TENNESSEE'S AEROSPACE AND DEFENSE CLUSTER

TN Department of Economic & Community Development

Center for Economic Research in Tennessee (CERT)

Authored by

John Patten, Research Analyst
Jeremy Stiles, Research Manager
Sally Avery, Director of the Center for
Economic Research in Tennessee (CERT)

CENTER FOR ECONOMIC RESEARCH IN
TENNESSEE (CERT)
Tennessee Department of Economic and
Community Development
312 Rosa L. Parks Avenue
Nashville, Tennessee 37243
Phone: (615) 741-1888
TNECD.com

For questions, please contact Sally Avery, Director of the
Center for Economic Research in Tennessee (CERT)
sally.avery@tn.gov, 615-979-6064

August 2018

Contents

Introduction

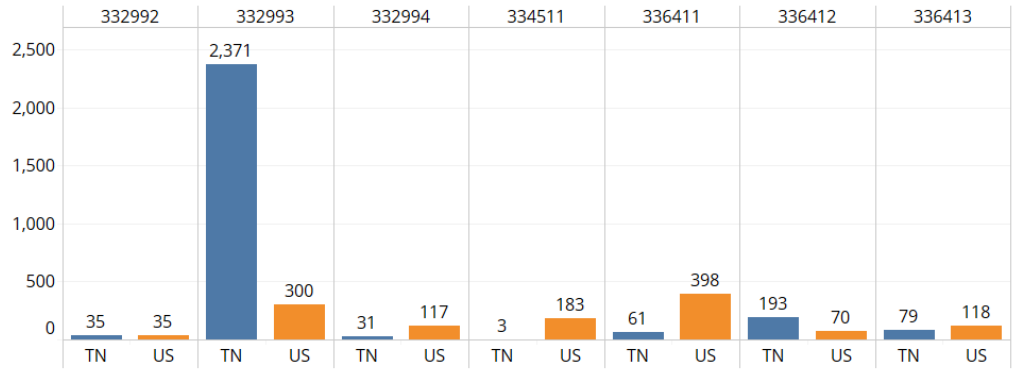
Tennessee's aerospace and defense cluster encompasses a wide range of manufacturing and service industries. Establishments in these industries produce everything from aerospace parts and helicopters to handguns and uranium for nuclear weapons. Tennessee ranks highly in weapons production, particularly ammunition manufacturing and small arms manufacturing. Tennessee's employment concentration in ammunition manufacturing (17.94) is the highest in the nation, due to the Y-12 National Security Complex in Anderson County. Y-12 is involved with the manufacture, maintenance, and dismantlement of the entire U.S. nuclear arsenal.[1] For small arms manufacturing, Tennessee exported more firearms in 2017 than any state besides Massachusetts.

Today, this cluster has 51 establishments. These establishments employ 7,954 Tennesseans, an increase of roughly 951 jobs since 2013. Nationally, employment in this industry remained stagnant during this time period. Tennessee's largest gains occurred in aircraft manufacturing, in which employment rose from 281 in 2013 to 419 today (a 204% increase). Employment in small arms manufacturing nearly doubled, with employment increasing by 226 jobs.

NAICS	Industry	2018 Employment	Five-Year Growth Rate (2013-2018)	Business Locations	Average Earnings
332993	Ammunition (except Small Arms) Manufacturing	4,778	4%	2	$123,571
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	1,342	(16%)	17	$113,113
336412	Aircraft Engine and Engine Parts Manufacturing	851	111%	4	$91,223
332994	Small Arms, Ordnance, and Ordnance Accessories Manufacturing	465	95%	14	$75,511
336411	Aircraft Manufacturing	419	204%	6	$110,872
332992	Small Arms Ammunition Manufacturing	77	166%	2	$67,986
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	23	44%	6	$98,481

Average establishment size (155 employees) varies substantially across industries. The average size of Tennessee's ammunition manufacturers is 2,389, which is nearly eight times higher than the national average for this industry. Nautical systems manufacturers in Tennessee employ on average only three workers.

Average Establishment Size (by NAICS)



[1] Industry and labor force estimates were obtained from Economic Modeling Specialist's 2018.3 data run.

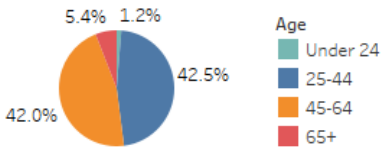
Workforce

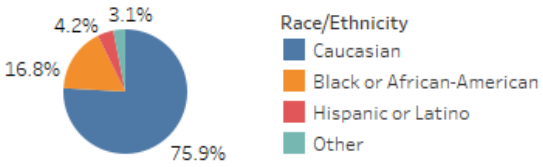
The aerospace and defense cluster in Tennessee includes 236 occupations. Currently, 1.91 million Tennesseans are employed in these occupations. Median hourly earnings in Tennessee for these occupations ($17.34) are $2.41 lower than the national median.

SOC	Industry	2017 Jobs	Median Hourly Earnings
Management Occupations			
11-1021	General and Operations Managers	42,569	$41.19
11-3051	Industrial Production Managers	4,760	$42.53
Business and Financial Operations Occupations			
13-1028	Buyers and Purchasing Agents	8,065	$27.80
Architecture and Engineering Occupations			
17-2112	Industrial Engineers	5,601	$39.26
17-2141	Mechanical Engineers	4,398	$39.76
Sales and Related Occupations			
41-4012	Sales Representatives, Wholesale and Manufacturing	21,544	$24.04
Office and Administrative Support Occupations			
43-5061	Production, Planning, and Expediting Clerks	8,589	$21.43
43-5071	Shipping, Receiving, and Traffic Clerks	18,077	$14.45
Installation, Maintenance, and Repair Occupations			
49-3011	Aircraft Mechanics and Service Technicians	2,053	$27.04
49-9041	Industrial Machinery Mechanics	9,644	$22.42
49-9071	Maintenance and Repair Workers, General	32,875	$17.46
Production Occupations			
51-1011	First-Line Supervisors of Production and Operating Workers	18,291	$25.91
51-2011	Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	320	$13.69
51-2041	Structural Metal Fabricators and Fitters	2,641	$15.23
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	55,846	$15.24
51-4022	Forging Machine Setters, Operators, and Tenders, Metal and Plastic	2,747	$26.01
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders	7,292	$14.49
51-4041	Machinists	7,014	$19.55
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	5,561	$15.15
51-4111	Tool and Die Makers	2,764	$22.13
51-4121	Welders, Cutters, Solderers, and Brazers	8,865	$17.93
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	14,509	$16.44
51-9198	Helpers—Production Workers	21,137	$11.93
51-9199	Production Workers, All Other	9,546	$14.80
Transportation and Material Moving Occupations			
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	90,447	$13.07

Tennessee's workforce is well-positioned to support continued growth in this cluster, particularly in relation to other states. The growth rate of these occupations in Tennessee between 2012 and 2017 (10.8%) exceeded the national average (8.3%). This trend is predicted to continue in coming years. From 2017 to 2022, these occupations will likely grow 6.5% in Tennessee, as compared to only 5.2% nationally. Today, Tennessee has 6% more workers capable of filling these positions than in the average state. Tennessee's educational pipeline is one of the driving forces behind this job concentration within the state. Post-secondary institutions in Tennessee offer 266 programs related to these occupations. In 2017, these 114 institutions produced 31,739 graduates with the educational credentials necessary to pursue a career in these industries.

