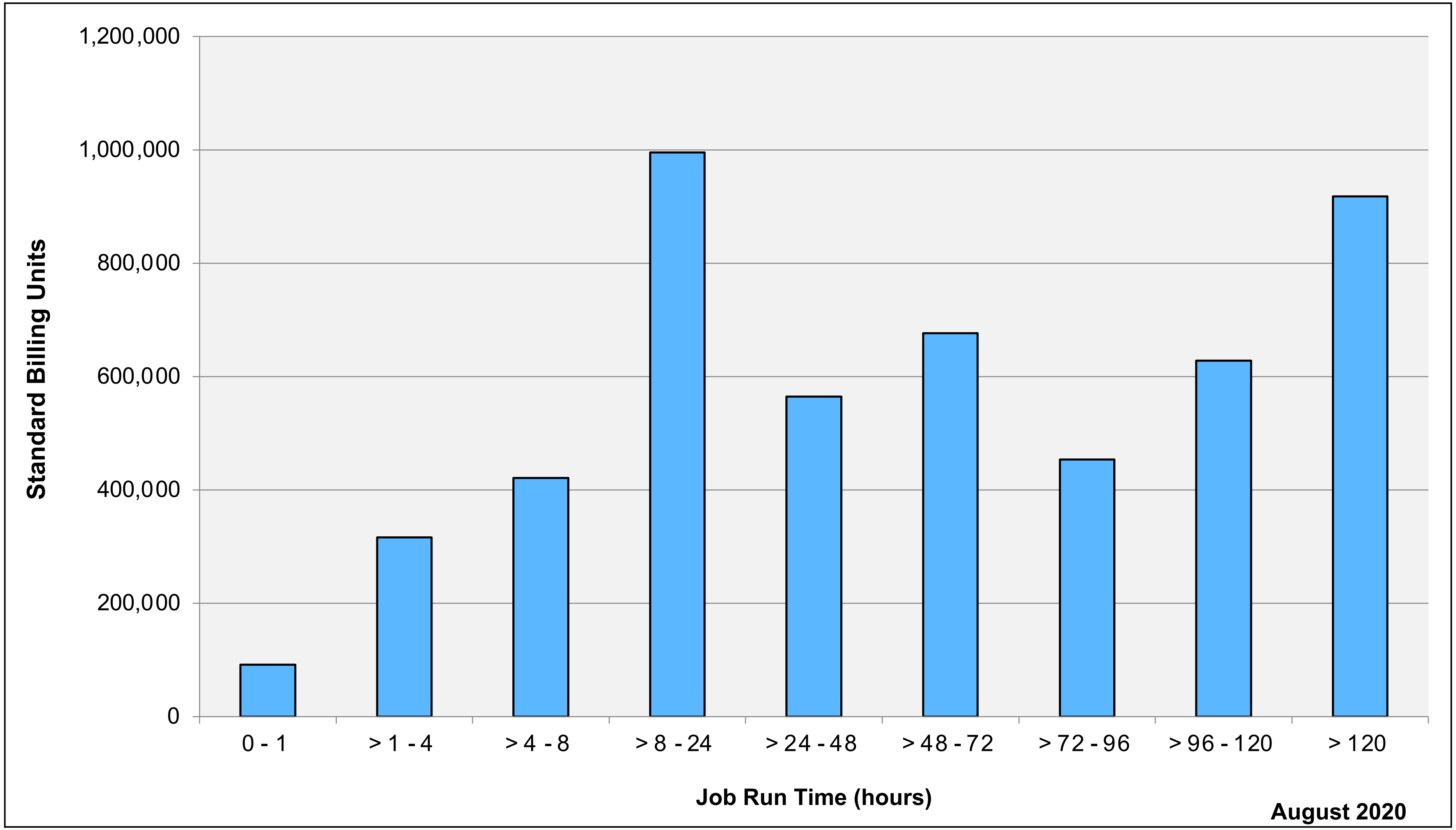
Pleiades: SBUs Reported, Normalized to 30-Day Month



Pleiades: Devel Queue Utilization



Pleiades: Monthly Utilization by Job Length



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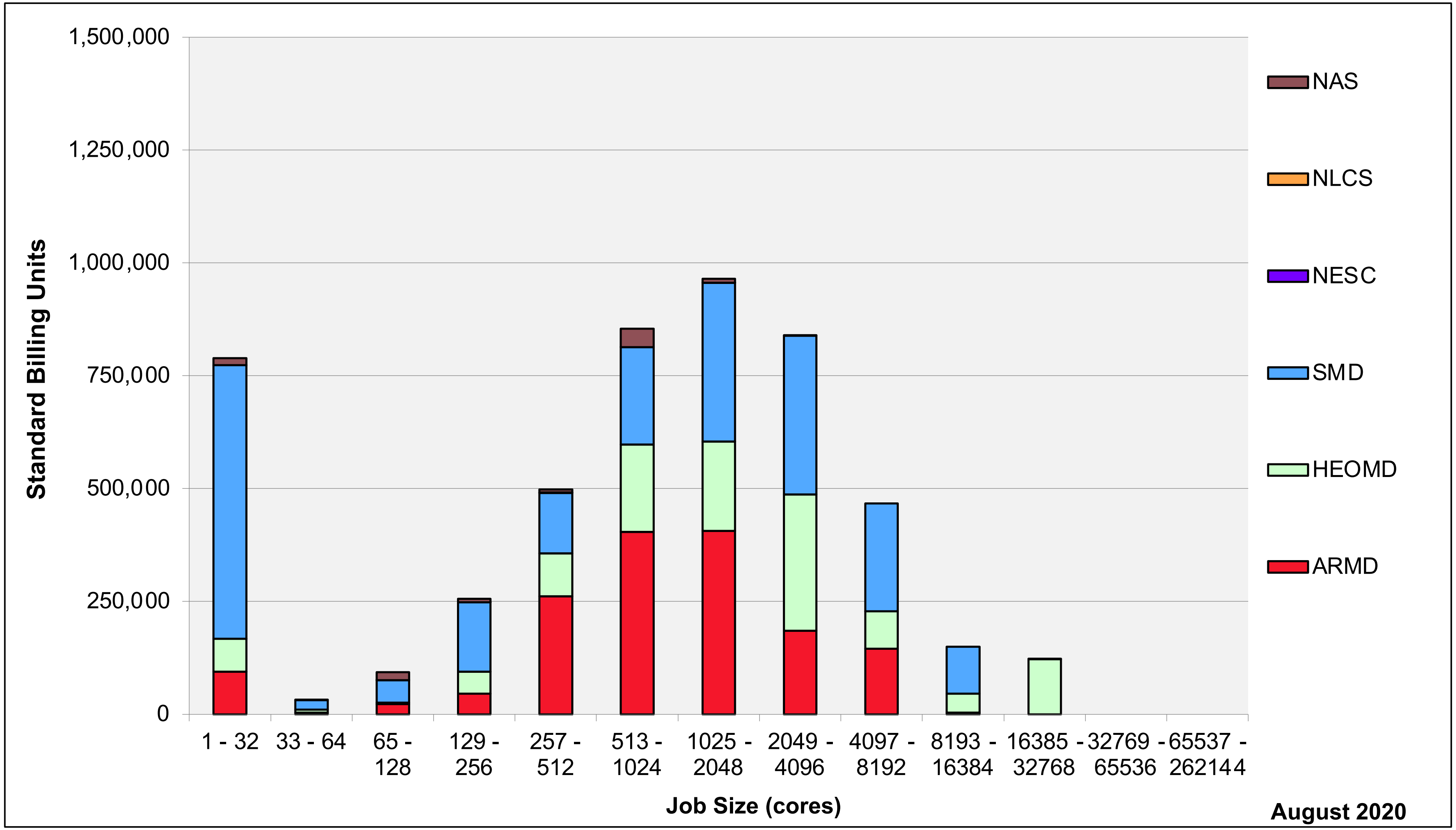
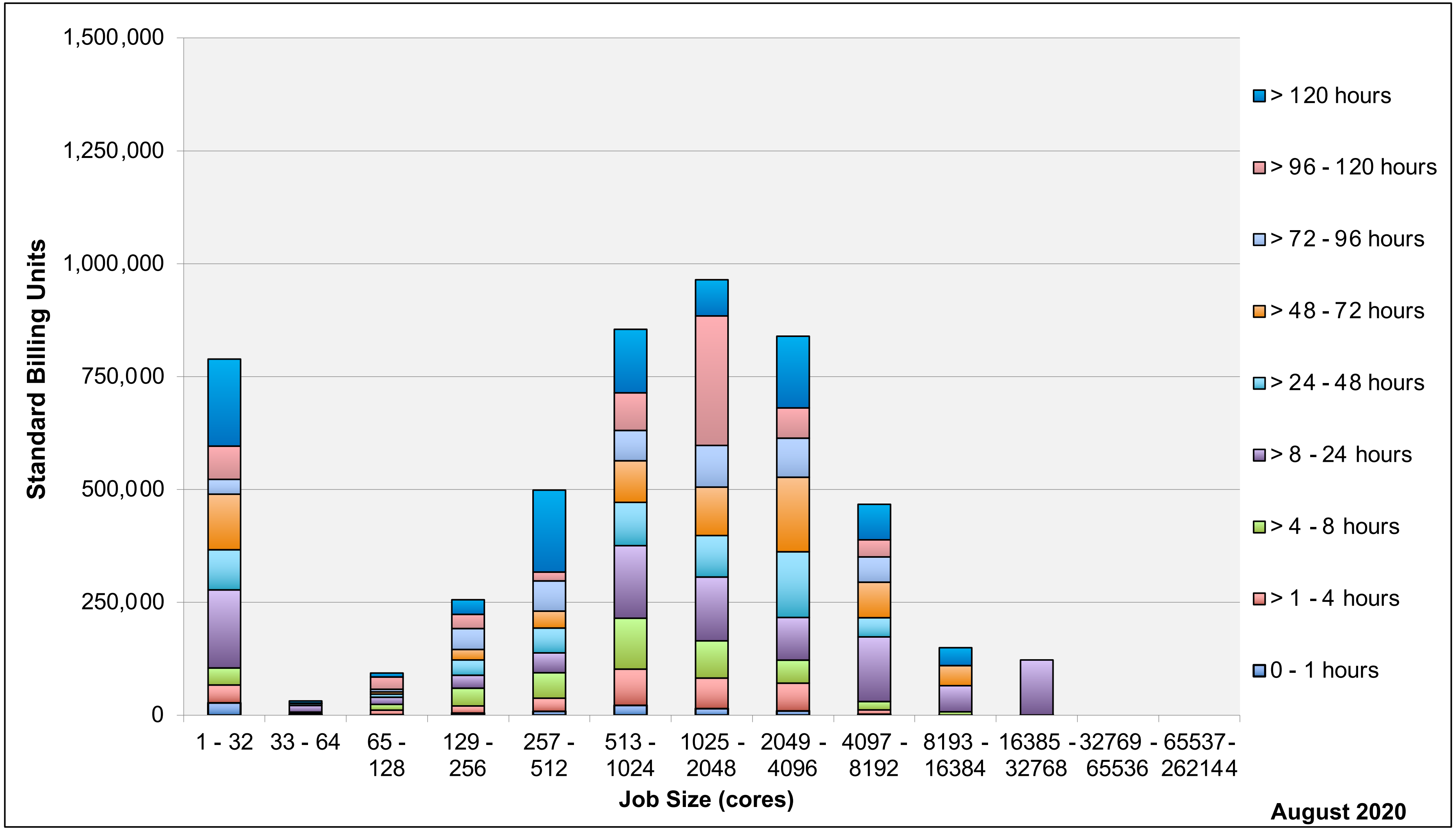
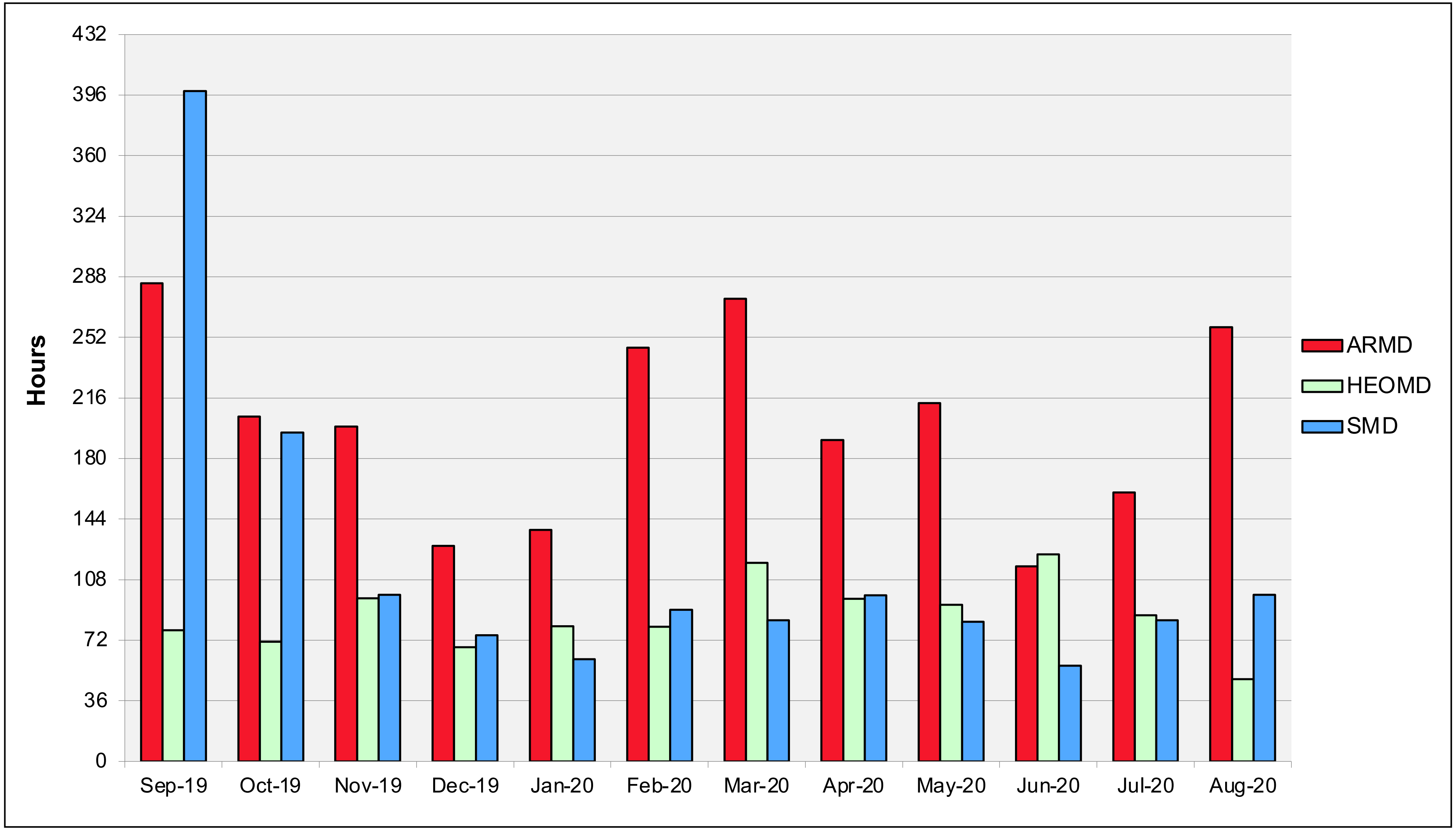


