

Brevard Workforce Development Board, Inc.
Senate Committee on Commerce, Science, and Transportation Field Hearing
June 23, 2008

Thank you for this opportunity to address your committee regarding the efforts of Brevard Workforce Development Board (BWDB) related to the aerospace workforce transition. This has been an ongoing collaborative effort and I thank all of those who were involved. We are anxious to serve the community and mitigate the impact of the changes as much as possible.

In August 2007, the Board released the Aerospace Workforce Outlook Report, which addressed several recommendations including gathering stakeholders to determine the path for the workforce transition. The Aerospace Career Development Council (ACDC), set up work teams around workforce, education and economic development activities, which resulted in securing \$1.25 million in general revenue funds for retooling and retraining the aerospace workforce. It is the implementation plan for these funds I will focus on in the next few minutes. However, before I begin outlining the plan, I'd like to quickly tell you about a bridge.

In October 1989 the Oakland Bay bridge top deck collapsed onto the lower deck. Normally it would take months to bring such a structure back into full operation; however, the bridge was closed for just over 30 days. The amazing reason for this quick rebuild is directly relevant to the upcoming changes from Shuttle to Constellation. The winning contractor embedded his workers and the city's inspectors into the production plants to allow for a quick - design to development to implementation cycle for rebuilding the bridge. This forward thinking approach is the same one the Board is taking with the retooling and retraining of aerospace workers.

The Board's transition plan begins with a communication effort focused on life long learning. Engaging the workforce in skills upgrades is necessary for those going to work on Constellation and for those who may venture into totally new careers. We view this as either retooling their skills for the next phase of aerospace work or retraining them for their next phase of life.

Additionally, communication with businesses will provide us information about emerging skills which then translates to training requirements for the workforce.

Our second component involves a workforce assessment to understand where workers need to improve to be competitive for Constellation activities. This will ensure that NASA and contractors take full advantage of the current workforce skills for the new spaceflight system.

However, not all workers will remain with Constellation and for those who are ready for the next phase of their life the workforce assessments will be valuable in pointing the way to high demand, high wage occupations in the area.

Training is the largest component in the transition plan. We're already retooling workers with Lockheed Martin's Orion production activities. The ability to sit with Lockheed Martin at an early stage to identify these training needs gave a jumpstart to the training processes.

These retooling activities are essential if we want to model the proactive approach used on that bridge in California. Our workforce has been through the life cycle of a space flight system and they are ready for the challenges of a new system. Following NASA's systems engineering framework, training is focused on common technical processes, incorporates tools and methods, and engages the workforce early. We must recognize that the US has not had a new spaceflight system since the Shuttle and it is incumbent upon us to undergo a corresponding organizational and skills transformation that's not been experienced since the end of Apollo,

We have the talented workforce, now we can build upon their skills through training embedded in the design, development, production and implementation phases critical to Constellation's success. Embedded training isn't a new concept as a similar approach was used with International Space Station allowing operations people to learn the system first hand and offer operations perspectives from the start.

The fourth component addresses the human factor of the plan. This is about life changes the workforce is already experiencing and will provide career transition mentoring designed to motivate workers by focusing on moving through the phases of transition. Our staff will be there to help the workers understand challenges, define goals and develop realistic action plans.

Additionally, staff will analyze customer education and work experience to provide direct information on occupations that match closely to their skills. As training needs are identified staff will: provide information on available courses; enter into individual training agreements with financial support; and follow up with individuals throughout the training process.

In closing, Wayne Gretsky was often recognized as the best hockey player ever. When asked why, Wayne replied that he goes where the hockey puck is going to be, not where it is now. We are taking this same approach in order to, increase workforce proficiency at the earliest possible stage while in complete support of the beginning of a new systems engineering life cycle.

Thank you for your time.

###



Aerospace Workforce Outlook

An Analysis of Shuttle Retirement Implications On the Aerospace Industry Workforce In Florida

August 2007

Abstract

This report provides a forward-looking analysis of select areas of the current Brevard County and statewide aerospace workforce that will be impacted by the planned retirement of the Space Shuttle in 2010. It also describes the challenges that are likely to be associated with transition of the Brevard workforce to new space programs of the future.

[The analysis is by nature preliminary, as the current workforce will continue at levels required to maintain full-scale Shuttle spaceflight operations through 2010, with the program going through an orderly phase down of program assets over the next few years after the retirement date. As such, the current visibility into the programs that likely represent the future utilization of the highly skilled Shuttle workforce are still being defined, and will continue to become better clarified as the transition comes closer in time. Therefore, this report will be updated periodically to support transition planning activities and development of training/assistance programs, and new work/program opportunities for the Shuttle workforce.]

Specifically, this report summarizes information gathered by the Brevard Workforce Development Board Inc. (BWDB) which characterizes the current workforce of the Shuttle prime contractor and the major sub-tiers of the aerospace supply chain that are directly involved with spaceflight operations and support of the NASA Shuttle Program. It also describes some of the challenges likely to be encountered by NASA and the State with transition of the workforce to new opportunities. Wherever possible, the analysis includes related and secondary workforce assessments for such indirect support activities as those provided by Air Force contractors for support functions at the Cape Canaveral Air Station, its Range operations, and the myriad of local businesses and supply services companies that will be affected by a significant decline in the Shuttle-related employment base.

The goal of the report is to provide a “snapshot” display of the aerospace workforce today, representing the BWDB information which includes the number of shuttle workers involved in the program, depth of experience, training levels and occupational classifications that are most likely to be impacted in some way following the planned retirement of the Shuttle. Data supporting the “snapshot” report were gathered through primary source research and survey contact with key industry employers. Where possible, an estimate of the primary and secondary economic contribution to the state from the Shuttle-related workforce and businesses is also provided.

Table of Contents

	<u>Page</u>
<u>Executive Summary</u>	4
<u>I. Introduction</u>	6
A. Survey Purpose and Background	6
B. Program Transition Challenges	7
C. Florida's Opportunity	14
<u>II. Brevard Workforce Development Board Response</u>	16
A. Role of the BWDB	16
B. Partnership Working Together for the Workforce	16
C. BWDB Response to the Future Need / Near-Term Impact	17
<u>III. Baseline Survey of Shuttle-Related Workforce</u>	20
A. Objectives / Scope of Survey	20
B. Approach and Execution	20
C. Issues Regarding Data Collection and Analysis	22
D. Characterization /Evolution of Current Shuttle Workforce	23
E. Economic Impact	26
<u>IV. Workforce Profile – “Snapshot”</u>	26
<u>V. Need for Skills Mapping Initiatives and Training</u>	31
<u>VI. Recommendations</u>	33

Appendices

	<u>Page</u>
Appendix A: Interview and Survey Guidelines - Shuttle Workforce Baseline Outlook Study	36
Appendix B: BWDB Baseline Elements	38
Appendix C: Sample – Survey Data The Prime Contractor for Space Program Operations	39
Appendix D: The Prime Contractor – Estimated Number of Workers (Summary Level Only)	42
Appendix E: Preliminary Constellation Program Skill-Area Needs (Summary Level only)	43
Appendix F: Selected Example Shuttle-related Job Titles and Work Definitions for Ground Systems Operations Support Functions	45
Appendix G: Estimated Engineering Manpower for Major Shuttle Contractors	46

Executive Summary

Cutbacks scheduled to occur during NASA's shift from the Shuttle to the Crew Exploration Vehicle (CEV) program known as Constellation, in a region overly dependent on tourism, aerospace and defense, and with no formal workforce transitional processes, is the impetus for Brevard Workforce Development Board Inc. (BWDB) to conduct a baseline survey of the Space Shuttle Program workforce in Florida. The result of that survey is the Aerospace Workforce Outlook (AWO) report. The AWO attempts to identify and characterize the size, job classifications and skills, of the Shuttle-related workforce as preparation for the planning and accomplishment of a successful transition of the workforce to new opportunities.

The survey took into account multiple issues including the need to: maintain required skills and workforce levels through the period of required shuttle operation; maintain the workforce skills required for completion of the ISS; successfully secure new space program opportunities in future Constellation program-related activities; create robust new employment opportunities for the workforce in targeted non-space industry areas; and ensure that there is a family of assistance and support services for workers to facilitate their taking advantage of the next generation employment opportunities available. BWDB recognizes that the transition is more than just workforce services, it also includes economic development and educational activities. This report focuses on the workforce support but also acknowledges the importance of simultaneously advancing economic development efforts by leveraging workforce skills and engaging education to meet the demands of new occupations and skills requirements.

The survey found that most employers recognize Florida's Shuttle workforce as a unique asset, critical to the future of the next generation space program. It is the best recruiting and economic development tool that Brevard has in attracting new space and other industry employers.

Shuttle-related activity in Florida supports a workforce level of approximately 9,235 employees, (not including Federal – NASA – workers) with approximately 6,340 United Space Alliance (USA) employees and an estimated 2,895 sub-tier and related support contractors. The total estimated shuttle-related payroll for this workforce is estimated at \$600,000,000.

The majority of this workforce is located at or near to the Kennedy Space Center; however the total economic spread of the Shuttle Program is statewide, and has a specific Shuttle-related supplier base of some 1046 companies throughout the state. The shuttle program provides an estimated secondary economic contribution to the state of approximately \$2 billion above salaries.

Shuttle workforce skills are highly translatable to any future work that the state pursues as part of its next-generation space activities. It is estimated that

approximately one-third of the Florida Shuttle-related Workforce will need some form of transition assistance.

The BDWB recommends, and intends to work towards, immediate implementation of the recommendations detailed in Section VI of this report, as the foundation for an effective transition for the Shuttle workforce. These recommendations include:

- Establish a Space Act Agreement with NASA for transition activities
 - Establish the Aerospace Career Development Council with state, local and industry partners to determine strategic direction and provide effective transition support to the workforce and employers.
 - Initiate immediate development of specific training and workforce assistance programs to support transition activities
 - Continue to develop a workforce data-base and workforce management system to support joint transition activities with NASA, economic development organizations and employers in multiple industries.

