Report of the

COMMISSION ON MAINTAINING UNITED STATES NUCLEAR WEAPONS EXPERTISE

Report to the Congress and Secretary of Energy

Pursuant to the National Defense Authorization Acts of 1997 and 1998

March 1, 1999

Dedication

On Thursday, February 11th, 1999, Henry Kendall signed this report, shook hands around the room, and bid us farewell until the next meeting. The next day he departed for Florida where he met an untimely death while participating in an underwater photography expedition. Henry Kendall was a brilliant scientist who worked unceasingly on public causes, including this Commission where his contributions dot every page. In signing this report, Henry accomplished the last official act of his life, and it thus is only fitting that the report be dedicated to his memory. Henry – colleague, companion, compatriot—we miss you. As Rilke wrote shortly before you were born, “Silent friend of many distances, feel how your breath is still expanding space.”

COMMISSION ON MAINTAINING UNITED STATES NUCLEAR WEAPONS EXPERTISE
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February 11, 1999

The Honorable Trent Lott
Majority Leader
United States Senate
Washington, DC 20510

Dear Senator Lott:

The Commission on Maintaining United States Nuclear Weapons Expertise submits this final report in compliance with the National Defense Authorization Acts of 1997 and 1998. These acts directed us to: "Develop a plan for recruiting and retaining within the Department of Energy (DOE) nuclear weapons complex such scientific, engineering and technical personnel as the Commission determines appropriate in order to permit the Department to maintain over the long term a safe and reliable nuclear weapons stockpile without engaging in underground nuclear testing."

During the past year the Commission visited DOE headquarters and field offices, laboratories, production facilities and the Nevada Test Site comprising the nuclear weapons complex. We compared personnel efforts ongoing in the nuclear weapons program with workforce retention and recruiting at other laboratories and industries. We assessed attitudes toward work in the nuclear weapons complex with faculty, placement officers and students at a number of educational institutions and met with representatives from the Office of the Secretary of Defense, Air Force, Navy and Defense Nuclear Facilities Safety Board.

We have developed 12 recommendations whose implementation will have a significant positive impact on personnel recruitment and retention. The concerted efforts of the Congress, the Administration, the Departments of Energy and Defense, and DOE contractor management will be required to make our recommendations a reality.

We found this to be a challenging and, we believe, important task, and we thank the personnel of the Departments of Energy and Defense and Department of Energy contractors for their full cooperation and support.

The Commission is in very broad agreement on our findings and unanimous in the recommendations which comprise our plan.

Respectfully submitted,

Robert B. Barker

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February 11, 1999

The Honorable Thomas Daschle
Minority Leader
United States Senate
Washington, DC 20510

Dear Senator Daschle:

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February 11, 1999

The Honorable Dennis J. Hastert
Speaker of the United States
House of Representatives
Washington, DC 20515

Dear Mr. Speaker:

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February 11, 1999

The Honorable Richard A. Gephardt
Minority Leader
United States House of Representatives
Washington, DC 20515

Dear Mr. Gephardt:

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February 11, 1999

Office of the Secretary of Energy
The Honorable Bill Richardson
U.S. Department of Energy
1000 Independence Avenue, S.W.
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Washington, D.C. 20585

Dear Mr. Secretary:

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Table of Contents

Executive Summary

The Commission on Maintaining United States Nuclear Weapons Expertise (hereafter referred to as 'the Commission' or 'we') was prescribed by the National Defense Authorization Act of FY 1997. The Congress identified the need for the Commission because of the substantial changes in the environment affecting nuclear weapons design, production, and testing since the end of the Cold War. In view of these changes, we were tasked with reviewing ongoing efforts of Department of Energy (DOE) to attract scientific, engineering, and technical personnel, recommending improvements and identifying actions where needed, and developing a plan for recruitment and retention within the DOE nuclear weapons complex.[1]

We have arrived at 12 recommendations in four areas: national commitment, program management, personnel policies, and oversight. What we propose is not a classic "plan" in the narrow sense, but a series of recommendations to assure that critical, well-qualified personnel are available to execute the Stockpile Stewardship Program (SSP) and to assure the safety and reliability of the U.S. nuclear weapons stockpile today and in future years.

A. National Commitment

1. Reinforce the National Commitment and Fortify the Sense of Mission.

The Administration and the Congress, through actions and words, should make a concerted and continuing effort to convey to the nuclear weapons community that their mission is vital to the security of the nation and will remain vital well beyond the planning horizons normally associated with programmatic decisions. This message should be unequivocal, clear, and periodically reinforced.

B. Program Management

2. Complete an Integrated, Long-Term Stockpile Life Extension Program Plan.

DOE needs to give a much higher priority to detailed planning for the production of replacement weapons components. In the absence of such planning,

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[1] Today's nuclear weapons complex consists of three national laboratories (Los Alamos, Lawrence Livermore, and Sandia); the Nevada Test Site; and four facilities dedicated primarily to production activities, but where some laboratory activities also take place (Kansas City Plant, Pantex, Oak Ridge/Y12, and the Savannah River Site). Some production activities also take place at the national laboratories.

the sizing of the nuclear weapons workforce at the production facilities is left unnecessarily uncertain. Accordingly, the Stockpile Life Extension Program (SLEP) plan must be made more effective for workforce planning, work prioritization, experimentation and design initiatives, and the funding necessary for implementing the SLEP needs to be identified.

3. Strengthen the Department of Energy (DOE)-Department of Defense (DOD) Relationship.

The DOE-DOD relationship should be strengthened to ensure better budget and program coordination to meet national security needs for nuclear weapons. DOE and DOD need to create a true partnership that forges both a shared commitment to the mission and an understanding of the details and funding of the programs required to accomplish the mission.

4. Take Immediate Steps to Achieve Greater Laboratory Coordination.

It is imperative that DOE and the laboratories ensure that the dual revalidation process and other important elements of the SSP be based upon independent, reliable checks with vigorous peer review. The nuclear weapons in the current stockpile were designed either by the Lawrence Livermore National Laboratory (LLNL) or by the Los Alamos National Laboratory (LANL), and the validation of the reliability and safety of the weapons during the era of nuclear testing was done separately by each laboratory for its own designs. Today, in the absence of nuclear testing, dual revalidation of the stockpile of nuclear weapons requires shared responsibility and cooperation between the laboratories while conducting independent checks of weapon performance. Although the laboratories have made considerable progress in developing a cooperative relationship, the sharing of nuclear weapon information remains difficult. The remaining barriers to information exchange and cooperation need to be eliminated.

5. Expedite Improvements and Efficient Use of the Nuclear Weapons Production Complex.

DOE should undertake expeditious implementation of a coordinated site-wide plan for production complex "rightsizing," supported by associated funds, to eliminate problems of maintenance of equipment and facilities, and modernization of equipment. A healthy production complex will enhance recruitment and retention of a quality production workforce.

6. Establish Clear Lines of Authority Within DOE.

Reorganization of DOE is needed to eliminate excessive oversight and overlapping, unclear government roles. The Assistant Secretary for Defense Programs

(ASDP) should be given direct line management authority over all aspects of the nuclear weapons complex, including corresponding elements of the DOE field structure.

C. Personnel Policies

7. Establish and Implement Plans on a Priority Basis for Replenishing Essential Technical Workforce Needs in Critical Skills.

DOE and its nuclear weapons program contractors should, on a priority basis, develop and implement a detailed and long-term site-specific and complex-wide plan for replenishing the essential scientific, engineering, and technical nuclear weapons workforce. Large numbers of workers are reaching retirement and a new generation of workers must be hired and trained in order to preserve essential skills.

8. Provide Contractors with Greatly Expanded Latitude and Flexibility in Personnel Matters.

DOE needs to modify its contract structure with its nuclear weapons program contractors to give them greater latitude in personnel practices so they can compete more effectively in today's market for scientific and technical personnel. DOE and its contractors also need to review contemporary industry initiatives and those of comparable federally funded organizations for recruitment and retention so as to identify and implement the best practices.

9. Expand Training and Career Planning Programs Which Are Adapted to the Dramatically Changed Workforce Environment.

Training the new workforce and validating the effectiveness of training must be among the highest priorities of the nuclear weapons complex. Training and career planning by DOE and its contractors need high-level review and adaptation to the changed environment. The design laboratories must also develop new means to judge the success of their training methods and of the design staff's competence. Production complex training programs should be coordinated with laboratory engineering training. Technicians should be cross-trained at a variety of jobs involving the unique materials and designs of the stockpile. There needs to be planning for the progression of key personnel. All facilities need mechanisms for periodic feedback from personnel to understand and respond to employee concerns.

10. Expand the Use of Former Nuclear Weapons Program Employees.

DOE should institute a small, select Nuclear Weapons Workers Reserve from those with key skills who have left the nuclear weapons program, to maintain the ability to increase experienced staff rapidly, when and if required. We also recommend greater use of retirees to assist in training new personnel and to participate in the peer review process.

D. Oversight

11. Create a Permanent Defense Programs Advisory Committee.

The ASDP in DOE should establish a Defense Programs Advisory Committee to assist in oversight of the SSP. The Committee should be formed of senior, experienced personnel capable of assessing SSP integration and priorities. The Committee also should assist the Assistant Secretary in ensuring that the SSP achieves the necessary advances in science and engineering needed to make the SSP successful.

12. Enhance Congressional Oversight.

Congressional oversight of the nuclear weapons program should be reinvigorated. Historically, the Congress took a major role in overseeing and supporting the nuclear weapons program. A focused and structured oversight is especially important today during the developmental period and implementation of the SSP. This will strengthen the program as well as the public's perception that the program is indeed a matter of supreme national interest.

The SSP is predicated on a ten-year appropriation of approximately $4.5 billion per year. A focused and structured oversight should also provide the basis for the Congress to establish a multi-year fiscal commitment to the program. This would provide essential fiscal stability and assurances to those personnel working on the scientific and technical challenges of the long-term support of their missions.

Finally, the Congress needs to provide positive, explicit reinforcement of the public service character of the mission to maintain a safe and reliable nuclear weapons stockpile.

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The preceding recommendations arise from the phased approach we took to understanding the problem. Initially we received overview briefings and orientations from senior DOE officials and from laboratory and facility directors, which basically involved understanding the key elements of the SSP and how it was being implemented.

