Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

November 10, 2012

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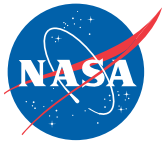
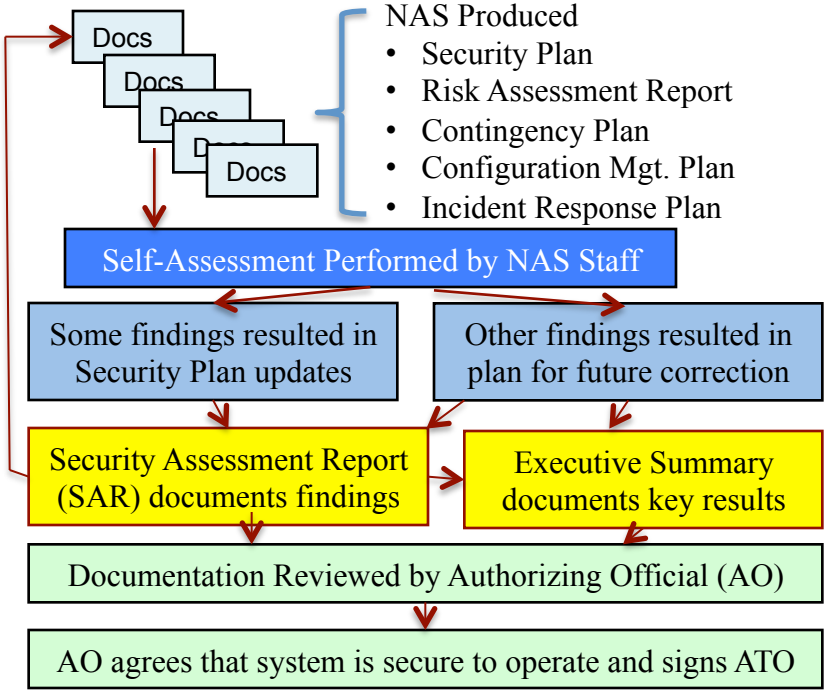
Recertification Assessment Results in New Authorization to Operate for HECC



- On October 9th, the Ames Research Center Deputy Director, who is the authorizing official for the HECC Project operated out of the NASA Advanced Supercomputing (NAS) facility, signed the full authorization to operate for all HECC systems, including the high-end computers.
- The approval was the final step in a recurring triennial certification/accreditation process.
- Per guidance from NASA Headquarters, a self-assessment for recertification/accreditation was performed by NAS staff instead of an outside third party, as was done in the past.
- NAS staff assessed the compliance of the facility's systems and operations, as well as the NAS Security Plan with NIST SP 800-53 Rev. 3, which specifies the controls required for federal information systems.

Mission Impact: Because the HECC supercomputers, storage systems, and support peripherals meet the stringent federal security requirements, users can have high confidence that their data and the processing performed on HECC systems are secure.



Flow chart outlining the recertification process.

POC: Thomas Hinke, thomas.h.hinke@nasa.gov, (650) 604-3662, NASA Advanced Supercomputing Division

HECC Selects Replacement for Columbia Supercomputer Nodes

- HECC's Application Performance and Productivity (APP) group conducted an evaluation of potential replacement systems for Columbia's large, shared-memory single-system image nodes.
- The group selected a set of benchmarks and applications for this evaluation, and ran the codes on two shared-memory systems:
  - A hardware-only solution – SGI UV2000 (access provided courtesy of SGI, Inc.) and;
  - A software-based solution – ScaleMP's vSMP Foundation running on a cluster of Sandy Bridge nodes (access provided courtesy of San Diego Supercomputer Center); ScaleMP also provided the performance of some of these codes (including optimized versions) on their own private cluster.
- Two SGI UV2000 shared-memory systems were selected as replacement for the Columbia nodes based on several factors, including performance, cost of ownership, and NASA's shared-memory requirements.
- HECC expects the systems to go into production in January 2013, and the existing Columbia nodes to be retired soon after that.

Mission Impact: Replacing the Columbia shared-memory systems with SGI's UV2000 system provides HECC users with a more efficient resource to meet their mission milestones.

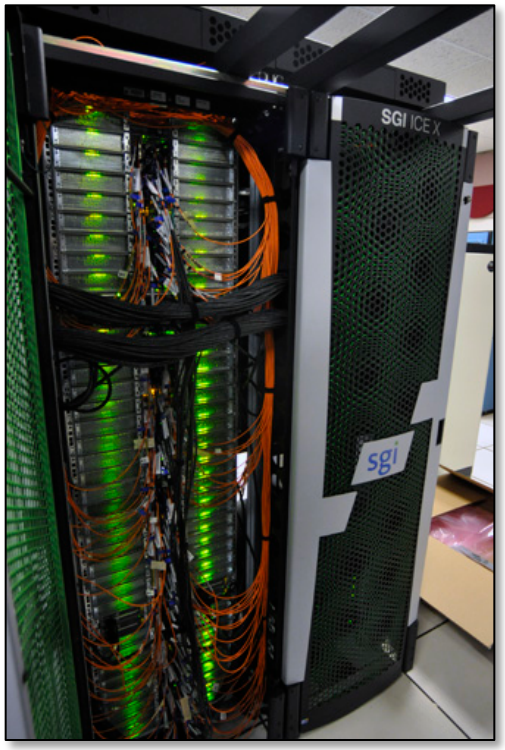
The SGI UV2000 scales up to 4,096 threads (256 CPU sockets) and up to 64 terabytes of cache-coherent, global shared memory in a single system.

POCs: Piyush Mehrotra, piyush.mehrotra@nasa.gov, (650) 604-5126, NASA Advanced Supercomputing Division
Robert Hood, robert.hood@nasa.gov, (650) 604-0740, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Pleiades Sandy Bridge Power Supply Replacement Enables Performance Gains

- During a scheduled dedicated time, HECC systems staff replaced power supplies and updated firmware on Pleiades' new Sandy Bridge racks.
- These updates enable the Intel Turbo Boost feature, which can increase processor performance and speed up simulations by increasing the core operating frequency within the controlled limits of the processor.
- After Turbo Boost was enabled on the system, the Standard Billing Unit (SBU) benchmark was run, and the SBU factor for the Sandy Bridge processors increased from 1.65 to 1.82 (see slide 6).
- Batch jobs running on Pleiades were suspended at the start of the dedicated time, then resumed once the work was completed; this results in more productive compute cycles delivered to users.

Mission Impact: Utilizing the Turbo Boost feature on the Pleiades Sandy Bridge processors will allow NASA researchers to improve the runtimes of many of their mission support simulations.



The Sandy Bridge racks had the power supplies replaced so that Turbo Boost could be enabled, which provides improved performance to NASA's science and engineering users.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division
Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

Pleiades' SBU Charging Rate Recalculated after Enabling Turbo Boost

- After upgrading the Pleiades power supplies to enable the Intel Turbo Boost feature on the Sandy Bridge racks (see slide 5), HECC's Application Performance and Productivity (APP) group found that performance had been improved by 10%.
- The group re-ran the benchmark suite used to determine Standard Billing Unit (SBU) rates for computer usage; the suite comprises of 6 codes that represent typical usage on the HECC systems:
  - Enzo represents cosmology applications;
  - GEOS-5 and WRF represent applications in climate and weather modeling; and
  - FUN3D, OVERFLOW, and USM3D represent computational fluid dynamics applications.
- The benchmarking led to a redefinition of the SBU charging rate for Pleiades' Sandy Bridge nodes from 1.65 to 1.82*.

* 1.0 is normalized to the runtime of the benchmark suite on the Westmere node with Turbo Boost enabled.

Mission Impact: Enabling the Turbo Boost feature on the new Pleiades Sandy Bridge racks has improved average performance for NASA users by 10%.

Code	Turbo Boost Off	Turbo Boost On	Performance Improvement
Enzo	1060	930	12%
FUN3D	1502	1439	4%
GEOS-5	1361	1231	10%
OVERFLOW	1253	1121	11%
USM3D	1670	1503	10%
WRF	1663	1499	10%

Performance across the SBU benchmark suite improved by an average of 10% when Turbo Boost was enabled on the Sandy Bridge nodes. The above table shows times in seconds before and after enabling the feature that allows faster clock speeds in the processors.

POCs: Piyush Mehrotra, piyush.mehrotra@nasa.gov, (650) 604-5126, NASA Advanced Supercomputing Division
Robert Hood, robert.hood@nasa.gov, (650) 604-0740, NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Engineers Triple the Display Area of Mini-Hyperwall

- HECC engineers recently tripled the size of the display grid of the mini-hyperwall, which is used at conferences and other events to help convey NASA's science and engineering advances to the public.
- In addition to an increase in size, the new displays in the 3×3 grid have significantly thinner bezels, which reduces the amount of visualization blocked by the bezels.
- As part of the upgrade, the support stand was re-engineered:
  - The display wall can now be either free standing or attached to an appropriately prepared wall, such as in a conference booth;
  - It can also be easily broken down and packed in crates for transportation.
- The mini-hyperwall will be a key part of NASA's SC12 booth. It may also be used in December at the AGU conference and at a press conference for the Kepler mission.

Mission Impact: The ability to bring a much larger mini-hyperwall to conferences and public events helps researchers properly convey the significance of NASA's science and engineering advances.

The Bolshoi visualization, showing the largest and most realistic cosmological simulations of the evolving universe ever developed, is brilliantly displayed on the new and improved mini-hyperwall. The re-engineered mini-hyperwall is three times larger than its predecessor, and its thinner bezels reduce visual blockage by a factor of 6.7.

POC: David Ellsworth, david.ellsworth@nasa.gov, (650) 604-0721, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Pleiades Achieves Major Milestone: 150 Million SBUs Delivered

- In October, Pleiades achieved the milestone of delivering 150 million Standard Billing Units (SBUs) to NASA users.
- 150 million SBUs is equivalent to 3 billion CPU hours on the Columbia system that preceded Pleiades, and represents four times the number of SBUs Columbia has delivered since it began operating in July 2004.
- Pleiades achieved this milestone in 50 months, having gone into production in August 2008.
- Major system expansions in Oct. 2009, June 2011, and June 2012 boosted Pleiades' performance to its current sustained speed of 1.24 petaflop/s.
- Computing resources continue to expand and are available to users from all Mission Directorates to support their critical computing needs.

Mission Impact: Increasing Pleiades' system capacity provides NASA Mission Directorates with more resources for the accomplishment of their critical goals and objectives.