I. Introduction

A. Study Purpose and Background

The National Aeronautics and Space Administration (NASA)'s Space Transportation System (STS) "Shuttle" is key to implementing the President's national space policy, which calls for completing the assembly of the International Space Station (ISS) by the end of the decade and, in the process, begin implementation of the nation's Vision for Space Exploration. It also calls for the Space Shuttle to be retired after ISS assembly is completed, which currently is the nation's only launch system capable of transporting personnel, ISS components, supply and other logistics, and science payloads up to the ISS and returning with critical payload mass.

To meet the goals of this space strategy, NASA and its industry partners must first satisfy the requirements of the ISS international partners and complete the assembly of the ISS to an acceptable configuration, and then retire the space shuttle and the program's assets over a phase-down period after the last shuttle flight. Concurrently the agency must initiate the development and delivery of a new class of spacecraft, launch vehicles and other space and ground support equipment, representing the near-term future of the NASA manned space and lunar exploration program. Achieving this will require the agency to rely on, and maintain the strength and integrity of its most important asset, its highly skilled spaceflight operations workforce.

Maintaining the skilled Shuttle workforce through retirement will be challenging at best, especially as the proposed shuttle retirement date approaches. However, this highly skilled workforce is a national resource and also represents a critical element of Florida's future in new space programs, as well as in some key non-space industries. As the retirement date draws near, the workforce attrition rate will likely rise unless the workforce can see a robust environment in future space program initiatives, or emerging industries, and a clear transition path to these opportunities. The successful management of the workforce transition to the new programs and future job opportunities is a critical priority for the Nation, State, County, NASA, key shuttle contractors, and BWDB.

The purpose of this effort is to identify and characterize the current workforce of the Shuttle prime contractors and the major sub-tiers of the aerospace supply chain, that are directly involved with spaceflight operations and support of the NASA Shuttle Program. The report describes some of the challenges likely to be encountered by NASA and the state in transition of the workforce to new opportunities. As a result of the survey effort, the Brevard Workforce Development Board (BWDB) has developed some recommendations and guidelines relative to training and other workforce assistance programs that will help ensure successful transition of this workforce to future opportunities.

B. Program and Transition Challenges

In order to manage this successful transition, it is essential that state, local and federal officials listen to, and work closely with, their industry counterparts to provide the programs, training, and other assistance services necessary to accomplish the following:

- Maintain required skills and workforce levels through the period of required shuttle operation, at least through 2010,
- Maintain the workforce skills required for completion of the ISS, and facilitate the transition of transportation, re-supply and logistics support of the station to future commercial and international operational support,
- Successfully secure new space program opportunities in future Constellation program-related activities,
- Create robust new employment opportunities for the workforce in targeted non-space industry areas, and
- Ensure that resources are available to provide assistance and support services for workers, where required, to facilitate their taking advantage of the next generation of employment opportunities available.
- Communicate to various industries nation-wide the existence of a workforce in Florida which has a culture of quality and whose skills are transferable

Each of these elements presents unique challenges for the agency, contractors, and community partners that are concerned with the shuttle workforce. Some of the issues associated with accomplishing these goals are described below:

Issue #1: Maintaining the shuttle workforce integrity and skill levels as required through ISS completion, while accomplishing a gradual phase-down and transition of the physical and knowledge assets of the shuttle program during its close out activities.

The shuttle's launch system preparation, mission conduct and retrieval, and post-flight servicing operations are both complex and extremely manpower intensive. On a national basis, the total shuttle workforce currently consists of approximately 2,000 civil service and approximately 15,000+ contractor personnel, mainly comprised of a large number of engineers, scientists and skilled technicians located primarily in the states of Texas, Alabama, and Florida. The system's remaining flight manifest consists of 14 flight missions, 13 to complete assembly and integration of the ISS, and one servicing mission to the Hubble Space Telescope. All shuttle flights are scheduled to be accomplished by 2010.

NASA Headquarters, Kennedy Space Center, and local officials have been planning for the retirement of the shuttle by reviewing lessons learned and examining best practices from the experience of other activities, including termination of other major programs, especially where the program involved closing facilities and the

transitioning of capabilities. Included among these were the termination of several past NASA spaceflight system development initiatives, the termination and close-out of the Titan IV rocket, the closing of the NAVY F/A-18 C/D fighter production, and the complexities associated with a number of Base Realignment and Closure (BRAC) activities.

A review of the lessons learned indicates that closing and transitioning facilities, equipment, and people is expensive and time consuming. The principal lesson learned is that, historically, it has generally taken 3+ years to close down a program fully, complete transition of usable assets and property to new programs, and dispose of excess property. In addition, keeping the existing workforce in-place after termination decisions have been announced is a significant related challenge.

BWDB's research on other workforce areas faced with large layoffs indicates several best practices to follow including: improving displaced workers knowledge of and access to re-employment services; mobilizing a community-wide team to strategically deal with issues of the workforce transition; extending and supporting new enterprise development; and enhancing business relationships to leverage training funds, understand skills development needs and gain access to the workforce before the layoffs begin.

In the case of the shuttle program, transition issues are even more complicated and include: sustaining workforce viability in the midst of retirements and attrition; managing and maintaining the reliability of the shuttle supplier base; completing and providing logistical support to the International Space Station; identifying and disposing of shuttle-related property and equipment; ensuring adequate environmental remediation; effectively managing the new systems development and acquisition efforts; and transforming other hardware, systems and workforce assets to the new space system programs.

The extent of the shuttle-related assets is estimated to be 900,000 pieces of hardware and equipment, and approximately 650 facilities. Space Shuttle-related assets and equipment is dispersed across a number of NASA Centers and its contractors, and has been valued at more than \$12 billion. The total value of NASA shuttle-related facilities is estimated at over \$6 billion. Much of the hardware and assets are aged and requires significant base maintenance and repair. The agency is evaluating existing facilities and equipment that will no longer be needed following shuttle retirement. In cases where facilities and equipment are too aged, or are not required for use in the Exploration Program and no other use is identified, they will transition to a designated NASA field center for disposition.

In addition to aged facilities, the shuttle workforce is itself aging and may require some replenishment through the period between now and 2010 if the program experiences other-than-normal retirements and attrition. The overall NASA workforce has matured like the shuttles. By 2010, it is estimated that approximately 30 percent of the workforce at the Kennedy, Marshall and Johnson Space Centers

will be eligible for retirement. An estimated one-quarter of all shuttle workers at those three centers are 51 years old or older. Maintaining workforce integrity and effectiveness through the end of the flight operations and phase down period will be a significant challenge in the light of normal retirements, attrition, and the attractiveness of new program opportunities in other areas.

Issue #2: Maintaining the extremely robust shuttle flight schedule will tax agency flight operations and staff, with political pressure from International partners and Capitol Hill, which may create the possibility of some flight stretches to ensure ISS completion.

The currently approved manifest and schedule for the 14 remaining flights, in order to complete the station by 2010, is extremely tight, and requires maintaining a flight rate of 4+ per year. The shuttle has historically and routinely experienced a number of computer, sensor and other glitches during check-out and preparation for each flight that have been particularly troublesome. Many of these are still being addressed by NASA engineers at KSC and other Centers on an on-going basis. Agency officials have been working hard to identify the causes and resolve other flight-preparation issues, and have clearly focused the shuttle workforce on completing the remaining 14 flight schedule that will, by itself, tax agency resources to its maximum.

With the aging, retirement and attrition that are normal within the shuttle workforce, some critical skills and knowledge may be lost to the program, especially, the “long-term, hands-on, experience-based knowledge that senior technicians and engineers have in their heads.” This problem could become more significant in the light of any accelerated attrition, and the attractiveness of new program opportunities.

Additionally, it has been suggested by some spaceflight officials that even with relaxed flight operations and launch rules and with the flexibility to conduct night launches, the total completion schedule will be difficult to attain by 2010. In the remaining assembly schedule, each flight is considered very intricate in its makeup, involving complex payloads and flight /construction operations (except for the last three which are primarily logistics re-supply missions). The remaining missions will severely challenge the agency’s abilities for flight operations and Station completion, even without normal attrition; and major perturbations in the quality and level of the workforce must be avoided.

While NASA’s plan and focus is on completing the remaining scheduled shuttle flights and the ISS by 2010, some members on Capitol Hill have recognized the difficulty of the remaining flight schedule for the agency, and have indicated a willingness to consider later-year funding for some flight operations of the STS beyond 2010 if required, and if requested by the White House. While this is not considered likely in the current environment, the possibility of some limited flight operations extending beyond 2010 should not be overlooked, in considering the

transition plan for the shuttle workforce and the need to maintain its skill level throughout.

Issue #3: Maintaining critical manned spaceflight skills during an extended gap in human spaceflight.

The first next-generation space vehicles currently are targeted to begin operating no earlier than 2015, thereby creating a potential gap in U.S. human space flight. The White House, Congress and the space community at large have voiced loud concern over the United States' loss of continuous access to space during this gap. NASA has made it a priority to minimize the gap to the extent possible, within its budget constraints. This gap in U.S. human space flight also presents a national security issue when all manned space flights will be dependent upon Russian or Chinese cooperation.

The agency is already deferring some lower-priority efforts, or scaling back and discontinuing others in order to stay within budgeted funding for the initial Constellation activities and other programs. In recent Congressional testimony, the NASA Administrator indicated that the costs associated with returning the shuttle to flight and continued shuttle operations, as well as recent budget reductions under the 2006 Continuing Resolution, had the combined effect of increasing the gap by delaying the first manned Orion test flight by 6 months. And, program "slips-in-schedule" generally contribute to "cost-growth" in a program, and could make workforce transition and retention efforts more difficult.

In an effort to address the gap in U.S. capability to re-supply the space station following retirement of the shuttle, NASA is investing in commercially supplied space transportation services. NASA's expectation is that by acquiring domestic orbital transportation services it will be able to send cargo and, in the future, transport crews to the ISS in a cost-effective manner. This is NASA's Commercial Orbital Transportation Services (COTS) program.