In June 1998, we began visiting the sites in the nuclear weapons complex and DOE area offices, where we reviewed recruitment and retention policies with individual managers and then had discussions with a wide range of scientific, engineering, and technical personnel in the nuclear weapons program. We met them in their workplaces, in small focus groups, and in private sessions between one worker and one Commissioner. Altogether, we conducted about 75 focus groups with over 1,000 personnel and met privately with at least 100 individuals who had expressed interest in such meetings. We also submitted an extensive personnel survey to 10,700 contractor and federal workers who were associated with the SSP. We asked that the responses be voluntary and not for attribution. We received 5,733 completed survey forms, all of which we evaluated and considered in our deliberations.

We then met with representatives of industries and activities outside the DOE nuclear weapons complex to examine their personnel recruitment and retention issues and practices. They were selected because of similar workforce situations, e.g., those of defense contractors (Lockheed Martin), nuclear industries (Commonwealth Edison), or laboratories engaged in defense work (Jet Propulsion Laboratory, Applied Physics Laboratory, Charles Stark Draper Laboratory, and Naval Research Laboratory). These sessions helped us "benchmark" the problem faced by the DOE nuclear weapons complex in its recruitment and retention programs.

We also examined the marketplace for scientific, engineering, and technical talent by administering a separate survey to the placement officers and department heads of a number of educational institutions from which the DOE nuclear weapons complex traditionally has recruited, followed by discussions at selected institutions with department heads and small focus groups of students.

Finally, we met with officials from DOD and the Defense Nuclear Facilities Safety Board (DNFSB) to gain their perspective on the problem.

In assessing the current plans for the nuclear weapons complex, we found that many of the major impediments to recruiting and retaining skilled personnel already were understood and that a number of activities already had been initiated to help maneuver the nuclear weapons complex to a more stable configuration. For example, funding appears to have stabilized, the SSP is providing a coherent planning focus, the current workforce is dedicated and talented, and training and hiring are resuming. Managers in the DOE nuclear weapons complex recognized that their work force was aging and that they needed to focus on hiring. On the other hand, we found few initiatives to change in any basic way the manner in which they approached recruitment, career management, or retention.

As a result of our work, we developed findings which formed the basis for our recommendations.

- The nuclear weapons workforce expressed to us a considerable amount of insecurity at three levels: (1) doubts about the strength of the commitment of the U.S. Governement to nuclear deterrence over the long run and to stockpile stewardship as a menas of maintaining safe and reliable nuclear weapons; (2) doubts about the continued existence of some of the facilities that are currently part of the nuclear weapons complex; and (3) fear of further reductions in personnel in the nuclear weapons workforce.

- The nuclear weapons workforce is aging and, indeed, is considerably older than the national average of scientific, engineering, and technical personnel engaged in other endeavors.

- The marketplace for hiring new scientific, engineering, and technical talent is highly competitive. Dealing with this marketplace was aptly described to us as a "war for talent."

- The number of college students in many of the scientific and engineering fields relevant to nuclear weapons work is shrinking while the overall needs in the economy for such graduates continue to grow. Moreover, there is a significant percentage of international students in these graduate curricula, which complicates recruitment in fields requiring security clearance and U.S. citizenship.

- DOE continues to have a number of management and program planning practices which hinder recruiting and retention. There are too many DOE employees with overlapping and competing responsibilities for supervising and overseeing the contractors in the nuclear weapons program. A number of DOE personnel have inadequate technical backgrounds for their tasks. Existing contract arrangements give the contractors inadequate latitude and flexibility to adjust salaries, benefit packages, and overall compensation to be competitive in the current and projected marketplace.

- There is a lack of coordinated DOE-DOD planning for sustaining the aging stockpile to maintain a fully competent DOE nuclear weapons complex.

- The two nuclear weapons physics design laboratories, LANL and LLNL, have yet to develop fully the sense of shared responsibility and cooperation which is critical to the new conditions of the post Cold War era.

- Finally, the current plan for the SLEP—which is essential to long-term planning of personnel needs, especially at the production facilities—is not yet adequate. It needs to be upgraded expeditiously for long-term as well as short-term requirements.

I. Background

The President has stated that maintaining a safe and reliable nuclear weapons stockpile is a supreme national interest of the United States.[2] The most recent annual White House report on national security strategy asserts that the United States must continue to maintain a robust triad of strategic forces for deterrent purposes, relying upon the SSP to guarantee the safety and reliability of U.S. nuclear weapons under the Comprehensive Test Ban Treaty (CTBT).[3] Strong expressions of the importance of the nuclear weapons program also have been reflected in the statement of the sense of the Congress regarding the reliability and safety of remaining nuclear forces.[4]

It is in the context of this national reaffirmation of the importance of the nuclear weapons program that the Congress established a Commission on Maintaining United States Nuclear Weapons Expertise.[5] The Commission was directed to develop a plan for recruiting and retaining within the DOE nuclear weapons complex such scientific, engineering, and technical personnel as the Commission determines appropriate to permit the Department to maintain over the long-term a safe and reliable nuclear weapons stockpile without underground nuclear testing. Information on the Commission can be found in Appendix A.

For the past 12 months, we have conducted a detailed study of the factors which shape and influence the workplace for the nuclear weapons program. Our members have reviewed a number of documents related to the program and received briefings on topics germane to this report from responsible officials in DOE, the national laboratories, the contractors managing the production, assembly, and disassembly of nuclear weapons, the Nevada Test Site (NTS), DOD, and the DNFSB. We traveled to the various facilities in the nuclear weapons complex to understand the institutional roles, see the facilities, and talk with personnel at all levels in the nuclear weapons program. We studied the practices of a number of organizations outside the nuclear weapons program which also face challenges in attracting and retaining high-quality technical personnel and sought the views of others on the topics at hand. Our study plan is described in Appendix B.

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[2]When the President announced in August 1995 that the United States would pursue a zero-yield test ban treaty, he said that, "As part of our national security strategy, the United States must and will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interest and to convince it that seeking a nuclear advantage would be futile." He then said, "In this regard, I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States."

[3]The White House, *A National Security Strategy For A New Century* (October 1998), p. 12.

[4]Section 3163 of the National Defense Authorization Act for Fiscal Year 1997.

[5]Section 3162 of the National Defense Authorization Act for Fiscal Year 1997, as modified by the National Defense Authorization Act for Fiscal Year 1998.

We also conducted a survey and received results from over 5700 men and women involved in nuclear weapons work. The survey solicited their views, concerns, and attitudes relative to why they chose their jobs and organizations, and their current levels of satisfaction with same. Recommendations for improvement were solicited. Additionally, we questioned and held discussions with placement officials and department chairs at several universities, colleges, and schools from which the nuclear weapons complex has recruited in the past. We also visited selected academic institutions where we spoke with technical, scientific, and engineering students. Details on the surveys we conducted are described in Appendix C.

What follows is our report and "plan." In assessing the current plans for the nuclear weapons complex, we found that many of the major impediments to recruiting and retaining skilled personnel already were understood and that a number of activities already had been initiated. We decided that what was needed was not a radical new departure or a narrow management plan in the classic sense, but rather a synoptic view of the situation and focused recommendations on where to accelerate change, how best to reinforce positive trends, how to offset or eliminate negative trends, and how to nurture a management and political climate and a consensus conducive to success in recruiting and retention. Our recommendations are composed with that perspective.

It has been our privilege to meet and speak with over 1,000 dedicated men and women at the national laboratories, nuclear weapons production facilities, test sites, and federal offices, in focus groups, private interviews, and discussions in the work place. The officials and individuals we encountered are the true "stewards" of the nuclear weapons program. Sustaining the needed expertise in a nuclear weapons program does not come cheaply or easily. It must be constantly nourished. It is important in that regard to acknowledge that the nature of nuclear weapons work, the secrecy imposed upon it, the dangers and risks attendant to it, the limited opportunities for peer interaction and review, and the national importance of the endeavor all conspire to make the nuclear weapons workplace a demanding environment. The men and women involved in the weapons program traditionally have seen themselves not simply as scientists, engineers, and technicians, but as public servants inspired by a sense of purpose and mission of national import. It is important that this attitude be maintained and—where necessary—reinforced as we enter a new era.

II. Nuclear Expertise Needed

To understand the expertise needed now and in the future to maintain a safe and reliable stockpile of nuclear weapons, we found that it is important first to appreciate what has changed since the end of the Cold War. Three factors are especially noteworthy.

First, the United States has ended underground nuclear weapons testing. Consequently, the nuclear weapons program must have expertise which can maintain the safety and reliability of individual weapons in the stockpile without the tool of these underground nuclear tests. This has led to the concept of science-based stockpile stewardship which draws more extensively upon non-nuclear experiments and advanced computational modeling. These experiments and calculations aim at better defining the physics of nuclear explosions and at improving understanding at a deeper scientific level of materials and what drives the performance of weapons.

Confidence in the safety and reliability of the stockpile always was based upon expert judgment. Historically, nuclear testing was important to this process. To put the current situation in context, it should be understood that even in the era before 1963 of atmospheric nuclear testing, we very rarely fully tested nuclear weapons systems, i.e., replicated the operational conditions under which a nuclear weapon and its delivery system would function from initial launch of the weapon until its final detonation.[6] Instead, atmospheric and underground tests of nuclear weapons provided an important input—but one among many— to expert judgments which drew not only on the data of a particular nuclear test but from a host of other non-nuclear tests, experiments, and modeling activities.

Nevertheless, nuclear testing was a pivotal element in weapons development that enabled the nation to deploy, with confidence, new and more advanced nuclear weapons and contributed to the evaluation of the quality of expert judgment at the national laboratories. In the absence of nuclear tests, the nation must rely upon information that is less decisive than demonstrative proof of full nuclear detonation, producing the predicted nuclear yield and other measurable phenomena.

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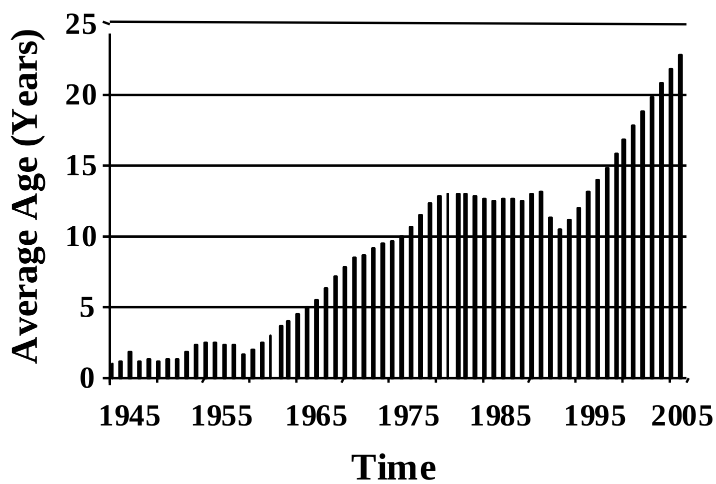
[6]During the era of atmospheric nuclear testing, the United States conducted tests of bombs in the stockpile and tactical weapons which included launch and nuclear detonation. However, only one test of this type was attempted for a ballistic missile system. That was the "Frigate Bird," a test of a Polaris A-1 missile launched from the USS *ETHAN ALLEN* on May 6, 1962, in the Pacific, in Operation Dominic. Nuclear detonation was achieved.