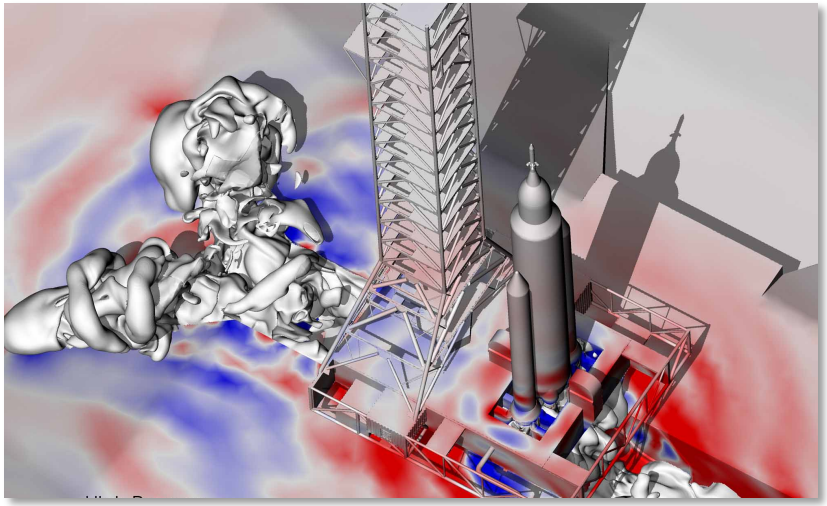
Pleiades now delivers a sustained performance rate of 1.24 petaflops to support more than 1,200 users across the country who rely on the system to perform their large, complex calculations.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

Simulations to Support the Next-Generation Launch Complex

- To assess the feasibility of launching the heavy-lift Space Launch System (SLS) from Kennedy Space Center (KSC), researchers at the NASA Advanced Supercomputing (NAS) Division have produced high-fidelity simulations of potential SLS launch environment configurations.
- Computational fluid dynamics (CFD) simulations of ignition overpressure (IOP) acoustic phenomena, and plume physics help designers ensure that the next-generation launch environment can withstand the extreme thrust conditions of the SLS and other new vehicles.
- These quick-turnaround CFD simulations on the Pleiades supercomputer, are enabling vehicle and launch pad engineers to quantitatively assess design decisions that would be difficult or impossible to test experimentally.

Mission Impact: Enabled by HECC supercomputing resources, CFD simulations to support design of the SLS launch pad are efficient and cost effective, and can provide results for a large number of launch configurations with a quick turnaround time.



Simulation of a potential Space Launch System (SLS) launch site configuration, showing surface pressure signatures with plume formation at an instant of time.

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Michael Barad, michael.f.barad@nasa.gov, (650) 604-0550,
NASA Advanced Supercomputing Division

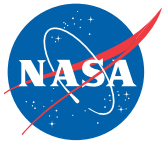
HECC Facility Hosts Several Visitors and Tours in October 2012

- HECC hosted 9 tour groups in October; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - A Kepler/Blender team, including representatives from the Harvard-Smithsonian Center for Astrophysics, held a working meeting at the NAS facility;
  - Members of the Headquarters Technical Capabilities Assessment Team, who are focused on NASA Entry Decent and Landing capabilities across all centers, visited Ames to review its unique and critical capabilities;
  - A large group from the Defense Foreign Liaisons visited Ames as part of their "goodwill efforts" tour of the San Francisco Bay Area;
  - Ames Fall Internship program participants enjoyed learning about the Pleiades supercomputer and viewing computer results on the NAS hyperwall-2.

NASA Ames Center Director Pete Worden and NAS Division Chief Rupak Biswas presented overviews of the center and division to 70 members of the Defense Foreign Liaisons group, who visited Ames as part of a Bay Area tour in October 2012.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division

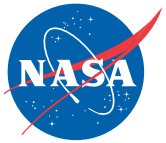
Presentations and Papers



- "**Angular Momentum Conservation in a Simplified Venus General Circulation Model**," C. Lee, M. I. Richardson, Icarus, Volume 22, November 2012, published online October 24, 2012.*
  http://www.sciencedirect.com/science/article/pii/S0019103512004149?v=s5/
- "**GRMHD Simulations of Magnetized Advection-Dominated Accretion on a Non-Black Hole: Role of Outflows**," R. Narayan, et al., Monthly Notices of the Royal Astronomical Society, Volume 426, Issue 4: 3241-3259, November 2012 (published online October 17, 2012).*
  http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2966.2012.22002.x/full
- "**Line Formation in the Inner Winds of Classical T Tauri Stars: Testing the Conical-Shell Wind Solution**," R. Kurosawa, M. M. Romanova, Monthly Notices of the Royal Astronomical Society, Volume 426, Issue 4: 2901-2916, November 2012 (published online October 17, 2012).*
  http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2966.2012.21853.x/full
- "**Recent Developments on the X-rays Approach to Hole-Cutting**," W. M. Chan, S. A. Pandya, Symposium on Overset Composite Grids and Solution Technology, Dayton, Ohio, October 15–18, 2012.*
- "**Aerodynamic Evaluation of the D8 'Double-bubble' Aircraft Nacelle Design**," Symposium on Overset Composite Grids and Solution Technology, Dayton, Ohio, October 15–18, 2012.*
- "**The Velocity Shear Tensor: Tracer of Halo Alignment**," N. Libeskind, Y. Hoffman, J. Forero-Romero, S. Gottlober, A. Knebe, M. Steinmetz, A. Klypin, arXiv:1210.4559 [astro-ph.CO], October 16, 2012.*
  http://arxiv.org/abs/1210.4559
- "**Spectral and Intermittency Properties of Relativistic Turbulence**," J. Zrake, A. MacFadyen, arXiv:1210.4066 [astro-ph.HE], October 15, 2012.*
  http://arxiv.org/abs/1210.4066
- "**Discrete Dipole Approximation Models of Crystalline Forsterite: Applications to Cometary Crystilline Silicates**," S. Lindsay, et al., presented at 44th meeting of the Division of Planetary Sciences of the American Astronomical Society, Reno, Nevada, October 14–19, 2012. *
  http://adsabs.harvard.edu/abs/2012DPS....4431402L

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

Presentations and Papers (continued)



- "**Nature of Lyman Alpha Blobs: Powered by Extreme Starbursts**," R. Cen, Z. Zeng, arXiv:1210.3600 [astro-ph.CO], October 12, 2012.*
  http://arxiv.org/abs/1210.3600
- "**Effects of Cloud Horizontal Inhomogeneity and Drizzle on Remote Sensing of Cloud Droplet Effective Radius: Case Studies Based on Large-Eddy Simulations**," Z. Zhang, et al., Journal of Geophysical Research, Volume 117, D19208, October 6, 2012.*
  http://www.agu.org/journals/jd/jd1219/2012JD017655/
- "**Pickup Proton Instabilities and Scattering in the Distant Solar Wind and the Outer Heliosheath: Hybrid Simulations**," K. Liu, et al., Journal of Geophysical Research, Volume 117, A10102, October 6, 2012.*
  http://www.agu.org/journals/ja/ja1210/2012JA017969/
- "**Conserved Actions, Maximum Entropy and Dark Matter Halos**," A. Pontzen, F. Governato, arXiv: 1210.1849 [astro-ph.CO], October 5, 2012.*
  http://arxiv.org/abs/1210.1849
- "**Analysis of Cloud-Resolving Simulations of a Tropical Mesoscale Convective System Observed During TWP-ICE: Vertical Fluxes and Draft Properties in Convective and Stratiform Regions**," A. Mrowiec, et al., Journal of Geophysical Research, Volume 117, D19201, October 2, 2012.*
  http://www.agu.org/journals/jd/jd1219/2012JD017759/
- "**The Universe in a Supercomputer,"** J. R. Primack, IEEE Spectrum, Volume 49, Issue 10, October 2012.*
  http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6309255
  http://spectrum.ieee.org/aerospace/astrophysics/the-cosmological-supercomputer

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

News and Events

- **What is NASA doing with Big Data Today?**, *open.NASA article,* October 4, 2012 – the open.NASA program manager, Nick Skytland, discusses the role of "big data" at NASA and uses Pleiades as a world-class example of how the agency approaches analysis of its ever- growing amount of data.
  http://open.nasa.gov/blog/2012/10/04/what-is-nasa-doing-with-big-data-today/

- **NASA – Computer Model Shows a Disk Galaxy's Life History**, *YouTube,* October 19, 2012 – Original video uploaded by NASAexplorer (operated by NASA Goddard) of spiral galaxy simulation run on Pleiades over an estimated one million CPU hours. Has been viewed more than 265,000 times, and has been picked up by many online media.* sources.**http://www.youtube.com/watch?v=_Ssc1GsqHds*