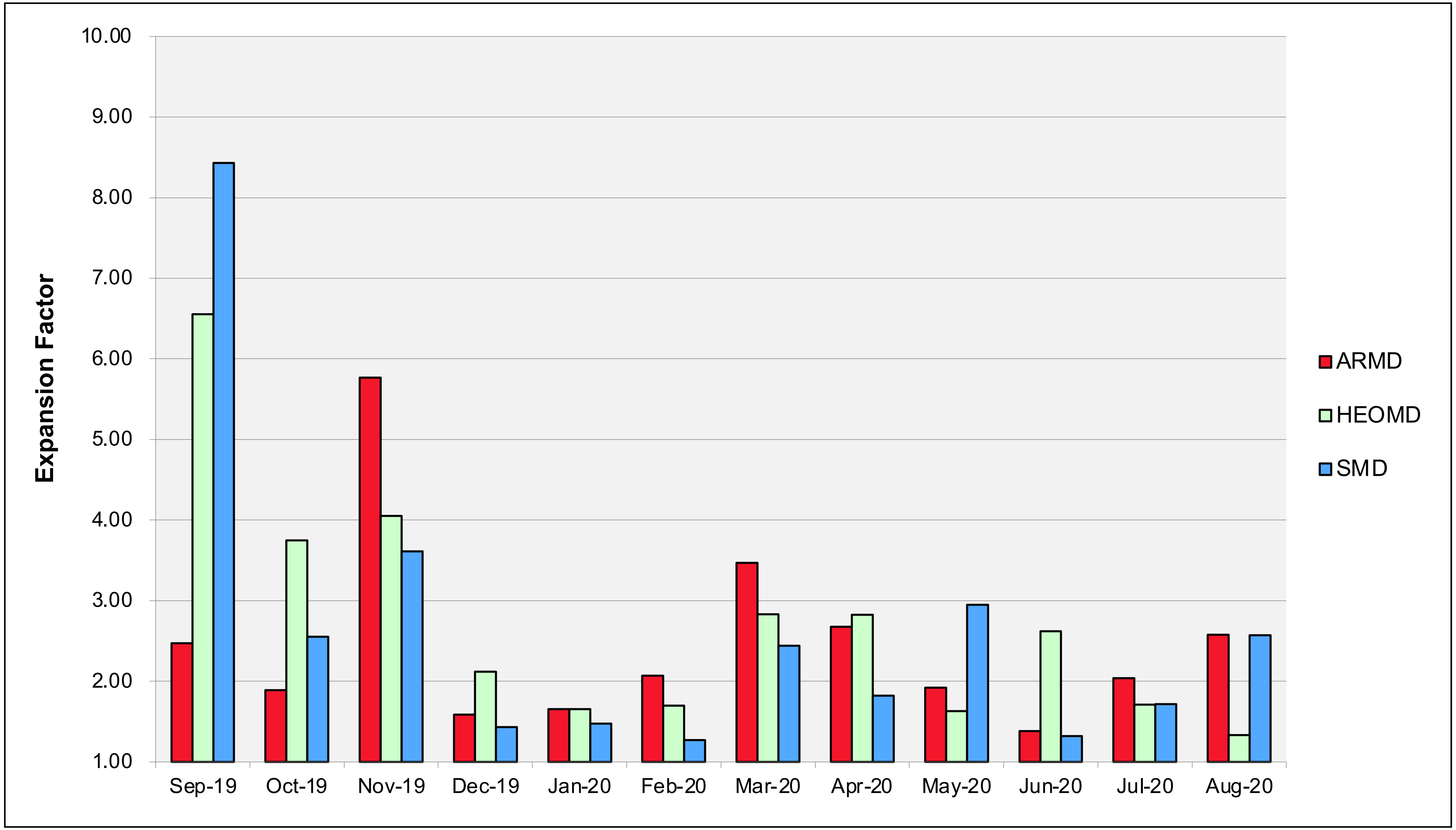
Pleiades: Monthly Utilization by Size and Length



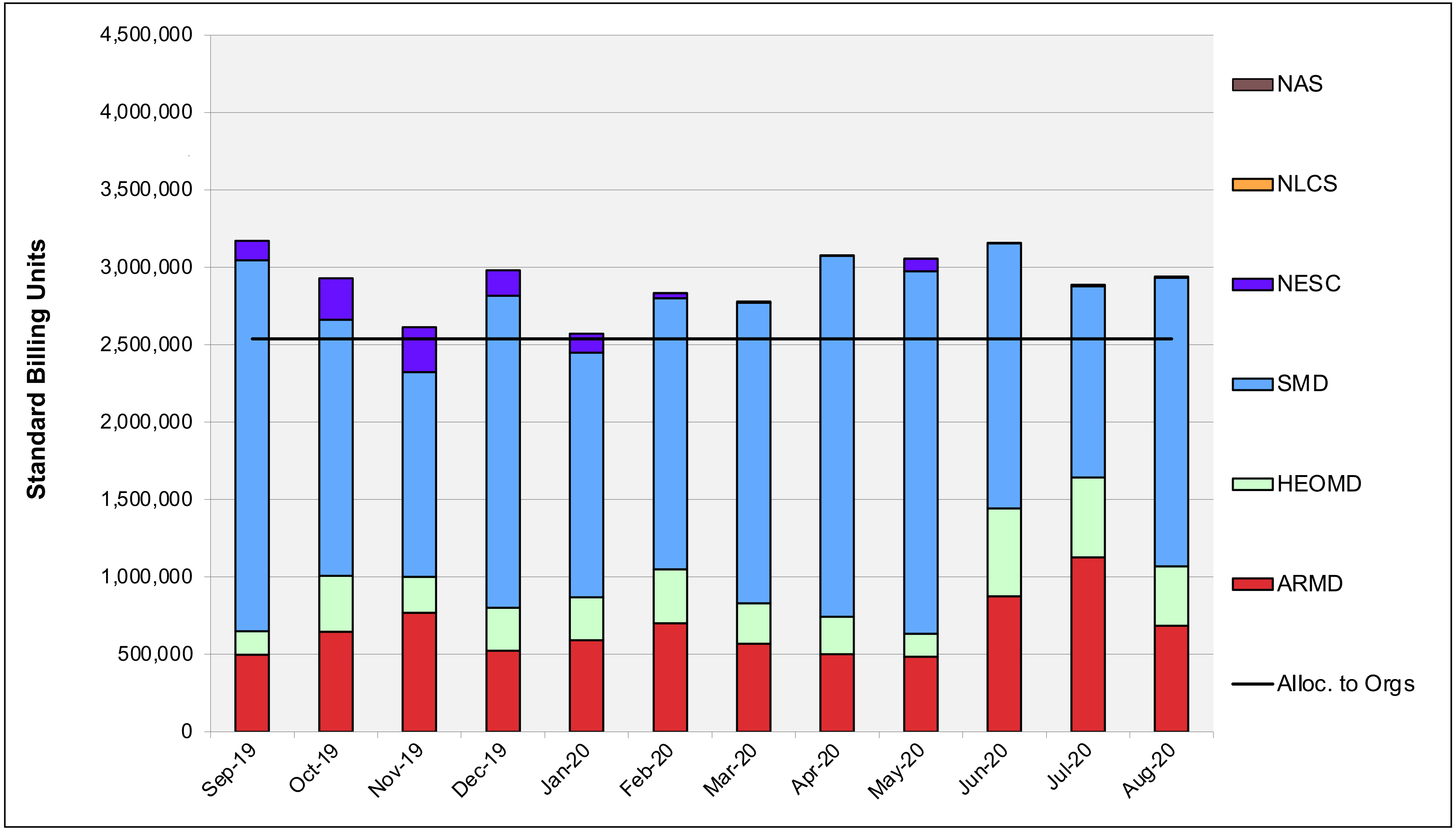
Pleiades: Average Time to Clear All Jobs



Pleiades: Average Expansion Factor



Aitken: SBUs Reported, Normalized to 30-Day Month



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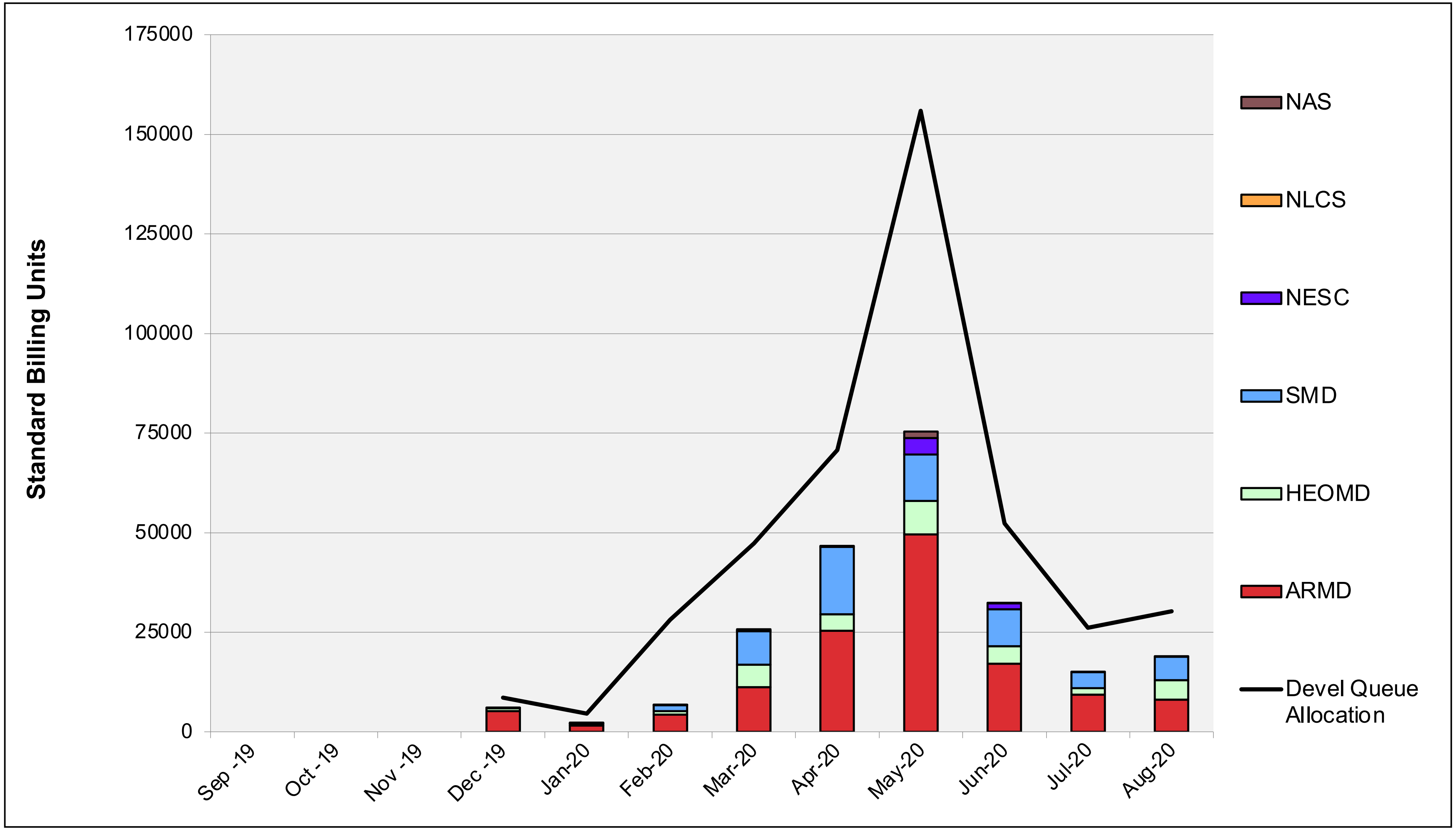