Notwithstanding the widespread perception that the principal new change is the ban on underground nuclear testing, there are two other factors of considerable significance for purposes of sustaining expertise. The second key difference is the move away from a large complex which continuously produced new nuclear weapons for the stockpile. During former eras, it was sufficient to identify design characteristics or parameters which could affect safety or reliability of weapons, to specify corrective actions, and to move quickly — sometimes massively — to replace defective systems. Now, the expertise needed must be up to the task not only of identifying actual or potential defects, but of anticipating failures and defining corrective actions which will have to be taken with a level of discrimination that permits the far smaller production complex to meet the need effectively and in a timely fashion.

Third, there is the challenge of dealing with an aging stockpile. Today, there are no plans to replace weapons but to replace weapon components.[7] The age of the stockpile is shown as a function of time in Figure 1.

Figure 1. Average Stockpile Age



In these circumstances, it is imperative to acquire a far better understanding of the changes which occur in existing nuclear weapons due to aging at a deeper level of materials science and to develop the ability to take corrective actions in a timely and responsible fashion. On balance, these fundamental changes define a new nuclear weapons workplace. In response to these changes, DOE has been formulating a strategy for maintaining the safety and reliability of the stockpile over the long-term.

[7]Moreover, since the end of the Cold War, DOD has not established a requirement for a new–design nuclear weapon, but has established the requirement for DOE to maintain the capability to design new weapons.

That strategy — the SSP, also known as the Green Book — whose components include science-based stockpile stewardship and the production and manufacturing plans, will provide the basis for determining and providing the type of expertise needed today and in the future. Workforce requirements to execute the program should be determined based on the program plans for surveillance, assessment and certification, design and manufacturing, simulation and modeling, and restoring production capabilities, especially for plutonium parts and tritium.

To implement this strategy, it is necessary to retain and sharpen expertise already available, and to recruit, train, retain, and inspire an evolving nuclear workforce of great breadth, depth, and capability. The workforce must include highly competent physicists, computer scientists and engineers, craftsmen, and managers of scientific and process research, manufacturing, security, operations, and support. The key more than ever before to the success of maintaining a safe and reliable stockpile is the quality of people who make the expert judgments necessary to the endeavor and their sustained dedication to their work.

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III. Findings

We found a great deal that was healthy in the nuclear weapons complex with many trends moving in the right direction. For example, funding appears to have stabilized, the SSP is providing a coherent planning focus, the current workforce is dedicated and talented and training and hiring are resuming. The management at each of the facilities in the nuclear weapons complex is responding in its own way to the challenges of nuclear weapons stewardship.

Still, we found other matters that are disturbing, especially the aging workforce, the tight market for talent, the lack of a long-term hiring plan, and other constraints which make it difficult to conclude that the Department will succeed in maintaining future nuclear weapon expertise in the complex. The nuclear weapons program is not in crisis, but additional steps are needed now. In the following 12 findings, we identify areas where action is required. Our recommendations refer to these findings.

1. A Workforce Uncertain About the Future.

(See Recommendations 1, 2, 3, 5, and 12)

During our visits to the facilities in the nuclear weapons complex, we encountered insecurity, expressed to us at three levels. The first concerned the strength of the national commitment to maintaining an effective, safe and reliable deterrent and to stockpile stewardship as a necessity for sustaining that commitment. The second concerned the future of individual facilities and whether there would be another round of re-engineering the complex to consolidate activities which might result in new facility closings. The third concerned individual jobs and whether the downsizing of the last decade would continue in the future. All of these uncertainties contribute to the image of a "sunset" industry which is not conducive to worker morale nor to recruitment and retention of highly talented individuals.

In the survey we conducted of essential personnel in the nuclear weapons program, job security was consistently one of the top three most important job related factors. The other two were challenging work and benefits.

Some uncertainty and anxiety is to be expected during a time of transition of the magnitude experienced in the nuclear weapons program during the past 10 years. We are sufficiently concerned, however, about the impact of uncertainty on morale as to warrant highlighting this finding in our report, and we have crafted several recommendations to address that concern.

2. An Aging Nuclear Weapons Workforce.

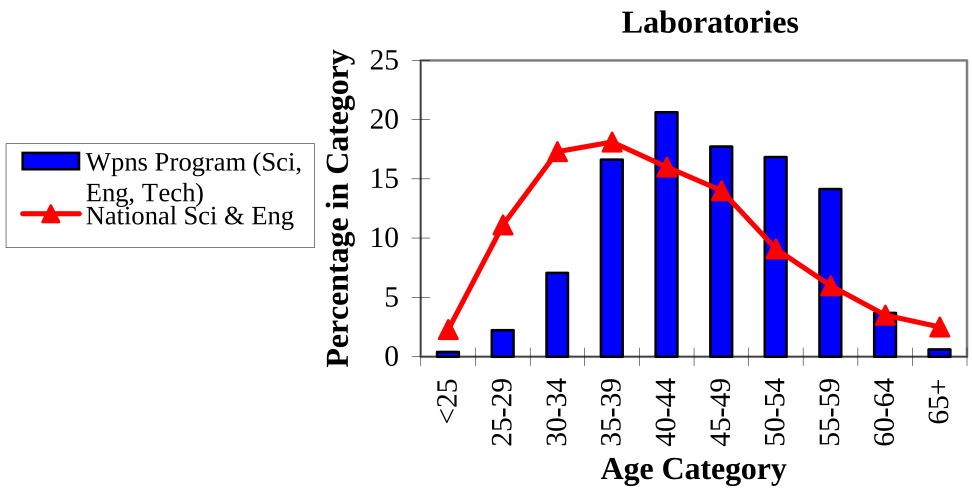
(See Recommendations 7, 8, 9, and 10)

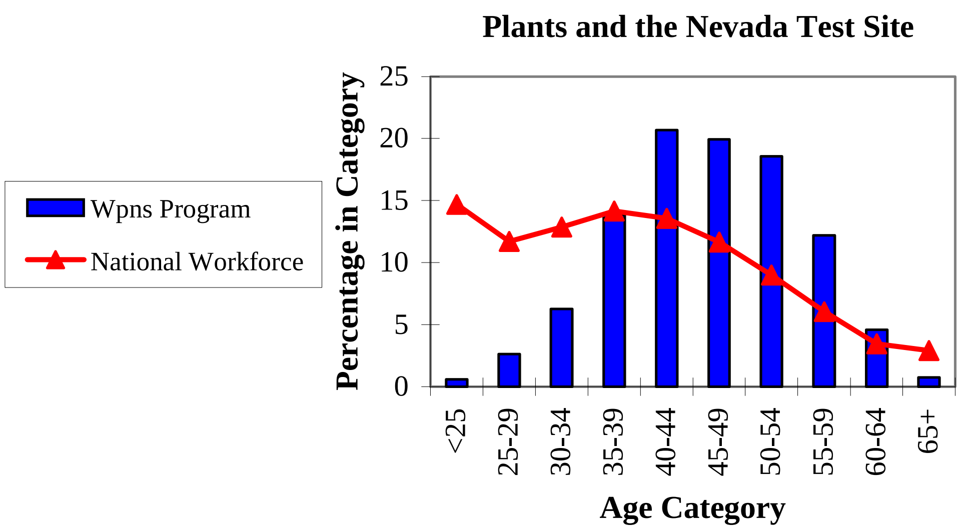
The nuclear weapons workforce shrank through the early 1990s as a consequence of the reduced workload since the end of the Cold War and has only begun to stabilize since 1996. Overall, the eight facilities have cut approximately 23 percent of their total workforce since 1993, continuing a trend that began in the late 1980s.

During this downsizing, most facilities have done minimal hiring, raising concerns that the nation is not developing the next generation of nuclear stewards to replace the senior scientists, engineers, technicians and technical managers. We found that the complex generally adopted a conventional business approach to reducing workforces: managers cut back on hiring and workers were offered incentives to retire early. As a result, the normal flow into and out of the workforce was seriously disrupted. For example, over the four-year period 1993-1996, LANL hired a total of about 115 scientists and engineers into its weapons program divisions, while more than 400 departed. Of those departed, 250 were separated. Y-12 at Oak Ridge provides the most extreme instance of this pattern, only 60 new hires were made into the weapons program during this four-year period, while there were over 1,200 separations.

The long-term challenge is to restore an adequate flow of new talent. The more senior generation of workers (45 to 65 year-old) accounts for between one-third and one-half of the workforce at five of the eight facilities: Los Alamos, Lawrence Livermore, Nevada Test Site, Kansas City Plant, and Y-12 (Oak Ridge). As this senior generation retires over the next fifteen years, the managers must be prepared to hire and train new generations of workers to sustain the complex into the next century. A comparison with the national workforce demographic patterns in Figure 2 places this challenge in context: slightly over 20 percent of the nation's employed scientists and engineers are over 50, whereas over 34 percent of the nuclear weapons workforce is over 50. Thus, annual losses due to retirement within the nuclear weapons complex will be roughly 60 to 150 percent higher on average than in the economy at large.

Figure 2. Demographics of Nuclear Weapons Workforce





In some highly specialized skill areas, however, the time is shorter, and our concerns are more immediate. More than 60 percent of the nuclear designers at Los Alamos and Lawrence Livermore fall in the 50 to 65 year old group. This is an area where there is wide agreement that five or more years of experience working with experienced senior designers is required to develop a fully capable, independent designer. Steps need to be taken now to ensure that the upcoming generation of designers is recruited and trained, while the more experienced designers remain at the labs or are available through retiree programs. There are comparable situations in other skill areas throughout the complex.

The demographic challenges outlined here are now recognized within DOE and the nuclear weapons complex, but as yet, no comprehensive plans have been established to address them. Demographic statistics supporting this finding can be found in Appendix D.