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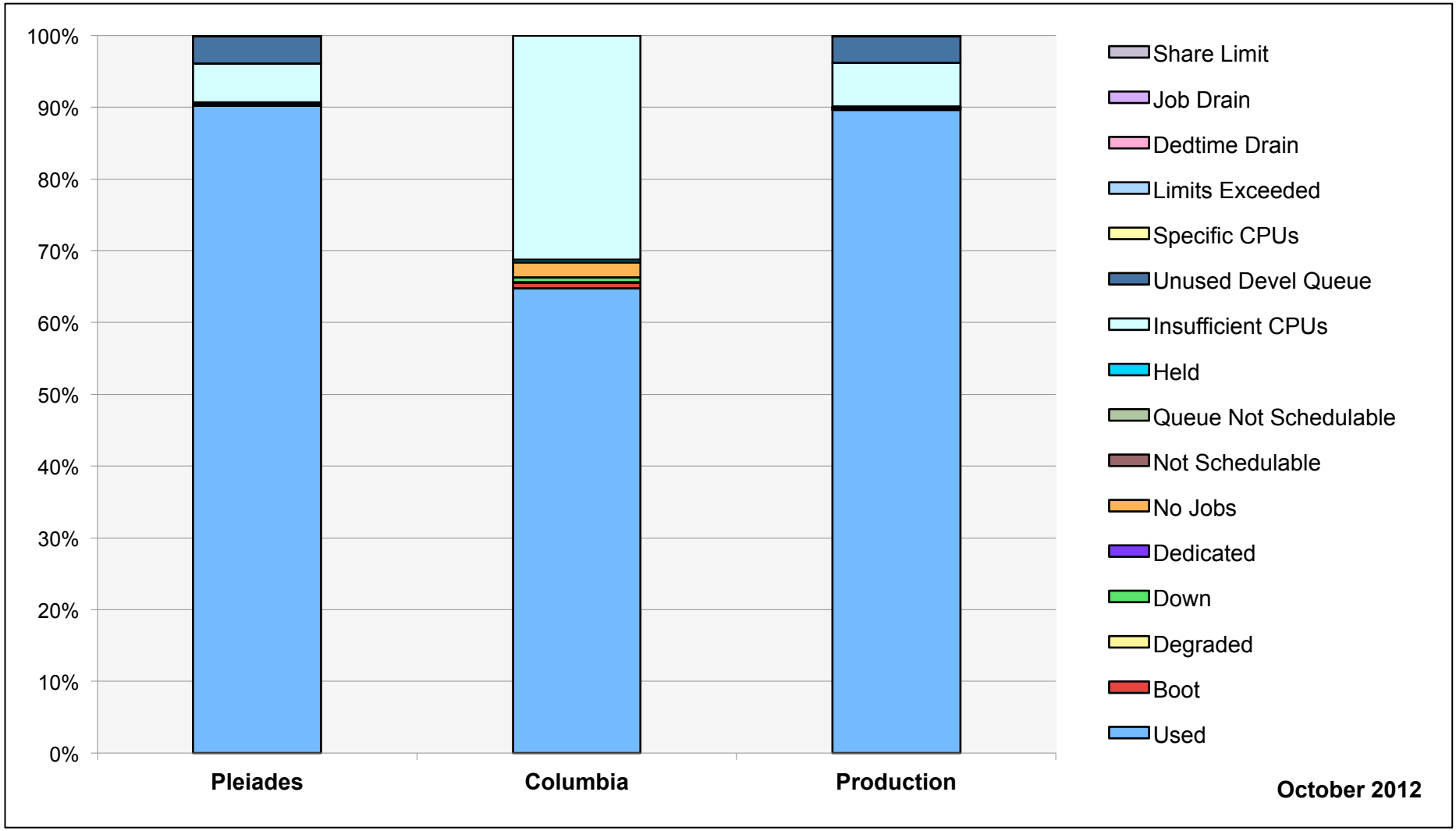
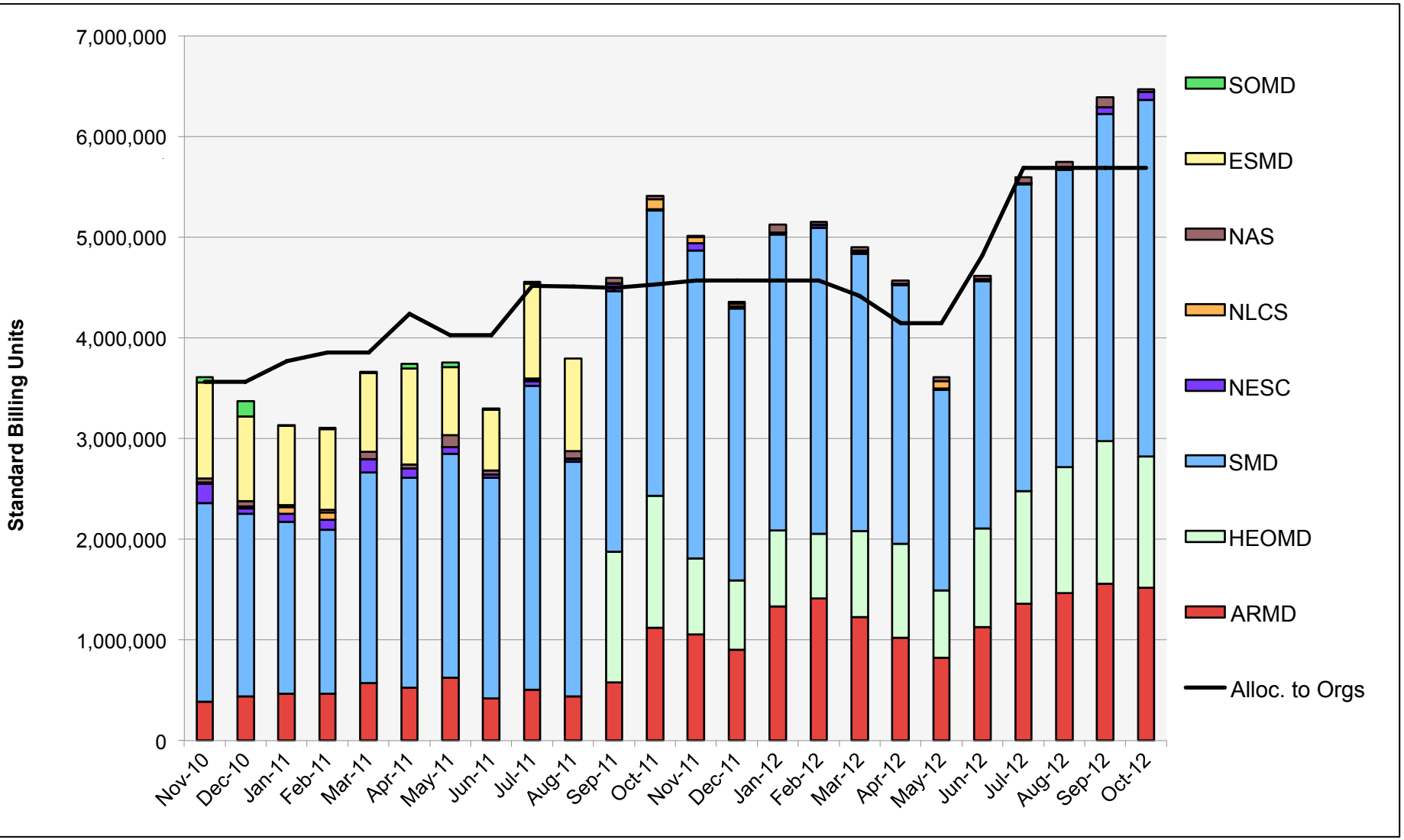
HECC Utilization



HECC Utilization Normalized to 30-Day Month



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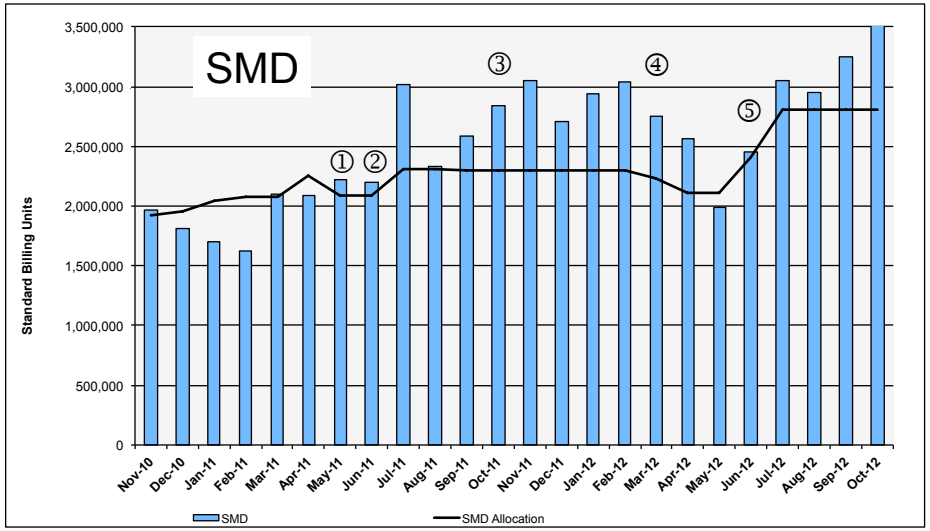
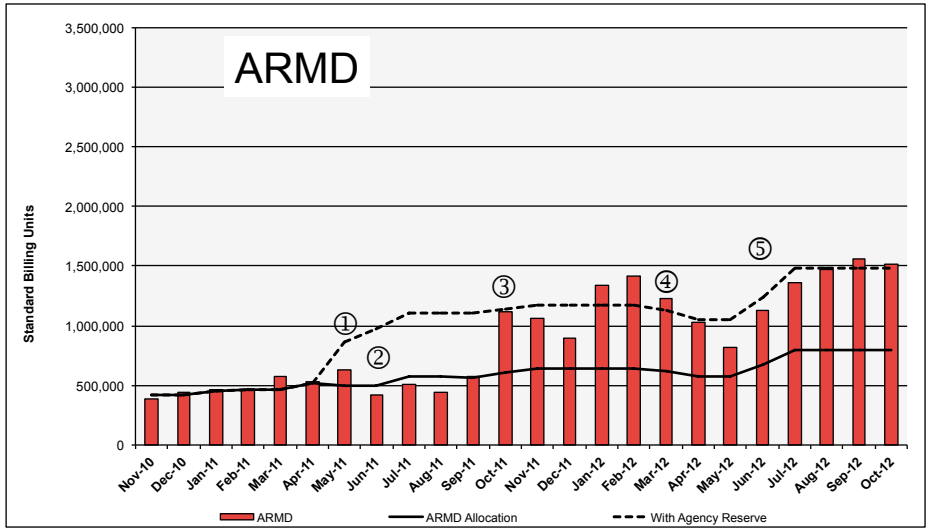
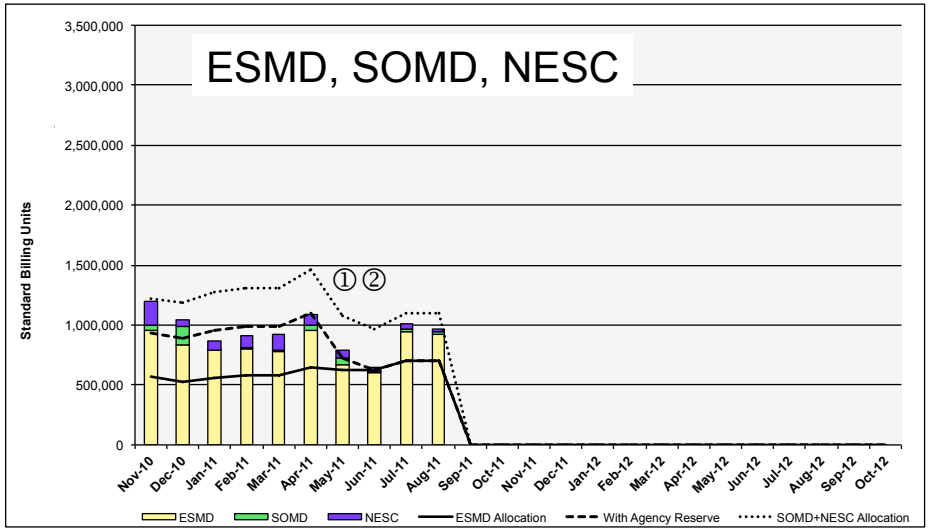
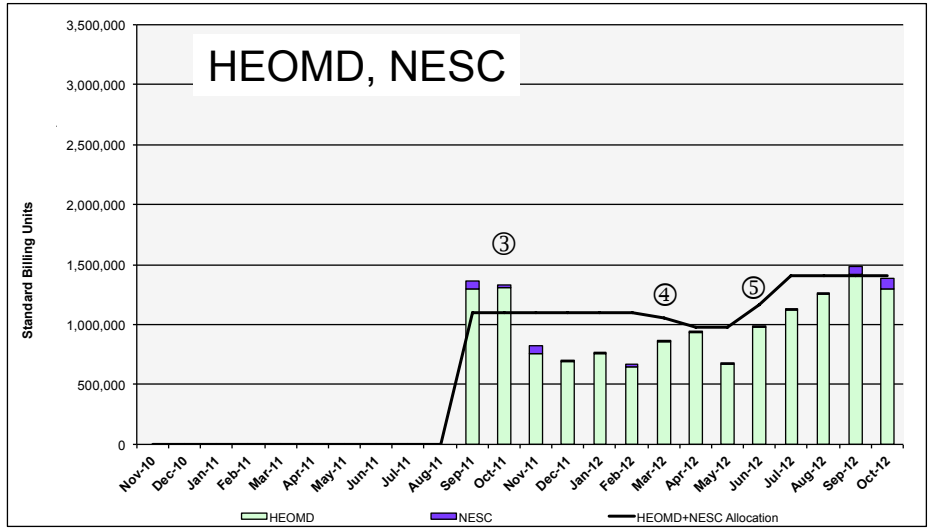