At the time of this paper, the COTS program is in the early stages of development, with several companies who will likely bid on supplying these services for the NASA. Rocketplane-Kistler and Space X have been given funded Space Act Agreements for development and demonstration of the capability to meet the re-supply missions. At least five others have unfunded agreements which provide for NASA cooperation in similar demonstrations. Several other companies, even though unannounced, are considering competing to supply these future services to the ISS and NASA.

However, should COTS services not materialize, or should they prove to be unreliable or more costly than anticipated, NASA will likely purchase space transportation services from its international partners to meet obligations to the ISS until new next-generation spacecraft become operational.

The existence of a robust workforce with considerable spaceflight and launch operations skills and experience will provide a powerful asset for COTS success, as

well as a powerful incentive for COTS suppliers to locate their future operations near the Florida Space Coast. The viability of the workforce must be maintained during any prolonged down-time in manned and un-manned space flight, to avoid this capability being lost to other areas.

Issue #4: Securing new work opportunities in the next generation space program and activities for the Florida workforce.

In January of 2004, the President of the United States announced a new national program entitled the nation's *Vision* for Space Exploration, which directed NASA to initiate the multiple programs and system developments necessary for returning humans to the moon by 2020 and setting the stage for future, longer duration missions to Mars and other destinations.

NASA has responded to this mandate through definition of its Constellation Program which will develop and field a new class of spacecraft, launch vehicles and other vehicles and ground support equipment, representing the near-term future of the NASA manned space and lunar exploration program. A new class of robotic and science based spacecraft for lunar and Mars and other planetary exploration will complement this fleet.

NASA's plan includes returning to the moon aboard the new space craft, the Orion Crew Exploration Vehicle which is under development and scheduled for its first flights early in the next decade. Lockheed Martin Corporation was awarded the contract to build Orion in August, 2006, and the development is taking place in parallel with missions to complete the International Space Station (ISS).

The Constellation Program contains multiple target areas for future program activity which could and will take advantage of Florida's robust workforce asset. These include:

- Crew Exploration Vehicle - There is the opportunity to attract additional CEV-related manufacturing work to Florida. In early 2006, Lockheed Martin, chose Florida as its site to perform final assembly and testing of the CEV at Cape Canaveral creating 350 to 400 jobs. There will be similar program cost gains to be realized from placing selected additional manufacturing and sub-system assembly and processing work also at Cape Canaveral. In addition, there will be later-term opportunities in the Orion Program related to later stage system elements and multiple sub-tier contracts to be pursued.
- Crew Launch Vehicle (CLV) / Cargo Launch Vehicle (CaLV) - There is the opportunity to pursue selected sub-system work, including assembly, processing, and/or maintenance and operations support service activity for the CLV/CaLV's. In addition, there are multiple later stage opportunities in both the Crew Launch Vehicle (2 Stages; multiple sub-tier contracts and vendor relationships) and the Cargo Launch Vehicle (3 Stages; similar sub-

tier contract opportunities) to be pursued, all requiring Florida's skilled workforce for multiple functions.

- System Engineering and Integration of Constellation elements - to include modeling and simulation opportunities for Florida, highlighting the state's historical strength in Simulation and modeling capabilities and aerospace education and engineering.

- CLV Instrument Unit – The KSC will have a surplus of facilities, equipment and other resources that are well suited as assets for the eventual winner of the CLV Instrumentation Unit. Dialogue is on-going with most of the industry teams that are competing for this program in an effort to identify program efficiencies and benefits to their placement of future work functions in Florida.

- Lunar Surface Access Module – There are near-term opportunities to establish dialogue with system planners on placing local processing and maintenance support of these vehicles close to the point of launch. Significant life sciences and crew-environment support opportunities also exist for Florida-based operations.

- Multiple other opportunities exist in future elements of the program as well:

- Lunar Surface Access Module, LSSM (2 Stages; hundreds of contracts)
- Launch and Mission Systems (Ground Support infrastructure; multiple vendors and sub-tier contract opportunities)
 - Crew and Cargo Processing Services (multiple contracts)
- Lunar Surface Systems (Lunar Outpost Requirements; hundreds of contracts)
 - Mars Surface Lander (2 Stages; multiple contracts)
- Mars Surface Systems (Mars Outpost Requirements; hundreds of contracts)

The State is aggressively pursuing many of the opportunities listed above, to play significant roles in other aspects of the CEV, as well as the assembly, testing, maintenance, and refurbishing of the other new launch vehicles, programs and equipment, in order to leverage the economic efficiencies derived from conducting these activities in one location.

The state is also in dialogue with most all of the potential suppliers for the COTS Re-Supply services for the ISS and other missions. Significant opportunity exists for one or more of these companies to place robust launch and operations capabilities, or even some manufacturing capabilities close to their primary point of launch. Similar manufacturing work is also being considered by several other emerging

space manufacturers of spaceflight, space propulsion, and space habitat equipment and facilities.

In addition, the state's economic development agencies are aggressively pursuing new work programs in non-space emerging business opportunities such as Digital Media, Life Sciences, Alternative Energy research and production, Space Tourism and other ground-based commercial space applications. One target initiative involves the development of a complete "supply-chain solution" for the wind power industry, which could eventually include the manufacturing of turbine engines, fabrication and assembly of the wind towers and utilization of Brevard's aerospace expertise for development of the wind drive mechanisms.

There are many similar economic development opportunities that must be pursued as a base for transition of Florida's workforce. Florida's space industry partners must work together with NASA and the state to secure a robust opportunity environment for the shuttle workforce transition.

Issue #5: Maintaining political and budget support for the Constellation Program and Florida's workforce issues.

Successful implementation of the Vision will require sustained national political will and sustained commitment from multiple administrations and legislative branches over the next decade, along with sustained adequate funding which Congressional Hearings have indicated may well approach \$150 - \$175 billion.

The ambitious Vision will be constrained by NASA's budget unless Congress and the nation muster the will and consistency of support to provide the funding to attain it. NASA's Fiscal Year (FY) 2006 budget was \$16.6 billion with a minor increase in its request for FY 2007. However, NASA's 2007 budget was held at the 2006 level under a Continuing Resolution passed this fall, causing a six month slip in the Orion first flight.

The FY 2008 -2012 Budget Plan forecasts relatively small, but required annual increases in the total budget, bringing the total budget to \$18+ billion by FY 2010. However, NASA has yet to address full funding for the total Vision and, in the near-term, the Congress is likely to be facing an environment of severe limitations in its discretionary spending.

The White House has planned that some significant portion of the required funding for Constellation would come as a result of the retirement of the shuttle, from budget allocations that could be released after the last scheduled flight in 2010. Additionally, it has also considered that even greater funding might be made available from a future termination of U.S. government participation in the International Space Station, thereby moving US participation to the private sector sometime after the year 2016.

Sustained funding and political support will continue to be an issue for the manned spaceflight program in the years to come. There must be a united message communicated regarding the importance of space issues to the community and the workforce, which will garner consistent support and funding for the Constellation Program. In an environment of program and budget instability, uncertainties with respect to the future of the new space program will be raised, further exacerbating loss of skilled workforce to other areas.

Issue #6: Retaining and developing adequate numbers of required skills and systems engineering capability to support future work opportunities in next generation space initiatives for Florida.

While maintaining sustained political support in the climate of the annual Congressional funding process is a major challenge, an equally difficult challenge for the program will be retaining and developing an adequate depth of skilled workforce to meet new program requirements. Given that the Constellation program will take over eight years to implement, it is a major issue as to whether NASA and its contractors will have the required space-qualified systems design and systems engineering workforce available to achieve its Constellation objectives.

While there is much heritage hardware planned into the Constellation Program, NASA, as a technical direction and design agency, will be technically challenged with the myriad of new spacecraft, launch vehicle, robotics and other spacecraft and ground support equipment that will be required. Further, NASA has not fielded a new spaceflight system since the Shuttle and must undergo a corresponding organizational and skills transformation that the agency has not experienced since the end of the Apollo program more than 3 decades ago.

The issues range from short-term concerns about the current workforce skills for overseeing the development of new spacecraft and launch vehicles as well as long-term structural issues within the aerospace industry itself, related to the depth of space systems design and systems engineering capability in the industry. A secondary but equally important concern is the ability of the industry to attract and develop its next generation of science and engineering personnel. The training and recruiting of scientists and next-generation systems engineers is a major industry wide issue that will need to be addressed by K – post-secondary institutions.

Florida has a robust depth of space qualified systems engineering and operations capability that must be retained for the future space program and for Brevard County through an effective transition to future programs. Some aspect of Brevard's workforce transition planning must address the availability or development of adequate curricula and skills development initiatives relative to design and systems engineering needs, and the specialized required skills for the Constellation Program.

C. Florida's Workforce Opportunity

Florida's workforce is a unique asset and is critical to the future of the next generation space program. It is also the best recruiting tool and economic development incentive that Brevard has in attracting new space and other industry employers.

The transition of the shuttle workforce must be managed successfully to avoid loss of this vital capability to the County, State and to the nation's space future. Its existence is an economic development opportunity for the state, and one that is vital for the future of the manned space program and the aerospace industry in general.

The work of managing through the issues associated with the transition of the Shuttle workforce, and securing many of the required new opportunities for that workforce in the future must be accomplished by a true partnership among the federal, state, county and industry partners associated with this issue. A partnership based on an environment of "lip service" and concern about who gets the credit will not achieve the objectives for the workforce.

The Brevard Workforce Development Board (BWDB) can provide essential services to the workforce and its space industry employers to ensure a successful transition, and will develop and assist in providing the required workforce information, training and support resources for the transition and to help attract new opportunities for a robust future.

In the near-term, BWDB and its partners must focus on immediate skills transition opportunities for Lockheed Martin and other near-term Constellation program work assigned to the KSC area by NASA or its contractors.

