Economic and Workforce Impacts of Hurricane Katrina, Demographic and Related Changes on NASA’s Space Shuttle Program: Findings and Recommendations

FINAL REPORT

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Launch image provided by NASA.

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Executive Summary

National Aeronautics and Space Administration (NASA) Space Shuttle Program (SSP) officials are concerned about potential adverse impacts of several major factors on their capacity to fly up to sixteen missions between late 2006 and the SSP “fly-out” date in September 2010. This final report assesses the impacts of factors including Hurricane Katrina and the aging of the shuttle program workforce, and offers findings and recommended strategies for consideration by NASA and its major contractors in the Gulf Coast region.

Background

Prior to President George W. Bush’s January 2004 announcement of the new vision for space exploration, NASA’s mission schedule kept the shuttle active through 2012, and officials were assessing requirements to maintain operations through 2020. With the announcement of the Constellation Program, the shuttle’s fly-out date was re-set for 2010. This abbreviated time horizon forced NASA to accelerate the mission schedule in order to complete construction of the International Space Station (ISS), since international research partners have specifically designed ISS components to take advantage of the shuttle’s cargo hold.

Each space shuttle mission requires months of intensive planning and preparation by highly skilled teams of scientists, engineers, production, technical, and support staff in key NASA facilities, including John C. Stennis Space Center in Hancock County, MS and Michoud Assembly Facility in New Orleans East, LA. Together, these facilities employ nearly 4,000 workers. Because these workers are highly educated and uniquely skilled, they would be very costly to replace, in terms of both the time it would take to recruit, screen, hire, and train new workers, and lost productivity for the shuttle program.

The Facilities

Michoud Assembly Facility (MAF) is responsible for the production of the space shuttle’s external fuel tank (ET). For more than 30 years, Lockheed Martin (Lockheed) has been the prime contractor for the ET, and its employees have developed a strong
commitment to the work and to the mission of the space program. Lockheed will continue to produce the ET through 2008 under current contracts. Beyond that, Michoud will play a key role in the development of the new Orion space exploration vehicle. Some 40% of Lockheed’s workforce will be retirement-eligible in the next five years.

The highly skilled workforce at Stennis Space Center has been involved in the testing of the space shuttle main engine (SSME) since 1975. The center allows NASA and other public and private organizations to test large propulsion systems at one of three test complexes with the flexibility to focus on individual engine parts all the way to complete rocket stages. There are four SSME contractors at Stennis: Applied Geo Technologies, Inc; Jacobs-Sverdrup; Mississippi Space Services; and Pratt & Whitney Rocketdyne. In the next five years, between 2-30% of their workers will be retirement-eligible.

Hurricane Katrina

Hurricane Katrina made landfall along the Louisiana-Mississippi border on the morning of August 29, 2005. In all, more than 90,000 square miles were declared a disaster area. While the storm surge primarily swept in and out of coastal areas quickly, the flooding in New Orleans, which covered more than 80% of the city, lasted for weeks due to the failure of the levees and the breakdown of the pumping systems normally used to keep the below-sea level city dry.

The storm passed between the Stennis and Michoud facilities, which are just 45 miles apart. While neither facility suffered major damage, repair estimates at both MAF and SSC total approximately $760 million. The destruction of much of the region's infrastructure, as well as the uncertain, protracted pace of recovery, has created difficult, and ongoing, problems for many SSP workers. The status of the economic and physical infrastructure of the Gulf Coast will factor heavily in the ability of NASA to meet its goals for SSP by September 2010.

Approach

Katrina and its effects, the aging of the SSP workforce, as well flight scheduling pressures, contracting and management practices, and continuing uncertainty over the details
of future space exploration and contractors’ roles in it, all may adversely affect the ability of NASA’s Space Shuttle Program to accomplish its mission between now and fly-out in September 2010. NASA turned to researchers at the University of Texas at Austin to conduct an independent analysis of these factors and their effects on the shuttle program and recommend strategies for addressing identified issues.

UT researchers established three parameters for this analysis:

- A time period of 2006 through September 2010.
- A focus primarily on Michoud and Stennis and their roles in the manned space flight program. Developments in closely related programs, related sites (such as Marshall Space Flight Center in Huntsville, AL), and the contractors themselves were considered as well.
- A focus on the contractor workforce, since NASA employees represent only a small fraction of the total workforce at these two facilities, and NASA has more direct control over working conditions and retention incentives for its own workers.

The analysis derives from a conceptual model of the factors affecting NASA/SSP workers and their families. Households, as the principal decision making units, are influenced by a series of major factors, some of which are within the household’s control and others that may be under the control of NASA, contractors/employers, or community leaders. The analysis draws on the following data sources:

- Extant data on the nature of work, community, and related factors in the NASA facilities and the region, before and since September 2005.
- In-depth interviews with NASA and contractor administrators and staff, as well as union, government, community, business, and education leaders.
- Focus groups with contractor staff at the Marshall, MAF, and SSC facilities to learn about the issues affecting NASA’s contract workforce.
- Surveys of NASA’s contractor employees to gain detailed knowledge of the external (e.g., Katrina-related) and internal (e.g., aging workforce, retirement) factors affecting their decisions about remaining with the SSP program, as well as possible actions by NASA, its contractors, and others that would induce them to remain at work through mission fly-out.

**Key Findings and Impact Assessment**

Study findings offer a compelling story of great adversity and challenges tempered by perseverance and adaptability in the wake of Hurricane Katrina. They also highlight
workforce and workplace trends that existed prior to, and continued after, Katrina. One of the major findings is the strong attachment to community and longevity with and dedication to the Space Shuttle Program, the facilities, and specific employers/contractors in the Gulf Coast region. This has prevented greater losses through attrition and disruptions in the program than might have been expected or experienced in another setting. Other findings are as follows.

**Findings Related to NASA.** The current production schedule requires regular overtime at both facilities, negatively affecting the ability of workers to recover from Hurricane Katrina and potentially affecting safety. Workers at both facilities are uncertain about future job prospects and noted that communication gaps between NASA and contractors and among contractors themselves have caused false starts and delays that contribute to schedule pressures. Finally, personnel changes at NASA have resulted in a lack of understanding of key systems and relationships, and have interrupted or delayed critical decisions and work processes.

**Findings Related to Contractors/Employers.** Work satisfaction at both facilities has declined since the storm. Compensation is a significant concern as current market conditions and the high cost of living are eroding effective salary and wage rates. In addition, there are “thin” staffing levels or outright shortages in critical or “single-point failure” positions, particularly in the short-term. Hurricane Katrina has contributed to worker attrition, and current contracting requirements limit hiring. Contractors are reluctant to seek modifications to address these issues out of competitive and cost concerns.

Limited manpower and schedule disruptions have led to production backlogs, mandatory overtime, constant on-call status, and offsite assignments for some groups of workers, in turn leading to workplace stress and potential safety lapses. Nearly a quarter of MAF survey respondents reported being “burned out from work” often or very often, as did 18% of SSC respondents. Almost a fifth of MAF workers and 14% of SSC workers reported searching for other work on a weekly or daily basis. Despite staffing challenges, contractors have not engaged with regional workforce and education systems to develop an adequate “pipeline” system for providing new workers, in part due to the contracting structure. A lack of training for MAF and SSC workers, and limited career advancement opportunities, make internal cultivation of an appropriately skilled workforce challenging.
Findings Related to Households. Workers at both SSC and MAF reported large drops in overall life satisfaction following Hurricane Katrina, as well as declines in physical and mental health. These workers are facing a number of challenges, including: a shortage of livable housing at affordable prices; a lack of reliable and reasonably priced contractors and supplies needed to complete reconstruction; lack of other businesses in the community; and the lack of critical public and governmental infrastructure and services, such as law enforcement, healthcare, education, and childcare. In addition, workers face multiple new demands on their time given the challenges of personal and regional reconstruction and recovery. These experiences are having a profound and possibly lasting effect on SSC and MAF workers in terms of personal/family stress, fatigue, fear, burnout and health, and are undoubtedly having, and will continue to have, residual affects on their work performance.

Modeling the Impact of Hurricane Katrina and Other Factors

System dynamics, an approach to understanding the behavior of complex systems over time, models feedback loops and delays that exist in any complex system. A simulation model based on system dynamics methodology was developed to assess the possible ramifications that Katrina and other factors might have on the successful completion of the Space Shuttle Program. The model focused on the “burnout dynamics” that occur when a workforce is subjected to extended overtime and excessive fatigue. SSP workers have endured excessive non-work-related fatigue as a result of Katrina, in addition to the stress resulting from the aggressive work schedule needed to meet Return-to-Flight requirements and the new fly-out deadline. The purpose of the model is to see how these factors influence the completion of the remaining shuttle missions.

Work-week Models With and Without Katrina Effects

The baseline model was simulated to test the program’s performance without the effects of Hurricane Katrina. It was assumed that the current workforce could meet the production schedule of five shuttles in 2007, although this assumption could not be empirically verified. The model also assumes that experienced workers are replaced with new workers as they retire, but that the new workers’ productivity is reduced by 15% until they become fully trained after three years, an effect derived from both the productivity...
literature and estimates provided by contractor human resource directors. The weekly hours needed to keep the program on track according to the current flight schedule in the simulation reaches a maximum of 46 at month 23; that is, 23 months after the beginning of 2007 or near the end of 2008.

The model was then simulated to test the effects of worker fatigue caused by Hurricane Katrina and the continuing recovery efforts. Although the actual loss in productivity could not be determined, a conservative estimate of 10% was used. As shown in the figure below, the resulting loss in productivity greatly increases the need for overtime in the contractor workforce. The peak demand for labor is 72 hours per week in month 23, and significant overtime is required into 2010.

![Average Work-week with and without Katrina Effects](image)

**Average Work-week with and without Katrina Effects**

**Work-week Effects of Policy Interventions**

Several policy changes were tested to quantify their potential impacts on system performance. While reducing the employees’ external fatigue can improve program performance, NASA’s and contractor’s influence over the factors creating external fatigue may be insufficient to materially change productivity. Two leverage points that can be addressed, however, are: 1) reducing the rate at which experienced employees retire, which both NASA and contractors can accomplish; and 2) modifying the shuttle schedule, which
only NASA can do (presumably in consultation with Congress). The table below summarizes the results of simulating these policy changes.

### Work-week Effects of the System Dynamics Models

<table>
<thead>
<tr>
<th>System Dynamics Models</th>
<th>Maximum Work-week Required (hrs/wk)</th>
<th>Timing of Maximum Work-week (months from Jan. 2007)</th>
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<tbody>
<tr>
<td>Baseline</td>
<td></td>
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<tr>
<td>2007--5 shuttle missions</td>
<td>43</td>
<td>23</td>
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<tr>
<td>2008--5 shuttle missions</td>
<td></td>
<td></td>
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<tr>
<td>2009--4 shuttle missions</td>
<td></td>
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<tr>
<td>2010--2 shuttle missions</td>
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<tr>
<td>Hurricane Effect</td>
<td>72</td>
<td>23</td>
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#### Interventions

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<tr>
<th>Interventions</th>
<th>Maximum Work-week Required (hrs/wk)</th>
<th>Timing of Maximum Work-week (months from Jan. 2007)</th>
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<tr>
<td>Reduce External Fatigue</td>
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<td>23</td>
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<td>Retention of Retirement-Eligible Workers</td>
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<td>23</td>
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<tr>
<td>Modified Shuttle Schedule 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007--4 shuttle missions</td>
<td>No overtime required</td>
<td>n/a</td>
</tr>
<tr>
<td>2008--4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009--4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010--4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Shuttle Schedule 2</td>
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<tr>
<td>2007--4.5 shuttle missions</td>
<td>53</td>
<td>35</td>
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<tr>
<td>2008--4.5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009--4.5 shuttle missions</td>
<td></td>
<td></td>
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<tr>
<td>2010--2.5 shuttle missions</td>
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Source: Authors’ estimates

The simulations clearly show that significant overtime is required to stay on schedule under any simulation given the impact of Katrina, its prolonged recovery and other factors. However, the simulations also show that the most influential leverage point is changing the timing of the scheduled shuttle missions. Even modest modifications of the SSP mission schedule will yield disproportionate results in terms of reduced fatigue and concomitant productivity gains.

### Recommendations

Based on key findings from the analysis and modeling, a series of recommended actions are suggested for NASA and contractors to consider.
Among other things, NASA should:

- Reduce the number of shuttle flights in 2007 and 2008, either by extending shuttle fly-out to 2011 or by reducing the number of flights in those years by one per year.
- Permit contractors greater flexibility to modify work procedures, such as telecommuting and varied work schedules.
- Engage in a comprehensive communication strategy to provide greater transparency and keep contractor employees better informed about plans for the current and future space program.
- Review policies and procedures for establishing and communicating operational and administrative requirements, approvals, and personnel and other changes to minimize paperwork and to make sure all contractor employees are fully informed of, prepared for, and able to carry out critical tasks in a timely and efficient manner.
- Advocate and demand accountability for prioritized, rapid, orderly, and sustained improvements in community infrastructure that address the critical issues identified by workers.

Among other things, employers/contractors should:

- Explore meaningful changes to employee net compensation, including: negotiating an aggressive increase in salary across the board; implementing site-based eligibility for retirement and insurance benefits; instituting a housing subsidy; creating a retraining benefit or out-service training for workers facing job losses at or near the end of the SSP; and revisiting the retention incentives and bonuses provided for government and contractor employees in the Air Force’s Titan Program.
- Review current and future expected work requirements to determine optimal staffing levels given the aggressive SSP production schedule and safety imperatives.
- Develop ongoing relationships with the region’s education, employment and training institutions to create and maintain a robust “pipeline” for growing and keeping the workforce skills they need locally.
- Review the safety environment to ensure that actual practices are in compliance with stated policies and procedures, while not overly burdening work processes.
- Develop strategies to relieve or offset the costs and lost time associated with excessively long commutes.
- Determine the effectiveness of traditional EAP programs in meeting the extraordinary and ongoing needs of their workforce, and develop customized programs and strategies as necessary.
I. Introduction

Officials with the National Aeronautics and Space Administration’s (NASA) Space Shuttle Program (SSP) are concerned about potential economic and workforce impacts of several major factors on their ability to carry out the mission of flying up to five human space flight missions annually between now and its September 2010 "fly-out" date, among them Hurricane Katrina and the aging of the Shuttle Program workforce. This report assesses the effects of these factors based on an examination of existing data and reports, in-depth interviews with NASA and contractor staff and knowledgeable individuals in the region, and focus groups with NASA contractor employees at all levels in the affected facilities. It offers findings and recommended strategies for consideration by NASA and its major contractors.

Background

In 2004 and 2005, a series of hurricanes, including powerful Hurricane Katrina which made landfall on August 29, 2005, wreaked havoc all along the Gulf Coast. While not inflicting major direct damage on SSP facilities in the area, Katrina shut down schools and destroyed homes, roads, water treatment plants and other essential components of the region’s infrastructure. The uncertain, protracted pace of recovery in the region has created its own set of problems that must be addressed.

Each Space Shuttle mission—including Atlantis (STS-115), which successfully completed its scheduled work on the International Space Station before returning on September 21, 2006, and Discovery (STS-116), which made the first night launch since 2002 and landed safely Kennedy Space Center thirteen days later on December 22, 2006—requires months of intensive planning and subsequent implementation by highly skilled teams of scientists, engineers, production and technical and support staff in several key NASA facilities located on or near the Gulf Coast (see Figure 1), including:

John C. Stennis Space Center in Hancock County (MS), which tests all rocket engines for the shuttle, is operated by NASA with Pratt & Whitney Rocketdyne as the primary engine-testing contractor. Staff from three other contractors also work directly on or provided material support for testing all of the Space Shuttle Main Engines (SSME) at Stennis: Jacobs Sverdrup’s NASA Test Operations Group...
Michoud Assembly Facility (MAF) in New Orleans East builds all of the external fuel tanks for the space shuttles. Lockheed Martin operates MAF.

Marshall Space Flight Center in Huntsville (AL), a NASA-run facility, develops space transportation and propulsion technologies for space flight programs and oversees activity at Stennis and Michoud. Lockheed Martin and Pratt & Whitney Rocketdyne are the two primary contractors working on the shuttle for NASA at Marshall.

John F. Kennedy Space Center located at Cape Canaveral on Florida’s east coast is NASA’s main launch operations center for space flight.

Lyndon B. Johnson Space Center in Houston (TX), with around 17,500 public and contractor employees, is NASA’s lead facility for human space exploration as it has been since 1961.

Figure 1: Major NASA Space Program Operations in the Gulf Coast Region

The primary focus of this study is contractor workforce issues at NASA’s Stennis and Michoud facilities. Together, these facilities currently employ more than 4,000 workers in the Gulf Coast region, many of whom are highly educated scientists, engineers and technical
staff with skills that would be very costly to replace, in terms of both the time it would take to recruit, screen, hire and train them and the lost productivity for the Shuttle Program. Of these workers, more than 2,100 are employed by Lockheed Martin working on external tank assembly and related operations, and 240 are employed by Pratt & Whitney Rocketdyne on various aspects of rocket engine testing for the Space Shuttle at Stennis (see Table 1). Jacobs Sverdrup NTOG, AGT and Mississippi Space Services also employ substantial numbers of workers at the Stennis Space Center.

Table 1: NASA Space Shuttle Program-related Employment in the Gulf Coast Region, June/July 2006

<table>
<thead>
<tr>
<th>Facility &amp; Contractor</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michoud Assembly Facility (New Orleans East, LA)</td>
<td>2,143</td>
</tr>
<tr>
<td>NASA Direct</td>
<td>6</td>
</tr>
<tr>
<td>Lockheed Martin</td>
<td>2,137</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>John C. Stennis Space Center (Stennis Space Center, MS)</td>
<td>1,712</td>
</tr>
<tr>
<td>NASA Direct</td>
<td>365</td>
</tr>
<tr>
<td>Pratt &amp; Whitney Rocketdyne</td>
<td>240</td>
</tr>
<tr>
<td>AGT, Inc.</td>
<td>63</td>
</tr>
<tr>
<td>Jacobs-Sverdrup NTOG</td>
<td>169</td>
</tr>
<tr>
<td>Mississippi Space Services</td>
<td>617</td>
</tr>
<tr>
<td>Other</td>
<td>258</td>
</tr>
</tbody>
</table>

Source: Unpublished figures provided by NASA and SSP contractors.

In addition to the effects of Hurricane Katrina, both facilities also face serious internal challenges as a result of ongoing demographic changes, primarily the aging of their workforce. The aging workforce has been identified as an important challenge throughout the space industry, particularly for its scientific and engineering workers as noted in a recent report issued by the National Research Council (2006), which found that the NASA space program workforce had a mono-modal distribution that peaked with workers in their early 40s, while the workforce in the aerospace industry generally had a bi-modal distribution,
peaking with workers in their early 40s and 50s (NRC, 2006, p. 11). The aging workforce is an issue that affects substantial numbers of nonscientific skilled occupations, such as machinists, welders and others as well. It is important to acknowledge, as other researchers and experts recently have, that recurring fears over the imminent retirement of highly skilled, specialized workforce have been overblown and have thus far failed to materialize in the U.S. aerospace industry.

A substantial share of the engineers, technical and support staff at both facilities are seasoned workers in their 40s and 50s who are fast approaching retirement age and, given the added “push” from Katrina and its aftermath, may decide to leave their jobs at some point in the near future. As many as 40% of the contractor workforce at Michoud and 2-30% at Stennis are estimated to be eligible for or considering retirement in the next few years.\(^1\) The fact that many members of their immediate and extended families have yet to return to the area is a contributing factor to their unease about remaining in the Gulf Coast region.

Katrina and its effects, aging of the SSP workforce, as well as other factors, including flight scheduling pressures, contracting and management practices and continuing uncertainty over the details of future space exploration and contractors’ roles in it, all may adversely affect the ability of NASA’s Space Shuttle Program to accomplish its mission between now and "fly-out" in September 2010. Substantial anecdotal information has surfaced about the seriousness and magnitude of these problems, accompanied by an increasing output of research reports and analyses, some conducted by NASA contractors themselves.\(^2\) To date, comprehensive, objective information about these factors and their effects on the Shuttle Program has been lacking. As a result, NASA turned to teams of researchers at the University of Texas at Austin and Texas A&M University to conduct independent, structured analyses of these factors and their impacts and to recommend strategies for addressing them.\(^3\)

\(^1\) Researcher field notes.
\(^2\) For example, see Pat Powell, “Feb. 2006 Post Hurricane Katrina Employee Survey Results,” Lockheed Martin, June 27, 2006.
\(^3\) Researchers at Texas A&M University’s Mays Business School studied these issues independently, collaborating on surveys of NASA contractor employees and their spouses to avoid excessive staff burden.
Purpose of the Study

The purpose of the UT-Austin study for NASA is two-fold:

- To estimate the potential adverse impacts of the complex of factors discussed above, including Hurricane Katrina and aging of the Shuttle Program workforce; and
- To develop and recommend strategies for addressing them.

This final report offers findings and recommendations from the analysis based on existing data and reports, field interviews, and focus groups conducted with NASA contractor staff at all levels at the Michoud, Stennis and Marshall facilities, as well as surveys conducted with NASA contractor employees at Michoud and Stennis.

Approach

This analysis derives from a conceptual model of the factors affecting NASA/SSP workers and their families that is depicted in Figure 2. This model posits that households, as the principal decision-making units, are influenced by a series of major factors at home, in the workplace and in the wider community, including:

- **Working conditions and compensation**, e.g., workplace safety, job satisfaction, commuting time, as well as inflation-adjusted wages and salaries plus the value of employee benefits, both for workers and their other working family members;
- **Family/personal factors**, e.g., including marital status, age, race/ethnicity, numbers and ages of dependents (children and parents), assets/liabilities; and
- **Community/environmental factors**, e.g., attachment to and engagement in the community, quality-of-life, quality and accessibility of schools, and related services.

While some of these factors are within the household’s control (e.g., assets/liabilities, whether the spouse works outside the home), many others are not. The pace and extent of recovery from Katrina depends to a large extent on the efforts of the larger community and its elected and civic leaders. NASA and its contractors have a large say in compensation and working conditions, as well as whether key groups of workers will be employed at these facilities in the future. In addition, the type and availability of other job opportunities in the region is also a key factor affecting households’ decisions: there may be greater numbers of
jobs—many of them very high-paying—for hourly assembly workers than for highly
specialized aerospace engineers in the Gulf Coast region.

Figure 2: Conceptual Model of Household Decision-making

At any given time, one set of factors may become more important in the household’s
decision-making than others. For example, in the aftermath of Hurricane Katrina, with
growing unease and uncertainty over the recovery of the communities surrounding the
Michoud and Stennis facilities, workers and their families may come to value family and
community factors more highly than compensation and working conditions in their decision-
making processes. To the extent that workers are in their 40s, 50s and 60s with job- or firm-
specific skills as well as substantial debt (e.g., mortgages), attachment to the workplace may
become that much greater and may overwhelm community/environmental factors.
Uncertainty over the future of their employment—especially their future role in NASA’s
space exploration program—may also affect their decisions in important ways.

A significant factor in the Gulf Coast area appears to be the strength of attachment to
the area and its cultural traditions, especially among the skilled and semi-skilled workforce.
This may be less of a factor for scientific and technical workers who have been accustomed
to moving within a national labor market, but many of these workers may also have had or
developed strong regional ties.
To estimate the likely economic and workforce impacts of Katrina and other factors on employee retention, we must take into account all of these factors and recognize that the magnitude of the impacts may vary over time.

The analysis draws on a number of data sources. First, extant data on the nature of work, community and related factors in the NASA facilities and the surrounding area and how they have been changing before and since September 2005 have been assembled and synthesized. The extant data encompasses standard data sources—e.g., the Bureau of Labor Statistics, the Census Bureau, the Bureau of Economic Analysis—as well as the Brookings Institution’s Katrina reports and surveys of Shuttle Program workers conducted by Lockheed Martin. New data series, such as the American Community Survey data, have also been examined. Several of the latter sources feature special components tracking developments in the Gulf Coast region as a result of Hurricanes Katrina and Rita.

Second, UT researchers have conducted numerous in-depth interviews with NASA and contractor administrators and staff, as well as with union, government, community, business and education leaders to obtain their views regarding the internal and external factors affecting workers decisions surrounding SSP and actions that might be taken to address them. (A sample interview guide is provided as Appendix A.) In addition to interviews conducted with NASA leadership at the Johnson Space Center in Houston, Marshall Space Flight Center in Huntsville, Michoud in New Orleans, and Stennis Space Center in Mississippi, the UT research team conducted 51 interviews, as follows:

- five (5) interviews with managers at Marshall;
- eighteen (18) interviews with Lockheed Martin managers, supervisors and human resource directors at MAF;
- four (4) interviews with UAW leadership at MAF;
- two (2) interviews with staff at the National Center for Advanced Manufacturing housed at MAF;
- one (1) interview with a senior Pratt & Whitney Rocketdyne manager at Stennis;
- three (3) interviews with AGT, Inc. contractor managers, supervisors and human resource directors at Stennis;
- six (6) interviews with Jacobs-Sverdrup NTOG contractor managers, supervisors and human resource directors at Stennis;
• ten (10) interviews with MSS contractor managers, supervisors and human resource directors at Stennis; and
• two (2) interviews with staff at the University of Southern Mississippi’s Center for Higher Learning based at Stennis.

More than a dozen additional interviews were conducted with leaders and representatives of the following groups in the affected communities: Greater New Orleans, Inc.; the Louisiana Secretary of Tourism; the Louisiana Recovery Authority; Idea Village (New Orleans); the Hancock County (MS) Chamber of Commerce; the Mississippi Governor’s Commission for Economic Recovery in Hancock County (MS); and community/technical college (e.g., Delgado Nunez, Pearl River Gulf Coast) and university (e.g., University of New Orleans, University of Southern Mississippi) leaders.

Third, the UT research team conducted focus groups with contractor staff both to learn more about the pressing issues that are affecting NASA’s contract workforce and to assist in tailoring the in-depth surveys of employees and their spouses. (A sample focus group protocol is provided as Appendix B.) The UT team conducted a total of 13 focus groups with 109 individuals, as follows: two groups with 16 employees at Marshall; four groups with 37 Lockheed Martin employees at Michoud; two groups with 20 Jacobs-Sverdrup NTOG employees at Stennis; two with 11 AGT, Inc. employees at Stennis; and three with 25 MSS employees at Stennis.

Fourth, working with the Texas A&M University team, UT researchers developed and conducted surveys of NASA’s contractor employees and their spouses to gain detailed knowledge of the external (e.g., Katrina-related) and internal (e.g., aging workforce, retirement) factors that have been affecting their decisions about remaining at work on the SSP program, as well as possible actions by NASA, its contractors and others that would induce them to remain at work through mission "fly-out" in September 2010. The surveys were conducted in two Times in the fall of 2006. (Appendix E provides a copy of the Time 1 survey; Appendix F provides a copy of the Time 2 survey). Together, data from these sources informed the analysis and shaped a series of recommendations to NASA.4

4 Spouse surveys are the exception. So few spouses responded to the survey that UT researchers decided not to use them in the analysis. It was not clear whether their responses were sufficiently representative of the views of all contractor employee spouses.
The primary question addressed by the UT analysis is whether NASA will have the employment capacity it requires to achieve its mission: September 2010 “‘fly-out’.” This suggests several parameters for the analysis:

- The time period for analysis is 2006 through September 2010. While events beyond 2010 may be of some interest, they are not considered directly for this analysis.
- While the focus is primarily on Michoud and Stennis and their roles in the manned space flight program, developments in closely related programs—e.g., especially the new and emerging space exploration program—related sites (especially the Marshall Space Flight and Kennedy Space Centers) and the contractors themselves, including Pratt & Whitney Rocketdyne, Lockheed Martin, Jacobs-Sverdrup NTOG, AGT and Mississippi Space Services, have been considered as well. UT researchers conducted parallel sets of interviews and focus groups at Marshall largely in order to “benchmark” NASA and contractor employee experiences and concerns.

The approach has involved several key steps, as follows:

1. Establishing employment requirements by facility and contractor.
2. Making ‘softer’ judgments about the likelihood of key events and factors affecting workers and their households, e.g., poor housing, inadequate Katrina recovery, loss of contracts.
3. Determining the likely effects of key factors on Shuttle Program employment requirements using system dynamics models based on data collected from the various sources.
4. Estimating deviations from the employment requirements under various scenarios.
5. Articulating recommended strategies to be implemented by NASA, its contractors and/or other key actors to address problems identified.

While both NASA and contractor employees are potentially affected by Katrina, workforce aging, retirement and related factors, the focus of this research is primarily on the contractor workforce for two reasons. First, NASA employment represents only a small fraction of the total workforce at these two facilities. And, second, NASA has more direct control over working conditions and retention incentives for its own workers than it does for contract employees. Thus, this analysis focuses primarily on potential effects and associated solutions for NASA’s Space Shuttle Program contractor workforces and their families.
Report Organization

The remainder of this report is organized as follows. The next section provides an overview of NASA’s Space Shuttle Program and two of its key Gulf Coast centers, Michoud and Stennis Space Center. It also profiles other Gulf Coast NASA centers that are involved in the space program. The third section discusses Hurricane Katrina and its recovery in the region. The fourth section outlines recent Gulf Coast labor market developments. The fifth section presents the results of the Time 1 and Time 2 employee surveys. The sixth section examines the major factors affecting NASA’s workforce in the Gulf Coast region—including workforce aging and retirement, compensation and working conditions, Hurricane Katrina and its aftermath, changing area labor market opportunities, and contracting for future space exploration. The seventh section presents the system dynamics models developed for this analysis and the estimated impacts on the Space Shuttle workforce in the region. The eighth section outlines recommended strategies for addressing potential adverse impacts on the workforce. The final section offers concluding observations. References and several appendices follow the main body of the report.
II. **NASA’s Space Shuttle Program and Future Space Exploration**

The current mission of the Space Shuttle Program is to support the completion of the International Space Station (ISS). Save for one mission to repair the Hubble Telescope, the remaining sixteen shuttle flights are intended to deliver the rest of the space station infrastructure and provide the manpower for its construction. The SSP "fly-out" in 2010 will mark the end of an era for the U.S. space program—the plane-like design and landings will not be repeated in the new Orion exploration vehicles which are scheduled for launch no later than 2014 and possibly as early as 2012. This “potential gap in U.S. human spaceflight”⁵ is a concern to Congress and others involved in space-based scientific and exploratory research.

As the timeline in Figure 3 illustrates, the Space Shuttle Program has played an integral role in the advancement of human space flight since 1981. The design of the SSP makes it an appropriate vehicle for the scientific and space construction tasks it has supported over the years; the space shuttle is not an exploration vehicle but rather a workhorse. In that capacity, the space shuttle is essential for the growth of the International Space Station. If this research outpost is to reach its potential, it will require numerous missions from the three remaining shuttle vehicles—Discovery, Atlantis, and Endeavor.

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Mission Schedule

When President George W. Bush announced his vision for space exploration in January 2004, he tacitly called for NASA to end the SSP in late 2010.\textsuperscript{7} Prior to this announcement, NASA had been working under a mission schedule that kept the shuttle active through 2012, and had been undergoing an assessment of the fleet’s requirements to maintain operations through 2020.\textsuperscript{8} Given the 2010 target "fly-out" date, NASA has had to adjust the mission schedule in order to meet the shuttle’s commitments to the ISS. As it currently stands, the SSP will fly sixteen more missions—fifteen to complete the ISS and one to repair the Hubble Telescope. This schedule requires 4-5 missions per year for the next four years, a tight schedule for the SSP team, including its contractors at Michoud and Stennis.

NASA and its contractors are accustomed to milestone pressures. In fall 2002, NASA was considering ten missions in sixteen months to achieve the February 2004 target

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\textsuperscript{6} Adapted from CNN, "Milestones in Space Shuttle History."; "List of Space Shuttle Missions," (Wikipedia, 2006).

\textsuperscript{7} White House, "President Bush Announces New Vision for Space Exploration," (White House, 2004).

\textsuperscript{8} Frederick D. Gregory, "Statement of Frederick D. Gregory Associate Administrator Office of Space Flight NASA before the Subcommittee on Space & Aeronautics Committee on Science United States House of Representatives," (Washington, DC: Committee on Science, United States House of Representatives, 2002).
date for the installation of Node 2, which would complete a basic station configuration for continued operations of the ISS. Indeed, it is the intense focus NASA placed on achieving this “US Core Complete” milestone in ISS construction that was blamed, in part, for the failures leading to the Columbia disaster in February 2003.⁹

Since the Columbia accident, NASA’s schedule pressures have been focused around “Return-to-Flight” and “Return to Assembly.” Return-to-Flight was delayed until July 2005, and subsequent foam debris issues delayed Return to Assembly until September 2006. NASA is now facing increasing pressure to accelerate ISS construction in order to comply with the President’s desired “fly-out” in late 2010. To meet the construction timetable, NASA will focus on delivery of ISS components first and defer logistical and other, primarily scientific, missions for future flights.¹⁰ Table 2 below highlights key missions and milestones in the pre- and post-Columbia schedule.