Demographics of workers in these industries resemble the overall Tennessee workforce except in terms of gender. Males are more predominant in these industries (59.2%) than the average industry in Tennessee (51.9%). Racial and age demographics mirror the broader labor force.





Related Industries

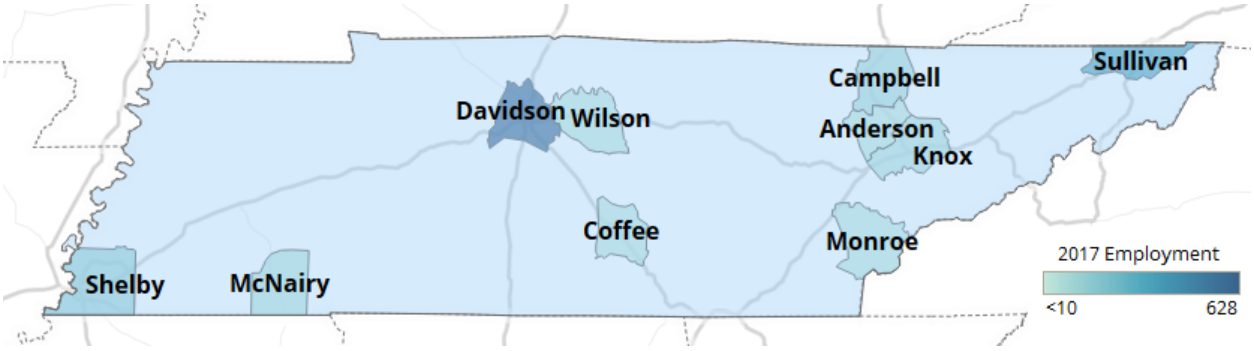
Several companies in Tennessee are closely tied to this cluster but do not explicitly fall within one of the cluster industries. Collectively, these companies employ an additional 1,881 Tennesseans.

Company	NAICS	Industry	City	County
AAR Cargo Systems	488190	Other Support Activities for Air Transportation	Memphis	Shelby
Aces System	334519	Other Measuring and Controlling Device Manufacturing	Knoxville	Knox
Avionics Specialist Inc.	488119	Other Airport Operations	Memphis	Shelby
BAE Systems Ordnance	325920	Explosives Manufacturing	Kingsport	Sullivan
Canberra Industries	334519	Other Measuring and Controlling Device Manufacturing	Oak Ridge	Anderson
Eaton Corporation	336220	Rubber and Plastics Hoses and Belting Manufacturing	Cleveland	Bradley
Kilgore Flares	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	Toone	Hardeman
Memphis Group, Inc.	488190	Other Support Activities for Air Transportation	Memphis	Shelby
Security Signals Inc.	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing	Oakland	Fayette
Universal Technologies	332112	Nonferrous Forging	Estill Springs	Franklin

Aerospace Industries

Other Aircraft Parts and Auxiliary Equipment Manufacturing (NAICS 336413)

Currently, manufacturers of aircraft parts and equipment employ 1,342 Tennesseans at 17 business locations. The size of Tennessee's industry is comparable to most states in the region.[2] Tennessee ranks fifth for employment and fourth for total establishments among Southeast states. Major products produced by this industry include: crop dusting apparatuses, inflight refueling equipment, external fuel tanks, aircraft assemblies and parts, propellers, brakes, wheels, joints, and control surface assemblies.



Davidson County is the leader among Tennessee counties for aircraft component manufacturing. The Triumph Group, one of the industry's largest names, has a location in Nashville. Triumph employs over 14,000 across its 57 locations. The Nashville facility specializes in design, manufacturing, and assembly. Key products made at this facility include aircraft wings, tail sections, and systems integration. The 600+ Triumph employees in Nashville engage in a variety of activities, including structure assembly, machining, and manufacturing of materials like advanced composites and metal bonding.[3]

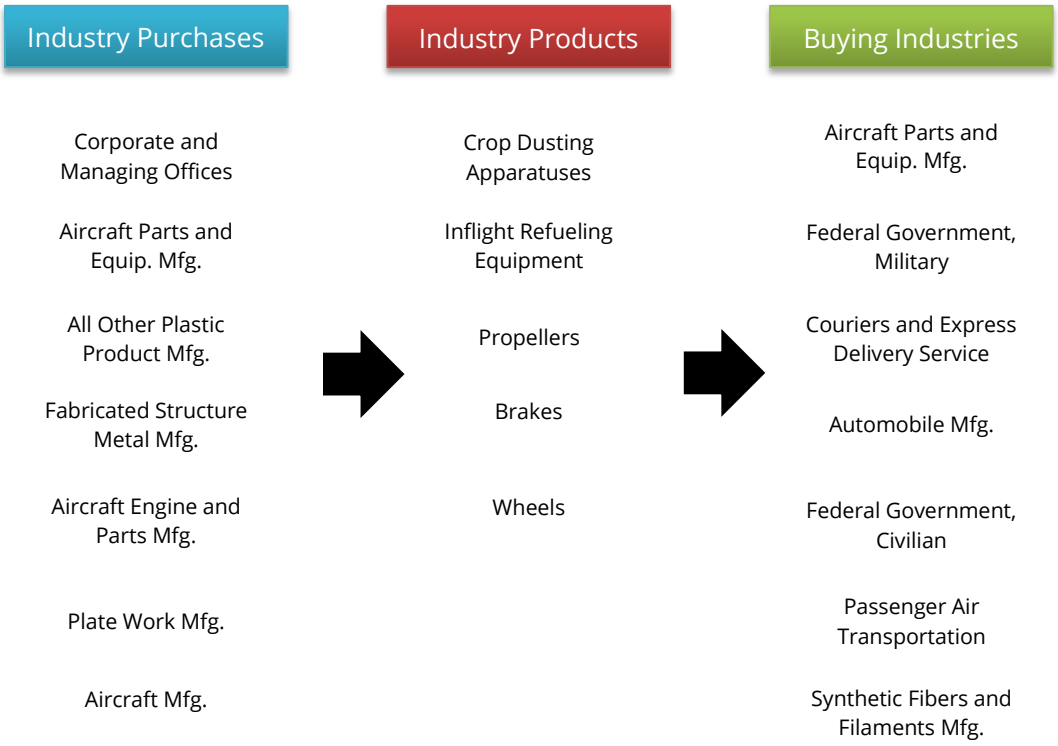
Sullivan County is another important location for this industry in Tennessee. Piney Flats, in particular, has carved out a niche in the helicopter market. Aeronautical Accessories designs and manufactures a wide variety of helicopter accessory products, including landing gear, wheels, skid-gear, vibration monitoring, and voice recorders. Bell Helicopter Textron's facility in Piney Flats creates custom modifications for helicopters, including seating, electronics, and upholstery. Shelby County also has a relatively strong presence in this industry. Float and Fuel Cells, which manufactures aircraft fuel bladders, is based in Memphis.