3. A Highly Competitive Marketplace for Technical Talent.

(See Recommendations 7 and 8)

As the nuclear weapons laboratories and production sites increase their recruiting to refresh their workforce, they are encountering a highly competitive marketplace. The American economy of the 1990s has generated robust growth in high technology jobs. While overall unemployment hovers at around five percent, unemployment of those with college degrees is less than two percent.[8] Unemployment of those with degrees in chemical, electrical, and mechanical engineering, or mathematics and computer science, is between 0.9 and 1.4 percent.[9]

The combination of strong demand and limited supply in these fields has resulted in salary inflation well above the cost of living increases experienced by the nation as a whole. The most dramatic increases are in information technology. The National Association of Colleges and Employers reports that the average salary offered to 1998 college graduates with computer science degrees grew by 12 percent during the year.[10] Anecdotal reports along with interviews from corporate personnel officers suggest that lucrative offers, perks, and signing incentives in the information technology field are legion. The same is true, although of lesser magnitude, for electrical, mechanical, and chemical engineering initial job offers.

Our discussions with college students, placement officers, and department heads revealed several additional recruitment problems for the nuclear weapons complex. In most instances, undergraduates in the engineering and information technology fields are no longer knowledgeable of DOE laboratories and production facilities. The many years without significant recruitment have left the labs and production facilities without reputations on campuses across the country— campuses where they once were very competitive prospective recruiters. Further, where they are known, they do not have a reputation for offering challenging design and development opportunities. One of the most effective tools in overcoming this problem appears to be the intern and co-op programs offered within the nuclear weapons complex. Several of our benchmark organizations have been hiring continuously over the last several years. These organizations have had to adopt significant changes in their recruitment and retention strategies to compete in what McKinsey & Company calls "The War for Talent."[11] Typical strategies they have adopted to maintain their positions as employers of choice include: hiring bonuses, flextime and increased time off, telecommuting, educational benefits, and career counseling.

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[8] Bureau of Labor Statistics, November 1998 data.
[9] Bureau of Labor Statistics, Data by Profession, November 1998 data.
[10] "Just Say Money," Computerworld Careers, Fall 1998, p. 67.
[11] "You Hired 'Em. But Can You Keep 'Em?" Fortune Magazine, November 9, 1998, p. 248.

The national laboratories and production facilities in the nuclear weapons program have not yet experienced the full impact of this tight labor market and shifting employee attitudes because of the limited amount of hiring conducted during the last decade (except in their requirements for computer programmers). But as the demographics of the nuclear weapons workforce demonstrate, that will change.

4. Challenging Trends in the Future Supply of Technical Personnel.

(See Recommendations 7 and 8)

There are levels of technical skills required in the nuclear weapons program which help define the pool of potential recruits. As a gross generalization, we found that physicists generally are recruited at the Ph.D. level, engineers often are recruited at the bachelor or masters level, while technician craftsmen may be recruited at the associate degree level. Recruitment may be at the entry level or lateral from within the nuclear weapons complex, from other high technology sectors within and outside government, and from the retired military community. Nuclear weapons work requires American citizenship, and many of the tasks also require possession of some of the highest (and, hence, most demanding to obtain) security clearances.

In assessing future trends in the supply and demand for talent, we concentrate on the formal, technical education programs at American universities as a major supplier of future nuclear stewards, since even those who enter the program laterally will initially have come primarily from this source.

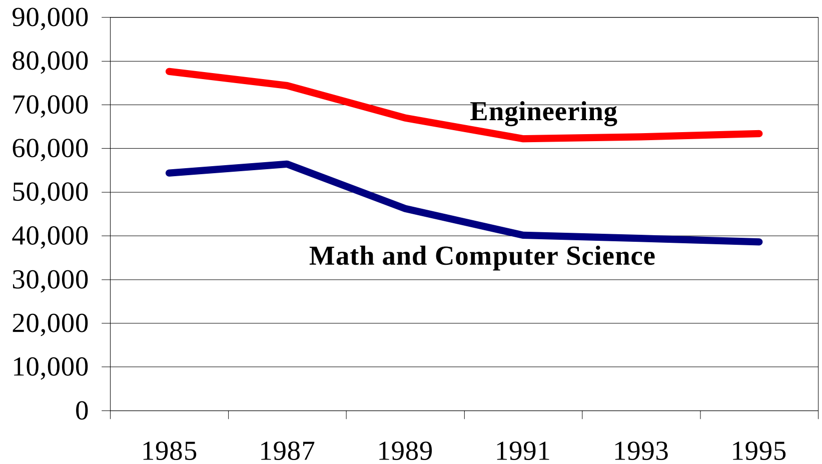
Undergraduate enrollments in science and engineering peaked in 1983 and since then have decreased by 19 percent, flattening in the mid-1990s.[12] Graduate student enrollments in these same technical fields peaked in 1993 and since then have shrunk, led by three percent per year declines in engineering, computer science, and mathematics.[13] We have examined eight skill areas of particular interest to the nuclear weapons program: computer science, mathematics, physics, chemical engineering, materials science, mechanical engineering, electrical engineering, and nuclear engineering. In every case, graduate student enrollments are below enrollment levels

[12] Data from National Center for Education Statistics (NCES), *Earned Degrees and Completion Surveys* (Washington, DC: 1995) and National Science Foundation (NSF), Science Resources Studies Division reported in Table 2-20, *Science and Engineering Indicators – 1998*, www.nsf.gov.

[13] NSF, Science Resources Studies Division, *Graduate Students and Postdoctorates in Science and Engineering*, Fall 1995, NSF 97-312 (Arlington, VA: 1997) reported in Appendix Table 2-24, *Science and Engineering Indicators – 1998*, www.nsf.gov.

of 10 years ago, despite strong growth in jobs for most of these fields.[14] Figure 3 below illustrates those trends and the impact on degrees awarded at the undergraduate level.

Figure 3. Technical Undergraduate Degrees Awarded Per Year[15]



At the doctoral level, the number of degrees awarded in science and engineering was stable from 1975 to 1985, then grew substantially over the next ten years, fueled by a large increase in international students attending U.S. institutions as shown in Figure 4.[16] Recently, the enrollments of international students in U.S. institutions have dropped slightly, reflecting the increasing capacity of many countries to provide technical education. Currently, international student enrollment in graduate programs in the U.S. varies across the disciplines of interest, from a high of over 40 percent in electrical engineering to a low of 33 percent in mathematics.[17] Since foreign nationals are precluded from working on classified programs, this effectively reduces the talent pool from which the nuclear weapons stewards of the future can be recruited and flattens the supply of the most highly educated talent.

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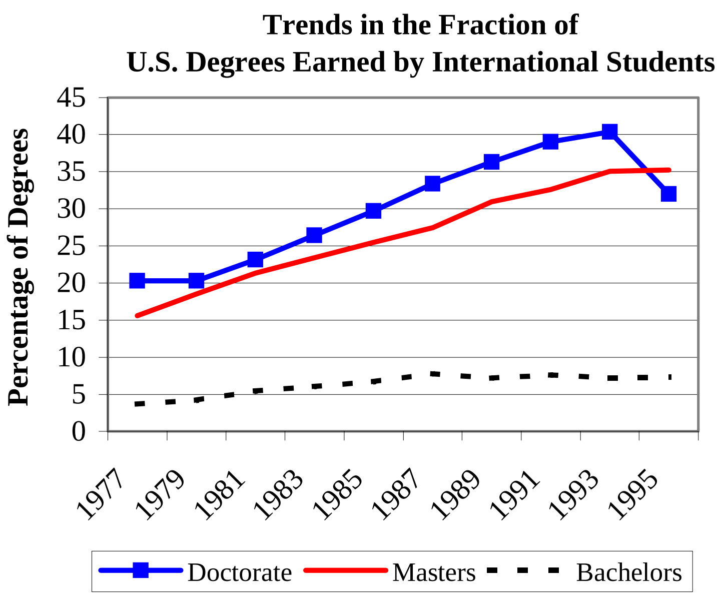
[14] Data from NSF WebCASPAR Database System and *Graduate Students and Postdoctorates(NSF, Science and Engineering Indicators – 1998)*, the NCES web site, and the Engineering Workforce Commission of the American Association of Engineering Societies

[15]NSF, *Science and Engineering Indicators – 1998* (Table 2-20)

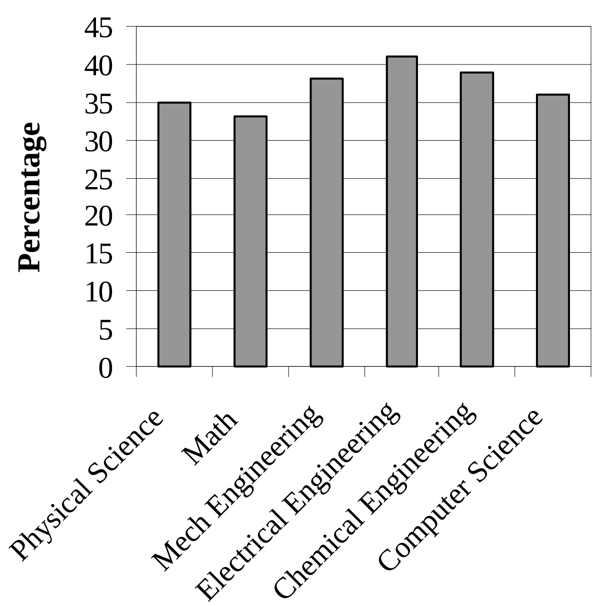
[16]NSF Science Resources Studies Division, *Selected Data on Science and Engineering Doctorate Awards: 1995*, NSF 96-303 (Arlington, VA: 1996) published in Appendix Table 2-35, *Science and Engineering Indicators – 1998*, www.nsf.gov.

[17]NSF/SRS, Survey of Graduate Students and Postdoctorates in Science and Engineering, www.nsf.gov.

Figure 4. International Graduate Student Enrollment[18]



International Graduate Student Enrollment by Field (1997)

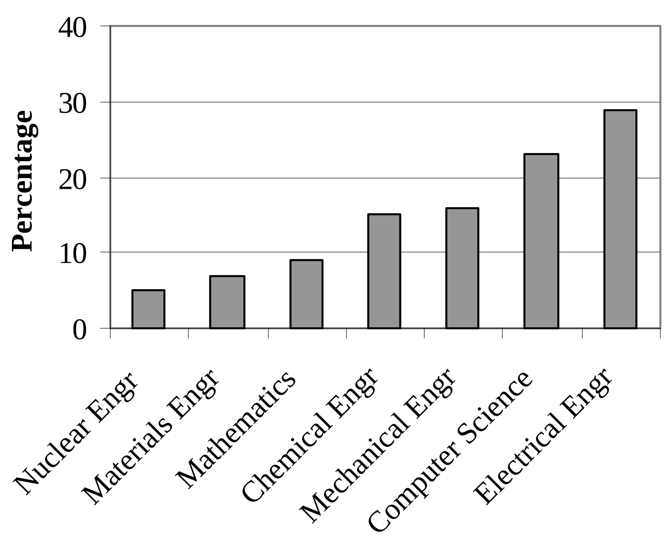


[18] NSF, *Science and Engineering Indicators – 1998* (Table 2-20), and NSF/SRS, Survey of Graduate Students and Postdoctorates in Sciences and Engineering, www.nsf.gov.