Table 2: Space Shuttle Program Mission Schedule¹¹

<table>
<thead>
<tr>
<th>Target Launch</th>
<th>Mission</th>
<th>Purpose</th>
<th>Target Launch</th>
<th>Mission</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2003</td>
<td>STS-114</td>
<td>All of these are ISS-related missions</td>
<td>July 2005*</td>
<td>STS-114</td>
<td>Return-to-Flight</td>
</tr>
<tr>
<td>May 2003</td>
<td>STS-115</td>
<td>US Core Complete</td>
<td>July 2006*</td>
<td>STS-121</td>
<td>Return-to-Flight  - Test</td>
</tr>
<tr>
<td>July 2003</td>
<td>STS-116</td>
<td></td>
<td>September 2006*</td>
<td>STS-115</td>
<td>Return to Assembly (ISS)</td>
</tr>
<tr>
<td>October 2003</td>
<td>STS-117</td>
<td></td>
<td>December 2006*</td>
<td>STS-116</td>
<td>ISS</td>
</tr>
<tr>
<td>November 2003</td>
<td>STS-118</td>
<td></td>
<td>February 2007</td>
<td>STS-117</td>
<td>ISS</td>
</tr>
<tr>
<td>January 2004</td>
<td>STS-119</td>
<td></td>
<td>June 2007</td>
<td>STS-118</td>
<td>ISS</td>
</tr>
<tr>
<td>February 2004</td>
<td>STS-120</td>
<td></td>
<td>August 2007</td>
<td>STS-120</td>
<td>ISS</td>
</tr>
<tr>
<td>April-December 2004</td>
<td>3 planned</td>
<td>Hubble and two ISS</td>
<td>October 2007</td>
<td>STS-122</td>
<td>ISS</td>
</tr>
<tr>
<td>2005</td>
<td>4 planned</td>
<td>ISS</td>
<td>December 2007</td>
<td>STS-123</td>
<td>ISS</td>
</tr>
<tr>
<td>2006</td>
<td>4 planned</td>
<td>ISS</td>
<td>2008</td>
<td>5 planned</td>
<td>ISS</td>
</tr>
<tr>
<td>2007</td>
<td>4 planned</td>
<td>ISS</td>
<td>2009</td>
<td>4 planned</td>
<td>ISS</td>
</tr>
<tr>
<td>2008</td>
<td>4 planned</td>
<td>ISS</td>
<td>2010</td>
<td>2 planned</td>
<td>ISS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+1 possible</td>
<td>Hubble</td>
</tr>
</tbody>
</table>

* Completed Mission
Please note, the purpose of this table is illustrative.
Source: NASA; Students for Exploration and Development of Space

In order to adhere to the "fly-out" timetable, NASA and its contractors must overcome key challenges to the program as well as in the space shuttle itself. Since the Columbia disaster, Congressional leaders and others have questioned the justification for and expense of continuing the program. “The average cost to launch a Space Shuttle is about $450 million per mission.”12 Were it not for completed ISS components waiting for delivery and America’s obligation to our international partners, the program might have ended in 2003. NASA, however, made a strong commitment to return to space after the Columbia disaster and in the intervening two and a half years before Return-to-Flight, undertook major overhauls of the orbiter vehicles, the external tank, and other SSP components. More than thirty-seven pounds of problematic foam insulation have been removed from the external fuel tank to minimize the risk of debris damaging the orbiter’s thermal protection system.13 While minor modifications may continue to be made between missions, NASA has moved forward with the existing tank design and shifted its focus to completing ISS construction by September 2010.

The mission schedule for the Space Shuttle Program is constantly undergoing revision. As of January 8, 2007, there were five scheduled missions in 2007, all dedicated to the construction of the International Space Station. Moving into 2008, NASA currently has five missions scheduled, four of which will be targeted at construction of the International Space Station and one to service the Hubble telescope. In the final two years of the program, NASA will attempt four to six missions, most of them occurring in 2009.

Profiles of NASA Gulf Coast Facilities

Two facilities on the Gulf Coast are critical to NASA’s ability to continue space shuttle operations. The Michoud Assembly Facility produces the external tank, and Stennis Space Center is the testing site for the space shuttle main engines. In August 2005, Hurricane Katrina made landfall between these two facilities, which are only about forty-five miles apart (see Figure 4). While the facilities themselves escaped the storm without significant damage, the workforce and the surrounding communities were not so lucky. The

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following sections profile these facilities, the major NASA contractors involved at each site, and their workforce, as well as highlighting some of Katrina’s impacts. More specific discussion of Hurricane Katrina’s impacts on the region and the recovery process are detailed in the next section.

Figure 4: Map of NASA's Gulf Coast Facilities

Michoud Assembly Facility

Lockheed Martin Operations and Production of the External Tank

Michoud Assembly Facility (MAF), one of the world’s largest production facilities under one roof (43 acres), is responsible for the production of the space shuttle’s external tank (ET). The facility in New Orleans East was ideal for the ET because of its large production buildings and its access to a deep-water port, which is necessary to transport the ET to Kennedy Space Center. Each ET, the only part of the space shuttle that is not reusable, takes approximately 18 months to build.  

For more than thirty years, Lockheed Martin (Lockheed) has been the prime contractor for the ET, and its employees have developed a strong commitment to the work and to the mission of the space program. The value of Lockheed’s Michoud contracts from 1973-2005 is approximately $9.6 billion, with a payroll over that period of approximately $3.5 billion. The 2005 payroll at Michoud was $142 million. Lockheed sub-contracted $74.1 million of work in 2005, and $3.3 billion over the course of their Michoud operations.16 Under current contracts, Lockheed will continue to produce the ET through 2008. Beyond that, Michoud will play a key role in the development of the new Orion space exploration vehicle, a project which was awarded to Lockheed in August 2006.

**Michoud Workforce**

Lockheed employs 2,137 people at the Michoud facility, making it one of the largest employers in the New Orleans area. These workers include engineers, assembly line workers, highly skilled welders and electricians, and other essential personnel. Many employees have worked at Michoud for more than twenty years, and a large number have been with Lockheed Martin since it took over operation of the facility. Approximately 40% of Lockheed’s Michoud employees are or will be eligible to retire with in the next five years.17

The Lockheed workforce at Michoud is split between two major groups: 1) those hired when the Space Shuttle Program was ramping up in the late 1970s and early 1980s; and 2) those hired since 2000 when Lockheed realized that it needed to start addressing aging workforce issues. In between those two periods, hiring simply kept pace with annual turnover. These two primary groups have very different expectations as employees. The older group was hired when a traditional pension package was standard and employees could expect to work for a single employer over the entire course of their career. The younger group has come on-board during a time when the American workplace no longer rewards those who make long-term commitments to a single employer as handsomely; their benefits package only includes a 401k retirement option, not a defined-benefit pension.

17 Researcher, "Interview Notes - Michoud Site Visit."
This age division will influence the commitment of the Lockheed workforce to the SSP "fly-out". Older workers are tied to Michoud by Lockheed’s retirement policies that require a worker to be 55 years old and have at least ten years of service with the company to qualify for a pension. These workers are likely to stay on at MAF unless another factor or factors drives them out.\textsuperscript{18} For the “touch” employees—approximately 600 workers that are involved with the actual hands-on production and assembly of the ET—their union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW) recently re-negotiated the contract with Lockheed. Under the new contract, workers with less than 30 years at Lockheed will lose fully covered retiree medical benefits in September 2006. Some workers are considering early retirement at a lower pension in order to ensure that they and their spouses will continue to have full medical coverage.\textsuperscript{19}

Lockheed Martin currently assesses its workforce capacity at 90% of what is needed to "fly-out" the space shuttle. The company has more than 400 job postings for Michoud work, but is currently focusing on local recruiting only due to the challenges of bringing in outside individuals to an area facing a severe housing shortage.\textsuperscript{20} The MAF workforce was spread across the region prior to Hurricane Katrina; while many lived near the facility in New Orleans East, significant numbers lived in Orleans, Jefferson and St. Tammany parishes in Louisiana and along the Mississippi Gulf Coast.\textsuperscript{21} According to Lockheed Martin data, the top communities losing Michoud employee residents were the City of New Orleans (-111 employees), Chalmette, LA (-60 employees), and Meraux, LA (-28 employees). The communities that gained the most Michoud employee residents are Slidell, LA (+43 employees), Metairie, LA (+27 employees) and Covington, LA (+16 employees).\textsuperscript{22}

Hurricane Katrina, though devastating, is not the only factor contributing to worker stress at Michoud. Prior to the Columbia disaster, Michoud was under intense pressure to accelerate the delivery of ETs. After the disaster, when the accident investigation zeroed in on the ET’s foam insulation as the culprit, the stress changed but did not lessen. Workers described long hours and mandatory overtime to redesign the ET and minimize the risk for\textsuperscript{18} Ibid.
\textsuperscript{19} Researcher, "Interview Notes - Meeting with UAW Leadership."
\textsuperscript{20} Researcher, "Interview Notes - Michoud Site Visit."
\textsuperscript{21} Ibid.
\textsuperscript{22} Pat Powell, "Population Shift by City," (Lockheed Martin 2006).
future launches. During this process, the President announced his new space exploration vision and the end of the SSP—essentially handing these workers a lay-off notice. Despite the success of the first Return-to-Flight mission, continued foam problems meant additional modification work. Just as the second redesign process was getting underway, Hurricane Katrina hit the Gulf Coast. Once the facility was fully operational, workers again were required to work mandatory overtime and extra shifts to meet NASA’s tight launch schedule. While the Michoud workers rose to that challenge and have continued to meet NASA’s accelerated tank delivery schedule—some even volunteering to assist in the paperwork closeout process to get the ET for the STS-115 mission shipped on time—the cumulative impact of this stress is starting to be evident. As one supervisor put it, “After Columbia, we’d go home to escape work. After Katrina, we go to work to escape home.”

Indeed, many Michoud employees expressed concern about their co-workers during focus groups and interviews conducted by the research staff. They see evidence of stress, worry, and lack of sleep in quick tempers, angry exchanges, and deteriorating health. While Michoud prides itself on an impeccable safety record, some workers wonder how long it can continue with so many people on-edge. A Michoud worker summed it up for the researchers as “we are a long way from normal.”

Katrina Impacts and Recovery

Despite hurricane force winds in excess of 130mph, a storm surge and subsequent flooding, the Michoud facility escaped Hurricane Katrina with relatively minor damage. A ride-out crew of thirty-eight Lockheed employees has been credited with saving the facility and, essentially, the Space Shuttle Program. These employees stayed on-site to keep the water pumps working and ensured that the levees surrounding the facility were not breached. Indeed, aerial photographs taken of the New Orleans area after Hurricane Katrina reveal the Michoud site to be one of the only areas for miles with green grass—a sure sign that there

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23 Researcher, "Interview Notes--Michoud Site Visit."
25 Researcher, "Interview Notes - Michoud Site Visit."
26 Researcher, "Interview Notes - Meeting with UAW Leadership."
was no flooding. For their efforts, these 38 employees were awarded NASA’s Exceptional Bravery Medal\textsuperscript{27} and recognized by Congress for their dedication in House Resolution 892.\textsuperscript{28}

The storm did tear off part of the roof of the main production facility, and other buildings on-site sustained heavier damage. Damage estimates to both Michoud and Stennis Space Center total approximately $760 million.\textsuperscript{29} It is a testament of the commitment of Lockheed employees to the Space Shuttle Program that Michoud was back in operation about five weeks after the storm and able to deliver a modified external tank less than three months after the facility fully re-opened, despite the ongoing upheaval and uncertainty Hurricane Katrina created in their own personal lives.\textsuperscript{30}

Lockheed took several steps to support its workforce through the immediate aftermath of the storm. Michoud employees were heavily affected by Hurricane Katrina, with approximately half of the workers losing their homes or suffering damage extensive enough to make their home uninhabitable. In order to retain its workforce, Lockheed made payroll for two months after the storm whether or not the employee had returned to work. Lockheed also established a Katrina Fund for employees and distributed between $500 and $3,000 to workers as needed. When operations at Michoud restarted, Lockheed arranged for temporary housing and transportation to bring workers back. Since the storm, employees have received raises and other wage increases to help them deal with the rapidly rising cost-of-living in the Gulf Coast region, estimated to be about 30\% higher than in the pre-Katrina period.\textsuperscript{31} Despite all of these efforts, Lockheed’s workers face ongoing challenges such as continued separation from their families, increased commute times, lack of resources in the community, and other barriers to resuming a “normal” life.

\textsuperscript{27} "NASA Honors Michoud Workers for Bravery During Hurricane," (New Orleans, LA: Lockheed Martin, 2006).
\textsuperscript{28} House Science Committee, "House Commends Employees of NASA's Michoud Facility for Dedicated Service During Katrina," (2006).
\textsuperscript{30} "Lockheed Martin Delivers Next Flight Tank to NASA," (New Orleans, LA: Lockheed Martin, 2006).
\textsuperscript{31} "GCN Recovery News Report," (Biloxi, MS: Gulf Coast News, 2006).
Stennis Space Center

Description and Economic Impact

Stennis Space Center (SSC) encompasses more than 8,300 acres in Hancock County, Mississippi and is surrounded by a 125,000 acre acoustic buffer-zone. This zone allows NASA, U.S. Department of Defense, and other public and private organizations to test large propulsion systems at one of three test complexes with the flexibility to focus on individual engine parts all the way through to complete rocket stages.32

More than 30 government agencies and private companies are located at SSC, employing approximately 4,500 workers. NASA and its contractors make up about one-third of this workforce, with NASA directly employing 365 workers.33

Dr. Charles Campbell at Mississippi State University conducts an annual study to estimate the economic impact of SSC on the surrounding communities. The fiscal year 2005 report, released in March 2006, highlights how integral the Center is to the economic viability of the Mississippi and Louisiana Gulf Coast. Seventy percent of SSC budgets are spent within a fifty-mile radius of the Center, totaling about $500 million in FY 2005.34 “Every dollar Stennis Space Center spends generates another 81 cents in the coastal area personal income…Every $1 million [SSC] spends generates another 25 jobs in the local coastal area.”35 SSC has a total employment impact (those who are employed directly and indirectly as a result of SSC operations) of 19,700 jobs and a total personal income impact of about $819 million.36 The direct global economic impact of SSC is estimated at $691 million (see Figure 5).

34 Charles A. Campbell, "Estimation of the Economic Impact of the Stennis Space Center on the Area Including Harrison, Hancock, and Pearl River Counties in Mississippi, and St. Tammany Parish in Louisiana for Fiscal Year 2005," (Mississippi State, MS: Mississippi State University, 2006).
36 Ibid, 1.
The SSC workforce is highly skilled. Approximately 35% of its employees are engaged in scientific or engineering occupations, another 16% are business professionals, 29% are engaged as technicians, skilled craftsmen, or production specialists, and the remaining 20% are occupied in clerical and other positions. Figure 6 shows the educational attainment of the SSC workforce.

**Figure 6: SSC Employee Educational Achievement**

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38 Ibid.
39 Charles Campbell, "Estimation of the Economic Impact of the Stennis Space Center on the Area Including Harrison, Hancock, and Pearl River Counties in Mississippi, and St. Tammany Parish in Louisiana for Fiscal Year 2005." 15.
**SSC and Hurricane Katrina**

Many buildings at Stennis Space Center suffered damage as a result of the storm; more than sixty suffered moderate-to-severe damage. Indeed, satellite imagery shows the eye of the storm passing directly over the Center. Normal operations resumed about a month after the storm, however, the Center was used as a shelter and distribution point from the start. Approximately 3,700 employees, families, and members of the general public sought shelter at SSC during the storm, and many remained on-site well into November. Approximately 25% of all Stennis workers lost their homes to storm damage. Despite these disruptions to the workplace and their personal lives, NASA’s contractors resumed rocket testing at SSC on October 25, 2005.

The U.S. Navy’s Fleet & Family Support Center (FFSC) is also located on-site at SSC. Since Hurricane Katrina, the FFSC has facilitated employee applications for Red Cross assistance, Small Business Administration (SBA) loans, free tax preparation services, as well as other basic needs such as housing, transportation, and childcare. The center has also retained a variety of advisers to meet the needs of the Stennis community, from a Chaplain to licensed counselors and therapists available for both group and individual support. Individual case managers are assigned to help employees identify available resources to meet their specific recovery needs.

**Role in the Space Shuttle Program - SSME testing**

John C. Stennis Space Center has been involved in the testing of the space shuttle main engine (SSME) since 1975. Each space shuttle is powered by three space shuttle main engines. All of these engines are tested and certified as flight-worthy at Stennis.

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Contractors

Four contractors are involved with the SSME testing program at Stennis: Applied Geo Technologies, Jacobs-Sverdrup, Mississippi Space Services, and Pratt & Whitney Rocketdyne. Each of these companies, their workforce, and their role in the Space Shuttle Program are described below.

Applied Geo Technologies (AGT)

Applied Geo Technologies, Inc. is owned by the Choctaw Indian Tribe of Mississippi. Among other functions, AGT provides advanced manufacturing capabilities and operational services for both aerospace and military customers in Mississippi, Alabama, and Texas. AGT is currently supporting a number of operations at SSC, including SSME testing, through instrument calibration, cleaning and repair services. AGT oversees the Measurement Standards & Calibration Lab, the Environmental Testing Labs, and the Gas & Material Analysis Lab, and provides Metrology Engineering services.44

AGT has held the $4 million annual lab services contract, which is cost plus award fee, since 2004 when NASA designated the function as a small business set-aside. In NASA’s quarterly metrics review of financial data, technical performance, and safety issues, AGT has earned a 100% rating every quarter since the second quarter of 2004.45 In addition to their contract with NASA, AGT is under contract to the Mississippi Army Ammunitions Plant at SSC. Under this contract, AGT is responsible for “tenant leasing, environmental regulations, facility maintenance, safety and security.”46 During the post-Katrina recovery period, AGT provided “mapping support to FEMA, NASA, and other agencies with relief efforts based at Stennis Space Center.”47

Many of AGT’s 63 SSC-based employees have worked at the Center for years, transferring to new employers when the lab services contractor changed. Average time at

44 "Laboratory Services Operated By: Applied Geo Technologies, Inc.,” (Stennis Space Center: Applied Geo Technologies, 2006).
SSC for these employees is eighteen years, demonstrating their commitment to the NASA mission. The metrology and calibration team comprises about half of the AGT employees at Stennis. Most of these individuals received their training through the military, as few postsecondary institutions offer programs in precision metrology (PMEL). The military is slowly starting to outsource the metrology function, meaning that fewer workers are available with the depth of knowledge and skills that military experience used to provide. Where the average age of workers leaving the military with PMEL training used to be under 25, that has now risen to 30-35. Currently, only five colleges around the country have PMEL programs in development; however, they are far from producing their first graduates. AGT estimates that individuals who enter PMEL occupations without military experience, for instance those with degrees in electrical engineering generally require between two and three years of on-the-job training before they can effectively take on the full responsibilities of their job.48

Approximately one-third of AGT employees lived on the Mississippi Gulf Coast prior to Katrina, another one-third lived in Pearl River County, Mississippi, and one-third lived in the Slidell, Louisiana area. About one-third of the AGT workforce lost their homes during Hurricane Katrina, and nearly all (95%) experienced some type of significant damage. Immediately following the storm, AGT worked to make payroll—in cash—so that their workers could function in the cash-only economy that developed. Some employees stayed temporarily in Choctaw-owned hotels in Northern Mississippi, but most have since found temporary or permanent housing closer to SSC.

AGT’s management is concerned that between 5-10% of their workforce may leave their jobs in the next year, with Hurricane Katrina and the recovery process being a primary factor in their decision to leave. Several AGT employees appear to have floundered since the storm and have made very little progress toward recovery. AGT has instituted more social gatherings, including meals and company-wide activities, as a way to rebuild connections between workers since the storm. Workers face a lot of stress in dealing with insurance companies, construction contractors, and government agencies, and AGT management sees these gatherings as an opportunity for workers to vent and to realize that they are not alone.

48 Researcher, "Interview Notes - Stennis Site Visit: AGT."
Given the fact that many of these full-time workers go home to do an additional four to six hours of work on their homes each night, fatigue and safety issues are a real concern.

**Jacobs-Sverdrup (Jacobs)**

Jacobs-Sverdrup currently holds the Test Operations Contract for Stennis Space Center. At SSC, this contract involves “test operations and maintenance of high pressure gas, industrial water, cryogenic fluid operations, and mechanical and electrical systems.”

This six-year consolidated contract for services at SSC and Marshall Space Flight Center (MSFC) in Huntsville, Alabama was awarded in June 2003. The company, formerly Sverdrup Corporation, has been an active contractor for test facility support and modifications at SSC since the 1960s. In August 2006, NASA exercised a 2-year, $42 million option on the test operations services contract that will keep Jacobs active at Stennis and Marshall Space Flight Center through August 2008, with a second option possible through August 2010.

At SSC, Jacobs staffs the NASA Test Operations Group (NTOG) with 169 employees; an additional 75 Jacobs employees are based at MSFC. NTOG is responsible for engineering support and performance testing, as well as providing engineers and technicians for testing systems. Of the 169 employees at Stennis, about 85 are technicians and the rest are engineers and engineering associates drawn from a national labor pool. In July 2006, about 67% of Jacobs workers voted to unionize. The biggest issue driving this vote was wages. As part of their NASA contract, Jacobs salaries are based on U.S. Department of Labor wage determinations which did not increase in 2006 despite rising inflation and increased costs of living on the Gulf Coast.

Like AGT, approximately one-third of Jacobs employees lived on the Mississippi Gulf Coast prior to Hurricane Katrina, another one-third lived in northern Mississippi, and one-third lived in the Slidell—New Orleans, Louisiana area. After the storm, about a dozen

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50 "NASA Stennis Space Center," (Jacobs-Sverdrup, 2005).
employees did not return to work, and managers estimate that another 18-20 employees who are near retirement may decide to leave in the near future, though others who had planned to retire are now staying on to earn money needed for rebuilding. About 25% of the Jacobs workforce suffered a total home loss due to Hurricane Katrina. Jacobs went to work after the storm to bring in supplies for workers living on-site, wired money to those who had evacuated, and brought in counselors to help individuals after they returned to work. Through Christmas 2005, Jacobs operated on a 4-day/10-hour work schedule so that workers had time to rebuild their homes.53

Looking forward, Jacobs is concerned about the workload at SSC during the transition from the Space Shuttle Program to the new exploration program. Jacobs is also concerned about employees who continue to face challenges in Hurricane Katrina recovery. Rising insurance costs, the lack of progress by state and local government, and the severe shortage of affordable housing are factors that are likely to have a negative impact on current workers and limit the company’s ability to attract new workers.

Mississippi Space Services (MSS)

Mississippi Space Services currently holds the Facility Operating Services (FOS) contract at Stennis Center; however, they are in the last year of a seven-year contract. MSS was created as “a joint venture of Computer Sciences Corporation (CSC) and Shaw Group’s Environmental & Infrastructure, Inc.”54 specifically for this contract. While the FOS contract was up for re-competition in fall 2006, NASA exercised a one-year option in August 2006 that will keep MSS on-site through 2007. The one-year extension is valued at $61.6 million.55 The FOS contractor is responsible for a wide range of SSC activities, including infrastructure maintenance, construction, mail services, public affairs, as well as some testing and certification services. MSS employees are involved in SSME testing and certification processes, as well as barge operations, logistics support, and test stand and building maintenance.56

53 Ibid.
54 "Welcome to Mississippi Space Services!," in Mississippi Space Services Homepage (Mississippi Space Services).
55 “NASA Announces Stennis Space Center Contracts.” Stennis Space Center.
There are approximately 600 MSS employees at SSC, of which about two-thirds are in the International Association of Machinists (IAM) union and the rest, mostly business and engineering professionals, are not. Because it supports the whole Stennis complex, MSS has found that many of its staff are lured away by other organizations on-site, including NASA.\textsuperscript{57} Since the storm, MSS has lost seven of their eleven safety professionals. Two were hired away by other SSC employers; the other five left to recover from Hurricane Katrina damage. About 265 MSS (nearly 43%) employees lost homes due to Hurricane Katrina.

During the immediate post-Katrina recovery, MSS provided “roadway clearance into and out of Stennis Space Center, generator power supply for SSC facilities, support for emergency vehicles, aid to FEMA distribution operations, and 9,000 meals a day served to evacuees.”\textsuperscript{58} In the current recovery phase, MSS is responsible for repairing Katrina damage to facilities as well as upgrading facilities identified in poor condition during the post-storm review. For the next three years, the construction budget at SSC will be approximately $100 million per year to cover the costs of post-Katrina repairs and modifications necessary for the development of the crew exploration vehicle.\textsuperscript{59}

**Pratt & Whitney Rocketdyne (PWR)**

Pratt & Whitney Rocketdyne is responsible for rocket propulsion testing at Stennis Space Center. Initially just Rocketdyne Propulsion and Power, this company has been on-site at SSC since it opened. In the current contract, PWR manages the “rocket engine component warehouse-assembly-test-delivery value stream for the…SSME”\textsuperscript{60} and other programs.

Rocketdyne has made all the engines used in US space travel. Bought by Pratt & Whitney’s parent company, UTC, last August, Rocketdyne has a sole-source contract with NASA which was up for renegotiation in December 2006. PWR has about 240 employees on-site at SSC, evenly split between technicians and engineers, with another 125 employees at Kennedy Space Center. Prior to acquisition by UTC, Rocketdyne employees frequently

\textsuperscript{57} Ibid.

\textsuperscript{58} Technology, "Mset Companies Help Post-Katrina Recovery."

\textsuperscript{59} Researcher, "Interview Notes - Stennis Site Visit: MSS."

\textsuperscript{60} "Rocketdyne: NASA Stennis Space Center (SSC), Stennis, Mississippi," in *Pratt & Whitney - Products - Space - Rocketdyne* (Pratt & Whitney).
worked overtime to meet NASA’s schedule demands. UTC policy significantly cuts back compensated overtime to control costs, which in turn compels PWR employees to work uncompensated overtime with predictable impacts on worker morale. The average age of PWR employees is 46, with approximately 30% at or near retirement age. Due to the conditions of the acquisition, the health benefits for employees have changed considerably. Because of this PWR’s chief executive at SSC expects many workers to retire before the end of the four-year grace period in 2009.61

The PWR test engineering force is comprised of petroleum, mechanical and electrical engineers. Their biggest sources of new workers are graduates of Mississippi State University and the University of New Orleans. The position of test engineer actually requires several years of on-the-job training as there is no specific college preparation program for the profession. Originally a five-year apprenticeship, the process has been honed into a two-year detailed certification process with formal standards.62

Prior to Hurricane Katrina, PWR employees lived primarily in Slidell, Louisiana and Picayuné and Diamond Head, Mississippi. Approximately 50 of the 240 (21%) employees lost everything in the storm. PWR sent out search teams after the storm; it took about a month to locate all the current employees and the fifty or so retirees who still live in the area.63 After the storm, PWR managers worked to bring in supplies, temporary housing, and other materials that their workers needed. In preparation for this hurricane season, PWR developed a personal evacuation plan with each employee that includes multiple points of contact for each worker and for the company.

Other Key NASA Sites

Marshall Space Flight Center

Marshall Space Flight Center (MSFC) oversees all components of the space shuttle propulsion system, including the external tank built at Michoud and SSME testing at Stennis. Located in Huntsville, Alabama, MSFC has a long history of involvement in America’s space program and will continue these operations through the development of “key space

61 Researcher, "Interview Notes - Stennis Site Visit: PWR."
62 Ibid.
63 Ibid.
transportation and propulsion technologies”\textsuperscript{64} for the Constellation program. MSFC is home to approximately “2,700 civil servants and more than 4,000 on-site support contractors.”\textsuperscript{65}

The Lockheed Martin group at MSFC is primarily an applied R&D unit for the Michoud External Tank operation. With a team of approximately 65 employees, Lockheed Martin—MSFC does thermal protection, welding, test operations, and composites development, and it manufactures the shuttle’s nose cone. Lockheed Martin-MSFC collaborates with the Lockheed Martin ET facility at Michoud. Also at MSFC, Pratt & Whitney Rocketdyne, similarly, works on SSME projects in conjunction with the operation at Stennis.

\textit{Kennedy Space Center}

John F. Kennedy Space Center (KSC), located on the East Coast of Florida about halfway between Jacksonville and Miami at Cape Canaveral, is “America’s Spaceport.”\textsuperscript{66} Since 1981, KSC has been “the primary NASA center for the test, checkout and launch of space shuttle vehicles and their payloads, as well as the turnaround of orbiters between missions. It is the primary landing site for the shuttle.”\textsuperscript{67}

External Tanks are delivered by barge to KSC from Michoud. Space Shuttle Main Engines (SSMEs) are delivered to KSC from Stennis Space Center.

\textbf{Future of Human Space Flight}

\textit{Mars Vision and Space Shuttle ""fly-out""}

In January 2004, President Bush outlined a new vision for America’s space program, based around three goals:

1. “America will complete its work on the International Space Station by 2010, fulfilling our commitment to our 15 partner countries. The United States will launch a re-focused research effort on board the International Space Station to

\textsuperscript{64} "MSFC Home Page," (NASA, 2006).
\textsuperscript{66} "America's Spaceport," (NASA, 2005).
\textsuperscript{67} "What We Do at KSC" (paper presented at the Information Summary, Kennedy Space Center, FL, 2006).
better understand and overcome the effects of human space flight on astronaut health, increasing the safety of future space missions."68 The Space Shuttle Program will come to an end with the completion of the ISS—what NASA calls the program’s "fly-out".  

2. America “will begin developing a new manned exploration vehicle to explore beyond our orbit to other worlds—the first of its kind since the Apollo Command Module [which was used in the 1960s and 1970s]. The new spacecraft, the Crew Exploration Vehicle [recently named Orion], will be developed and tested by 2008 and will conduct its first manned mission no later than 2014. The Crew Exploration Vehicle will also be capable of transporting astronauts and scientists to the International Space Station after the shuttle is retired.”69  

3. The United States “will return to the Moon as early as 2015 and no later than 2020 and use it as a stepping stone for more ambitious missions. A series of robotic missions to the Moon, similar to the Spirit Rover [which sent] remarkable images back to Earth from Mars, will explore the lunar surface beginning no later than 2008 to research and prepare for future human exploration. Using [the Orion vehicle], humans will conduct extended lunar missions as early as 2015, with the goal of living and working there for increasingly extended periods.”70

**Constellation Program**

The new exploration program has been named the Constellation Program. “Constellation … will provide humans the capabilities necessary to travel and explore the solar system. Constellation will be made up of Earth-to-orbit, in-space and surface transportation systems, surface and space-based infrastructures, power generation, communications systems, maintenance and science instrumentation, and robotic investigators and assistants.”71

**Orion**

Orion is the name of the new Crew Exploration Vehicle (CEV) which will be powered by the Ares I, a two-stage rocket configuration. The Ares I program is being led by NASA’s Marshall Space Flight Center. Lockheed Martin recently won the contract to build the Orion vehicle, and part of this work will occur at the Michoud Assembly Facility. Orion

68 White House. "President Bush Announces New Vision for Space Exploration."
69 Ibid.
70 Ibid.
will be an Apollo-like capsule designed to carry cargo and six crew members to the ISS, or cargo and four crew members to the moon. The capsule “will be 16.5 feet in diameter and have a mass of about 25 tons.”72 NASA expects the Orion vehicle to be safer than the space shuttle due to two aspects of its design: the capsule will sit atop the rocket engines, reducing the possibility for damage by falling debris; and Orion will include an escape rocket.73

**Cargo Launch Vehicle**

The Cargo Launch Vehicle (CLV) will take over the space shuttle’s role as the workhorse of the space program. The CLV will be powered by the Ares V, a two-stage launch system capable of putting “290,000 pounds [of cargo] into low Earth orbit and 144,000 pounds to the moon.”74 NASA awarded a sole-source contract to PWR “for development of the J-2X engine in November 2006.”75

Stennis Space Center will be the test and certification site for both the Ares I, the engine for the Orion vehicle, and the Ares V, which will power the CLV. Jeff Hanley, the Constellation Program Manager at NASA, has committed to SSC employees that “half the cost of developing these vehicles goes toward the testing and certification services you already provide to the country.”76 The first scheduled test for Constellation Program hardware is November 2007.77

**Status of NASA Contracts**

The latest information on NASA contracts for the Space Shuttle and Constellation Programs is as follows:

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73 Ibid.
75 Li. "NASA: Long-Term Commitment to and Investment in Space Exploration Program Requires More Knowledge."
• The Ares I first-stage prime contract will be awarded in February 2007. ATK Launch Systems is currently under contract (for $111 million) to design and develop the first stage for the Ares I crew launch vehicle.

• In January 2007, NASA awarded the safety and mission assurance services contract for Marshall Space Flight Center to Hernandez Engineering. This ten-year, cost-plus-award-fee contract has a potential value of $376.2 million.

• In October 2006, NASA awarded a four-year contract to cover remaining Space Shuttle Program Operations to United Space Alliance, a consortium of Lockheed Martin and Boeing. The first six months of this contract are valued at $1.1 billion.

• In September 2006, NASA awarded a five-year contract worth potentially $448.86 million to Lockheed Martin Space Operations for SSP and ISS support work. This is a two-year contract with three one-year options, which should cover operations through September 2011.

• In August 2006, NASA announced that Lockheed Martin will be the contractor for the Crew Exploration Vehicle, Orion. Also, NASA exercised options to extend the contracts for both Mississippi Space Services and Jacobs-Sverdrup to continue operations at Stennis Space Center.
III. Hurricane Katrina

Hurricane Katrina is estimated to have caused $81 billion in damages and claimed more than 1,833 lives. The number of confirmed dead continues to rise as bodies are still being pulled from damaged houses and debris in New Orleans and along the Gulf Coast. In August of 2006, 135 people were still listed as missing in Louisiana, and 29—18 confirmed and 11 unknown—are still listed as missing in Mississippi.