Average industry wages in Tennessee ($104,064) are the sixth highest nationally and second highest in the region behind North Carolina. The top occupations in this industry include production workers (aircraft assemblers, machinists, CNC tool operators), scientific specialists (industrial engineers, aerospace engineers, software developers), and technicians (aircraft mechanics and service technicians, industrial engineering technicians). In 2016, Tennessee's post-secondary institutions produced 22,258 graduates with the educational certifications necessary to pursue a career in this industry.

[2] The Southeast region includes 12 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

[3] Triumph Group. (2018). *Aerospace Structures – Nashville*. http://www.triumphgroup.com/who-we-are/locations/

This industry has been highly profitable for Tennessee manufacturers. In 2017, manufacturers in the state earned $142.6 million after completing $648.9 million in sales transactions. 89% of these sales were made to out-of-state businesses. Roughly half of materials used by these manufacturers are bought from other businesses in the state (49.1%). Sales between parts and equipment manufacturers were the second highest category of industry purchases during FY2017. 92.1% of these sales were between Tennessee businesses. Parts and equipment manufacturers in Tennessee buy the majority of their engines and engine parts (59.9%) from other in-state businesses. In-state purchases account for a much smaller percentage of other purchase categories: 32.3% for corporate and managing offices, 16.6% for all other plastic products manufacturing, 37.3% for fabricated structural metal manufacturing, 32.9% for plate work manufacturing, and 1.3% for aircraft manufacturing.



Between 2013 and 2018, industry employment in Tennessee decreased by 16% (a net decrease of roughly 250 jobs). Overall, employment in the U.S. grew slightly for this industry. Tennessee also netted a loss of three business locations, while establishments were increasing across the nation. Tennessee's recent struggles to grow this industry were likely due to changes that were occurring in the aerospace industry at this time. Demand for commercial aircraft surged in recent years. Across the world, air travel was increasing due to economic recovery and the emergence of middle classes in non-Western countries. Airlines were replacing their fleets and ordering new equipment. Manufacturers of helicopters did not see a similar growth in demand. Sales to the military and the oil gas industry, the two primary buyers of helicopters, declined substantially.[4] Companies like Bell Helicopter took a substantial hit during this slump.[5] Bell

[4] IBISWorld. (2017). *Gearing up: Increased military spending is expected to augment private sector gains*.
[5] Dallas News. (2016). *Bell Helicopter navigates turbulent times as it marks 65 years in Fort Worth*. www.dallasnews.com/business/business/2016/10/10/bell-helicopter-navigates-turbulent-times-marks-65-years-fort-worth

Helicopter laid off more than 100 workers at its facility in Piney Flats.[6] As a result, employment declined by 115 jobs in Sullivan County.

Even in the commercial airliner market, parts and equipment manufacturers faced formidable new challenges. The aircraft manufacturing industry is now dominated by only a few major manufacturers of commercial airliners. Consolidation of aircraft manufacturers has rippled into the parts and equipment industry. OEMs like Boeing and Airbus are demanding lower prices from their parts suppliers, creating consolidation pressures across the aerospace sub-cluster. In 2013, Boeing demanded price cuts from their suppliers. United Technologies Corp. Aerospace Systems (UTC Aerospace) in Tullahoma was unwilling to meet Boeing's expectations, which resulted in a non-renewal of the Boeing contract. As a result, UTC Aerospace was forced to make lay-offs at their Tullahoma and Smyrna locations.[7] In coming years, parts and equipment manufacturers will likely face the same challenges and opportunities. Demand for air travel is growing, creating revenue opportunities at home and in export markets. However, manufacturers will face increasingly steep competition in the bidding for OEM contracts.[8]

Aircraft Engine and Engine Parts Manufacturing (NAICS 336412)

This industry employs 851 Tennesseans at 4 business locations. This industry produces several kinds of engines, including gasoline engines, internal combustion engines, jet propulsion, rocket engines, and engine prototypes, as well as engine parts and aircraft turbines. Moreover, establishments in this industry perform overhauling and rebuilding of existing product.

Tennessee ranks fourth in the region for this industry. Employment concentration for this industry (0.51) is not as high as other aerospace and defense industries. However, other metrics demonstrate more clearly the strength of this industry in Tennessee. Between 2013 and 2018, Tennessee added 447 net new jobs for a five-year growth rate of 111%. This job creation was the fourth highest in the nation and second in the region behind Florida. Tennessee's growth rate outpaced every state except Colorado and Wisconsin, and the sizes of these states' industries are only a fraction of Tennessee's industry. Lastly, Tennessee achieved this strong growth even as the overall aircraft manufacturing industry in the U.S. stagnated. The five-year growth rate nationally was 0%. Analysts predicted Tennessee's industry to also remain stagnant at this time, yet businesses in the state overcame the challenges that beset regional competitors. Today, more than half of Tennessee's existing industry is directly attributable to Tennessee's advantages in this industry. (Competitive effect explains how much job creation in a geographic area is due to unique characteristics of the area rather than overall growth in the industry or national economy.) This competitive effect is arguably the highest in the nation, when controlling for outliers.[9]

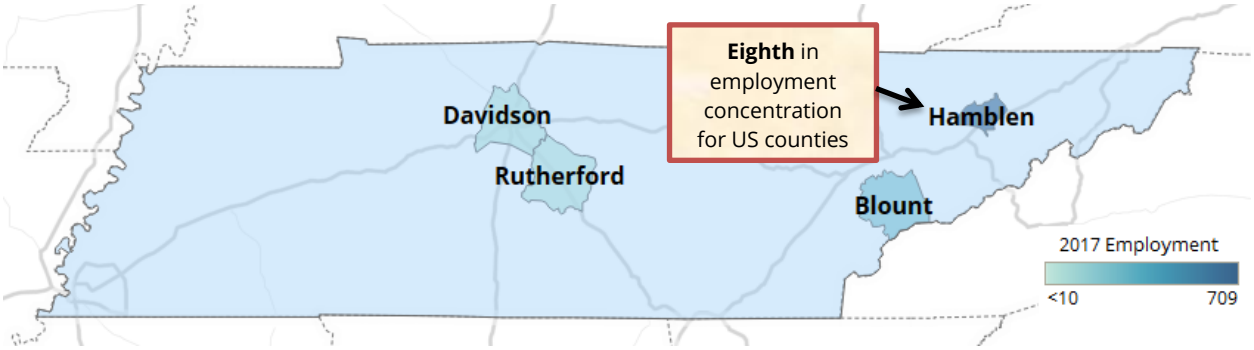
---

[6] WCYB. (Apr. 23, 2018). *Bell Helicopter announces company-wide layoffs, includes Piney Flats facility*. https://wcyb.com/news/local/bell-helicopter-announces-company-wide-layoffs-includes-piney-flats-facility

[7] Lapczynski, K. (2017). *UTC Aerospace to lay off 90*. https://www.tullahomanews.com/news/local/utc-aerospace-to-lay-off/article_ce14fdb4-8cc7-5d07-b6b2-5c0cc3b2f67a.html

[8] IBISWorld. (2017). *Gearing up: Increased military spending is expected to augment private sector gains*.