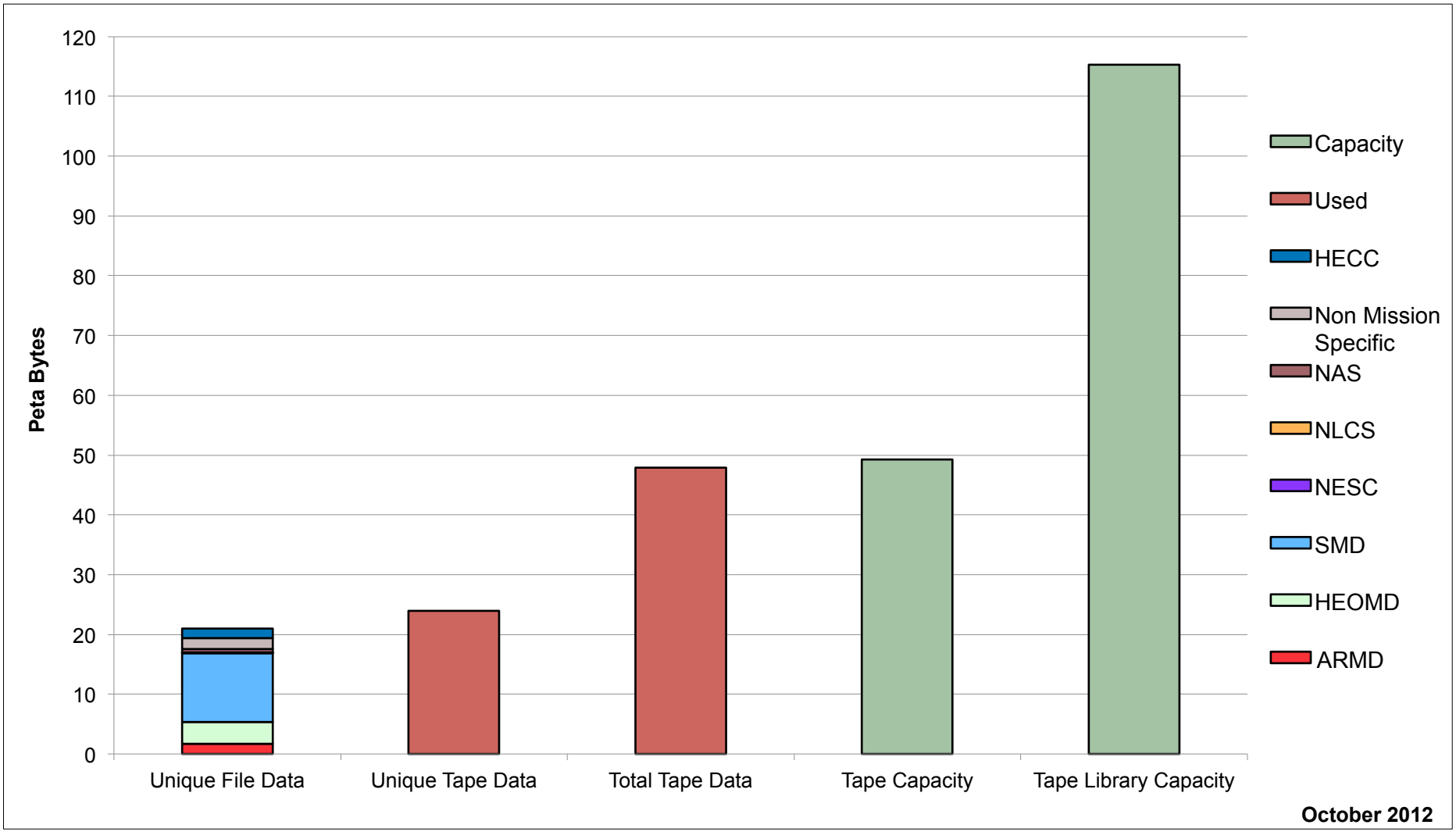






① Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD ② 14 Westmere racks added
③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed ⑤ 24 Sandy Bridge racks added

Tape Archive Status



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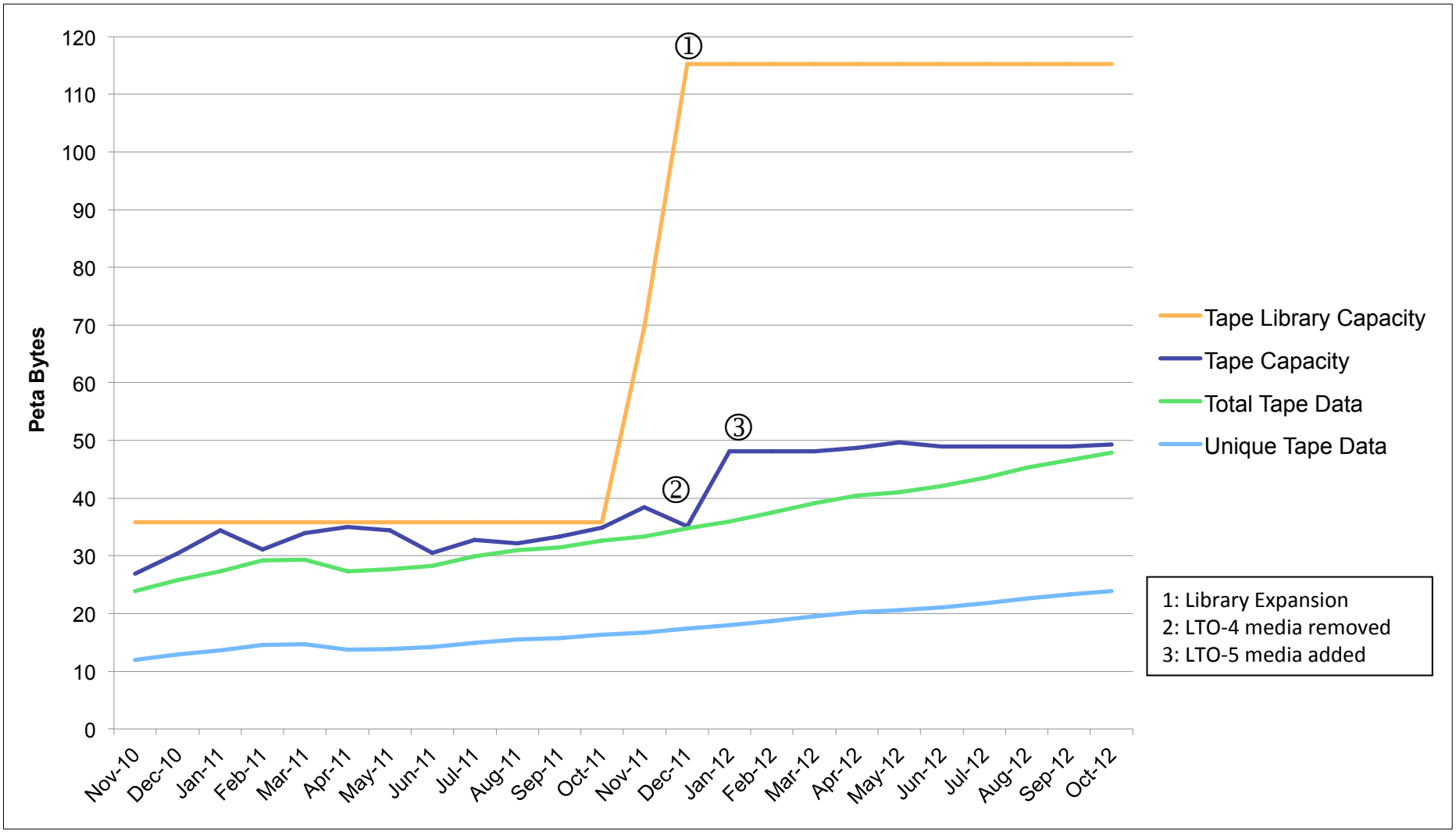
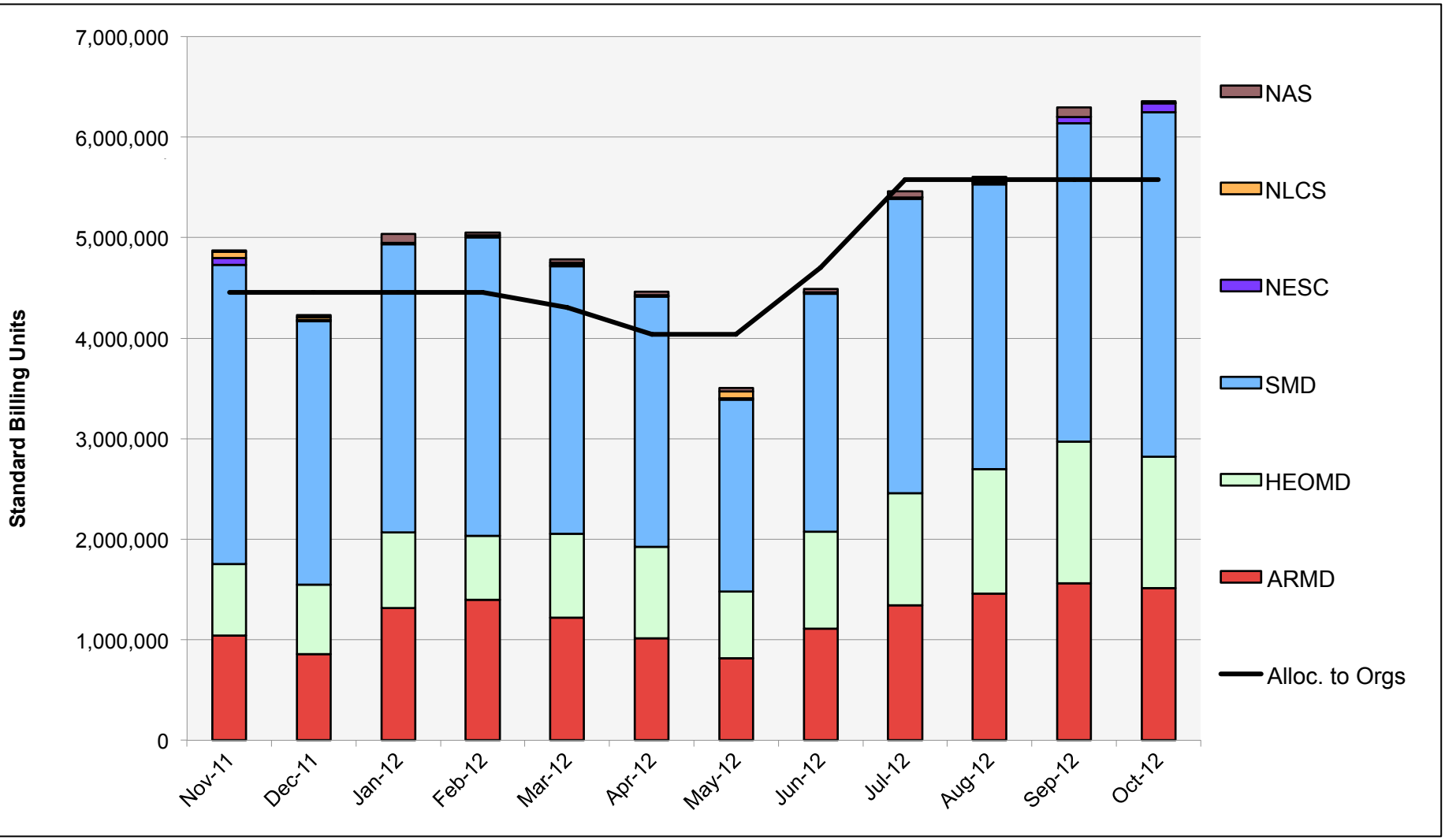
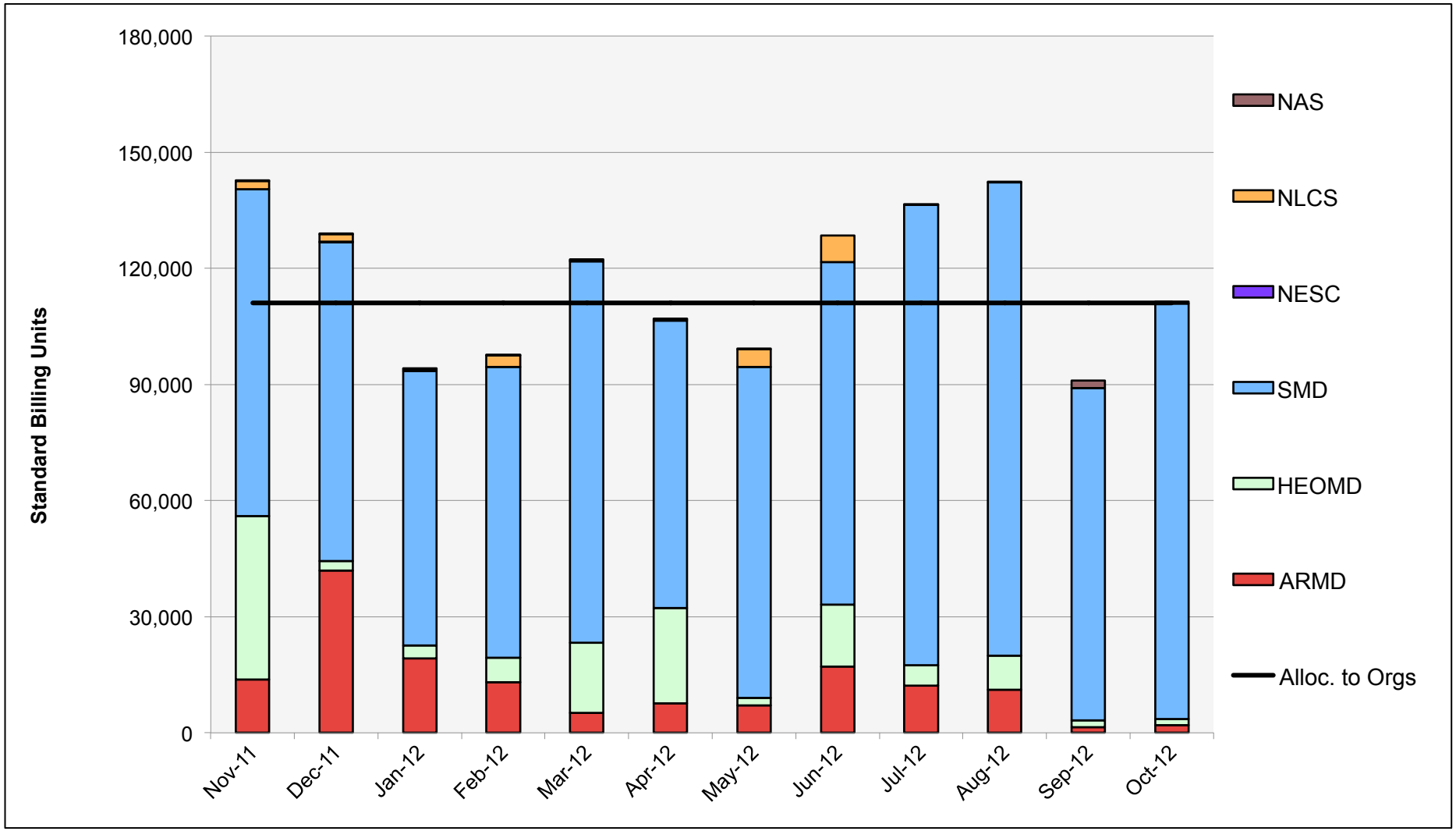