An additional factor affecting recruitment is that more and more women are entering technical fields of interest to the nuclear weapons program. In 1977 women earned barely two percent of all undergraduate degrees in engineering and less than 20 percent in computer science. By 1995 they earned nearly 17 percent in engineering and 30 percent in computer science.[19] Growth in the number of graduate degrees awarded to women in scientific and technical fields continues as well, albeit somewhat more slowly. Women traditionally have been under-represented in defense work. Our interviews on campuses suggest some evidence that women undergraduates and graduates are less aware of the nuclear weapons programs than men as an employment opportunity. We have not found evidence that the growth in the number of women in the scientific and engineering fields has been taken into account in the hiring and workforce support activities of the nuclear weapons complex.

Taken together, these trends imply flat or slightly decreasing supplies of talent across all educational levels within the fields of interest. This is unfortunate because these same fields are likely to experience significant job growth in the future. As Figure 5 below shows, job growth in electrical, mechanical and chemical engineering and computer science is expected to continue to be dramatic, expanding by 15 to 30 percent over the next 10 years.

Figure 5. Projected U.S. Job Growth 1996-2006[20]



[19] NCES, *Earned Degrees and Completion Surveys* (Washington, DC: 1995) as reported in Table 2-20, *Science and Engineering Indicators – 1998*, www.nsf.gov.
[20] BLS, Office of Employment Projections, *National Industry-Occupation Employment Projections 1996-2006* (Washington, DC: US Department of Labor, 1997).

Thus, there are several challenging trends and market changes that combine to establish significant implications for the future of the management of the nuclear weapons stockpile:

- Declining numbers of undergraduates in the eight skill areas;
- The large international graduate student segment in the eight skill areas that further reduces the available pool of people;
- The growing number of women in these fields and some evidence of their greater reluctance than men to seek employment opportunities in nuclear weapons programs;
- The intensely competitive labor market especially in the information sciences and engineering related fields; and
- The relative unawareness of the college community about the laboratories and production facilities and/or a perception that the absence of design and development opportunities limits their opportunities.

Although the aggregate hiring needs of the nuclear weapons complex amount to a relatively small percentage of the total supply, the laboratories and production facilities face a highly competitive recruiting environment. Nothing we noted in the available projections of the supply and demand for technical talent suggests that this will improve and some data argue that challenges will increase.

5. An Over-Sized, But Incomplete, Nuclear Weapons Complex.

(See Recommendation 5)

The nuclear weapons production complex and facilities at the Nevada Test Site are generally more than 40 years old. Efforts are underway to reestablish the capability to produce two essential nuclear weapon components—plutonium parts and tritium. However, DOE continues to maintain and provide budgetary support for a complex — an artifact of the Cold War — that is oversized for its contemporary mission or any foreseeable requirements.

For example, two million square feet of floor space of a total seven million square feet at the Y-12 plant at Oak Ridge, Tennessee are used for weapon component production. The current downsizing goal, consistent with DOE's Final Programmatic Environmental Impact Statement (PEIS) For Stockpile Stewardship and Management, September 1996, is to reduce the two million square feet to one million square feet by the year 2006. This will not solve the unbudgeted maintenance backlog for the remaining facilities at Y-12, some of which are more than 50 years old. Another example of excess plant floor space is the Kansas City Plant (KCP) which has a goal of reducing 2.9 million square feet by 600,000 square feet.

DOE is aware of the above situations and has adopted an implementing strategy—Stockpile Management Restructuring Initiative (SMRI)—for downsizing which started in 1998 and is expected to take some eight years. At most plants there is a relatively small fraction of the people working in old, partly vacant facilities with outdated equipment, and there is little impact on morale. However, of the approximately 4000 weapons program personnel at the Y-12 plant, some 150 people work in buildings scheduled for abandonment and another 1000 work in obsolete buildings whose condition is rated as poor to fair.

Each of the facilities in the nuclear weapons complex has a site-specific plan to refurbish or eliminate unneeded floor space consistent with the PEIS. However, there is not a complex-wide coordinated plan to achieve the required space reductions, to modernize the facilities, and to meet current and projected maintenance requirements. The cost to eliminate unneeded facilities is considerable: $340 million to execute the SMRI by 2006, which will address only some of the required reductions and will not meet all modernization needs.

The above factors are not conducive to morale, productivity, and retention of the current work force.

6. Negative Aspects of Current Management of the Nuclear Weapons Program.

(See Recommendations 6, 7, 8, and 12)

The nuclear weapons complex consists of government owned, contractor operated facilities, in which federal managers oversee contractor managers in an arrangement governed by a complex network of federal and state laws, rules, regulations, and contractual agreements. This arrangement has evolved over the past 50 years since the Manhattan Project gave way to the Atomic Energy Act of 1946.

The current stewards of the stockpile experience frustration caused by the high level of DOE micromanagement in the workplace. Worker feelings range from anger to resigned despair. Uncertainties are created by the overlapping and unclear government roles in supervision of operations. At the extreme, some felt that supervisory bureaucracies had become the prime customer of their facility — that is, pleasing the overseers has become equally or more important than accomplishing their stewardship mission.

Compounding the above problem is a perceived lack of technically competent DOE management, a lack that was noted in the surveys from all facilities. This perception is held by research and production personnel in the complex as well as by personnel within DOE management itself.

In response to the growing concerns with the management of the complex in the late 1980s, the Congress and DOE built a large government organization for health and safety. This is divided among several sub-organizations. From the field's perspective, the government management structure exhibits fuzzy lines of authority, no accountability, and inconsistent direction, stemming from a lack of a defined oversight process and the fact that government overseers have not established a common understanding of what it means to be "safe." In effect, a chain of command has been established operating parallel to programmatic line management. This translates into day-to-day frustrations among those in the field performing hands-on stewardship tasks. DOE has been on record for several years in support of Integrated Safety Management that would focus responsibility and authority for Environment Safety and Health (ES&H) in line management. This is also supported by the DNFSB, a key external advisory body established by the Congress.

These issues are not new. The Galvin Commission saw the same thing earlier in this decade. They also were noted when DOE commissioned the "120 Day Study"[21] of weapon program management. The Department has repeatedly acknowledged these deficiencies in Congressional hearings and has adopted a number of internal reforms intended to improve the situation. Contractors have been relieved of the obligation to observe the Federal norm in contracting practices, business reviews have been consolidated and restricted to an annual audit, the Department's internal regulations have been significantly reduced and simplified, and a special Laboratory Operations Board has been formed consisting of senior managers and outside experts focused on improving the Department's interaction with its laboratories. This contract reform initiative, applicable to all DOE contractor relationships, has significantly reduced the Department's historical command-control hold on its contractors and relies on performance-based flexible criteria in contrast to the personnel and ES&H problems which remain vexing.

The evidence we have gathered clearly shows that these persistent personnel and ES&H management problems are undermining workplace morale and the shared sense of mission so necessary to program success. These conditions must be remedied if DOE is to succeed in attracting and retaining a new generation of "stewards."

Programmatic micromanagement also has been cited as a problem within the nuclear weapons complex in that headquarters is allocating funding within narrower stovepipes than historically has been the case and restricting the discretionary funding of research.

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[21] Paul H. Richanbach, David R. Graham, James P. Bell, and James D. Silk, *The Organization and Management of the Nuclear Weapons Program,* Institute for Defense Analyses, March 1997.

Despite these handicaps, a core group of capable and dedicated government officials is able to make the current program work. But these officials could do a better job with fewer resources if there were systematic improvements in management structures and processes. A thorough revamping to institute streamlined, efficient management would send a strong signal throughout the complex that DOE takes its weapons program seriously and is not willing to tolerate less-than-the-best approach in its management. Such internal reform would reinforce the benefits of our proposals for strengthening Congressional commitment and oversight, and reaffirming the partnership between DOE and DOD.

We also found that the contractors lacked sufficient flexibility in personnel practices to recruit and retain critical personnel in the increasingly competitive technical labor market. One of the obstacles to more business-like practices is DOE's system for controlling contractual personnel costs known as the "Appendix A" system. The limits on personnel costs are specified in an Appendix A of each DOE contract. This system is distinguished from others by greater control exercised by the government than any encountered by the Commission in its discussions with organizations engaged in such work outside the DOE complex. The Appendix A system has not been subjected to the rigors of contract reform leading to changes better suited to current personnel market conditions. We note that the Department has gone to extraordinary lengths to enhance competition in search of the best contractors to manage its work. However, the current Appendix A system poses a risk of blunting the efforts of these managers and limiting their effectiveness through micromanagement of critical recruitment and retention programs. In the 'war for talent' discussed previously, successful firms vest their managers with the ability to remain flexible in the recruitment of new employees, especially in the technical fields.

We found concern regarding security clearances for personnel entering the workforce. Managers have been required too often to assign new hires to unclassified work for extended periods, often in areas unrelated to work for which the personnel were hired. This has discouraged and unreasonably delayed the integration and training of new recruits. DOE to its credit has established an Accelerated Access Authorization Program to expedite clearances. Nevertheless, the pace and availability of security clearances continues to be identified as an inhibition to recruitment efforts.

7. Problems in Coordination Within the Nuclear Weapons Complex.

(See Recommendation 4)

The two nuclear weapons physics design laboratories, Los Alamos and Lawrence Livermore, have yet to develop fully the sense of shared responsibility and cooperation which we believe is critical to the new conditions of the post Cold War era.

During the Cold War, the two laboratories had a highly competitive relationship in which they pursued much of their work relatively independent of one another, and the discipline of nuclear testing was the mechanism for determining success in new weapons designs. With the end of nuclear testing, independent and detailed inter-laboratory peer review has become the critical mechanism for validating calculations and judgments on the performance of aging and remanufactured weapons remaining in the arsenal. Vigorous peer review has become an essential part of science-based stockpile stewardship. The spirit of cooperation and trust has measurably improved; however, even closer coordination is necessary to ensure that both laboratories have complete data to facilitate dual revalidation.