Figure 7: Path of Hurricane Katrina

Source: Center for Earthquake Research and Information

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80 "Microseismic Effects of Hurricane Katrina," (University of Memphis: Center for Earthquake Research and Information ).
Hurricane Katrina passed over the Florida Peninsula as a Category 1 storm on August 25, 2005. Once in the Gulf Coast, it quickly gained strength and was briefly a Category 5 storm with winds topping 175 miles per hour. Hurricane Katrina again made landfall along the Louisiana-Mississippi border on the morning of August 29, 2005 with sustained winds of more than 125 miles per hour, a strong Category 3 storm81 (Figure 7). The sheer size of the storm—hurricane force winds were measured more than 125 miles from the eye, with the eye itself being more than 32 miles across82—meant that communities across Louisiana, Mississippi, Alabama, and the Florida panhandle experienced significant rainfall, damaging winds and storm surge. The storm was downgraded to a Tropical Storm about 150 miles inland, near the town of Meridian, MS. In all, more than 90,000 square miles were declared a disaster area.83

Storm surge and tornadoes resulting from Hurricane Katrina caused significant damage across the Gulf Coast. Katrina spun out 43 confirmed tornadoes, eleven in Mississippi. In Western Mississippi, storm surge topped 24-28 feet. St. Tammany Parish experienced a 12-16 foot storm surge; in New Orleans East, St. Bernard and Plaquemines Parishes storm surge was estimated at 15-19 feet; and in western New Orleans storm surged topped 10-14 feet.84 Following the storm’s landfall, more than 80% of the City of New Orleans was under water, in some places more than 20 feet of water, as a result of levee failures along Lake Pontchartrain.85 While the storm surge primarily swept in and out of coastal areas quickly, the flooding in New Orleans lasted for weeks due to the failure of the levees and the breakdown of the pumping systems normally used to keep the below-sea level city dry (Figure 8).

83 "Hurricane Katrina," (Wikipedia).
84 Habib, "Katrina's Statistics Tell Story of Its Wrath."
85 "Hurricane Season 2005: Katrina."
Figure 8: New Orleans Flooding\textsuperscript{86}

In the April 2000 image, developed areas are in lavender. In the August 2005 image, flood waters appear grey or dark blue/black. Source: NASA

\textsuperscript{86} "New Orleans and Gulf Coast Flooding in the Aftermath of Katrina," (NASA, 2005).
In Louisiana, the twin spans of the Interstate 10 bridge over Lake Pontchartrain that connected the cities of New Orleans and Slidell were also wiped out. While temporary spans are in place and have allowed this major thoroughfare to reopen, work is underway to replace these bridges with new, higher spans that will be less susceptible to storm surge. Along the coast, the U.S. Geological Survey determined that “a total of 118 square miles of land has been transformed to new water areas” between the Chandeleur Islands and the Atchafalaya River. In addition to the widely publicized flooding in the city of New Orleans, several parishes in the New Orleans MSA, including St. Bernard’s Parish where Michoud is located, suffered enormous damage from Hurricane Katrina.

Figure 9: Waveland, MS Katrina Damage

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87 "I-10 ‘Twin-Span’ Bridge Project Fact Sheet," (Louisiana Department of Transportation and Development, 2005).
As this photo study demonstrates, Waveland, MS was a beach-front community. The top photo was taken in September 1998. In the bottom photo, the same community as seen on August 31, 2005, two days after Hurricane Katrina made landfall.
Source: US Geological Survey

In Mississippi, the US Highway 90 bridge over St. Louis Bay was wiped out, and officials estimated that more than 90% of all the structures within half a mile of the coastline were completely destroyed.\textsuperscript{90} Forty-seven counties in Mississippi were declared disaster areas, and the three coastal counties (Hancock, Harrison, and Jackson) were devastated. The communities of Pass Christian, Waveland and Bay St. Louis, MS, where many Stennis Space Center employees lived, were particularly hard hit (see Figure 9).

Post-Katrina Recovery: Issues and Progress

The status of the economic and physical infrastructure of the Gulf Coast will factor heavily in the ability of NASA to meet its goals for SSP between now and the September 2010 "fly-out." More than a year after Hurricane Katrina, the residents of New Orleans and the surrounding region continue to face housing shortages and negotiate damage to the transportation, health care and educational infrastructure. It is unclear how long it will take public and private actors to overcome these obstacles, rebuild the region and return to normalcy.

Major Road Construction Projects

Long commutes are a common barrier to attracting and retaining workers. The storm surge during Hurricane Katrina destroyed large amounts of the Gulf Coast transportation infrastructure. Longer commutes and increased traffic congestion were major issues raised by workers participating in focus groups at both Michoud and Stennis. Moreover, transportation issues are not likely to be resolved promptly. Among the problems are:

- Bay St. Louis Bridge, which has been closed since Katrina hit, is scheduled to open two lanes by May 16, 2007, and finish six months later.\textsuperscript{91}

\textsuperscript{90} "Mississippi Coast Areas Wiped Out," (CBS News, 2005).
• Interstate 10 in both directions from Causeway Boulevard to Interstate 610—
  Long-term road construction and narrow lanes expected until March 31, 2009.  
  [Footnote 92]

• SR 67 from I-110 to SR 605 in Harrison County - The second phase of this
  project was scheduled to be let in October 2006.  
  [Footnote 93]

• SR 67 from SR 605 to US 49 in Harrison County - The project is scheduled to be
  completed in 2007.  
  [Footnote 94]

• SR 605 from I-10 to SR 67 in Harrison County - The project is scheduled for a
  summer 2007 completion, but early completion is likely.  
  [Footnote 95]

• US 90 Biloxi Bay Bridge between Biloxi and Ocean Springs - MDOT anticipates
  two lanes opening to traffic by mid-November 2007 with a completion date of
  April 2008.  
  [Footnote 96]

• The Biloxi Bay Bridge's first two lanes are scheduled to open in November 2007
  with project completion by spring of 2008.  
  [Footnote 97]

Housing Availability

About 50% of Lockheed Martin’s workforce at Michoud and 25% of Stennis’
contractor workforce had their homes either destroyed or seriously damaged by Hurricane
Katrina.  
  [Footnote 98] The overall housing supply was massively degraded (Table 3). Fully tens of
thousands of families now reside (often with multiple generations) in severely damaged
property or temporary shelter, such as mobile homes or even smaller FEMA trailers. Many
are not back in their homes or even their neighborhoods a year later. The cost of renting in
New Orleans has increased substantially since the storm (Table 4), and there have been
significant increases in the sale prices of homes in those cities, towns and neighborhoods just
beyond the areas directly affected by Hurricane Katrina.  
  [Footnote 99]

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92 W/S Highway Trouble Board (Louisiana Department of Transportation, 2006 [cited September 19
93 Construction Project Updates (Mississippi Department of Transportation, [cited September 19
94 Ibid.
95 Ibid.
96 Ibid.
97 Bergeron, "Gulf Coast Rebirth Starts in Casting Yard."
98 Interviews with NASA officials and contractor employees, July 2006; and Pat Powell (2006).
### Table 3: DHS Katrina and Rita Housing Damage Assessments by County

<table>
<thead>
<tr>
<th>Parish</th>
<th>Census 2000 Occupied Units</th>
<th>Minor Damages</th>
<th>Major Damages</th>
<th>Severe Damages</th>
<th>Total Damages</th>
<th>Percent Occupied Units with Damage</th>
<th>Percent Occupied Major/Severe Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jefferson Parish, LA</td>
<td>176,234</td>
<td>59,552</td>
<td>29,643</td>
<td>4,677</td>
<td>93,872</td>
<td>53.30%</td>
<td>19.50%</td>
</tr>
<tr>
<td>Orleans Parish, LA</td>
<td>188,251</td>
<td>29,241</td>
<td>26,405</td>
<td>78,918</td>
<td>134,564</td>
<td>71.50%</td>
<td>55.90%</td>
</tr>
<tr>
<td>Plaquemines Parish, LA</td>
<td>9,021</td>
<td>2,033</td>
<td>1,190</td>
<td>3,994</td>
<td>7,217</td>
<td>80.00%</td>
<td>57.50%</td>
</tr>
<tr>
<td>St. Bernard Parish, LA</td>
<td>25,123</td>
<td>561</td>
<td>5,938</td>
<td>13,748</td>
<td>20,247</td>
<td>80.60%</td>
<td>78.40%</td>
</tr>
<tr>
<td>St. Charles Parish, LA</td>
<td>16,422</td>
<td>7,736</td>
<td>350</td>
<td>51</td>
<td>8,137</td>
<td>49.50%</td>
<td>2.40%</td>
</tr>
<tr>
<td>St. John the Baptist Parish, LA</td>
<td>14,283</td>
<td>6,332</td>
<td>237</td>
<td>40</td>
<td>6,609</td>
<td>46.30%</td>
<td>1.90%</td>
</tr>
<tr>
<td>St. Tammany Parish, LA</td>
<td>69,253</td>
<td>31,182</td>
<td>15,948</td>
<td>1,682</td>
<td>48,812</td>
<td>70.50%</td>
<td>25.50%</td>
</tr>
<tr>
<td>Hancock County, MS</td>
<td>16,897</td>
<td>3,406</td>
<td>7,185</td>
<td>4,611</td>
<td>15,202</td>
<td>90.00%</td>
<td>69.80%</td>
</tr>
<tr>
<td>Harrison County, MS</td>
<td>71,538</td>
<td>24,204</td>
<td>16,829</td>
<td>7,618</td>
<td>48,651</td>
<td>68.00%</td>
<td>34.20%</td>
</tr>
<tr>
<td>Pearl River County, MS</td>
<td>18,078</td>
<td>9,857</td>
<td>1,272</td>
<td>218</td>
<td>11,347</td>
<td>62.80%</td>
<td>8.20%</td>
</tr>
<tr>
<td>Stone County, MS</td>
<td>4,747</td>
<td>2,681</td>
<td>432</td>
<td>101</td>
<td>3,214</td>
<td>67.70%</td>
<td>11.20%</td>
</tr>
</tbody>
</table>

Source: U.S. Department of Housing and Urban Development

### Table 4: Monthly Fair Market Rents in New Orleans Metro, by Unit Bedrooms

<table>
<thead>
<tr>
<th>Year</th>
<th>Efficiency</th>
<th>1-Bedroom</th>
<th>2-Bedroom</th>
<th>3-Bedroom</th>
<th>4-Bedroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2000</td>
<td>$365</td>
<td>$418</td>
<td>$521</td>
<td>$709</td>
<td>$858</td>
</tr>
<tr>
<td>FY 2004</td>
<td>463</td>
<td>531</td>
<td>661</td>
<td>899</td>
<td>1,089</td>
</tr>
<tr>
<td>FY 2005</td>
<td>522</td>
<td>578</td>
<td>676</td>
<td>868</td>
<td>897</td>
</tr>
<tr>
<td>FY 2006</td>
<td>725</td>
<td>803</td>
<td>940</td>
<td>1,206</td>
<td>1,247</td>
</tr>
<tr>
<td>FY 2007</td>
<td>755</td>
<td>836</td>
<td>978</td>
<td>1,256</td>
<td>1,298</td>
</tr>
</tbody>
</table>

Source: Greater New Orleans Community Data Center

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Utility Infrastructure

A large area of the Gulf Coast remained without full utility service almost a year after Katrina (Table 5, Figure 10), both adversely affecting the livability of relatively undamaged properties and delaying the repair and restoration of more severely damaged housing.

Table 5: Percentage of Residential Utilities Customers with Restored Service in Orleans Parish: Electric, Water, and Gas

<table>
<thead>
<tr>
<th>Date</th>
<th>Electric</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proportion of former customers</td>
<td>Proportion of former customers</td>
</tr>
<tr>
<td></td>
<td>with access</td>
<td>using service</td>
</tr>
<tr>
<td>Pre-Katrina</td>
<td>190,000 former customers</td>
<td>145,000 former customers</td>
</tr>
<tr>
<td>9/21/05</td>
<td>19%</td>
<td>36%</td>
</tr>
<tr>
<td>12/28/05</td>
<td>77%</td>
<td>75%</td>
</tr>
<tr>
<td>3/25/06</td>
<td>96%</td>
<td>50%</td>
</tr>
<tr>
<td>7/25/06</td>
<td>95-100%*</td>
<td>60%</td>
</tr>
</tbody>
</table>

Notes: As of May 2006, Entergy had restored electric service in all of New Orleans city except in some areas in the Lower 9th Ward and Lakeview that have been selected for demolition by City Hall. Data for water service are not currently available. Source: City of New Orleans Situation Report; Entergy New Orleans

Figure 10: New Orleans Metro Electric Service by Parish, as of Aug. 26, 2006

Source: The Times-Picayune

102 Ibid, 43.
103 "Katrina: One Year Later," The Times-Picayune, August 26, 2006.
**Education and Child Care**

Another obstacle for NASA’s workforce in the Gulf Coast is Katrina’s effect on schools and childcare providers, especially in New Orleans. The New Orleans Recovery District, a state entity first established in 2003, took over 107 of the city's worst-performing schools following Hurricane Katrina. The state began interviewing and hiring teachers for the New Orleans Recovery District in July 2006. It reported that it had filled 60% of its openings when the school year commenced on September 7. Eight thousand students were expected to enroll in the 17 operational schools. However, at that time only ten administrative staff members had been hired for the entire district.\(^\text{104}\)

In all, 33 public schools opened in New Orleans in Fall 2006, serving 25,000 students—33% as many schools and 38% as many students as before the storm (Table 6).\(^\text{105}\) Within the broader New Orleans MSA, enrollment in Catholic schools declined 12%, and there were 23% fewer schools.\(^\text{106}\) As of February 2007, 56% of schools remained closed and “the public school system had to put returning students on a waiting list due to a lack of facilities and teachers.”\(^\text{107}\)

According to the Mississippi Department of Education, 22 schools were closed in the state as of January 2006.\(^\text{108}\) FEMA has obligated funds for the repair and construction of 19 schools in Hancock County, 51 in Harrison County, 36 in Jackson County and 16 schools operated by the Catholic Diocese of Biloxi.\(^\text{109}\) In Gulfport, 88% of the pre-storm student population enrolled in the school system this fall.\(^\text{110}\) In Bay St. Louis-Waveland, enrollment is at 68%, six points higher than the end of the 2005-2006 school year.\(^\text{111}\)

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105 Ibid.
106 Loren Scott, "Advancing in the Aftermath II: Tracking the Recovery from Katrina and Rita." 33.
107 Katrina Index Files, 2007.
Table 6: Proportion of Open Public Schools in New Orleans Metro, by Parish

<table>
<thead>
<tr>
<th>Date</th>
<th>Orleans</th>
<th>Jefferson</th>
<th>Plaquemines</th>
<th>St. Bernard</th>
<th>St. Charles</th>
<th>St. John the Baptist</th>
<th>St. Tammany</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 2005</td>
<td>0%</td>
<td>94%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>92%</td>
</tr>
<tr>
<td>Dec. 2005</td>
<td>5%</td>
<td>100%</td>
<td>33%</td>
<td>7%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Mar. 2006</td>
<td>15%</td>
<td>100%</td>
<td>33%</td>
<td>7%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Aug. 2006</td>
<td>29%</td>
<td>100%</td>
<td>33%</td>
<td>7%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Nov. 2006</td>
<td>42%</td>
<td>100%</td>
<td>78%</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Jan. 2007</td>
<td>44%</td>
<td>100%</td>
<td>78%</td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Sources: Louisiana Department of Education; Orleans Parish Schools; Jefferson Parish Schools; Plaquemines Parish Schools; St. Charles Parish Schools; St. Tammany Parish Schools

The effect of Hurricane Katrina on New Orleans childcare facilities has been substantial. A study by the Early Childhood Institute at Mississippi State University (cited in the Times-Picayune) found that New Orleans lost 80% of its licensed daycare centers, accounting for 75% of the number of children served (Table 7). The childcare facility that had been operating at the Michoud Assembly Facility closed its doors and has yet to reopen. It is not clear that it will. Eighteen months after the storm, almost 70% of child care centers in Orleans Parish remain closed.

Table 7: Number of Operational Child Care Centers in Louisiana and Selected Parishes

<table>
<thead>
<tr>
<th>Month</th>
<th>Orleans</th>
<th>Jefferson</th>
<th>Plaquemines</th>
<th>St. Bernard</th>
<th>St. Charles</th>
<th>St. John the Baptist</th>
<th>St. Tammany</th>
<th>Louisiana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Katrina</td>
<td>266</td>
<td>197</td>
<td>14</td>
<td>24</td>
<td>26</td>
<td>76</td>
<td>1,996</td>
<td></td>
</tr>
<tr>
<td>March 2006</td>
<td>46</td>
<td>144</td>
<td>8</td>
<td>0</td>
<td>24</td>
<td>72</td>
<td>1,677</td>
<td></td>
</tr>
<tr>
<td>June 2006</td>
<td>57</td>
<td>147</td>
<td>9</td>
<td>1</td>
<td>24</td>
<td>72</td>
<td>1,696</td>
<td></td>
</tr>
<tr>
<td>October 2006</td>
<td>74</td>
<td>159</td>
<td>9</td>
<td>2</td>
<td>23</td>
<td>74</td>
<td>1737</td>
<td></td>
</tr>
<tr>
<td>February 2007</td>
<td>84</td>
<td>165</td>
<td>10</td>
<td>2</td>
<td>25</td>
<td>75</td>
<td>1757</td>
<td></td>
</tr>
</tbody>
</table>

Source: Louisiana Department of Social Services Bureau of Licensing

The Louisiana Community and Technical College system is a potentially important link in the region’s workforce supply, especially for NASA contractors who hire many of their technicians from area two-year institutions. Enrollment figures from the Louisiana Board of Regents in September 2006 show that freshman enrollment at the Delgado Community College campuses, primarily located in New Orleans, was down 30% from their pre-Katrina expectations. The number of freshmen enrolled at Nunez Community College, located in the New Orleans suburb of Chalmette, was down by 68%, while overall enrollment at Nunez was down by 53%. Major four-year institutions reported enrollment declines of up to 50% in the Spring 2006 semester and, of those reporting, declines were about a third of pre-Katrina levels in Fall 2006. In Spring 2007, enrollment remained below pre-Katrina levels for all institutions. Enrollment figures for area two- and four-year colleges are shown in Table 8. Statewide, omitting the New Orleans campuses, the enrollment of first-time freshmen at public colleges and universities is down just 5%.

Table 8: Number of College Students to Returning to New Orleans

<table>
<thead>
<tr>
<th>Date</th>
<th>Delgado Community College</th>
<th>Dillard University</th>
<th>Loyola University</th>
<th>Southern University of New Orleans</th>
<th>Tulane University</th>
<th>University of New Orleans</th>
<th>Xavier University</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pre-Katrina)</td>
<td>16,669</td>
<td>2,155</td>
<td>5,480</td>
<td>3,600</td>
<td>13,214</td>
<td>17,124</td>
<td>4,100</td>
</tr>
<tr>
<td>Spring 2006</td>
<td>NA</td>
<td>1,085</td>
<td>4,993</td>
<td>NA</td>
<td>11,307</td>
<td>11,446</td>
<td>3,110</td>
</tr>
<tr>
<td>Fall 2006</td>
<td>NA</td>
<td>50%</td>
<td>91%</td>
<td>NA</td>
<td>86%</td>
<td>67%</td>
<td>76%</td>
</tr>
<tr>
<td>Spring 2007</td>
<td>NA</td>
<td>NA</td>
<td>4,548</td>
<td>2,344</td>
<td>NA</td>
<td>10,765</td>
<td>2,880</td>
</tr>
</tbody>
</table>

Sources: Institutional Research, Louisiana Community and Technical College System; Public Relations, Dillard University; Office of Institutional Research, Loyola University; Media Relations, Tulane University; Data Management, University of New Orleans; Office of Admissions, Xavier University; Washington Post, Inside Higher Ed

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Healthcare

The effect of Hurricane Katrina on the New Orleans healthcare infrastructure has dire implications for both the region’s economy and its perceived suitability for workers. While hospitals in coastal Mississippi were back online by November 2005,\textsuperscript{117} the locus of hospital services—especially for critical and acute care—was New Orleans with its teaching hospitals. As shown in Table 9, only 63% of the hospitals in three of New Orleans parishes had reopened by August 2006. Neither of the two located in hard-hit St. Bernard’s Parish were operating by then. As a result of Katrina and severe healthcare worker shortages elsewhere in the country, there has been an exodus of doctors, nurses and other professionals who may be very difficult to replace, especially given the closures of teaching hospitals that could otherwise produce new talent. Employment in New Orleans hospitals was still 3,600 jobs short of pre-Katrina levels, and ambulatory care employment was 9,700 below those levels (Figures 11 and 12). NASA and contractor employees, especially those with children or elderly dependents, may find the healthcare shortage a serious barrier to remaining in the region. This issue surfaced in several focus groups as a major concern.

### Table 9: Proportion of Major Hospitals in Operation, by Parish\textsuperscript{118}

<table>
<thead>
<tr>
<th>Date</th>
<th>Orleans Parish</th>
<th>Jefferson Parish</th>
<th>St. Bernard Parish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Katrina</td>
<td>100% (23)</td>
<td>100% (14)</td>
<td>100% (2)</td>
<td>100% (39)</td>
</tr>
<tr>
<td>10/2005</td>
<td>9% (2)</td>
<td>50% (7)</td>
<td>0% (0)</td>
<td>23% (9)</td>
</tr>
<tr>
<td>12/2005</td>
<td>30% (7)</td>
<td>93% (13)</td>
<td>0% (0)</td>
<td>51% (20)</td>
</tr>
<tr>
<td>6/2006</td>
<td>39% (9)</td>
<td>93% (13)</td>
<td>0% (0)</td>
<td>56% (22)</td>
</tr>
<tr>
<td>12/2006</td>
<td>52% (12)</td>
<td>93% (13)</td>
<td>0% (0)</td>
<td>64% (25)</td>
</tr>
</tbody>
</table>

Source: Louisiana Hospital Association, individual hospital branches in Orleans, Jefferson, and St. Bernard parishes

\textsuperscript{117} Scott. "Advancing in the Aftermath II: Tracking the Recovery from Katrina and Rita." 51.

\textsuperscript{118} Liu, Fellowes, and Mabanta. "Katrina Index: Tracking Variables of Post-Katrina Recovery." 60.
Figure 11: New Orleans MSA Hospital Employment

![Graph showing hospital employment](image1)

Source: The Brookings Institution

Figure 12: New Orleans MSA Ambulatory Care Employment

![Graph showing ambulatory care employment](image2)

Source: The Brookings Institution

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120 Ibid., 27.
Redevelopment Status\textsuperscript{121}

The largest Katrina-related obstacle for NASA in meeting its workforce goals appears to be continued uncertainty surrounding the redevelopment of the Gulf Coast region. Federal, state and private entities have yet to reach key agreements on how, where, or even if, reconstruction will be allowed. Only the most preliminary guidelines have been issued by the U.S. Department of Homeland Security (DHS) for flood insurance coverage, undermining the ability of the financial services sector to act on and issue private policy coverage, as well as underwrite lending. Numerous local, state and federally appointed commissions and authorities conflict in their vision of reconstruction. In Louisiana in particular, the lack of agreement has impeded the flow of federal recovery monies to property owners. In New Orleans, impatient citizens have pressured city employees to reevaluate damage assessments, leading to a frenzy of do-it-yourself (DIY) disaster reconstruction, with little regard to the long-term sustainability, or even legality, of such efforts. Overall, the uncertainty is undermining the desirability of the entire region for NASA’s contractor workforce.

\textit{Flood Insurance Guidelines}

The federal government released the new base flood plain level for Orleans, Jefferson, St. Bernard, and Plaquemines Parishes in April 2006. The new required base flood plain elevation is three feet, meaning that destroyed or substantially damaged homes must be rebuilt three feet higher. Elevating one’s home in this way both reduces annual flood insurance premiums and makes the homeowner eligible for some federal rebuilding assistance. Property owners with flood insurance in high-risk areas are eligible for up to $30,000 through the Federal Flood Insurance Program to cover the cost of elevating their home.\textsuperscript{122} In many instances, the cost of doing so is likely to be substantially higher.

\textsuperscript{121} Harvey, "Mississippi’s Recovery Effort Seems to Be Leaving Louisiana's Behind. Why?"
\textsuperscript{122} Scott. "Advancing in the Aftermath II: Tracking the Recovery from Katrina and Rita." 72.
**Disaster Mitigation**

The Louisiana Coastal Protection and Restoration Authority (CPRA) is in the process of developing a master plan for an integrated coastal and wetland restoration system, due to be published in February 2007. It will inform an integrated Category 5 coastal protection plan by the Army Corps of Engineers, to be submitted to Congress by December 2007.\(^\text{123}\) That plan will guide future federal investments in Louisiana’s coastal protection and restoration program, and thus provide a baseline by which the financial services sector can measure risk and determine a lending and insurance paradigm for the region.

**Community Planning and Revitalization**

Louisiana lost approximately 123,000 homes and 82,000 rental properties to both hurricanes Katrina and Rita. Before March 2007, the Louisiana Recovery Authority is supposed to announce guidelines by which reconstruction can take place.\(^\text{124}\)

The Road Home is Louisiana’s program to compensate homeowners and landlords for their losses and to help them repair, rebuild, relocate, or sell their damaged properties. The program pre-registered more than 100,000 people, who were scheduled to begin receiving checks in early September 2006.\(^\text{125}\) As of February 12, 2007, there have been only 632 Road Home closings out of 107,789 applications for assistance.\(^\text{126}\)

Katrina destroyed roughly 70,000 homes in Mississippi. The Barksdale Commission, appointed by the governor, issued a 178-page report with 238 recommendations on every aspect of the economic and social revitalization of the state. A key part of this revitalization effort is the Mississippi Development Authority’s Homeowner Assistance Program. As of March 14, 2007, 18,235 individuals had applied for assistance. Of the 14,744 who have been determined eligible, 11,640 have received grants totaling $810,540,501.\(^\text{127}\)


\(^{125}\) Ibid.

\(^{126}\) Katrina Index February 2007

\(^{127}\) "Homeowner Assistance Program—Phase 1." Mississippi Development Authority.
IV. Gulf Coast Labor Markets, Pre- and Post-Katrina

Labor market conditions are likely to exert considerable influence on the Gulf Coast region’s workforce that is available to complete work on the Space Shuttle Program between now and mission "fly-out" in September 2010. Recent and expected trends in labor availability and costs are likely to have greater direct effects on NASA contractors’ skilled and semi-skilled workers than they are on its scientific and engineering workers. However, to the extent that scientists and other highly educated SSP workers grapple with the rising costs of rebuilding their homes, they are expected to experience indirect effects as well.

This section describes regional labor market developments, both pre- and post-Katrina, that are likely to affect the NASA SSP contractor workforce. It begins by describing population shifts in the region, and then examines employment and wage trends. Data are disaggregated by state and MSA, as well as parish and county, in some portions of the analysis. Not surprisingly, more, and more detailed, data are available for the New Orleans MSA than for the portions of Mississippi that also were affected by the storm.

It is important to recognize from the outset that the quality of population and labor market data for this region has suffered considerably due to Katrina. Many of the most common data collection programs of the Census Bureau and the Bureau of Labor Statistics (BLS) rely on regular reporting by households or employer establishments, many of which have been displaced, either permanently or temporarily. Both Census and BLS have enhanced their existing data collection and reporting efforts and launched special ones in the region, even as other groups (e.g., the Brookings Institution, the Rockefeller Institute of Government) have embarked upon intense studies of the Gulf Coast. All of these data sources have been utilized.

Regional Population Changes

As is now well known, Katrina has had substantial effects on the region’s population, both in terms of the absolute numbers of residents as well as its composition. Figures presented here encompass parts of southern Mississippi as well as the greater New Orleans MSA.
Prior to Hurricane Katrina, the southern coast of Mississippi, consisting of Hancock, Harrison, and Jackson counties, had a total population of over 360,000, of which 230,000 were 25 years of age or over (Table 10). In the four months after the hurricane, the total population of these southern Mississippi counties dropped to just 303,000, while the over-25 population fell to just 195,000. Those with a high school diploma or equivalent accounted for 31% of the population before Katrina, rising to over 41% of the population after the storm. In contrast, the percentages of the population with some college experience, and associate’s, bachelor’s or graduate degrees fell.128

### Table 10: Population Estimates by Highest Level of Educational Attainment for those 25 and Over, for Southern Mississippi and the New Orleans MSA

<table>
<thead>
<tr>
<th>Educational Attainment</th>
<th>January—August 2005</th>
<th>September—December 2005</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Southern Mississippi</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population 25 yrs and over</td>
<td>232,772</td>
<td>194,831</td>
<td>-37,941*</td>
</tr>
<tr>
<td>Less than 9th grade</td>
<td>4.2%</td>
<td>3.8%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>9th to 12th grade, no diploma</td>
<td>11.3%</td>
<td>11.0%</td>
<td>-0.3%</td>
</tr>
<tr>
<td>High School graduate and equivalency</td>
<td>31.0%</td>
<td>41.3%</td>
<td>+10.3%*</td>
</tr>
<tr>
<td>Some college, no degree</td>
<td>22.1%</td>
<td>19.0%</td>
<td>-3.1%</td>
</tr>
<tr>
<td>Associate's degree</td>
<td>11.3%</td>
<td>7.7%</td>
<td>-3.6%</td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>13.4%</td>
<td>11.0%</td>
<td>-2.4%</td>
</tr>
<tr>
<td>Graduate or professional degree</td>
<td>6.8%</td>
<td>6.2%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>High school graduate or higher</td>
<td>84.5%</td>
<td>85.2%</td>
<td>+0.7%</td>
</tr>
<tr>
<td>Bachelor's degree or higher</td>
<td>20.1%</td>
<td>17.1%</td>
<td>-3.0%</td>
</tr>
<tr>
<td><strong>New Orleans MSA</strong></td>
<td><strong>792,668</strong></td>
<td><strong>503,177</strong></td>
<td><strong>-289,491</strong>*</td>
</tr>
<tr>
<td>Population 25 yrs and over</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 9th grade</td>
<td>5.7%</td>
<td>4.5%</td>
<td>-1.2%</td>
</tr>
<tr>
<td>9th to 12th grade, no diploma</td>
<td>11.1%</td>
<td>9.8%</td>
<td>-1.3%</td>
</tr>
<tr>
<td>High School graduate and equivalency</td>
<td>31.2%</td>
<td>33.6%</td>
<td>+2.4%</td>
</tr>
<tr>
<td>Some college, no degree</td>
<td>22.1%</td>
<td>20.0%</td>
<td>-2.1%</td>
</tr>
<tr>
<td>Associate's degree</td>
<td>5.1%</td>
<td>5.9%</td>
<td>+0.8%</td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>15.8%</td>
<td>17.4%</td>
<td>+1.6%</td>
</tr>
<tr>
<td>Graduate or professional degree</td>
<td>9.0%</td>
<td>8.8%</td>
<td>-0.2%</td>
</tr>
<tr>
<td>High school graduate or higher</td>
<td>83.2%</td>
<td>85.7%</td>
<td>+2.5%</td>
</tr>
<tr>
<td>Bachelor's degree or higher</td>
<td>24.8%</td>
<td>26.2%</td>
<td>+1.4%</td>
</tr>
</tbody>
</table>

*Statistically significant.

The total population of the New Orleans Metropolitan Statistical Area during the first
eight months of 2005 was just under 1.2 million, while the over-25 population was about
790,000. Following Hurricane Katrina, the total population was reduced significantly, to just
a little below 724,000, of which those 25 years and older accounted for 503,000. Unlike
Mississippi, there were no substantial or statistically significant changes in the proportion of
residents by educational level. High school graduates and equivalents rose by 2.4 percentage
points, the largest increase. Those with associate and bachelor’s degrees also became
slightly larger parts of the population, increasing by 0.8 and 1.6 percentage points,
respectively.

Regional Labor Force and Unemployment Changes

For the first two-thirds of 2005, the civilian labor force in the three-county southern
Mississippi area numbered some 167,000, with an unemployment rate of 7.3%. In the near-
term post-Katrina period, the labor force fell to just 137,000, and the unemployment rate
more than doubled to 15.9% (Table 11). The overall population 16 years of age and over fell
by over 47,000; the proportion of the population not in the labor force rose by 0.9 percentage
points after the hurricane. According to the American Community Survey, the civilian labor force in the New
Orleans MSA consisted of about 600,000 people, 8.6% of them unemployed, in the months
leading up to Katrina. In the three months after the storm, the labor force was reduced to
342,000, with an unemployment rate of 12.6%.

129 The reliability of American Community Survey data for the Gulf Coast region is considerably
below that of traditional Bureau of Census data for many reasons. Basically, the challenge of
sampling a population that is confronting major displacement issues is substantial.
130 Ibid.
Table 11: Labor Force Status of the Population, for Southern Mississippi

<table>
<thead>
<tr>
<th>Selected Economic Characteristic</th>
<th>January - August 2005</th>
<th>September - December 2005</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Southern Mississippi</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population 16 yrs &amp; over</td>
<td>275,341</td>
<td>227,744</td>
<td>-47,597*</td>
</tr>
<tr>
<td>In labor force</td>
<td>62.2%</td>
<td>61.3%</td>
<td>-0.9</td>
</tr>
<tr>
<td>Civilian labor force</td>
<td>60.7%</td>
<td>60.0%</td>
<td>-0.7</td>
</tr>
<tr>
<td>Employed</td>
<td>56.3%</td>
<td>50.5%</td>
<td>-5.8*</td>
</tr>
<tr>
<td>Unemployed</td>
<td>4.4%</td>
<td>9.5%</td>
<td>+5.1*</td>
</tr>
<tr>
<td>Armed forces</td>
<td>1.5%</td>
<td>1.3%</td>
<td>-0.2</td>
</tr>
<tr>
<td>Not in labor force</td>
<td>37.8%</td>
<td>38.7%</td>
<td>+0.9</td>
</tr>
<tr>
<td>Civilian labor force</td>
<td>167,087</td>
<td>136,653</td>
<td>-30,434*</td>
</tr>
<tr>
<td>Unemployed</td>
<td>7.3%</td>
<td>15.9%</td>
<td>+8.6*</td>
</tr>
</tbody>
</table>

Source: American Community Survey  
*statistically significant

The Brookings Institution estimates the pre-Katrina labor force in the New Orleans MSA at about 634,000 (Table 12), with an unemployment rate as 5.8%. Brookings also has measures of the labor force size and unemployment rates six months and one year after Katrina. The labor force was considerably diminished in the first six months, but had begun to rise by the end of the second six months. The unemployment rate was higher a year after Katrina than at six months. In terms of key industries, all but one (Leisure and Hospitality) had higher employment numbers a year later, though all were far below their pre-Katrina levels.131 Seventeen months after the storm employment continues to rebound, with the share of private employment showing strong gains.