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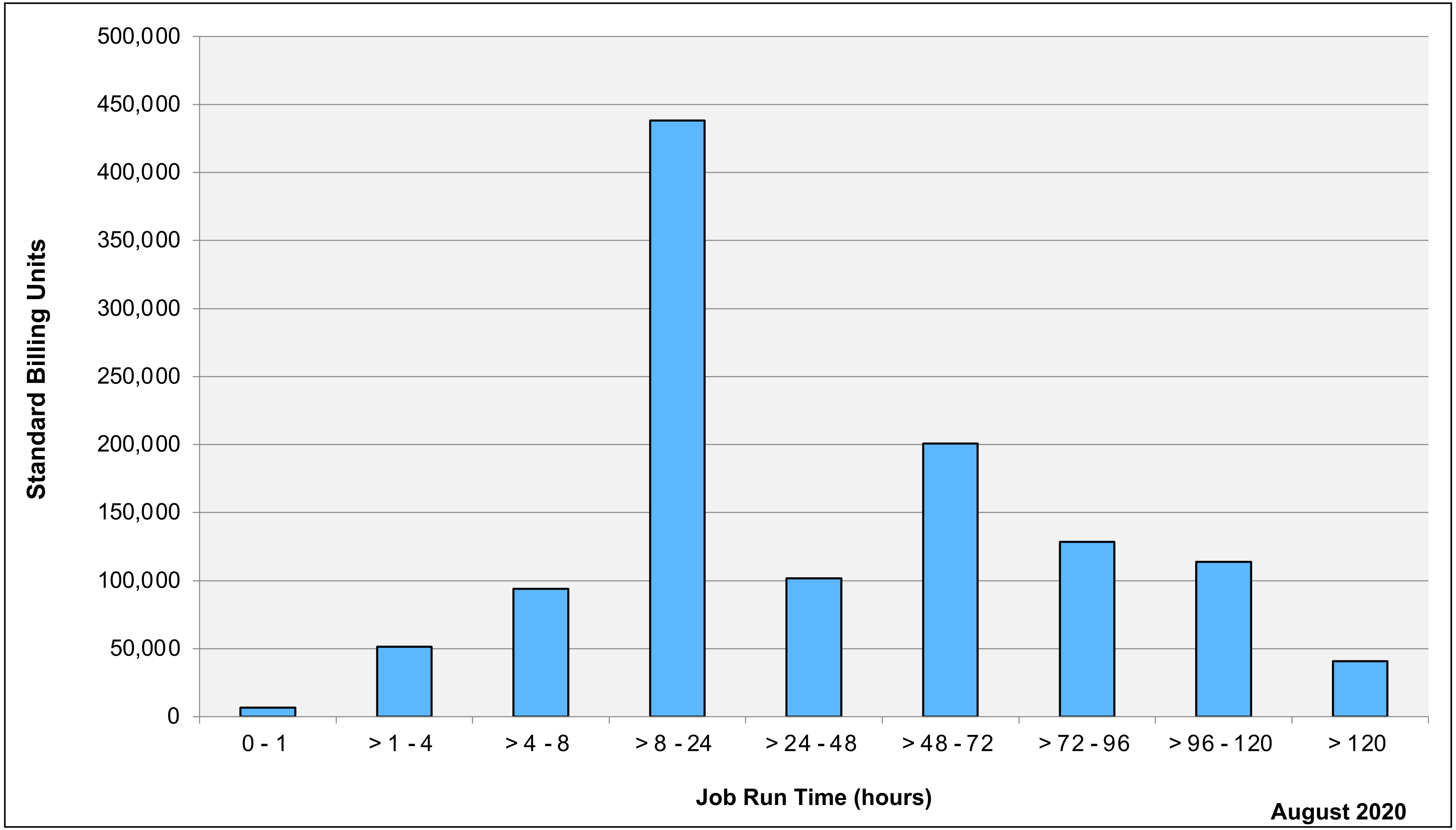

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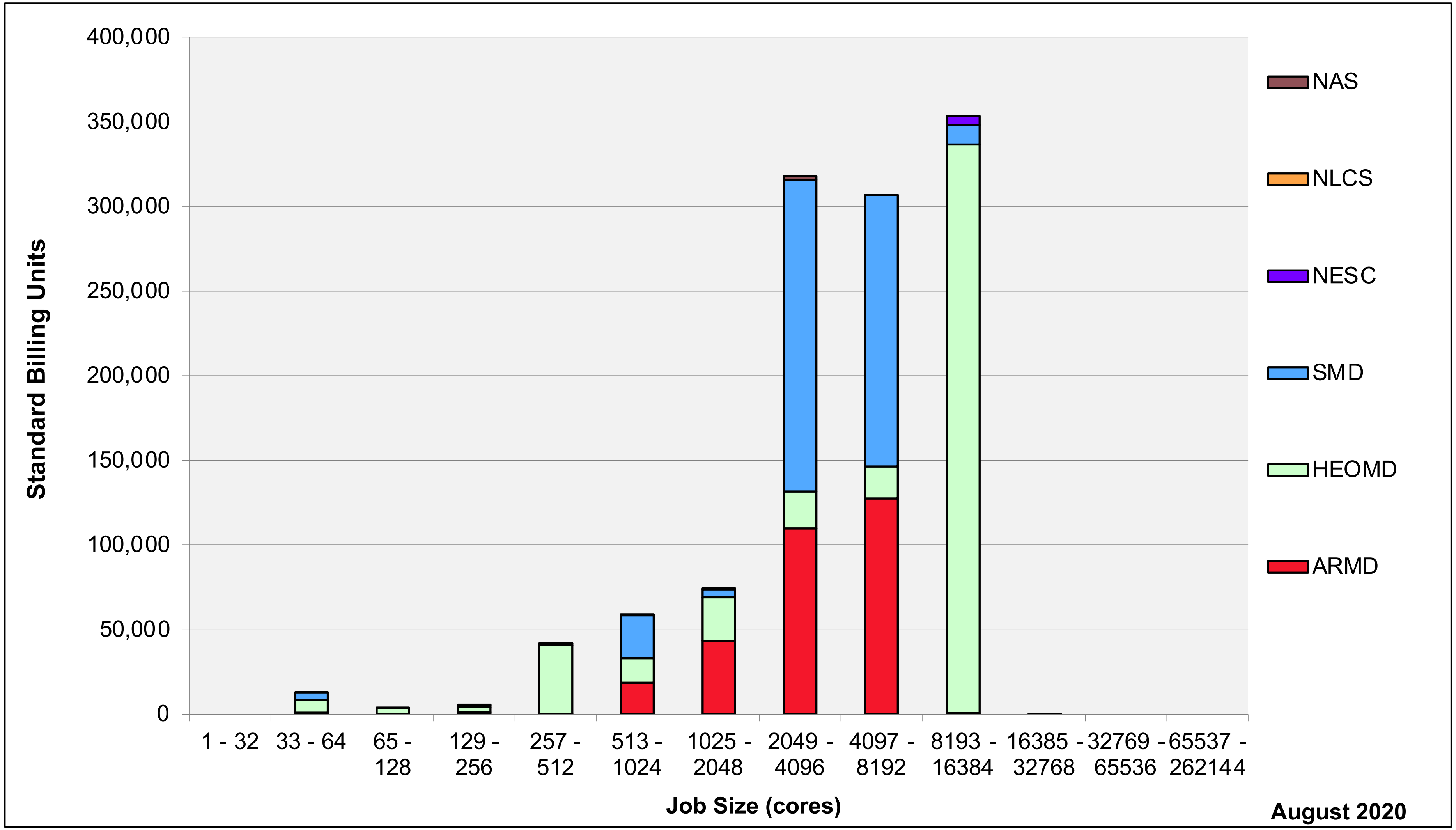

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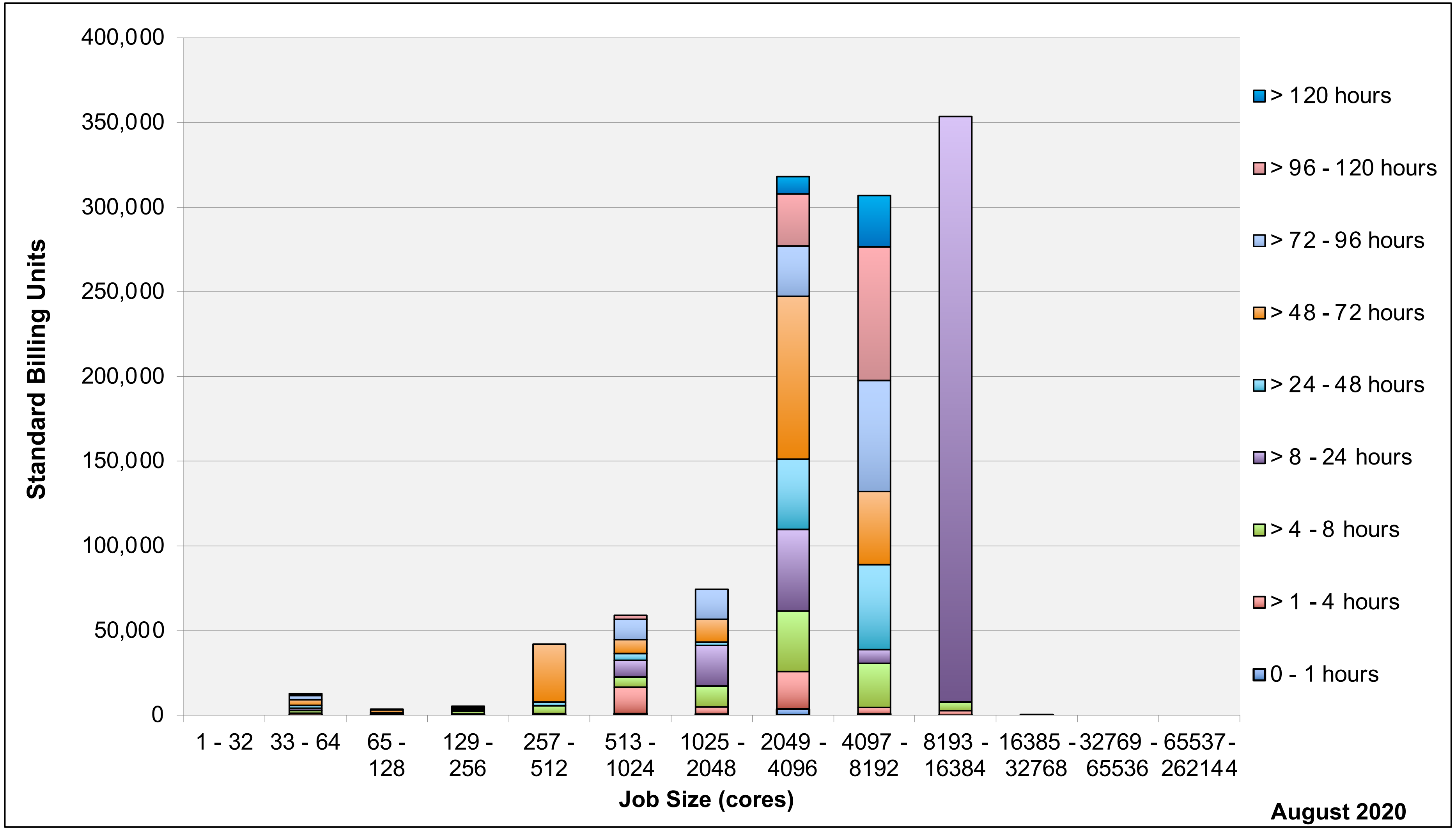

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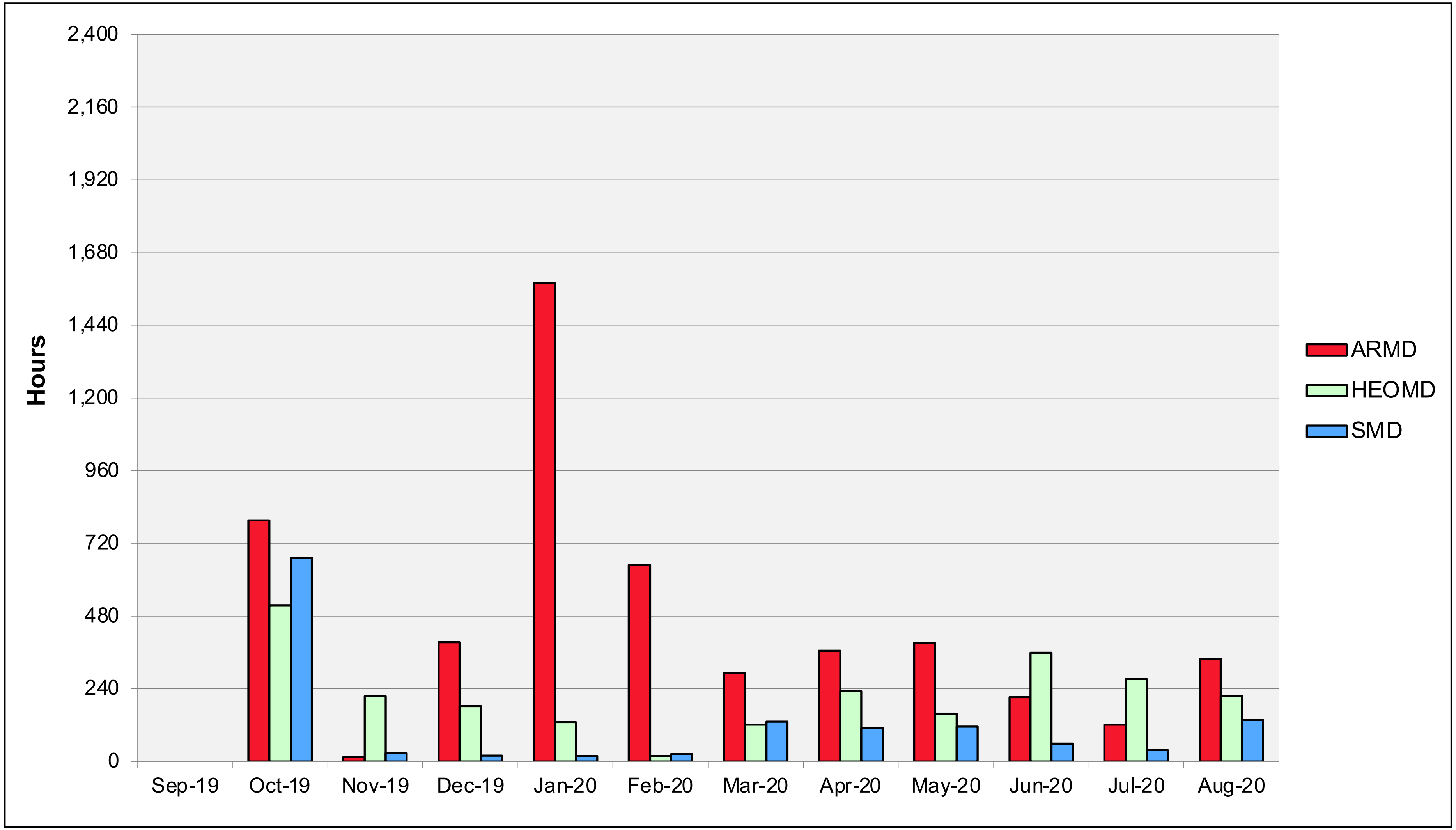