8. Problems in Oversight of the Stockpile Stewardship Program.

(See Recommendation 11)

The SSP has many elements in its programs to maintain the existing nuclear deterrent and the capability to satisfy future requirements. Important to both objectives is acquiring detailed scientific understanding of nuclear weapons at a far deeper level than previously was the case. The research program which supports this task has theoretical, computational, and experimental components. The task of organizing and directing this research program is demanding, particularly so in an era of constrained resources. Especially difficult is the challenge of ensuring satisfactory balance among the program elements on a continuing basis to optimize the scientific advances with astute allocation of resources, to review progress and quality, to anticipate changes of emphasis in the program as knowledge accumulates, and to implement needed changes in the stockpile with minimum disruption. Interviewees raised concerns over the balance of funding between laboratories and production facilities, and within the laboratories between science and traditional weapons work. Others expressed concerns regarding the apparent mismatch between available resources and requirements, leading to cycles of doing more with less. We also found concerns over the lack of consistency in priorities, leading to cycles of program stops and starts.

Within each of the major laboratories—Los Alamos, Lawrence Livermore, and Sandia—the intra-laboratory tasks of setting research priorities, allocating resources, assessing progress, and insuring balance among the program elements is in place although not everyone concurs with the established priorities. Each laboratory director has a senior management council to provide program overview. The Assistant Secretary for Defense Programs has from time to time sought external review of SSP elements by the JASONS, Joint Advisory Committee, and the National Academy of Sciences (NAS). Recently, the NAS was asked to review the entire SSP. However, the Assistant Secretary has no permanent oversight body to assist in providing focused, high level oversight of the program.

9. Shortcomings in Knowledge Transfer Programs.

(See Recommendations 7, 9, and 10)

"Knowledge transfer" is a broad phrase which, for our purposes, has two different meanings.

The first meaning involves archiving the data upon which the current stockpile is based, baselining each weapon type in the stockpile,[22] and establishing the specifications for all weapon components which may at some time need remanufacture. This is necessary before the nuclear weapons complex loses the personnel who had active involvement in new nuclear weapon design, development, systems engineering, production, and nuclear testing.

We found that work was underway to accomplish these things. It was not clear that it had the priority nor the funding to insure success, nor that there was adequate staff available to accomplish the tasks that needed to be done.

The second meaning of knowledge transfer is to train new recruits in the nuclear weapons program in the technical aspects of their jobs. For obvious reasons, much of the specific, detailed science, engineering, and craft of nuclear weapons work does not lend itself to programs for a broad student population at civilian schools. It is accomplished once an individual is recruited into the nuclear weapons program, which may happen directly from school, indirectly from other programs at the national laboratories, or via lateral moves.

Over the last half century, the nuclear weapons complex has successfully managed the training of such individuals primarily through mentoring and on-the-job training. In some critical skill areas this training takes about five or more years to gain sufficient experience to make design decisions.

Currently, two new training initiatives have started as a supplement to on-the-job training. The "Intern Program" conducted by Sandia Laboratories is a two-year course intended to provide a general perspective for new employees concerning the nuclear weapons program as a whole and Sandia's role. The initial class was started in October 1998 with twelve people. "TITANS," an acronym for Theoretical Institute for Thermonuclear and Nuclear Studies, was initiated in October 1996 at Los Alamos as a course primarily focused on nuclear weapons design for new design personnel to facilitate knowledge transfer, use of archived data, and cross training. Both courses are in their initial pilot phase. Critical assessment of the curricula has not been done, nor

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[22] "Baselining" means acquiring a comprehensive understanding of the safety, reliability, and performance of each type of nuclear weapon, using all available tools.

have metrics for success been established. There are no other internal courses primarily designed as initial or continuing training for young engineers and scientists.

In describing the impact of the new environment on training, we found it useful to distinguish three separate communities: weapons design groups, weapons engineering groups, and groups at the production facilities. The most drastic change affecting knowledge transfer for the weapons design groups has been the disappearance of what used to be the key test which would show that a person had been trained successfully, a nuclear test. The weapons engineers are not as directly affected by the absence of nuclear testing but are affected by the absence of new system design and integration work. The technicians have a different problem. There are likely to be certain techniques which will be used only rarely in life extension programs for weapons in the nuclear stockpile because weapons components will fail at very different rates and need repair or replacement infrequently.

We also found that many of the traditional training tools had been used infrequently during the last decade as the program downsized, and are now slowly being reinvigorated. We are concerned, however, that given the centrality of on-the-job training, the current staff of experienced stewards may not be large enough, nor have the time to devote to the necessary training once the complex begins hiring at the greater rates which will be required in future years.

Concerning career planning and progression, many contractors and DOE personnel interviewed were not aware of a career plan for personnel. This was not a normal topic of discussion with their supervisors, although many of these individuals were given a periodic evaluation of their performance and had regular contact with the personnel they normally reported to. Additionally, key program documents provided little information on the status of personnel program issues or personnel initiatives.

The use of surveys of the attitudes of the workforce by employers varied widely throughout the nuclear weapons complex. One contractor surveyed a portion of the workforce quarterly so that all personnel were assessed every two years. Other sites investigated personnel satisfaction at annual or bi-annual intervals. Management at two sites had not done an assessment of workforce attitudes since the end of the Cold War. We found that employee surveys were valuable diagnostic tools.

10. Deficiencies in Reconstitution Capability.

(See Recommendation 7, 8, 9, and 10)

Throughout the nuclear weapons complex there are positions which require years of training to master requisite skills and develop technical judgment. These positions range from nuclear weapons designer, to the machinist of materials unique to nuclear weapons, to the nuclear test engineer who supervises the emplacement of the nuclear explosive. In many areas these skills exist today but are in short supply. As a result of downsizing throughout the complex during the last ten years, experts in key areas retired or moved on to employment in other areas, sometimes within the same contractor organization. Upcoming retirements will exacerbate the problem. New employees will have to be trained in these skill areas, but it will take time to train them to the level and in the numbers necessary to handle all potential demands. Further, as new employees are hired and trained in these unique skills we can expect some loss of newly trained personnel to other fields of work. Personnel with critical skills who leave the program represent an unexploited national asset.

We found no systematic planning within DOE to ensure that the complex could count on accessing qualified personnel with these critical skills once they have left the nuclear weapons program. Several facilities have programs to call upon the services of retired personnel, and others are beginning to improve their access to the expertise of retired personnel, but these programs are not as extensive as they could be. We did not find any plans to facilitate the recall of trained personnel still in the workforce but no longer in the weapons program. This was true even where persons with critical skills had moved on to other non-weapons related positions at the same facility. Since there were no plans in place to use these personnel there were also no plans in place to provide them with the information they might need to remain current in nuclear weapon program issues.

This situation is in contrast to the approach taken by the U.S. military who have long recognized the value of the investment in trained personnel, especially in rare skill areas. The military depends on reserve forces to augment active duty forces in times of need. Reserves are paid to be available when needed and are compensated for periodic training which maintains their skills.

Also, DOE must be prepared to respond rapidly should new weapons be required or nuclear testing be resumed. Conclusions in the September 1994, Nuclear Posture Review (NPR) were validated in the Quadrennial Defense Review and direct that the Department of Energy be ready to resume nuclear testing if necessary and be prepared to design and build new nuclear weapons, as required. When President Clinton announced the intent of the United States to pursue a comprehensive ban on nuclear testing, he established several safeguards, one of which is to be prepared to resume nuclear testing should the U.S. cease to be bound by the treaty.[23] The cadre of trained personnel with unique skills who have retired or moved on to other jobs represent a significant potential addition to the workforce that would be needed to address these increased demands should they arise.

11. Perceived Weaknesses in the DOE-DOD Relationship.

(See Recommendations 3 and 12)

During the downsizing of the nuclear weapons program, the working relationship between DOE and DOD which once helped structure the process was disrupted. Until recently, meetings of the Nuclear Weapons Council—the key body for coordinating future requirements with existing plans—were infrequent. Debates over programs and resource allocations fed the perception that DOE and DOD had less than a full partnership. Plans for weapon requirements lacked agreement, and DOD had not prepared a comprehensive roadmap as detailed or definitive as the SSP plan.[24] However, the Commission was encouraged to learn that the preparation of a DOD plan has now been directed.[25]

We also found that there is a perceived, and often real, disconnect between DOE and DOD understanding of program needs. Part of the problem arises from very different programming and budgeting processes in the two agencies. The prospects for maintaining long-term support for the SSP are a powerful driver of workforce attitudes towards their future. There is little hope for long term support unless DOE and DOD agree in both defining and supporting the program — in public statements, in dealing with the budget process in the administration, in dealing with the Congress.

12. Deficiencies in Current Plans for the Nuclear Weapons Program.

(See Recommendation 2)

A great deal of planning occurs continuously for the nuclear weapons program. For example, the NPR of 1994 set the force levels for START I and START II postures. The Nuclear Weapons Stockpile Memorandum (NWSM) and the Long Range Planning Assessment (LRPA) establish the size of the nuclear weapons stockpile to meet requirements. These documents are reviewed annually by DOE and DOD. Nevertheless, we found that there is not an adequate, mission-oriented,

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[23] Safeguard F, Comprehensive Test Ban Safeguards, The White House, September 22, 1997.
[24] This also was the conclusion of the Defense Science Board Task Force on Nuclear Deterrence, September 30, 1998.
[25] DEPSECDEF Memorandum, Nuclear Mission Management Plan, dated December 8, 1998.

requirements-driven, integrated long-range plan to order laboratory and plant priorities. While the Department acknowledges the need for such a plan, it does not appear to be addressing the matter with a sufficient degree of urgency.

The SSP must, but does not yet achieve a balance between addressing short-term needs and deliverables that will affect the stockpile over the coming decade. This requires expediting the Enhanced Surveillance Program (ESP), whose purpose is to provide confidence of timely detection of any significant effects of aging in the weapons, and identifying ways of fixing the weapons as required. Carefully validated data on the aging of metals, explosives and other parts of the weapons are essential to a deeper science-based understanding of the weapons. These data will be the key to a SLEP plan which will provide a valid basis for sizing and timing the production and remanufacturing complex needed to meet the strategic needs of the nation and to assuring the continued reliability and effectiveness of the U.S. deterrent forces.