Table 12: New Orleans Labor Force and Employment, Pre- and Post-Katrina

<table>
<thead>
<tr>
<th>Workforce and Economy</th>
<th>Pre-Katrina</th>
<th>6 Months Post-Katrina</th>
<th>12 Months Post-Katrina</th>
<th>17 Months Post-Katrina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate (metro)</td>
<td>5.80%</td>
<td>5.90%</td>
<td>7.20%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Labor force size (metro)</td>
<td>633,759</td>
<td>429,469</td>
<td>444,153</td>
<td>495,800</td>
</tr>
</tbody>
</table>

Proportion employed by type of industry (metro)

| Good producing | 12.60% | 13.60% | 15.6% | 15.6% |
| Service providing | 87.40% | 86.40% | 84.4% | 84.4% |

Proportion employed by sector (metro)

| Public | 16.90% | 21.70% | 21% | 15.1% |
| Private | 83.10% | 78.30% | 79% | 84.9% |

Population employed in key industries (metro)

| Education and health | 79,100 | 47,300 | 46,500 | 59,000 |
| Leisure and hospitality | 86,400 | 54,800 | 58,200 | 61,400 |
| Trade, transportation, and utilities | 123,300 | 86,800 | 90,700 | 105,100 |
| Natural resources, mining and construction | 38,500 | 28,400 | 29,900 | 45,000 |
| Professional and business services | 74,000 | 41,200 | 47,300 | 68,400 |

Source: Brookings Institution, Greater New Orleans Community Data Center.

Brookings also has data from the US Bureau of Labor Statistics that tracks the unemployment rates of Katrina evacuees who have returned home and those who are still displaced. The unemployment rate among returning evacuees in November 2005 was 12.5% (Table 13). After November, the unemployment rate for returnees dropped below double digits. The unemployment rate for displaced evacuees was 27.8% in November 2005. Though it dropped the next month, the rate stayed above 20% through July 2006.\(^{132}\) By October 2006, when the Bureau of Labor Statistics stopped collecting this data, the unemployment rate for displaced evacuees had fallen to 17.9% while the rate for returning evacuees stood at 7%.

\(^{132}\) Katrina Index: Tracking Variables of Post-Katrina Recovery (Brookings Institution)
Table 13: Unemployment among Katrina Evacuees, 2005 - 2006

<table>
<thead>
<tr>
<th>Month &amp; Year</th>
<th>Returning Evacuees</th>
<th>Displaced Evacuees</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/05</td>
<td>12.5%</td>
<td>27.8%</td>
</tr>
<tr>
<td>12/05</td>
<td>5.6%</td>
<td>20.7%</td>
</tr>
<tr>
<td>1/06</td>
<td>2.9%</td>
<td>26.3%</td>
</tr>
<tr>
<td>2/06</td>
<td>4.8%</td>
<td>22.6%</td>
</tr>
<tr>
<td>3/06</td>
<td>5.3%</td>
<td>34.7%</td>
</tr>
<tr>
<td>4/06</td>
<td>5.3%</td>
<td>26.5%</td>
</tr>
<tr>
<td>5/06</td>
<td>6.5%</td>
<td>24.9%</td>
</tr>
<tr>
<td>6/06</td>
<td>5.9%</td>
<td>25.9%</td>
</tr>
<tr>
<td>7/06</td>
<td>4.2%</td>
<td>23.0%</td>
</tr>
<tr>
<td>8/06</td>
<td>4.8%</td>
<td>22.2%</td>
</tr>
<tr>
<td>9/06</td>
<td>4.7%</td>
<td>14.5%</td>
</tr>
<tr>
<td>10/06</td>
<td>7.0%</td>
<td>17.9%</td>
</tr>
</tbody>
</table>

Source: USBLS data as reported by the Brookings Institution’s Katrina Index.

Regional Employment, Earnings and Wage Changes

There have been dramatic changes in the Gulf Coast labor markets affected by Hurricane Katrina and its aftermath, and these are likely to continue for a considerable period of time and lead to real impacts on NASA’s SSP workforce during the critical 2007-2010 timeframe. This subsection examines major changes in the composition of employment, wages and related labor market conditions.

The southern Mississippi workforce lost more than 40,000 workers overall in the three-month wake of Katrina (Table 14). There were only marginal shifts in terms of the occupational composition of employment. Keeping in mind that none of the changes reported were statistically significant, the industry that experienced the greatest decline in terms of employment share was professional, scientific, and management, and administrative and waste management services which decreased by 3.3 points. There were noticeable, though not statistically significant, gains in finance and insurance, and real estate and rental
and leasing; retail trade; and construction, though the gain in construction employment could not possibly match the greatly increased demand for construction workers.

### Table 14: Employment by Occupation and Industry, Southern Mississippi

<table>
<thead>
<tr>
<th>Occupation</th>
<th>January—August 2005</th>
<th>September–December 2005</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed civilian population 16 yrs and over</td>
<td>154,942</td>
<td>114,917</td>
<td>-40,025</td>
</tr>
<tr>
<td>Management, professional and related occupations</td>
<td>27.7%</td>
<td>27.6%</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Service occupations</td>
<td>20.5%</td>
<td>20.7%</td>
<td>+0.2%</td>
</tr>
<tr>
<td>Sales and office occupations</td>
<td>25.6%</td>
<td>24.0%</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Construction, extraction, maintenance and repair occupations</td>
<td>12.7%</td>
<td>13.9%</td>
<td>+1.2%</td>
</tr>
<tr>
<td>Production, transportation, and material moving occupations</td>
<td>13.1%</td>
<td>13.3%</td>
<td>+0.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>7.6%</td>
<td>9.6%</td>
<td>+2.0%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>10.6%</td>
<td>10.7%</td>
<td>+0.1%</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>2.1%</td>
<td>1.4%</td>
<td>-0.7%</td>
</tr>
<tr>
<td>Retail trade</td>
<td>10.8%</td>
<td>13.9%</td>
<td>-3.1%</td>
</tr>
<tr>
<td>Transportation and warehousing and utilities</td>
<td>5.6%</td>
<td>5.9%</td>
<td>+0.3%</td>
</tr>
<tr>
<td>Finance and insurance, and real estate and rental and leasing</td>
<td>4.5%</td>
<td>7.6%</td>
<td>+3.1%</td>
</tr>
<tr>
<td>Professional, scientific, and management, and administrative and waste management services</td>
<td>7.0%</td>
<td>3.7%</td>
<td>-3.3%</td>
</tr>
<tr>
<td>Educational services, and health care and social assistance</td>
<td>18.8%</td>
<td>19.0%</td>
<td>+.2%</td>
</tr>
<tr>
<td>Arts, entertainment, and recreation, and accommodation and food services</td>
<td>17.8%</td>
<td>16.3%</td>
<td>-1.5%</td>
</tr>
<tr>
<td>Other services (except public administration)</td>
<td>3.9%</td>
<td>2.2%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>Public administration</td>
<td>8.0%</td>
<td>7.4%</td>
<td>-0.6%</td>
</tr>
</tbody>
</table>

Source: American Community Survey.
*Statistically significant.
Table 15, based on American Community Survey data, shows the distribution of employment in the New Orleans MSA by occupation and industry. The workforce in New Orleans was cut nearly in half by the hurricane, a loss of nearly a quarter million jobs. The biggest share increases by occupation—none statistically significant—were in management, professional and related and in construction. By industry, there was a statistically significant 4.8-point decline in arts, entertainment, and recreation, and accommodation and food services and relatively large share increases in construction and manufacturing.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>January – August 2005</th>
<th>September – December 2005</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed civilian population 16 yrs and over</td>
<td>547,842</td>
<td>299,534</td>
<td>-248,308*</td>
</tr>
<tr>
<td>Management, professional and related occupations</td>
<td>34.7%</td>
<td>40.0%</td>
<td>+5.3</td>
</tr>
<tr>
<td>Service occupations</td>
<td>17.5%</td>
<td>14.6%</td>
<td>-2.9</td>
</tr>
<tr>
<td>Sales and office occupations</td>
<td>28.4%</td>
<td>24.5%</td>
<td>-3.9</td>
</tr>
<tr>
<td>Construction, extraction, maintenance and repair occupations</td>
<td>9.4%</td>
<td>11.9%</td>
<td>+2.5</td>
</tr>
<tr>
<td>Production, transportation, and material moving occupations</td>
<td>9.7%</td>
<td>8.4%</td>
<td>-1.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th>January – August 2005</th>
<th>September – December 2005</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>6.3%</td>
<td>9.3%</td>
<td>+3.0</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>7.5%</td>
<td>10.3%</td>
<td>+2.8</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>3.2%</td>
<td>4.6%</td>
<td>+1.4</td>
</tr>
<tr>
<td>Retail trade</td>
<td>11.6%</td>
<td>10.4%</td>
<td>-1.2</td>
</tr>
<tr>
<td>Transportation and warehousing and utilities</td>
<td>6.2%</td>
<td>4.5%</td>
<td>-1.7</td>
</tr>
<tr>
<td>Finance and insurance, and real estate and rental and leasing</td>
<td>7.4%</td>
<td>7.1%</td>
<td>-0.3</td>
</tr>
<tr>
<td>Professional, scientific, and management, and administrative and waste management services</td>
<td>10.0%</td>
<td>9.6%</td>
<td>-0.4</td>
</tr>
<tr>
<td>Educational services, and health care and social assistance</td>
<td>22.2%</td>
<td>24.1%</td>
<td>+1.9</td>
</tr>
<tr>
<td>Arts, entertainment, and recreation, and accommodation and food services</td>
<td>11.5%</td>
<td>6.7%</td>
<td>-4.8*</td>
</tr>
<tr>
<td>Other services (except public administration)</td>
<td>4.8%</td>
<td>3.7%</td>
<td>-1.1</td>
</tr>
<tr>
<td>Public administration</td>
<td>5.9%</td>
<td>6.3%</td>
<td>+0.4</td>
</tr>
</tbody>
</table>

Source: American Community Survey.
Employment for selected industry groups in the New Orleans MSA has rebounded more fully than others post-Katrina (Table 16). For example, chemical manufacturing employment by June 2006 was approaching its pre-Katrina levels, while grocery stores and food and beverage stores were substantially below those levels. Even the construction-related industries were struggling to rebound, in part reflecting the difficulties with securing housing for the needed construction workforce.

Table 16: Employment in Selected Industries (in thousands), New Orleans-Metairie-Kenner MSA

<table>
<thead>
<tr>
<th>Industry</th>
<th>June 2005</th>
<th>June 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty Trade Contractors</td>
<td>16.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Heavy and Civil Engineering Construction</td>
<td>7.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Construction</td>
<td>30.0</td>
<td>19.7</td>
</tr>
<tr>
<td>Chemical Manufacturing</td>
<td>5.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Health and Personal Care Stores</td>
<td>5.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Grocery Stores</td>
<td>10.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Food and Beverage Stores</td>
<td>12.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Professional, Scientific, and Technical Services</td>
<td>28.3</td>
<td>14.9</td>
</tr>
<tr>
<td>Accommodation and Food Services</td>
<td>73.7</td>
<td>51.9</td>
</tr>
<tr>
<td>Hospitals</td>
<td>21.2</td>
<td>17.8</td>
</tr>
</tbody>
</table>


Wages currently being paid in construction-related occupations reflect the shortage of workers in these industries in the area. In September and early October 2006, data for construction trades from Monster.com indicate that the median salaries for General Laborers and General Maintenance Workers, relatively unskilled workers, were the equivalent of $12 to $15 per hour, while for highly skilled workers and supervisors, median wages topped $30 per hour and, in some cases (e.g., Civil Engineering Supervisor II), were approaching $50 per hour. Given the shortages of construction workers, the difficulties associated with arranging their housing and the scope and expected duration of rebuilding efforts in New Orleans and the surrounding region, pay for the construction trades is likely to continue to rise.

134 US Department of Labor, Bureau of Labor Statistics
Table 17: Current Wages for Construction-related Occupations, New Orleans MSA

<table>
<thead>
<tr>
<th>Occupation</th>
<th>25th Percentile Salary</th>
<th>Median Salary</th>
<th>75th Percentile Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricklayer</td>
<td>$38,129</td>
<td>$41,773</td>
<td>$51,325</td>
</tr>
<tr>
<td>Carpenter I</td>
<td>$30,153</td>
<td>$35,829</td>
<td>$42,973</td>
</tr>
<tr>
<td>Carpenter II</td>
<td>$36,239</td>
<td>$41,484</td>
<td>$47,754</td>
</tr>
<tr>
<td>Carpenter III</td>
<td>$38,721</td>
<td>$43,735</td>
<td>$51,144</td>
</tr>
<tr>
<td>Civil Engineering Supervisor I</td>
<td>$54,686</td>
<td>$62,864</td>
<td>$68,568</td>
</tr>
<tr>
<td>Civil Engineering Supervisor II</td>
<td>$76,904</td>
<td>$86,076</td>
<td>$95,137</td>
</tr>
<tr>
<td>Civil Engineering Supervisor III</td>
<td>$83,387</td>
<td>$93,297</td>
<td>$107,005</td>
</tr>
<tr>
<td>Construction Coordinator I</td>
<td>$39,207</td>
<td>$45,819</td>
<td>$52,006</td>
</tr>
<tr>
<td>Construction Coordinator V</td>
<td>$61,860</td>
<td>$75,969</td>
<td>$80,233</td>
</tr>
<tr>
<td>Electrician I</td>
<td>$32,978</td>
<td>$38,452</td>
<td>$44,511</td>
</tr>
<tr>
<td>Electrician III</td>
<td>$42,835</td>
<td>$47,592</td>
<td>$56,026</td>
</tr>
<tr>
<td>Electrical Engineering Supervisor I</td>
<td>$62,437</td>
<td>$69,884</td>
<td>$80,856</td>
</tr>
<tr>
<td>Engineer II</td>
<td>$55,232</td>
<td>$61,062</td>
<td>$69,301</td>
</tr>
<tr>
<td>General Laborer</td>
<td>$21,890</td>
<td>$24,725</td>
<td>$28,515</td>
</tr>
<tr>
<td>General Maintenance Worker I</td>
<td>$25,498</td>
<td>$29,382</td>
<td>$34,014</td>
</tr>
<tr>
<td>Pipe fitter</td>
<td>$32,165</td>
<td>$37,524</td>
<td>$44,467</td>
</tr>
<tr>
<td>Resident Construction Manager I</td>
<td>$69,996</td>
<td>$85,730</td>
<td>$97,232</td>
</tr>
</tbody>
</table>


Gulf Coast Labor Market Summary

Most industries in the Gulf Coast region are still operating at well under their pre-Katrina capacity. Demand is likely to be highest for occupations integral to reconstruction efforts. This will affect the NASA SSP contractor workforce on several fronts. First, the rebuilding of their own homes will proceed very slowly. The workforce is substantially smaller; the Rand Corporation estimates that it will take another year for the city’s population to reach 60% of its pre-storm level. The pool of

---

135 Data collected from the Monster.com Salary Wizard and is current as of September and October 2006. Estimates are not based only on Monster.com job postings. For methodology: http://monster.salary.com/salarywizard/docs/salwizhtmls/methodology.html
contractors is likewise smaller at a time when the demand for construction work in the city has never been higher. Getting one’s home in line for a site visit, estimate or supplies will likely continue to consume a large part of employees’ working and non-working hours.

Second, fixing one’s home is going to cost much more for some time to come. A London-based immigration consultancy firm, workpermit.com, estimated in October 2005 that day laborers in New Orleans were being paid $15 - $17 an hour, and skilled workers, roofers specifically, could make upwards of $300 a day.136

The increased cost of contracting for home repair work may well have one more effect for the NASA SSP workforce: wages in New Orleans are increasing. Aside from the wages paid to laborers and specialized construction workers, fast food chains are increasing their hourly offerings. For example, Burger King received a lot of attention for offering a $6,000 bonus for new hires at the end of their first year.137 For the time being, Mayor Ray Nagin has predicted that, “minimum wage is out in New Orleans.”138 NASA contractor employees do not need to be tempted to leave Michoud for Burger King and contract work to be affected by these wage increases and bonuses; more than one focus group participant referenced the increased wages in other sectors of the local economy, and said it felt like their wages did not go as far as they once did.

Finally, many of the SSP hourly and maintenance workers at Michoud and Stennis clearly are facing rapidly expanding employment opportunities at high pay in the surrounding market and could leave to take advantage of this unique situation. This is a subject that arose in a number of focus group sessions. However, employment opportunities for SSP scientists and engineers in the immediate area are circumscribed, the only aerospace employment in the region is with NASA and its contractors. So, the “pull” of other labor market opportunities in the region is very different depending on the type of work the SSP employees perform.

138 http://www.washingtonpost.com/wp-dyn/content/article/2005/10/12/AR2005101202500.html
V. Major Factors Potentially Affecting the NASA Space Shuttle Program Workforce on the Gulf Coast: Survey Results

In this section, we present the results from the Time 1 and Time 2 surveys of Michoud Assembly Facility and Stennis Space Center contractor employees in the fall of 2006. The decision to phase the survey was made both to verify responses given in the Time 1 survey and to reduce the amount of time workers spent away from their job duties during survey administration. Response rates to the Time 2 survey at both facilities lagged those obtained in the Time 1 survey. It is important to note that only survey responses statistically significant (based on Chi Squares tests) are discussed. It should also be noted that respondents were generally offered a range of seven answer choices. To facilitate analysis and discussion, the two highest categories on each scale have been combined, as have the two lowest categories. Michoud results are presented first, followed by those for Stennis.

Michoud Assembly Facility

Overview of Survey Respondents

A total of 878 Lockheed Martin Michoud Assembly Facility employees responded to the Time 1 survey, approximately 36% of the overall workforce. While not every person answered every question, response rates for all the variables detailed in Table 18 below exceeded 86%. In the Time 2 survey, a total of 714 Lockheed employees participated, representing approximately 30% of the MAF workforce. Response rates for the Time 2 variables in Table 18 exceed 88%, except for the question about union status.139 Five hundred four respondents completed both surveys.

Forty to 42% of Lockheed respondents fall in the 45-54 age range across both survey periods; 23-26% were over age 55. In terms of educational attainment, the vast majority of survey respondents, 65%, hold a college degree or higher. About 10% of respondents hold a high school diploma or less. Only 14% of survey respondents were dues-paying union members in the Time 1 survey; in the Time 2 survey that portion declined to 6%. The

139 Response rates for all questions are available from the authors by request.
number of workers who have been employed by Lockheed for over 21 years is about equal to
the number who have been at Michoud for over 21 years, approximately half of Time 1
respondents. In the Time 2 survey, those percentages were slightly lower though still
roughly equal, at about 48%. The majority of survey respondents in Time 1, 65%, report
working more than 40 hours per week in a normal work week.

    Most survey respondents, 83% of Time 1 and 92% of Time 2, suffered home damage
during Hurricane Katrina. The Time 2 survey asked workers about the extent of damage
their homes suffered as a result of the storm. Less than 7% of survey respondents suffered no
damage, while almost 11% suffered total destruction. Another 46% reported damage ranging
from “significant” to “major.” Nearly one out of five (19%) of respondents had friends or
relatives who were killed or seriously injured in the storm.

    In July 2005, about 65% of Time 2 survey respondents had a monthly household
income over $4,000. Some 5% reported monthly income at less than $1,200. At the time of
the Time 2 survey in fall 2006, 69% reported monthly household income over $4,000, while
only 2% earned less than $1,200.
### Table 18: Overview of Michoud Survey Respondents

#### Time 1 Survey
(Total Responses: 878)

<table>
<thead>
<tr>
<th>Variable</th>
<th>% of Question Respondents (Total Responses: 878)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong> (807 / 91.9%)</td>
<td></td>
</tr>
<tr>
<td>&lt;24</td>
<td>4.50%</td>
</tr>
<tr>
<td>25-34</td>
<td>14.40%</td>
</tr>
<tr>
<td>35-44</td>
<td>16.40%</td>
</tr>
<tr>
<td>45-54</td>
<td>41.80%</td>
</tr>
<tr>
<td>55-64</td>
<td>21.70%</td>
</tr>
<tr>
<td>65+</td>
<td>1.40%</td>
</tr>
<tr>
<td><strong>Education</strong> (799 / 91.0%)</td>
<td></td>
</tr>
<tr>
<td>High school (HS) or less</td>
<td>10.00%</td>
</tr>
<tr>
<td>Some college</td>
<td>25.20%</td>
</tr>
<tr>
<td>College degree or higher</td>
<td>64.80%</td>
</tr>
<tr>
<td><strong>Union Status</strong> (787 / 89.6%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>86.10%</td>
</tr>
<tr>
<td>Yes</td>
<td>13.90%</td>
</tr>
<tr>
<td><strong>Lockheed Martin Years of Service</strong> (829 / 94.4%)</td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>22.80%</td>
</tr>
<tr>
<td>6-20 years</td>
<td>26.80%</td>
</tr>
<tr>
<td>21-25 years</td>
<td>31.00%</td>
</tr>
<tr>
<td>26+ years</td>
<td>19.40%</td>
</tr>
<tr>
<td><strong>Michoud Years of Service</strong> (832 / 94.8%)</td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>24.50%</td>
</tr>
<tr>
<td>6-20 years</td>
<td>25.80%</td>
</tr>
<tr>
<td>21-25 years</td>
<td>28.40%</td>
</tr>
<tr>
<td>26+ years</td>
<td>21.30%</td>
</tr>
<tr>
<td><strong>Home Damaged by Katrina</strong> (784 / 89.3%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>16.60%</td>
</tr>
<tr>
<td>Yes</td>
<td>83.40%</td>
</tr>
<tr>
<td><strong>Usual Work Hours Per Week</strong> (831 / 94.6%)</td>
<td></td>
</tr>
<tr>
<td>&lt;40 hours</td>
<td>1.10%</td>
</tr>
<tr>
<td>40 hours</td>
<td>34.20%</td>
</tr>
<tr>
<td>40+ hours</td>
<td>64.70%</td>
</tr>
<tr>
<td><strong>Change in Zip Code Since Katrina</strong> (780 / 88.8%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>72.60%</td>
</tr>
<tr>
<td>Yes</td>
<td>27.40%</td>
</tr>
<tr>
<td><strong>Change in Commute Since Katrina</strong> (760 / 86.6%)</td>
<td></td>
</tr>
<tr>
<td>Less time</td>
<td>4.30%</td>
</tr>
<tr>
<td>Same amount of time</td>
<td>42.90%</td>
</tr>
<tr>
<td>More time</td>
<td>52.80%</td>
</tr>
</tbody>
</table>

#### Time 2 Survey
(Total Responses: 714)

<table>
<thead>
<tr>
<th>Variable</th>
<th>% of Question Respondents (Total Responses: 714)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong> (636 / 89.1%)</td>
<td></td>
</tr>
<tr>
<td>&lt;24</td>
<td>3.50%</td>
</tr>
<tr>
<td>25-34</td>
<td>14.90%</td>
</tr>
<tr>
<td>35-44</td>
<td>15.30%</td>
</tr>
<tr>
<td>45-54</td>
<td>40.40%</td>
</tr>
<tr>
<td>55-64</td>
<td>24.40%</td>
</tr>
<tr>
<td>65+</td>
<td>1.60%</td>
</tr>
<tr>
<td><strong>Education</strong> (630 / 88.2%)</td>
<td></td>
</tr>
<tr>
<td>High school (HS) or less</td>
<td>9.20%</td>
</tr>
<tr>
<td>Some college</td>
<td>25.60%</td>
</tr>
<tr>
<td>College degree or higher</td>
<td>65.20%</td>
</tr>
<tr>
<td><strong>Union Status</strong> (502 / 70.3%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>93.60%</td>
</tr>
<tr>
<td>Yes</td>
<td>6.40%</td>
</tr>
<tr>
<td><strong>Lockheed Martin Years of Service</strong> (635 / 88.9%)</td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>22.70%</td>
</tr>
<tr>
<td>6-20 years</td>
<td>29.40%</td>
</tr>
<tr>
<td>21-25 years</td>
<td>29.10%</td>
</tr>
<tr>
<td>26+ years</td>
<td>18.70%</td>
</tr>
<tr>
<td><strong>Michoud Years of Service</strong> (638 / 89.4%)</td>
<td></td>
</tr>
<tr>
<td>0-5 years</td>
<td>23.80%</td>
</tr>
<tr>
<td>6-20 years</td>
<td>28.70%</td>
</tr>
<tr>
<td>21-25 years</td>
<td>27.30%</td>
</tr>
<tr>
<td>26+ years</td>
<td>20.20%</td>
</tr>
<tr>
<td><strong>Home Damaged by Katrina</strong> (658 / 92.2%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6.50%</td>
</tr>
<tr>
<td>Yes</td>
<td>93.50%</td>
</tr>
<tr>
<td>○ Minor damage</td>
<td>17.80%</td>
</tr>
<tr>
<td>○ Some minor damage</td>
<td>18.80%</td>
</tr>
<tr>
<td>○ Significant damage</td>
<td>16.90%</td>
</tr>
<tr>
<td>○ Some major damage</td>
<td>7.90%</td>
</tr>
<tr>
<td>○ Major damage</td>
<td>21.40%</td>
</tr>
<tr>
<td>○ Complete destruction</td>
<td>10.60%</td>
</tr>
<tr>
<td><strong>Friend/Relative Killed or Injured by Katrina</strong> (665 / 93.1%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>81.20%</td>
</tr>
<tr>
<td>Yes</td>
<td>18.80%</td>
</tr>
<tr>
<td><strong>Monthly Household Income Before Katrina—July 2005</strong> (645 / 90.3%)</td>
<td></td>
</tr>
<tr>
<td>$1,199 or less</td>
<td>5.00%</td>
</tr>
<tr>
<td>$1,200 - $2,399</td>
<td>10.20%</td>
</tr>
<tr>
<td>$2,400 - $3,999</td>
<td>20.00%</td>
</tr>
<tr>
<td>$4,000 - $6,399</td>
<td>28.10%</td>
</tr>
<tr>
<td><strong>Monthly Household Income Currently—Fall 2006</strong> (634 / 88.8%)</td>
<td></td>
</tr>
<tr>
<td>$1,199 or less</td>
<td>2.10%</td>
</tr>
<tr>
<td>$1,200 - $2,399</td>
<td>9.50%</td>
</tr>
<tr>
<td>$2,400 - $3,999</td>
<td>19.20%</td>
</tr>
<tr>
<td>$4,000 - $6,399</td>
<td>30.80%</td>
</tr>
<tr>
<td>$6,400+</td>
<td>38.50%</td>
</tr>
</tbody>
</table>
Workforce Aging and Retirement

In response to a question about the most important factors keeping workers at the Michoud facility, several noted that the key factor was their pension plan or upcoming retirement. One respondent indicated that being “vested in the company pension plan is the most direct route to an adequate retirement.” Another stated, “I will retire as soon as possible—conditions at work are making this decision easy.” Lockheed Martin estimates that approximately 40-50% of their workforce will be eligible to retire in the next 5 years.

Fully 30% of survey respondents believe that they have invested too much time in Lockheed Martin to consider working elsewhere (Figure 13). Interestingly, 33% of those whose home was damaged in Hurricane Katrina agree with this statement, while only 19% of those without home damage did. Education level shows a significant correlation with this feeling of commitment, with those holding a high school diploma or less agreeing far more than other workers. As could be expected, older workers and those with more years of service are more likely to feel that they have invested too much in Lockheed to consider changing employment.

Figure 13: LM Survey Response: Time Invested

*I have invested too much time in Lockheed Martin to consider working elsewhere.*
Twenty-seven percent of survey respondents report that they would not leave Lockheed Martin because of what they could stand to lose. Union employees were more likely to agree with this sentiment than non-union employees (35% vs. 27%). Those with a high school education or less were also significantly more likely to agree with this feeling than other employees. A quarter of survey respondents indicated that the costs of leaving Lockheed Martin would be greater than the benefits. Once again, those with a high school education or less were more likely to agree with this sentiment than other respondents (Figure 14).

**Figure 14: LM Survey Response: Costs of Leaving**

*I would not leave because of what I stand to lose.*

*The costs of leaving are greater than the benefits.*
Compensation and Working Conditions

When asked about their overall satisfaction with their work situation, 45% of respondents reported being satisfied or very satisfied in the year prior to Hurricane Katrina, while only 34% report being satisfied with their work situation currently (Figure 15). Before the storm, those with only some college education were less likely to be satisfied with their work (39%) than workers with more (46%) or less (49%) education. In the post-storm period, fully half of workers with only a high school education or less are satisfied with their work situation; however, satisfaction dropped for other workers, to 33% of college-degreed workers and only 27% of those with some college experience.

Figure 15: LM Survey Response: Work Satisfaction

Prior to Hurricane Katrina, how satisfied were you with your work situation now?

How satisfied are you with your work situation now?

![Bar chart showing survey responses to work satisfaction questions for different levels of education before and after Hurricane Katrina.](chart.png)
Sizeable numbers of survey respondents report negative feelings associated with their work (Figure 16). Twenty-four percent report feeling “burned out from work” often or very often, with 30% of respondents in the 35-44 age range indicating this feeling. Those respondents who have worked for 26 or more years with Lockheed also report high rates of feeling burned out (33%) and of feeling emotionally drained from their work (27%). More than 20% of all respondents said that they often or very often feel emotionally drained from their work. Eighteen percent indicated that they are exhausted when they “think about having to face another day on the job,” a feeling most frequently expressed by those with a high school education or less (22%).

Figure 16: LM Survey Response: Feelings About Work

From my work, I feel:

- Burned out.
- Emotionally drained.
- Exhausted thinking about another day.
**Work Schedule and Hours**

Sixty-five percent of survey respondents report that they like their current work schedule; interestingly, 65% also report that they work more than 40 hours in a normal week. There is a considerable disparity, however, between the number of union (43%) and non-union (74%) respondents who report being satisfied with their work schedule. Those with some college education are less likely to report being happy with their current work schedule than those with either more or less education (Figure 17).

**Figure 17: LM Survey Response: Work Schedule**

I like my work schedule.

Thirty percent of survey respondents report that they were always or almost always required to work overtime prior to Hurricane Katrina. In the post-Katrina period, 33% report being required to always or almost always work overtime (Figure 18). Before the storm, union members were more likely to work overtime than non-union (37% vs. 29%); however,
since the storm the two groups report almost equal numbers working overtime (34% vs. 33%).

Figure 18: LM Survey Response: Overtime

How often were you required to work overtime before Katrina? How often are you now required to work overtime?

<table>
<thead>
<tr>
<th>% of Survey Respondents</th>
<th>Overall</th>
<th>Union member</th>
<th>Non-union</th>
<th>Overall</th>
<th>Union member</th>
<th>Non-union</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always/Almost Always</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Often</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Sometimes</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Not Often</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Almost Never/Never</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Compensation

The hours that employees are willing to put in at Michoud week in and week out may be one factor in the number of employees who report that they are not well compensated for their level of performance. Only 34% of respondents believe they are well compensated. A further look at this question reveals that while 37% of non-union employees believe they are well compensated, only 17% of union employees believe the same. More than 40% of respondents with six to 20 years of service feel well compensated for their performance. Only 30% of workers who responded to the survey feel that the outcomes they receive for their work reflect their contributions to Lockheed. Respondents over the age of 65 are more
likely than workers in other age groups to feel that their contributions are being recognized (Figure 19).

**Figure 19: LM Survey Response: Outcomes and Compensation**

![Survey response chart]

**Training and Advancement Opportunities**

Two key areas of dissatisfaction for Lockheed Martin respondents are training and advancement opportunities. Workers were asked about their level of satisfaction with the training/professional development plan for their current position. One quarter of respondents indicated that they are satisfied or very satisfied with the plan; however just 12% of those in the 35-44 age range and only 19% of those with 21-25 years of service at Michoud agree. Merely 15% of respondents are satisfied with their opportunities for advancement at work. Survey respondents under age 24 are the most likely to be satisfied, 27%, while those aged
55-64 are the least likely, with only 11% being satisfied with their advancement opportunities (Figure 20).