[9] Three states (Maryland, Colorado, and Wisconsin) demonstrated a stronger competitive effect between 2012 and 2017 than Tennessee. However, none of these states employed more than 200 workers in this industry in 2012, which artificially inflated the competitive effect. It is highly unlikely th
at these states will be able to sustain growth between 250% and 700% as their industries continue to grow. Analysts predict that growth in these states will cool significantly between 2017 and 2022, with Tennessee's growth rate outpacing every state besides Maryland.



Tennessee's largest employer in this industry is Howmet Castings & Services, Inc. (Hamblen), which manufactures aluminum die castings for the aerospace industry. Howmet is a subsidiary of Arconic, one of the world's top alumina producers. The Morristown facility has been operational for more than 30 years and specializes in turbine components, like ceramic cores used for cooling turbine airfoils. The other large employer in Tennessee is Blount County's Standard Aero, Inc. The company provides two main types of services: maintenance, repair, and overhaul (MRO) services and operational redesigns. Standard Aero, which is headquartered in Canada, has numerous facilities in North America and several other international locations.

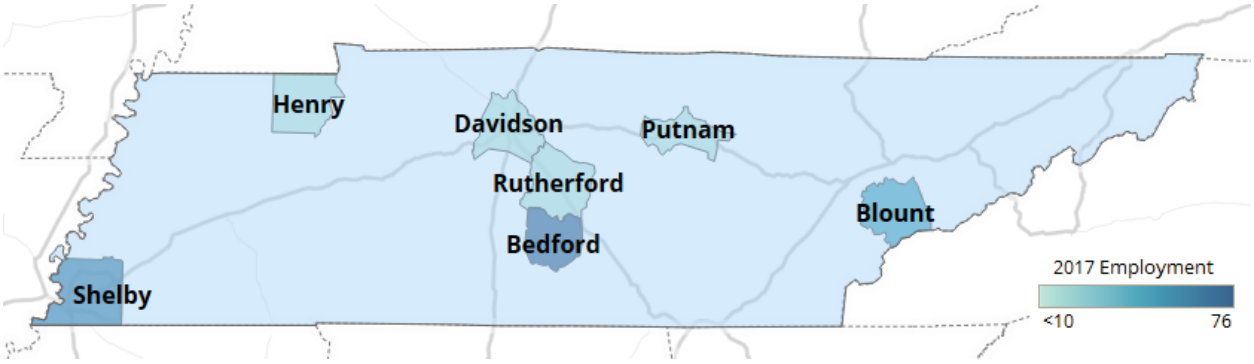
Average wages for this industry in Tennessee are $83,925. In 2017, Tennessee businesses earned $65.4 million, with $325.7 million in total sales. 77% of these sales were transacted with businesses outside Tennessee. Many of the purchases made by Tennessee's manufacturers were also out-of-state. Tennessee manufacturers tend to rely on neighboring states for purchases of search, detection, and navigation instruments (99.7% out-of-state), aircraft manufacturing (98.0%), and aircraft parts and auxiliary equipment (81.6%). Other purchase types tended to be acquired from in-state suppliers, including iron and steel forging and purchases between engine and engines parts manufacturers.

Industry Purchases	Industry Products	Buying Industries
Aircraft Engine and Engine Parts Mfg.	Aircraft Engines	Aircraft Engine and Engine Parts Mfg.
Corporate and Managing Offices	Aircraft Turbines	Other Aircraft Part and Equip. Mfg.
Search and Navigation Instrument Mfg.	Rebuilding and Overhaul Services	Federal Government, Military
Other Aircraft Part and Equip. Mfg.		Physical, Engineering, and Life Sciences R&D
Iron and Steel Forging		Federal Government, Civilian
Iron and Steel Mills and Ferroalloy Mfg.		Aircraft Mfg.
Wholesale Trade Agents and Brokers		Other Engine Equip. Mfg.

Tennessee enjoys several advantages in this industry, including favorable tax policies and right-to-work laws. Another advantage is the average establishment size in Tennessee for this industry. Tennessee only has four establishments, but the average size is 213 employees per business location. Tennessee ranks sixth in the nation for this metric. The average size has grown considerably in the last few years. In 2013, Tennessee's six establishments employed 67 workers on average. This overarching trend– employment growth and establishment consolidation leading to fewer yet larger manufacturers– puts Tennessee manufacturers at a competitive advantage over regional competitors. In today's aerospace industries, establishment size matters greatly for profitability. Companies with economies of scale are best positioned to secure long-term contracts.[10] States like Colorado and Wisconsin, which notched slightly higher growth rates than Tennessee in recent years, are seeing an expansion in establishment number as well. This employment growth might be a hollow victory for these regions if these companies struggle to remain competitive in the long-term. Moreover, Standard Aero is one of the leaders in aircraft MRO. Demand for these services, and aftermarket services more generally, will grow from increased air travel and fleet modernization.[11]

Aircraft Manufacturing (NAICS 336411)

This industry is currently one of the smallest in Tennessee's cluster. Major industry products are complete aircraft and aircraft prototypes. This industry also includes businesses that perform full rebuilds or overhauls of existing aircraft. Tennessee's six aircraft manufacturers employ 419 workers, a net increase of 281 jobs since 2013. Tennessee has yet to grow employment in this industry to the extent of other states, as demonstrated by the current location quotient (0.09).



Although not highly ranked, this industry provides real value to Tennessee. Average wages in Tennessee for aircraft manufacturing ($102,002) are strong compared to the state's average salary ($56,526). Key occupations include aircraft, structures, rigging, and systems assemblers; industrial engineers; inspectors, testers, samplers, sorters, and weighers; layout workers, metal and plastic; coating, painting and spraying machine setters, operators, and tenders. In 2017, Tennessee businesses earned $39.1 million after $170.8 million in sales (38% of which were made to other Tennessee businesses). The primary buying industries for aircraft manufacturing are the military, courier services, and other aircraft manufacturers.

[10] IBISWorld. (2017). *Gearing up: Increased military spending is expected to augment private sector gains*.
[11] IBISWorld. (June 2018). *Clear skies: Increased air travel and aircraft use will raise demand for industry services*.

