Virginia's Aerospace Industry

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An Economic Impact Analysis
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Photo Credit: NASA

I. EXECUTIVE SUMMARY

Virginia is home to a diverse aerospace industry that includes interconnected industries such as aircraft manufacturing, satellite telecommunication, and space research and development. Over the past several years, Virginia's aerospace economy has enjoyed an increase in the presence and investments by private firms manufacturing aerospace equipment and supplies (e.g. Rolls Royce, Orbital Sciences Corporation, and General Dynamics). The investments in these industries come at a time when many mature industries are declining both nationally and in the state.

Virginia is well poised to respond to the growth in demand of commercial space launches for medium-heavy lift rockets and small satellites into low earth orbit. Both National Aeronautics and Space Administration (NASA) research centers, NASA Langley and NASA Wallops, have attracted new commercial clients for applied research and increased funding for existing and new programs from NASA headquarters.

The Virginia Commercial Space Flight Authority, established by the Virginia General Assembly in 1995, owns and operates the Mid-Atlantic Regional Spaceport (MARS) located at Wallops Flight Facility—one of four spaceports nationally licensed by the FAA to send rockets into orbit. Commercial operations to the International Space Station will commence from MARS in Virginia beginning in 2011 as NASA phases out its current space shuttle program.

It is hoped that these factors combined with other economic development will be favorable for Virginia's aerospace industry. To provide a baseline for the industry and its contributions to the Commonwealth, and to gather accurate information to outreach to the aerospace companies already located in Virginia, the Department of Aviation commissioned an economic impact study of the aerospace industry.

The aerospace industry is defined as nine 6-digit North American Industrial Classification System (NAICS) industries.

- Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
- Aircraft Manufacturing
- Aircraft Engine and Engine Parts Manufacturing
- Other Aircraft Parts and Auxiliary Equipment Manufacturing
- Guided Missile and Space Vehicle Manufacturing
- Guided Missile and Space Vehicle Propulsion Units
- Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment
- Satellite Telecommunications
- Space Research and Technology

Virginia's aerospace industry contributed $7.6 billion per year in economic output and supported 28,110 jobs in 2009[1] through direct impacts and ripple effects.

Aerospace directly employed 9,029 workers and created $4.3 billion in annual economic output in 2009. The ongoing operations of the industry had ripple impacts throughout the state, estimated to be an additional 19,081 jobs and $3.3 billion annually.

Aerospace pays much higher wages than the average in Virginia.

In 2009, the annual average wage of the aerospace industry was $99,385 compared to $48,334 for all industries in Virginia. Among its top 20 occupations, the highest paying positions are engineering managers ($123,600), general and operations managers ($119,600), and computer software engineers ($106,300).

Virginia's space research and technology industry holds a clear competitive advantage for the Commonwealth compared with other states in the nation.

The space research and technology industry has four times the concentration of employment in Virginia when compared to the national average. This is not surprising in light of the notable and historical firsts for Virginia's aerospace industry. Langley Air Force Base (AFB) was designed for air domination during WorldWar I which eventually led to its acquisition by the Aviation Section of the U.S. Army Signal Corps in December 1916. A portion of Langley Field was set aside for use by the National Advisory Council for Aeronautics to study the problems of flight. This site, known today as NASA Langley Research Center, is the nation's first civilian aeronautics laboratory and NASA's original field center. In addition, the NASA Goddard Space Flight Center's Wallops Flight Facility was created in 1945 as a center for aeronautics research on Virginia's Eastern Shore. Over a quarter of the state's aerospace industry employment is in the space research and technology subsector.

1 2009 is the latest year where full year data are available.

The aerospace industry employed 9,029 workers in Virginia in 2009, ranking it 16th in the nation for aerospace employment.

California ranked first among the states in 2009, employing 119,684 people, or a quarter of the nation's 677,393 aerospace industry workers. Unlike the nation, where aerospace employment contracted 2.1%, the Virginia aerospace industry expanded in 2009 for a gain of 4.2% or 366 jobs.

Each job in the aerospace industry supports 2.11 additional jobs elsewhere in Virginia.

The employment multiplier[2] for aerospace is higher than 0.71, the average multiplier for an industry in Virginia. Each job in aerospace can support 2.11 additional jobs elsewhere in Virginia. This means that 100 aerospace jobs can support 140 more than the typical 100 jobs on average in the Commonwealth. This multiplier is higher than average due to the industry's sophistication and high wages.

Aerospace contributed 1.9% to Virginia's gross state product while utilizing only 0.8% of total employment in the state.

The percentage of this sector's GSP relative to employment reflects its highly skilled and highly productive workers.

Business-to-Business and Business-to-Consumer networks in Virginia benefit from the aerospace industry.

Businesses and consumers throughout the Commonwealth enjoy the economic benefits due to aerospace businesses and consumers of goods and services. The state's more essential industries to the operations and productivity of aerospace are:

- management
- wholesale trade
- employment services
- scientific research and development
- computer system design
- architecture and engineering services

Consumers benefit from the higher average wages from aerospace; higher wages contribute to the higher demand for consumer services such as food services, health care, and retail.

Virginia encompasses a substantial military aerospace industry with roughly 26,000 uniformed, civilian, and contractor employees.

Overall, the Department of Defense employs almost 153,000 Virginians, the third highest total employment by state in the country. The military aerospace employment figure of 26,000 was obtained through a survey which showed nearly half of this employment in the state to be associated with Langley Air Force Base.[3]

The economic impacts of the aerospace industry in Virginia are summarized in Table 1.1:

Table 1.1: Economic Impact Summary of the Aerospace Industry in Virginia

	Direct	Indirect	Induced	Total
Spending ($Millions)	$4,314.0	$1,753.4	$1,521.0	$7,588.4
Employment	9,029	8,934	10,147	28,110

Source: Chmura Economics & Analytics & IMPLAN Pro 2008

Photo Credit: NASA

2 The employment multiplier measures the additional jobs created for each job in the aerospace industry.

3 Included within the survey instrument's "aerospace" definition was the request for personnel figures relating to aviation operations, as well as, conventional aerospace functions. Therefore, the figures displayed above and within Table 4.7 incorporate personnel performing military aerospace and aviation-related duties.

2. BACKGROUND

Virginia has a long history of supporting and advancing the aerospace industry with strongholds in space research, education, development, and launch facilities. The Commonwealth houses centers of excellence including NASA's Langley Research Center and the Wallops Flight Facility. These institutions date back to the early 1900's and have been instrumental in advancing the U.S. aerospace program and providing scientific and atmospheric research. In addition, Virginia Polytechnic Institute and State University (Virginia Tech) has an aerospace engineering program that is consistently ranked in the top three nationally and the university is among the top for recruiting by aerospace companies and organizations.

Recent developments in commercial space launch for medium-heavy lift rockets and small satellites into low earth orbit, combined with private investments from corporate partners such as Rolls Royce, Orbital Sciences, and General Dynamics, are creating growth in this economic engine. It is hoped that the forecast for Virginia's aerospace industry will continue to grow aided by cooperative legislative and economic policies and practices, a healthy and competitive workforce, and scientific, medical and research applications in the industry.

The FAA's 2009 report, "State Support for Commercial Space," states:

> Virginia has recently taken the lead in the area of innovative incentives to lure space transportation companies to the state. In the last two years, the state passed two bills intended to boost the presence of the industry. The first, the Virginia Space Liability and Immunity Act, enacted in 2007, effectively made Virginia the most progressive state in the country in addressing the challenge that existing tort law posed to emerging human spaceflight transportation companies. The second, the Zero G Zero Tax Act of 2008, will provide an exemption from state income taxes to any space transportation company doing business in Virginia with the intent to either launch payloads from the Mid-Atlantic Regional Spaceport (MARS) or conduct spaceflight training. These two pieces of legislation, coupled with other, more traditional financial incentives, are largely credited with being the driving force behind Orbital Sciences' decision to locate the launch operations for its new Taurus II launch vehicle in Virginia.[4]

To provide a baseline for the industry and its contributions to the Commonwealth, and to gather accurate information to

Virginia Economic Impact Research Consortium Model

Ensure high credibility
- o Objective approach
- o Peer reviewed model
- o Replicable results
- o Outcome not pre-determined

Identify objectives
- o Understand the role of agency in generating the study
- o Identify agency's plans for using the study
- o Establish outcomes needed to meet agency's goals
- o Advise agency on additional needed research

Identify other considerations and influences from outside of the model
- o Estimate or acknowledge costs & benefits not captured by the model
- o Provide anecdotal evidence, as appropriate
- o Consider changes in other industries relative to "study" industry

Develop clear implementation plan
- o Knowledgeable & qualified staff
- o Clear timeframe
- o Sufficient funds and other resources
- o Project plan

Clearly define geographic boundaries and units of observation
- o Define the "local economy" and geography
- o Estimate percentage of expenditures made within study area
- o Define terms and explain what is included in definition

Develop results that are understandable, accessible, and useable to client and public
- o Explain results in an understandable manner
- o Present results in a format useful to the client
- o Provide executive summary of project

Plan for direct impact estimates
- o Clearly define and document model inputs
- o Use credible and accepted data sources
- o Use up-to-date data and impact models
- o Modify model data, as applicable

Document assumptions
- o Make reasonable assumptions
- o Clarify and justify assumptions
- o Indicate clearly the degree of dependence on assumptions

4 Source:http://www.faa.gov/about/office_org/headquarters_offices/ast/media/State%20Support%20for%20Commercial%20Space%20Activities.pdf

outreach and connect space companies and communities, the Virginia Department of Aviation commissioned this economic impact analysis of the aerospace industry.

2.1. ECONOMIC IMPACT RESEARCH CONSORTIUM

This project included a concurrent effort to gather and develop standards for research methodology that could be applied to future economic impact studies. The benefits of a standard approach include clear definitions for important assumptions, a higher level of data integrity, and cost savings.

The Economic Impact Research Consortium (EIRC) Model, developed and refined during the spring of 2010, was led by the Performance Management Group at Virginia Commonwealth University in collaboration with economists from the following agencies and universities who took part in the consortium meeting: College of William & Mary, George Mason University, Old Dominion University, University of Virginia, Virginia Department of Planning & Budget, Virginia Economic Development Partnership, Virginia Employment Commission, and Virginia Tech (See Appendix 1 for a list of participating economists). The EIRC Model economic impact analysis procedures shown in the table on the opposite page were adhered to for this economic impact analysis of the Virginia aerospace industry.

2.2. INDUSTRY DEFINITION

The federal government classifies firms into industries for statistical purposes based on the process by which the product or service is created. Under the North American Industry Classification System (NAICS), for example, goods that are manufactured are in one sector while the transmission of information via satellite is in another sector. Oftentimes, there is an interest in industries that crossover more than one NAICS sector. High-technology industries are one such example. Aerospace, the topic of this report, is another example. Consequently, defining the aerospace industry is required before beginning the analysis.

There is no standard definition for the aerospace industry. Many states, such as Alabama, California, and Texas, have conducted economic impact studies of their aerospace industries. Appendix 2 provides a table of the NAICS codes represented in each of these studies. None of the studies, however, provide a nationally standardized or recognized definition for the aerospace industry.