**Figure 20: LM Survey Response: Training Plan and Advancement Opportunities**

*How satisfied are you with the:*

![Survey Response Chart](chart.png)

While 63% of survey respondents indicated that they had received employer-provided training in the previous twelve months (Figure 21), with more than half receiving between ten and 50 hours of training during that period, less than a quarter of respondents are satisfied with the resources available for training (Figure 22). For workers in the 35-44 age range, only 55% of survey respondents report receiving training in the last year and just 10% report being satisfied with training resources. Less than half of survey respondents (49%) with a high school education or less report receiving training, however they are the most likely (30%) to be satisfied with the resources available for training.
Figure 21: LM Survey Response: Training Received

*Over the past 12 months, have you received employer-provided training?*

<table>
<thead>
<tr>
<th>Overall Age</th>
<th>% of Survey Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 25 to 34</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 35 to 44</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 45 to 54</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 55 to 64</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 65+</td>
<td>100%</td>
</tr>
<tr>
<td>HS or less</td>
<td>100%</td>
</tr>
<tr>
<td>Some College</td>
<td>100%</td>
</tr>
<tr>
<td>College Degree</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Yes
- No

Figure 22: LM Survey Response: Training Resources

*How satisfied were you with the resources available for you to participate in training?*

<table>
<thead>
<tr>
<th>Overall Age</th>
<th>% of Survey Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 25 to 34</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 35 to 44</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 45 to 54</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 55 to 64</td>
<td>100%</td>
</tr>
<tr>
<td>Age: 65+</td>
<td>100%</td>
</tr>
<tr>
<td>HS or less</td>
<td>100%</td>
</tr>
<tr>
<td>Some College</td>
<td>100%</td>
</tr>
<tr>
<td>College Degree</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Satisfied
- Slightly Satisfied
- Neutral
- Slightly Dissatisfied
- Dissatisfied
Researchers explored some of the factors that may impact training opportunities for workers at Michoud. Lockheed Martin does provide training to its employees to upgrade occupational skills and to improve safety and efficiency. The company, however, has not forged strong ties to the postsecondary education and training institutions in the local community that could provide additional or alternative skills development opportunities for Lockheed workers. The research team met with leaders from engineering and/or workforce education departments from the University of New Orleans, Delgado and Nunez Community Colleges, and the Louisiana Technical College development system. Outside of UNO’s Center for Advanced Manufacturing which is located at Michoud, none of these institutions have collaborated with Lockheed on current workforce training programs or workforce pipeline development programs in at least five years.

**Working Conditions**

Working conditions are another important factor in respondents’ overall satisfaction with their work situation. Sixteen percent of Michoud respondents report that they often thinking about quitting their job because of working conditions. Workers with more than 26 years of service with Lockheed are most likely (23%) to cite working conditions as a factor for consideration of quitting (Figure 23).

*Figure 23: LM Survey Response: Working Conditions*

*I often think about quitting my job because of working conditions.*
Safety is a primary concern at a facility like Michoud. Almost three-quarters of survey respondents are satisfied with safety at Lockheed (Figure 24). Workers with a high school education or less are least likely to be satisfied (65%) while workers with the least years of service at Michoud are the most satisfied (78%). Interestingly though, only 26% of respondents believe that there is always or almost always sufficient staffing to get the job done safely and on time. Those with less education were more likely to indicate sufficient staffing exists to do the job safely and on time than were those with a college degree. In fact, only 18% of survey respondents report that there is always or almost always sufficient staff available to get the job done. Far more non-union employees (19%) than union employees (11%) believe that staffing is sufficient. Strikingly, the longer a respondent has been employed at Michoud, the less likely they were to believe that there is sufficient staffing to get the job done (Figure 25).

Figure 24: LM Survey Response: Work Safety

How satisfied are you with the safety within Lockheed Martin?
Lockheed has been undertaking a serious push to increase hiring at Michoud in the last few years. Lockheed managers report that they realized early in the century that they needed to begin to bring in the next generation of aerospace worker while their existing workforce was still active. Since Hurricane Katrina made landfall in August 2005, Lockheed Martin’s workforce has grown by some 340 workers. When asked about the adequacy of training for new employees, 23% of survey respondents said they were satisfied or very satisfied. Respondents in the 35-44 age range were the least likely to be satisfied (13%) and only 23% of new employees themselves—survey respondents with five or fewer years of service at Michoud—are satisfied with the training they and others in their cohort have received (Figure 26).
One factor that may be limiting the skills of new employees is the fact that Lockheed has not worked closely with local school systems and postsecondary institutions to build a workforce pipeline. A strong relationship between the company and the education and training community could ensure that local graduates are aware of opportunities at Michoud and that they have the knowledge and skills they need to succeed on the job.

Finally, survey respondents were asked to identify other aspects of their work-life that could be improved. Many respondents focused on the need to upgrade and repair building infrastructure. Issues such as drinking water quality, mold, water damage, and the condition of office furniture were noted for their impact on employees’ morale and health. One worker described the building condition this way, “I hate to walk into a building that has missing/stained ceiling tiles and dirty carpets and floors, it reminds me of the current condition of the city.” Other issues identified by respondents focused on making more support services available for employees, including daycare, legal advice, workout facilities, carpools or other transit services, and personal services such as dry cleaning.
Hurricane Katrina and Its Aftermath

Forty-four percent of Lockheed Martin’s survey respondents have roots in the community where they live. Most appear committed to staying on the Gulf Coast and remaining employed at Michoud. However, it is important to remember that many of these employees are still trying to rebuild their homes and personal lives and that this process will continue for the foreseeable future. In the survey, respondents provided information on the most serious issues they are still dealing with as a result of Hurricane Katrina. One respondent seemed to sum the situation up:

The practical problems of today involve balancing the same unchanged pre-Katrina work demands in a post-Katrina world, while the home life requires a huge increase in effort for many employees. Many employees are doing more with less time.

Many respondents expressed ongoing frustration with home contractors, insurance companies, the SBA, and other issues surrounding repairing their damaged homes. Others are concerned about the lack of community amenities as a result of the storm, including schools and basic services. A serious issue arises from ongoing health and mental health problems resulting from the storm. This section will examine some of the myriad challenges Lockheed workers continue to face in the aftermath of Hurricane Katrina.

Emotional Impact

A large portion of the Time 2 survey focused on how Michoud employees feel about their lives currently, especially as compared with their lives in the year before Hurricane Katrina struck. Overall, between 17 and 21% of respondents indicated that they often or very often feel exhausted, emotionally drained, or burned out. Workers in the 35-44 age range were the most likely to indicate feeling either emotionally drained (27%) or burned out (31%). Almost 26% of respondents with a high school education or less indicated they feel exhausted at the thought of another day. Nineteen percent of respondents report feeling frequently or very frequently anxious at the possibility of future hurricanes (Figure 27).
Figure 27: LM Survey Response: Feelings About Life

Declining Health

Sharp differences are apparent in respondents’ health assessments when comparing the pre-Katrina and post-Katrina time periods (Figure 28). Prior to Hurricane Katrina, approximately 75% of respondents report that their physical (74%) and mental health (76%) was good or very good. Less than half of respondents now rate their physical health (47%) or mental health (42%) as good or very good. There are marked differences between the health ratings of college educated respondents and those with a high school education or less in both time periods.
Figure 28: LM Survey Response: Physical/Mental Health

### Physical Health:
- **Before Katrina**
- **Fall 2006**

### Mental Health:
- **Before Katrina**
- **Fall 2006**

#### Quality-of-life

In the year before the storm, 83% of respondents say they were satisfied or very satisfied with their life overall (Figure 29). Areas with the most favorable ratings include respondents’ marriages (76%), family relationships (83%), friendships (82%), neighborhood (77%), and access to retail stores and services (80%). Respondents were less likely to be happy with their access to health care, with 71% reporting satisfaction, and their child’s school, with only 67% reporting satisfaction, in the pre-storm period. Less than half of respondents indicated satisfaction before Hurricane Katrina with their financial situation (44%).
In the year before Hurricane Katrina, how satisfied were you with your:

At the time of the survey, in the fall of 2006, just 47% of respondents said that they were currently satisfied or very satisfied with their life overall (Figure 30). Only two factors received satisfactory ratings by more than 60% of respondents—their marriage (69%) and their friendships (62%). Fifty-four percent of respondents were currently satisfied with their child’s school. Less than half of respondents indicated satisfaction with their access to quality healthcare (49%); their neighborhood (38%); their access to retail stores and services (36%); their leisure activities (33%); and their access to quality daycare for their children (24%). Respondent satisfaction with their financial situation declined from the pre-Katrina period, standing at only 34%.
Public services have been a real struggle in New Orleans since the storm. Electric and gas utilities have been unable to restore full power in some parts of the city, and others continue to suffer frequent outages more than a year after becoming re-inhabited. Thirty-five percent of Lockheed respondents indicate that they would like to move somewhere with better public services. Nearly half of workers (46%) in the 25-34 age range agree (Figure 31).
Figure 31: LM Survey Response: Public Services

I would like to move some place that has better public services.

Recovery and Rebuilding Process

The survey specifically asked respondents about their level of satisfaction with the Hurricane Katrina recovery process (Figure 32). Only 23% of respondents feel satisfied or very satisfied with their community’s recovery and rebuilding progress. Respondents whose homes were not damaged in the storm were more likely to feel that their community’s rebuilding progress was satisfactory than those who suffered damage (32% vs. 23%). In terms of their own personal recovery and rebuilding progress, 39% of respondents indicate that they are satisfied or very satisfied. Workers who have been at Michoud six to 20 years and those with more than 26 years of service are the least likely to be satisfied, at only 35% and 32% respectively.
Katrina and Work

About 12% of respondents indicate that they often think about quitting their job because of non-work factors such as those related to housing and community (Figure 33). More than a quarter of respondents who did not suffer damage to their home as a result of the storm think about quitting for non-work factors, compared with only 11% of those whose homes were damaged.
Most survey respondents, 63%; believe that Lockheed Martin took care of its employees’ needs resulting from Hurricane Katrina (Figure 34). Those whose homes were not damaged in the storm were more likely to agree with this sentiment than those who suffered damage (71% vs. 62%). More strikingly, 69% of non-union employees agreed, while only 30% of union employees did.
Lockheed Martin took care of its employees needs resulting from Hurricane Katrina

The majority of respondents, 60%, agree that they have ready access to the Employee Assistance Program (EAP) at work though only 8% report using the service in the last three months (Figure 35). Those whose commute has shortened since the storm report using EAP in the last three months at about twice the rate of other employees. Fifteen percent of respondents have sought assistance outside the EAP program, through their church, a mental health professional, or other source, in the last three months. Union employees were more likely than non-union employees to report seeking this assistance (23% vs. 14%).
In terms of what employees believe Lockheed Martin could still do to assist them in their recovery, survey respondents identified many opportunities for further action. These include using Lockheed’s purchasing power to help obtain living and rebuilding supplies, insurance, and construction workers; allowing employees time off to rebuild homes and personal lives, perhaps through a more flexible work day or telecommuting arrangements; and working with the city to rebuild and improve the New Orleans East area around the Michoud facility. Respondents also asked for Lockheed’s continued empathy and understanding of the pressures and challenges that workers face. As one respondent stated, “Work with employees to better understand their situation and help them accordingly. Every person’s situation is different and one action may not be right for all.”

Respondents also provided input on the actions that NASA might be able to take to assist them in their recovery from Hurricane Katrina. Many respondents expressed their appreciation for all that NASA has done since the storm. “If it wasn’t for NASA I don’t
know where we would be now,” stated one worker. Some did not feel that NASA should be expected to do anymore. Others believe that some of the most serious issues are beyond NASA’s ability to address.

Key issues that were identified for action by NASA include schedule pressures and job security. Several respondents echoed the feeling that “Schedule requirements [have] forced LM to require excessive amounts of overtime from hourly and support people.” As one respondent bluntly stated, “The 2010 date is driving us to take unnecessary risks to deliver ET’s quickly, and pressure to launch when problems may not be fully understood.” Another sums up the situation in terms of Hurricane Katrina:

Rigid schedules do not allow a balance between work and personal time (to rebuild, etc)...Life post-Katrina has been a never ending maze and there just never seems to be enough time to accomplish what is required, both professionally and personally.

The fact that one of Lockheed Martin’s Michoud work contracts is expiring in 2008 is a real concern for some survey respondents.

Respondents also identified problems with the Michoud facility itself, as well as the surrounding community, that NASA might be able to affect. The MAF buildings were frequently described as in poor condition and outdated, negatively impacting employee morale. One worker highlights an issue that may impact Lockheed’s/NASA’s ability to draw new workers to the facility: “The buildings and offices are old and outdated. They do not emulate the positive and exciting future, or the technical wonder and prestige of the NASA space program.” Suggestions for working with city officials focused on repairing Old Gentilly Road in front of MAF; continuing debris removal; and improving utility services in New Orleans East and across the city.

Finally, respondents noted several things that NASA could support at MAF that would facilitate their personal recovery from Hurricane Katrina. These include allowing a cost-of-living salary adjustment and increasing the availability of off-time, flex-time and telecommuting options. One respondent asked for NASA to consider working with Lockheed to allow “those employees in need to take time off of work to concentrate on their rebuilding process without fear of losing their jobs/positions.”
Changing Labor Market Opportunities

Most respondents, 72%, believe they are a good match for Lockheed Martin. Nineteen percent of survey respondents, however, report that they often think about quitting their job (Figure 36). While only 6% of those who report a shorter commute time since the storm often think about quitting, 23% of those whose commute is now longer often think about quitting. Survey respondents with less than a high school education are less likely to say that they often think about quitting than those with a college degree (11% vs. 20%).

Figure 36: LM Survey Response: Job Match and Retention

![Graph showing job match and retention](image)

Job Search Activity

Twenty-two percent of Lockheed respondents acknowledge that they have been actively seeking other employment. Those workers who have been with Lockheed between 6 and 20 years are the most likely to be searching for a new job, at about 30% of respondents.
Nineteen percent of those who are job searching are doing so on a daily or weekly basis. Respondents with a high school education or less were much more likely than other respondents to indicate this level of job search activity (Figure 37).

**Figure 37: LM Survey Response: Job Search Activity**

*If you have been actively seeking employment, how often have you done so?*

In addition, 13% of survey respondents report that they will probably look for a new job in the next year. Almost 20% of respondents aged 25-44 report that they will be seeking a new job. Fewer than 3% of those with a high school education or less will be seeking a new job in the coming year, though 17% of those with a college degree believe they will be (Figure 38).
Figure 38: LM Survey Response: Job Search Plans

*I will probably look for a new job in the next year.*

Job Market Opportunities

Whether or not they are seeking new employment, 35% of survey respondents believe it would be easy or very easy to find a new job (Figure 39). Almost 43% of union respondents believe it would be easy, while only 34% of non-union employees feel the same way. Twenty-four percent of those with a high school education or less and 38% of those with some college education believe it would be easy to obtain new employment.
Figure 39: LM Survey Response: Job Search Difficulty

*How difficult do you think it would be for you to obtain new employment?*

Despite their views on how easy it would be to find new employment, only 25% of survey respondents believe there are many or very many alternate employment opportunities available to them (Figure 40). Those between the ages of 35 and 44 are most likely to believe there are many available opportunities for alternate employment (37%).
Survey respondents were asked about the factors that are important in their personal decisions to stay working at Michoud or to quit. The reasons for workers to stay are numerous. Many indicate their decision boils down to money and benefits. Some respondents say they are staying on because they like the work; they take pride in their jobs and in the space mission. Others say it is because their family remains in the area. Still others stay because they are loyal to Lockheed, particularly in light of what happened after Hurricane Katrina. As one respondent noted, “our Lockheed family was so generous at a time when we truly needed them.”

Among the most common reasons that workers cited for wanting to quit working at Michoud are that salaries are not keeping pace with the rising cost-of-living and constant overtime. Other respondents noted frustrations with management and working conditions, new commute times, and health problems. Finally, workers noted a lack of advancement opportunities and the desire for them or their spouse to find a better paying job elsewhere.
Contracts for Space Exploration: Changing Roles and Status

Survey respondents at Michoud are uncertain about their future. When asked if Lockheed Martin provides accurate and timely information to employees about the status of important projects and contract issues related to the Space Shuttle Program or related programs, 42% of respondents agreed or strongly agreed. Those respondents who were members of the union were the least likely, at only 23%, to feel that Lockheed maintained good communications compared with 43% of non-union respondents. The survey also asked workers about Lockheed’s communications with NASA and other contractors; 43% of respondents agreed that these lines of communication were good, though once again union members were less likely to feel this way than others (Figure 41).

Figure 41: LM Survey Response: Communications

Lockheed provides timely and accurate info on project and contract issues.

Lockheed maintains good communications with NASA and other contractors.
Lockheed Martin’s workforce at the Michoud Assembly Facility in New Orleans East, Louisiana, is committed to NASA—75% of survey respondents would be happy to spend the rest of their career working on NASA projects. Strikingly though, only 38% of respondents feel secure in their jobs (Figure 42). A closer look at the responses to that question reveals an interesting dichotomy—while 41% of non-union employees feel secure in their job, only 20% of union employees feel the same. These numbers are echoed by the percent of respondents who believe that their prospects for continued employment with Lockheed Martin are excellent.

Figure 42: LM Survey Response: Job Security

<table>
<thead>
<tr>
<th>Happy to spend rest of Career with NASA</th>
<th>I am secure in my job</th>
<th>Prospects for continuing employment with LM are excellent</th>
</tr>
</thead>
</table>

Overall | Overall | Union member | Non-union | Overall | Union member | Non-union |

% of Survey Respondents

- Agree
- Slightly Agree
- Neutral
- Slightly Disagree
- Disagree
The survey asked workers what NASA could do to help them recover from Hurricane Katrina. Several Lockheed employees focused on this issue of job security. One respondent suggested that NASA “sole source the CLV Upper Stage to Lockheed Martin, include design and engineering in the contract, to be done at Michoud.” Others simply requested that NASA keep giving work to Lockheed Martin.

Stennis Space Center

Overview of Survey Respondents

A total of 343 Stennis Space Center employees responded to the Time 1 survey, about 42% of the workforce for the three contractors that participated in the study (Pratt-Whitney & Rocketdyne chose not to participate). Just 231 employees, or 21% of the contractors’ workforce, responded to the second phase of the survey at Stennis Space Center. Mississippi Space Services (MSS) employees comprise the largest share of survey respondents (55% of Time 1 and 46% of Time 2) and about 72% of the overall workforce. About one-third of respondents to both surveys are employed by Jacobs-Sverdrup (Jacobs); they represent about 21% of the overall workforce. The remaining survey respondents are employed by Applied Geo Technologies (AGT), approximately 13% of Time 1 and 20% of Time 2 respondents. AGT only comprises about 7% of the total workforce. One hundred sixty-five respondents participated in both phases of the survey.

While few respondents answered every question, response rates for all of the questions examined here exceeded 86% (Table 19), except for the question on union status in the Time 2 survey which only received an answer from about three-quarters of respondents. Union status is included in the analysis below as it may be an important factor in job retention, particularly for employees at Jacobs-Sverdrup.

Most respondents to the Time 1 survey were over age 45, with the largest group (37%) in the 45-54 age range. Twenty-two percent were over age 55. Respondents to the second phase of the survey were evenly split—about half were age 44 and under, the other

140 Response rates for individual questions are available on request.
half 45 or older. In terms of educational attainment, respondents overwhelmingly had at least some college education with more than 56% of respondents in each phase holding a college degree or higher. Union members make up 23% of survey respondents in the first phase but just 13% of the survey sample in the second phase.

A key difference between the Michoud and the Stennis facilities is the length of time the contractors have been on site. At Stennis, only about one-quarter of survey respondents in either phase have been employed for seven or more years by their current employer. The real longevity of these employees is evident in their time at Stennis. Almost half of the respondents in Time 1 have been working at SSC for 10 or more years, 55% of the Time 2 respondents have been on-site for that amount of time. Forty-five percent of survey respondents at Stennis report working more than 40 hours per week in a normal work week.

Most survey respondents, 82% of Time 1 and 94% of Time 2, suffered some damage to their home as a result of Hurricane Katrina. The Time 2 survey asked workers specifically about the extent of damage their homes suffered as a result of the storm. Thirteen percent of respondents suffered total destruction, while only 6% suffered no damage. Stennis survey respondents were also touched by the human tragedy of the storm, with 16% having friends or relatives seriously injured or killed. Only 25% of respondents changed zip codes following the storm. The vast majority of Stennis survey respondents (78%) have not had a change in their commute time since Hurricane Katrina.

In the month before Hurricane Katrina hit, 56% of respondents to the Time 2 survey reported a total monthly household income over $4,000. Just 2% report monthly income at less than $1,200 before the storm. Fall 2006 monthly income levels were reported as very similar to the pre-Katrina levels.
Table 19: Overview of Stennis Survey Respondents

<table>
<thead>
<tr>
<th>Time 1 Survey</th>
<th>Variable</th>
<th># of Question Respondents</th>
<th>% of Question Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>AGT</td>
<td>343 / 100%</td>
<td>13.4%</td>
</tr>
<tr>
<td></td>
<td>Jacobs</td>
<td></td>
<td>31.8%</td>
</tr>
<tr>
<td></td>
<td>MSS</td>
<td></td>
<td>54.8%</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;34</td>
<td>316 / 92.1%</td>
<td>17.4%</td>
</tr>
<tr>
<td></td>
<td>35-44</td>
<td></td>
<td>23.7%</td>
</tr>
<tr>
<td></td>
<td>45-54</td>
<td></td>
<td>37.0%</td>
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<tr>
<td></td>
<td>55+</td>
<td></td>
<td>21.8%</td>
</tr>
<tr>
<td>Education</td>
<td>High school</td>
<td>306 / 89.2%</td>
<td>14.4%</td>
</tr>
<tr>
<td></td>
<td>Some college</td>
<td></td>
<td>29.1%</td>
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<tr>
<td></td>
<td>College degree</td>
<td></td>
<td>56.5%</td>
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<td>Union Status</td>
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<td>77.0%</td>
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<td></td>
<td>23.0%</td>
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<td>0-1 years</td>
<td>319 / 93.0%</td>
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</tr>
<tr>
<td></td>
<td>2 years</td>
<td></td>
<td>29.8%</td>
</tr>
<tr>
<td></td>
<td>3-6 years</td>
<td></td>
<td>29.8%</td>
</tr>
<tr>
<td></td>
<td>7+ years</td>
<td></td>
<td>24.8%</td>
</tr>
<tr>
<td>Stennis Years of Service</td>
<td>0-4 years</td>
<td>318 / 92.7%</td>
<td>27.4%</td>
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<tr>
<td></td>
<td>5-9 years</td>
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<td>10-19 years</td>
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<td></td>
<td>20+ years</td>
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<td>21.7%</td>
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<tr>
<td>Home Damaged by Katrina</td>
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<td>309 / 90.1%</td>
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<tr>
<td></td>
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<td>82.2%</td>
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<td>40+ hours</td>
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<td>Change in Commute since Katrina</td>
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<td></td>
<td>Same amount</td>
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<td></td>
<td>More time</td>
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<td>Stennis Years of Service</td>
<td>0-4 years</td>
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<td>5-9 years</td>
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<td>10-19 years</td>
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<td>Major damage</td>
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<td>Complete destruction</td>
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<td>Monthly Household Income Currently—Fall 2006 (201 / 87.0%)</td>
<td>$1,199 or less</td>
<td>1.5%</td>
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<tr>
<td></td>
<td>$1,200 - $2,399</td>
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<td>32.8%</td>
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<td>$6,400+</td>
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<td>22.9%</td>
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<td>Monthly Household Income Before Katrina - July 2005 (201 / 87.0%)</td>
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<td>2.0%</td>
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<td></td>
<td>$1,200 - $2,399</td>
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<td>16.9%</td>
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</tr>
<tr>
<td></td>
<td>$6,400+</td>
<td></td>
<td>23.4%</td>
</tr>
</tbody>
</table>
Workforce Aging and Retirement

Workforce aging and the impending baby boomer retirement are issues of great concern across the aerospace industry as a whole. Despite the fact that many aerospace workers seem content to work beyond retirement age, including those at Stennis, changing work conditions and potential curtailment of retiree benefits, as well as other factors, may cause some to accelerate their retirement plans.

Overall, only 13% of Stennis Space Center respondents believe they have invested too much time in their present employer to consider working elsewhere (Figure 43). Workers with a high school education or less (43%) were much more likely to express this belief than others (< 15%). Union members, at 35%, were also more likely to feel bound by their tenure than non-union respondents, as were almost 20% of MSS respondents.

Figure 43: SSC Survey Response: Time Invested

*I have invested too much time with my employer to consider working elsewhere.*
Stennis survey respondents with a high school education or less were also more likely to believe that the costs of leaving their present employment would be greater than the possible benefits (36%). Thirty-nine percent of respondents gave a good indication of their future intentions when they agreed that they would not leave because of what they stand to lose. Overall, 18% of respondents think the costs of leaving exceed the benefits, and only 16% believe that what they stand to lose is worth staying for. Jacobs employees were far less likely to say they would not leave than others (Figure 44).

**Figure 44: SSC Survey Response: Costs of Leaving**

* I would not leave because of what I stand to lose  
* The costs of leaving are greater than the benefits.
Compensation and Working Conditions

Overall, 52% of Stennis respondents are currently satisfied with their working situation, compared with 57% prior to Hurricane Katrina. AGT workers are much more likely to report being satisfied with their work currently than are Jacobs or MSS respondents (74% vs. < 50%). Just a third of respondents who have worked at Stennis up to four years say that they are happy with their situation at work (Figure 45).

Figure 45: SSC Survey Response: Work Satisfaction

_Satisfaction with work situation now_

Despite the fairly strong numbers of respondents reporting satisfaction with their work, a sizeable number report that they often have negative feelings about work (Figure 46). While only 12% of respondents overall report often feeling emotionally drained from their work, 18% of MSS respondents shared this sentiment. Jacobs and MSS respondents are
equally likely to say that they often feel burned out from their work. Respondents with a college degree are about half as likely as other respondents to report that they often feel exhausted when thinking about another day on the job.

**Figure 46: SSC Survey Response: Feelings About Work**

*From my work, I often feel:*

<table>
<thead>
<tr>
<th></th>
<th>Emotionally Drained</th>
<th>Burned out</th>
<th>Exhausted at the thought of another day.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGT MSS Overall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jacobs MSS Overall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS or less Some college</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College degree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Work Schedule and Hours**

Overall 76% of respondents say that they like their work schedule, with 45% of respondents reporting that they work more than 40 hours in a normal work week. At the time of the survey, fall 2006, almost 17% of respondents indicated that they always work overtime. Prior to Hurricane Katrina, only 15% of respondents said the same. Currently, 19% of Jacobs, and 17% of MSS respondents report constant overtime. Some 21% of Jacobs and only 13% of MSS respondents always worked overtime before the storm (Figure 47).
**Compensation**

Compensation is a real concern for Stennis survey respondents. Along the Gulf Coast, the cost-of-living has increased substantially since Hurricane Katrina; this could be a concern for NASA as workers who are struggling financially may look for more lucrative employment. As one MSS respondent noted, “I am basically going to be forced to leave this company due to the rising cost-of-living here with no significant raise in wages.” Just 29% of respondents believe they are well compensated for their level of performance, and only 33% of respondents say that their outcomes and rewards, the salary and benefits they receive for their work, reflect their contributions to their employer (Figure 48). AGT employees are far more likely to feel well compensated (45%) than workers with other contractors and more than half of AGT respondents (51%), feel that their outcomes reflect their contributions.
Figure 48: SSC Survey Response: Outcomes and Compensation

I am well compensated for my level of performance.  My outcomes reflect what I contribute to my employer.

Training and Advancement Opportunities

Along with compensation issues, only 21% of respondents are satisfied with their opportunities for advancement at work. Workers over age 55 are much less likely to see advancement options than younger respondents. Non-union respondents are about four times more likely to report being satisfied with their advancement opportunities than union members (Figure 49).
In terms of training and professional development, only 27% of workers are satisfied with the training plan for their job. Those who have been employed at Stennis for five to nine years are less than half as likely as other respondents to be happy with their professional development plan. Thirty-one percent of respondents are satisfied with the resources available for their participation in training; however, once again those who have been on site at SSC for 5-9 years are less happy than others (Figure 50). Part of these workers’ dissatisfaction may arise from the fact that they report lower levels of participation in employer-provided training over the last 12 months than any other group. One reason for this may be that few of the contractors at Stennis have forged connections with local education and training providers. While both the University of Southern Mississippi and Pearl River Community College offer classes on-site at Stennis, representatives for these
institutions indicated to researchers that only AGT has sought to connect their employees with the classes offered on-site.

**Figure 50: SSC Survey Response: Training Plan and Resources for Training**

*How satisfied are you with:*

- **The training/professional development plan for your job?**
- **The resources available for participation in training?**

*Overall*

<table>
<thead>
<tr>
<th>% of Survey Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
</tr>
<tr>
<td>0-4 yrs SSC service</td>
</tr>
<tr>
<td>5-9 yrs SSC service</td>
</tr>
<tr>
<td>10-19 yrs SSC service</td>
</tr>
<tr>
<td>20+ yrs SSC service</td>
</tr>
</tbody>
</table>

*Working Conditions*

Working conditions are an important factor in employees’ overall level of satisfaction with their job. Less than 10% of Stennis respondents are thinking about quitting their job because of working conditions (Figure 51). Respondents who have been with their current employer from three to six years are more likely to consider quitting than others (15%).
I often think about quitting my job because of working conditions.

One factor in working conditions at a facility like Stennis is safety. Overall, 64% of workers are satisfied with the level of safety exhibited within their company. The vast majority of AGT workers feel their workplace is safe (84%). One aspect of safety that may be a problem however is the level of staffing that contractors provide. Only 21% of respondents believe that there is always or almost always sufficient staff to get the job done. Thirty-two percent believe there is always or almost always sufficient staff to get it done safely and on time. Workers with AGT are much more likely than other workers to believe that staffing levels are sufficient. Forty-four percent of union respondents and those with less than a high school education indicated that staffing is always at the level needed to get the job done safely and on time (Figure 52).
Another factor in working conditions—treatment by management—was identified by multiple Stennis survey respondents as something that may lead them to quit their current jobs. Lack of recognition and respect are key frustrations for these workers. Jacobs respondents indicated that the union vote and its subsequent impact on raises and salaries continue to be a problem. One worker noted, “I just do not like the games that the workers are subjected to.”

When asked what could be done to improve working conditions at Stennis, respondents had a wide variety of suggestions. A common theme across contractors was a need for improved benefits and compensation. Site-wide health insurance and pension plans were noted as something that would benefit workers beyond those involved in the SSP. Time was a key concern for the many respondents who requested flex-time, time-off during the
week, or to simply not be forced to use their leave time to visit the EAP program. Other respondents requested that pay levels be equal to industry and/or regional standards, or for their employers to provide real cost-of-living adjustments. Some suggested that better equipment would improve work processes, while others requested more manpower. Stennis employees also noted a need for some of the “little things that improve morale” like stress reduction programs, fresh water dispensers, peer support, and team building activities.

**Hurricane Katrina and Its Aftermath**

Half of Stennis survey respondents have their family roots in the community where they live; those with more years of service at Stennis were more likely to feel rooted in their community. These workers still face numerous challenges in their recovery from Hurricane Katrina. The survey asked workers about their most serious problems. Across contractors, respondents noted that their housing situation remains a critical issue. The slow progress on repairs; the hassles of dealing with insurance companies, FEMA, the state’s home grants program, and others; the rising costs of materials; and the difficulty in finding a reliable contractor are all factors adding to the stress of respondents’ home lives. Several respondents also remarked on their financial strain since the storm.

Other challenges are more personal. Many respondents noted the emotional toll from the storm and its aftermath—they are stressed, depressed, and anxious. They are grieving for lost family members, lost pets and lost homes. This section examines some of the issues that Stennis workers continue to deal with more than a year after the storm.

**Emotional Impact**

More than 12% of Stennis survey respondents report that they often feel emotionally drained, burned out, and exhausted at the thought of facing another day. Union members and those whose homes were damaged in the storm were more likely to report often having these negative feelings than other respondents. Thirteen percent of respondents, including 26% of union members, experience anxiety at the thought of future hurricanes (Figure 53).
I generally feel:

**Emotionally drained.**

**Burned out.**

**Exhausted thinking about another day.**

**Anxious about future hurricanes.**

---

**Impact on Health**

Hurricane Katrina affected Stennis workers in numerous ways. In the year prior to Katrina, 81% of respondents report being in good physical health. Eighty-two percent report being in good mental health before the storm. Now, just 59% report good physical health and just 52% report good mental health (Figure 54). Workers whose home was damaged as a result of the storm report lower health ratings than respondents whose homes were not damaged. Union members are much less likely to report good mental health than non-union members.
Some of the issues employees face in the aftermath of Katrina relate to their personal quality-of-life (Figure 55). In the year before the storm, the majority of respondents were satisfied with their life overall (88%). High levels of satisfaction were reported for many facets of life, including: access to quality healthcare (73%); marriage (83%); relationships with family (85%); neighborhood (78%); and access to retail stores and services (79%). When asked how satisfied they are with these things now, the numbers drop considerably. Only 63% of Stennis respondents are satisfied with their life overall currently. Satisfaction
numbers declined in every category: financial situation (38%); access to quality healthcare (62%); marriage (74%); relationships with family (74%); neighborhood (51%); and access to retail stores and services (46%).

**Figure 55: SSC Survey Response: Life Satisfaction Before and After Katrina**

*In the year before Katrina, how satisfied were you with your:*  
*Currently, how satisfied are you with:* 

![Bar chart showing life satisfaction before and after Katrina](image_url)

Satisfied □ Slightly Satisfied □ Neutral □ Slightly Dissatisfied □ Dissatisfied

**Recovery and Rebuilding Process**

Hurricane Katrina substantially changed people’s perception of their community. As one respondent remarked, “This community does not appeal to me any longer. There are much nicer places to live with better services, less crime, more family activities to do that have an equal if not less cost-of-living.” About 16% of Stennis respondents agreed with that worker, indicating a strong desire to move somewhere with better public services. Workers
in the 35-44 age range were much more likely to want to move—a third of respondents—than others. Respondents who have been at Stennis up to four years, and those with a college degree, would also like to move (Figure 56).