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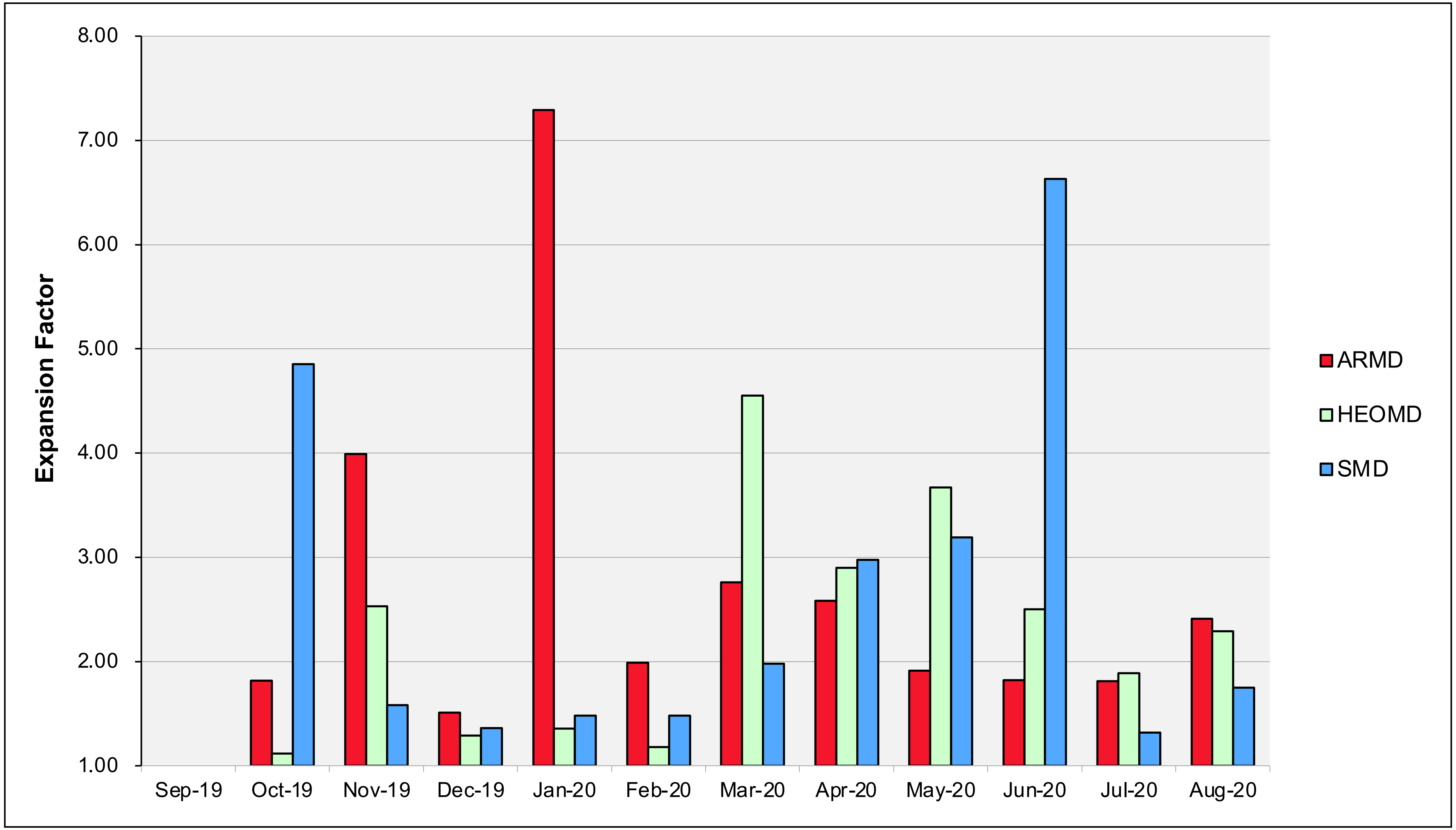
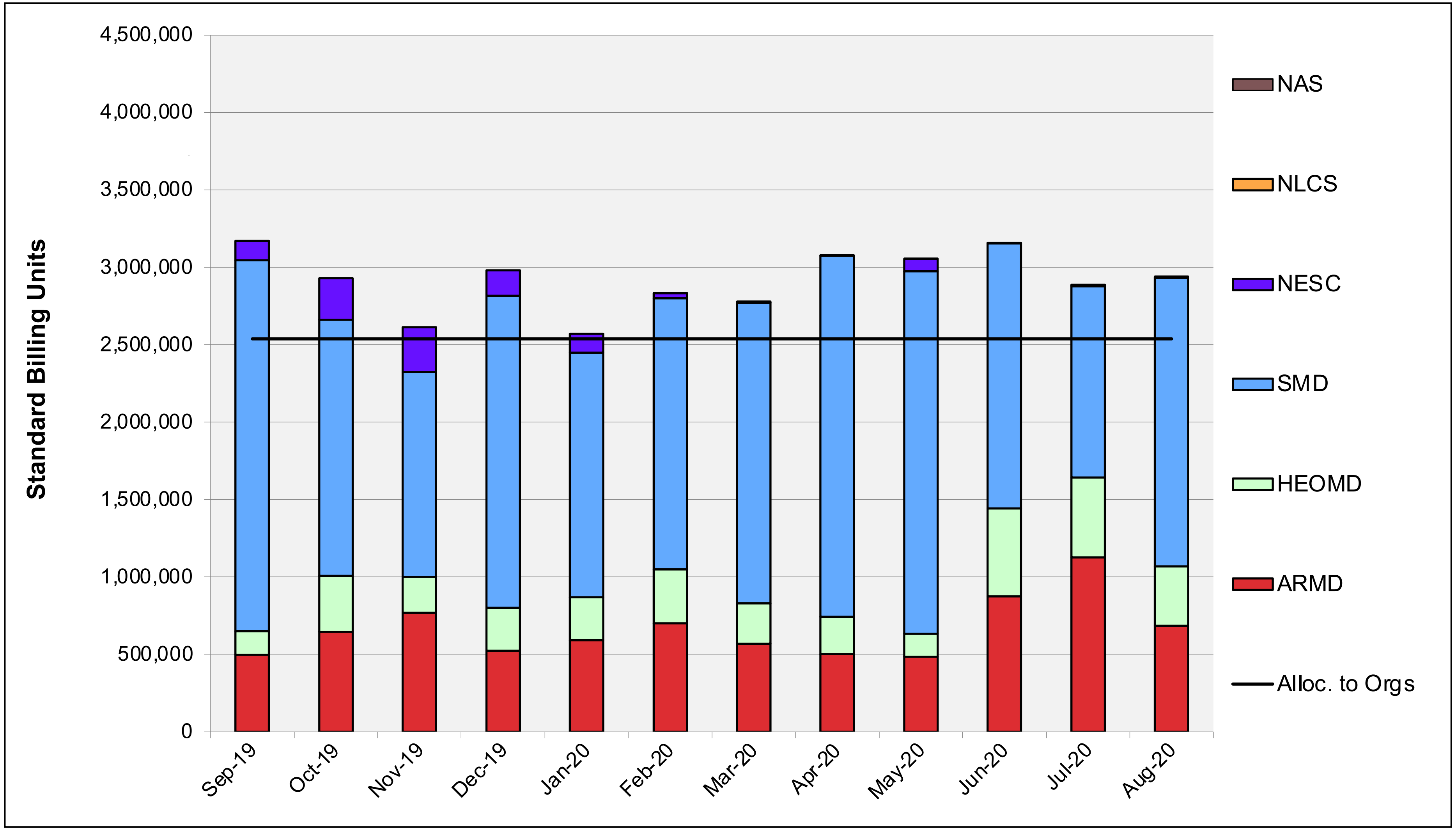
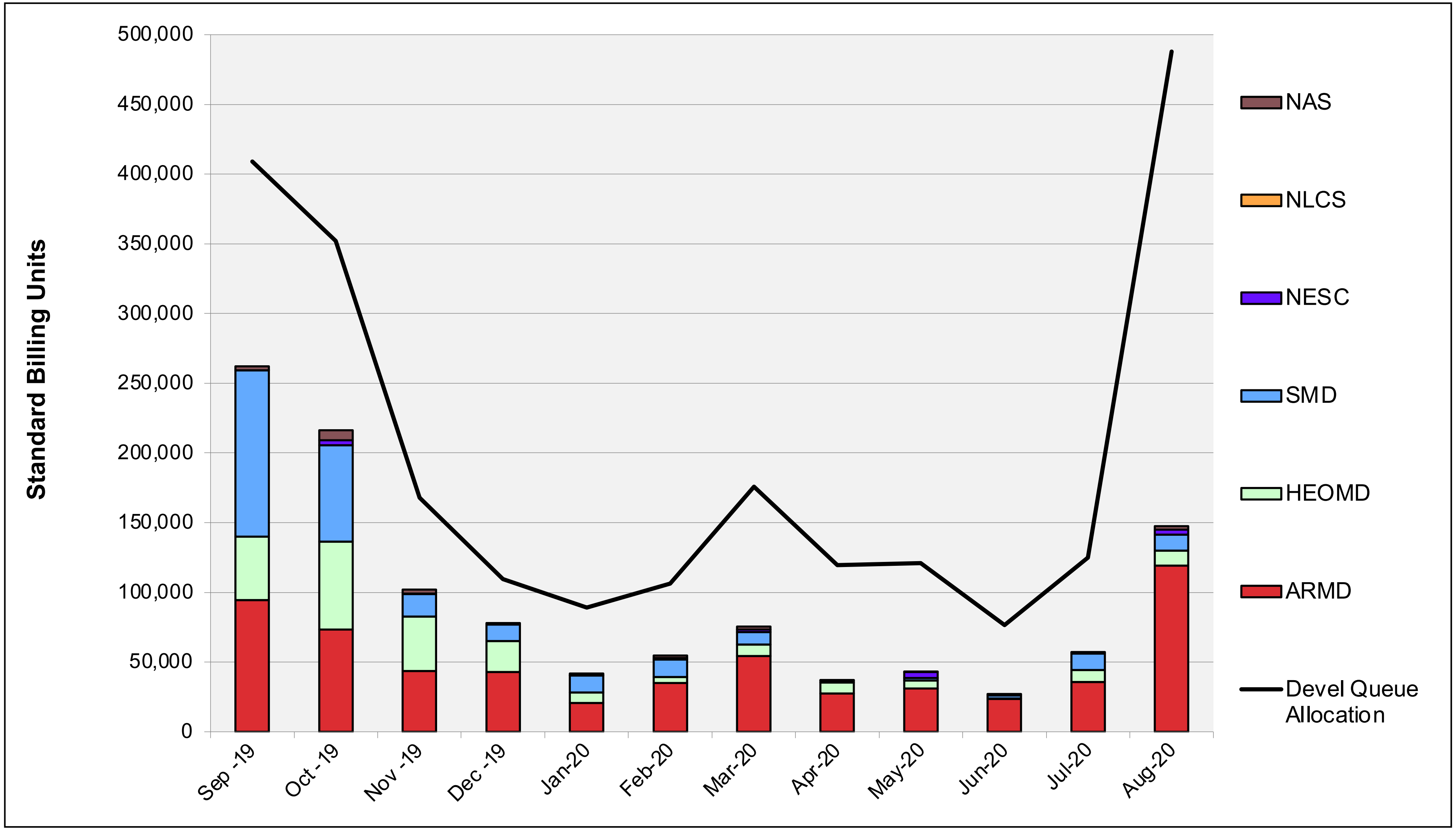


Electra: SBUs Reported, Normalized to 30-Day Month



Electra: Devel Queue Utilization



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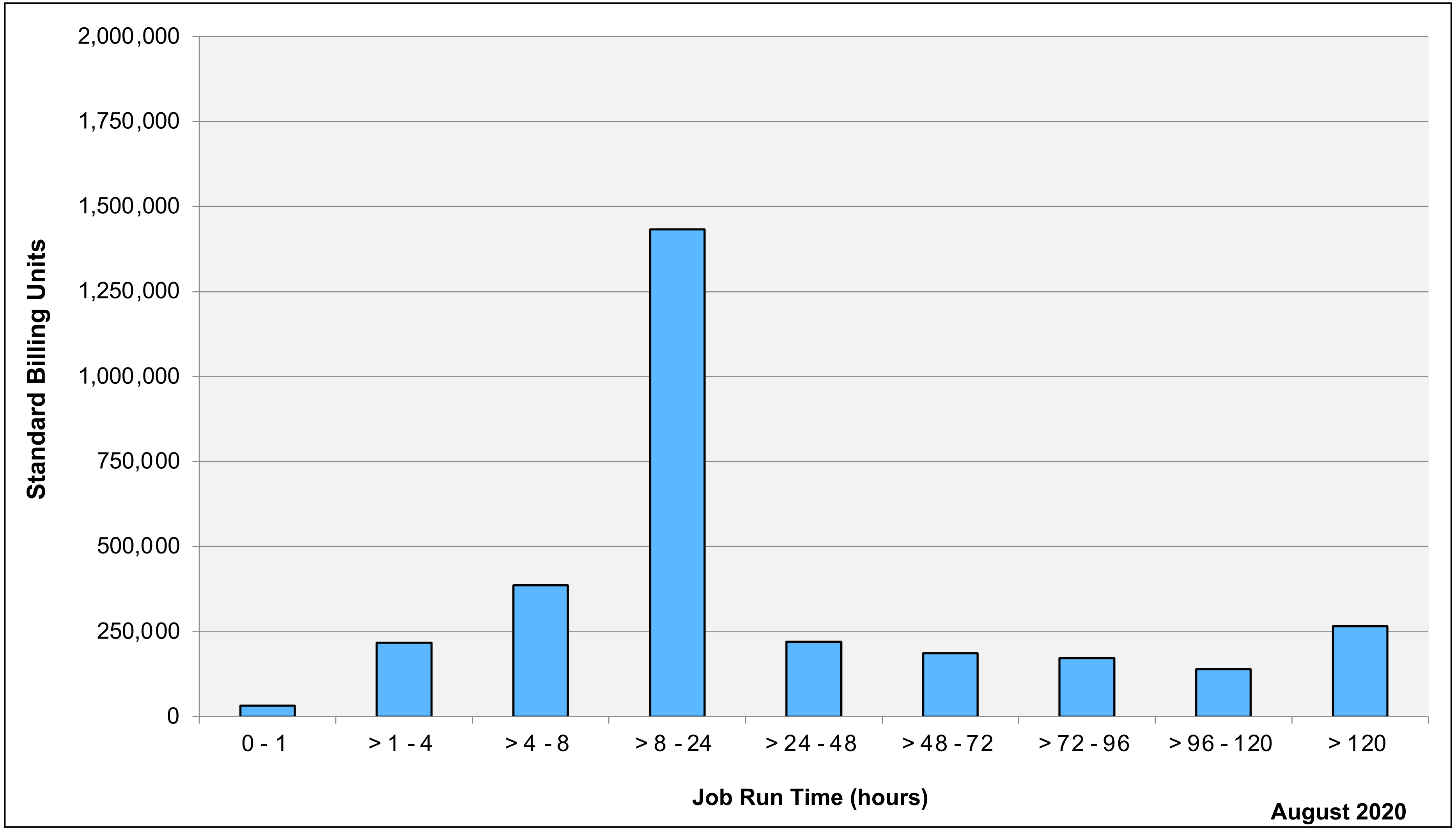