The state studies basically used two approaches to identify the aerospace industry: company-based and industry-based. The first approach attempts to identify companies (or the division of

Table 2.1: NAICS Industries that Compose the Aerospace Industry

NAICS	Industry	Virginia Definition (Excluding Airports)	Aerospace Industry Association	Federal Aviation Administration: Commercial Space Transportation	U.S. Department of Commerce: Aerospace Workforce
339113	Surgical Appliance and Supplies Manufacturing*				✓
334220	Radio and Television Broadcasting and Wireless Communication Equipment			✓	✓
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	✓	✓		✓
336411	Aircraft Manufacturing	✓	✓		
336412	Aircraft Engine and Engine Parts Manufacturing	✓	✓		
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing	✓	✓		
336414	Guided Missile and Space Vehicle Manufacturing	✓	✓	✓	✓
336415	Guided Missile and Space Vehicle Propulsion Units	✓	✓		
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment	✓	✓		✓
481212	Nonscheduled Chartered Freight Air Transportation				✓
517410	Satellite Telecommunications	✓			
513220	Cable and Other Programs Distribution			✓	
541370	Surveying and Mapping (Except Geophysical)			✓	
927110	Space Research and Technology	✓			✓

*This sector includes the manufacturing of personal industrial safery devices, which includes space suits.

a company) that create aerospace products or services. Surveys are necessary for an accurate assessment. Within Virginia, for example, Northrop Grumman has offices in Northern Virginia that produce search detection, navigation, guidance, aeronautical, and nautical system and instrument products, which can be considered part of the aerospace industry, while Northrop Grumman's Norfolk shipyard is not directly connected to aerospace. Both Alabama and Colorado used this approach. Surveys are costly, time-consuming, and need to be updated over time. In addition, this approach makes regional comparisons difficult because of the survey-based nature of the definition.

The alternative approach is to identify a list of NAICS codes that define the overall aerospace industry. Under this approach, all companies incorporated with these NAICS codes are used in the economic impact analysis. Ohio and Texas, for example, used the NAICS approach. This approach allows comparisons across regions and states because of its standard definition.

Oftentimes, trade associations or federal government agencies identify an industry using the NAICS approach because of its broad view across states. For that reason, trade associations and federal agencies were contacted to obtain their definitions of aerospace which are shown in Table 2.1. (See Appendix 3 for a description of each NAICS code.) However, these institutions often have a mission that drives their definition. The mission of the Aerospace Industries Association of America (AIA), Inc. is to shape "public policy that ensures the U.S. aerospace, defense, and homeland security industry remains preeminent and that its members are successful and profitable in a changing global market."[5] The Federal Aviation Administration (FAA) study in 2006 focused on the economic impact only of commercial space transportation.[6] More recently, the U.S. Department of Commerce defined aerospace for the purpose of assessing workforce needs. Only one industry, guided missile and space vehicle manufacturing, is in all three definitions.

The purpose of the Virginia definition—to be used in this report—is to define aerospace in a broad manner while excluding airport operations.[7] The economic impact of airport operations for the 66 Commonwealth airports will be calculated in a separate study. The Virginia definition most closely resembles that of the AIA. Four industries were included in the FAA or Commerce Department definitions but were not included in the Virginia definition for the reasons that follow:

- **Radio and Television Broadcasting and Wireless Communication Equipment** - although GPS equipment is included, as it is a small percentage of the total.
- **Nonscheduled Chartered Freight Air Transportation** - includes travel by spacecraft but it is a small percentage of the total.
- **Cable and Other Programs** - this NAICS code no longer exists in the 2007 classification system.
- **Surveying and Mapping (Except Geophysical)** - includes mapping from the air but it is a small segment of the total.

2.3. REGION DEFINITIONS

The economic impacts of the aerospace industry in this report are measured for Virginia in aggregate, as well as for each of Virginia's eleven metropolitan statistical areas (MSAs) defined below.[8]

Table 2.2: Virginia MSA Definitions

Blacksburg MSA	Newport News	**Richmond MSA**
Giles	Norfolk	Amelia
Montgomery	Poquoson	Caroline
Pulaski	Portsmouth	Charles City
Radford	Suffolk	Chesterfield
Bristol MSA	Virginia Beach	Cumberland
Scott	Williamsburg	Dinwiddie
Washington	**Lynchburg MSA**	Goochland
Bristol	Amherst	Hanover
Charlottesville MSA	Appomattox	Henrico
Albemarle	Bedford County	King And Queen
Fluvanna	Campbell	King William
Greene	Bedford City	Louisa
Nelson	Lynchburg	New Kent
Charlottesville	**Northern Virginia MSA**	Powhatan
Danville MSA	Arlington	Prince George
Pittsylvania	Clarke	Sussex
Danville	Fairfax County	Colonial Heights
Harrisonburg MSA	Fauquier	Hopewell
Rockingham	Loudoun	Petersburg
Harrisonburg	Prince William	Richmond City
Hampton Roads MSA	Spotsylvania	**Roanoke MSA**
Gloucester	Stafford	Botetourt
Isle Of Wight	Warren	Craig
James City	Alexandria	Franklin County
Mathews	Fairfax City	Roanoke County
Surry	Falls Church	Roanoke City
York	Fredericksburg	Salem
Chesapeake	Manassas	**Winchester MSA**
Hampton	Manassas Park	Frederick
		Winchester

Source: U.S. Census

5 Source: http://www.aia-aerospace.org/about_aia/mission/ accessed on August 9, 2010.

6 Federal Aerospace Administration, "The Economic Impact of Commercial Space Transportation on the U.S. Economy: 2004," February 2006.

7 Nonscheduled chartered freight transportation was determined to be part of airport operations.

8 The impact of the MSAs will not sum to the state total due to the impacts from the aerospace industry in the non-MSA localities in Virginia.

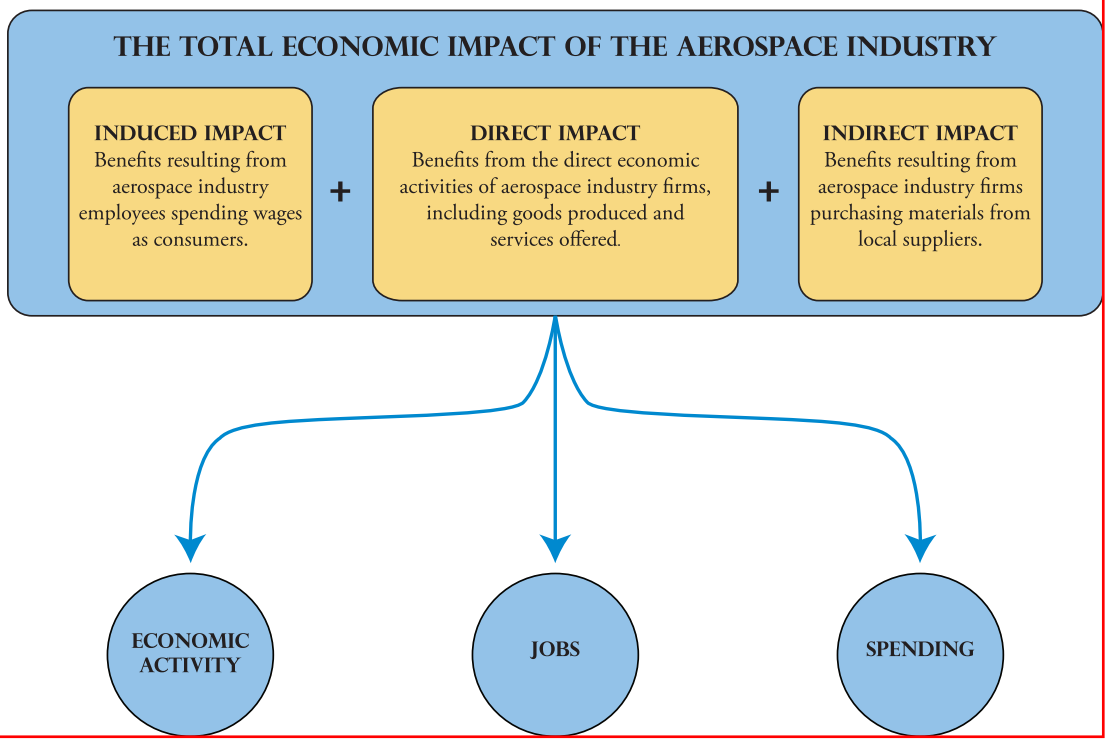
2.4. ECONOMIC IMPACT METHODOLOGY

Figure 2.1 illustrates the conceptual framework for the economic impact analysis of the aerospace industry which includes the direct, indirect, and induced impacts in Virginia and its metropolitan statistical areas.

The total employment (number of workers) and output (sales) of all companies in the aerospace industries represent the direct impact of the industry in Virginia and its MSAs. The number of workers in the aerospace industry is based on data from the Quarterly Census of Employment and Wages (QCEW),[9] while direct sales are derived from the average output for the industry from IMPLAN Pro[10] software. A key assumption for the output is based on the number of employees.[11] Furthermore, the total economic impact from aerospace industries includes the ripple effects.

The economic ripple effects that are captured and categorized in this report are the indirect and induced impacts that measure the secondary benefits generated by the aerospace industry. The indirect impacts are increased sales and employment that occur for the local businesses that sell supplies and services to the aerospace industries. The induced impacts are the increased sales and employment that occurs in the local communities as a result of employees in the aerospace industry spending their wages and salaries. The benefactors of the induced impacts are primarily consumer-related businesses such as retail stores, restaurants, and hospitals. The indirect and induced effects are estimated with IMPLAN Pro software after the direct impacts are identified. (See Appendix 4 for an impact study glossary.)

Figure 2.1: Economic Impact Conceptual Framework



9 Source: Virginia Employment Commission.

10 IMPLAN Professional is an economic impact assessment modeling system developed by the Minnesota IMPLAN Group that is often used by economists to build economic models that estimate the impact of industries or economic changes in local economies. The IMPLAN model tracks total industry output and employment for each industry in each state. The average output per worker was used in this study to estimate total industry output.

11 The IMPLAN output per worker is adjusted with average wages from QCEW to reflect the 2009 situation.

3. THE AEROSPACE INDUSTRY

The aerospace industry ranks among the nation's largest manufacturing industries in terms of employment and output. Mass production of airplanes did not begin until World War I in August 1914.[12] Less than a year later, on March 3, 1915, the National Advisory Committee for Aeronautics (NACA) was founded to undertake, promote, and institutionalize aeronautics research. Under the NACA, Langley Research Center in Hampton, Virginia was established as the first civilian aeronautics laboratory in the nation.[13] NACA was dissolved and its assets transferred to the National Aeronautics and Space Administration (NASA) when it was created in 1958.

The U.S. aerospace industry employed 677,393 non-military people in 2009, but had declined by 14,459 (-2.1%) since 2008.