**Figure 56: SSC Survey Response: Public Services**

*I would like to move some place that has better public services.*

Only 35% of respondents are satisfied with the rebuilding progress in their community; those whose home was not damaged are about twice as likely to be satisfied as those who suffered damage to their home. In terms of their own rebuilding progress, 42% of respondents are satisfied (Figure 57). As with the community, workers with damaged homes are less satisfied with the recovery process than those without damage.
**Katrina and Work**

Twelve percent of respondents report that they are often tired at work because of what they are doing at home. Fifteen percent report often being absent from work to deal with their recovery from Katrina. Almost 16% say they have often felt guilty for missing work. These non-work factors may have an impact on whether or not employees remain on the job. Eleven percent of all respondents say that they have thought about quitting their job for non-work reasons such as housing and community (Figure 58). Workers in the 35-44 age range, and those with at least some college education, are more likely to be taking these issues into consideration when thinking about their employment.
Most respondents (59%) believe that their employer took care of the needs of employees following Hurricane Katrina (Figure 59). This sentiment was expressed more often by non-union respondents than by union members (61% vs. 51%) and by those whose zip code did not change following the storm than those whose zip code did change (63% vs. 44%). Many respondents, particularly those with AGT, expressed their gratitude for the assistance their employer had already provided.

For some workers, continued employment at Stennis meets their basic needs during this recovery period: steady income and health insurance. Many respondents noted that their bills and overall debt level, as well as the money they need for rebuilding, are what keep them dedicated to their job. Others noted that they come to work because their co-workers are like family; because as one respondent put it, “work is mostly normal - [my] personal life isn’t.”
When asked what their employer could do to help them with their recovery from Hurricane Katrina, respondents noted their need for time off during the week, or flex-time options including leave without pay. Many respondents expressed the need for help with addressing legal issues or with navigating the social and recovery services available. Cost-of-living adjustments, and simply keeping workers employed were suggestions made by other respondents. AGT employees want their company to “just keep doing what they have been doing.”

**Figure 59: SSC Survey Response: Employer Response to Katrina**

*My employer took care of its employees’ needs following Hurricane Katrina.*

Survey respondents were also asked what NASA itself could do to help them recover from the effects of Hurricane Katrina. Many took the opportunity to express their gratitude to NASA. One worker wrote about what NASA let him do: “I still don’t need help. However, NASA did allow us to go out into the community to help others…that was really good.”
Other Stennis workers did have some concrete suggestions for NASA. Many would like for NASA to let the contractors provide flex-time and telecommuting options to employees, and cost-of-living adjustments. Others request that NASA keep counseling services available or that NASA add counseling services for the legal, tax, and recovery issues that many still face. More than a few Jacobs respondents requested that their employer be replaced with a new contractor.

Finally, many respondents simply requested that NASA remember that the recovery will be a long-term process. One worker summed up his feelings this way; “I haven’t skipped a beat in doing my work for NASA after the hurricane, but I believe that in trying to rebuild my entire life outside of work…it’s probably larger than most people can handle. I’d appreciate a little help.”

**Changing Labor Market Opportunities**

AGT respondents strongly believe (89%) that they are a good match for their company; overall, 66% of Stennis respondents believe they are well-matched. Those whose zip code changed following the storm are less likely to feel well-matched (52%) than those whose zip code did not change (70%). Seventeen percent of Stennis respondents report that they often think about quitting their job. Respondents who have been employed by their current contractor between two and six years are more likely than other respondents to consider quitting (Figure 60).
I am a good match for my employer.  I often think about quitting my job.

Job Search Activity

A quarter of SSC respondents indicate that they are seeking alternate employment elsewhere (Figure 61). Of the three contractors, AGT’s respondents are the least likely to be looking for another job. Respondents who have been on-site at Stennis between five and nine years are the most likely to be seeking other employment (38%). About 14% of workers who are job searching report looking on a weekly basis.
Overall, 8% of workers report having spent a lot of time in the last six months looking for another job. Those in the 35-44 age range are more likely than other workers to report this level of activity. While only 15% of all respondents indicate that they will probably look for a new job in the next year, 28% of respondents in the 35-44 age group will be looking. Jacobs and MSS respondents are almost twice as likely as AGT employees to say that they will look for other work (Figure 62).
Job Market Opportunities

Whether or not they are looking or planning to look for work, 40% of Stennis survey respondents believe it will be easy to find employment. Twenty-seven percent believe that they have many alternative employment opportunities (Figure 63). Respondents whose commute has shortened since Hurricane Katrina are much more likely than others to estimate that there are many opportunities available (47% vs. < 27%). Those in the 35-44 age group are also more likely to indicate that they have many job options.
Contracts for Space Exploration: Changing Roles and Status

The survey asked workers if their employer provides accurate and timely information to them about project and contract issues related to the Space Shuttle Program or other programs. Overall, 37% of Stennis respondents agreed that their companies met this standard (Figure 64). Just a third of Jacobs and MSS respondents agreed, while more than half of AGT respondents felt well-informed. A third of all Stennis respondents believe that their employer maintains good communication channels with NASA and other contractors. Once again, AGT employees are more likely to feel this way than others. Non-union members are far more likely than union members to believe their company maintains good lines of communication with NASA (38% vs. 5%).
When asked what NASA could do to help Stennis workers recover from Hurricane Katrina, a few said that job security assurance was all they needed. More than three-quarters (78%) of Stennis survey respondents would be happy to spend the rest of their career with NASA; for those with some college education that number exceeds 90% (Figure 65). Similar to the survey findings from Michoud, far fewer Stennis respondents feel secure in their job—just half. Respondents from AGT, 70%, are much more likely to feel secure than those working for Jacobs (53%) or MSS (43%). Only 41% of respondents feel that the prospects for continued employment with their current contractor are excellent. Again, AGT workers are much more likely to agree with that feeling (68%) than the others (40% Jacobs, 35% MSS). Respondents with a high school education or less believe that their prospects for continued employment are much better (63%) than those with other levels of education (36%).
While there are definitely issues that can be addressed, survey respondents noted many factors that lead them to continue employment at Stennis. The most common reasons noted revolve around the work itself—these employees want to be a part of the space program and take great pride in their contributions. Their comments say it well:

“I believe in the pioneering spirit of space exploration. I’ve helped support the space program for over 21 years. The company… is very supportive of its employees. I like what I do, where I work, and the people I work with.”

“We provide world class rocket test capability.”

“I really like working here at Stennis. I have always wanted to work here ever since I was young. I enjoy the atmosphere/environment here along with being close to my home.”

There is a real opportunity for NASA and the contractors to capitalize on this enthusiasm and retain the SSP workforce.
VI. Key Findings and Impact Assessment

The findings presented here offer a compelling story of great adversity and challenges, tempered by perseverance and adaptability in the wake of Hurricane Katrina. As well, they highlight workforce and workplace trends that existed prior to, and which continue after, Katrina. The findings and impact assessment are based on data derived from four sources: an environmental scan, interviews, focus groups and surveys of the Michoud and Stennis contractor workforces.

One of the major findings is the workforce's strong attachment to community and longevity with and dedication to the Space Shuttle Program, the facilities, and specific contractors. This is a major strength of the workforce in the area and has prevented greater losses through attrition and disruptions in the SSP than might have been expected or experienced in another setting. Still, the continuing effects more than a year after Katrina are a cause for major concern and will require thoughtful action to mitigate their adverse impacts.

Context Overview

Prior to Katrina, MAF and SSC faced the daunting challenges of Return to Flight, a compressed production and testing schedule, an aging workforce, and a changing contractual and competitive environment. In addition, the program has evolved in an absence of an innovation system that typically supports complex, high-performance enterprises like SSP through the provision of technological and process improvements and an appropriately skilled workforce.

For decades, workers at MAF and SSC and the contractors who employ them have enjoyed a high degree of revenue and job security without having to adopt an aggressive market orientation. Employees at every level of responsibility expressed an awareness that what is a new emphasis for them has been status quo for US business for some time and that they have yet to fully operationalize this new business focus. The issue is particularly pronounced at MAF where one company has produced one product for one customer for nearly 30 years, and customer needs are undergoing significant changes. By their own admission, contractor employees at both facilities have only recently begun to appreciate that their job
security is dependent at least in part on the ability of their companies to generate new business. This increasingly market-oriented stance is good for contractors and their employees in the long term, but this orientation strains the short-term requirements of the SSP. Employees who are planning the rest of their careers are concerned that they do not have skills that can be transferred to other employers or rewarded internally, increasing their anxiety about remaining with a program that is unlikely to carry many of them through to retirement.

Compounding these challenges is the lack of critical mass in the aerospace industry to attract more technologies, businesses, and talent to the Gulf Coast region to create a sustainable, mutually reinforcing environment with sufficient churn of ideas, revenue, and people to support SSP and related NASA programs.

The interaction of these global trends, the local innovation context, and a compressed timeframe has had the following consequences for the pre-Katrina SSP: significant productivity improvements and little or no inflow of new talent in the context of greater productivity requirements for Return-to-Flight. To reach the productivity levels required from an already thin workforce means the SSP is dependent upon more work from the same pool of people, using the same tools to produce products that must perform flawlessly.

To date, the principal means employed to accomplish program goals have been compulsory overtime, uncompensated overtime, discouragement of accumulated leave time use, and willing contributions of workers' time due to good will and personal commitment to the SSP mission. Hurricane Katrina has had obvious negative consequences for this delicate but serviceable arrangement that existed prior to the storm.

These issues have evolved over decades and will not be resolved by the time the SSP program is completed. However, they have significant implications for the success of the mission. Despite the significant effort put forth by NASA, contractors and employees to fulfill the SSP mission, Katrina continues to stress many if not all of the systems on which the mission depends, leaving only limited fault tolerance.
Findings

NASA

Production Schedule and Work Organization Issues. As late as May 2005, NASA was considering 28 shuttle missions to complete the ISS. Given the pressure to "fly-out" the Space Shuttle Program in 2010, NASA developed an alternate ISS configuration which requires about ten fewer shuttle missions.\textsuperscript{141} To meet the revised launch schedule, an aggressive ET production schedule has been put in place at Michoud along with an accelerated SSME testing schedule at Stennis. Several issues arise from this situation:

- Tighter schedules require employees at both facilities to work overtime on a regular basis. Fully 65\% of Michoud survey respondents and 45\% of Stennis respondents report a usual work week of greater than 40 hours. Some groups of workers are affected disproportionately (e.g., foam sprayers).

- For a period following Hurricane Katrina, part of the new production schedule at Michoud called for external tanks to be shipped to Kennedy Space Center for completion, requiring a cadre of Michoud workers to be detailed to KSC for 60-day assignments for final assembly. This practice has since ended.

- Schedule pressure is contributing to worker stress and may present safety challenges.

Time is at a premium for workers at both facilities, and mandatory overtime and off-site details that have been instituted in order to meet the schedule have made it hard for employees to manage the demands of their home rebuilding and reconstruction activities as well as the demands of day-to-day life in hurricane-affected areas.

Program/Contract/Job Uncertainty. Employees are very dedicated to the Space Shuttle Program and are proud of their role in it. However, the imminent termination of the Program and the transition to the new CEV/CLV Program creates uncertainty about future job prospects. Only half of Stennis survey respondents and 57\% of Michoud respondents report feeling secure in their jobs. Incomplete communications about the Program and the impacts on/options for employees are also hampering workers ability to process and plan for

the changes. Only 37% of Stennis employees and 42% of Michoud employees agreed that the contractors provided timely communication about projects and contract status.

In the short term, workers expressed concern about organizational changes which may disrupt the workflow and employee benefits (such as retirement and health care) as contracts are/are not renewed. In both the focus groups and surveys, SSC respondents suggested implementing a site-based insurance and retirement benefits scheme to provide continuity during SSP and contractor transitions. Employees have been offered some broad-brush information about the Program as a whole but need assistance in translating such “macro” information into more “micro” contractor-specific, job-related information.

**Paperwork, Bureaucracy, and Communication.** Employees understand the need for and value of a well-documented process and clear, formal rules for public accountability. However, in many cases, these governmental requirements were described as redundant, contradictory, constantly changing or otherwise hampering efficient completion of the work.

- Several noted that paperwork consumed a major portion of their workweek.
- Communication gaps between NASA and contractors and between contractors themselves have caused false starts and delays. Only 33% of respondents at Stennis and 43% at Michoud agreed that there is good communication with NASA and other contractors.
- Many noted that personnel changes at NASA have resulted in a lack of understanding of key systems and relationships and have interrupted or delayed critical decisions and work processes. Coupled with the multiple layers of bureaucracy required to make and interpret decisions and authorize work, these conditions can impair project management and reduce mission effectiveness.

**Employers/Contractors**

**Compensation.** In focus groups, workers at both facilities reported being generally well-compensated. However, in the survey, only 29-30% of Stennis and Michoud survey respondents reported being well compensated relative to their performance. While hourly workers noted the adequacy of wage scales in many occupations, they believe individuals are often not hired at a high enough level within the scale to attract and retain new workers. Several compensation issues were highlighted during the focus groups:
• Current market conditions and the high cost-of-living are eroding effective salary and wage rates and will likely impact contractor’s ability to retain and recruit employees.
• Wage rates in the region have risen overall, and select employers in the region have made adjustments to salaries.
• While NASA has, in many cases, recognized the cost overruns in construction and repairs, adjustments to staff salaries have not been forthcoming, notwithstanding recent cost-of-living and other increases.
• Respondents noted that these recent increases were either not available to all employees, based on dated performance ratings, and/or otherwise inadequate in the current market.

Compensation is also a barrier to recruitment. Human Resources managers, particularly with Mississippi Space Services, noted the difficulty in filling open positions due to salary constraints. Skilled job-seekers such as engineers and safety professionals are demanding higher starting salaries than current contracts allow.

**Workforce Development.** The NASA strategy for executing its mission has not fully exploited ongoing research or workforce development at centers explicitly created and funded by Louisiana and Mississippi to enhance SSP innovative and productive capacity and workforce quality. Both facilities are associated with higher education consortia to engage in applied research to address problems related to work conducted at MAF and SSC and to provide tailored workforce development, particularly in skilled, technical work. However, the exigencies of the SSP production and launch schedule have forestalled meaningful transfer and integration of innovation and workforce development programs. The absorptive capacity of both facilities is very limited, and as a consequence the partnerships between NASA and contractors with the National Center for Advanced Manufacturing (at MAF) and the Center for Higher Learning (at SSC) are not as productive as they might be if there were the resources to plan, implement, and integrate complementary programs.

The future of NASA programs in the Gulf Coast region depends on a coherent workforce development strategy employed by contractors in partnership with NASA and the local/regional workforce entities, e.g. workforce investment boards, colleges, universities, trade/technical schools, and other training providers.
Respondents noted the lack of comprehensive recruitment efforts and an inadequate “pipeline” system for providing such workers in the long term.

The hurricane disrupted education and training institutions, many of which still need to re-stabilize their facilities and course offerings.

In combination with the short-term manpower and training issues identified below, employers will need to work with their partners to establish a coordinated workforce development approach for long-term success.

Time and funding for pre-service and in-service training for the exiting MAF and SSC workforces and limited career advancement opportunities in the face of increased job demands and responsibilities make internal cultivation of an appropriately skilled workforce challenging.

The aging workforce and the related challenges associated with recruiting and hiring replacement workers given Program uncertainty, and the living challenges costs, and competitive pressures associated with the post-Katrina environment are likely to exacerbate this condition.

**Manpower, Workload, and Productivity.** The Space Shuttle Program enjoys a very skilled and motivated workforce performing unique functions. However, this asset is threatened due to a number of factors.

Respondents noted “thin” staffing levels or outright shortages in critical or “single-point-failure” positions and tasks in the short term. The case of foam sprayers at Michoud is illustrative. Workers noted that this critical function is performed by a small number of individuals working in highly specialized teams, many of whose members are currently suffering from Katrina-related dislocations and health problems. This situation makes the tasks they perform subject to failure or significant delays with little ability for short-term recovery. There are undoubtedly other positions which fall into this category.

Katrina has disrupted the supply of workers through attrition (i.e. workers who have not returned/will not return), but the issue is broader than Katrina. Many noted that current contracts limit the ability to hire sufficient numbers of workers and that contractors are reluctant to hire workers or seek contract modifications out of competitive and cost concerns. Only 18% of Michoud survey respondents and 21% of Stennis survey respondents believe their employers are staffed sufficiently to complete the SSP mission.

These issues have manifested themselves in production backlogs, mandatory overtime, constant on-call status, and time away from home to be on-site at KSC at a time of increasing workload requirements. This is causing workplace stress and potential safety lapses for workers who are tired and preoccupied with personal reconstruction concerns.
• Respondents do not always have adequate up-to-date equipment, technology and facilities in certain areas. New employees often lack basic equipment like computers and telephones.

• Workers believe that management is aware that they have outdated equipment, software, and tools but are continuing to use them in a sort of “holding pattern” until the SSP has ended.

• Preventative and corrective maintenance is often lacking, and needed repairs delayed due to the dictates of the production schedule.

While Katrina has exacerbated many of these factors, they were a concern prior to Katrina, in part due to the current environment where cost control and speedy Space Shuttle component delivery are the focus. While these imperatives are understandable, they are adversely affecting the morale and productivity of incumbent workers and can potentially interfere with retention and recruitment efforts as well.

**Fatigue and Morale.** In addition to the concerns associated with changing employee benefits, many respondents noted that policies regarding annual and sick leave are often unfair, unrealistic, inconsistently applied, and/or require further flexibility. Employees were very grateful for the forbearance shown and flexibility provided to them post-Katrina, which allowed them to maintain their incomes and attend to personal business. However, many face continuing personal disruptions and require ongoing flexibility for the foreseeable future to reduce workplace stress and turnover.

• Nearly a quarter of Michoud respondents report being “burned out from work” often or very often, as did 18% of the Stennis respondents.

• Work satisfaction has declined at both sites since the hurricane. Overall work satisfaction at Michoud declined to 34% from a pre-Katrina level of 45%. Work satisfaction at Stennis is higher but declined to 52% from pre-Katrina levels.

• Overall work satisfaction is reflected in their job search behavior. Nearly a fifth of Michoud workers and 14% of Stennis workers report searching for other work on a weekly or even a daily basis.

**Safety.** The issues identified in the previous sections all have potential impacts on workplace and Space Shuttle safety.

• Respondents noted the pervasive disruptive affects of the Columbia disaster and the time and effort devoted to investigation and redesign.
While safety is a clear focus of the program, which has resulted in substantive changes, many expressed concern that necessary actions and investments in equipment, training, and compliance have not been made.

While an independent review of workplace accident/injury rates, workers’ compensation claims, or the overall safety profile of the Program is not part of this report, this issue is worthy of further review.

**Households**

**Continuing Effects of Katrina.** The hurricane has had a pervasive impact on day-to-day living and working conditions of most if not all employees. In each of the focus group sessions, at least half of the participants noted significant housing issues, ranging from the entire or partial loss of their homes, to continued dislocation of themselves and their families, to scarcity of affordable temporary and permanent housing options for incumbent workers during the reconstruction phase and for new employees. These findings are corroborated by the results of the survey in which 57% of Michoud respondents and 54% of Stennis respondents reported houses with significant or major damage. According to a February 2006 Lockheed Martin survey of its Michoud employees:

- almost half lost their homes or had homes that were unlivable;
- hundreds had to temporarily or permanently relocate; and
- multiple generations and families now share a single house.

Many employees have family members who still reside outside of the region. Uncertainty surrounding the recovery and reconstruction of housing, schools/day care centers, businesses, roadways, and other critical public, private, and governmental infrastructure continues as the major overall factor impacting employees. Even those employees who did not experience a loss of home or property and related dislocation are impacted by the community and workplace factors. These factors are adversely affecting the facilities’ ability to recruit new workers to replace those that have left or that will leave due to retirement and other exigencies.

Respondents recounted harrowing stories of the hurricane and its immediate aftermath. They expressed gratitude for the job they have and the support they have received from NASA and their employers. Most exhibited resilience and determination to rebuild and
remain with the program as productive workers. However, one year after the storm, many, perhaps most, workers still face significant obstacles to normalcy. Like others in the region, they are experiencing:

- Shortages of livable housing for ownership or rental at affordable prices
- Lack of reliable, reasonably priced contractors, materials, and supplies to complete reconstruction
- Lack of other business, household, and personal services in such areas as food services and utilities
- Lack of schools and day care options
- Lack of, inadequate, or high cost of property, auto, or health insurance
- Significant blocks of time required to commute, resettle/re-employ family members and attend to children and the elderly, meet with construction/remodeling contractors, address insurance and financing challenges
- Overall high cost-of-living
- Crime
- Lack of critical public and governmental infrastructure and services
- Hassles dealing with FEMA, SBA, state and local requirements, and other governmental entities
- Lack of recreational and social amenities
- Lack of medical and mental health services

Workers at both sites face significant recovery challenges in their personal and community lives, and reported large drops in overall life satisfaction. This is especially the case at Michoud.

These experiences are having a profound and possibly lasting effect on workers in terms of personal/family stress, fatigue, fear, burnout, and health impacts and are undoubtedly having, and will continue to have, residual effects on their work performance.

- EAP staff at both Michoud and Stennis continue to counsel employees about their problems and caution that these stresses traditionally become even greater about a year after the event that led to them.
- It is important to note that for many workers and their families the fact that rebuilding is only just beginning means the stress of balancing work and family time is going to get worse, not better, in the coming months.
The interplay between these factors and the effects of the production schedule noted above is a variable that must be fully understood in program policy decisions.

Community Environment

Transportation Challenges and Commute Times. Transportation challenges continue to be a factor affecting commute times and, ultimately, workers’ stress and the time available to complete personal and work related functions. This has been exacerbated by high gasoline prices. Though some major roadways have reopened, others remain closed or are operating at less than full capacity. Traffic congestion is increasing in some corridors as the population returns to the region. Many workers still live in areas geographically more dispersed than before Katrina. Some workers are still living as far away as Baton Rouge, Gulfport or Hattiesburg. While transportation infrastructure remains a critical issue throughout the region, Michoud and Stennis employees were affected differently. More than half (54%) of Michoud employees report longer post-Katrina commute times, compared to just 16% of Stennis employees. This finding could be a function of the relative isolation of the Stennis facility and the likelihood that commuting times will be considerable no matter where the worker lives or relocates. Since “time” is at such a premium for employees at the two facilities, effective management of transportation challenges and commuting times can have a significant positive impact on worker productivity.
VII. Modeling the Impact of Hurricane Katrina and Other Factors on the Space Shuttle Program at Michoud and Stennis

The System Dynamics Approach

A simulation model was developed to assess the possible ramifications that Hurricane Katrina might have on the successful completion of the Space Shuttle Program. The simulation model was built using the Vensim simulation software, which utilizes the methodology of system dynamics. System dynamics is an approach to understanding the behavior of complex systems over time. It models the feedback loops and delays that exist in any complex system. Through simulation, a dynamic system can be modeled and the behavior of that system studied under different external scenarios, and the results of different policies on the system’s behavior can be examined (see Sterman 2000).

Purpose of the Model

The model focused on the “burnout dynamics” that occur when a workforce is subjected to extended overtime and excessive fatigue. The workers on the Space Shuttle Program have endured excessive non-work-related fatigue as a result of Hurricane Katrina. This pressure is on top of the stress placed on the workers as a result of the aggressive work schedule needed to meet Return to Flight requirements and the "fly-out" of the Shuttle Program. The purpose of the model is to see how these factors influence the completion of the remaining shuttles. Using the model, different policies can be tested to quantify their impact on the program.

Model Assumptions

The assumptions and logic of the model are supported by interview, survey and focus group findings regarding fatigue related to Katrina recovery, the production schedule, Return to Flight, and mission “fly-out.” Key assumptions of the system dynamics model are as follows:

- All of the contractors had the capacity to complete their tasks on five space shuttles per year before Katrina without the use of extensive overtime. This assumption sets base productivity levels that are utilized in all of the model simulations. The results of these simulations may be very different if the
ambitious schedule of five shuttles per year for 2007 and 2008 could not have been accomplished by the extant workforce under a no-Katrina scenario.

- **The Shuttle Program production schedule would have featured five shuttles in 2007, five in 2008, four in 2009 and two in 2010, for a total of 16 shuttle flights before ending in 2010 (see Table 2).**

- **Extended overtime**—i.e., 50 to 60 hours per week for weeks on end—**leads to a drop of 10 to 15% in worker productivity** (Thomas and Raynar 1997). This assumption was used in the model to calculate worker productivity deterioration due to extended periods of overtime as have been instituted at MAF and SSC.

- **There is an additional productivity loss of approximately 10% as the result of Hurricane Katrina and its aftermath over and above that related to overtime fatigue.** Stewart et al. (2003) found a productivity loss of 5.1 hours per worker per week for each employee reporting “pain, weakness or fatigue.” Focus group, interview and other data indicate that while the fatigue related to rebuilding may be abating for some, many contractor employees will have to commit significant personal resources to rebuilding for the foreseeable future. Also, the slow recovery means that the extra effort people living along the Gulf Coast have to expend to meet the requirements of their daily lives can be expected to continue through the end of the Shuttle Program. Thus, the 10% loss due to external fatigue is assumed to be constant through the remainder of the Shuttle Program.

- **The worker retirement rate over the period was assumed to be 30% in the base model**, a figure that is a rough average across NASA contractors at MAF and SSC.

- **New workers can and will be hired to replace all of those leaving due to retirement or other reasons**, perhaps a strong assumption given the continuing state of disarray in Gulf Coast labor markets.

- **The productivity of a new worker is around 85% of an experienced worker, and it takes three years for a new worker in a critical role to reach full productivity.** These assumptions are based directly on estimates provided by NASA contractor HR directors and supervisors.

- **The model aggregates effects for contractors and facilities.** Although each NASA contractor has different roles, responsibilities and employment policies, the variables from the employee survey and interviews used in the model mostly revealed differences too small to significantly influence system behavior. The model incorporates data from LM, J-S, MSS, and AGT at the Michoud and Stennis facilities.

- The model did not account for any quality deterioration that may arise due to the stress and fatigue of extended overtime and the recovery from Katrina, which would effectively lower productivity due to the required rework to fix these quality issues. Studies have clearly shown that the incidence of defects and the
need for rework increase under stress (Oliva and Sterman 2001). Data were not available related to these factors. Hence, the effects of stress and fatigue on quality and rework are not factored in to the model.

**Model Dynamics**

The complete structure and equations for the model are presented in Appendix F. While other factors affect system behaviors, the two structures presented in this section proved most influential in the simulations. The primary dynamics of the simulation are illustrated by the structure presented in Figure 66, which is known in system dynamics as a causal-loop diagram. Following system dynamics conventions, each arrow in the diagram represents a causal link between two variables. In this case, it is assumed that Katrina caused a significant increase in worker fatigue as the workers try to put their lives back together in a far more stressful living environment. This increases worker fatigue, which—although not directly work related—leads to a decrease in productivity. Because an increase in worker fatigue leads to a decrease in productivity, the arrow is labeled with an “O” next to it, representing a move in the opposite direction. In contrast, an “S” label next to an arrow indicates that the two linked variables always move in the same direction. For example, a decrease in overtime decreases worker fatigue and vice versa.

Any drop in productivity will decrease the work completion rate, and, in turn, increase the work load. In order to meet the planned shuttle flight schedule with current staffing levels, overtime will be necessary at both the Michoud and Stennis facilities. This increased overtime leads to an even greater loss in productivity. This is commonly called a reinforcing loop (notated in the diagram by an "R" in the center of the loop enclosed by a circular arrow) because any increase in worker fatigue ultimately reinforces itself by leading to even more fatigue.
Another factor threatening the flight schedule is the number of experienced workers who may retire before completion of the program. It has been estimated that 26% of all aerospace workers are eligible to retire by 2008, and that the average age of production workers at NASA is 51. As shown in Table 20, the shares of contractor employees who are retirement eligible in the next few years ranges from a low of 0-2% at Jacobs-Sverdrup and MSS to a high of 40-50% at Lockheed Martin (MAF). Katrina has possibly made this an even more critical issue as illustrated in Figure 67, in which increasing worker fatigue may in turn increase the retirement rate as workers choose to retire earlier than they would otherwise. An increase in the retirement rate eventually decreases the number of workers, which increases the work load on the remaining workers. Because this leads to even more worker fatigue, another reinforcing loop is created. It is important to point out that the retirement rate could have an impact on the production schedule even without the Katrina effects. When experienced workers leave as they become eligible for retirement, they place an increasing burden on the remaining workforce which, in itself, will increase the fatigue of those remaining and negatively impact their productivity. This scenario is investigated in the simulations presented below.
Although the model primarily considers the age structure of the contractor workforce, retirement decisions are influenced by more than age or eligibility. Pull factors include the negative impact Hurricane Katrina may have had on family finances. Researchers heard of employees' retirement savings being wiped out by the cost of rebuilding. Push factors include the uncertain contracting environment which calls into question the viability of retirement benefits should the worker have to change employers in order to remain with the Space Shuttle Program. The continued quality-of-life challenges also enter into employee retirement decision-making.

Table 20: Contractor Estimates of Retirement-eligible Workforce

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Share Retirement-eligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockheed-Martin</td>
<td>40-50% in next 5 years</td>
</tr>
<tr>
<td>AGT</td>
<td>17% in next 5 years</td>
</tr>
<tr>
<td>MSS</td>
<td>2% in next 5 years</td>
</tr>
<tr>
<td>Jacobs NTOG</td>
<td>None</td>
</tr>
<tr>
<td>PWR</td>
<td>30% in next 3 years</td>
</tr>
</tbody>
</table>

Source: Field interviews
Simulation Results

The model was simulated using a production schedule of five space shuttles each in 2007 and 2008, 4 in 2009, and 2 for 2010, after which the program ends. The model is not meant to provide a point prediction of the program’s performance but instead to show the anticipated behavior of the system given the accuracy of the underlying data and assumptions.

Baseline Program Performance

The model was simulated to test the program’s performance without the effects of the hurricane. It was assumed that the current workforce could meet the production schedule of five shuttles in 2007, although this assumption could not be formally verified. The model also assumes that experienced workers are replaced with new workers as they retire, but that the new workers’ productivity is reduced by 15% until they become fully trained after 3 years. As is illustrated in Figure 68, the hours per week needed to keep the program on schedule according to the current flight schedule in the simulation reaches a maximum of 46 at month 23 (that is, 23 months after the beginning of 2007). When the number of shuttles per year decreases at month 24 to four per year, the required number of hours significantly decreases, and overtime is no longer required for the duration of the program. In fact, some reduction in workforce after month 23 could be facilitated without consequence to the program timing. Again, these results are highly dependent on the assumption that current capacity could produce five shuttles per year, which is an aggressive schedule compared with past production.
The Hurricane Effect

The model was then simulated to test the effects of worker fatigue caused by Hurricane Katrina and the related recovery efforts. Although the actual loss in productivity caused by fatigue could not be determined, a conservative estimate of 10% was used (Stewart et al. 2003). As Figure 69 shows, the resulting loss in productivity greatly increases the need for overtime. The peak demand for labor is 72 hours per week, which, as in the base simulation, occurs just before the shuttle demand decreases to four missions per year. As can be seen, significant overtime will be required into the final year of the program.
Policy Impacts

Several policies were tested to quantify their potential impact on system performance. Two leverage points of influence are, first, reducing the rate at which experienced employees retire, which both NASA and contractors can accomplish, and, second, modifying the shuttle schedule, which only NASA can do.\textsuperscript{142} Reducing the external fatigue that employees are experiencing can also improve program performance; however, NASA and contractor influence over the factors leading to external fatigue may be insufficient to materially change productivity. The possible outcomes of each policy option are discussed below.

Effect of Reducing External Fatigue

The available data give only a static view of the fatigue being experienced by the workers and do not provide insight into how policies altering their external environment will reduce this fatigue. Because of the lack of dynamic data, i.e., the change in external fatigue over time, the model was simulated assuming that actions were taken to reduce their

\textsuperscript{142} Of course, this is a very complex, multi-party decision and not solely up to NASA. The U.S. has commitments to its partners in the International Space Station, and Congress is certainly interested in such issues.
external fatigue and that this decrease in fatigue persisted throughout the entire simulation. As illustrated in Figure 70, this reduces the maximum workload requirement to 56 hours/week with substantial overtime, and production returns to a standard 40-hour week at approximately month 29 (the middle of 2009). Other reductions in fatigue were simulated with similar scaled results.

**Figure 70: Workweek Effects of Externally Reduced Fatigue**

Although implementing policies to reduce external fatigue greatly improves system performance, the resources required and the ability to implement such policies may not exist or be readily attainable. However, some reduction of the rate of retirement during the remaining years of the Shuttle Program may well be feasible.

In the simulation, it is assumed that 30% of the workers are eligible to retire in the next three years, a rough average of contractors’ self-reports of the percentage of workers who are or will be eligible for retirement in the next few years. To illustrate the consequences of implementing policies that would reduce the retirement rate, a simulation assuming only a 2% retirement rate per year for the remainder of the program was run. As illustrated in Figure 71, policies to encourage workers to stay on the job until the end of the program can significantly reduce the need for overtime in the system. The peak workweek
is reduced to 59 hours per week and falls to a standard 40-hour week at month 31 (around the middle of 2009).

Figure 71: Workweek Effect of Reducing the Retirement Rate

Achievement of these lower-than-expected retirement rates will require intervention on the part of both the contractors and NASA. Retention of potential retirees requires addressing 1) the widely held view that contractor compensation has not kept pace with cost-of-living increases since Katrina, 2) decreasing job satisfaction, and 3) general uncertainly related to the contracting environment.

Effect of Modifying the Shuttle Schedule

Figure 72 shows the results of changing the production schedule. The model was simulated using two different scenarios:

Simulation 1: Assumes level production of four shuttles per year for the remainder of the Program.