The next stage of skills transition must be managed for program opportunities in the 2008 – 2009 time frame due to retirement of Atlantis and the reduction of the available shuttle fleet to two spacecraft. The challenge of increased shuttle workforce retirements and attrition to other opportunities will require a focus on maintaining required shuttle workforce levels by engaging workers in skills training that supports Constellation initiatives and builds their competitive advantage.

Finally, to meet the longer term requirements, workforce partners must position themselves now to address individual worker needs and to engage them today in training so they will be prepared for new careers once the actual dates of Shuttle retirement and program phase down (2010 – 2012) are upon us. The services needed for this transition include:

- Career Counseling
- Workforce Counseling in Change Management, Financial Planning, Resume writing and job search activities
- New Occupation Transition Assistance – Job Networking, Training and Placement Assistance

- New Skills Development and Training Programs to transition to Constellation activities

The mere existence of the shuttle workforce is an economic development opportunity for the state, and one that the economic development partners must successfully bring to the attention of future employers and new program opportunities. BWDB will help with this effort through early identification of the occupations that require skills similar to those of the current workforce.

II. Brevard Workforce Development Board Response

A. Role of the BWDB

The Brevard Workforce Development Board (BWDB), is a non-profit workforce services corporation that seeks to develop and maintain a highly competitive workforce for Brevard County, home of the majority of the NASA and Shuttle workforce. Its mission is to facilitate and serve as the catalyst for workforce development services that are responsive to employer / employment needs of Brevard County.

BWDB has established a broad array of services and programs aimed at ensuring the existence of a vibrant and robust workforce for Brevard's employers, current and future. BWDB oversees the Brevard Job Link which develops and provides resources and information referral services to connect the employers with the workforce resources they need. For instance, Brevard's unemployment rate has recently been running around 3.6 percent placing Brevard's unemployment at a historical low. This has created multiple new employment opportunities for job seekers and challenges for businesses looking for skilled workers. To assist in overcoming the challenges, BWDB established a new recruitment tool called the Virtual Job Fair. The Virtual Job Fair is a low-cost, innovative and cutting edge solution for Brevard's employers in their recruitment efforts for specialized skills.

BWDB also works in partnership with industry, education and economic development partners, to develop and provide specialized curricula materials and training services for select elements of the workforce to assist them in acquiring the specialized skills and unique certifications that today's industries are demanding. BWDB continually seeks to create innovative and effective ways to develop and provide quality workforce programs and initiatives for the Brevard workforce and the employer community.

B. Partnership Working Together for the Workforce

BWDB is the lead agency in Brevard County for ensuring the availability and robustness of skilled workforce for space industry employer and employee needs in the County. The importance of the shuttle workforce transition was recognized

early-on by BWDB and resulted in BWDB developing this study as well as a plan for the workforce transition.

Early in its planning, BWDB acknowledged that preparation for, and successful management of the workforce transition to new programs and next-generation space industry job opportunities is a critical priority for the State, County, the agency, and key shuttle contractors to work through in partnership. To that end, BWDB has established and maintains a close working relationship with key Federal, State, and County officials who represent, or are concerned with, Florida's key space industry asset; its highly skilled workforce.

BWDB has moved to put the baseline planning and dialogue in-place to understand the scope of the workforce transition challenge and to identify the necessary federal, state and other-source funding required for a broad range of workforce assistance initiatives. BWDB initiatives, developed in conjunction with industry, education and economic development partners, will be focused on: smoothly transitioning the workforce to CEV and other emerging business; assisting industry leadership with upgrading the skills of the current workforce; securing next-generation programs, and engaging educational components that are business-driven and innovative in their learning approaches.

C. BWDB Response to the Future Need / Near-Term Impact

1. Baseline Study

The first initiative of BWDB with respect to preparing for the shuttle workforce transition has been to conduct an Aerospace Workforce Outlook Report (AWO) aimed at establishing a baseline definition of the workforce today. The AWO tasks include:

- Conduct a baseline survey of shuttle prime and sub-tier contractors to identify and characterize the current shuttle workforce,
- In conducting the initial baseline "snapshot" survey, establish a communications network and working relationships with shuttle-related employers, to support on-going workforce-related activities,
- Together, with shuttle workforce employers, define the numbers, job classifications, qualifications, functional areas of work application for each major area of the workforce,
- On a continuing longer-term basis, assess each job classification, experience level and/or grouping of the workforce, to develop work descriptions and definitions of skills required to perform each work or task definition.
- Establish and maintain this workforce and skills characterization information in a database suitable for continuing analysis of skills available at an aggregate level for the industry.

- Work with NASA and industry program managers relative to future space program opportunities, and identify future work definition and skills required
- Identify gaps in skills capabilities and, with educational partners, define training and/or re-training programs aimed at enhancing skills, providing required certifications and developing required new capabilities and numbers of workers.

BWDB has a strong track record, working in partnership with industry in programs to develop needed capabilities and enhance worker skill levels to fill needed employer capabilities.

2. Formation of an Integrated Partnership Response

In order to facilitate the identification and characterization of workforce skills and capabilities, and assist both workers and employers to identify and respond to future skills needs, BWDB is establishing an integrated partnership with NASA, relevant state agencies, economic development organization and employers to help define workforce needs, new skills requirements, training and assistance programs and new business opportunities in relation to the available skills sets.

An Aerospace Career Development Council (ACDC) will be established by BWDB as the coordinating mechanism for this partnership. On an on-going basis, the Council will review the aerospace industry information to determine strategic steps each partner organization will spearhead and the anticipated results. As work progresses, and to ensure the Council's effectiveness in developing required workforce information and insights into workforce needs, Council members may be asked to enter into a structured Non-Disclosure arrangement with the BWDB directly, and then assist with the process of defining current workforce capabilities, skills gaps and training requirements and initiatives. From this work the Council will have subsections that will look at specific outcomes in regards to educational opportunities, economic development activities and workforce transition steps. BWDB is already pursuing the development of a number of specific workforce education, training and workforce assistance grants, to support Council initiatives for the benefit of the workforce and their employers.

3. Space Act Agreement

BWDB is engaged in a dialogue with NASA officials regarding shuttle workforce and transition issues, and will have a Space Act Agreement (SAA) with the agency, aimed at several initiatives:

- Collaborate with KSC in strategic planning and development of new workforce initiatives and assistance programs supporting the planned retirement of the nation's Space Transportation System (STS) – Shuttle, to assist retention of required critical skills for successful completion of the program and for transition of the workforce to next-generation space and related programs.

- Development of a uniform approach to the language and definition of functional and work area application within major program elements for next-generation program opportunities
- Development of a means of interfacing with NASA's workforce planning systems to further understand future skills needs, and
- Continued joint activity aimed at identification and development of requirements and curriculum objectives for training/re-training to assist meet those future program skills needs.

4. Development of Workforce Education, Counseling and Assistance programs
 BWDB currently operates, maintains and has access to a number of employer/employee counseling and assistance programs which have effectively supported workforce transition objectives in other industry situations. These include: Career Counseling, Job Search Assistance; Employ Florida Marketplace information and referral; liaison with other state and private employment search systems in other industries; access to BWDB's employer network; cultural change/and management of crisis counseling services; referral to financial counseling and other support services. However, the scope of the transition requires funding of additional capacity to meet the workforce needs.

In select circumstances, BWDB will enter into a joint-agreement with employers and employees, to support a retention/training/job placement objective. These joint employer-employee-employer agreements are meant to retain specific job skills which an employer needs for critical mission completion but also support an employee's objective to transition to a new opportunity while filling the new employer's needs of a skilled workforce. BWDB will facilitate these E3 (Employer –Employee-Employer) agreements to provide for training and assistance to employees while they are employed with the current aerospace employer as a retention benefit, while at the same time preparing the employee for a new opportunity with a new employer, who will also be a party to the agreement.

BWDB will work directly with community colleges and universities and employer selected trainers to: provide demand-driven education to meet the needs of businesses; ensure the timely development and availability of training and re-training curricula and programs to assist in meeting future skills requirements in both space and non-space-related opportunities. BWDB can and will employ all necessary assistance initiatives to assist the implementation of an efficient and effective transition effort for the shuttle workforce.

III. Baseline Study of Shuttle-Related Workforce

A. Objectives / Scope of Study

The objective of this baseline study is to provide a snapshot of select areas of the aerospace workforce that will be impacted by the planned retirement of the Space Shuttle in 2010, and to provide insight and guidelines for ensuring a successful transition of that workforce to new opportunities.

The initial focus was to identify and assess the current aerospace workforce of the Shuttle prime contractor and the major sub-tiers of the aerospace supply chain that are directly involved with spaceflight operations and support of the NASA Shuttle Program. Also, some of the challenges likely to be encountered by NASA and the County in transition of the workforce to new opportunities were to be identified for consideration in transition planning.

When possible, BWDB attempted to identify the impact on related and secondary workforce sectors, including such indirect support activities as those Air Force contractors providing support functions at the Cape Canaveral Air Station, its Range operations, and the myriad of local businesses and supply services companies that will be affected by a significant decline in the areas' Shuttle-related employment base.

The goal is a "snapshot" baseline of the aerospace workforce today to be used by BWDB and its workforce partners in strategically planning training and assistance programs for the aerospace transition. Data supporting the "snapshot" report were gathered through primary source research and survey contact with key industry employers. The baseline information represents in an aggregated manner the size of the workforce, occupational classifications, and class of skills. The next phase of the study is to obtain training levels and specialized certifications the current workforce.

[Data gathered as part of this survey was done so on the aggregate level and is summarized in this report, from multiple employer organizations that cooperated in the survey. Use of summary level information was permitted by employer organizations specifically for the purpose of this snapshot report. Key Shuttle workforce employers are continuing to work with BWDB in support of the development of skills mix information and the training insights required to assist transition planning and skills mapping to new program opportunities.]