Table 3.1: State Rankings by Employment for the Aerospace Industry*

	2009		2008		2008 to 2009 Change	
	Employment	Rank	2008	Rank	Number	Percentage
California	119,684	1	125,320	1	-5,636	-4.5
Texas	61,679	2	61,538	2	141	0.2
Kansas	38,431	3	44,380	3	-5,949	-13.4
Florida	29,749	4	31,030	4	-1,280	-4.1
Arizona	25,262	5	23,583	5	1,679	7.1
Georgia	19,763	6	19,649	7	114	0.6
Ohio	19,099	7	19,901	6	-803	-4.0
New York	17,320	8	17,712	9	-391	-2.2
Connecticut	17,173	9	18,617	8	-1,444	-7.8
Maryland	15,360	10	12,261	12	3,099	25.3
Alabama	14,121	11	13,684	10	438	3.2
Washington	11,519	12	13,041	11	-1,522	-11.7
Massachusetts	10,439	13	10,772	13	-332	-3.1
Pennsylvania	9,408	14	9,144	15	264	2.9
New Jersey	9,050	15	9,422	14	-373	-4.0
Virginia	**9,029**	**16**	**8,663**	**17**	**366**	**4.2**
Indiana	8,592	17	8,721	16	-129	-1.5
Illinois	5,620	18	5,564	19	56	1.0
Oklahoma	5,416	19	6,152	18	-735	-12.0
Michigan	5,073	20	5,469	20	-396	-7.2
North Carolina	3,970	21	4,076	21	-106	-2.6
Missouri	3,653	22	3,564	24	88	2.5
Minnesota	3,447	23	3,725	22	-278	-7.4
Colorado	3,439	24	3,629	23	-190	-5.2
Oregon	2,946	25	3,151	25	-205	-6.5
Utah	2,429	26	2,519	26	-90	-3.6
South Carolina	1,543	27	991	33	552	55.7
Arkansas	1,421	28	1,494	28	-73	-4.9
Tennessee	1,381	29	1,515	27	-134	-8.8
District of Columbia	1,314	30	1,185	30	129	10.9

Sources: Chmura Economics & Analytics and U.S. Bureau of Labor Statistics

*Note: Employment by state is understated in most states because employment for 6-digit NAICS are not disclosed when there are less than 3 firms in that classification in the state or one firm accounts for 80% or more of employment in that particular NAICS code.

12 "The History of the Aerospace Industry," http://eh.net/encyclopedia/article/bugos.aerospace.industry.history. Accessed on August 10, 2010.

13 Source: http://www.nasa.gov/centers/langley/research/index.html, accessed on August 10, 2010.

The decline is not surprising in light of the recession. California ranked first among the states in 2009, employing 119,684 people, or a quarter of the nation's aerospace industry. It shed 5,636 aerospace jobs or 4.5% of its employment over the last year. Texas follows California with about half the number of aerospace jobs, and Kansas follows Texas with about 40% less aerospace employment than the second-ranked state.

Virginia ranked 16th among the states in aerospace employment with 9,029 workers in 2009. New Jersey ranked 15th with 21 more aerospace jobs than Virginia. Massachusetts and Pennsylvania ranked in the two positions above New Jersey with only slightly higher aerospace employment.

Unlike the nation, the Virginia aerospace industry expanded in 2009 for a gain of 4.2% or 366 jobs. Massachusetts shed 332 aerospace jobs during the same period, and New Jersey decreased by 373 workers. Pennsylvania expanded its aerospace industry by 264 jobs in 2009.

3.1. THE AEROSPACE INDUSTRY IN VIRGINIA

Although Virginia's aerospace footprint ranks it 16th in the nation, its space research and technology industry holds a clear competitive advantage for the Commonwealth with four times the concentration of employment as compared to the national average (as shown in its location quotient[14] which is greater than 4.0). This is not surprising in light of the notable firsts for Virginia's aerospace industry: Langley Air Force Base (AFB) was designed for air domination during World War I which eventually led to its acquisition by the Aviation Section of the U.S. Army Signal Corps in December 1916. A portion of Langley Field was set aside for use by the National Advisory Council for Aeronautics to study the problems of flight. This site, known today as NASA Langley Research Center, is the nation's first civilian aeronautics laboratory and NASA's original field center. In addition, the NASA Goddard Space Flight Center's Wallops Flight Facility was created in 1945 as a center for aeronautics research on Virginia's Eastern Shore. Over a quarter of the state's aerospace industry employment is in the space research and technology subsector.

14 The location quotient (LQ) is a measure of the relative size of an industry in a region compared to the average size in the nation. An LQ of 1.0 indicates an industry is the same size in the region as is average in the nation; an LQ of 2.0 means the industry is twice as large in the region compared to average; and an LQ of 1/2 indicates the industry is half as large regionally as average in the nation. The location quotient for an industry identifies the degree to which the industry specializes in or is concentrated in a region. With an LQ of 1.25 or higher, a region is considered to possess a competitive advantage in that industry. Firms in a specific industry often aggregate because of some competitive advantage found in an area such as geographic location, natural resources, and human resources. (A region can have a competitive advantage in a growing or declining industry.) Mathematically, the location quotient is the ratio of an industry's share of total employment within the region to the same industry's share of employment in the nation.

As previously stated, Virginia's aerospace economy has enjoyed an increase in the presence and investments by private firms manufacturing aerospace equipment and supplies (e.g. Rolls Royce, Orbit Sciences Corporation, and General Dynamics). The investments in these industries come at a time when many mature industries are declining both nationally and in the state.

In 1995, the Virginia General Assembly created the Virginia Commercial Space Flight Authority (VCSFA). The Authority's mission includes commercial space flight development, human space flight, aerospace research, and economic development. The Authority created the Mid-Atlantic Regional Spaceport (MARS). VCSFA is one of only four rocket launching organizations licensed by the FAA to send rockets into orbit (the other three are Kennedy Space Center in Florida; Vandenberg AFB, California; and the Alaska Aerospace Corp. in Kodiak, Alaska).

Table 3.2: Top 10 Aerospace Employers in Virginia, 4th Quarter, 2009

Raytheon Company
NASA
Orbital Sciences Corporation
Northrop Grumman Corp.
General Dynamics Armament
Tamsco
Aerojet General Corp.
Baysys Technologies, LLC
Lockheed Martin Operations Support, Inc.
Triumph Aerospace Systems

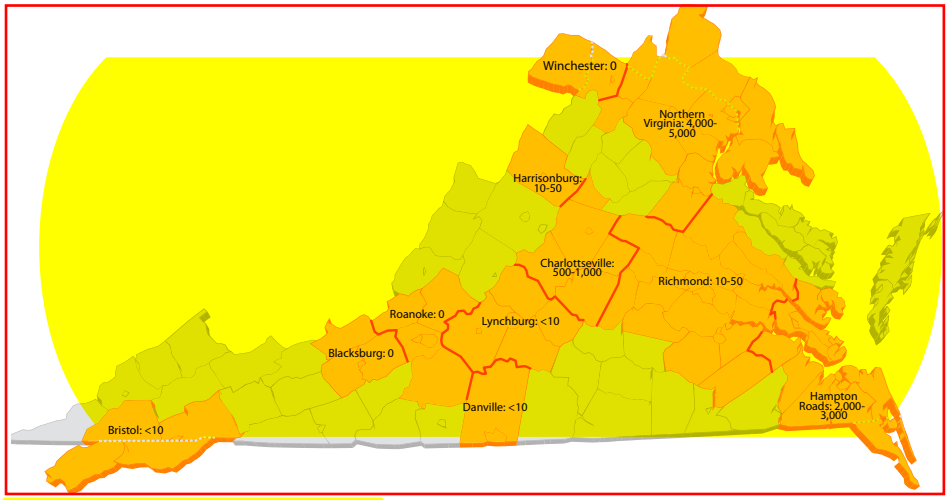
Source: Virginia Employment Commission and Chmura Economics & Analytics

MARS is a commercial spaceport, operating with a Space Act Agreement at NASA Wallops Flight Facility on Virginia's Eastern Shore. Virginia's General Assembly has been quite aggressive in providing incentives to the commercial sector to launch from MARS, by adopting 'zero gravity, zero tax' legislation; sales tax exemptions, and limiting liability for human space flights from MARS. Partially due to this, Orbital Sciences Corporation chose MARS over Florida as the launch site for the demonstration of its new Taurus II rocket, which will, among other things, resupply the international space station. Beginning in 2011, commercial operations to the International Space Station will commence from MARS under a $1.9 billion dollar NASA contract to Orbital Sciences Corporation for eight resupply missions.

The aerospace industry is part of a growing integrated cluster of industry sectors, buyers, and suppliers that have a shared marketplace and workforce. The economic benefits to the economies of the Commonwealth and its eleven MSAs are provided in the remainder of this report.

The Virginia aerospace industry employed 9,029 workers on average in 2009. These workers and their output make up the di-

Figure 3.1: Aerospace Employment in Virginia MSAs, 2009

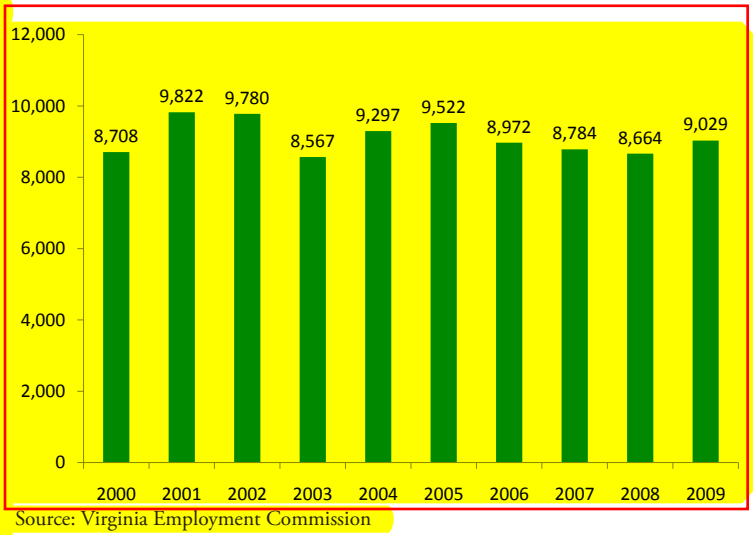


Source: Virginia Employment Commission

rect impact from the aerospace industry. Total wages and salaries for the 9,029 Virginia aerospace workers in 2009 were $897.4 million or an average of $99,385 per worker.

The aerospace industry in Virginia reaches all parts of the state due to the dispersed locations of its firms. As shown in Figure 3.1, three MSAs stand out as having the largest aerospace workforce in Virginia. Northern Virginia (NOVA) alone accounted for more than 50% of employment (over 4,000 jobs) in the aerospace industry in 2009. Hampton Roads (HR) ranked second with over 2,000 workers while Charlottesville ranked third with over 500 employed. Together, these three regions accounted for over 85% of all aerospace jobs in Virginia. Looking beyond the top three MSAs, many fewer aerospace jobs are found in the other metro areas in the state. In fact, there is no direct aerospace employment in the Blacksburg, Roanoke, or Winchester MSAs. In addition, 13.8% or 1,244 of the total aerospace jobs are located outside the eleven metropolitan areas in rural Virginia localities.