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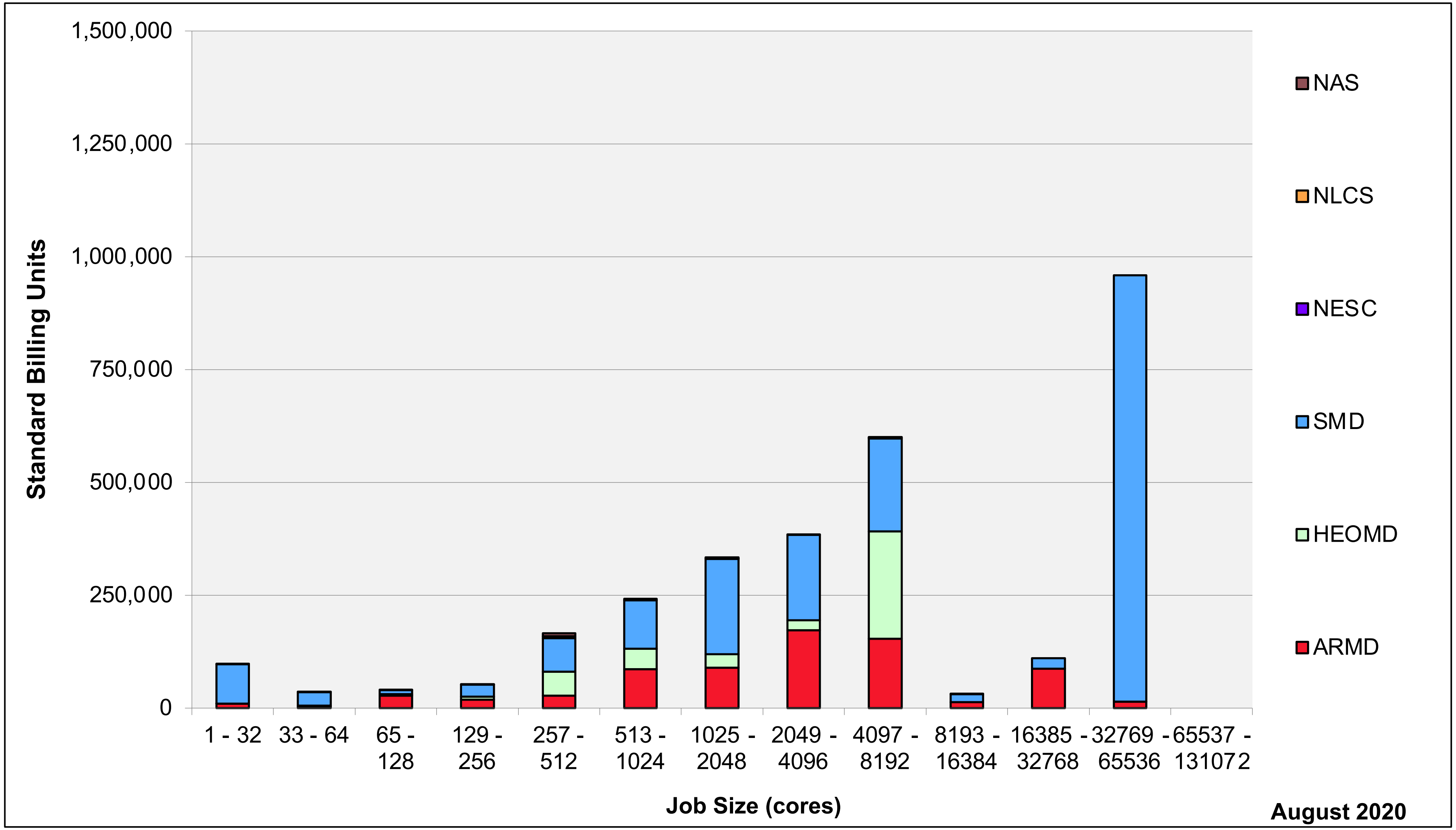

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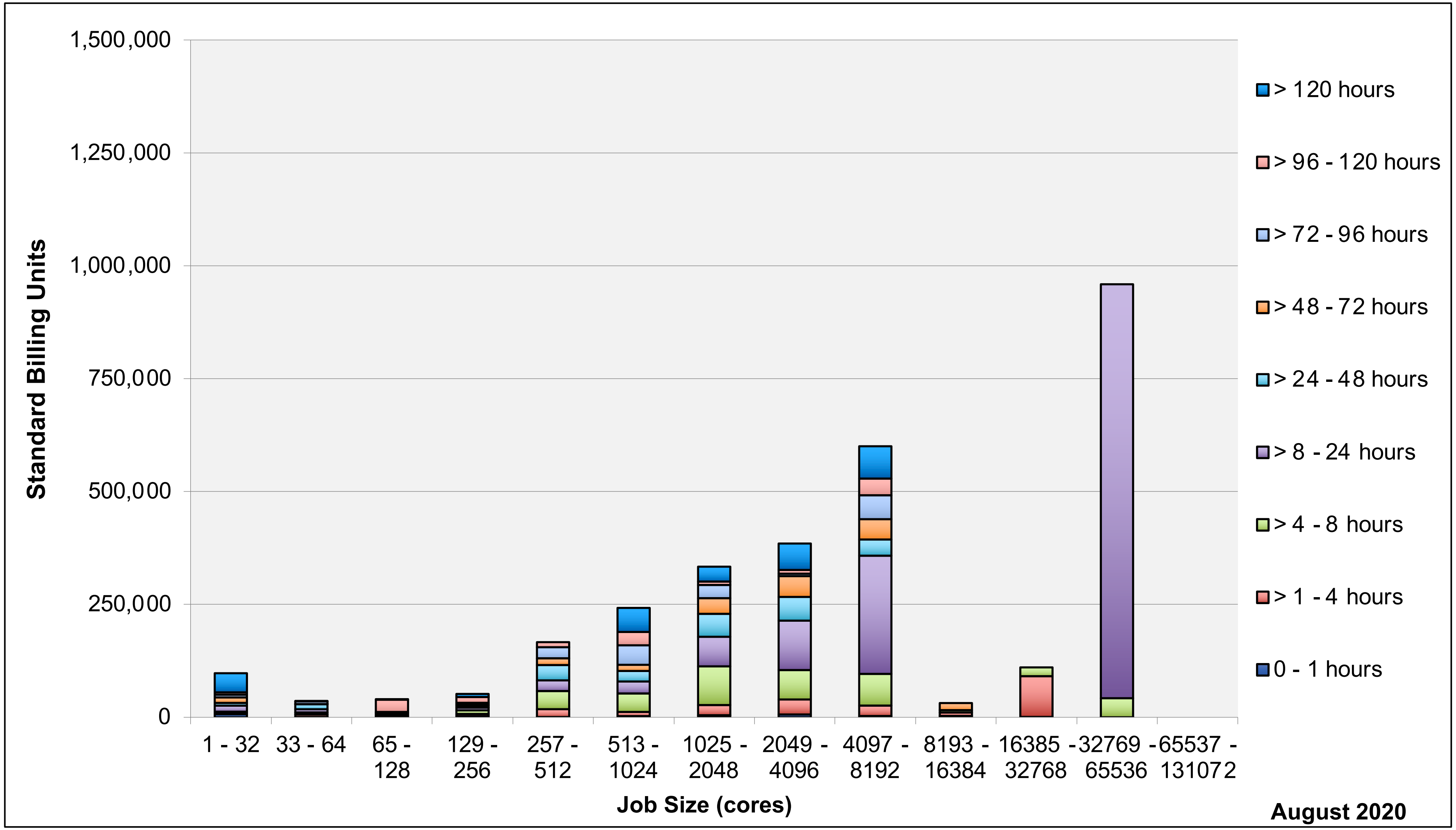

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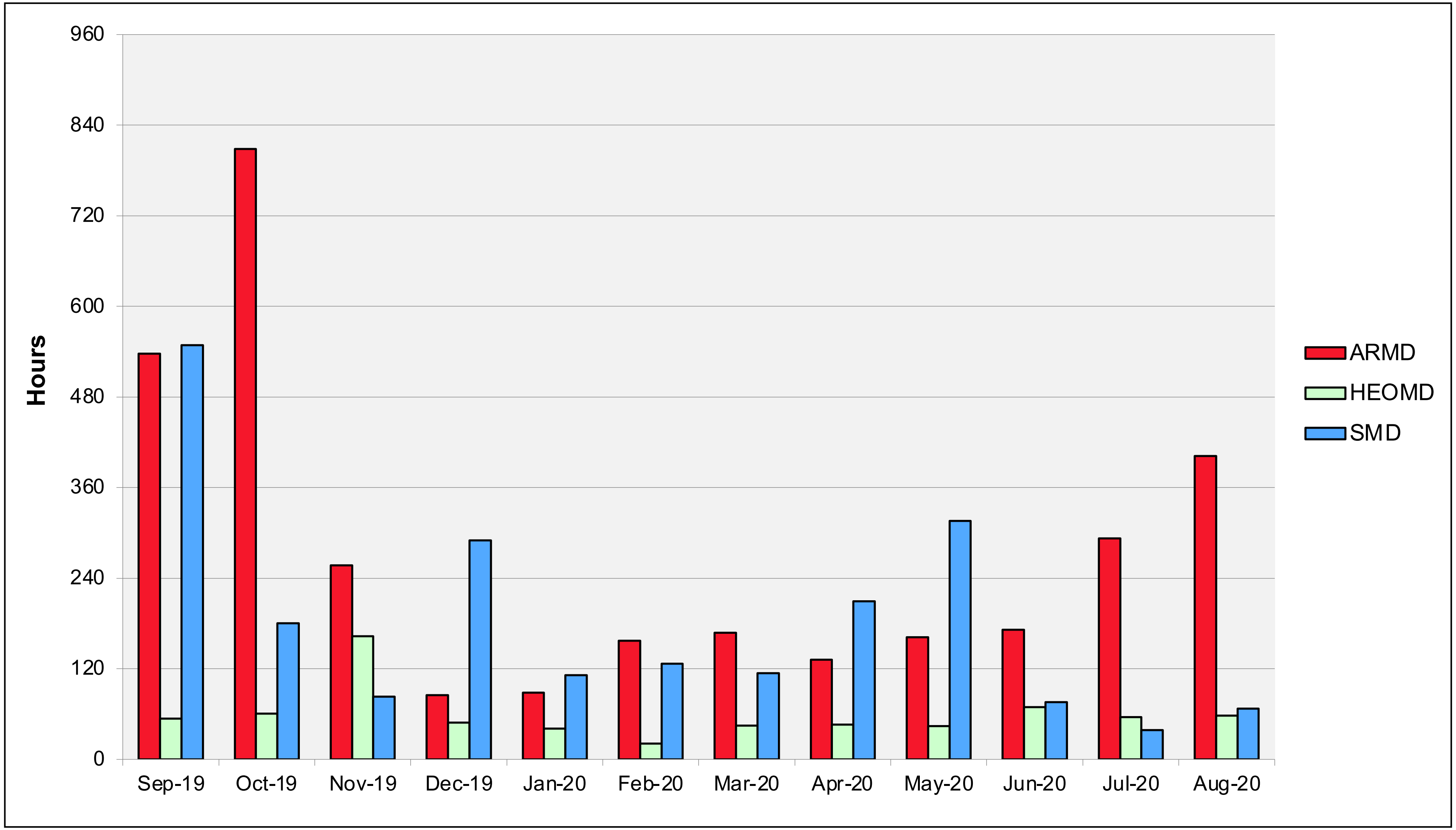