Other Industries

Tennessee has some aerospace assets that provide great value to the state but are not technically part of this traded cluster. For example, Tennessee is home to the Arnold Engineering Development Complex (AEDC), located at the Arnold Air Force Base in Tullahoma. [12] AEDC is the world's largest flight simulation facility and has provided testing for nearly all high-performance aircrafts and missile systems used by the U.S. Department of Defense. 14 of the 27 simulations currently housed at AEDC are not available anywhere else in the world. AEDC also operates 55 wind tunnels, test cells for rocket and turbine engines, and other units.

The aerospace sub-cluster also encompasses some industries in which Tennessee has little to no employment at the current time. (Nautical system and instrument manufacturing employs 21 Tennesseans at 6 establishments, while the other three industries have no presence in the state.) Growth of these industries would provide value to the overall cluster if Tennessee succeeds in attracting and retaining these businesses.

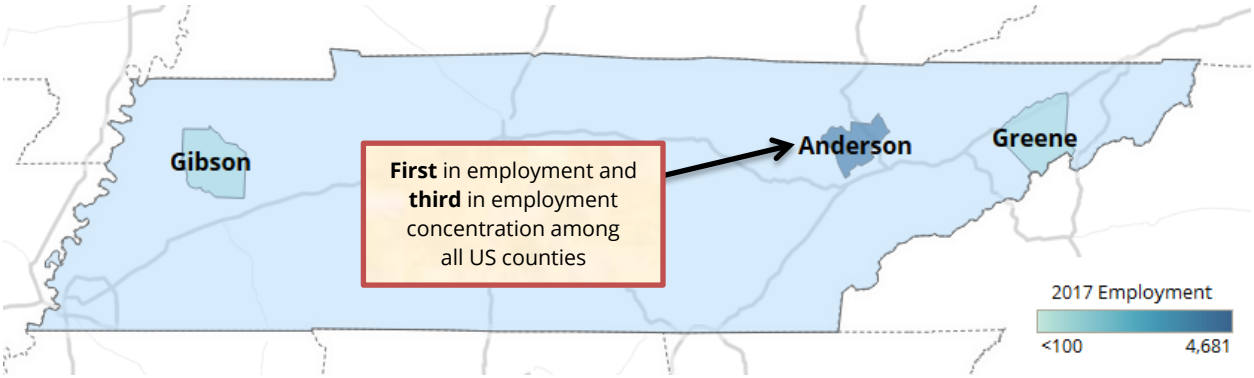
NAICS	Industry	Employment		Business Locations		Average Earnings	
		Regional	US	Regional	US	Regional	National
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	15,240	120,895	199	1,011	$127,839	$134,818
336414	Guided Missile and Space Vehicle Manufacturing	9,496	58,652	62	150	$152,702	$166,496
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	3,422	9,940	25	58	$121,426	$122,199
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	1,373	5,467	9	60	$118,748	$125,457

[12] Traded clusters are defined as "groups of related industries that serve markets beyond the region in which they are located" (Cluster Mapping Project, 2018). Branches of the U.S. military or government-operated national security establishments are not part of traded clusters. The key exception would be military establishments that are managed by government sub-contractors, such as Consolidated Nuclear Security, LLC. This company manages the Y-12 National Security Complex as part of a DOD contract.

Defense Industries

Ammunition Except Small Arms Manufacturing (NAICS 332993)

With total employment of 4,778, Tennessee's ammunition manufacturing industry is the largest in the nation. Tennessee's employment concentration in this industry (17.94) also ranks first in the nation. Establishments in this industry manufacture miscellaneous types of ammunition, like bombs, depth charges, non-guided rockets, grenades, mines, and torpedoes.[13]



Nearly all of Tennessee's employment is located at the Y-12 National Security Complex in Anderson County. Y-12 is not only the largest industry location in the United States. It plays a vital role in maintaining our nation's nuclear deterrent.

Built in 1943 as part of the Manhattan Project, Y-12 is the only manufacturer of enriched uranium nuclear weapons components in the United States. Y-12 has a hand in manufacturing, maintaining, or dismantling every weapon in the nuclear arsenal.[14] Key responsibilities include:

- Production of weapons components
- Recycling and refurbishing old components into new subassemblies
- Assessing the effectiveness of stockpiled weapons
- Dismantling weapons and storing nuclear materials

Y-12's responsibilities extend beyond maintaining the nuclear stockpile. The Navy uses enriched uranium from Y-12 for reactors on its nuclear-powered aircraft, submarines, and carriers. Y-12 provides the National Guard with equipment to protect against radiological attack. Y-12 assists the National Nuclear Security Administration (NNSA) and other federal agencies in keeping nuclear materials secure both at home and abroad.

Y-12 works closely with the Texas-based Pantex Plant, a primary location for nuclear weapons assembly in the US. Pantex and Y-12 comprise the NNSA Production Office (NPO), which is managed and operated by Consolidated Nuclear Security LLC as part of a contract with the Department of Energy.[15] This company, based in Oak Ridge, is a joint effort between Bechtel National, Leidos, Orbital ATK, and SOC LLC.

---

[13] United States Census Bureau. (2017). *332993 Ammunition (except Small Arms) Manufacturing*. https://www.census.gov/cgi-bin/sssd/naics/naicsrch

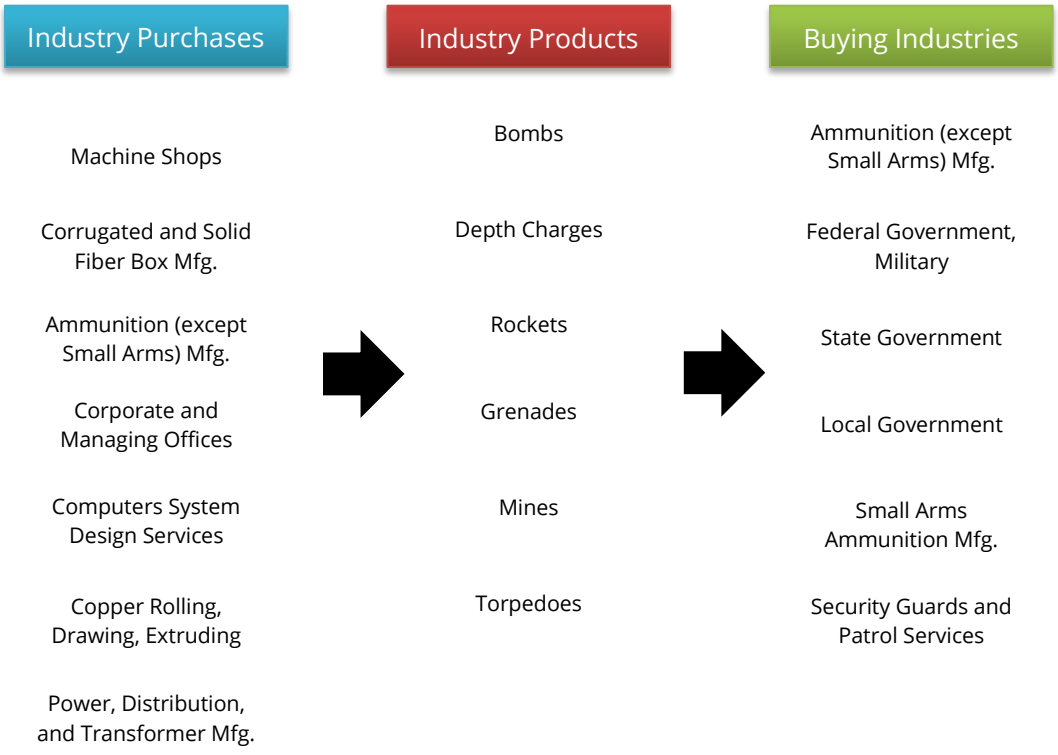
[14] Department of Energy, *About Y-12.* (2016). https://www.y12.doe.gov/sites/default/files/assets/document/ygg-14-0371r3_about_y12.pdf