Simulation 2: Assumes that 4.5 shuttles would be scheduled for the next three years, and 2.5 shuttles would be completed during the final year.
Both scenarios assume that 16 shuttles, the same as the current schedule, will be produced within the current Program timeframe through September 2010.

The results for the level-production scenario show no need for overtime because of the earlier assumption that current resources had the capacity to produce five shuttles per year without overtime.

The scenario that decreases production to 4.5 shuttles per year produces some interesting results. The peak workload occurs at month 35—near the end of 2009—with a required workweek of 53 hours. The fact that the peak occurs much later in the schedule is encouraging, because it is possible that outside factors may change, easing workers’ fatigue from external sources. Hence, the required hours per week may even be less in reality than indicated in the simulation because all of the simulations assume a constant level of external fatigue.

**Figure 72: Workweek Effects of Modifying the Program Schedule**
Implications of the System Dynamics Model Simulations

In the initial interviews with NASA and contractor managers at both MAF and SSC, respondents repeatedly voiced their concerns about employee fatigue and the impact this fatigue could have on workforce retention, overall worker physical and mental wellbeing, and the successful completion of SSP. The one-year anniversary of Katrina had just passed, and managers expected that fatigue, morale, recruitment, and retention problems would escalate as Katrina recovery across the Gulf Coast continued its slow pace.

The system dynamics model simulations illustrate that managers’ concerns are well founded. Employee survey results reported in a previous section show that burnout, poor physical and mental health and other proximate determinants of fatigue are present in the contractor workforce at both MAF and SSC. These findings are further supported by the multiple and indirect signals that a not-insignificant share of workers want or are seeking a way out as evidenced by their job search behavior, their deteriorating satisfaction with work and life at home and in their communities, and their continued frustration with the slow pace of Katrina recovery.

The system dynamics model simulations also show that if interventions geared toward reducing worker fatigue are implemented, there will be measurable, positive results that support successful SSP missions. The model is not prescriptive. There are a number of interventions NASA and contractors may consider pursuing to achieve the results reflected in the simulations. However, the model does show the direction and magnitude of both modest and dramatic changes in retirement policies, external fatigue factors, and production and testing schedules. The model does not illustrate the combined effect of multiple interventions, but it does show when and how much interventions are likely to affect behavior.

According to the current schedule, the majority of production and testing for SSP will occur in the near term, with ten of the remaining 16 shuttle flights scheduled for 2007 and 2008. Table 21 summarizes the results. The baseline model shows that, even in the absence of Katrina, the current production schedule would require a maximum workweek of 43 hours per week in month 23 (January 2007 = month 1), a workload that is in line with past employee experience. However, as the Hurricane Effect simulation shows, when the
impact of Katrina-related fatigue is factored in, the maximum workweek balloons to 72 hours per week, also in month 23. Clearly, a workload requirement on this order for this already stressed population is untenable, even if only for a short time.

Four remediation options are simulated, all of which show significant reduction from the Hurricane Effect simulation in the maximum workweek required, as summarized in Table 21. Reduction of fatigue caused by hurricane recovery and the challenges of meeting the exigencies of everyday life, no matter what the mechanism for achieving this reduction, might be—e.g., telecommuting, onsite health and daycare, and commuter busses, to name just a few—potentially reduces the 72 hour maximum workweek to 56 hours. Reduction of the retirement rate of the eligible workforce to 2% also drops the maximum workweek from the 72-hour week to 59 hours. Two modified shuttle mission schedules are presented to illustrate the productivity impact of reorienting workflow such that more work is pushed out in time—to month 35 in Modified Shuttle Schedule 2—when workers may be better able to meet a demanding work schedule should hurricane recovery accelerate and take hold. Modified Schedule 1 illustrates the effect of pushing the most demanding workload even further out. It shows an under-employed workforce during the time when the other simulations have very high workloads.

Table 21: Workweek Effects of the System Dynamics Models

<table>
<thead>
<tr>
<th>System Dynamics Models</th>
<th>Maximum Workweek Required (hrs/wk)</th>
<th>Timing of Maximum Workweek (months from Jan. 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007—5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008—5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009—9 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010—2 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane Effect</td>
<td>72</td>
<td>23</td>
</tr>
<tr>
<td>Interventions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce External Fatigue</td>
<td>56</td>
<td>23</td>
</tr>
<tr>
<td>Retention of Retirement-Eligible Workers</td>
<td>59</td>
<td>23</td>
</tr>
<tr>
<td>Modified Shuttle Schedule 1</td>
<td>No overtime required</td>
<td>n/a</td>
</tr>
<tr>
<td>2007—4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008—4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009—4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010—4 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Shuttle Schedule 2</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>2007—4.5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008—4.5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009—4.5 shuttle missions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010—2.5 shuttle missions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ estimates.
The point is not to advocate for any particular simulation as a specific policy choice but to show the dynamics to which NASA and it contractors are subject in the direct relationship between fatigue and productivity and the probable consequences for the SSP given different parameters. All but one of these simulations fail to yield a level of relief required to meet SSP "fly-out" and to maintain a healthy, safe and productive workforce. The necessary reduction in worker fatigue will require multiple and diverse interventions to yield the productivity of which this population under stress is capable.

The simulations clearly show that significant overtime is required to stay on schedule under any scenario given the impact of Katrina. However, the simulations also show that the most influential leverage point within the program is changing the timing of the scheduled shuttles. By leveling the shuttle production over the remaining life of the program, overtime would not be required if all other conditions remain the same. Even a slight reduction of one half of a shuttle per year will ease overtime requirement during the next two years, which are critical for the hurricane recovery process. Both of these policies will, however, still produce 16 shuttles within the current program timing. Even modest modifications of the SSP mission schedule will yield disproportionate results in terms of reduced fatigue and concomitant productivity gains. Policies to retain aging workers and to reduce external fatigue may also prove effective in relieving overtime requirements. Specific recommendations are discussed in the next section.
VIII. Recommendations

This section builds on key findings from the analysis of information gained from focus groups, interviews, an environmental scan, and contractor employee surveys. The University of Texas research team offers a series of recommended actions for NASA and the contractor community to consider implementing at MAF and SSC. No effort has been made to estimate the cost of these recommended measures. The recommendations are organized by the primary entity that would be expected to implement or act on them.

NASA 1. Work Scheduling and Organization

Consistent with the mission of the Space Shuttle Program and its required deliverables, NASA should consider modifications to the current Shuttle Program flight schedule that will allow for completion of key tasks in an orderly and less stressful manner. Specifically, NASA should:

- Reduce the number of shuttle flights in 2007 and 2008, either by extending shuttle "fly-out" to 2011 or by reducing the number of flights in those years by one per year. Any reduction in workload during the rebuilding and recovery process from Hurricane Katrina would alleviate pressure on contractor workforces by lessening mandatory overtime, worker fatigue, and attrition. The shuttle schedule has been modified in recent years, and the U.S. Government Accountability Office and others have urged NASA to consider reducing the number of annual shuttle flights. An extension in the "fly-out" period also would reduce the gap in contractor tasks between the end of the SSP and the start of the new Orion CEV program, another issue that has been raised by space program analysts and Congress.

- Permit contractors greater flexibility to modify work procedures, such as telecommuting and varied work schedules (for instance, staggered start and stop times and four-day work weeks), to minimize lost productivity and work/family stresses due to extended commuting times caused by civil infrastructure damaged by the hurricane. This appears to be a bigger issue at Michoud than at Stennis.

NASA 2. Contracting and Job Uncertainty

NASA should engage in a comprehensive communication strategy to provide greater transparency and keep contractor employees better informed about its plans for the current and future Space Program and the impacts on and prospects and opportunities for employees in the
NASA contractor community. The combined effects of Katrina and its aftermath and changes to the Shuttle Program have generated enormous, sometimes unbearable uncertainty for these workers in the Gulf Coast region. Uncertainty leads to stress, which can produce fatigue and adverse impacts on safety and productivity. NASA should actively seek to communicate better with its contractors and their employees to counteract this situation.

**NASA 3. Reduction of Paperwork and Bureaucracy, and Communication Improvements**

Working with contractors and auditors, NASA should review policies and procedures for establishing and communicating operational and administrative requirements, approvals, and personnel and other changes. The purpose of the review is to minimize redundant or unnecessary paperwork and other requirements, and to make sure all contractor employees are fully informed of, prepared for, and able to carry out critical tasks in a timely and efficient manner.

**NASA 4. Internal Awareness and Communications**

A continued awareness of the ongoing impact of the hurricane and related job stresses on households and communities is a necessary overall strategy. In addition to this report and the project as a whole, NASA and contractors should continue to develop effective communications strategies (such as newsletters, releases, forums, surveys, etc.) that both deliver information about the Program, its schedule, contracting conditions, and employment, as well as collect feedback about personal, program, and workplace issues. In the first few weeks and months immediately following Katrina, employees reported in focus groups that NASA and the contractors were very aggressive about scheduling morale- and community-building events to support employees. One year later, however, during a time period in which EAP experts say that the stress and strain of coping with a disaster like Katrina actually peaks, the frequency of community-building events at both facilities has tapered off.

**NASA 5. External Community Involvement and Advocacy**

Both Stennis and Michoud are considered valuable community assets that drive high-skill, high-wage employment and economic development in the surrounding areas. NASA and its contractors should use their position, power, and influence in the community and with
federal, state, and local government officials to advocate and demand accountability for prioritized, rapid, orderly, and sustained improvements in community infrastructure and that address the critical issues identified by their workers.

Employers/Contractors 1. Compensation

Contractors should take whatever steps they can and also urge NASA to consider **meaningful changes to employee net compensation** to address the rising cost-of-living in the Gulf Coast region and help them recruit and retain critical talent in local and national labor markets. In particular, NASA’s SSP contractors should:

- Negotiate an aggressive increase in salary across the board to help employees keep pace with the rising cost-of-living along the Gulf Coast;
- Consider implementing site- rather than just employer-based eligibility for critically important retirement and insurance benefits;
- Consider instituting a Gulf Coast housing subsidy for SSP contractor employees;
- Examine options for creating a retraining benefit or services for workers facing job losses at or near the end of the SSP;
- Revisit the retention incentives and bonuses provided for government and contractor employees in the Air Force’s Titan Program, including providing additional years of service to the retirement formula for employees who stay on the job through mission “fly-out.” As indicated in the simulations, reducing the retirement rate in the immediate future can have a substantial effect in reducing the required workweek and thus employee stress.

Employers/Contractors 2. Manpower, Education and Training Improvements

Working closely with NASA, contractors should:

- **Review current and future expected work requirements** to determine optimal staffing levels given the aggressive SSP production schedule and safety imperatives;
- **Complete a comprehensive staffing, compensation/benefits, promotion, and training plan** that reduces mandatory overtime, accounts for natural attrition and anticipated retirements, addresses retirement and health benefit concerns, and provides adequate skill-based capacity.

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143 Some of the recommended actions in this part have parallels for civil servants in the NASA Workforce Flexibility Act of 2004.
• **Develop ongoing relationships with the region’s education, employment and training institutions** (e.g., area colleges and universities, workforce boards) to create and maintain a robust “pipeline” for growing and keeping the workforce skills they need locally. The current “pipeline” is haphazard, and the relationships with these institutions are largely shallow. In part, these contractors, as major regional employers, can help to invigorate the local education and training systems and contribute positively to the region’s recovery and future economic development.

• **Hire temporary workers** as needed and feasible to address current work backlogs.

Such a review and plan would reduce scheduling and delivery bottlenecks and prevent delays. Specialized training should be consistent with the required new and ongoing skill sets identified in the plan. Key operational positions should be the critical focus of this review, but administrative and support positions should also be considered.

**Employers/Contractors 3. Workplace Environment and Morale/ Productivity**

In the months immediately after Hurricane Katrina, NASA and its contractors responded with great compassion and granted noteworthy flexibility to its workforce as they adapted to a very difficult and unprecedented situation. In conjunction with the manpower and training improvements outlined above, contractors should **review their human resource policies and practices for consistency and fairness** and should extend flexibility in the application where needed to allow employees to conduct necessary personal business without fear of formal or informal reprisals.

• Any such modifications to these provisions should **include a “sunset” feature** to allow for formal reconsideration/modification as conditions necessitate.

• Contractors should also **conduct a function inventory of general and specialized workplace equipment, business/office tools, and facilities** to make sure they are in good condition and sufficient for the demands of the schedule, follow industry standards for safety and preventative/corrective maintenance, and are available for new employees immediately upon hiring so new workers can be trained and equipped in a timely manner.

• As the USGAO 2005 has suggested, NASA contractors should **include employee retention strategies as a contract requirement**.
Employers/Contractors 4. Safety

Contractors should carefully and thoroughly review the safety environment to ensure that actual practices comply with stated policies and procedures, without overly burdening work processes. Worker comments in focus groups and survey suggest that work-site safety is increasingly an issue in Katrina's aftermath. Contractors should assess whether and the degree to which the issues identified in the Key Issues and Impacts section of this report are or maybe contributing to safety lapses and an increase in safety risks of the Program to workers at the facilities, to astronauts, and to the public. This is clearly an area that cannot be taken too seriously.

Employers/Contractors 5. Transportation and Commuting Options

Employers should consider strategies to relieve or offset the costs and lost time associated with excessively long commutes. Several focus group participants noted the value of a company-arranged shuttle bus that once ran from Baton Rouge to these facilities, stating that the time spent on the buses not only relieved workers from the stress of dealing with traffic, but also provided them with time to arrange for repairs on their homes, communicate with displaced family members, and other important personal matters. Contractors should consider reinstating free or fare-based shuttle bus options serving employees living in certain concentrated regions. This may require an employee survey to identify likely locations and to gauge interest in such an option. Additionally, work options such as telecommuting and varied work schedules (such as staggered start and stop times and 4-day work weeks) may be deployed to minimize lost time due to commuting.

Employers/Contractors 6. Employee Assistance Programs (EAP)

Contractors have apparently relied upon valuable traditional EAP offerings and Katrina-related services for their workers. The recent offering of U.S. Navy services to employees at the Stennis Center is an encouraging development. However, the lingering effects of Katrina and very slow pace of recovery in the region suggest that more can be done. Although an independent review of the quality and accessibility of these programs is beyond the scope of this report, contractors should undertake a review of EAP offerings effectiveness in meeting the extraordinary and ongoing needs of their workforce. In addition
to continuing and extending traditional EAP programs such as counseling, workshops, and referrals, contractors should consider customized offerings and strategies that comport with the time and family demands of workers and that address particularly stubborn issues such as housing (both obtaining new housing and repairing/reconstructing existing housing), casualty insurance, education/day care services, transportation, working with government agencies and regulations. Strategies might include business referral services, negotiated group discounts, and ombudsman services.
IX. Concluding Observations

This section offers concluding observations from the University of Texas at Austin team’s research into the economic and workforce impacts of Hurricane Katrina, the aging workforce and other factors on NASA’s Space Shuttle Program in the Gulf Coast region.

Observations

In addition to the trends, issues and recommendations that have been outlined in the earlier sections, several observations are noteworthy.

First, no one single factor is leading to adverse impacts on the Space Shuttle Program’s capacity to successfully and safely "fly-out" the program by September 2010. Rather, a complex, dynamic array of interacting forces is doing so. Hurricane Katrina’s effects have been serious and enduring, and they are coming hard on the heels of stresses stemming from the Columbia disaster and its ongoing investigation, the recently announced ten-year truncation of the Shuttle Program itself, the continued aging of the contractor workforce and other factors. Addressing the situation effectively and systemically will necessarily entail a number of related responses on the part of all of the key actors, including NASA, the contractors, employee unions and associations, and leaders from the wider community.

Second, Hurricane Katrina’s effects are truly unimaginable for anyone who has not actually experienced them. Residents suffered through the storm, which was horrible enough, but they have had to continue dealing with its aftermath every single day since. The effects clearly are not abating for the foreseeable future, which makes them that much harder to bear. Roads, schools, hospitals, utilities and housing—the very basics in life that everyone simply takes for granted—are still not back to capacity in the region. Neither are the amenities such as restaurants, movie theaters, malls and beaches that make life pleasant on a day-to-day basis. NASA’s and the contractors’ workforces are continuing to meet the SSP schedule, whether testing SSMEs or assembling ETs, despite having to live in such difficult conditions.

Third, the uncertainty that the SSP workforce is grappling with remains a very serious issue to the present. Recent announcements about space exploration contracts for the
Constellation Program with its contractors/employers notwithstanding, for many of the workers at Michoud and Stennis it is not at all clear whether they and their particular skill sets will be required once the Space Shuttle Program ends in 2010. For workers in their late 40s or 50s who are not yet eligible to retire from their current employer, this uncertainty is especially troubling. Unlike many workers in the U.S. who have become accustomed to dealing with the ups and downs of market forces and who may have worked for an ever-changing list of employers in recent decades, workers at Michoud in particular have largely been insulated from these realities—until now. Confronting such realities in the best of times is painful. In hard times such as those in the Gulf Coast, they can be terrifying.

Fourth, the SSP workforce is unabashedly passionate about the program and their role in it. They are committed to carrying out their work on the shuttle well and on time, almost no matter what the personal cost. This passion and commitment is an enormous asset to the space program, but it is unlikely that it is sufficient to carry NASA and SSP far enough without exacting too high a price. The intense strain these workers are under came through loud and clear in the interviews and focus groups, in which several workers broke down in tears while recounting their experiences. As one supervisor noted, “Several of my workers are about to snap.” The employee survey results bear out both employees’ abiding commitment to the Shuttle Program and the difficulties they endure to remain part of it. It would behoove NASA and its contractors to take action to address these issues through a variety of strategies so that workers can meet the program’s goals can be met while balancing vitally important work and family demands.

Finally, although some of the forces affecting the Gulf Coast, e.g., Katrina, are highly unusual, the strategies recommended for addressing them are not. In fact, between NASA and the U.S. military, many of these strategies—e.g., added compensation, modified schedules, retention bonuses, retirement incentives—are now quite commonplace and well within the scope of traditional government/contractor responses for such large and important national programs.
X. Bibliography


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--. "Interview Notes—Stennis Site Visit: AGT." 2006.

--. "Interview Notes—Stennis Site Visit: Jacobs." 2006.

--. "Interview Notes—Stennis Site Visit: MSS." 2006.

--. "Interview Notes—Stennis Site Visit: PWR." 2006.


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Appendix A: NASA Contractor Interview Guide

INTRODUCTION & PURPOSE
My name is __________ and I’m with the Ray Marshall Center/IC² Institute at the University of Texas at Austin. We’re conducting a study for NASA to determine the economic and workforce impacts of Hurricane Katrina and other factors on the Space Shuttle Program’s ability to successfully achieve its mission by 2010.

The members of our research team here today are: [introduce]. This interview should take about an hour. Thanks for sharing your time and insights with us.

THE STUDY IN BRIEF
This interview is part of the larger study that includes interviews with administrators and staff from NASA, contractors, business and civic leaders; focus groups with contractor workers at various levels of two NASA facilities; online surveys of workers and their spouses; and collection of relevant data and documents. The end result will be reports to NASA/JSC in late September 2006 and mid December 2006 providing major findings and recommendations. Texas A&M University is conducting a parallel study for NASA.

We’re interested in both external and internal factors affecting the Space Shuttle mission and have a series of questions to ask you about these. We also want to gather any data, documents, reports, etc. and obtain additional contacts that you think might be helpful to us in conducting our study.

INTERVIEWEE NAME, TITLE, ORGANIZATION & AREA(S) OF RESPONSIBILITY
Name & Title:
Organization:
Areas of Responsibility:
Contact Information:

I. FACILITY & WORKFORCE OVERVIEW
1.1 What role does [Stennis/Michoud] play in the space program? Key tasks performed? Products/services provided? Timing/phasing of this work?
1.2 How many employees typically carry out this work? Regular v. contract workers? Full- v. part-time?
1.3 What tasks do they perform? At what skill levels?
1.4 Worker education, certification and skill requirements?
1.5 What are their pay ranges?
1.6 Typical rates of employee turnover, by skill/employee level? Jobs/tasks that are more difficult to keep filled than others?
1.9 Do your workers reside more in certain communities than others? Explore.
1.8 What is likely to be the status of your facility/workforce post-2010?

II. **KEY ISSUES AFFECTING THE SSP MISSION LOCALLY**

2.1 Biggest issues affecting your ability to fulfill your role in the Space Program and its mission, i.e., 3-4 missions/year from now to Sept. 2010 “fly-out”?

2.2 Some more important in the near-term v. longer-term?

2.3 Role of Hurricane Katrina and its recovery played (external factors)? Explain.

2.4 Facility/workforce-specific factors (internal) factors—e.g., aging of the workforce, normal turnover, etc.—having adverse effects? Explain.

2.5 Some levels/positions/tasks bigger concerns than others?

2.6 What share of the workforce returned post-Katrina?

III. **COMPANY POLICY**

3.1 Hiring bonuses?

3.2 Retention policies?

3.3 Transfer policies, to other company/NASA facilities?

3.4 Tracking mechanisms in place? Patterns for hiring/transfer/retention?

3.5 Training provided, in-service and externally?

3.6 Succession planning within company/program?

IV. **RESPONSE TO KATRINA**

4.1 The company’s response to Katrina, then and now?

4.2 Organized efforts to help employees/families?

4.3 The community’s response to Katrina, then and now?

4.4 Organized efforts to help employees/families?

4.5 Are there any active employee support/recovery groups? If so, how can we contact them?

V. **SUPPLIER RELATIONSHIPS**

5.1 Are there any bottlenecks in the supply chain that could impact success? If so, where and what kind?

5.2 Which suppliers should we definitely contact?

5.3 Are there any local industry work groups, perhaps through the Chamber of Commerce, that may have information on workforce challenges from a broad perspective?

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VI. POSSIBLE SOLUTIONS

6.1 What might make a difference in overcoming the identified challenges?
6.2 What solutions are already being considered by the contractor organization? What solution strategies are already being implemented?
6.3 What solution strategies have been used in the past to address workforce challenges?

VII. WRAP-UP

7.1 What employee associations/unions are active at the facility? How can we get in contact with the leadership of these organizations?
7.2 Which community leaders/organizations are active in the recovery, particularly in communities with significant concentrations of Michoud/Stennis employees? Contact information?
7.3 We’ve talked about a lot of different topics today. We would like to follow-up this conversation with a review of relevant documents—we can either wait for these now, or you can send them by mail/email at your convenience.

Documents requested may include:

- Company policy and HR documents (orientation materials, newsletters, etc)
- Job descriptions
- Workforce summary data
- Contact information for other key informants/organizations

7.4 Finally, what dates are available in August-September for scheduling the focus groups and survey?
7.5 Would it be possible to schedule mixed-contractor focus groups?

Thank you very much for meeting with us today. We appreciate the insight you’ve been able to provide on the workforce challenges [NASA/contractor] faces to meet the Space Shuttle Program’s mission. If you think of anything that may be relevant to the study, please do not hesitate to contact us. We also hope to talk with you again as our research progresses in order to get your perspective on issues we’ve identified and other findings.
Appendix B: NASA Focus Group Protocol

Introduction

NASA has contracted with the University of Texas at Austin and Texas A&M University to conduct independent assessments of the economic and workforce impacts of Hurricane Katrina and ongoing demographic changes on the Space Shuttle Program, focusing on NASA contractors and their employees at both the Stennis and Michoud facilities.

The project involves focus group sessions, employee and spouse surveys, field interviews and other research designed to produce recommended strategies for addressing any current or projected adverse economic and workforce impacts.

Purpose

We are conducting focus groups this week to solicit input from representative groups of contractor managers and employees to:

- Highlight the ‘context’ of the employment situation at Michoud and Stennis;
- Identify the most pressing issues you face on your jobs and in your communities;
- Identify barriers to improving working/living conditions; and
- Identify possible solutions to these issues and barriers.

Information from these focus groups will help shape our surveys as well.

Session Logistics

Thank you for your participation. Please, speak freely and openly about your thoughts on the questions we’re about to ask.

4. What are the most pressing/urgent issues you face working at your facility since Hurricane Katrina? Consider issues that affect your job performance or job satisfaction, your short- or long-term career plans, or your family situation.

5. What are the barriers to improving your job performance or satisfaction, with respect to the issues you just identified?

6. Can you identify ideas or proposed initiatives that would improve your ability to work successfully at your facility and be satisfied with your job/career?

This session will last no more than 2 hours. All responses will be strictly confidential and will be summarized without identifying individual participants by name.

Feel free to call either Dr. Chris King or Tara Smith at 512/471-7891 at UT’s Ray Marshall Center if you would like more information about these sessions.
Appendix C: Selected NASA Acronyms

AGT  Applied Geo Technologies, Inc.
AL   Alabama
BLS  United States Bureau of Labor Statistics
CEV  Crew Exploration Vehicle
CPRA Coastal Protection and Restoration Authority
DHS  United States Department of Homeland Security
EAP  Employee Assistance Program
ET   External Tank
FFSC United States Navy's Fleet and Family Support Center
FL   Florida
FOS  Facility Operating Services
IAM  International Association of Machinists
ISS  International Space Station
Jacobs Jacobs-Sverdrup NTOG
JSC  Johnson Space Center (Houston, TX)
KSC  Kennedy Space Center (Cape Canaveral, FL)
LA   Louisiana
LM   Lockheed Martin
MSFC Marshall Space Flight Center (Huntsville, AL)
MAF  Michoud Assembly Facility (New Orleans East, LA)
MS   Mississippi
MSA  Metropolitan Statistical Area
MSS  Mississippi Space Services
NO   New Orleans
NTOG NASA Test Operations Group
PMEL Precision Metrology
PWR  Pratt & Whitney Rocketdyne
SSC  John C. Stennis Space Center
SSME Space Shuttle Main Engine
SSP  Space Shuttle Program
UAW United Automobile, Aerospace and Agricultural Implement Workers of America
Appendix D: NASA Contractor Employee Survey—Time 1

The following questions are about your **employer/contractor**. Please use the scale provided below to indicate the extent to which you agree with the following statements.

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<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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1. I would be very happy to spend the rest of my career with my employer/contractor.
2. I really feel as if my employer/contractor’s problems are my own.
3. I do not feel a strong sense of belonging to my employer/contractor.
4. I do not feel emotionally attached to my employer/contractor.
5. I do not feel like part of the family at my employer/contractor.
6. My employer/contractor has a great deal of personal meaning for me.
7. I feel that I have too few options to consider leaving my employer/contractor.
8. One of the few negative consequences of leaving my employer/contractor would be the scarcity of available alternatives.
9. What keeps me working at this company is the lack of opportunities elsewhere.
10. I have invested too much time in my employer/contractor to consider working elsewhere.
11. Leaving my employer/contractor now would require considerable personal sacrifice.
12. For me personally, the costs of leaving my employer/contractor would be far greater than the benefits.
13. I would not leave my employer/contractor because of what I would stand to lose.
14. If I decided to leave my employer/contractor, too much of my life would be disrupted.
15. I continue to work for my employer/contractor because I don’t believe another employer/contractor could offer the benefits I have here.

The following questions are about **NASA**. Please use the scale provided below to indicate the extent to which you agree with the following statements.

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<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
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16. I would be very happy to spend the rest of my career with NASA.
17. I really feel as if this NASA’s problems are my own.
18. I do not feel a strong sense of belonging to NASA.
19. I do not feel emotionally attached to NASA.
20. I do not feel like part of the family at NASA.
21. NASA has a great deal of personal meaning for me.

The following questions ask you about your **employer/contractor**. Please use the scale provided below to indicate the extent to which you agree with the following statements.

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<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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16. I would be very happy to spend the rest of my career with NASA.
17. I really feel as if this NASA’s problems are my own.
18. I do not feel a strong sense of belonging to NASA.
19. I do not feel emotionally attached to NASA.
20. I do not feel like part of the family at NASA.
21. NASA has a great deal of personal meaning for me.
1. My employer/contractor really cares about my well-being.
2. My employer/contractor strongly considers my goals and values.
3. My employer/contractor shows little concern for me.
4. My employer/contractor cares about my opinions.
5. My employer/contractor is willing to help me if I need a special favor.
6. Help is available from my employer/contractor when I have a problem.
7. My employer/contractor would forgive an honest mistake on my part.
8. If given the opportunity, my employer/contractor would take advantage of me.

The following questions are about the support you receive from your supervisor. Please use the scale provided below to indicate the extent to which your supervisor does the following things.

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<tbody>
<tr>
<td>Never</td>
<td>Rarely</td>
<td>Infrequently</td>
<td>Sometimes</td>
<td>Frequently</td>
<td>Almost Always</td>
<td>Always</td>
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9. How often does s/he really listen to you when you talk about your concerns or problems?
10. How often do you feel that s/he is really trying to understand your problems?
11. How often does s/he try to take your mind off your problems by telling jokes or chattering about other things?
12. How often does s/he make you feel really cared about?
13. How often does s/he help you in practical ways, like doing things for you or lending you money?
14. How often does s/he answer your questions or give you advice about how to solve your problems?
15. How often can you use her/him as an example of how to deal with your problems?

The following statements refer to NASA. Please use the scale provided below to indicate the extent to which you agree with these statements.

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<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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16. I believe NASA has high integrity.
17. NASA is not always honest and truthful.
18. In general, I believe NASA’s motives and intentions are good.
19. I am not sure I fully trust NASA.

The following statements refer to your employer/contractor. Please use the scale provided below to indicate the extent to which you agree with these statements.

1 | 2 | 3 | 4 | 5 | 6 | 7

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Please use the scale provided to indicate to what extent you agree with the following statements.

1. I believe my employer/contractor has high integrity.
2. I can expect my employer/contractor to treat me in a consistent and predictable fashion.
3. My employer/contractor is not always honest and truthful.
4. In general, I believe my employer/contractor’s motives and intentions are good.
5. I don’t think my employer/contractor treats me fairly.
6. My employer/contractor is open and upfront with me.
7. I am not sure I fully trust my employer/contractor.

Please use the scale provided to indicate to what extent you agree with the following statements.

8. I have been able to express my views and feelings during those procedures.
9. I have had influence over the (outcome) arrived at by those procedures.
10. Those procedures have been applied consistently.
11. Those procedures have been free of bias.
12. Those procedures have been based on accurate information.
13. I have been able to appeal the (outcome) arrived at by those procedures.
14. Those procedures have upheld ethical and moral standards.

The following items refer to the outcomes you receive at work (e.g., pay, bonus, benefit, awards, praise, promotion, paid-day off, etc.). To what extent do you agree with the following statements:

15. My outcome reflects the effort I have put into my work.
16. My outcome is appropriate for the work I have completed.
17. My outcome reflects what I have contributed to the employer/contractor.
18. My outcome is justified, given my performance.

Please use the scale provided to indicate to what extent you agree with the following statements.

The following items refer to your supervisor.

1. My supervisor treats me in a polite manner.
2. My supervisor treats me with dignity.
3. My supervisor treats me with respect.
4. My supervisor refrains from improper remarks or comments.
5. My supervisor has been candid in his/her communications with me.
6. My supervisor explained the procedures thoroughly.
7. My supervisor’s explanations regarding the procedures were reasonable.
8. My supervisor has communicated details in a timely manner.
9. My supervisor seems to tailor his/her communications to individuals’ specific needs.

**Please answer the following questions about yourself.**

In the past 24 hours, I have discussed my feelings about things that happened to me at work with: (Please check all that apply)

- a. no one
- b. my spouse/romantic partner
- c. a relative
- d. a friend
- e. my coworker
- f. my supervisor
- g. EAP (employee assistance program)
- h. other (please specify who______________________________)

Please use the scale provided below to indicate the extent to which you agree with the following statements.

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<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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</table>

1. I often think about quitting my job.
2. I will probably look for a new job in the next year.

Please answer the following questions about your perceived job opportunities:

1. How difficult do you think it would be for you to obtain new employment? *(circle one)*

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<tbody>
<tr>
<td>Extremely difficult</td>
<td>Difficult</td>
<td>Slightly Difficult</td>
<td>Average</td>
<td>Slightly easy</td>
<td>Easy</td>
<td>Extremely Easy</td>
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2. Give your best estimate of your present alternative employment opportunities *(circle one)*

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<th>6</th>
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<tbody>
<tr>
<td>No opportunities</td>
<td>Almost no opportunities</td>
<td>Few opportunities</td>
<td>Some opportunities</td>
<td>Several opportunities</td>
<td>Many opportunities</td>
<td>Very many opportunities</td>
</tr>
</tbody>
</table>

Please indicate the extent to which you agree or disagree with each of the following statements:
1. I am satisfied with the way that my employer responded to Hurricane Katrina.
2. My employer took care of its employees’ needs resulting from Hurricane Katrina.
3. My employer did everything that it should have in response to Hurricane Katrina.
4. I will be able to keep my present job as long as I wish.
5. I am confident that I will be able to work for my employer/contractor as long as I wish.
6. My job will be there as long as I want it.
7. I am secure in my job.

In general, how significant or important is your job? That is, are the results of your work likely to significantly affect the lives or well-being of others?

1. My job is one where a lot of other people can be affected by how well the work gets done.
2. The job itself is not very significant or important in the broader scheme of things.

Please use the scale provided below to indicate the extent to which you agree with the following statements.

1. The most important things that happen in life involve work.
2. Work is something people should get involved in most of the time.
3. Work should be only a small part of one’s life.
4. Work should be considered central to life.
5. In my view, an individual’s personal life goals should be work-oriented.
6. Life is worth living only when people get absorbed in work.

Please use the scale below to answer the following questions about your work load.

1. Never
2. Sometimes
3. Always
BEFORE HURRICANE KATRINA,
7. How often did your job require you to work very fast?
8. How often did your job require you to work very hard?
9. How often did your job leave you with little time to get things done?
10. How often was there a great deal to be done?
11. How often were you required to work overtime?