Figure 3.2: Virginia Aerospace Employment

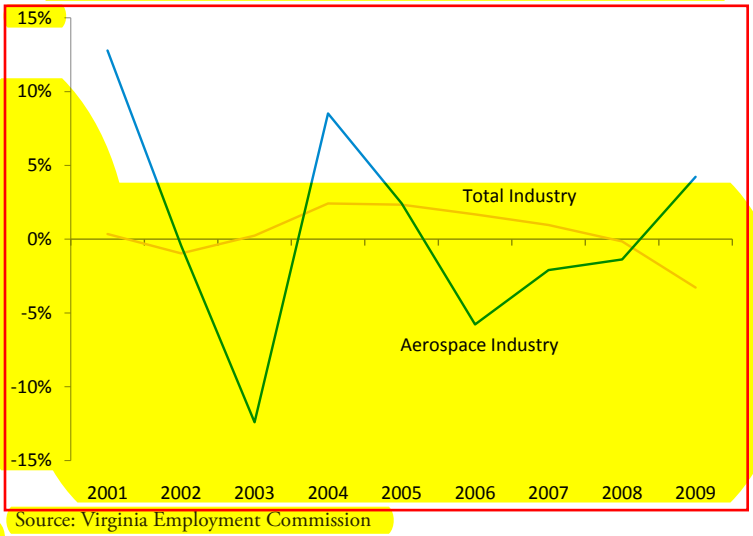


Source: Virginia Employment Commission

3.2. OVERALL EMPLOYMENT AND WAGES

The size of the aerospace industry in Virginia, as measured by total employment, amounted to 9,029 in 2009. The industry employment peaked at 9,822 in 2001 and fell to a low of 8,567 in 2003.[15] Despite the recession, the aerospace industry in Virginia added 366 jobs from 2008 to 2009 after shedding 121 jobs between 2007 and 2008 as the recession began its peak descent. From 2000 to 2009, jobs in aerospace grew at an annual rate of 0.4% (Figure 3.3). Meanwhile, overall employment in Virginia expanded steadily over the same period, growing an

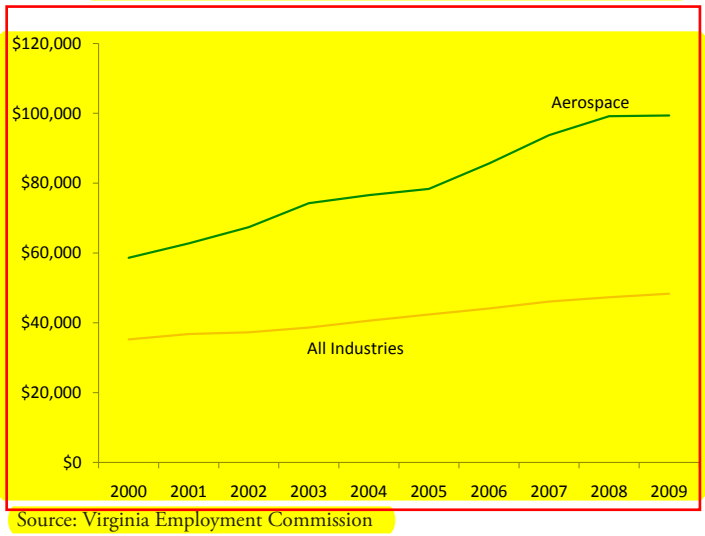
Figure 3.3: Annual Employment Growth, Virginia



Source: Virginia Employment Commission

15 From 2002 to 2003, two guided missile manufacturers ceased their operations in Virginia, both of them in Fairfax County, causing a sharp decline in industry employment. Taken together, these two firms employed over 1,300 workers in 2002.

Figure 3.4: Average Annual Wages, Virginia



Source: Virginia Employment Commission

average 0.4% per year. In 2009, 0.3% of Virginia workers were employed in the aerospace industry.

Virginia's aerospace industry pays much higher than the state's average wage (Figure 3.4). In 2009, the average wage in Virginia's aerospace industry was $99,385, double the state's average wage of $48,334 per year. Not only was the aerospace wage higher than the state average, it has also been growing at a faster pace for the last decade. From 2000 to 2009, wages in Virginia's aerospace industry grew an average 6.0% per year in nominal terms, much faster than the 3.6% growth in overall average wages.

The aerospace industry provides advanced and sophisticated products and services. It employs a highly skilled workforce with high education requirements. Therefore, it is not surprising that the average wage in this industry is much higher than the state average.

The relatively higher wages paid to aerospace industry employees in Virginia have important implications for the economic ripple effects, especially the induced impacts. The higher average wages indicate that aerospace employee wages have a larger multiplier for induced impacts that support jobs among consumer-related establishments such as retail and restaurants.

3.3. EMPLOYMENT AND WAGES DETAILS

Among all of the 6-digit NAICS industries that make up the total aerospace footprint in Virginia, the largest in terms of employment is search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing (NAICS 334511); this sector had 3,393 employees in 2009 (Table 3.3). Other 6-digit industries with sizable employment in 2009 were space research and technology (over 2,000 jobs), guided missile and space vehicle manufacturing (over 1,500 jobs), other aircraft parts and auxiliary equipment manufacturing (over 500 jobs), aircraft manufacturing (496 jobs), and satellite telecommunications (428 jobs).

There are also large variations in average wages among the nine aerospace industries in Virginia, even though all pay higher wages than the state average. For example, average wages for search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing (NAICS 334511) were $104,334 per year in 2009. Average wages were over $90,000 for NAICS 927110 space research and technology and $140,930 for NAICS 517410 satellite telecommunication. The average wages for NAICS 336413 other aircraft parts and auxiliary equipment manufacturing were at the low end of the spectrum in 2009, but were still over $50,000 per year. Among the largest occupations (by employment size) for the aerospace industry are high-wage, skilled occupations such as aerospace, mechanical, and computer software engineers. The aerospace industry, however, also employs large numbers of lower skilled and lower wage occupations such as team assemblers and electrical and electronic equipment assemblers.

Table 3.3: Virginia Aerospace Industry Employment and Wages (2009)

Six-Digit NAICS Aerospace Industries	Employment	Average Wages
Aircraft Engine and Engine Parts Manufacturing	45	$77,859
Aircraft Manufacturing	496	$74,505
Guided Missile and Space Vehicle Manufacturing	>1,500	>$100,000
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	>100	>$70,000
Other Aircraft Parts and Auxiliary Equipment Manufacturing	>500	>$50,000
Satellite Telecommunications	428	$140,930
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	3,393	$104,334
Space Research and Technology	>2,000	>$90,000
Total Aerospace Industry	**9,029**	**$99,385**
Total All Industry	**3,534,840**	**$48,334**

Note: A range of employment indicates that the exact employment number is non-disclosed.
Source: Virginia Employment Commission

4. ECONOMIC IMPACT OF AEROSPACE IN VIRGINIA

Table 4.1: Annual Economic Impact of Aerospace Industry on Virginia, 2009

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$1,659.8	$753.8	$631.7	$3,045.3	3,393	3,723	4,458	11,573
Aircraft Manufacturing	$429.3	$103.3	$72.0	$604.6	496	669	699	1,863
Aircraft Engine and Engine Parts Manufacturing	$35.4	$11.3	$7.4	$54.1	45	63	55	163
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$327.5	$149.7	$92.9	$570.1	>500	938	817	>2,255
Guided Missile and Space Vehicle Manufacturing	$931.7	$396.1	$320.3	$1648.2	>1,500	2,646	2,316	>6,462
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$46.1	$14.4	$16.4	$76.9	>100	79	126	>305
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$482.6	$277.2	$128.6	$888.4	428	676	536	1,639
Space Research and Technology	$401.7	$47.5	$251.6	$700.9	>2,000	140	1,141	>3,281
Total	**$4,314.0**	**$1,753.4**	**$1,521.0**	**$7,588.4**	**9,029**	**8,934**	**10,147**	**28,110**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

4.1. ECONOMIC IMPACT OF AEROSPACE ON THE STATE

The aerospace industry in Virginia contributed a total economic impact (direct, indirect, and induced) of $7.6 billion annually (in 2009 dollars) and supported 28,110 jobs in Virginia (Table 4.1).[16] In terms of direct impact, this industry employed 9,029 workers in 2009 and is estimated to produce $4.3 billion in annual gross revenue. Indirect impacts of $1.8 billion annually and 8,934 additional jobs are generated by the aerospace industry, benefitting the Virginia-based businesses supporting aerospace in the state—examples of these industries are aircraft parts and equipment manufacturing, tire manufacturing, and computer systems design. Without the aerospace industry, these businesses would see reduced revenue and jobs. The induced impact from aerospace is derived from the purchases that aerospace employees make as consumers in Virginia, with the benefactors being largely the restaurants, doctor's offices, and retail establishments close to the aerospace facilities. The number of jobs created from the induced impact amounted to 10,147 in 2009 with associated sales of $1.5 billion.

Table 4.1 indicates that each job in the aerospace industry can support 2.11 additional jobs elsewhere in Virginia. The employment multiplier[17] for this industry is higher than that for the average Virginia industry which stands at 0.71. This means that 100 aerospace jobs can support 140 more jobs than can 100 jobs in the average Virginia industry.[18] The reasons for higher employment multipliers for the aerospace industry are twofold. First, the aerospace industry is complex and sophisticated, requiring many specialized parts and services for its operation. This enables Virginia's aerospace industry to establish extensive links with other industries in Virginia, boosting the indirect impact. Second, the aerospace industry pays higher wages than the average Virginia industry, allowing workers to earn more disposable income which in turn boosts the induced impacts in Virginia.

To put the economic impact of the Virginia aerospace industry in perspective, total employment in Virginia[19] was 3.5 million in 2009. The aerospace industry's direct, indirect, and induced jobs totaled 28,110, or 0.8% of total state employment. Meanwhile,

Table 4.2: Aerospace Impact in Perspective (2009)

	Aerospace Industry	Virginia	Aerospace as a Percentage of All Industry in Virginia
Total Employment Impact	28,110	3,534,840	0.8%
Total Spending Impact ($Billions)	$7.6	$404.3	1.9%

Source: Chmura Economics & Analytics

16 IMPLANPro® models were used to simulate the ripple economic impacts of the aerospace industry in Virginia.

17 The employment multiplier of an industry measures the additional jobs created by one job in the aerospace industry.

18 140 = (100 * 2.11) – (100 * 0.71).

19 Source: Virginia Employment Commission.

the estimated gross state product (GSP) of Virginia was $405.6 billion in 2008.[20] The total economic impacts of the aerospace industry, at $7.6 billion in 2009, accounted for 1.9% of the Virginia GSP.[21] With 0.8% of employment contributing 1.9% of the GSP, the aerospace industry is much more productive than the average industry in Virginia.

4.2. ECONOMIC IMPACT BREAKDOWN BY SUB-INDUSTRIES

Table 4.1 details the economic impact of each of the nine industries that make up the aerospace industry in Virginia. The industry with the largest impact is NAICS 334511, search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing. In 2009, this industry contributed total economic impacts (direct, indirect, and induced) of $3.0 billion and supported 11,573 jobs in Virginia. About 40% of the total economic impacts of the aerospace industry come from this sub-industry alone. Other sub-industries making the largest economic impacts in Virginia are guided missiles and space vehicle manufacturing, satellite telecommunications, space research and technology, aircraft manufacturing, and aircraft engine and engine parts manufacturing. The remainder of the 6-digit NAICS industries had considerably smaller impacts on the Virginia economy.

4.3. INDIRECT AND INDUCED IMPACT FROM THE AEROSPACE INDUSTRY

Many industries in Virginia benefit from the aerospace industry. Table 4.3 lists the top ten benefactors of the aerospace industry in terms of jobs created through the indirect impact. Industries essential for operations and production in the aerospace industry include professional and business services such as management (1,054 jobs in Virginia are supported by the aerospace industry's indirect impact), wholesale trade (517 jobs), and employment services (434 jobs). Engineering, computer, and research firms in Virginia also benefit from the economic impact of the aerospace industry, including scientific research and development (291 jobs), architectural and engineering services (284 jobs), and computer systems design (275 jobs).

Table 4.3 displays the top ten industries that share 40% of the total indirect benefits from the aerospace industry in Virginia; more than 400 sectors share the remaining 60% of the indirect employment impacts.