B. Approach and Execution

The following tasks were performed in the study:

- BWDB team met internally and with other County officials to identify and assess issues that might be associated with the shuttle workforce transition, discuss current BWDB assistance programs, as well as assess requirements of the state's Ready-to-Work and other programs that might be available to assist the shuttle workforce. A set of survey and interview guidelines, and data requirements and formats for primary and secondary source contacts was developed for use in contacting shuttle and other employers.
- The team met with select NASA, Air Force and shuttle prime contractor and sub-tier officials to identify and secure supply chain information required to define the scope of the survey and the companies to be contacted.
- Considerable effort was expended in contact and data gathering with designated shuttle-related aerospace industry organizations as well as from key commercial and other service suppliers in the local area. A combination of phone, in-person interview and electronic communication were used to support data gathering. *[As many of these organizations are currently engaged in the pursuit of competitive future opportunities involving use of their space-knowledgeable workforce, employers have provided summary level information aggregated into this report, on a limited use basis, to support joint analysis and development of future skills mapping initiatives for shuttle workforce benefit in new work opportunities.]*
- Estimated numbers of worker and full-time-equivalent staffing currently supporting the shuttle program, have been identified, along with some characterization of their class of skills, depth of experience (years of experience), training levels, and where possible, specialized certifications and occupational classifications. This is an on-going effort of BWDB, as data gathered is not uniform from contractor to contractor, nor based on uniform definitions of job classifications, work definition, and skills classification methodologies.
- Some assessment of historical, normal attrition and retirement experience were also identified. And, where appropriate, the status of internal company transition planning, re-training, and assistance planning was also discussed.
- Analysis of the data, which has yielded a number of findings and conclusions regarding classification of the shuttle-related workforce, and the nature of the insights required for managing the workforce transition to new opportunities. This report reflects recommendations, where appropriate, on future activities to support implementation of a smooth transition effort, as well as how BWDB initiatives may work for the Shuttle

employers participating in this survey, and to the ultimate benefit of their workforce.

- A total of 27 companies were contacted as primary sources for participation in the survey. A much wider base of companies were and are being surveyed for secondary source information.

C. Issues Regarding Data Collection and Analysis

Appendix A reflects the guidelines and question areas supporting the data gathering / survey phase of the study. The data gathering and analysis efforts were complicated by several factors which directly impact the ability to definitively characterize the shuttle workforce at this time, at the level required to clearly and fully map existing skill and work functions into the skills requirements and planned work functions of new program opportunities.

First among these issues was the reticence of some employers to release data on their workforce that might in any way be used to highlight individuals or groups that could be impacted by the impending shuttle retirement. Their reticence is based on a concern that the early highlighting of any workgroup or work function vulnerability to future instability might accelerate worker initiatives to seek work stability in other industry areas.

Second, many of the current shuttle contractors are actively pursuing new space program opportunities under competitive bid. Nonetheless, most did cooperate in the survey, but have not released specific man-loading data by work function which could be competitively used by another company in pursuit of future opportunities. Most have indicated a willingness to support on-going BWDB efforts to continue to refine the workforce database.

A third difficulty lies in the fact that contractors may not use the same criteria for classification of a worker to a position description, or in the reverse, may use differing qualifications for similar position description titles.

Fourth, and perhaps most important, the description of future skills needs and capabilities requirements in the Constellation or any other future space program opportunity, is best done by defining the functional or work area of application, and then assessing the nature of the skills required to perform that work, and at a certain level of competence. There is not a consistent form or methodology applied from program to program or from company to company that permits an “apples to apples” mapping of current worker classification to future need, that is commonly in use in the industry. Effort must be applied to structure required consistency in the workforce database from each contractor.

Appendix B identifies the principal data elements assembled during the study. In partnership with NASA, BWDB will work on a parallel activity to evolve a uniform

approach to the definition of job classification, work definition and skills mapping capability, to permit thorough “skills gap” analysis and implementation of the required training and re-training activities required to fill them. On-going data gathering with shuttle prime and sub-tier contractors, and joint analysis of information reflected in the Appendix A guidelines will be part of the Aerospace Career Development Council’s resources and strategic information.

D. Characterization /Evolution of Current Shuttle Workforce

1. History/Shuttle Growth

In the early years of the Space Shuttle Program, the shuttle operations and support workforce was spread across five principal NASA Centers, with most other Centers playing a support role in the program, and across 12 major support contracts, each with a significant sub-tier. In August 1995, NASA announced a plan to consolidate the 12 principal Shuttle program contracts under a single prime contractor. More than 40 companies responded to the Request for Proposals.

The United Space Alliance was formed for the purpose of pursuing the NASA consolidation of Shuttle contracts. At the conclusion of the proposal evaluation period by the agency, the new venture, the United Space Alliance was selected as the single prime contractor for future Shuttle operations support.

The initial Space Flight Operations Contract (SFOC) between USA and NASA was signed in September 1996 at the Johnson Space Center and both Lockheed Martin’s Shuttle workforce and Rockwell’s employees at the NASA Shuttle Logistics Depot joined together in USA. Boeing, later purchased the aerospace and defense components of Rockwell Corporation, including its share in USA, with USA ownership principally remaining steady through today.

The first Space Shuttle flight managed by USA was STS-80, in November 1996, and was launched from the Kennedy Space Center. Since then, USA has managed the operations for 36 additional shuttle flights. The initial focus of the SFOC Contract was primarily Orbiter focused, however, NASA later added more than \$900 million in additional work to the contract for performing Solid Rocket Booster (SRB) assembly and refurbishment previously performed by USBI at Kennedy Space Center in Florida, Shuttle flight software design, production and verification from Lockheed Martin in Houston, and flight crew equipment processing from Boeing Aerospace Operations, also in Houston.

Most of the personnel performing those functions were moved from their predecessor companies to USA at that time. The flight software and flight crew equipment processing employees joined also joined USA at that time. USBI employees joined USA in September 2001, pushing the workforce level being managed under the SFOC Contract and related support, to approximately 12,000 people.

NASA did exercise a number of contract options for SFOC, keeping USA as prime contractor for the Space Shuttle program through 2004, and then again through 2006. NASA has recently completed negotiations for a new contract, the Space Program Operations Contract (SPOC), which keeps USA as NASA's prime contractor for Space Shuttle operations through the planned retirement of the Shuttle fleet.

It is anticipated that a future modification to the contract will be initiated at some point providing for a planned phase-down of Shuttle operations and an orderly disposition of the Program's assets and intellectual property, some for use in the Constellation Program and others to storage or transfer to a resident NASA field center for disposition. USA support will likely continue through 2012.

The current total workforce associated with the US Shuttle Program is approximately 2,000 civil servants and approximately 15,560 + contractor personnel across all NASA Centers and industry facilities. The bulk of those employees are located at the Johnson Space Center and at the Kennedy Space Center in Florida.

Under the Shuttle Space Program Operations Contract (SPOC), USA has approximately 10,080 employees located primarily in Texas, Alabama and in Florida. In Florida, the principal site for shuttle spaceflight operations, USA has a workforce of approximately 6,340 employees, contributing an estimated payroll value to the state of approximately \$402,590,000 per year.

Shuttle workforce numbers used in this report are based on both headcount, as well as on full-time equivalent (FTE) calculations, where full-time equivalent is a measure of staff hours equal to those of an employee who works 40 hours per week throughout the year; and therefore, the actual number of employees who work part-time or full-time on the Shuttle Program may be greater than the numbers indicated. All FTE numbers were calculated by averaging the number of industry employees over fiscal year 2006. *[Where FTE numbers are referred to in the report, they are designated FTE.]*

2. Workforce Supply Chain Profile

USA has maintained an active base of sub-tier support contractors and suppliers ranging from 1400 to 1550 at any point in time, out of a total qualified vendor list totaling between 3,000 to 4,000 companies. The remaining economic contribution is attributed to the shuttle-related sub-tier and related support contractors.

This Shuttle-related workforce represents a significant customer for other Florida-based industries as well, such as electronics, materials, engineering, research, and a variety of business support and hospitality services. Employees in this industry, because of their above-average wages, are important customers and economic contributors to Florida's retail and service industries. Indeed, the U.S. Department of Commerce, Bureau of Economic Analysis estimates that every dollar earned in the space and aeronautics industry in Florida generates \$2.83 in earnings for other sectors of the economy (RIMS II Multiplier).

As part of this survey, BWDB initiated contact with a broad array of the Shuttle sub-tier and related services contractors. A partial list is shown below. These companies were identified and included as the major shuttle program sub-tier and related services providers. *[Only companies with over 50 employees are shown. The actual information gathered is across a much larger population of aerospace suppliers, including many with less than 50 employee and includes Shuttle related companies, business support and retail suppliers.]*

- All Points Corporation
- A.G. Solutions, Inc.
- Analex Corporation
- ASRC Aerospace Corporation
- ATK Launch Services
- Bionetics Corporation
- The Boeing Company
- Creative Technologies
- Creative Management Technologies
- Dynamac
- Geologics
- Honeywell
- Indyne Corp
- Jacobs Sverdrup
- Launch Coast Services
- Lockheed Martin Corporation, Space Systems
- Northrup Grumman
- Pratt Whitney-Rocketdyne
- SAIC
- Space Gateway Support
- Spacemark International
- Spherion
- Troutman Technical Services
- Wiltech Corporation
- Wyle Laboratories
- Yang Enterprises

Some companies did not respond to the survey and there was not uniformity of data response in the submissions received. Appendix C provides a summary level description of the prime shuttle operations contractor (USA), and is a partial representation of a typical survey response for this study. Appendix D is a partial (summary only) display, which is indicative of the level of data provided in support of this study. The ongoing work of gathering further information will require the support of shuttle employers to reach more definitive levels required to eventually map shuttle workforce skills and capabilities to stated requirements (in uniform terminology) for future needs.

E. Economic Impact

The companies in this data base are located in counties across the state from Miami to Pensacola, and Tampa to Jacksonville. The application of RIMS II Department of Commerce multipliers as a basis for estimating secondary economic impact to the state yields an approximate \$2 billion contribution to the state's economic well-being from Shuttle-related activity in Florida, over and above the direct salary contribution of the Shuttle workforce.