The need for such a fully developed SLEP plan is well recognized at the facilities we visited. The contractor workforce at nearly all nuclear weapons facilities expressed uncertainty, concern for the future and a high degree of skepticism concerning the current (preliminary) SLEP. We found that the management at one facility had not yet promulgated a future year plan to the workforce because the existing SLEP was not sufficiently well defined. We understand that work is in progress to revise the existing plan by a SLEP working group at DOE headquarters. Added to this, there also are funding and planning uncertainties associated with tritium production and pit production that must be dealt with to sustain the stockpile.[26] Present and future arms control issues will continue to affect such planning.

[26] Recently, Secretary Richardson made the decision that tritium production will take place at TVA's Watts Bar and Sequoyah Reactors. Congressional action with respect to this decision is pending.

IV. Recommendations

A. National Commitment

1. Reinforce the National Commitment and Fortify the Sense of Mission.

(Reference Finding 1)

The Administration and the Congress through their actions as well as words, should make a concerted and continuing effort to convey to the nuclear weapons community that its mission is vital to the security of the nation and will continue to be vital well beyond the planning horizons normally associated with programmatic decisions. This message needs to be unequivocal and clearly emphasized since as we learned the nuclear weapons community still is concerned about its future and the future of the nuclear weapons complex. In spite of public declarations by national leaders, we found a high degree of skepticism, shared by many of the men and women we talked to, about the nation's long-term commitment to nuclear weapons programs.

It is thus imperative that the nation's long term commitment to maintaining an effective, safe, and reliable deterrent be powerfully and clearly emphasized by the nation's leaders. Part of the challenge is to distinguish this commitment from goals or hopes stated by individuals in and out of government that nuclear weapons may be eliminated over the long term. The distinction between long-term political goals and nearer-term programmatic goals is a critical one to the sense of mission within the nuclear weapons program.

B. Program Management

2. Complete an Integrated, Long-Term Stockpile Life Extension Program Plan.

(Reference Findings 1 and 12)

Detailed planning for the inevitable remanufacture of weapons components needs to receive a very high priority — higher, we believe, than we currently encountered. In particular, the nuclear weapons complex must establish an empirical base for the remanufacturing and production facilities based on what is learned from the vigorous ESP, dual revalidation and the evolving SLEP. In the absence of such planning, the sizing of the staff at the production facilities will be left unnecessarily uncertain.

DOE has been working on a mission-oriented, requirements driven, integrated long-range plan. We recognize that many detailed SLEP issues cannot be settled at this time and that the plan must have significant flexibility. But we urge the early completion and dissemination of such a plan to provide the baseline workload level for future years with a surge capability, and account for activities that are currently unfunded. Such a plan would:

- Establish the programmatic need for hiring and retention of essential personnel to counter the current perception that the nuclear weapons program will either experience near-term downsizing or that the work will disappear at their facilities;
- Create and enhance a sense of workforce stability and commitment;
- Permit all sites to prioritize work, experiments and design initiatives; and
- Aid in demonstrating the need for long-term fiscal commitment to the SSP.

3. Strengthen the DOE-DOD Relationship.

(Reference Findings 1 and 11)

The DOE-DOD relationship needs strengthening to ensure better budget and program coordination to meet national security needs. A strong partnership must be created between the DOE and DOD with solid support and agreement on stockpile stewardship matters. This partnership must transcend the relationship normally expected between a customer and a supplier. Agreement between the two agencies should extend from the need for the mission to the details of the programs required to accomplish the mission.

This partnership must be able to deal with inherent uncertainties, in the likelihood of ratifying START II, in the timing and provisions of START III, in the confidence in stockpile stewardship, and others.

DOD, through the mechanism of the Nuclear Weapon Council and its subordinate structure, should arrive at an understanding with DOE on the dimensions and priorities for the nuclear weapons complex. Once that is accomplished, DOD needs to be highly vocal in its long-term commitment to maintaining the nuclear forces as defined by national policy. It will take a serious commitment to erase the existing perception among the nuclear weapons workforce that DOE and DOD are at odds over requirements and that DOD is opposed to the funding needed by DOE to maintain nuclear capabilities.

DOE with DOD full support needs to proceed with the detailed planning and programming which is the visible manifestation of the nation's commitment to maintaining the nuclear weapons stockpile. The program should lay out requirements in enough specificity to clearly convey that this is a serious, continuing, high priority enterprise. This message must be communicated clearly and convincingly to the workforce at all levels.

DOD has no companion nuclear weapon stewardship plan comparable to the SSP. We recommend that DOD develop such a plan to facilitate mutual planning and support. We understand such action has been directed.

4. Take Immediate Steps to Achieve Greater Laboratory Coordination.

(Reference Finding 7)

It is imperative that DOE and the laboratories ensure that the dual revalidation process and other important elements of the SSP, in particular data from the ESP and SLEP, be based upon independent, reliable checks with vigorous peer review. We believe that this peer review can best be achieved by having our two nuclear weapon design laboratories, Los Alamos and Lawrence Livermore, accept a shared but independent responsibility for the nuclear weapons. Dual revalidation and confident certification of replacement parts for weapons, in particular newly manufactured pits, require a fully open process of coordination and cooperation between the scientific communities of the labs as they compare and critique each others' work.

Enhancing the spirit of open cooperation and trust between the scientific and engineering communities working at the laboratories also is valuable in the training of a new generation of weapons scientists as they learn the varied styles and methods of analysis of each laboratory. More joint working seminars and task forces could, for example, develop and critique plans to understand and sustain adequate performance margins or to evaluate the strengths and weaknesses, if any, in modeling codes developed at the two laboratories.

5. Expedite Improvements and Efficient Use of the Nuclear Weapons Production Complex.

(Reference Findings 1 and 5)

We urge expeditious preparation of a coordinated plan with necessary funds to modernize and rightsize the production facilities. This would help morale through upgrading that part of the complex needed to maintain the stockpile and help resolve the uncertainties at the nuclear weapons production facilities. It also would resolve issues of maintenance of equipment and facilities no longer needed and allow contractors to achieve a reasoned balance between production and maintenance.

6. Establish Clear Lines of Authority Within DOE.

(Reference Finding 6)

The Commission believes that the disorderly organization within DOE has a pervasive, and negative, impact on the working environment and, therefore, on recruitment and retention. Accordingly, the Commission recommends that the Secretary of Energy organize Defense Programs (DP) consistent with the recommendations of the 120-Day Study. We recommend three structural changes.

First, Integrated Safety Management should be adopted. This necessary change will place operational responsibility for ES&H in line management and will correspondingly focus the missions of headquarters staffs in DP (and EH) on developing policies and overseeing processes. This should drive a corresponding reduction in headquarters staffs.

Second, DP should be structured to eliminate overlapping responsibilities between headquarters and the Albuquerque Operations Office. DP headquarters should focus on top management tasks, including shaping and guiding the organization (strategic management, budget guidance, policy guidance, and program direction) and managing external relationships with DOD, the Congress, federal regulatory organizations, and other elements of DOE. The Albuquerque Operations Office should become responsible for operational activities, including program execution, contract management, and facility operations oversight. The Manager of Albuquerque Operations should report directly to the Assistant Secretary for Defense Programs. The Assistant Secretary for Defense Programs can then determine proper roles of headquarters and Albuquerque Operations Office for research and development (R&D) program execution and ensure integration of production and R&D activities.

Third, direct reporting chains should be established for the remaining operations offices responsible for administering weapons facility contracts. Thus, for operational matters relating to the nuclear weapons program, the Operations Offices at Oakland, Oak Ridge, Nevada, and Savannah River should report to the Assistant Secretary for Defense Programs through the Albuquerque Operations Office. This will provide the Assistant Secretary for Defense Programs with oversight authority for all facilities supporting the nuclear weapons program, as well as the execution of the program.

It is our judgment that these organizational and reporting changes can and should take place without awaiting changes in the management and organization of the remainder of the DOE. As part of this reorganization effort, DP should strengthen its adjustment of program requirements and resources.

C. Personnel

7. Establish and Implement Plans on a Priority Basis for Replenishing Essential Technical Workforce Needs in Critical Skills.

(Reference Findings 2, 3, 4, 6, 9, and 10)

We recommend that DOE, the laboratories, and the production plants establish and implement plans on a priority basis for replenishing essential personnel. These plans should have long-term as well as short-term focus and should provide for hiring scientific, engineering, and technical talent in anticipation of recognized needs. The Secretary and other senior DOE managers should take responsibility to ensure that these plans are developed and implemented.

Following a period of significant downsizing of the nuclear weapons complex, recruitment of a new generation of employees, especially critically skilled employees that constitute the essential workforce addressed in this report, has resumed slowly. Yet it has not resumed at the pace nor with the scope needed to reverse the demographic trends described in the findings and in Appendix D. Unless this is changed, the complex will face a crisis of talent within the next 15 years. Moreover, unless the pace of hiring significantly accelerates, the knowledge transfer programs that are being established at separate facilities will have difficulty succeeding.

We found no coordinated plan or management perspective addressing these serious problems across the entire nuclear complex, and we found a universal lack of long-term strategic personnel plans at individual facilities. Management at each facility is approaching the problem piecemeal, with a pronounced short-term focus and without the urgency or priority the issue deserves. Managers appeared to appreciate in a general way the seriousness of the situation, but in an era of constrained resources following a long period of downsizing with little or no recruitment, the situation — as it was described to us at one location in terms applicable to all — is one of being in a "fragile recovery state." We agree.

In the overall plans, the best practices of industry and comparable federally funded organizations for the recruitment of employees should be identified, encouraged, and supported programmatically. The laboratories and production facilities must increase their presence at national and regional universities, i.e., at science fairs and colloquia and through recruitment visits. Post-doctoral, intern, and continuing education programs should be emphasized as especially important recruitment tools, and special emphasis should be placed on making the nuclear weapons complex an attractive place for women to work, given the increasing fraction of women in the scientific and engineering programs at American universities.

DOE must take necessary actions to obtain prompt security clearances to accommodate the influx and rapid integration of new personnel required to maintain critical skills.

8. Provide Contractors with Greatly Expanded Latitude and Flexibility in Personnel Matters.

(Reference Findings 2, 3, 4, 6, and 10)

We recommend that DOE, working with its contractors, change the personnel appendix of facilities contracts (Appendix A to each of those contracts) so that contractors can offer genuinely competitive salaries and benefits packages to recruit and retain scarce and highly sought talent. To be competitive in the war for talent, DOE must accept significant departures from its past practices. Contractors should be authorized and encouraged to make salary and benefits adjustment decisions for employees without having to refer individual cases to DOE for concurrence, particularly for personnel in critical skill areas.