Table 4.3: Top 10 Beneficiaries of the Aerospace Industry, 2009 (Indirect Impact)

	Employment
Management of companies and enterprises	1,054
Wholesale trade businesses	517
Employment services	434
Scientific research and development services	291
Architectural, engineering, and related services	284
Computer systems design services	275
Business support services	211
Telecommunications	185
Food services and drinking places	176
Real estate establishments	169
Total Top 10 Industries	**3,596**
Total Indirect Impact	**8,934**
Source: IMPLAN 2008	

Because induced effects are caused by the spending activities of aerospace industry workers, the biggest benefactors of the induced effects are businesses that provide consumer services. These beneficiaries include hospitals, doctor's offices, restaurants, and retail establishments. Table 4.4 lists the top ten industries that benefit from Virginia's aerospace industry by jobs created through induced impact. These include food services (679 jobs), health care (1,004 jobs for doctor's offices and hospitals), and various retail sectors (such as grocery stores and car dealerships). The top ten sectors account for 34% of the total induced benefit, while the other 400 plus sectors share the remaining 66% of the induced benefit.

Table 4.4: Top 10 Beneficiaries of the Aerospace Industry, 2009 (Induced Impact)

	Employment
Food services and drinking places	679
Offices of physicians, dentists, and other health practitioners	579
Private hospitals	425
Real estate establishments	376
Wholesale trade businesses	324
Retail Stores - General merchandise	257
Retail Stores - Food and beverage	232
Nursing and residential care facilities	230
Retail Stores - Motor vehicle and parts	221
Private household operations	149
Total Top 10 Industries	**3,472**
Total Indirect Impact	**10,147**
Source: IMPLAN 2008	

20 Source: IMPLAN Pro Model 2008.
21 The 2008 GSP is inflated to a 2009 figure based on the consumer price index before calculating this percentage.

Table 4.5: Virginia MSA Economic Impact Summary					
		Direct	Indirect	Induced	Total
Bristol	Spending ($Millions)	$0.1	$0.0	$0.0	$0.1
	Employment	<10	0	0	<10
Charlottesville	Spending ($Millions)	$408.5	$126.1	$86.6	$621.2
	Employment	500-1,000	759	678	1,938-2,438
Danville	Spending ($Millions)	$5.1	$0.5	$0.4	$6.0
	Employment	<10	5	4	10-19
Harrisonburg	Spending ($Millions)	$12.0	$2.1	$1.0	$15.2
	Employment	10-50	15	9	34-74
Hampton Roads	Spending ($Millions)	$523.6	$86.6	$206.1	$816.2
	Employment	2,000-3,000	487	1,154	3,641-4,641
Lynchburg	Spending ($Millions)	$3.4	$0.7	$0.2	$4.3
	Employment	<10	5	2	7-17
Northern Virginia	Spending ($Millions)	$3,150.1	$1,246.2	$797.4	$5,193.8
	Employment	4,000-5,000	5,252	4,892	14,144-15,144
Richmond	Spending ($Millions)	$12.6	$0.9	$0.6	$14.1
	Employment	10-20	4	4	18-28
Virginia	Spending ($Millions)	$4,314.0	$1,753.4	$1,521.0	$7,588.4
	Employment	9,029	8,934	10,147	28,110

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

4.4. SUMMARY IMPACT OF AEROSPACE ON VIRGINIA'S METRO AREAS

The eleven Virginia MSAs receive various degrees of the economic impact of the aerospace industry. Table 4.5 details the economic impact on Virginia's eleven metropolitan statistical areas. The Northern Virginia MSA accounts for the dominant share of the statewide economic impact. The total economic impact of the aerospace industry in the Northern Virginia MSA is estimated at $5.2 billion and over 14,000 jobs in 2009. The Hampton Roads and Charlottesville MSAs follow with the next-largest economic impacts from aerospace. In the Hampton Roads MSA, the impacts of aerospace are estimated at $816.2 million and over 3,000 jobs in 2009. In the Charlottesville MSA, the impacts of the aerospace industry are estimated at $621.2 million and over 2,000 jobs in 2009. Compared with the top three metros, the impact of the aerospace industry in the other metro areas is limited.

The MSAs where the aerospace industry has a large impact have different strengths in the aerospace industry. In the Northern Virginia MSA, the largest 6-digit aerospace industries are search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing; and guided missile and space vehicle manufacturing. By comparison, the largest 6-digit aerospace industry in the Hampton Roads MSA is space research and technology. The largest in the Charlottesville MSA is search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing.[22]

The aerospace industry in Virginia directly employed 9,029 workers and generated $4.3 billion in economic output in 2009. The ongoing operations from this industry also had ripple impacts throughout the state. The annual indirect impact is estimated at 8,934 jobs and $1.8 billion while the induced impact is estimated at 10,147 jobs and $1.5 billion in 2009. The total annual economic impact from the aerospace industry is $7.6 billion and 28,110 jobs. In addition, the aerospace industry supports 0.8% of total employment in Virginia but accounts for 1.9% of Virginia's gross state product (GSP); as such, the aerospace industry is more productive than the average industry in the state.

4.5. FISCAL IMPACT ON VIRGINIA

The state government can collect two taxes from the aerospace industry in Virginia: individual income taxes from wages and salaries generated by the aerospace industry, and corporate income taxes levied on the profits made by aerospace businesses.

The following methodology was utilized to estimate corporate and personal income taxes. The IMPLAN Pro model provides profit margins and the relative weight of wages and salaries in the total output of the aerospace industry. For example, IMPLAN Pro shows that profits account for 4.9% of the total output while wages and salaries account for 29.7% of total industry output in 2008. Moreover, the state corporate income tax rate is 6.0% of the profit, and the average personal income tax rate is 5.0% of the wages and salaries.[23]

Table 4.6 shows that the aerospace industry paid an estimated $57.5 million in tax revenue in 2009. The majority of state tax revenue comes from personal income tax amounting to $44.9

22 Please see Appendix 5 for the aerospace industry's detailed MSA impact.
23 Virginia has a progressive income tax rate. This is the tax rate for those individual making a medium income.

Table 4.6: State Fiscal Impact ($Millions, 2009)			
	Individual Income Tax	Corporate Income Tax	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$17.7	$0.7	$18.4
Aircraft Manufacturing	$1.8	$1.7	$3.6
Aircraft Engine and Engine Parts Manufacturing	$0.2	$0.1	$0.3
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$2.2	$1.1	$3.3
Guided Missile and Space Vehicle Manufacturing	$8.6	$1.1	$9.7
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.5	$0.1	$0.7
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0
Satellite Telecommunications	$3.0	$6.9	$9.9
Space Research and Technology	$10.8	$0.9	$11.7
Total	$44.9	$12.7	$57.5
Source: Chmura Economics & Analytics and IMPLAN 2008			

million per year, while the corporate income tax is estimated to total $12.7 million per year.

Among Virginia's MSAs, Northern Virginia leads the state in its concentration of aerospace industries. In 2009, the aerospace industry generated an economic impact of $5.2 billion that supported over 14,000 jobs in Northern Virginia. The Hampton Roads and Charlottesville MSAs have the next-largest presences of aerospace industry in the state.

4.6. AEROSPACE TOURISM

Aerospace tourism in Virginia is founded on the operation of museums, visitor centers, and gift shops associated with the established centers of aerospace activity around the state. These sites attract guests from within the state and abroad, bolstering the state's economy through visitors' purchases of merchandise and travel necessities. Virginia's aerospace tourism assets include four major sites: the Smithsonian National Air & Space Museum's Udvar-Hazy Center in Chantilly; the Virginia Air & Space Center in Hampton; the NASA Visitors Center Wallops Flight Facility on the Eastern Shore; and the Science Museum of Virginia, Virginia Aviation Museum.

The Steven F. Udvar-Hazy Center opened in 2003 and currently includes the massive Boeing Aviation Hangar, the James S. McDonnell Space Hangar, an observation tower, a 500-seat IMAX theater, three classrooms, and a museum shop. A second phase, including a restoration hangar, and archive and storage facilities, will be built when adequate funds are available.[24]

The two main exhibition hangars total nearly 350,000 square feet, displaying over 300 large aircraft, spacecraft, and missiles. These include an SR-71 Blackbird, the Space Shuttle Enterprise, a Concorde supersonic airliner, and the Gemini VII space capsule. The site accommodated roughly 1,199,000 visitors throughout the 2009 fiscal year. Gross sales for 2009 were estimated at $8,288,000.

The Virginia Air & Space Center (VASC) is the visitor center for NASA Langley Research Center and Langley Air Force Base. It opened in 1992 and houses 110,000 square feet of exhibits and activities, including a 3D IMAX theater, a hands-on space gallery, unique space flight artifacts, a carousel, amusement rides, and an interactive flight simulator.[25]

The Adventures in Flight gallery features 30 historic aircraft, including a DC-9 passenger jet, a B-24 Liberator, an F/A-18 Hornet, and a Wright Flyer replica. As the region's leading source of informal science education, VASC serves over 200,000 children annually with hands-on programs, demonstrations, and tours. Every summer, over 1,000 students attend VASC's science camps. VASC attracted 412,815 visitors in 2008 and collected roughly $4,500,000 in gross sales during the fiscal year.

Established in 1945, Wallops is NASA's primary facility for suborbital research programs. In addition to six rocket launch pads and a launch control center, the facility includes a research airport and engineering facilities.

NASA's recent decision to center suborbital launches at Wallops comes with the potential increase in touristic value. The escalated frequency by which NASA launches suborbital rockets is expected to attract spectators in numbers previously unseen in the past. The Wallops Flight Facility Visitor Center will be at the forefront in accommodating these visitors.

Currently, the visitor center includes several exhibits with scale models of rockets as well as full-size sounding rockets outdoors. An Educator Resource Center for teachers and group leaders offers supplemental educational resources for K-University curricula.[26]

24 National Air and Space Museum. "Steven F. Udvar-Hazy Center." Retrieved from http://www.nasm.si.edu/udvarhazy/, September 9, 2010.

25 Virginia Air and Space Center. "General Information." Retrieved from http://www.vasc.org/, September 9, 2010.

26 NASA Wallops Visitor Center. "Visiting NASA." Retrieved from http://sites.wff.nasa.gov/wvc/, September 9, 2010.

The newest asset to Virginia's space tourism portfolio will be the launches of Orbital Sciences Corporation's new Taurus II rocket to resupply the International Space Station (ISS). This 130-foot rocket will be launched from the Virginia Commercial Space Flight Authority's Mid-Atlantic Regional Spaceport. The Virginia Tourism Corporation has been actively working with MARS and hospitality industry partners throughout the Delmarva region to determine how best to develop and capture the space tourism market for these launches.

Finally, the Science Museum of Virginia, Virginia Aviation Museum houses thirty-seven historic aircraft, multiple flight simulators, and the 65-seat J.D. Benn Theater. Educational programs, tailored to students K-12, acknowledge the scientific and historical foundations of aviation. The museum also encompasses the Virginia Aviation Hall of Fame. Annual events include the Hall of Fame induction ceremony, various educational forums, and the Air Fair.

4.7. AEROSPACE EDUCATION

Virginia's educational institutions are some of the aerospace industry's strongest assets. Three public universities offer undergraduate and graduate degrees in aerospace-related fields: Old Dominion University, University of Virginia, and Virginia Polytechnic Institute and State University (Virginia Tech). In recent years, Virginia Tech has ranked among the top three universities for recruiting aerospace workers as reported through an annual workforce survey conducted by the industry magazine, *Aviation Week & Space Technology*.

The Virginia Space Grant Consortium (VSGC) fosters a collaborative atmosphere among the state's colleges/universities, NASA, state agencies, and many of the state's museum and research institutions. The VSGC is devoted to producing a skilled workforce to meet the demands of Virginia's growing aerospace industry. Every year, the VSGC extends a number of scholarships, fellowships, and internships to science, technology, engineering, and mathematics students enrolled at VSGC partner universities, colleges, and community colleges. VSGC also offers student space flight programs.