[15] Department of Energy, *NNSA Production Office Contract*. https://www.energy.gov/nnsa/nnsa-production-office-contract

Tennessee has two other establishments in this industry. Delfasco, headquartered in Afton, manufactures products and provides custom metal fabrication and forging for the U.S. Armed Forces. Delfasco is an industry leader in the manufacturing of practice bombs. For decades, the company has been the exclusive supplier of BDU-33 and MK76 practice bombs to the Navy and Air Force.[16] American Ordnance, a Day & Zimmerman subsidiary based in Milan, manufactures medium to large caliber ammunition as well as explosives. The company's primary customers include the Department of Defense and defense subcontractors. American Ordnance also provides specific ammunition-related services, including modification, maintenance, and disarmament.

Average earnings in this industry in Tennessee are $113,685. Tennessee ranks second in the nation for average industry wages (when adjusting for cost-of-living differences). Key occupations include team assemblers; machinists; welders, cutters, solderers, and brazers; first-line supervisors of production and operating workers; and inspectors, testers, sorters, samplers, and weighers.

In 2017, Tennessee businesses earned $539.6 million after completing $2.1 billion in total sales. 96% of these sales were made to establishments outside Tennessee. Most purchases made by Tennessee manufacturers were from suppliers outside the state: machine shops (81.1% out-of-state), corrugated and solid fiber box manufacturing (90.7%), corporate, subsidiary, and regional managing offices (89.9%), computer systems design services (74.1%), and copper rolling, drawing, extruding, and alloying (94.0%). Many of these purchases were from small suppliers. Consolidated Nuclear Security has been recognized for its support of small businesses. In FY2016, the company had the highest percentage of purchases from small businesses (67%) of any DOE subcontractor.[17]



[16] Delfasco. *About Us.* *http://www.delfasco.com/docs/Corporate%20Profile.pdf*

[17] Department of Energy. (2017). *Consolidated Nuclear Security, LLC honored for small business achievement*. https://www.y12.doe.gov/news/press-releases/consolidated-nuclear-security-llc-honored-small-business-achievement

Establishments in this industry face unique challenges and opportunities based on the type of weapon being produced. Job losses were contained to ordnance manufacturing in Gibson County. Milan lost nearly 500 industry jobs due to significant downsizing at American Ordnance and the closure of Esterline Defense Solutions. Elsewhere in the state, employment grew. Anderson County added more than 200 net new jobs, and Greene County had virtually the same level of employment in 2018 as in 2013.

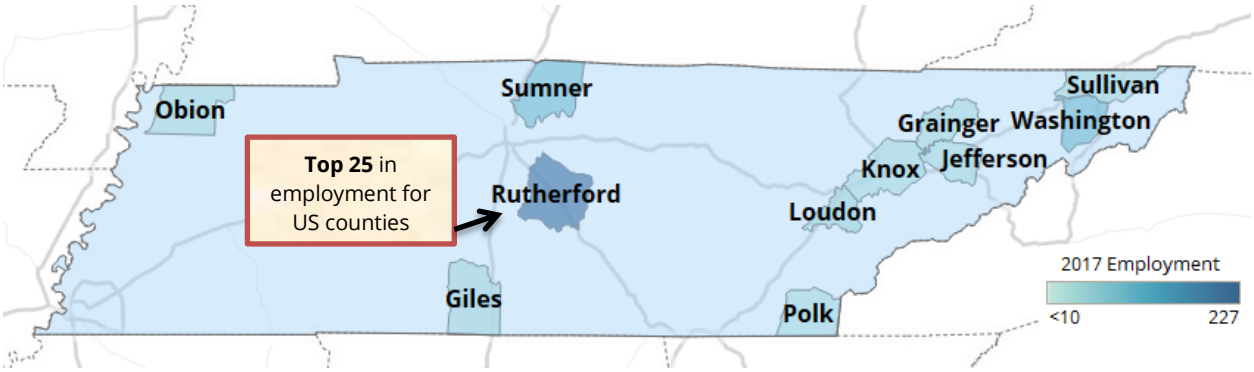
Despite these job losses, Tennessee achieved stronger job retention than most states. The five-year growth rate was -18% nationally. Consolidation of employment and manufacturing locations has been a driving trend in this industry. Companies pursued consolidation in response to declining defense spending. For example, Esterline Defense Solutions cited these struggles in its decision to consolidate the Milan operations into its Camden, AR facility.[18] Employment is expected to increase in coming years. Employment growth will be driven by an uptick in defense spending, growing usage of munitions by the U.S. in its Middle East campaigns, and heightened exports. Geopolitical instability in areas around the world has created new markets for Tennessee manufacturers to target.[19]

Tennessee was predicted to lose 919 jobs between 2013 and 2018 due to overall industry declines. Tennessee's actual job losses were much less severe, demonstrating a strong competitive effect in this industry. This advantage over other states is likely attributable to the Y-12 Security Complex, which does not compete with other manufacturers. The Trump administration's call to modernize and rebuild the U.S. nuclear arsenal should result in greater activity at the Y-12 facility. The FY2019 defense budget allocated several billion dollars towards development of the nuclear-capable B-21 bomber, replacement of the Air Force's Minuteman III ICBM system, refurbishment of the W80-4 warheads, as well as other nuclear programs.[20]

Small Arms, Ordnance, and Ordnance Accessories Manufacturing (NAICS 332994)

Tennessee's small arms and ordnance manufacturing industry employs 465, a net increase of 226 jobs since 2013. This nearly two-fold increase in employment substantially exceeded national and regional changes in this industry during this time. Today, Tennessee has 14 manufacturers in this industry. The location quotient for this industry (1.07) shows that Tennessee's employment concentration in this industry is comparable to that of the average state. Businesses in this industry produce a wide range of weaponry. Major product categories include firearms (rifles, shotguns, pistols, machine guns, carbines, revolvers), military artillery (aircraft artillery, antiaircraft artillery, field artillery, tank artillery), mortars and projectors, cannons, rocket launchers, flame throwers, turrets, air guns (BB guns, pellet guns, dart guns), and miscellaneous equipment (clips, cleaning kits, gun barrels).