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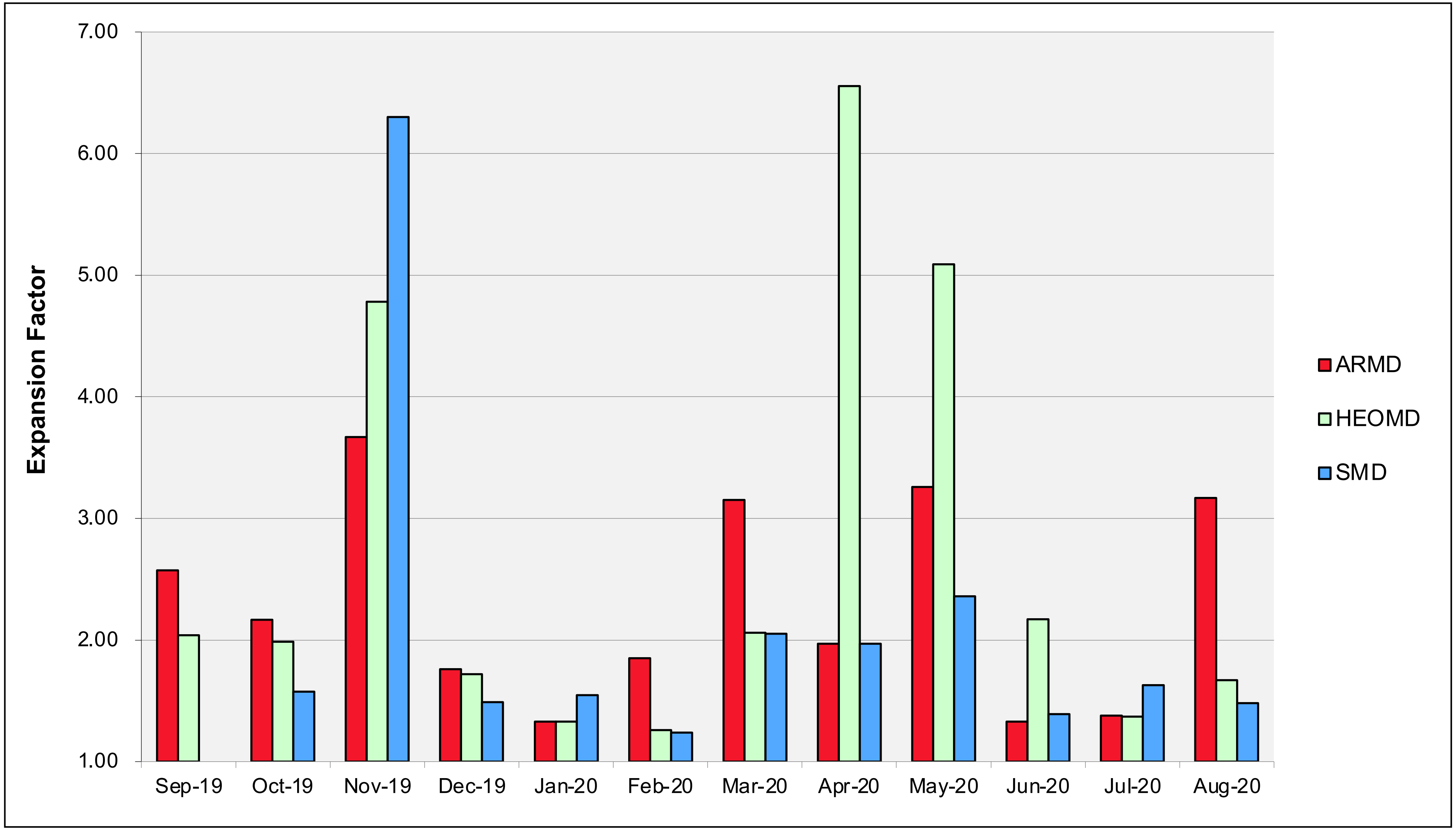
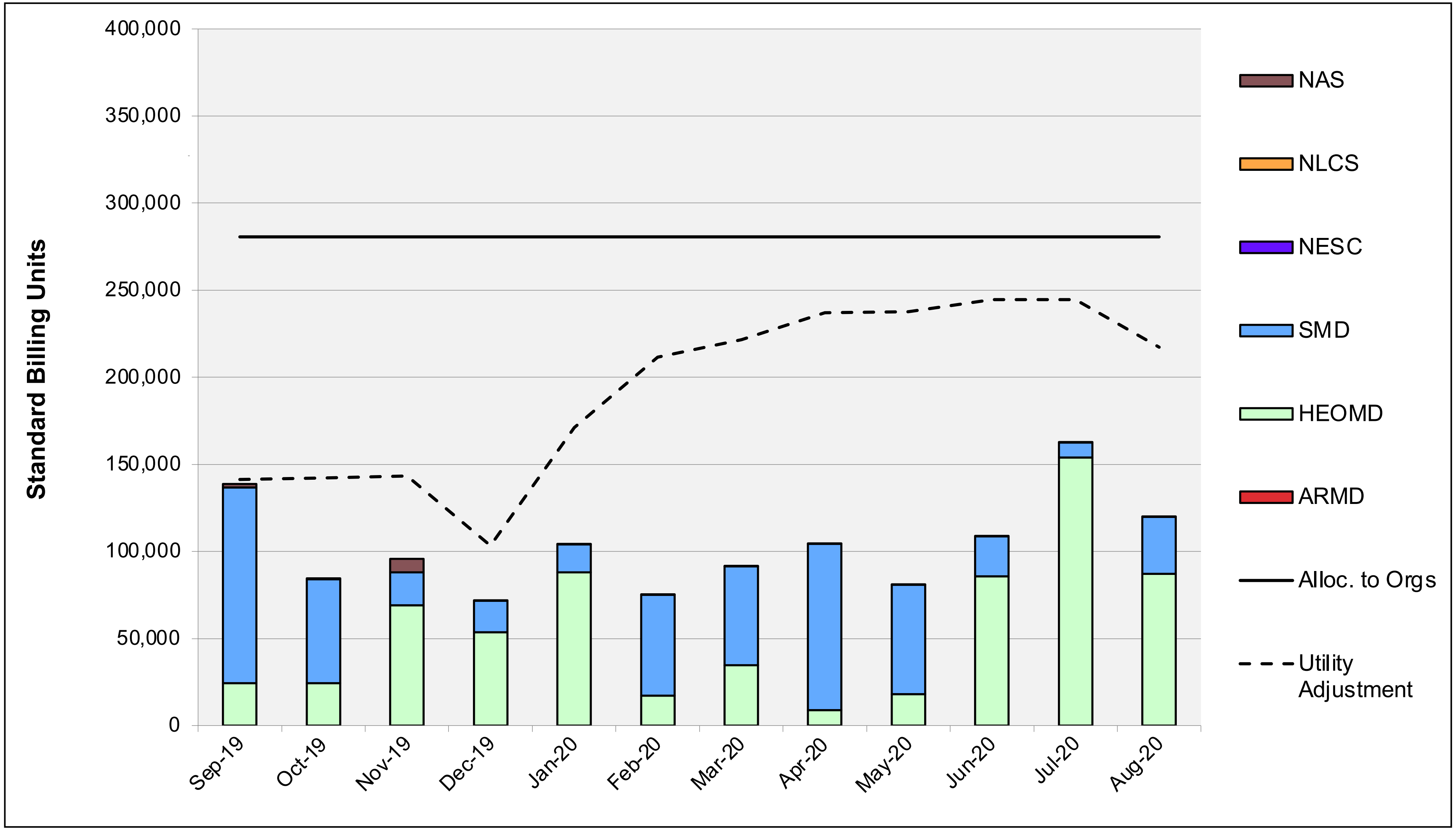


Merope: SBUs Reported, Normalized to 30-Day Month



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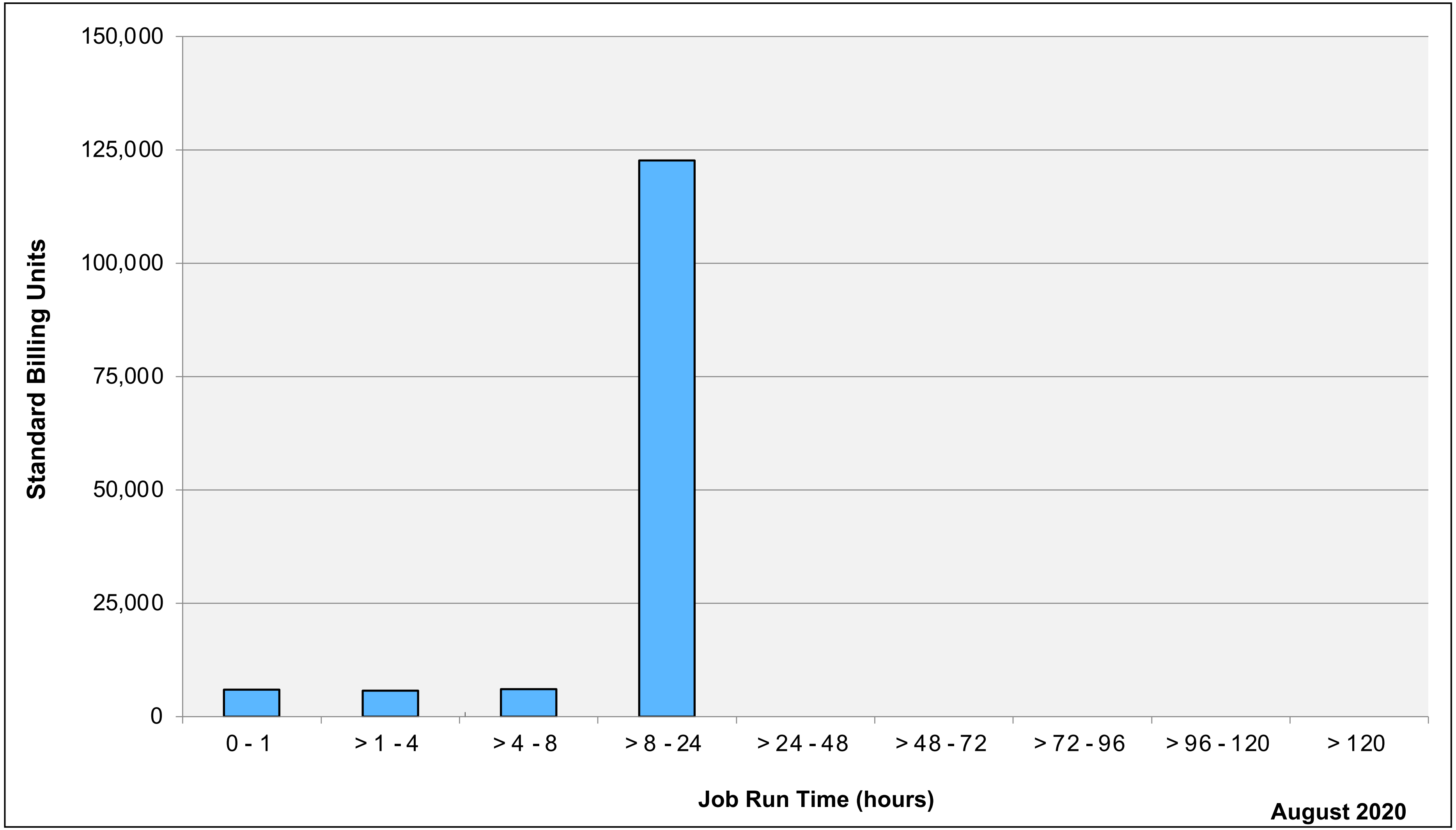

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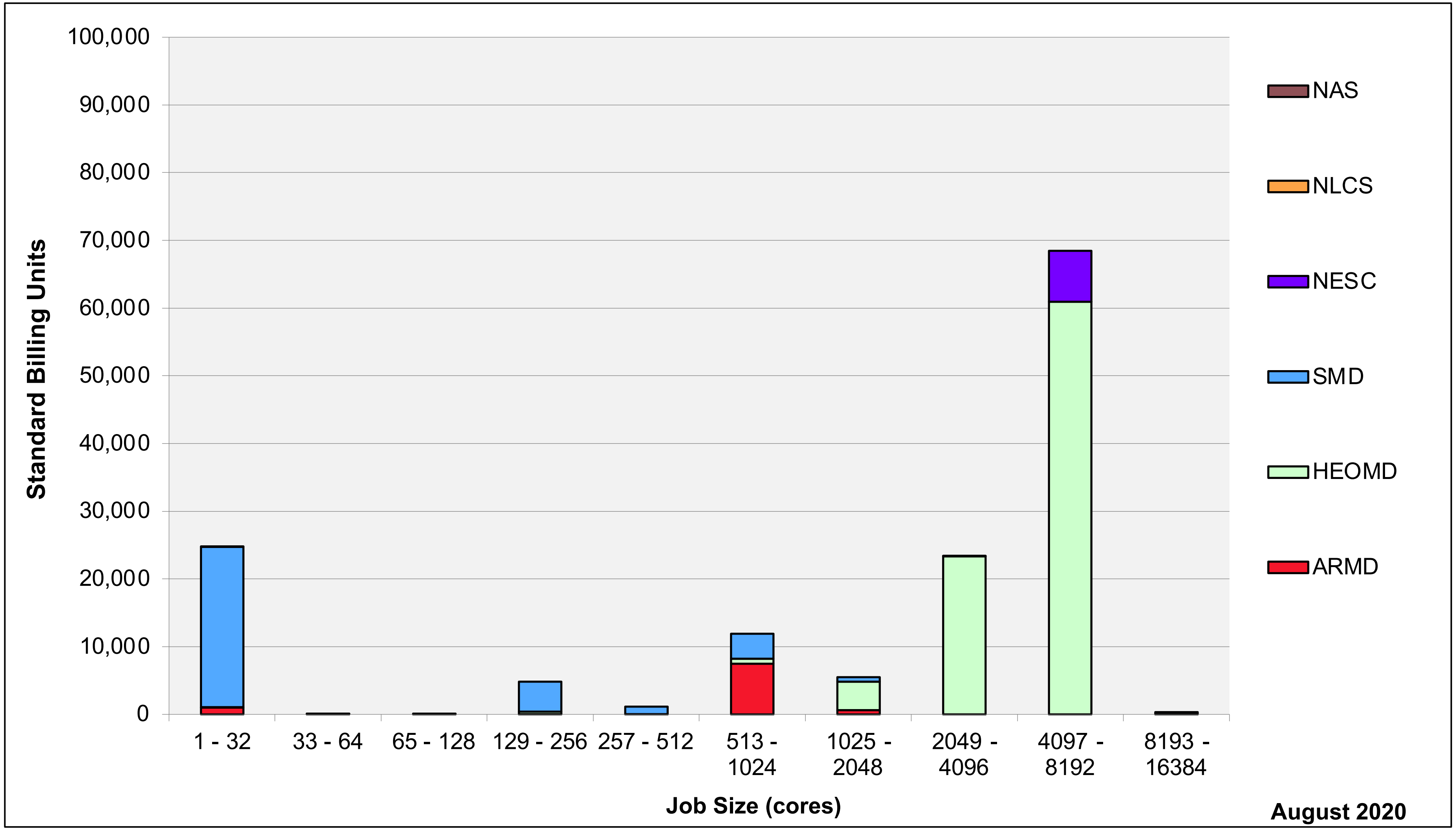

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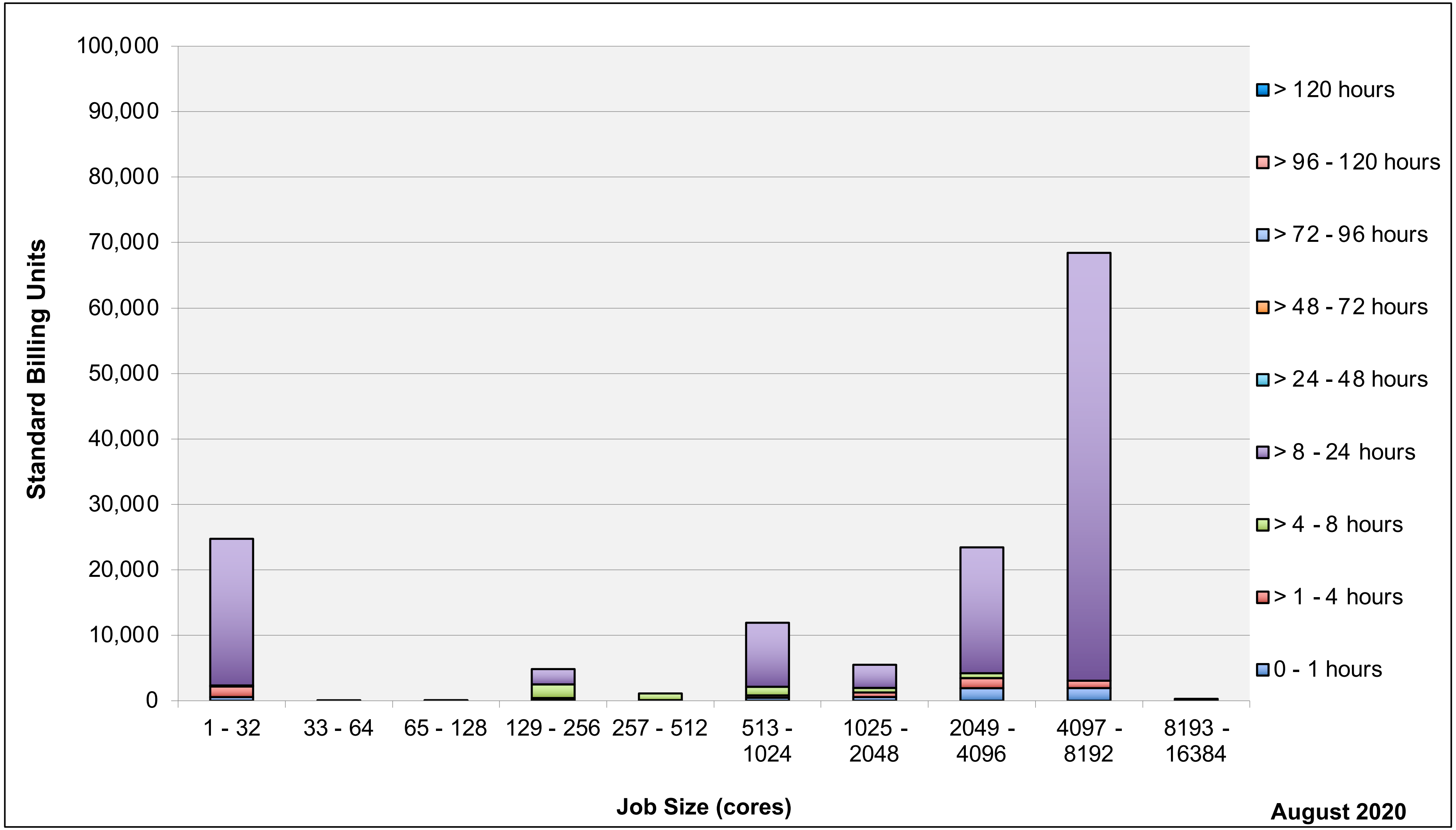