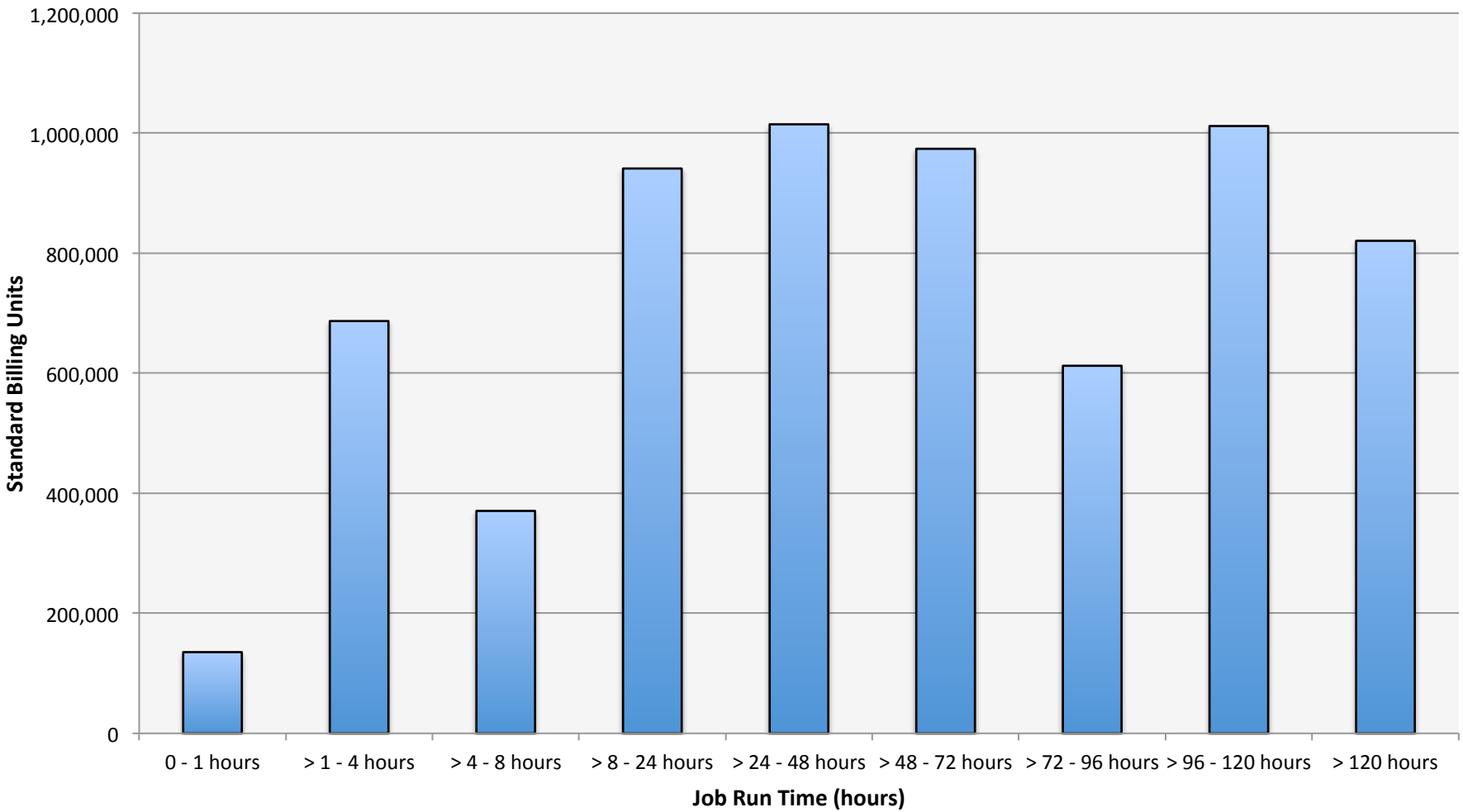
Pleiades:
SBUs Reported, Normalized to 30-Day Month