[18] Esterline. (2014). *Munitions Executive Summit*. https://ndiastorage.blob.core.usgovcloudapi.net/ndia/2014/munitions/Brandt.pdf
[19] IBISWorld. (Feb. 2018). *On target: Increased demand from the defense market will boost industry revenue.*
[20] Bipartisan Budget Act of 2018. https://www.congress.gov/bill/115th-congress/house-bill/1892/text



Tennessee has three major establishments in this industry, two of which are small arms manufacturers. Barrett Firearms, headquartered in Murfreesboro, manufactures large-caliber rifles at its Christiana location. The company is considered one of the world's finest small arms manufacturers, winning numerous accolades since its formation in 1982. In 2005, the U.S. Army included Barrett's .50-caliber M107 rifles in its list of ten greatest inventions for soldiers. Tennessee's official state rifle is the Barrett Model 82. Today, the company continues to offer a diverse portfolio of rifles while exporting its product across the globe. Tennessee is also home to Beretta USA's manufacturing and engineering center. Beretta, an Italian-owned arms manufacturer, announced in 2014 that it was relocating its Maryland operations to Gallatin, Tennessee. The facility currently employs more than 100 workers, and Beretta continues to expand production as it works toward its goal of manufacturing 500,000 firearms in Gallatin per year.

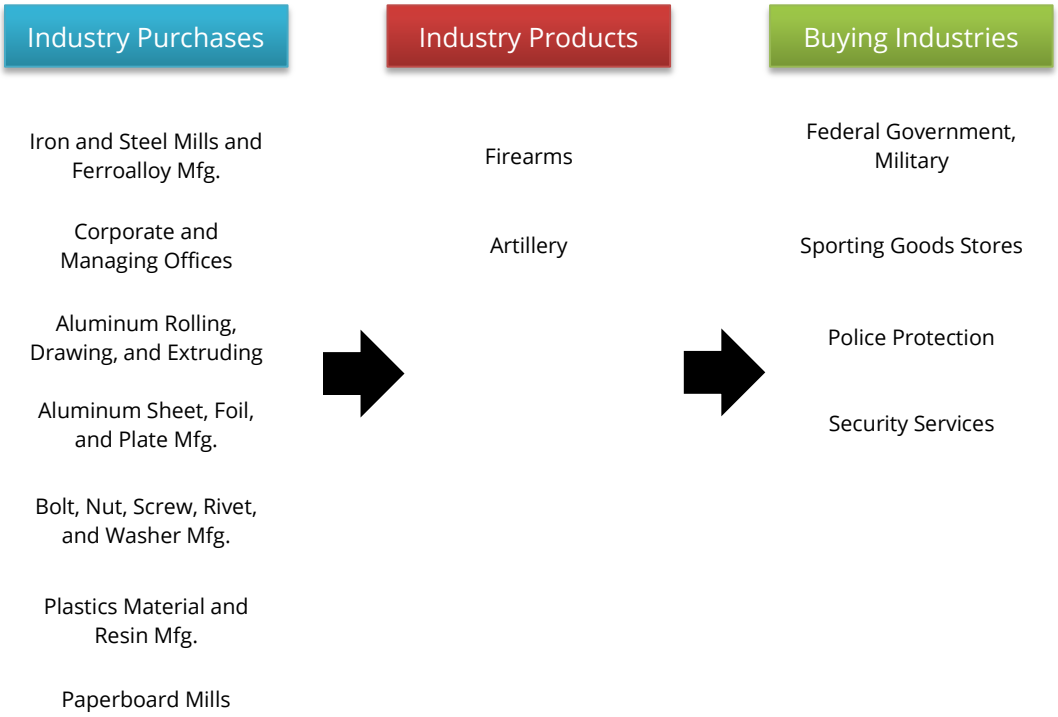
The third major establishment in Tennessee is Aerojet Ordnance Tennessee (AOT), based in Jonesborough. AOT is a subsidiary of Aerojet Rocketdyne, which is owned by publicly-traded GenCorp (NYSE: GY). Aerojet Rocketdyne has three major product areas: propulsion and energetics systems; precision tactical weapon systems; and armament systems for munitions and warheads. The solid and liquid propulsion systems that Aerojet manufactures have applications in both aerospace and defense industries. AOT specializes in advanced metals manufacturing. Key defense products include hand grenades, propulsion systems, and fire extinguishers for military aircraft. In June 2017, AOT delivered the seven millionth M67 hand grenade body assembly to Day & Zimmerman, which completes the final assembly of these weapons for the U.S. Army. AOT has been the sole supplier of M67 body assemblies to the U.S. and Canada for more than 15 years.[21]

Average wages in Tennessee for small arms manufacturing ($69,470) rank seventh in the nation and third in the region behind Kentucky and Alabama. The top occupations in this industry are production-related: team assemblers; machinists, welders, solders, cutters, and brazers; first-line supervisors of production and operating workers; and inspectors, testers, sorters, samplers, and weighers. In 2016, Tennessee's post-secondary institutions produced 15,993 graduates with the educational completions necessary to pursue a career in this field. These institutions offer 121 programs that are related to these occupations.

Tennessee businesses earned $31.8 million in 2017 after completing $105.8 million in sales transactions. 37% of these sales were made to other Tennessee companies. The primary buyers for this industry are the military and sporting goods stores. Small arms and ordnance manufacturers obtain a very small percentage of their production materials from other Tennessee businesses. Major purchase categories include: iron and steel mills and ferroalloy manufacturing (17.9% in-

[21] Aerojet Rocketdyne. (2017). *Aerojet Ordnance Tennessee Delivers Seven Millionth M67 Hand Grenade Body Assembly*. http://www.rocket.com/article/aerojet-ordnance-tennessee-delivers-seven-millionth-m67-hand-grenade-body-assembly

region purchases), corporate and managing offices (19.3%), aluminum rolling, drawing, and extruding (11.5%), aluminum sheet, foil, and plate manufacturing (33.9%), and bolt, nut, screw, rivet, and washer manufacturing (55.3%).



Tennessee's industry is expected to experience strong growth through 2023. The predicted five-year growth rate for Tennessee (25%) is higher than both the regional rate (23%) and the national rate (15%). Revenue for small arms manufacturing will increase due to an uptick in U.S. military spending. Rising geopolitical instability has created new export opportunities for American manufacturers as well. The future of the consumer market is too volatile to predict. An increase in mass shootings led to renewed discussions of gun control, which motivated many gun enthusiasts to purchase more weapons. In recent months, the likelihood of new gun control legislation has dwindled, leading to fewer overall gun sales. However, gun sales are highly dependent on current events, making the future of this market hard to predict.[22] Moreover, Tennessee small arms manufacturers face less import competition than other manufacturing industries due to the popularity of American brands, contracts with the American military, and high-quality craftsmanship of local businesses. The relocation of Beretta USA to Tennessee was also very significant, given that Beretta is perhaps this industry's most competitive importer.

[22] IBISWorld. (Feb. 2018). *On target: Increased demand from the defense market will boost industry revenue*.