Much of this secondary economic contribution is realized in the state's retail, hospitality, tourism and health services support industries. A significant loss of a portion of the shuttle workforce out of the state, or out of the income stream of the state's economy would have a significant impact on the state's economic well being.

IV. Workforce Profile – “Snapshot”

Survey results indicate a prime, sub-tier and related base support workforce level of approximately 9,235 Shuttle-related employees in the state of Florida, with approximately 6,340 USA employees and an estimated 2,895 sub-tier and related support contractors. While this number does not represent all companies involved in the program, it does constitute the majority of the shuttle operations and support workforce. The total estimated shuttle-related payroll for this workforce is approximately \$600,000,000, with USA accounting for approximately \$402,590,000 of that total.

Only Florida specific contractors and data are shown. The majority of this workforce is located at or near to the Kennedy Space Center; however the total economic spread of the Shuttle Program is statewide, and has a specific Shuttle-related supplier base of some 1046 companies throughout the state. This does not reflect the number of secondary effect retail, hospitality, tourism and other businesses that benefit from the economic effects of the program.

An indication of the numbers of Shuttle-related workers associated with major contracts, prime and sub-tier, as well as some key services companies who are at the Cape and provide some Program support, are provided below. Only

Shuttle-specific numbers of workers are shown in the right-hand column. An indication of the Job Titles and Qualifications that are reflected in these workforce numbers is shown in Appendix F.

<u>Prime and Subcontractors over 50 employees</u> (Direct shuttle manpower shown in right column)	<u>Number of FL Employees</u>
United Space Alliance (USA) <u>Space Program Operations Contract (SPOC)</u> Responsible for the operation and management of the Space Shuttle fleet. This includes all ground processing activity on the Orbiters, the External Tank, the Solid Rocket Boosters (both launch and recovery), the Ground Support Equipment/Facilities and all Logistics Support. USA is a joint venture company owned by Boeing and Lockheed Martin. Total SPOC Employees - 7020 (6331 USA and 686 subcontractor)	6340
Space Gateway Support (SGS) <u>Joint Base Operations Support Contract (JBOSC)</u> SGS provides all base operations support for the Kennedy Space Center and the Cape Canaveral Air Force Station. They are responsible for such activities as roads and grounds maintenance, facilities maintenance, custodial, fire, security, calibrations and propellants handling. SGS is a joint venture company owned by Northrup Grumman and Wackenhut. Total Employees - 2751 (includes 1801 SGS and 950 subcontractor employees)	989
The Boeing Company <u>Checkout, Assembly and Payload Processing Services Contract (CAPPS)</u> Responsible for pre-launch processing of payloads for the Space Shuttle and the International Space Station. They perform all aspects of payload processing, including the planning and receiving of payloads, maintaining payload ground systems, integrating payloads with the Space Shuttle and supporting both the launch and post-landing payload activities. Boeing also provides Orbiter Sustaining Engineering Services to the Shuttle Processing Contractor on SFOC Subcontract. Includes the engineering expertise necessary to prepare, launch and recover the Orbiter vehicles and represents the technical specialties required for all Orbiter Systems. Total Employees - 1010 (both roles and includes 230 subcontractor employees)	648
Indyne Corporation <u>KSC Integrated Communications Services Contract (KICS)</u> Responsible for communication services in support of the Space Shuttle, Payload Carriers and Launch Services, and the International Space Station. Included are hardware and software integration and development for voice, video and data communications. They also provide motion picture, still	332

photographic, digital and video products and services for NASA, DOD and Commercial customers as well as operate and maintain the telephone system contractors as a subcontractor.

Total Employees - 450 (KICS only; includes 50 subcontractor employees)
250 (as Subcontractor to JBOSC and CAPPs)

Artic Slope Research Corporation (ASRC) 101

University Affiliated Spaceport Technology Development Contract (USTDC)

ASRC provides research and engineering services and technical support to the KSC Engineering and Technology Directorates and other operational customers at the center. This includes spaceport systems design, engineering development, management of research and technology projects and operation of various KSC laboratories and test-beds. They use a group of affiliated universities in performing applied research and technology development efforts. They are currently designing facilities for Constellation.

Total Employees - 370 (includes 25 subcontractor employees)

Creative Management Technologies 80

Major Subcontractor to JBOSC and CAPPs

Perform custodial services and materials handling and transportation in Contract assigned facilities.

Total Employees - 255

Analex, Inc --

Expendable Launch Vehicle Integrated Support Contract (ELVIS)

Responsible for performing, planning and integrating the ELV program business and administrative functions. Provide engineering and technical services for various ground and flight systems, payloads and missions. Manage, operate, maintain and provide sustaining engineering for the NASA ELV communications and telemetry stations as well as other assigned facilities, systems and equipment.

Total Employees - 215 (includes 37 subcontractor employees)

Wyle Laboratories 105

Major Subcontractor to JBOSC.

Provides technical and engineering support to KSC/CCAS Programs in the areas of independent test and analysis, test systems, special failure investigation testing, and other test related requirements.

Total Employees - 130

Yang Enterprizes 60

Major Subcontractor to JBOSC and CAPPs

Provides computer related services to users including employee training in information technology, workflow management, procurement and other applications. Direct support to the Shuttle Launch Control System.

Total Employees - 180

Comprehensive Health Services	---
<u>Major Subcontractor to JBOSC</u>	
Provide health and medical services to the KSC workforce.	
Total Employees - 130	
Pratt & Whitney-Rocketdyne	110
<u>Major Subcontractor to SFOC</u>	
Responsible for Space Shuttle Main Engine (SSME) Launch operations.	
Responsible for pre-launch processing and post-mission refurbishment of the Shuttle main engines. They assemble new engines, remove and replace engines in the Orbiter, operate the ground support equipment, perform repairs and provide all logistics. (Included on the MSFC contract for project engineering services to the launch operations team.)	
Total Employees - 110 (SFOC....95, MSFC....15)	
Jacobs Sverdrup	101
<u>Major Subcontractor to CAPPs</u>	
Perform facilities operations and maintenance in CAPPs assigned facilities.	
Total Employees - 102	
Dynamac Corporation	56
<u>Life Sciences Services Contract (LSSC)</u>	
Dynamac provides a broad range of life sciences services to NASA. These include medical operations for Shuttle and Station programs, environmental compliance, life sciences payload development and operations, biological science, workforce protection, fitness and muscle rehabilitation, and education outreach. Represent NASA's Occupational Health Program Office.	
Total Employees - 130 (includes 50 subcontractor employees - Bionetics)	
Wiltec, Inc	76
<u>Major Subcontractor to SFOC</u>	
Responsible for providing cleaning services to all Shuttle and Station launch hardware providers and processors.	
Total Employees - 76	
Lachmann Culinary Services	--
<u>KSC contract for food services at the Center</u>	
Total Employees.....75	
Launch Coast Services	60
<u>Subcontractor to SFOC (Included in JBOSC)</u>	
Provide logistical support to Shuttle flight and ground hardware systems.	
Total Employees - 60	
Bionetics Corporation	--

Major Subcontractors to LSSC Performs life sciences and biological science applied technology research; Supports life sciences payload development and operations.

Total Employees.....50

Lockheed Martin

40

Launch and Mission Support Services; CEV Assembly/Checkout

Provide engineering services to the Shuttle External Tank program (MSFC Contract), specific mission support tasks (JSC contract) and the preparation phase of the Crew Exploration Vehicle final assembly and checkout in KSC's O&C Building.

Total Employees.....50

Other Shuttle Contractors (under 50 employees)

137

Troutman Technical Services.....

42

ATK.....

37

Boeing CAPPs

15

All other

43

Total supporting Space Shuttle Program

9235

(Not including Civil Service)

The Appendix D information content is also reflective of the level of qualifications and training that is associated with specific job titles. While there are many areas of workforce application that may not be required in the same numbers in the next-generation of space program activity at KSC, the skills and experience are assessed as highly transferable to space and other industries. Some specific examples are as follows:

- Shuttle protection system engineers and technicians
- Safety monitoring specialists
- Thermal Protection System engineers and technicians
- Landing and recovery operations technicians
- SRB Water Recovery operators

However, most Shuttle-related skills reflect vital components of an employee's overall training and work approach. For example, each employee involved in Shuttle work is engrained with a strong quality ethic. Without a strong quality and work ethic in spaceflight operations, those engaged in future spaceflight missions could be placed in greater danger.

Much of the Shuttle workforce is dedicated to the requirement for precision in work-process and measurement-monitoring functions. Without a disciplined attention to precision and accuracy in operations and flight preparation, spaceflight operations consistency and reliability would be impacted.

The Shuttle workforce is also thoroughly acclimated to an environment of accurate monitoring and record-keeping. Keeping track of the voluminous data produced by monitoring and documentation requirements is a skill in and of itself. The Shuttle workforce learns and practices this discipline from their first day on-the-job, and has internalized in work practice, that every action requires a proper recording trail and documentation.

Above all, the Shuttle workforce is engrained with a strong culture of safety. Each and every worker is acutely aware to look for safety-impairments, and when they observe an unsafe condition, they are empowered to stop the activity in any area.

Industries world-wide value very highly, and commit vast resources to engrain their workforces with these traits that are so much a part of the Shuttle workforce. It is reasonable to assume that these traits would be considered highly translatable to any future work that the state pursues as part of its next-generation space activities.