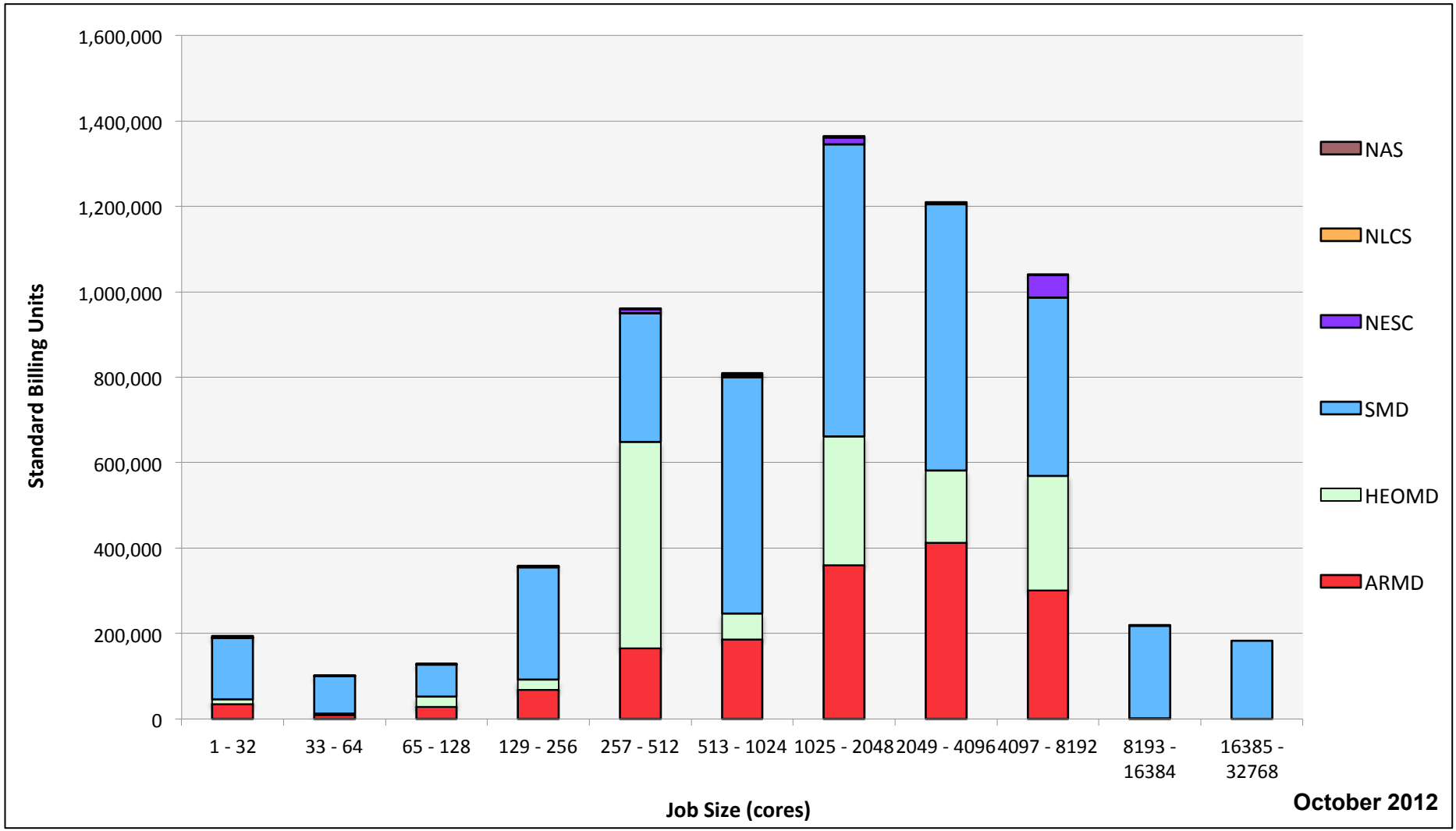
Pleiades:
Devel Queue Utilization



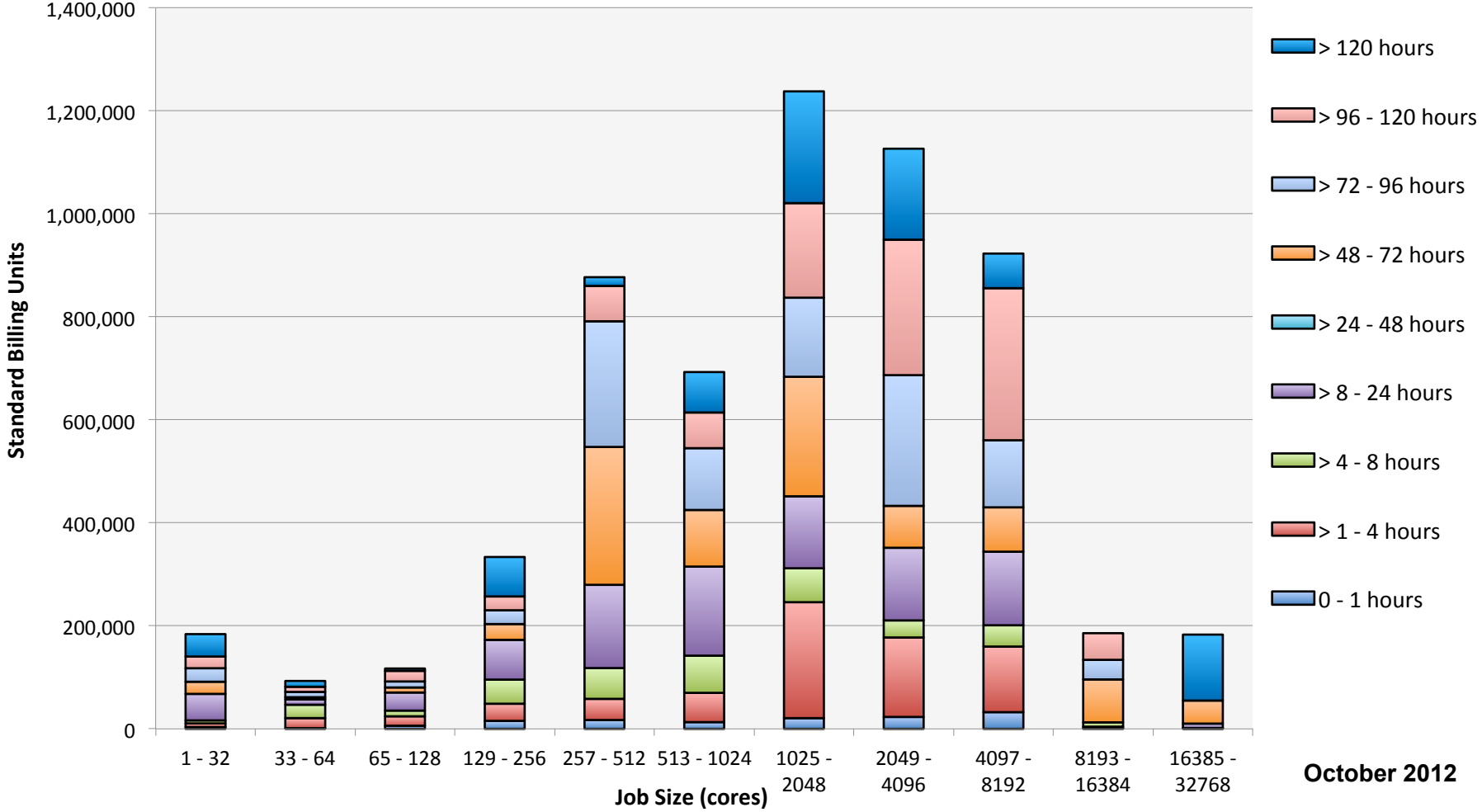
Pleiades:
SBUs Reported, Normalized to 30-Day Month



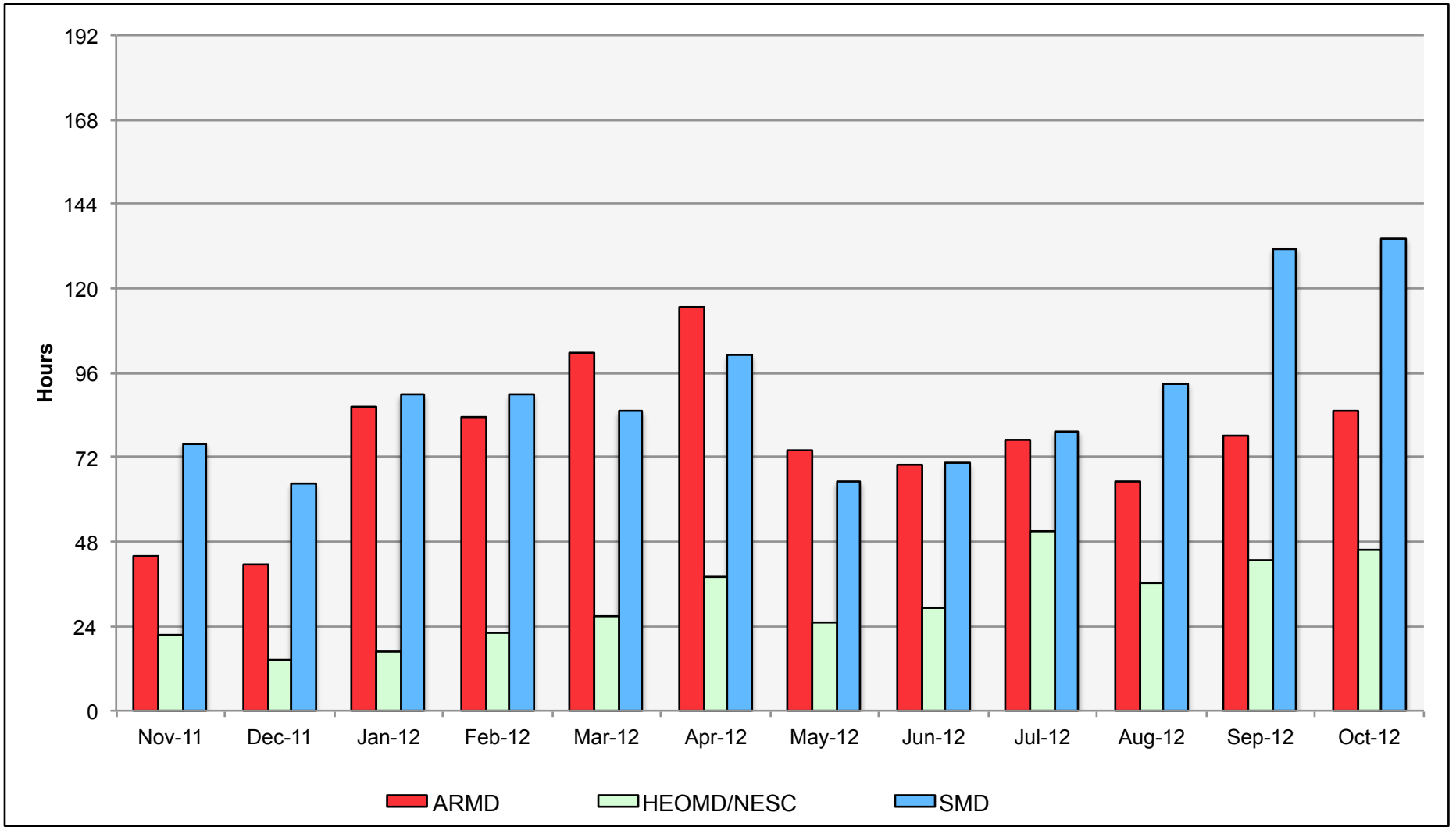
Pleiades:
Monthly Utilization by Size and Mission