The VSGC's commitment to the future of aerospace research and engineering is further evidenced by their partnership with the NASA Langley Research Center and the Department of Education in the facilitation of the Virginia Aerospace Science and Technology Scholars program (VASTS). An educational program for high school juniors, VASTS consists of an interactive online program capped by a seven-day summer academy in which the scholars experience the day to day operations at NASA's Langley Research Center in Hampton.[27] The program has seen recent success with 347 participants in 2010, 138 of which attended the seven-day residential academy.

The National Institute of Aerospace (NIA) is a research and education institute in Hampton, Virginia. Formed by a consortium of research universities, NIA serves as a strategic partner of NASA and the Langley Research Center. NIA's research programs span over many aerospace disciplines, including aeronautics, space exploration technologies, planetary science, and space physics. The partnership between NIA and NASA allows students to pursue graduate degrees at NIA while conducting research at NASA Langley Research Center. Approximately 60 full-time and 25 part-time graduate students currently pursue master's and doctoral degrees at NIA, conducting their thesis and dissertation research at NASA Langley Research Center. NIA is also involved in aerospace education through undergraduate outreach, as well as public educational programs. In support of its mission, NIA employs approximately 100 engineers, scientists, postdoctoral fellows, and support staff along with approximately 15 faculty from NIA's member universities.

In an effort to nurture young Virginians' passion for the aerospace industry, the Virginia Space Flight Academy hosts multiple installments of the Space Flight Adventure Camp throughout the summer months. Designed for children ages 11-15, the week-long, residential camps introduce students with an interest in space flight, rocketry, robotics, astronomy, and other aerospace sciences to the inner workings of the Wallops Flight Facility. The Space Flight Adventure Camp has grown from one installment in 1998 to seven in the summer of 2010.[28]

Of the $1.124 billion in NASA grants to educational institutions nationwide during FY09, Virginia universities received just fewer than 2%. Old Dominion University, George Mason University, Hampton University, Virginia Tech, and the University of Virginia received, in total, $20,489,492 in NASA grant funding devoted to aerospace research and engineering.

4.8. INTELLIGENCE-RELATED AEROSPACE

In addition to a strong military presence, Virginia is home to a number of organizations within the U.S. Intelligence Community. Several have significant aerospace components, but details are, by necessity, often unavailable.

The National Reconnaissance Office (NRO) develops and operates overhead intelligence systems for the Intelligence Community and policy makers. An unclassified FY10 budget justification obtained under the Freedom of Information Act included

27 "About Virginia Aerospace Science and Technology Scholars." Retrieved from http://www.vasts.spacegrant.org/about September 17, 2010.

28 Space Flight Adventure Camp. "Five-Day Residential Camps," Virginia Space Flight Authority. Retrieved from http://www.vaspaceflightacademy.org/homepage.html October 22, 2010.

NRO funding for aerospace items such as launch vehicles, launch services, and launch vehicle system integration.[29]

According to NRO's Human Resources office, there are approximately 3,000 employees at the National Reconnaissance Office's headquarters in Chantilly. However, NRO has no employees of its own. NRO is jointly staffed by members of the armed services, Central Intelligence Agency, and DoD civilian personnel. Presumably, none of these 3,000 personnel are included in the survey of military base commanders described below, since NRO headquarters is not a military base.

The Central Intelligence Agency's headquarters are in Langley, near McLean. For security reasons, very little is published concerning the CIA's operations, budget, and number of employees. Furthermore, the percentage of total employees which work in Virginia is also unknown.

For these reasons, it is especially difficult to draw conclusions about the CIA's aerospace operations. Intelligence activities often involve aerospace in the form of aircraft (manned and unmanned) and satellites (for both communications and imagery). Some number of CIA personnel also perform aerospace work at NRO (see above). It is plausible that other CIA personnel work on aerospace-related tasks at the Langley headquarters. However, given the limitations on accessing information about CIA activities, these employees are not included in this study.

Table 4.7: Military Aerospace Survey Results*

Branch	Uniform	Civilian	Contractor	Total
Navy**				
Naval Air Station Oceana	7,250	721	130	8,101
Marines				
Quantico	865	32	12	909
Army				
Fort Eustis	603	420	34	1,057
Virginia Army Air Guard RIC	120	5	32	157
Air Force				
Langley Air Force Base***	10,758	1,712	619	13,089
Joint				
Defense Logistics Agency Aviation (Formerly Defense Supply Center Richmond)	42	2,851	252	3,145
Total**	**19,638**	**5,741**	**1,079**	**26,458**

*All data obtained from survey responses, unless otherwise noted.

**Navy aerospace data was reported in an aggregated format. The Naval Oceana Air Station category includes aerospace-related employees at NAS Oceana, Dam Neck Annex, and Chambers Field at Naval Station Norfolk.

***Data sourced from Fiscal Year 2008 Economic Impact Analysis: Langley Air Force Base (includes employment figures from the 192nd Virginia Air Guard)

****Installments surveyed and/or originally determined to have no aerospace-related employment: Naval Support Activity, Norfolk; Naval Activity NW Annex; Fort A.P. Hill; Fort Belvoir; Fort Lee; Fort Monroe; Joint Base Myer-Henderson Hall; Radford Ammunition Plant; Rivanna Station; U.S. Army Corps of Engineers, Norfolk District; Naval Support Facility Dahlgren; Naval Weapons Station Yorktown; Norfolk Naval Shipyard.

NOTE: Included within the survey instrument's "aerospace" definition was the request for personnel figures relating to aviation operations, as well as, conventional aerospace functions. Therefore, the figures displayed within Table 4.7 incorporate personnel performing military aerospace and aviation-related duties.

4.9. MILITARY AEROSPACE

PMG felt it necessary to include a measure of military aerospace activities within the state. The purpose of this analysis was to determine total economic impact of the aerospace industry in order to better plan the Commonwealth's promotion and support of the aerospace industry, including but not limited to tailoring workforce development in support of, and for, our returning veterans.

According to the Department of Defense's Fiscal Year 2009 Atlas, the DoD employs almost 153,000 Virginians, representing the third highest total employment by state in the country.[30] Since aerospace is an important and growing component of a modern military, its impact on the state economy should be included in a comprehensive view of the aerospace industry in Virginia. However, statistics are not available that identify the number of personnel related to military aerospace activities.

Consequently, PMG worked in close collaboration with VNDIA to develop and distribute a survey of base commanders and public affairs officers at facilities with aerospace personnel. The survey offered a cohesive definition of "aerospace" and asked respondents to report on the number of uniformed, civilian, and contractor personnel on their base who fit the definition.

With assistance from VEDP and VNDIA, PMG identified twenty-one military installations. Of these, eight were determined not to encompass aerospace-related activities. The remaining thirteen were administered the survey. Based on the survey, military spending represents an integral part of Virginia's aerospace industry. Langley Air Force Base has the highest employment totals with 13,019 uniformed, civilian, and contractor employees. Naval Air Station Oceana and Defense Logistics Agency Aviation have the second and third highest employment totals, respectively. Virginia encompasses a substantial military aerospace industry with roughly 26,000 uniformed, civilian, and contractor employees. The 1,079 contract employees have most likely been counted as part of the private-sector Virginia aerospace industry already noted earlier in this report.

29 National Reconnaissance Program. "FY 2010 Congressional Budget Justification: Volume IV." Retrieved from http://www.fas.org/irp/nro/fy2010cbjb.pdf, September 9, 2010.

30 Virginia National Defense Authority. "U.S. Department of Defense Economic Impact Data." Retrieved from http://www.vndia.org/affectedbybrac.asp, September 27, 2010.

APPENDIX 1: ECONOMIC IMPACT CONSORTIUM MEMBERS

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APPENDIX 2: STATE AEROSPACE INDUSTRY DEFINITIONS

State	Study	Summary	Industry Definition
Alabama	**The Alabama Aerospace Industry Economic Impact Survey for 2002.** Mary S. Spann, Ph.D. Office of Economic Development. University of Alabama in Huntsville. September 2003.	Survey of a combined list of approximately 400 potential aerospace companies provided by Economic Development Partnership of Alabama as well as a list of members of the Alabama Aerospace Industry Association. 203 companies retained for analysis. Federal government aerospace employment and payroll in Alabama was obtained from Public Affairs Offices at Redstone Arsenal, Maxwell/Gunter AFB and Fort Rucker.	General Manufacturing (SIC: 2823–3999; NAICS: 325211-333299) Missile & Space Vehicle Parts Manufacturing (SIC: 3764, 3769, 3795; NAICS: 336415,336419, 336992) Aircraft Parts MRO & Manufacturing (SIC: 3724, 3728; NAICS: 336412, 336413) Missile & Space Vehicle Manufacturing (SIC: 3671; NAICS: 336414) Aircraft MRO (SIC: 3721; NAICS: 336411) Engineering & R&D Services (SEC: 8711, 8731; NAICS: 41330, 1701) Information Technology Services (Not provided)
Alaska	**The Economic Benefits of the Alaska Aerospace Development Corporation. Northern Economics, Inc.** Prepared for the Alaska Aerospace Development Corporation FY2008. 2009. **Economic Impacts of the Kodiak Launch Complex.** Pershing J. Hill and Alexandra Hill. Institute of Social and Economic Research. University of Alaska Anchorage. 1996. **Economic Impact of the Alaska Aerospace. Development Corporation on the Kodiak Island Borough and the State of Alaska.** Brian Rogers, Bobby Wilken, and Jana Peirce for the Alaska Aerospace Development Corporation. 2005. (http://library.state.ak.us/asp/edocs/2006/07/ocm70700200.pdf)	Annual study highlights the AADC's contributions to the development of Alaska's aerospace industry. Northern Economics, Inc., developed an Input-Output (I-O) Model via the IMPLAN program to highlight the direct and induced effects of the AADC's regional and state spending.	
Arizona	**Arizona Aerospace, Defense, and Avionics Industries Study.** Angle Technology Group. February 2008. **The Economic Impact of Aviation in Arizona.** SH&E, with Economic Development Research Group and Lee McPheters, ASU College of Business, for Arizona DOT, 2004.	A report concerned with the development of the Aerospace, Defense, and Avionics (ADA) industries within Arizona. The report lists specific strategies to build the industries, with a focus on sustaining political consensus in the process. The primary impacts of the various aviation sectors were identified through several sources: the Arizona Department of Economic Security (ADES), providing employment and wages; a survey of airport managers provided airport employment, operating budgets, and capital expenditures; 2002 and 2003 airport economic impact studies	Commercial Aviation and Airports: Air Carriers (On/Off Airport), Air Cargo and Courier Agents, Airport Businesses Ground Transportation, Government Services, Airport Administration, Airport Construction