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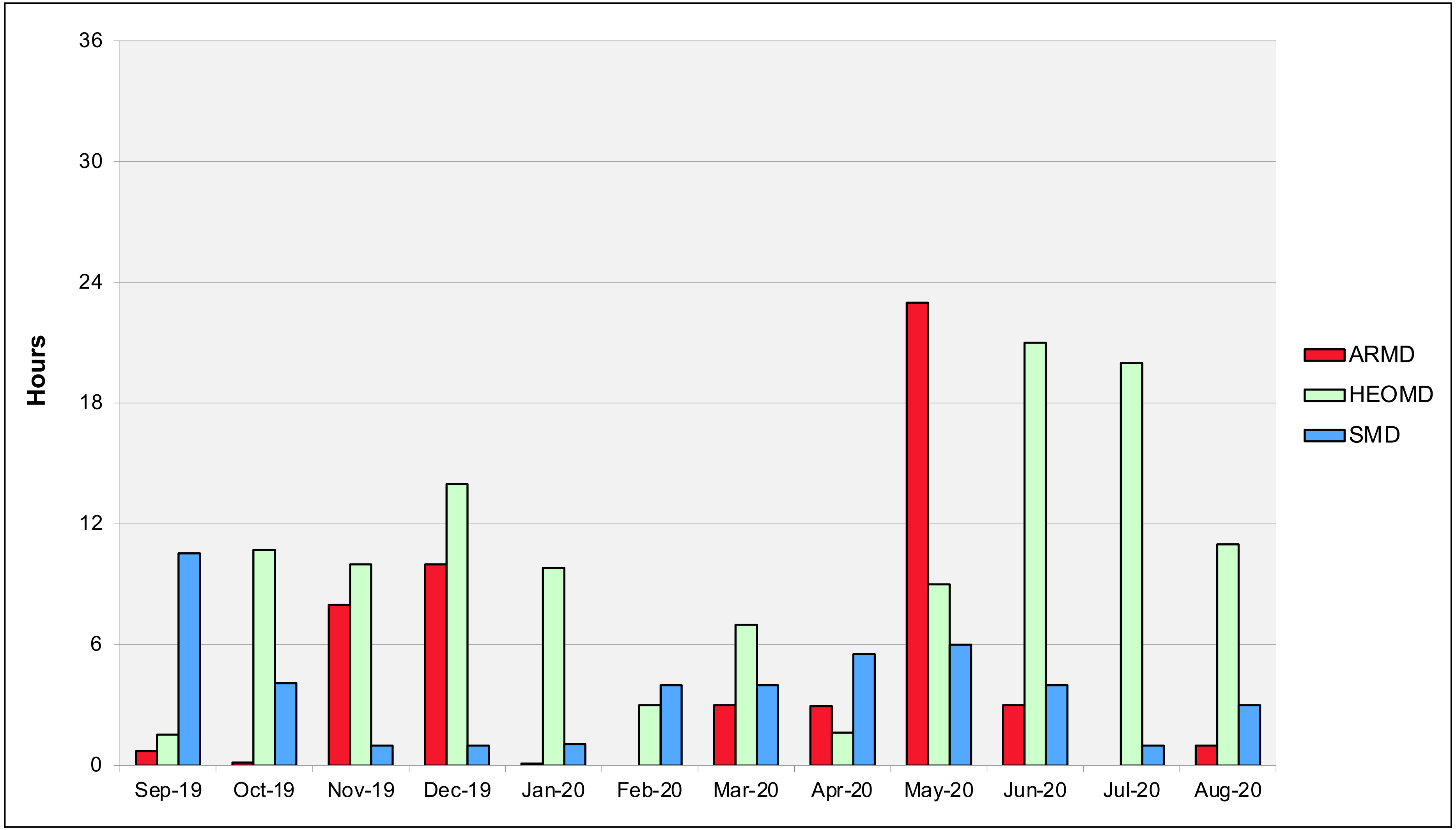

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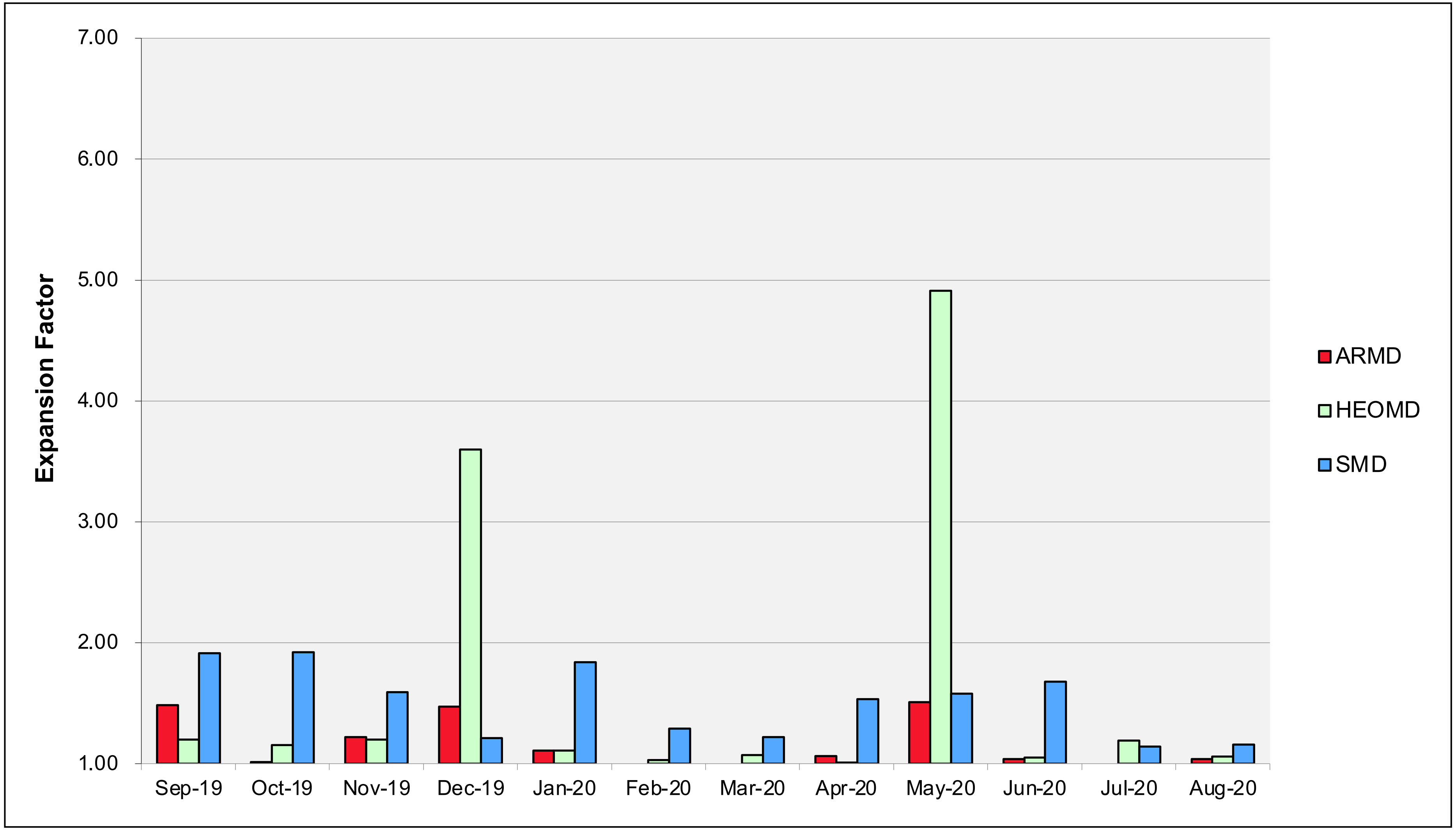
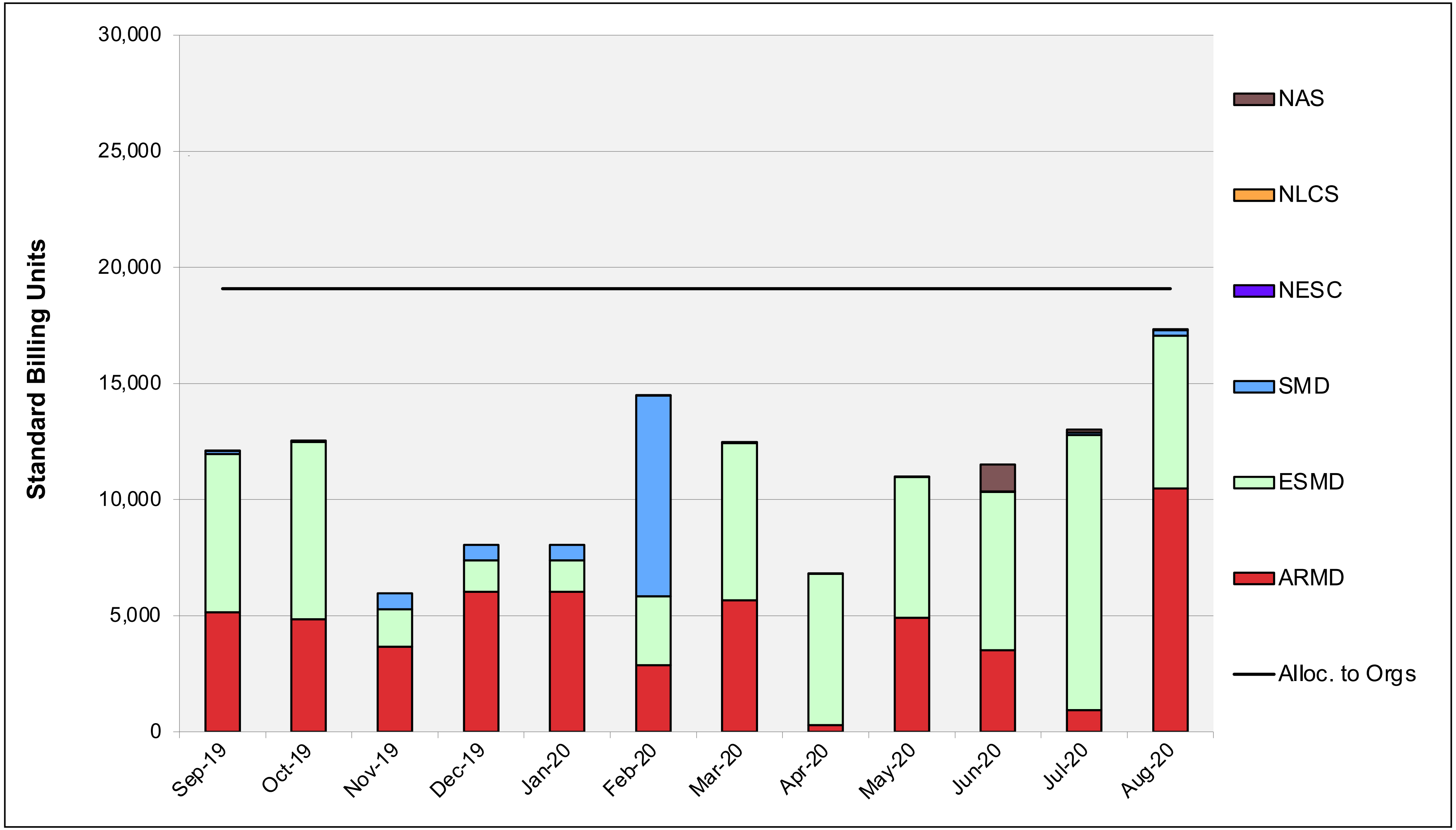
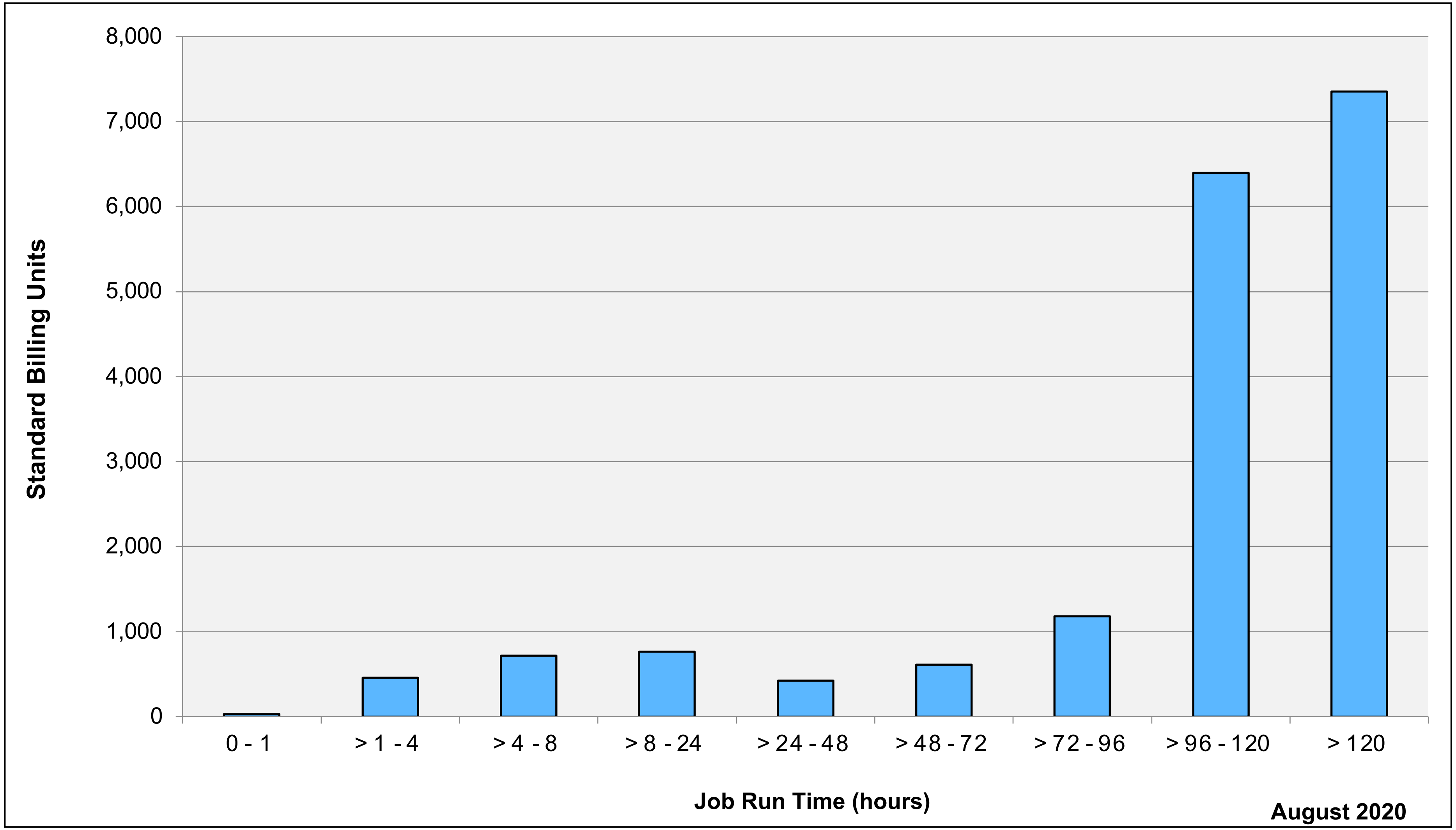