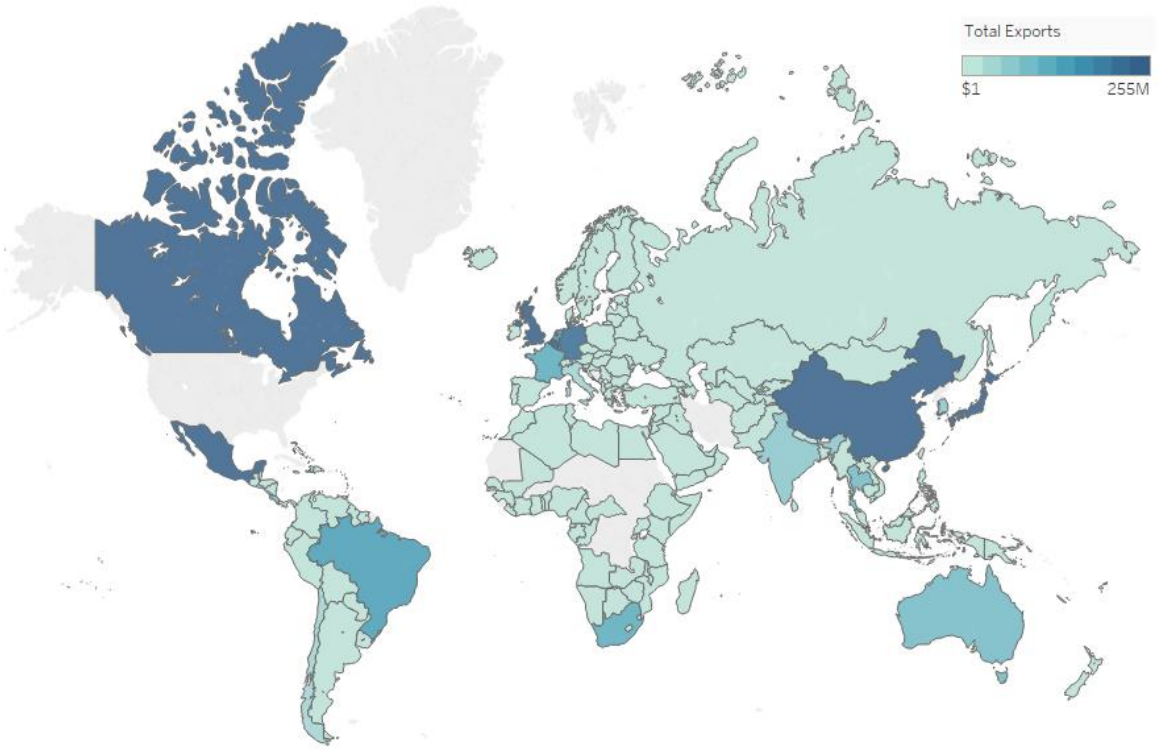
Other Industries

The only industry in the defense sub-cluster in which Tennessee currently does not have employment is manufacturing of military armored vehicles, tanks, and tank components. This industry is fairly small in the US overall.

NAICS	Industry	Employment		Business Locations		Average Earnings	
		Regional	US	Regional	US	Regional	National
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing	2,178	6,864	32	80	$99,441	$99,212

Exports

In 2017, Tennessee's aerospace and defense industries exported $4.3 billion in product, a 36.3% increase since the beginning of the Haslam administration. Major markets in 2017 were Canada ($562.3 million), the United Kingdom ($418.2 million), Mexico ($408.7 million), Singapore ($394.5 million), and Japan ($365.4 million).



The most significant export category for this cluster is navigational, measuring, medical, and control instruments, a subset of which is search, detection, navigation, guidance, aeronautical, and aerospace system products. Tennessee companies exported $1.9 billion in control instruments in 2017 (a 45.7% increase since 2011). Tennessee currently ranks second in the Southeast and seventh in the nation for this overall category. The largest markets for these exports in 2017 were Belgium

($296.9 million), Japan ($296.9 million), Canada ($254.0 million), Singapore ($251.6 million), and Germany ($177.6 million). Annual exports have been increasing since 2011, driven largely by growth in Asian markets (115.4%). Exports to Singapore increased by 897.5% during this time.

The next largest source of export revenue for this cluster is aerospace products and parts. In 2017, Tennessee companies exported $1.6 billion in aerospace parts. The major markets for these products are the United Kingdom ($380.0 million), Singapore ($134.7 million), Mexico ($120.9 million), South Africa ($103.9 million), and Brazil ($91.7 million). Annual exports of aerospace parts have grown by 30% since 2011. Most of this growth occurred due to increased exports to Europe (50.5% increase) and Latin America (133.6%), while exports to Asian declined slightly (-3.8%).

Tennessee companies exported $765.5 million in other fabricated metal products in 2017. Tennessee ranked second in the Southeast and eighth in the nation for fabricated metal exports. For shotguns, pistols, and revolvers, Tennessee earned more in revenue for these exports than any other state in the region and second most in the nation. Tennessee's major export markets for these products in 2017 were Canada ($353.9 million), Mexico ($176.6 million), Japan ($47.9 million), the Netherlands ($45.3 million), and China ($32.2 million). Tennessee exported more control instruments to Canada and Mexico in 2017 than all of Asia and Europe combined. Exports to Mexico have increased 148.1% since 2011.

Transportation equipment not otherwise specified generated $15.2 million in export revenue for Tennessee companies in 2017. The largest export markets were Kuwait ($3.8 million), Jordan ($3.2 million), Canada ($1.6 million), the United Kingdom ($1.4 million), and Brazil ($0.8 million). Export revenue for these products increased by 39.9% during the Haslam administration, which was attributable to explosive growth in exports to OPEC countries (a 9,095.4% increase). In 2011, Tennessee manufacturers exported no miscellaneous transportation equipment to Kuwait. In 2017, exports to Kuwait generated more revenue than the entire European market combined. Exports to Jordan also increased substantially since 2011 (a 56,197.3% increase).

Recent Projects

The aerospace and defenses cluster has been a component for the Haslam administration's economic development strategy. Since 2011, the Tennessee Department of Economic and Community Development has received 14 project commitments to create 1,630 jobs. Total capital investment has nearly reached $161.1 million.

Company	New Job Commitments	Capital Investment	County	Date
SCCY Firearms	356	$22,500,000	Blount	April 2017
Beretta USA Corporation	300	$45,000,000	Sumner	January 2014
West Star Aviation	200	$22,300,000	Hamilton	August 2015
Cirrus	170	$15,000,000	Blount	May 2015
Delfasco, LLC	128	$7,050,000	Greene	April 2018
Vantage LLC	100	$5,050,000	Davidson	August 2016
General Products Partners, Inc.	100	$6,450,000	Lincoln	December 2012
Standard Aero Alliance, Inc.	67	$5,000,000	Blount	June 2018
Campbell Arms Manufacturing	50	$887,500	Carroll	June 2017
Canberra Industries, Inc.	45	$1,200,000	Anderson	October 2011