State	Study	Summary	Industry Definition
		conducted for the Flagstaff, Phoenix Sky Harbor, Deer Valley and Goodyear; aviation activity levels at the state's public use airports; and the Arizona Office of Tourism (AOT), provided an estimate of annual spending by domestic and international airline. The economic contribution of Arizona's military air bases was based on the Economic Impact of Arizona's Principal Military Operations (2002), prepared by The Maguire Company.	General Aviation: Non-scheduled Carriers, Aircraft Sales and Service, Aerial Services, Government Services, Airport Administration, Airport Construction Other Aviations Sectors: Aerospace Manufacturing, Aviation Education, Air Travelers, Military Aviation
California	**Economic Impact of California Space Enterprise – Fact Sheet.** California Space Authority. 2009 (http://www.californiaspaceauthority.org/images/pdfs/economic-impact-fact-sheet.pdf) **Space Industry's Impact on the California Economy – Executive Summary.** California Space Authority. 2009 (http://www.californiaspaceauthority.org/images/pdfs/California-Space-Enterprise-Economic-Impact-Exec-Summary.pdf)	Cannot find report itself, compares CA to US and world in terms of share of "space market"…CA 40% of US "space market" and 21% of world "space market". Concludes total economic impact of $76 billion, 370,000 jobs and $19.4 billion in wages to CA.	Satellite Manufacturing, launch, satellite services, ground equipment manufacturing, and engineering services
Colorado	**Aerospace: Colorado Industry Cluster Profile.** Colorado Space Coalition 2008 (http://www.spacecolorado.org/files/colorado-space/industry-overview/Aerospace_2008_CO_031009.pdf)	The aerospace industry cluster includes companies that develop products and systems for commercial, military, and space applications. Colorado's aerospace companies focus on a wide variety of areas, from research and development to the design and manufacture of guided missiles and space vehicles, satellites and other communications equipment, and navigation and detection instruments. The companies in the aerospace industry cluster also produce planetary spacecraft and launch systems and provide mission support.	NAICS Code*, NAICS Description - SIC Code, SIC Description 331512 (P) Steel investment foundries - 3324-9901 Aerospace investment castings, ferrous mfg. 331524 (P) Aluminum foundries (except die-casting) - 3365-0201 Aerospace castings, aluminum mfg. 331528 (P) Other nonferrous foundries (except diecasting) - 3369-9901 Aerospace castings, nonferrous: except aluminum mfg. 332111 (P) Iron & steel forging - 3462-05 Missile & ordnance forgings mfg. 332111 (P) Iron & steel forging - 3463-02 Nonferrous missile & ordnance forgings mfg. 332313 (P) Plate work mfg. - 3443-1104 Space simulation chambers, metal plate mfg. 332813 (P) Electroplating, plating, polishing, anodizing & coloring - 3471-0204 Decontaminating & cleaning of missile or satellite parts mfg. 332993 (P) Ammunition (except small arms) mfg. - 3483-0101 Arming & fusing devices for missiles mfg. 332993 (P) Ammunition (except small arms) mfg. - 3483-9910 Missile warheads mfg.

State	Study	Summary	Industry Definition
			333314 (P) Optical instrument & lens mfg. - 3827 Optical instruments & lenses 334220 (P) Radio & television broadcasting & wireless communications equipment mfg. - 3663-9910 Space satellite communications equipment mfg. 334511 Search, detection & navigation instrument mfg. - 3812 Search, detection, navigation, guidance 336414 Guided missile & space vehicle mfg. - 3761 Guided missiles & space vehicles 336415 Guided missile & space vehicle propulsion unit & parts mfg. - 3764 Space propulsion units & parts 336419 Other guided missile & space vehicle parts & aux. equipment mfg. - 3769 Space vehicle equipment NEC 339113 (P) Surgical appliance & supplies mfg. - 3842-0113 Space suits mfg. 423860 (P) Transportation equipment & supplies (except motor vehicle) merchant wholesalers - 5088-0300 Aircraft & space vehicle supplies & parts - wholesale trade 423860 (P) Transportation equipment & supplies (except motor vehicle) merchant wholesalers -5088-0305 Guided missiles & space vehicles - wholesale trade 423860 (P) Transportation equipment & supplies (except motor vehicle) merchant wholesalers - 5088-0307 Space propulsion units & parts – wholesale trade 517110 (P) Wired telecommunications carriers- 4841-9905 Satellite master antenna systems services (smatv) 517410 (P) Satellite telecommunications - 4899-9902 Satellite earth stations 517919 (P) All other telecommunications - 4899-9905 Missile tracking by telemetry or photography 927110 Space research & technology - 9661 Space research & technology 927110 Space research & technology - 4789-9902 Space flight operations, except government *(P) indicates that only part of the NAICS industry category is represented in the industry cluster definition.
Connecticut	None at this time		
Delaware	None at this time		
District of Columbia	None at this time		

State	Study	Summary	Industry Definition
Florida	**Economic Impact of NASA In Florida FY 2008.** NASA Office of the CFO at Kennedy Space Center. Florida (http://www.nasa.gov/centers/kennedy/pdf/318131main_economic-impact08.pdf)	Direct spending, commodity spending and visitor spending	Uses IMPLAN, but says methodology available upon request.
	An Evaluation of Florida's Economic Development Policy for the Space Industry: 1988 to 2000. Sue Gaines. Department of Urban and Regional Planning Florida State University, 2002. (http://www.coss.fsu.edu/durp/files/pdfs/research/MSP_02-01_Gaines.pdf)		APPENDIX A – Index to Comparable NAICS and SIC Industry Codes for Aerospace (Too large to be listed here)
	Florida's Aviation and Aerospace Market Brief. Enterprise Florida, Inc. 2008. Accessed from eflorida.com	A regionalized snapshot of Florida's aviation and aerospace industries highlighting, the number of companies associated with each industry sector. Specifically highlights breakthroughs in the aerospace/aviation defense and research and development sectors.	Aviation (NAICS Code/Description): 481111-Scheduled Passenger Air Transportation; 481112-Scheduled Freight Air Transportation; 481211-Nonscheduled Chartered Passenger Air Transportation; 481212-Nonscheduled Chartered Freight Air Transportation; 481219-Other Nonscheduled Air Transportation; 488111-Air Traffic Control; 488119-Other Airport Operations; 488190-Other Support Activities for Air Transportation; 611512-Flight Training Aerospace (NAICS Code/Description): 334511-Search, Detection and Navigation Instrument Manufacturing; 336411-Aircraft Manufacturing; 336412- Aircraft Engine and Engine Parts Manufacturing; 336413-Other Aircraft Parts and Auxiliary Equipment Manufacturing; 336414- Guided Missile and Space Vehicle Manufacturing; 336415, 336419-Guided Missile and Space Vehicle Propulsion Unit and Other Parts Manufacturing; 517410- Satellite Telecommunications; 927110-Space Research and Technology
Georgia	None at this time		
Hawaii	None at this time		
Idaho	None at this time		
Illinois	None at this time		
Indiana	None at this time		
Iowa	None at this time		

State	Study	Summary	Industry Definition
Kansas	**Kansas Aerospace Industry Forecast.** Center for Economic Development and Business Research. W. Frank Barton School of Business. Wichita State University, 2006. (http://www.kansasinc.org/pubs/working/Kansas%20Aerospace%20Industry%20Forecast%20-%202006.pdf)	History of IMPLAN multipliers by year from 1990-2004 and projections until 2016. Implemented a combination of IMPLAN and RIMS II multipliers to compare and contrast economic impact figures. Focused on the commercial aviation, military & defense aerospace, and general aviation sectors of Kansas' aerospace industry to establish an optimistic, pessimistic, and likely scenario of the industry's future development.	Analyzed aerospace products and parts manufacturing industry sector (NAICS code 33641), which includes: -Aircraft engine and engine parts manufacturing -Other aircraft parts and auxiliary equipment manufacturing -Guided missile and space vehicle manufacturing -Guided missile and space vehicle propulsion unit and propulsion unit parts manufacturing -Other guided missile and space vehicle parts and auxiliary equipment manufacturing
Kentucky	None at this time		
Louisiana	None at this time		
Maine	None at this time		
Maryland	None at this time		
Massachusetts	None at this time		
Michigan	None at this time		
Minnesota	None at this time		
Mississippi	**Stennis Space Center 2008 Economic Impact.** National Aeronautics and Space Administration. NASA-Facts. NASA.gov. *Referenced study conducted by Charles A. Campbell, Professor of Economics, Mississippi State University.	Very brief economic impact snapshot of the Stennis Space Center. Diagrams the direct global impact of the Stennis Space Center's 2008 operations. Focuses more specifically on the workforce directly associated with the space center.	
Missouri	None at this time		
Montana	None at this time		
Nebraska	None at this time		
Nevada	None at this time		
New Hampshire	None at this time		
New Jersey	None at this time		
New Mexico	**New Mexico Commercial Spaceport Economic Impact Study.** Developed for the State of New Mexico Economic Development Corporation. Futron Corporation. December 2005.	Estimated economic impacts based on an aerospace cluster analysis and regional impact multipliers. Futron used the Regional Input-Output Modeling System (RIMS II) to calculate anticipated economic impacts of the commercial spaceport.	The NAICS industry codes input into the RIMS II system were those associated with: -Air transportation -Hotels and Motels -Spectator Sports -Manufacturing -Management of Enterprises -Construction
New York	None at this time		
North Carolina	None at this time		
North Dakota	None at this time		

State	Study	Summary	Industry Definition
Ohio	**A Strategy for Growing the Ohio Aerospace & Defense Industry.** Prepared for The Ohio Aerospace and Defense Advisory Council & The Ohio Department of Development, Technology Division. Prepared by Jack Kleinhenz, Ziona Austrian, Ed Morrison. May 2005.	Quantitative analysis methods were based on those found in the final report issued by the Commission on the Future of the U.S. Aerospace Industry. As such, the aerospace industry was divided into aerospace defense manufacturing and aerospace and defense services.	Aerospace and Defense Manufacturing Segment (NAICS codes—Descriptions): 336411-Aircraft; 336413-Other Aircraft Parts & Auxiliary Equipment; 336414-Guided Missiles and Space Vehicles; 336419-Other Missile & Space Vehicle Parts & Equipment; 336412-Aircraft Engine and Parts; 336415-Guided Missile & Space Vehicle Propulsion Units; 334511-Search, Detection, Navigation, Guidance, Aeronautical; 332992-Small Arms Ammunition; 332993-Ammunition; 332994-Small arms; 332995-Other Ordinance and Accessories; 336992-Military Armored Vehicle, Tank & Tank Components. Aerospace and Defense Services Segment (NAICS codes—Descriptions): 481111-Scheduled Passenger Air Transportation; 481112-Scheduled Freight Air Transportation; 481211-Nonscheduled Chartered Passenger; 481212-Nonscheduled Chartered Freight; 481219-Other Nonscheduled Air; 488111-Air Traffic Control; 488119-Other Airport Operations; 488190-Other Support Activities for Air Transportation; 517410-Satellite Communications; 611512-Flight Training Schools; 927110-Space Research & Technology; 928110-National Security
Oklahoma	**Economic Impact of Aviation and the Aerospace Industry in Oklahoma - Final Report.** Prepared for the Oklahoma Aeronautics and Space Commission of the Oklahoma Department of Transportation. Prepared by the Center for Economic and Management Research. Michael F. Price College of Business. The University of Oklahoma. September 1999.	An economic impact analysis based on a summary of payroll and employment data, in combination with an airport survey. Estimates rate of growth for the aviation and aerospace industries in the state, as well as, the elevation in the rate of fuel consumption. Analysis is divided into three major sectors: Air transportation, Aircraft Manufacturing, and Federal Government and Military Aviation.	Multipliers were generated by IMPLAN program, however no specifics were provided beyond the explanation of the major sectors: Air transportation – including civilian airports, airlines, airline aircraft maintenance centers, air freight and air cargo, airline reservation centers, and local spending by commercial airline passengers. Aircraft manufacturing – including private sector manufacturing of aircraft, aircraft engines, and aircraft parts. Federal Government and Military Aviation – including civilian, military, and federal government employment at Tinker Air Force Base, Altus Air Force Base, Vance Air Force Base, Henry Post Field at Ft. Sill, Air National Guard facilities and the Mike Monroney Aeronautical Center.
Oregon	None at this time		
Pennsylvania	None at this time		
Rhode Island	None at this time		
South Carolina	None at this time		
South Dakota	None at this time		
Tennessee	None at this time		