AFTER HURRICANE KATRINA,
12. How often does your job require you to work very fast?
13. How often does your job require you to work very hard?
14. How often does your job leave you with little time to get things done?
15. How often is there a great deal to be done?
16. How often are you now required to work overtime?

17. How many hours per week do you usually spend at the office? ______ hours per week
18. How many hours per week do you want to spend at the office? ______ hours per week

Please use the scale provided below to indicate the extent to which you agree with the following statements.

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<thead>
<tr>
<th></th>
<th>Strongly</th>
<th>2</th>
<th>Disagree</th>
<th>3</th>
<th>Slightly</th>
<th>4</th>
<th>Neither Agree</th>
<th>5</th>
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<th>6</th>
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<tr>
<td>1</td>
<td>Disagree</td>
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<td>Disagree</td>
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1. A great satisfaction in my life comes from my role(s) in my personal/family life.
2. For me, my “off-work” days really fly by.
3. I am very much involved personally with my friends and family members’ lives.
4. I would be a less fulfilled person without my role(s) in my personal and family life.
5. The most important things that happen to me are related to my personal and family roles.
6. Nothing is as important as being a good friend or family member.
7. I really love the place where I live.
8. I like the family-oriented environment of my community.
9. This community I live in is a good match for me.
10. I think of the community where I live as home.
11. The area where I live offers the leisure activities that I like (e.g., sports, outdoors, cultural, arts).
12. My job utilizes my skills and talents well.
13. I feel like I am a good match for this employer/contractor.
14. I feel personally valued by this employer/contractor.
15. I like my work schedule (e.g., flextime, shift).
16. I fit with this employer/contractor's culture.
17. I like the authority and responsibility I have at this company.
18. My family roots are in the community where I live.
19. Leaving this community would be very hard.
20. People respect me a lot in my community.
21. My neighborhood is safe.
22. I have a lot of freedom on this job to decide how to pursue my goals.
23. The perks on this job are outstanding.
24. I feel that people at work respect me a great deal.
25. I would incur very few costs if I left this employer/contractor.
26. I would sacrifice a lot if I left this job.
27. My promotional opportunities are excellent here.
28. I am well compensated for my level of performance.
29. The benefits are good on this job.
30. I believe the prospects for continuing employment with this company are excellent.

1. There are many people who believe that different groups enjoy different amounts of social status in society. You may not believe this for yourself, but if you had to rate each of the following groups as most people see them, how would you do so? Use the following scale to record your answer. Do not skip any statement.

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</thead>
<tbody>
<tr>
<td>Low Status</td>
<td>Neither Low nor High Status</td>
<td>High Status</td>
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</tbody>
</table>

_____Applied Geo Technologies (AGT)
_____Jacobs/Sverdrup
_____Lockheed Martin
_____NASA
_____Pratt & Whitney Rocketdyne

Please answer the following question about your Employee Assistance Program

Please circle one to indicate the extent to which you agree with the following statement.

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</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

1. I have adequate access to the Lockheed Martin/Michoud/Stennis operations employee assistance program.

**Background Information:**

1. What is your gender? (circle one) Female  Male
2. What is your age? (circle one)
   a. 24 and under
b. 25-34

c. 35-44

d. 45-54

e. 55 and over

3. What is your ethnicity? *(circle one)*
   a. Caucasian (non-Hispanic)
   b. Hispanic
   c. African American
   d. Asian American
   e. Native American
   f. Other ____________________

4. What is your highest education level? *(circle one)*
   a. Didn’t finish high school
   b. GED
   c. High school education
   d. Some college education
   e. College degree
   f. Graduate degree (e.g., MA, MBA, MS, PhD)
   g. Other (Please specify ____________)

5. Where did you spend the majority of your childhood?
   City __________________________ State _____ Zip Code __________

6. What is your marital status? *(circle one)*
   Married  Single  Divorced  Separated  Other: ____________

7. If you have a significant other, was he/she employed before Hurricane Katrina? *(circle one)*
   Yes  No
   If yes, what was his/her occupation? ________________________

8. If you have a significant other, has his/her employment situation changed since Hurricane Katrina? *(circle one)*
   Yes  No
   If yes, how has their employment situation changed? ________________________

9. If you have a significant other, where did he/she spend the majority of his/her childhood?
   City __________________________ State _____ Zip Code __________

10. How many children under 18 years old do you have? ____________

11. How many children in college are you supporting? ____________

12. If you have a significant other, were they living with you before Hurricane Katrina? *(circle one)*
   Yes  No
   If no, where did he/she live? ________________________________

13. If you have a significant other, are they living with you now? *(circle one)*
   Yes  No
   If no, where does he/she live? ________________________________

14. If you have children, were your children living with you before Hurricane Katrina? *(circle one)*
   Yes  No
15. If you have children, are your children living with you now? (circle one)  Yes  No
If no, where do they live? __________________________________
How long has your family lived there? ______________________

16. What is your job title in this employer/contractor?
_________________________________

17. How long have you been in your present position?  (years)
18. How long have you worked for this employer/contractor?  (years)
19. How long have you worked in this industry?  (years)
20. How long have you worked at this facility?  ______ (years)
21. How many coworkers do you interact with regularly?
22. How many coworkers are highly dependent on you?
23. How many work teams are you on?
24. How many work committees are you on?
25. Including income from all sources, such as wages, salaries, investment income, income from social security and retirement benefits, help from relatives, and so forth, what is the total income of your household before taxes:

**Pre Hurricane Katrina? (July, 2005)**  **Post Hurricane Katrina (now)**
(circle one)  (circle one)
a. $1,199/month or below  [~ $7.50/hr 40hrs/wk]  a. $1,199/month or below  [~ $7.50/hr 40hrs/wk]
b. $1,200 to $2,399  [~up to $15/hr]  b. $1,200 to $2,399  [~up to $15/hr]
c. $2,400 to $3,999  [~up to $25/hr]  c. $2,400 to $3,999  [~up to $25/hr]
d. $4,000 to $6,399  [~up to $40/hr.]  d. $4,000 to $6,399  [~up to $40/hr.]
e. $6,400 or above  [over $40/hr]  e. $6,400 or above  [over $40/hr]

26. How satisfied are you with the pension plan provided by this employer/contractor? (circle one)

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</thead>
<tbody>
<tr>
<td>Strongly Dissatisfied</td>
<td>Dissatisfied</td>
<td>Slightly Dissatisfied</td>
<td>Neither Satisfied nor Satisfied</td>
<td>Slightly Satisfied</td>
<td>Satisfied</td>
<td>Strongly Satisfied</td>
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</table>

27. If you have a pension, estimate the percentage your pension is vested: _____
28. If your pension is not completely vested, estimate the years until your pension is fully vested.  _____ (years)
29. Choose the option that best describes your living situation before Hurricane Katrina (circle one)
   a. A house you owned
   b. An apartment or condo you owned
   c. A mobile home you owned
   d. A house you rented
   e. An apartment or condo you rented
30. In what parish did you live before Hurricane Katrina?  

31. What was your zip code before Hurricane Katrina?  

32. Has your living situation changed since Hurricane Katrina?  (circle one)  Yes      No  
   If yes, how has it changed?  
   In what parish do you live now?  
   What is your current zip code?  

33. If you do not live in the same neighborhood as before Hurricane Katrina, would you say that you will:
   (circle one)  
   a. Definitely move back  
   b. Probably will move back  
   c. Probably will not move back  
   d. Definitely will not move back  

34. Did you attend one of the focus groups conducted by The University of Texas and Texas A&M?  
   (circle one)  Yes      No  

35. Are you dues paying member of the union?  (circle one)  Yes      No  

For each of the following questions, please fill in your answers in the box provided.

1.  Most people who lived through Katrina have practical problems—like dealing with insurance issues, finding a permanent place to live, and the like. What would you say are currently your most serious practical problems caused by Katrina?

2.  What practical actions would you say your EMPLOYER/CONTRACTOR could do right now that would be the MOST HELPFUL to you in dealing with the effects of Hurricane Katrina?
3. What practical actions would you say your SUPERVISOR could do right now that would be the MOST HELPFUL to you in dealing with the effects of Hurricane Katrina?

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4. What practical actions would you say NASA could do right now that would be the MOST HELPFUL to you in dealing with the effects of Hurricane Katrina?

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5. List the top three onsite services that could be provided to improve working conditions at your facility.

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Appendix E: NASA Contractor Employee Survey—Time 2

Please answer the following questions honestly. Keep in mind that there is no right or wrong answers. Also, don’t spend too much time on any one question. Often, your first reaction is the best response.

Please use the scale provided to indicate to what extent you agree with the following statements.

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<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
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The following items refer to the **outcomes/rewards** you receive at work (e.g., pay, bonus, benefit, awards, praise, promotion, paid-day off, etc.).

1. My outcomes/rewards reflect the effort I have put into my work.
2. My outcomes/rewards are appropriate for the work I have completed.
3. My outcomes/rewards reflect what I have contributed to the employer/contractor.
4. My outcomes/rewards are justified, given my performance.

The following items refer to the **procedures** used to arrive at the outcomes you receive at work (e.g., pay, bonus, benefits, awards, praise, promotion, paid-day off, etc.).

5. I have been able to express my views and feelings during those procedures.
6. I have had influence over the (outcome) arrived at by those procedures.
7. Those procedures have been applied consistently.
8. Those procedures have been free of bias.
9. Those procedures have been based on accurate information.
10. I have been able to appeal the (outcome) arrived at by those procedures.
11. Those procedures have upheld ethical and moral standards.

The following items refer to **your supervisor**.

12. My supervisor seems to tailor his/her communications to individuals’ specific needs.
13. My supervisor communicates details in a timely manner.
14. My supervisor is quite competent in doing his/her job.
15. My supervisor’s explanations regarding procedures are reasonable.
16. My supervisor treats me with dignity.
17. My supervisor shows too little interest in the feelings of subordinates.
18. My supervisor treats me with respect.
19. My supervisor has been candid in his/her communications with me.
20. I like my supervisor.
22. My supervisor treats me in a polite manner.
23. My supervisor refrains from improper remarks or comments.
24. My supervisor is unfair to me.
25. Hurricane Katrina has impacted how my supervisor treats me.
26. My supervisor’s demeanor has changed after Hurricane Katrina.
Using the following scale, in the past twelve months, how often have you:

1. Thought about being absent.
2. Chatted with co-workers about non-work topics.
3. Left your work station for unnecessary reasons.
4. Spent time daydreaming.
5. Spent work time on personal matters.
6. Put less effort into the job than should have.
7. Thought about leaving your current job.
8. Let others do your work.
9. Left work early without permission.
10. Taken longer lunch or rest breaks than allowed.
11. Taken supplies or equipment without permission.
12. Fallen asleep at work.
13. Been absent from work for health reasons.
14. Been absent from work for reasons related to recovery from Hurricane Katrina.
15. Felt guilty for missing work.

Please indicate how you generally feel at work using the following scale:

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<tbody>
<tr>
<td>Never</td>
<td>Sometimes</td>
<td>Tense</td>
<td>Worried</td>
<td>Frustrated</td>
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Please use the scale provided to indicate how satisfied you are with your coworkers (i.e., all of your coworkers on the whole).

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</thead>
<tbody>
<tr>
<td>Strongly Dissatisfied</td>
<td>Dissatisfied</td>
<td>Slightly Dissatisfied</td>
<td>Neither Satisfied nor Dissatisfied</td>
<td>Slightly Satisfied</td>
<td>Satisfied</td>
<td>Strongly Satisfied</td>
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</table>

20. The way you are treated by your coworkers.
21. The respect you receive from your coworkers.
22. The friendliness of your coworkers.

Please indicate how you generally feel at work using the following scale:

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<tbody>
<tr>
<td>Never</td>
<td>Sometimes</td>
<td>Tense</td>
<td>Worried</td>
<td>Frustrated</td>
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23. I feel emotionally drained from my work.
24. I feel burned out from my work.
25. I feel exhausted when I think about having to face another day on the job.
These questions are about how satisfied or dissatisfied you are with the following conditions at work.
Please use the following scale to answer the questions.

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<tbody>
<tr>
<td>Strongly</td>
<td>Dissatisfied</td>
<td>Slightly</td>
<td>Neither Satisfied nor Dissatisfied</td>
<td>Slightly</td>
<td>Satisfied</td>
<td>Strongly</td>
</tr>
<tr>
<td>Disatisfied</td>
<td></td>
<td>Dissatisfied</td>
<td></td>
<td>Satisfied</td>
<td></td>
<td>Satisfied</td>
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</table>

1. Advancement opportunities?
2. Job/task scheduling?
3. Time constraints on the job?
4. Equipment and facilities?
5. Training and development?
6. The amount of bureaucracy within your working environment?
7. The number of workers available to accomplish work goals?
8. Safety within Lockheed Martin?
9. Training/professional development plan for my job?
10. Resources (time, funding) for me to participate in training as scheduled or to otherwise meet the demands of my job?
11. Adequate training for new employees?
12. Over the past 12 months, have you received employee-provided on-site or off-site training? (circle one) Yes  No    If yes, how many training hours? _________ Hours
13. Have you been actively seeking employment elsewhere? (circle one) Yes  No  N/A
If no, please skip to question 15.
14. If you have been actively seeking employment elsewhere, how often have you done so? (circle one)

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<th>7</th>
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</thead>
<tbody>
<tr>
<td>Rarely</td>
<td>Every several months</td>
<td>Every couple of months</td>
<td>Monthly</td>
<td>Every few weeks</td>
<td>Weekly</td>
<td>Daily</td>
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Please use the following scale to indicate the extent to which you agree with the following statements.

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<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

15. I’m often too tired at work because of the things I have to do at home.
16. My work takes up time that I’d like to spend with family/friends.
17. I often think about quitting my job because of non-work factors (e.g., community, housing).
18. I often think about quitting my job because of working conditions.
19. My family/friends dislike how often I am preoccupied with my work while at home.
20. After work, I come home too tired to do some of the things I’d like to do.
21. In general, I don’t like my job.
Please use the following scale to indicate the extent to which you agree with the following statements.

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</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

1. I do not feel in control of my success in my career.
2. Lockheed Martin provides accurate and timely communications to me regarding important project and contract issues for the space shuttle and related programs.
3. I have spent a lot of time looking for an alternative position in the last 6 months.
4. I complete tasks successfully.
5. I will probably look for a new job in the next year.
6. All in all, I am satisfied with my job.
7. I have devoted much effort to looking for other positions in the last 6 months.
8. In general, I like working here.
9. My superiors and peers dislike how often I am preoccupied with my personal life while at work.
10. My personal life takes up time that I’d like to spend working.
11. I have given my best effort to find a new position in the last 6 months.
12. On the job, I have so much to do that it takes away from my personal interests.
13. Sometimes, I do not feel in control of my work.
14. Lockheed Martin maintains good communication channels with NASA and other contractors.
15. I have focused my time and effort on job search activities in the last 6 months.
16. My personal demands are so great that it takes away from my work.
17. I often think about quitting my job.
18. I am satisfied with the pension plan provided by Lockheed Martin.

Please use the following scale to answer the next four questions.

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<th>7</th>
</tr>
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<tbody>
<tr>
<td>Extremely poor</td>
<td>Poor</td>
<td>Slightly poor</td>
<td>Average</td>
<td>Slightly good</td>
<td>Good</td>
<td>Extremely good</td>
</tr>
</tbody>
</table>

19. How was your physical health before Hurricane Katrina?
20. How was your mental health (e.g., anxiety, depression) before Hurricane Katrina?
21. How is your physical health now?
22. How is your mental health (e.g., anxiety, depression) now?

Please indicate how you generally feel using the following scale:

<table>
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<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Sometimes</td>
<td>Very Often</td>
<td></td>
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</tbody>
</table>

23. I feel emotionally drained.
24. I feel burned out.
25. I feel exhausted when I think about having to face another day.
Please use the following scale to answer the questions on this page.

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<th>1</th>
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<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Dissatisfied</td>
<td>Dissatisfied</td>
<td>Slightly Dissatisfied</td>
<td>Neither Satisfied nor Dissatisfied</td>
<td>Slightly Satisfied</td>
<td>Satisfied</td>
<td>Strongly Satisfied</td>
<td>N/A</td>
</tr>
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</table>

In the year BEFORE HURRICANE KATRINA, how satisfied were you with the following aspects of your life:

____ 1. Your financial situation?
____ 2. Your work situation?
____ 3. Your access to quality health care?
____ 4. If you have young children, your access to day care?
____ 5. If married before Hurricane Katrina: your marriage?
____ 6. If you had school-aged children before Hurricane Katrina: your child’s school?
____ 7. If you had school-aged children before Hurricane Katrina: access to quality public education?
____ 8. Your relationships with your family?
____ 9. Your friendships?
____ 10. Your leisure activities?
____ 11. Your neighborhood?
____ 12. Your access to retail stores and services in your neighborhood?
____ 13. Your life overall?

These questions are about how satisfied or dissatisfied you are with various aspects of your life NOW.

____ 14. Your financial situation?
____ 15. Your work situation?
____ 16. Your access to quality health care?
____ 17. If you have young children, your access to day care?
____ 18. If married before Hurricane Katrina: your marriage?
____ 19. If you had school-aged children before Hurricane Katrina: your child’s school?
____ 20. If you had school-aged children before Hurricane Katrina: access to quality public education?
____ 21. Your relationships with your family?
____ 22. Your friendships?
____ 23. Your leisure activities?
____ 24. Your neighborhood?
____ 25. Your access to retail stores and services in your neighborhood?
____ 26. Your life overall?
____ 27. The rebuilding/recovery process and progress within your community?
____ 28. Your own rebuilding/recovery process?
Please use the following scale to indicate the extent to which you agree with the following statements.

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<th>1</th>
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<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Slightly Disagree</td>
<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

1. I trust my local government to do its job well.
2. The quality of the services provided by local government here is poor.
3. Local government here runs smoothly.
4. I am satisfied with the way local government here is doing its job.
5. Local government here is not doing enough to provide services.
6. Local government here does a good job of meeting my needs and the needs of my family.
7. I’d like to move some place that has better public services.
8. I wish that I had settled somewhere with better public services.

Please use the following scale to indicate the extent to which you agree with the following statements.

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<td>Neither Agree nor Disagree</td>
<td>Slightly Agree</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

9. I am filled with doubts about my competence.
10. I am confident I get the success I deserve in life.
11. Overall, I am satisfied with myself.
12. I am capable of coping with most of my problems.
13. When I try, I generally succeed.
14. Sometimes when I fail I feel worthless.
15. I determine what will happen in my life.
16. There are times when things look pretty bleak and hopeless to me.
17. Sometimes I feel depressed.

Please indicate how you generally feel using the following scale.

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<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
<td>Somewhat</td>
<td></td>
<td></td>
<td></td>
<td>Very much so</td>
<td></td>
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</table>

18. I find it difficult to get up in the morning
19. Very tired in a short time (i.e., fatigue)
20. Feel nervous or fidgety and tense
21. Feel spells of dizziness
22. Have trouble sleeping at night
23. Have an upset stomach or stomach ache
24. Experience anxiety about the possibility of future hurricanes
For the following 10 questions, please fill in the correct number in the space provided.

In the months **BEFORE** HURRICANE KATRINA

1. About how many friends and relatives did you have who lived in the same parish as you, NOT counting those who live with you? ________
2. Not counting relatives, about how many people in the parish were you friendly enough with that you could borrow a cup of sugar or have them pick up your mail if you were out of town? ________
3. About how many people counted on you for emotional or practical support? ________
4. About how many people did you have whom you could talk to about your private feelings without feeling embarrassed? ________

What about now, **AFTER** HURRICANE KATRINA?

5. About how many friends and relatives do you have who live in the same parish as you, NOT counting those who live with you? ________
6. Not counting relatives, about how many people in the parish are you friendly enough with that you could borrow a cup of sugar or have them pick up your mail if you were out of town? ________
7. About how many people CURRENTLY count on you for emotional or practical support? ________
8. About how many people do you CURRENTLY have whom you could talk to about your private feelings without feeling embarrassed? ________
9. Since Hurricane Katrina, about how many NEW people have you met that you expect to continue to have as a friend? ________
10. About how many old friends have you lost track of since Hurricane Katrina? ________

11. Did you personally have any friends or relatives who were killed or seriously injured in Hurricane Katrina? *circle one*  
Yes  No

12. Did you personally have any friends or relatives who have committed suicide after Hurricane Katrina? *circle one*  
Yes  No

**Background Information:**

Finally, we have some background questions about you. *Your responses to these questions will not be used to identify you.* We ask these questions to determine if we have a good representation of employees responding to the survey.

1. Including income from all sources, such as wages, salaries, investment income, income from social security and retirement benefits, help from relatives, and so forth, what is the total income of your household before taxes:

   **Pre Hurricane Katrina? (July, 2005)** *circle one*  
   a. $1,199/month or below  
   b. $1,200 to $2,399/month  
   c. $2,400 to $3,999/month  
   d. $4,000 to $6,399/month  
   e. $6,400/month or above

   **Post Hurricane Katrina (now)** *circle one*  
   f. $1,199/month or below  
   g. $1,200 to $2,399/month  
   h. $2,400 to $3,999/month  
   i. $4,000 to $6,399/month  
   j. $6,400/month or above

2. Do you currently have a pension plan? *circle one*  
Yes  No

   If yes, is it with *circle one*:
   a. Lockheed Martin?  
   b. Your union?  
   c. Other?  

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3. If you have an employer-based pension, what percentage of it is currently vested? ______

4. How many years until your pension is fully vested or you can retire from Lockheed Martin with full pension benefits? ______ (years)

5. In your opinion, to what extent was your house damaged during Hurricane Katrina (circle one)
   
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<td>1</td>
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<tr>
<td>No</td>
<td>Minor</td>
<td>Somewhat minor</td>
<td>Significant</td>
<td>Somewhat major</td>
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6. Below, please list the most important factors that could cause you to quit working (end employment) at the Michoud facility.

____________________________________________________________________________________
____________________________________________________________________________________

7. Below, please list the most important factors in your decision to remain working (stay employed) at the Michoud facility.

____________________________________________________________________________________
____________________________________________________________________________________

******************************************************************************
If you have responded to Time 1 survey last month, you can stop here and mail the survey back to us. Thank you very much for your participation in this research project!

If you did not respond to Time 1 survey last month, please answer a few more questions below.
******************************************************************************

1. What is your gender? (circle one) Female Male

2. What is your age? (circle one)
   a. 24 and under  
   b. 25-34  
   c. 35-44  
   d. 45-54  
   e. 55-64  
   f. 65 and over

3. What is your ethnicity? (circle one)
   a. Caucasian (non-Hispanic)  
   b. Hispanic  
   c. African American  
   d. Asian American  
   e. Native American  
   f. Other __________

4. What is your highest education level? (circle one)
   a. Didn’t finish high school  
   b. GED  
   c. High school education  
   d. Some college education  
   e. College degree  
   f. Graduate degree (e.g., MA, MBA, MS, PhD)  
   g. Other (Please specify __________)

5. What is your current job title? ___________________________________________________________________________

6. How long have you been in your present position? ___(years)

7. How long have you worked for Lockheed Martin? ___(years)

8. How long have you worked at this facility? ______(years)

9. How long have you worked in this industry? ___(years)

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Appendix F: Full System Dynamics Model

Causal-Loop Diagram of Full System Dynamics Model

A causal-loop diagram of the complete system dynamics model featured in the report is shown below in Figure F.1.

Figure F.1: Causal-Loop Diagram of the Complete System Dynamics Model

The diagram above is a representation of the essential dynamic relationships in the full model.
Stock and Flow Diagrams of Full System Dynamics Model

The stock and flow diagrams (Sterman 2000) of the full model are presented below in Figures F.2 through F.6. The equations for the simulation model follow immediately after and are presented in system dynamics format from the Vensim modeling package.

Figure F.2: Work To Be Completed

Diagram showing the flow of work to be completed, including variables such as Actual Delivery Delay, Beginning Work Backlog, Work Arrival Rate, and Work to Be Done.
Figure F.3: Worker Fatigue

- Normal Fatigue Level
- Time for Fatigue to Increase
- Time for Fatigue to Decrease
- Fatigue factor
- Indicated Fatigue
- Change in Fatigue
- Average Fatigue
- Effect of Outside Factors on Fatigue
- Katrina Switch
- Fatigue in Effect

Figure F.4: Worker Hiring and Retirement

- Time to hire
- New Workers Leaving
- Experienced Leaving
- Mature Workers Retiring
- Total Experienced and Mature Workers
- Indicated Quit Rate
- Normal Attrition Rate
- Percent Attrition
- Time to Retire
- Normal Retirement Rate
- Time to Mature
- Time to Become Experienced
- Growing
- Maturing
- <Experienced Workers>
- <Mature Workers>
Figure F.5: Effect of Experience on Productivity

Percent of Full Productivity for New Worker

Starting equivalent Mature/Experienced Workers

Starting Ratio of New Workers

Starting Ratio of Experience Workers

<Beginning employment of Experienced and Mature Workers>

Figure F.6: Effect of Overtime on Productivity

Time to average

Change in Average

Average Workweek

effect of workweek on Productivity

<Indicated Work Week>
Equations Listing of Full System Dynamics Model

The equations listed below exist in a one-to-one correspondence with the stock-and-flow diagrams in Figures F.2 through F.6.

Actual Delivery Delay = Work to Be Done / Work Completion Rate

Actual hours Worked per Month = Max ( Indicated Work Week , Standard Workweek ) * 4

Annual Shuttle Schedule Table ( [(0,0)-(60,10)],(0,5),(11,5),(12,5),(23,5),(24,4),(35,4),(36,2),(47,2),(48,0) )

Average Fatigue = INTEG( Change in Fatigue , Normal Fatigue Level )

Average Workweek = INTEG( Change in Average , Standard Workweek )

Beginning employment of Experienced and Mature Workers = 100

Beginning percent within 3 years retirement = 0.3

Beginning Work Backlog = 1
Assumes a workload for 4 months of work which is on shuttle assuming 3 per year

Change in Average = ( Indicated Work Week - Average Workweek ) / Time to average

Change in Fatigue = Indicated Fatigue / Time to change Fatigue

Desired Completion Rate = zidz ( Work to Be Done , Target Delivery Delay )
Normal completion rate

Effect of Fatigue on Productivity = IF THEN ELSE ( Fatigue in Effect = 1, 0.9, 1)
Assume 10% change in productivity

Effect of Fatigue on Retirement Rate = WITH LOOKUP( Fatigue factor , ([(0,0)-(3,2)],(0.5,1),(1,1),(1.1,1.05),(1.2,1.1),(1.3,1.2)
,(1.4,1.4),(1.5,1.5),(1.6,1.65),(1.7,1.7),(1.8,1.7),(1.9,1.7),(2,1.7))

Effect of Fatigue on Quit Rate = WITH LOOKUP( Fatigue factor , ([(0,0)-(3,2)],(0.5,1),(1,1),(1.1,1.05),(1.2,1.1),(1.3,1.2)
,(1.4,1.4),(1.5,1.5),(1.6,1.65),(1.7,1.7),(1.8,1.7),(1.9,1.7),(2,1.7))
Currently the same graph as the effect of fatigue on retirement

Effect of New Job Availability = New Job Availability

Effect of Outside Factors on Fatigue = Katrina Switch

Effect of Workweek on Fatigue = WITH LOOKUP( Workweek Factor , ([(0,0)-(3,2)],(0.5,1),(1,1),(1.1,1.05),(1.2,1.1),(1.3,1.2)
,(1.4,1.4),(1.5,1.5),(1.6,1.65),(1.7,1.7),(1.8,1.7),(1.9,1.7),(2,1.7))

Effect of workweek on Productivity = WITH LOOKUP( Average Workweek , ([(30,0)-(100,1)],(30,1),(40,1),(45,0.95),(50,0.85)

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Experienced Leaving = Min ( Indicated Quit Rate, Experienced Workers - Maturing )

Experienced Workers = \( \text{INTEG}( \text{Growing} - \text{Experienced Leaving} - \text{Maturing}, \text{Beginning employment of Experienced and Mature Workers} \times (1 - \text{Beginning percent within 3 years retirement}) \)

Fatigue = \( \text{INTEG}(\text{Increasing Fatigue Rate} - \text{Reducing Fatigue Rate}, \text{Normal Fatigue Level}) \)

Fatigue factor = \( \frac{\text{Fatigue}}{\text{Normal Fatigue Level}} \)

Fatigue in Effect = Katrina Switch

FINAL TIME = 47
The final time for the simulation.

Growing = \( \frac{\text{New Workers}}{\text{Time to Become Experienced}} \)

Hiring = \( \frac{(\text{Experienced Leaving} + \text{Retiring})}{\text{Time to hire}} \)
Assumes hiring only to replace those leaving. Does not try to adjust workforce for declining work.

Increasing Fatigue Rate = Max \( \frac{(\text{Indicated Fatigue} - \text{Fatigue})}{\text{Time for Fatigue to Increase}}, 0 \)

Indicated Fatigue = Effect of Outside Factors on Fatigue \times Effect of Workweek on Fatigue \times \text{Normal Fatigue Level}

Indicated Quit Rate = \text{Normal Attrition Rate} \times \text{Percent of experienced workers that would be leaving}

Indicated Retirement Rate = \text{Normal Retirement Rate}

Indicated Work Week = \( \frac{(\text{Desired Completion Rate} \div \text{Pre Katrina Shuttles per month})}{\text{Standard Workweek}} \)

Initial New Workers = 20

INITIAL TIME = 0
The initial time for the simulation.

Katrina Switch = 1
1 if Katrina, 0 for results without katrina

Mature Workers = \( \text{INTEG}(\text{Maturing} - \text{Retiring}, \text{Beginning employment of Experienced and Mature Workers} \times \text{Beginning percent within 3 years retirement}) \)

Maturing = \( \frac{\text{Experienced Workers}}{\text{Time to Mature}} \)

New Job Availability = 1
Available competitive positions

New Workers = \( \text{INTEG}(\text{Hiring} - \text{Growing} - \text{New Workers Leaving}, \text{Initial New Workers}) \)

New Workers Leaving = 0

Normal Attrition Rate = \( \frac{\text{Experienced Workers}}{\text{Percent Attrition}} \)

Normal Fatigue Level = 1
Assume base of 1

Normal hourly Productivity Experienced and Mature Workers = Pre Katrina Monthly Productivity for exp and mature workers / Normal Hours per Month

Normal Hours per Month = Standard Workweek * 4

Normal Productivity New Workers = Pre Katrina Monthly Productivity for exp and mature workers * Percent of Full Productivity for New Worker

Normal Retirement Rate = Mature Workers / Time to Retire

Percent Attrition = 0.05 / 12
   Using LM 2-3% annually pre Katrina and doubled immediately after the storm.

Percent of Full Productivity for New Worker = 0.85
   New workers’ Productivity as a percent of experienced workers

Pre Katrina Monthly Productivity for exp and mature workers = Pre Katrina Shuttles per month * Starting Ratio of Experience Workers / Beginning employment of Experienced and Mature Workers

Pre Katrina Shuttles per month = Pre Katrina Shuttles per year / 12

Pre Katrina Shuttles per year = 5

Pre Katrina Workforce = 100

Productivity Experienced and mature workers = Effect of Fatigue on Productivity * Normal hourly Productivity Experienced and Mature Workers
   * Actual hours Worked per Month * effect of workweek on Productivity

Productivity New Workers = Productivity Experienced and mature workers * Percent of Full Productivity for New Worker

Reducing Fatigue Rate = Max ( ( Fatigue - Indicated Fatigue ) / Time for Fatigue to Decrease , 0)

Retiring = Indicated Retirement Rate

SAVEPER = TIME STEP
   The frequency with which output is stored.

Shortest delivery delay = 12 / 5

Shuttle Schedule = Annual Shuttle Schedule Table ( Time ) / 12
   Assumes level arrival of work

Standard Workweek = 40

"Starting equivalent Mature/Experienced Workers" = Initial New Workers * Percent of Full Productivity for New Worker + Beginning employment of Experienced and Mature Workers

Starting Ratio of Experience Workers = Beginning employment of Experienced and Mature Workers / "Starting equivalent Mature/Experienced Workers"

Starting Ratio of New Workers = Initial New Workers / "Starting equivalent Mature/Experienced Workers"

Target Delivery Delay = zidz ( 1, Shuttle Schedule )
Delivery delay of 4 months to complete a shuttle

Time for Fatigue to Decrease = 6

Time for Fatigue to Increase = 3

TIME STEP = 0.0625
    The time step for the simulation.

Time to average = 1

Time to Become Experienced = 36
    It takes 3 years to become a fully experienced employee

Time to change Fatigue = 1

Time to hire = 2

Time to Mature = 180
    Average age at NASA = 51 years subtracting those already considered mature in 20 years all will be gone.

Time to Retire = 36
    Workers are within 3 years of retiring

Total Experienced and Mature Workers = Experienced Workers + Mature Workers

Total Workers = Mature Workers + Experienced Workers + New Workers

Work Arrival Rate = Shuttle Schedule

Work Completion Rate = \( \min \left( \frac{\text{Work to Be Done}}{\text{Shortest delivery delay}}, \frac{\text{New Workers} \times \text{Productivity New Workers} + \text{Total Experienced and Mature Workers} \times \text{Productivity Experienced and mature workers}}{\text{Productivity Experienced and mature workers}} \right) \)

Work to Be Done = \( \text{INTEG} \left( \text{Work Arrival Rate} - \text{Work Completion Rate}, \ Pre \ Katrina \ Shuttles \ per \ month \times \ Target \ Delivery \ Delay \right) \)

Workweek Factor = \( \frac{\text{Indicated Work Week}}{\text{Standard Workweek}} \)