V. Need for additional Skills and Training

Analysis of the data and information gathered in the Baseline Survey has provided a number of insights into the characteristics of the workforce, the numbers, and areas of impact that will be affected in the future. Even though, it is very early in the planning process leading to retirement of the shuttle and transition of the workforce to new program activities, a number of factors are known and can aid transition planning. Some of these are:

- Attrition experience and retirement numbers in this industry are known by each contractor, and while some increase in normal attrition can be expected as Shuttle retirement approaches, most employers believe that because of the strong workforce ethic and loyalty to the program, most critical employees will remain available for the program. Essential to this assumption is a sincere dialogue with employees that there is internal company planning for new work opportunities (either within the company or through other entities with employer assistance.)
- Each company has its own aggressive business development activities and plans for future work, and has plans in-place for much of its workforce. While these have not been fully disclosed at this time, a portion of the current shuttle workforce will be absorbed into each employer's future programs.
- Additionally, a considerable level of the workforce will be required in the new Constellation Program elements, and this is true for many areas of the program. For example, the KSC Ground Operation concept of operations for Constellation Ares I Crew Launch Vehicle and Ares V Cargo Launch Vehicles is based on experience from

extensive processing of Space Shuttle elements. Both use Solid Rocket Boosters (SRBs) of which 234 four-segment SRBs have flown to date.

This experience base is well developed and can be directly applied to processing the five-segment SRB vehicles for both the CLV and CaLV. The steps in manufacturing, transporting, storing, stacking and mating the SRB segments will remain basically unchanged and efficiencies developed to date will keep the manpower required at or near the current level. The Constellation manifest will require about the same quantity of segments being processed and refurbished as the Shuttle requires today.

- It has been noted by spaceflight officials, that the Ground Operations contractor workforce for processing the Ares I CLV elements will be a conservative 40% of the current Shuttle elements processing workforce. With SRB segment processing remaining nearly constant from today's baseline, the reduction in manpower is driven by exchanging the processing of the Orbiter and External Tank for "ready-to-fly" Upper Stage (US) and Crew Exploration Vehicle (CEV).

The current launch site concept of operations requires US and CEV delivery, stacking on the SRB, transfer to the launch pad, servicing and launch. While this is the stated plan today, and does not take into account any significant level of pre-launch processing at the Cape, experience has shown that this is not totally realistic and that a pre-launch processing team will likely be required for both the US and CEV.

Similar considerations exist for other multiple areas of future work application in the Constellation Program. In addition, KSC is engaged in continuing dialogue with NASA officials concerning additional future work assignments aimed at preserving critical elements of the space-operations workforce.

- Finally, state economic development partners are actively engaged in the pursuit and capture of new work opportunities in multiple areas, aimed at providing robust future opportunities for the transitioning workforce. This effort has met with considerable success and future successes are expected, providing some confidence that work requirements which will utilize shuttle related skills will be in place when needed. This is especially true when looking at the outlook for additional CEV related work assignments to the area, future assignments in other Constellation program segments, other Civil/Defense program initiatives, and significant opportunities in private sector and emerging industry areas.

Even though preliminary, an analysis was conducted of the data gathered in the survey, using assumptions concerning application of the skills capabilities for the workforce today, company retirement and attrition experience, and some indications regarding new business planning. Assessing the data gathered in the survey and utilizing a preliminary outlook for successful capture of new work assignments in other CEV, Constellation, and other future business areas, it is estimated that the number of workers likely to seek job and career assistance, counseling, and additional training and skills development to transition to completely new occupations or industries is approximately one third of the current 9235 workforce or approximately 2500 - 3000 workers. Additionally, approximately one third of the current workforce will need skills upgrade training to continue in their aerospace occupations.

A program of counseling, job referral and placement support, skills training and other assistance efforts must be put in place to prepare the workforce for this future.

VI. Recommendations

The following recommendations are made to support the evolution of an efficient and effective transition of the shuttle workforce to next generation aerospace-related opportunities in Florida:

A. Establish a Space Act Agreement (SAA) with NASA

The SAA should address the following items:

1. Continued development of a uniform approach to the language and definition of functional or work area application within major new program elements (by hardware breakdown), and work definition within this elements, and skills requirements for next-generation programs. opportunities
2. Development of workforce data-base and workforce management system to support joint transition activities with NASA, economic development organizations and employers in multiple industries. Continue to use this system for planning efforts related to defining next generation program needs and skills requirements and build upon the KSC Competency Management System. Joint systems and definitional efforts would be conducted under the SAA. The workforce management system could be used to track certification and currency of skills levels in the workforce receiving BWDB assistance, to support job skills preparation, job opportunity referral, and future opportunity development.
3. Coordinated identification and development of requirements and curriculum objectives for training, re-training and acquiring the next

generation skills that future space programs need. (BWDB has a number of initiatives underway to secure private sector, state, and federal funding to develop and conduct training and education programs through educational institutions as required for the Brevard workforce in support of the shuttle workforce transition.)

B. Establish an Aerospace Career Development Council.

The Council would include members from Shuttle-workforce corporations, economic development organizations and educational institutions and would serve to provide the BWDB and its federal, state, county and other industry partners with planning and transition advice and information necessary to provide effective transition support to the workforce and their employers.

C. Obtain resources for Workforce Assistance Programs

Funding strategies and resources will be part of the Aerospace Career Development Council's objective. Such funds will provide the basis for workforce assistance programs that include services such as:

- Career Counseling
- Job Search Assistance for displaced workers
- Broadened capabilities, including interface with employment search systems in other related Florida industries and with other industry employers,
 - Cultural Change/and Management of Crisis issues counseling
 - Access to financial and other supportive assistance programs
 - Training and skills upgrades that are business demand driven

Specific skills training will be required for the shuttle workforce, to qualify them for operations or work performance needs of next-generation opportunities. However, engaging the workforce in these training opportunities will require career coaching to ensure the skills are in demand and likely to retain the workforce in Florida.

Future programs will require updated and advanced skills and training, and investment in this subsidized training initiative would be a powerful tool to assist the workforce to successfully transition to future opportunities. Appendix G provides an estimate of the number of engineering staff in the contractor workforce supporting the shuttle program by functional area of application. There is much talent in the workforce to build on. However, additional coursework and training will be required for those who wish to advance their skills and for technicians seeking additional capabilities.

D. Exploration and development of more diverse curriculum

BWDB foresees the need to engage educational institutions and aerospace business leaders to define new educational programs that will result in industry recognized qualifications that today are not being addressed.

Program Management and Space Systems Engineering curriculum which permits flexible course selection from multiple university sources and use of multiple educational media for use by the Shuttle workforce during transition is also needed and should be further explored.

Any program should be structured to utilize a broad range of training methods including those shown below:

- Instructor Lead Classroom presentations
- Student self study
- Interactive Computer Based Training (CBT)
- Skills training with functional hardware
- Skills training with full size mock-ups

As NASA plans requirements for Constellation and for future human spaceflight initiatives in general, the challenge to develop or find adequate numbers of space-qualified program management and systems engineers in the existing workforce is difficult due to the lack of a major human spaceflight development program in recent years. In addition, constrained hiring as a result of continued aerospace industry downsizing and skepticism about whether NASA's Constellation program will have sustained political and financial support which exacerbates the difficulty of finding adequate numbers of space-related systems engineers. Educational institutions are part of the solution of attracting the pipeline of next generation workers.

There are a wide range of new economic development opportunities for the state to pursue and win in other aerospace areas and emerging markets as well. The state's best economic tool for attracting these future work opportunities is the strength and quality of its aerospace, shuttle-related workforce. BWDB and its federal, state, county and industry partners must invest in that workforce to assist and facilitate an effective transition to new opportunities.

The recommendations proposed by BWDB in this report, address the nature of the required investment and offer specific initiatives that must be undertaken to ensure a successful transition. With this range of activities underway, Florida should retain a large share of the jobs currently supporting the Shuttle program and stimulate new and expanded business growth for the state.

Appendix A

Interview and Survey Guidelines Shuttle Workforce Baseline Outlook Study

General Corporate Data

- Corporate Name and Address
- Key Officials - Contact Information
- Entity Representative(s) for workforce-related matters
- Descriptions of Shuttle-related Entities Including Classifications, if applicable (SIC codes, appropriate Industry codes, etc.)
- Description of Entity's Shuttle-related role, program involvement
- Description of Entity's General Industry Market Segments
- Description of Entity's Strengths

Workforce Data

- Estimated Number of Current Shuttle-Related Workers (Employees and FTE's)
- General Geographic Location(s) of Workers (Sites)- Estimate of Size of Current Shuttle-related workforce by site
- Estimated Number of Workers by General Job Classification and Qualifications
 - Engineer
 - Technical
 - Administrative
 - Other Support

Internal Company Planning

- Estimate of Numbers of Shuttle-related workers eligible to Retire Retirement (numbers estimated)
- Special Retirement Incentives planned (if any)
- Estimate of the number of Shuttle-related workers in the following categories of disciplines (engineering, technical, administrative or support), if available:
 - Mechanical
 - Electrical
 - Aerospace
 - Materials
 - Quality
 - Environmental
 - Civil
 - Ordinance
 - Pneumatics
 - Systems
 - Propulsion
 - Fluids

Appendix A

- Production
 - Communications
 - Life Support
 - Heating, Ventilation and Air Conditioning
 - Heavy Equipment Operation and Maintenance
 - Others, as applicable
-
- Provide descriptions of functional area of application or work definition associated with contractors' support of Shuttle processes or hardware elements. Does contractor maintain skills classification information for each work area application?
 - Discussion of approach and methodology for characterization of skills and workforce capabilities to fill specific work functions
 - Discussion of likely numbers that could be transitioned into other areas of the Company
 - Re-Training Required?
 - Re-Training Programs Available?
 - Assistance Needed? If possible, please provide some definition of training or curriculum development assistance needed.
 - Discussion of the Ready to Work Program, and participation requirements.
 - Anticipated Special Training Needs, Desired Special Training Needs

Appendix B

BWDB Baseline Elements

BWDB has established a baseline of elements as a foundation for support of the workforce analyses for this baseline report. The baseline of elements has been designed and will continue to be expanded to support continuing development of a uniform data foundation for the definition of additional job classifications, work descriptions and skills mapping capabilities, as well as to support future “skills gap” analysis and design of future training and re-training programs. On-going development will be conducted in partnership with the shuttle prime and sub-tier contractors as an activity of the Aerospace Career Development Council.