State	Study	Summary	Industry Definition
Texas	**Aerospace Industry Competitiveness Study**. April 2009.		
	The Aerospace Industry in San Antonio – Economic Impact in 2007. Prepared for the San Antonio Chamber of Commerce by Richard V. Butler, Ph.D. and Mary E. Stefl, Ph.D. Trinity University	The study is completed strictly from an aeronautics perspective. The industry is divided into two all-encompassing sectors: Services/Manufacturing and Transportation. It outlines the industry's growth, employment numbers, wage numbers, and economic impact.	Services and Manufacturing (NAICS code—description): 33641-Aerospace Products and Parts Manufacturing; 42386-Transportation Equipment and Supplies Wholesaling Transportation (NAICS codes—description): 48111-Scheduled Air Transportation; 48121-Nonscheduled Air Transportation; 48811-Airport Operations; 48819-Other Support Activities for Air Transportation; 611512-Flight Schools
Utah	None at this time		
Vermont	None at this time		
Virginia	**Definition of the Aerospace Industry.** Virginia Economic Development Partnership. (http://www.yesvirginia.org/businesssectors/Aerospace.aspx)		
Washington	**The Washington Aerospace Industry.** Prepared for Aerospace Futures Alliance of Washington. Richard S. Conway, Jr. and Douglas H. Pedersen of The Puget Sound Economic Forecaster / Conway Pedersen Economics, Inc. January 2006	The study attributes one chapter to an economic impact analysis of the aerospace industry in Washington. It takes a company/establishment based approach from which employment figures are then derived. These employment figures are then plugged into multiplier simulations which provide estimates for the overall impact of the industry on the state's economy.	Provides company numbers divided into four aerospace industry sectors: Aircraft manufacturing, Aircraft engines and parts, Other aircraft parts, Space vehicles
West Virginia	None at this time		
Wisconsin	None at this time		
Wyoming	None at this time		

Other Aerospace Links (Not Economic Impact Studies)

Alabama: Up in the Air Alabama. Barbara Sloan. Partners. Spring 2004.

* explores Alabama's role in aerospace and aviation

California: California Economic Strategy Panel - Special Statewide Forum on the California Aerospace Industry Cluster - White Paper on Issues and Opportunities.

Texas: A Snapshot of the Texas Aerospace Industry and a Comparison of Competitor States. The Bush School of Government and Public Service. Texas A&M University.

Texas: State of Texas Aerospace and Defense Cluster Assessment. August 2005.

Utah: Utah Aerospace Industry Profile. Economic Development Corporation of Utah. 2009.

United States: America's Aerospace Industry: Identifying and Addressing Workforce Challenges. Report of Findings and Recommendations for The President's High Growth Job Training Initiative in the Aerospace Industry. May 2005

Washington: Aerospace Industry Competitiveness Study. Deloitte Consulting. Prepared for the Economic Development Council of Snohomish County. April 2009.

APPENDIX 3: DETAILED NAICS DEFINITIONS FOR AEROSPACE

339113 Surgical Appliance and Supplies Manufacturing

This industry comprises establishments primarily engaged in manufacturing surgical appliances and supplies. Examples of products made by these establishments are orthopedic devices, prosthetic appliances, surgical dressings, crutches, surgical sutures, personal industrial safety devices (except protective eyewear), hospital beds, and operating room tables.

334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing

This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment. Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and broadcasting equipment.

334511 Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing

This industry comprises establishments primarily engaged in manufacturing search, detection, navigation, guidance, aeronautical, and nautical systems and instruments. Examples of products made by these establishments are aircraft instruments (except engine), flight recorders, navigational instruments and systems, radar systems and equipment, and sonar systems and equipment.

336411 Aircraft Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing or assembling complete aircraft; (2) developing and making aircraft prototypes; (3) aircraft conversion (i.e., major modifications to systems); and (4) complete aircraft overhaul and rebuilding (i.e., periodic restoration of aircraft to original design specifications).

336412 Aircraft Engine and Engine Parts Manufacturing

This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing aircraft engines and engine parts; (2) developing and making prototypes of aircraft engines and engine parts; (3) aircraft propulsion system conversion (i.e., major modifications to systems); and (4) aircraft propulsion systems overhaul and rebuilding (i.e., periodic restoration of aircraft propulsion system to original design specifications).

336413 Other Aircraft Parts and Auxiliary Equipment Manufacturing

This industry comprises establishment primarily engaged in (1) manufacturing aircraft parts or auxiliary equipment (except engines and aircraft fluid power subassemblies) and/or (2) developing and making prototypes of aircraft parts and auxiliary equipment. Auxiliary equipment includes such items as crop dusting apparatus, armament racks, inflight refueling equipment, and external fuel tanks.

336414 Guided Missile and Space Vehicle Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing complete guided missiles and space vehicles and/or (2) developing and making prototypes of guided missiles or space vehicles.

336415 Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing guided missile and/or space vehicle propulsion units and propulsion unit parts and/or (2) developing and making prototypes of guided missile and space vehicle propulsion units and propulsion unit parts.

336419 Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing

This industry comprises establishments primarily engaged in (1) manufacturing guided missile and space vehicle parts and auxiliary equipment (except guided missile and space vehicle propulsion units and propulsion unit parts) and/or (2) developing and making prototypes of guided missile and space vehicle parts and auxiliary equipment.

332995 Other Ordnance and Accessories Manufacturing

This industry comprises establishments primarily engaged in manufacturing ordnance (except small arms) and accessories.

481212 Nonscheduled Chartered Freight Air Transportation

This industry comprises establishments primarily engaged in providing air transportation of cargo without transporting passengers with no regular routes and regular schedules.

517410 Satellite Telecommunications

This industry comprises establishments primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications.

541370 Surveying and Mapping (except Geophysical) Services

This industry comprises establishments primarily engaged in performing surveying and mapping services of the surface of the earth, including the sea floor. These services may include surveying and mapping of areas above or below the surface of the earth, such as the creation of view easements or segregating rights in parcels of land by creating underground utility easements.

927110 Space Research and Technology

This industry comprises government establishments primarily engaged in the administration and operations of space flights, space research, and space exploration. Included in this industry are government establishments operating space flight centers.

APPENDIX 4: IMPACT STUDY GLOSSARY

IMPLAN Professional is an economic impact assessment modeling system. It allows the user to build economic models to estimate the impact of economic changes in states, counties, or communities. It was created in the 1970s by the Forestry Service and is widely used by economists to estimate the impact of specific events on the overall economy.

Input-Out Analysis—an examination of business-business and business-consumer economic relationships capturing all monetary transactions in a given period, allowing one to calculate the effects of a change in an economic activity on the entire economy (impact analysis).

Direct Impact—economic activity generated by a project or operation. For construction, this represents activity of the contractor; for operations, this represents activity by tenants of the property.

Overhead—construction inputs not provided by the contractor.

Indirect Impact—secondary economic activity that is generated by a project or operation. An example might be a new office building generating demand for parking garages.

Induced (Household) Impact—economic activity generated by household income resulting from direct and indirect impact.

Multiplier—the cumulative impact of a unit change in economic activity on the entire economy.

APPENDIX 5: DETAILED AEROSPACE IMPACT BY METRO AREA

Economic Impact of the Aerospace Industry on the Bristol MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Space Research and Technology	$0.1	$0.0	$0.0	$0.1	<10	0	0	<10
Total	**$0.1**	**$0.0**	**$0.0**	**$0.1**	**<10**	**0**	**0**	**<10**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Charlottesville MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$407.8	$125.9	$86.5	$620.2	500-1,000	758	677	1,935-2,435
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$0.7	$0.2	$0.1	$1.0	1	1	1	3
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$408.5**	**$126.1**	**$86.6**	**$621.2**	**500-1,000**	**759**	**678**	**1,938-2,438**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Danville MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$5.1	$0.5	$0.4	$6.0	<10	5	4	10-19
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$5.1**	**$0.5**	**$0.4**	**$6.0**	**<10**	**5**	**4**	**10-19**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Harrisonburg MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$12.0	$2.1	$1.0	$15.2	10-50	15	9	34-74
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$12.0**	**$2.1**	**$1.0**	**$15.2**	**10-50**	**15**	**9**	**34-74**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Hampton Roads MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$50.9	$18.2	$13.0	$82.0	100-500	105	101	306-706
Aircraft Manufacturing	$58.6	$11.3	$6.3	$76.1	50-100	84	67	201-251
Aircraft Engine and Engine Parts Manufacturing	$12.9	$2.8	$2.3	$18.0	10-50	19	18	47-87
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$59.3	$23.3	$10.6	$93.2	100-500	169	102	371-771
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$2.6	$1.3	$0.5	$4.4	<10	4	2	6-16
Space Research and Technology	$339.3	$29.7	$173.5	$542.5	1,000-2,000	106	864	1,970-2,970
Total	**$523.6**	**$86.6**	**$206.1**	**$816.2**	**2,000-3,000**	**487**	**1,154**	**3,641-4,641**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Lynchburg MSA

	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$3.4	$0.7	$0.2	$4.3	<10	5	2	7-17
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$3.4**	**$0.7**	**$0.2**	**$4.3**	**<10**	**5**	**2**	**7-17**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Northern Virginia MSA								
	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$1,430.3	$526.3	$444.2	$2,400.8	2,000-3,000	2,240	2,806	7,046-8,046
Aircraft Manufacturing	$249.0	$50.0	$31.9	$330.8	100-500	284	277	661-1,061
Aircraft Engine and Engine Parts Manufacturing	$0.9	$0.3	$0.1	$1.3	<10	1	1	2-12
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$1.6	$0.5	$0.4	$2.4	<10	3	3	6-16
Guided Missile and Space Vehicle Manufacturing	$931.7	$383.1	$220.9	$1,535.7	1,000-2000	2,129	1,429	4,558-5,558
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$2.6	$0.8	$0.9	$4.4	<10	5	7	12-22
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$534.1	$285.3	$99.0	$918.3	100-500	590	369	1,059-1,459
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$3,150.1**	**$1,246.2**	**$797.4**	**$5,193.8**	**4,000-5,000**	**5,252**	**4,892**	**14,144-15,144**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Economic Impact of the Aerospace Industry on the Richmond MSA								
	Spending Impact ($Millions)				Employment Impact			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	$0.3	$0.1	$0.1	$0.5	<10	1	1	2-12
Aircraft Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Aircraft Engine and Engine Parts Manufacturing	$10.6	$0.0	$0.0	$10.6	<20	0	0	<20
Other Aircraft Parts and Auxiliary Equipment Manufacturing	$0.8	$0.4	$0.2	$1.4	<10	2	2	4-14
Guided Missile and Space Vehicle Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Satellite Telecommunications	$0.9	$0.5	$0.2	$1.6	<10	1	1	2-12
Space Research and Technology	$0.0	$0.0	$0.0	$0.0	0	0	0	0
Total	**$12.6**	**$0.9**	**$0.6**	**$14.1**	**10-20**	**4**	**4**	**18-28**

Note: Figures may not sum due to rounding.
Source: Chmura Economics & Analytics and IMPLAN 2008

Notes:

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