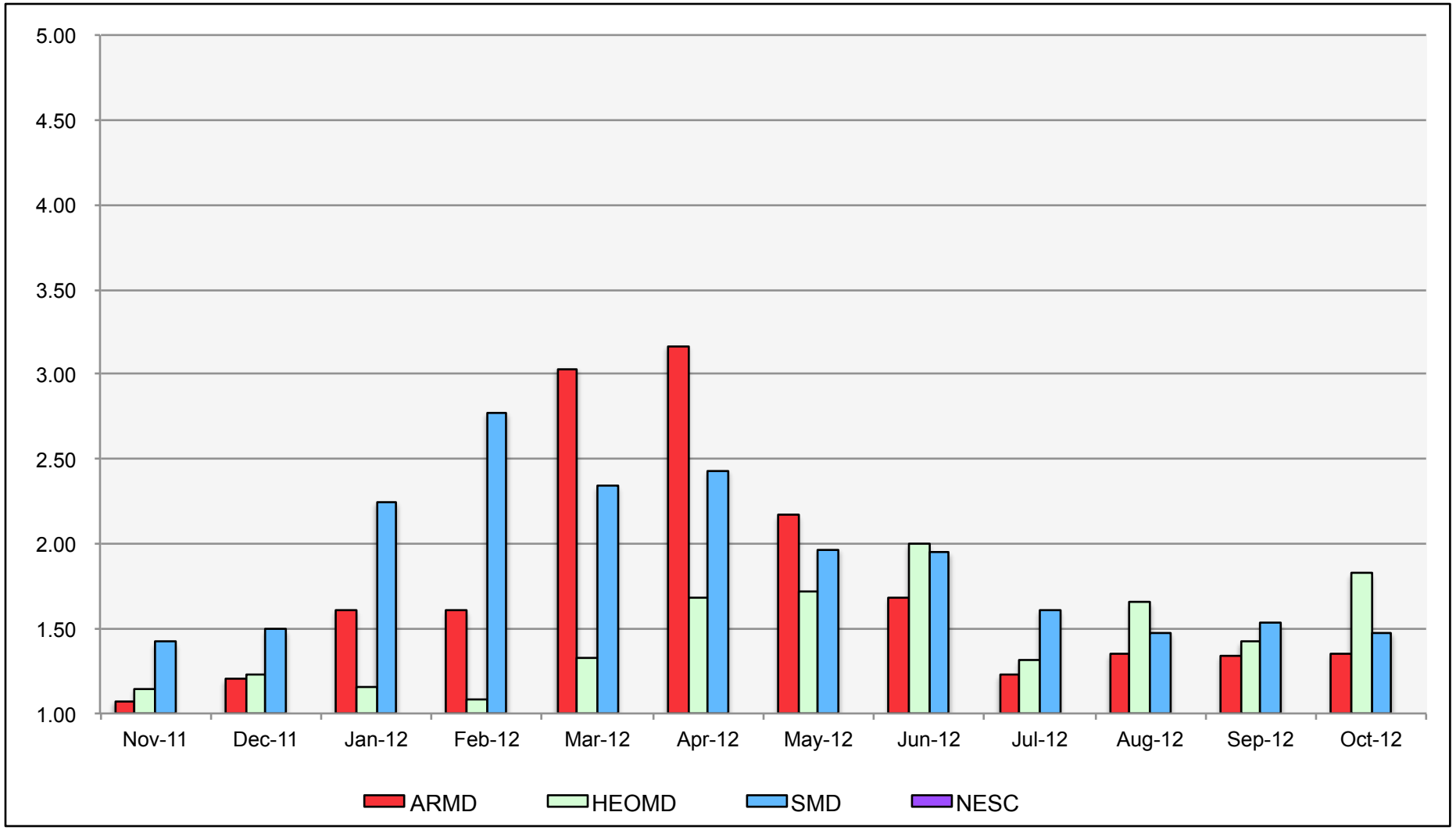
Pleiades:
Monthly Utilization by Size and Length



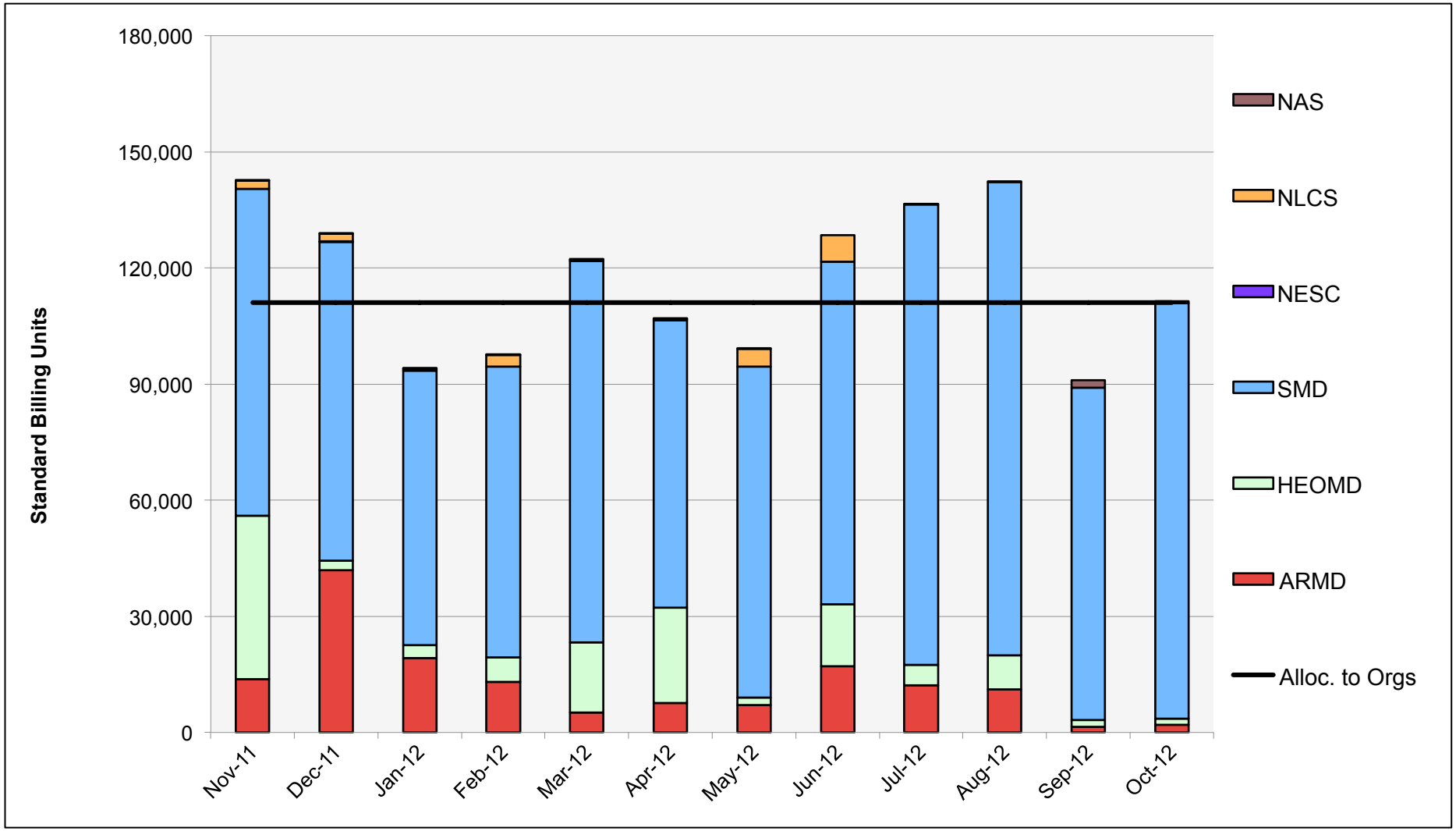
Pleiades:
Average Time to Clear All Jobs