Baseline elements:

- Organization or Contractor
- Total Number of Employees
- Numbers by state
- Facility or Site Locations
- Estimated Full-Time Equivalent (FTE's)
- Contractor's Position Title(s)
- Education, Qualifications or Experience Level for each title
- Within each title, a sub-tier breakdown of Work Area or Work Function description, generally defined at a level of hardware application, or work breakdown structure, i.e., system, sub-system, equipment, component, nature of function or skill application.
- Capability and/or Skills Description for each job title being applied
- Numbers of workers at that level at that job Classification
- Estimated Compensation Range at that level
- Notes/Remarks

Additional data elements were collected from each contractor which also reflect varying levels of shuttle workforce activity and are available for future use by the Council. Data collected were submitted, as available within each contractor's management systems and are subject to restrictions defined by each contractor. It is anticipated that for each new program opportunity, similar skills needs and work-function requirements can be developed to permit mapping of available capabilities within the workforce and skills descriptions to future capabilities and skills needs in new space programs and other emerging industry opportunities.

Appendix C

Sample – Survey Data

General Corporate Data:

Corporate Name and Address:

United Space Alliance, LLC
1150 Gemini
Houston, Texas 77058

Key Official - Contact Information:

Mike McCulley, Chief Executive Officer, Houston, Texas

Descriptions of Shuttle-related Entities, Including Classifications, if applicable (SIC codes, appropriate Industry codes, etc.)

NAICS Code 927110 and SIC Code 9661, National Aeronautics and Space Administration, operating and launching government satellites, space flight operations government, space research and technology

Description of Entity's Shuttle-related role: Prime Systems Contract for Space Program Operations (SPOC) Contract

USA is a private-sector contractor that provides services under contract to the National Aeronautics and Space Administration (NASA) in support of the nation's Space Transportation System (STS) Program, the Shuttle Program. Services include ground processing and launch of NASA's Shuttle fleet of three orbiters at the Kennedy Space Center ("KSC"), Florida, flight software creation, on-orbit mission control and astronaut training at Johnson Space Center ("JSC") in Houston, Texas. USA has a total of approximately 10,200 employees in its various locations. USA is a limited liability company, organized under the laws of the State of Delaware.

USA started performing these services for NASA in mid-1996, when an initial set of contracts, previously performed by other contractors, were transferred over to USA by NASA. Several of these contracts involved flight planning, flight control, and training conducted in and around the JSC and KSC areas. Since that time, NASA has also turned over to USA, additional functions previously performed by other contractors. USA is responsible for managing the day-to-day operations of the NASA Space Shuttle program and oversight of the construction of the International Space Station.

Description of United Space Alliance General Target Market(s):

Appendix C

USA work assignments include the Space Program Operations Contract (SPOC), implemented October 1, 2006, following the conclusion of the 10-year Space Flight Operations Contract (SFOC) and a myriad of other shuttle and ISS related tasks. The contract establishes USA as NASA's primary industry partner in human space operations, including the Space Shuttle and the International Space Station.

Additional assignments include working on the following contracts:

- International Space Station (ISS) contracts (Boeing)
- Mission Support Operations Contract (Lockheed Martin)
- Extra Vehicular Activity (EVA) Systems (Hamilton Sundstrand)
- ISS Cargo Mission Contract (Lockheed Martin)
- Ares I Crew Launch Vehicle Stage I studies (ATK)
- CRAVE Contract support (Oceaneering)
- Support NASA Data Mining & Trending Work Group (NASA Langley)

USA is also a participant on the Orion Program as a subcontractor for Lockheed Martin.

Description of Entity's Strengths:

The broad spectrum of skills available in the current shuttle workforce is directly applicable to the next-generation spacecraft and space programs envisioned in the Constellation program. Major areas of USA's technical strengths are described as follows:

Experience

USA manages and conducts space operations and maintenance of multi-purpose space systems. The corporation's specific capabilities include:

- Mission, manifest and trajectory planning and analyses
- On-Orbit assembly, payload deployment and servicing
- Extravehicular activity planning and execution
- Rendezvous/proximity operations and docking
- Space logistics/supply chain management
- Space operations software engineering
- Ground system design engineering
- Advanced space flight technology
- Launch and recovery operations
- Launch vehicle and flight hardware processing
- Mission control operations

- Space systems training
- Sustaining engineering
- Flight crew equipment preparation and maintenance
- Large scale integration

Appendix D

Partial Estimated Number of Workers
Summary Info Only For Select Titles –
Not All Inclusive

Employees	General Titles	Skills
FL= 1709	Engineer Staff, Computer Science Staff, Computer Science Staff	Possess an engineering, engineering technology or computer science degree from an accredited university and the appropriate professional level of work experience.
FL = 175	Manager - Engineer/ Computer Science	Manages an organization primarily accountable for the production of engineering or computer science products or services or an organization containing an engineering support component that requires engineering or computer science credentials to adequately manage.
FL = 1080	Technical	Possess a bachelor's degree from an accredited institution or equivalent and the appropriate professional level of work experience.
FL = 282	Technical Management	Manages skilled, semi-skilled or clerical personnel performing operations and maintenance, material movement and storage, planning, work control, records/data management, general office or similar activities. Workforce managed is typically nonexempt. BS/BA degree in related field plus applicable years of work experience.
FL = 680	Administrative (Ranges from business operations staff to Financial Officers)	Varies from High School Diploma through Bachelor's Degree's in specific areas (i.e. accounting).
FL = 168	Administrative Management	Manages an organization concerned with developing, implementing and managing general business policy, or performing tasks requiring advanced or specialized knowledge associated with recognized professional occupations, or accomplishing processing/operational tasks with an occupationally mixed (e.g. professional, engineering, skilled craft) department(s). Includes Project Managers.

Appendix E

Preliminary Constellation Program Skill-Area Needs Summary Level only

General

- Safety
- Flight Hardware accident prevention
- Hearing conservation
- Fall protection
- Hazardous materials prevention
- High pressure systems
- OIS/Communications
- Emergency Life Services Apparatus
- Respirator Usage
- Supplied Air
- Systems Familiarization
- Battery Systems
- Foreign Object Debris
- Task Team Responsibilities

Move Certifications/Hardware Handling

- Move Leader duties
- Handling and hoisting
- Tow Vehicle operations
- Hydraset
- CM/SM Stack
- Motorized handling equip
- Aerial Platform operations
- Fuel systems
- Crane certification

Test

- Test Discipline
- Proof/Leak testing
- Electrical testing
- Connector check-out
- Space Craft Operator
- Cautions and Warnings
- Vehicle power configuration
- Communications & Guidance

- Crew interfaces
- Test Conductors
- Mission Testing
- LAS/SM Interface
- Weight & Center of Gravity
- Altitude Chamber

Flight hardware

- Hatch Certification
- Heaters
- Structures
- Wire harness installation
- Coaxial fiber optic
- Structure buildup and repair
- Fasteners
- Sheet metal
- Electric Bonding
- Structural Bonding
- Layout
- Cold plate/Box installation
- Pyrotechnic handling
- Flight Crew systems
- TPS/TCS/MMOD blankets
- Composites
- Tube fabrication and Install
- Seals and connectors
- Installation clamping

Facility

- Doors
- Operating Process
- SAP
- Paper Processing

Aerospace Workforce Outlook

Appendix E

Contamination Control

- CWA plan
- GOX
- Methane
- Portable Clean Room

Tooling

- Configuration and use
- Maintenance
- Calibration
- ECS purge air
- Proof load

Tech Baselines

- Torque & Safety wire
- Connector Mating
- Electrical grounding

Quality

- Receiving Inspection
- Tech work verification
- Surveillance inspection
- Closeout inspection

Vehicle Access

- Platforms
- Tooling
- Entry
- Confined spaces

Aerospace Workforce Outlook

Aerospace Workforce Outlook

Appendix F

Some Example Shuttle-related Job Titles and Work Definitions For the Ground Systems Operations Support Function

Fluids Engineer	Provides fluids engineering expertise to design, build, operate and sustain ground systems and equipment and to operate and sustain flight systems. Examples include: cryogenics, pneumatics, hydraulics, hypergolic and ammonia systems.
Mechanical Engineer	Performs pneumatic, hydraulic, and cryogenic systems component fabrication; rapid prototyping; mechanical and structural fabrication, machining and testing; and welding in support of rapid solutions to complex problems with ground systems and equipment as well as flight hardware.
Electrical Engineer	Provides electrical engineering expertise to design, build, operate and sustain ground systems and equipment and to operate and sustain flight systems. Examples include: S-band/Ku-band antennas, GPS, electrical power distribution and instrumentation systems.
Civil/Structural Engineer	Provides civil and structural engineering expertise to design, build, operate and sustain ground systems and equipment and to operate and sustain flight systems. Examples include: passive thermal protection systems, aerospace structures, fasteners, and access panels/doors.
Avionics Engineer	Provides avionics engineering expertise to design, build, operate and sustain ground systems and equipment and to operate and sustain flight systems. Examples include: engine controllers; general purpose computers; guidance, navigation and control; displays and controls; and data processing systems.
Computer Engineer	Provides computer engineering hardware and firmware expertise to design, build, operate and sustain ground systems, equipment, and related support tools. Examples include: Computer platforms, enterprise servers, operating systems, computer networks, embedded systems, specialized test equipment, telemetry processing hardware, data centers, and simulation hardware.
Software Engineer/Computer Scientist	Provides software engineering expertise to design, build, operate and sustain ground software systems, equipment, and related support tools. Examples include: Control room system software, application software, recording and retrieval services, test support software, advisory systems, displays, telemetry processing software, math models, and simulation software.

Aerospace Workforce Outlook

Appendix G

Estimated Current Engineering Manpower for Major Shuttle Hardware Processing Contractors

<u>Shuttle Function</u>	<u>Senior Level Engineers</u>	<u>Junior Level Engineers</u>
Shuttle and Ground Systems Processing and Operations	1041	731
Shuttle Main Engine Processing	36	15
Shuttle Payload Processing and Orbiter Engineering Services	344	74