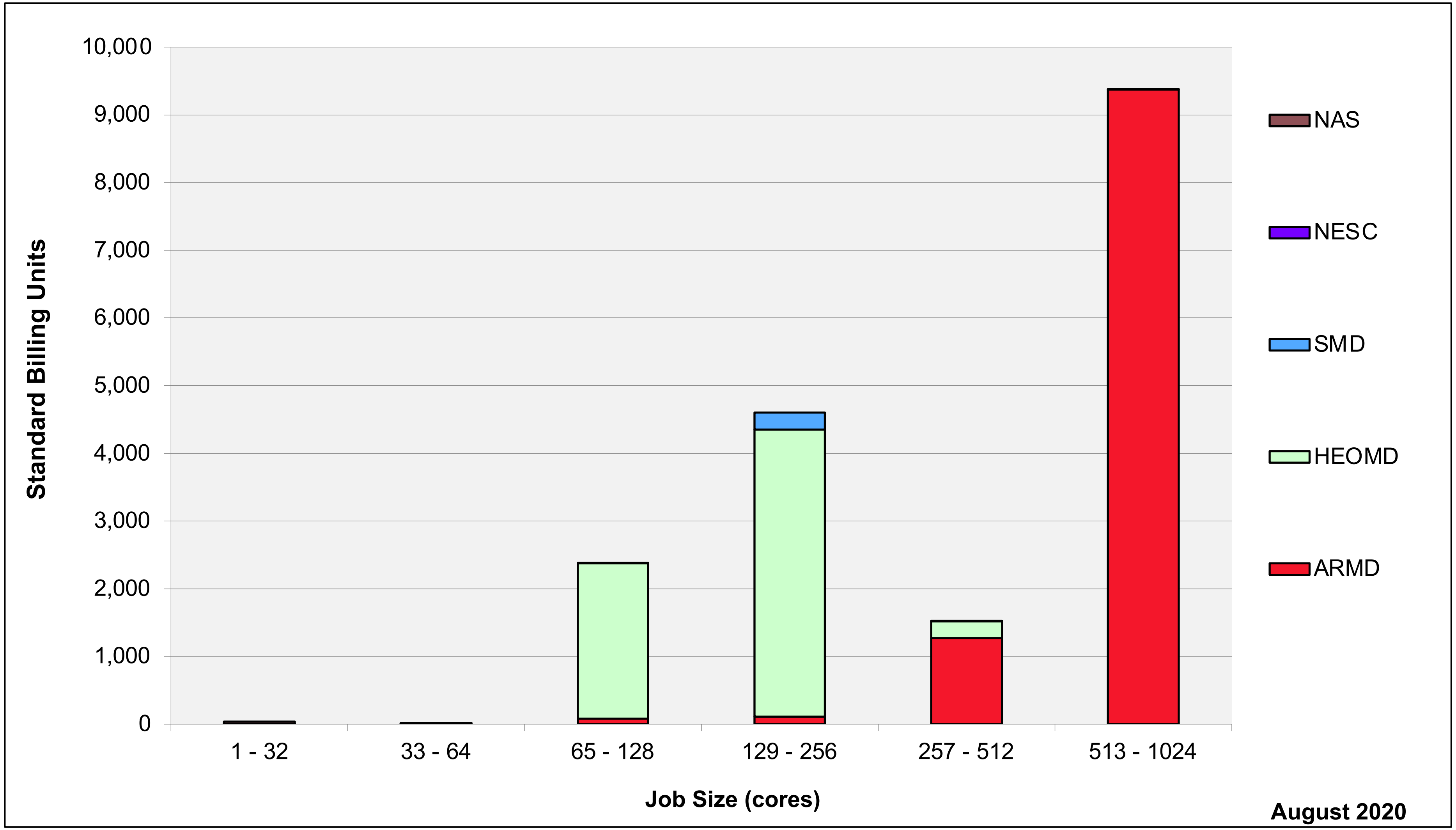
Endeavour: SBUs Reported, Normalized to 30-Day Month



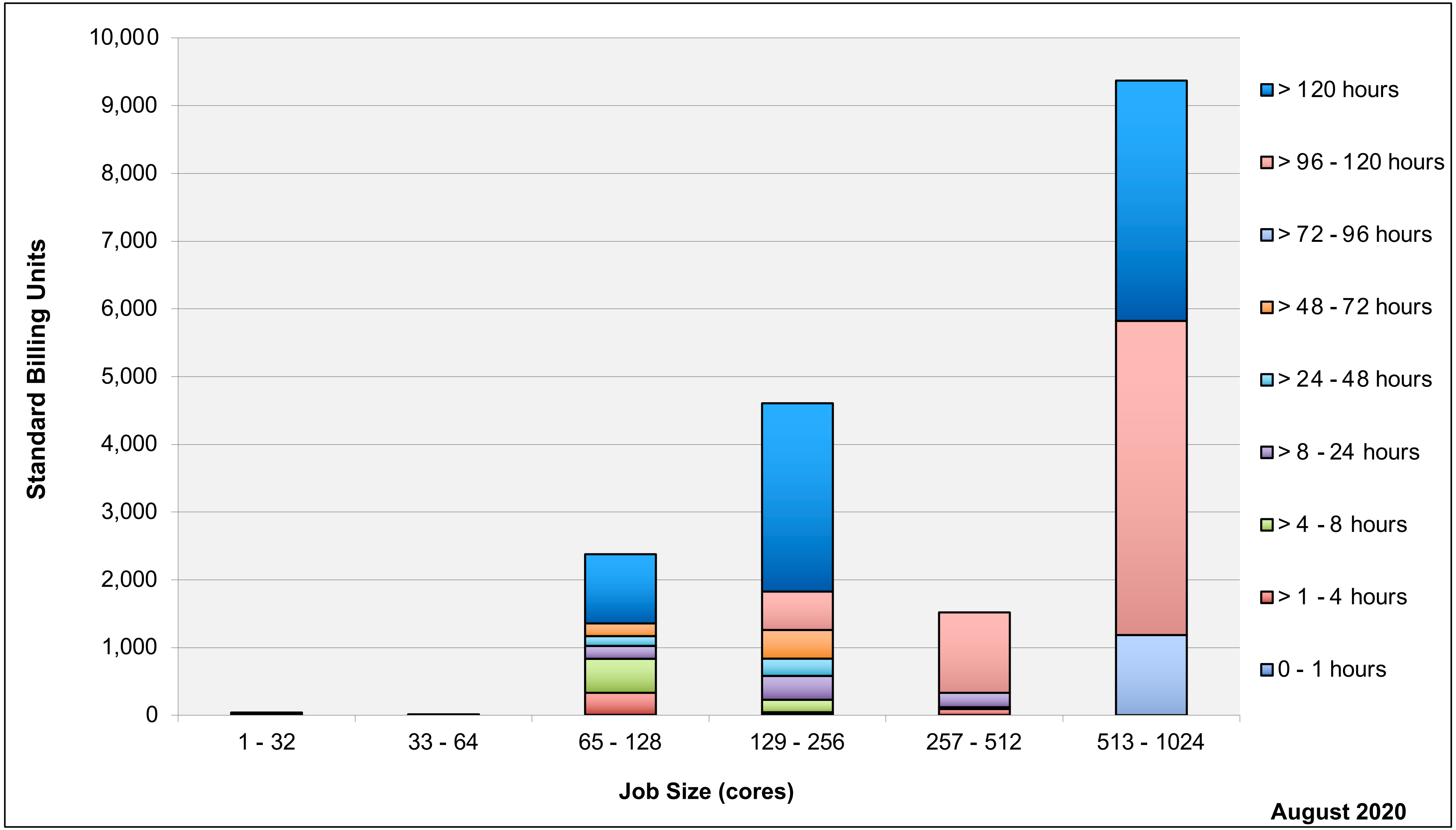
Endeavour: Monthly Utilization by Job Length



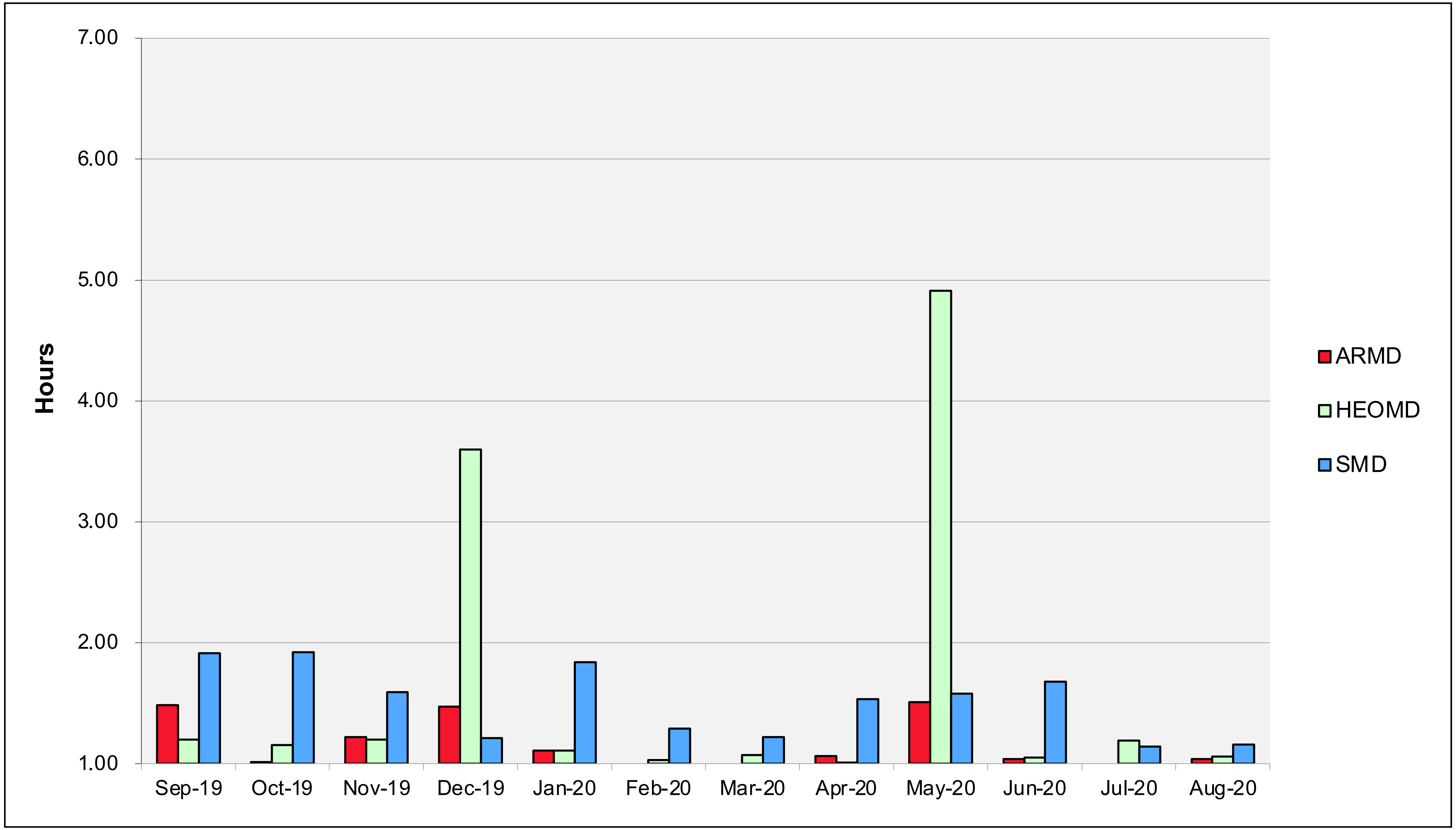
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Time to Clear All Jobs



Endeavour: Average Expansion Factor