Pleiades:
Average Expansion Factor



Columbia:
SBUs Reported, Normalized to 30-Day Month



Columbia:
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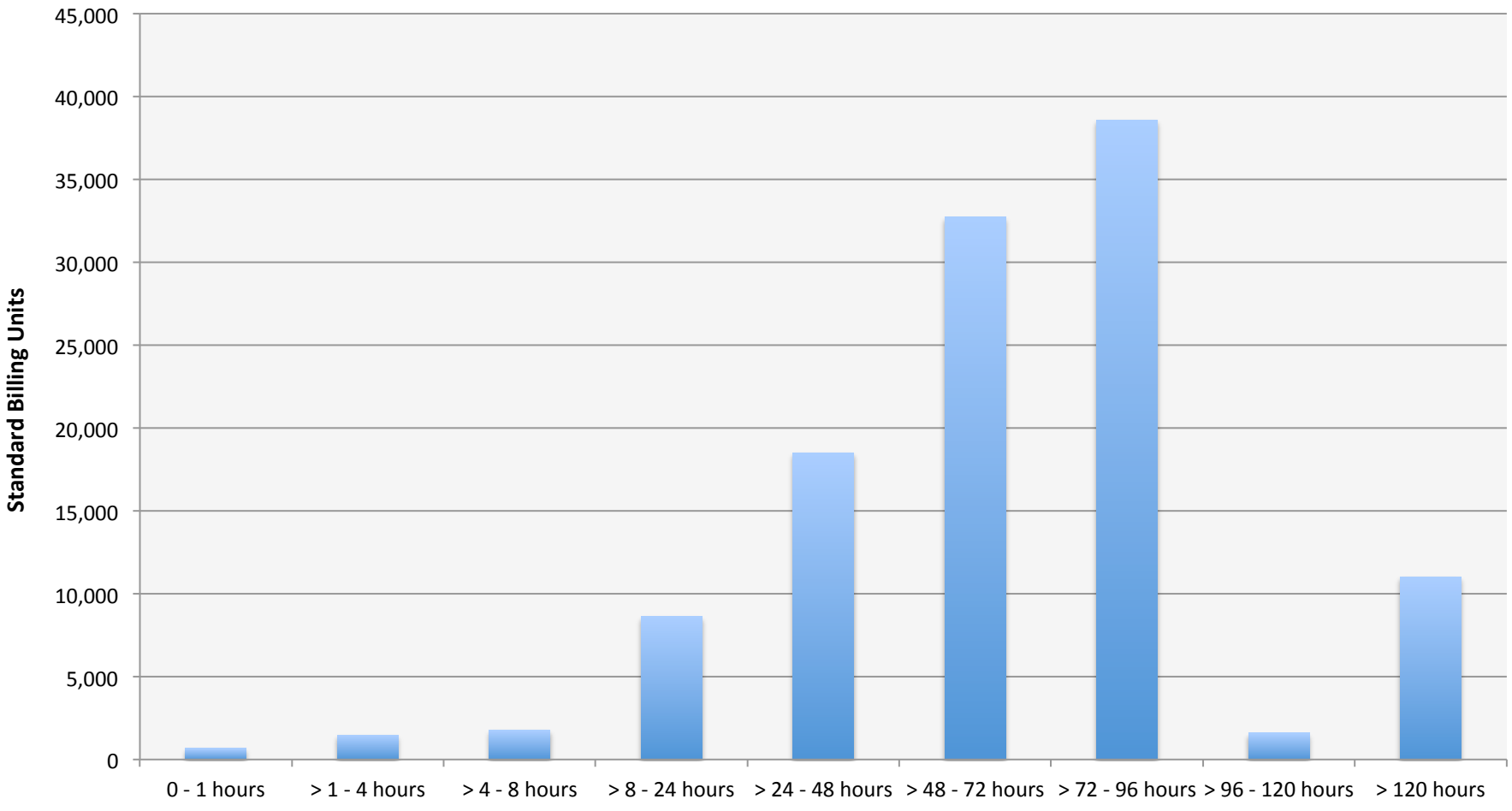
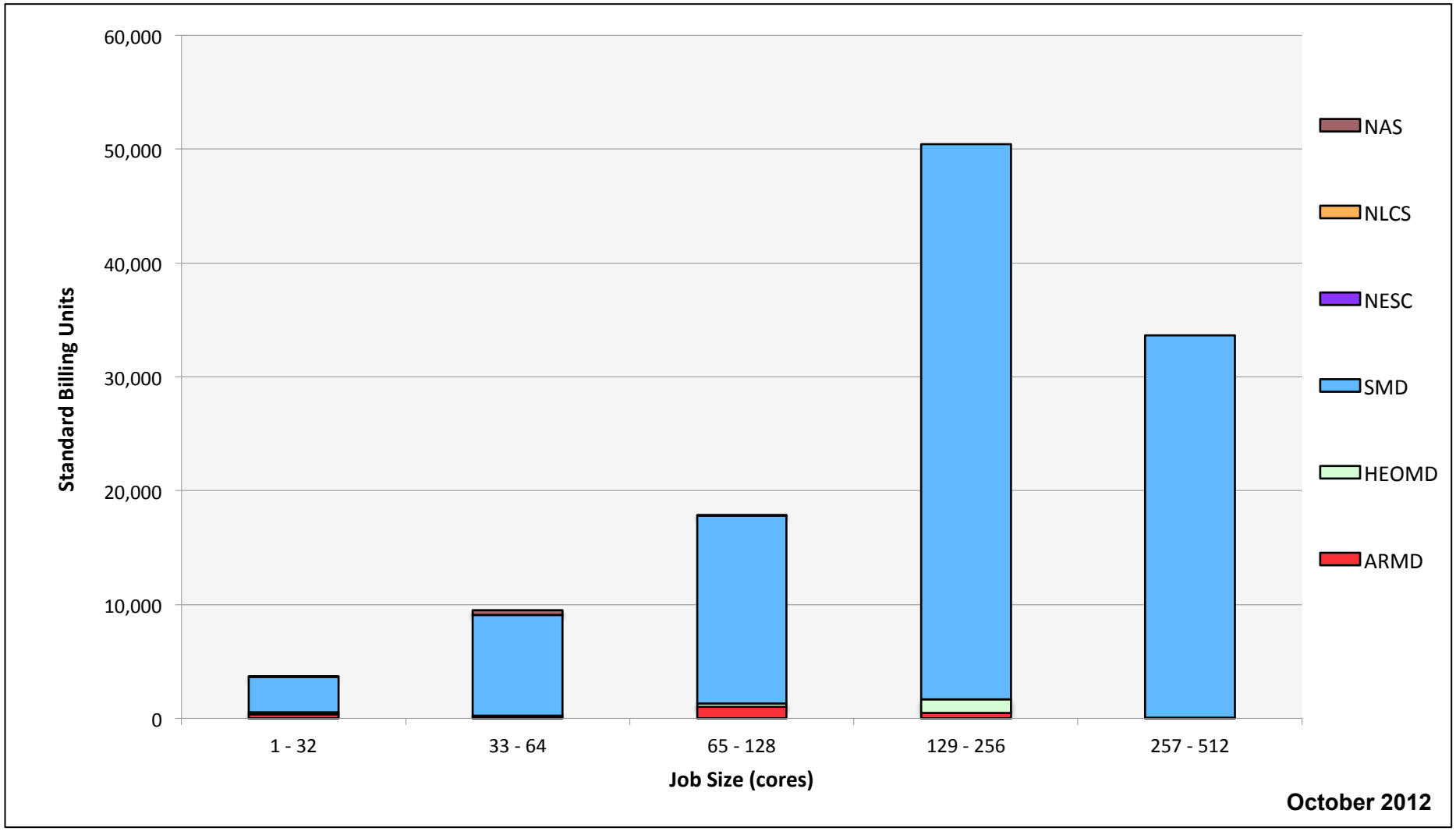
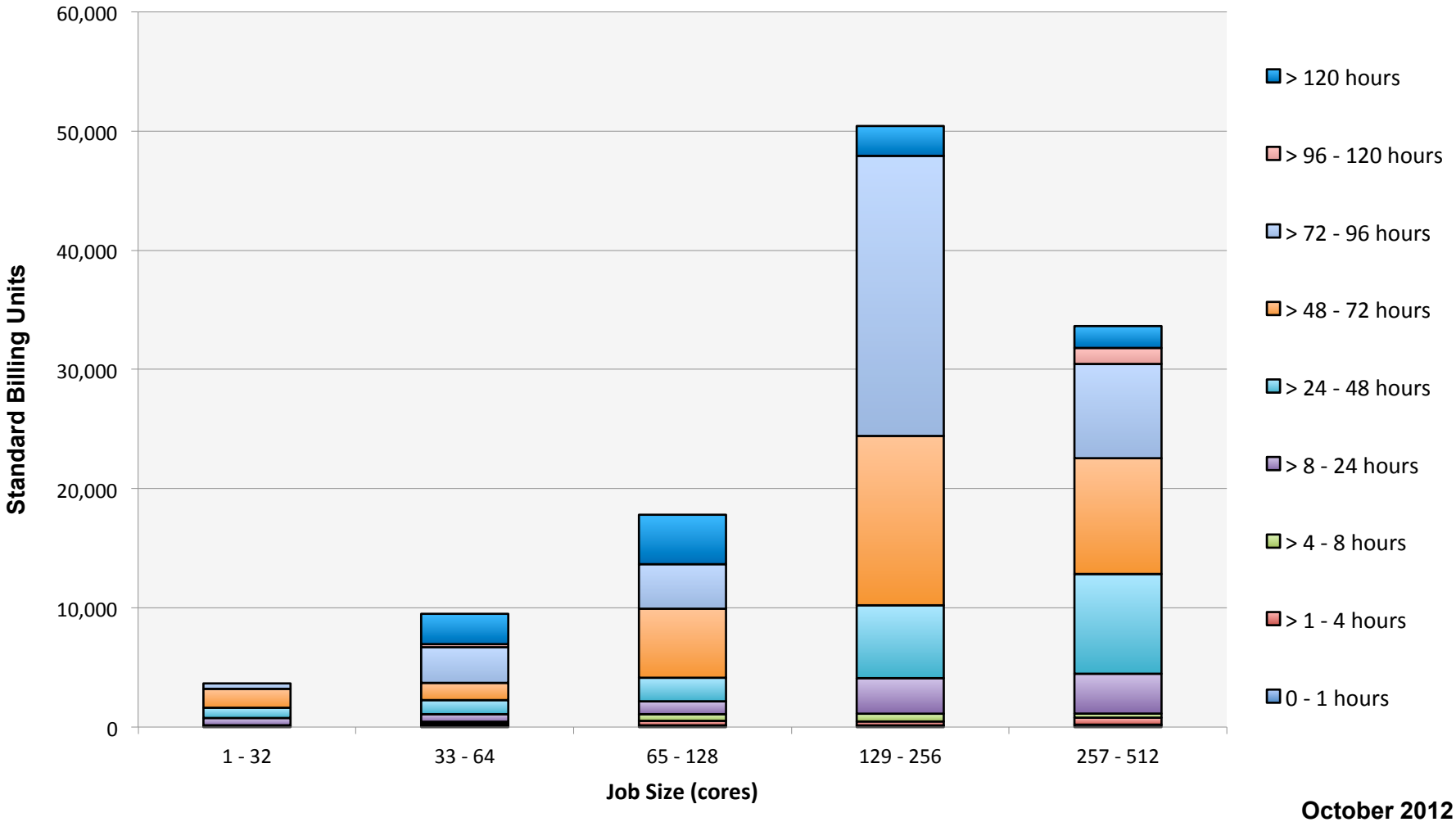


Columbia:
Monthly Utilization by Size and Mission



Columbia:
Monthly Utilization by Size and Length



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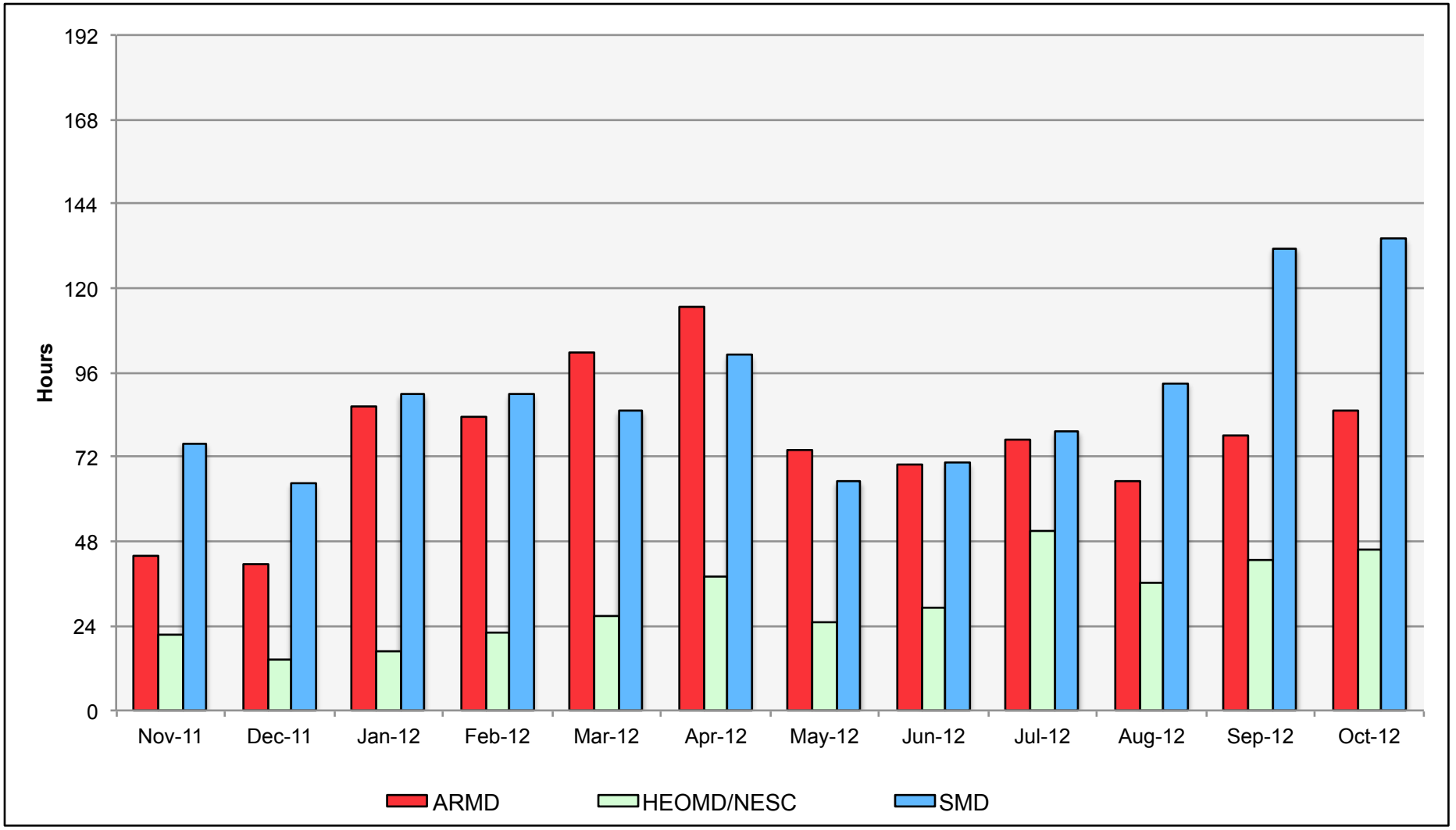

Columbia:
Average Expansion Factor