In keeping with the DOE's general duty to eliminate excessive oversight and micromanagement of its laboratories and contractors, a matter well documented in the Galvin Commission Report and other external reviews, the Department must make greater progress in providing the latitude and flexibility necessary for attracting and retaining personnel.

9. Expand Training and Career Planning Programs Which Are Adapted to the Dramatically Changed Workforce Environment.

(Reference Findings 2, 9, and 10)

Training the new workforce and validating the effectiveness of training must be among the highest priorities of the nuclear weapons complex. Over the last half-century, the nuclear weapons production plants and laboratories hired technically educated personnel and then trained them in the unique aspects of nuclear weapons work, primarily through apprenticeship and on-the-job training. We believe that the prudent procedure now would not change this basic process but adapt it to the changing environment. The most dramatic changes in this new era, as we have noted, are the end of nuclear testing and the lack of new nuclear weapons development and major production.

On-the-job training will continue to be the primary means of transferring the needed skills to the new generation of nuclear weapon designers and engineers. Dual revalidation of stockpiled weapons, including the effects of aging, the reevaluation of past anomalies in nuclear tests, exploratory development programs, and the design of non-nuclear experiments will provide the challenge for the on-the-job training of new nuclear weapons designers and engineers. Evaluating the effectiveness of the training of designers will present a different problem than it does for engineers.

For nuclear weapons designers a nuclear test was the ultimate measure of competence and training effectiveness, preceded by an intense pre-test peer review. Nuclear testing is not now available, and the review process therefore must take on the full burden. Special care should be given to establishing the highest quality possible review groups for this purpose. The members should be drawn from senior designers and engineers with test experience from both design laboratories, wherever they can be found. They should not be directly associated with the work to be reviewed if employed at the design laboratories. Retirees may be especially valuable for these review groups.

The loss of testing does not directly impact the weapons engineers who still have their traditional methods of checking the validity of their efforts. However, these engineers will be evaluating and repairing old systems. These systems are likely to have materials which are no longer available or which were fabricated differently than they are now. We recommend that the laboratories consider using former weapons engineers to clarify the reasons for past design decisions particularly when some of the fabrication methods or materials are no longer available to the new system. This might constitute a valuable "knowledge transfer" function.

In particular, we are concerned with DOE's capability to reconstitute the requisite skill set should a resumption of nuclear testing be required. Sub-critical experiments exercise some, but not all, of the core competencies required for a nuclear test. We believe there is risk that these competencies will erode over time through non-use. Consequently, we recommend periodic examinations to determine whether the requisite core competencies and proficiencies remain available to conduct a test in the event one is required. Specific attention should be directed to training exercises and advanced simulation techniques to address those skills and competencies that are not being exercised in a non-test environment. The emplacement of bore-hole diagnostic instrumentation and like procedures are particularly important examples.

There also appears to be value to some formal training component such as the Intern program recently begun at Sandia and the TITANS program underway at Los Alamos. It will be important to establish metrics to measure the success of these formal training programs to achieve an optimum balance between on-the-job training and formal training. Should it be established that formal courses are a valuable adjunct, such courses should be adopted more broadly.

It is recommended that system engineering design and integration skills be exercised to maintain competence and train new employees. For example, the Navy Strategic Systems Programs is conducting a Warhead Protection Program with DOE. This effort will exercise almost all of the system design and integration process. Such programs can give weapons engineers valuable experience. Maximum use of system designers should be pursued in this effort. Other similar programs should be developed. DOE should also encourage the laboratories to continue their decades old practice of exploratory development programs since these programs have allowed experienced engineers and scientists to maintain their systems engineering skills and train new employees.

We recommend providing the scientific and engineering staffs of the production complex the opportunity to participate in the laboratories' training programs, and vice versa. We also recommend increasing exchange programs between the laboratories and the production facilities to enhance cooperation between laboratory personnel and plant production engineers.

We concur with expanded formal training of technicians and personnel performing repetitive processes. Additionally, we urge that technicians be cross-trained so as to be available for a variety of jobs involving the unique materials and designs of the stockpile. There are likely to be some techniques only used rarely in the SLEP. Weapons components will fail at different rates and may need repair or replacement infrequently. Cross-training technicians is likely to be an advantage in scheduling weapons rebuilds and also should be appealing to the technicians themselves, making them more broadly employable.

Career planning needs high level review and adaptation to the changing environment. There needs to be better planning for the progression of key personnel. All facilities need to provide periodic feedback by supervisors to employees on their performance and potential for advancement. Additionally, a method is needed for periodic measurement of employee attitudes toward their work.

10. Expand the Use of Former Nuclear Weapons Program Employees.

(Reference Findings 2, 9, and 10)

We believe that use of former nuclear weapons program employees should be expanded in three ways. The first is to create a Nuclear Weapons Workers Reserve to maintain the ability to increase staff in response to requirements. A specialized reserve, of limited scope, could provide the nuclear weapons complex with the ability to rapidly expand its critical skills in times of need. A Nuclear Weapons Workers Reserve would be made up of personnel who had previously exercised their skills while working in the nuclear weapons complex but had left the nuclear weapons program for other employment either in the complex, or elsewhere. Membership would entail retention of security clearances and would require an annual return for a week or two to the nuclear weapons complex to refresh and exercise special skills. Appropriate reservists should also be involved in the peer review of the work of active employees. The intended purpose could only be achieved if, during active duty periods, the reservists exercise the specific skills they are being asked to retain, by doing real work, side-by-side with current workers. Reservists would be compensated for their active duty as well as receive compensation for being "ready" should the need arise.

We do not expect that every position in the work force would need a reserve component. For positions in which newly hired personnel could achieve competence in months, no reserve would be needed. But for positions which require years of training, the Reserve may be the only way to ensure that the country can respond to emergencies with the necessary alacrity.

Second, we recommend more aggressive use of recent retirees at the nuclear weapons laboratories to train new personnel. The retirees can also assist with time urgent work they are qualified to perform. In Recommendation 7 we call for the hiring of a substantial number of new scientists and engineers in anticipation of the retirement of the aging workforce. The training of these new personnel would require significant effort by the more experienced workforce who themselves would be hard pressed to accomplish their current work. In addition, the recent retiree is likely to have had hands-on experience with development of the enduring stockpile and is ideally suited to relevant archiving and baselining activities.

This pairing of new employees and retirees is a variation to the apprenticeship model which has been the core of nuclear weapon scientist and engineer training in the past. Throughout, it will be important that retirees accept their "master" to "apprentice" role and avoid the criticism we have heard from some current employees, that retirees too often want to do the work to the exclusion of others. Every effort should be made to provide sufficient incentives to make the opportunity attractive for retirees.

Third, we recommend that a select set of former weapon scientists and engineers be used as reviewers of on-going weapon program issues. All of the retained weapon types will have to be revalidated at various times. If controversial issues arise in those reviews it is suggested that the best of the former designers who are still competent be used for any high level reviews connected with these issues. The two nuclear design laboratories should establish a formal, cooperative program to keep these designers abreast of advances being made in the understanding of the operation of nuclear explosives.

D. Oversight

11. Create a Permanent Defense Programs Advisory Committee.

(Reference Finding 8)

DOE should have a new and more powerful means of providing oversight of the SSP than it has at present. We recommend the creation of a permanent board — a Defense Programs Advisory Committee. It should be comprised of senior, experienced people (including those with weapons design experience), reporting to the Assistant Secretary for Defense Programs and through the Assistant Secretary to the Under Secretary. The Committee should be responsible for providing a continuing assessment of the SSP effort, including identifying new needs in surveillance and manufacturing.

Such a Committee would assist the Assistant Secretary in setting program priorities and in making necessary adjustments. The Committee should address uncertainties in schedules, and support for research and production that otherwise can lower morale in the program. All of this, in turn, should enhance prospects for retaining critical personnel. Matching resources, personnel, priorities and schedules also should bring additional stability to the whole program and facilitate orderly planning of personnel requirements.

There are historical precedents where similar committees have provided services of immense, indeed irreplaceable, value to the nuclear weapons program. We believe that implementing this recommendation will help improve the SSP.

12. Enhance Congressional Oversight.

(Reference Findings 1, 6, and 11*)*

We believe that Congressional oversight of the nuclear weapons program should be reinvigorated. Historically, the Congress had a major role in the nuclear weapons program. It is our sense that the Congress again needs to take a strong role in overseeing and supporting the conduct of the nuclear weapons program in this critical transition period and should consider organizational changes as may be appropriate to this purpose.

A focused and structured Congressional nuclear weapons program oversight will go a long way to strengthening public and program participants' perceptions that the maintenance of the safety and reliability of the stockpile is, indeed, "a matter of supreme national interest." By investing the time and resources appropriate to a serious and continuing oversight effort, the Congress will give tangible evidence of the importance of the program.

Such oversight might also provide a basis for the Congress to make clear its commitment to a sustained, multiyear funding of the stewardship program. The SSP is predicated upon a 10-year appropriation of approximately $4.5 billion per year. The Congress has recently approved a first installment for fiscal year 1999.[27] Yet more needs to be done to give talented potential recruits and the existing laboratory and production plant workforce confidence that they will have career opportunities comparable to those of other endeavors they might pursue. Moreover, those attracted to the scientific and technical challenges of the SSP need to be assured that the high performance computational capabilities and the diagnostic tools essential to their work will actually be funded and available. Many have multiyear lead times. Consequently, it will be extremely helpful to our ability to retain and refresh the stockpile stewardship talent pool if the Congress could find a way to strengthen confidence in the outyear funding of the program by this or other means.

The Congress needs to provide explicit, positive reinforcement of the public service character of this undertaking in its deliberations and reports. Words also help. The deliberations of the Congress and the workings of its committees are closely followed in DOE and its contractor community. Affirmative reinforcement of the mission and its importance in committee reports and floor statements contribute to stewards' confidence that their work is valued by the Nation and that adequate funding support will be forthcoming.

Support within the Congress for the program would become broader if authorizers and appropriators become more knowledgeable about program details and implementation. There is an equally important matter. There should be an enforced obligation to give a periodic, scheduled accounting to Congressional overseers. This will focus management attention at the highest levels of DOE and DOD and help ensure that both are working at common purpose. To this end, we recommend that the Congress hear directly from the Nuclear Weapons Council on an annual basis.

An enhanced Congressional oversight process would improve Congressional confidence in program integrity sufficiently to allow DOE managers greater reprogramming latitude. The SSP is currently at a stage of development where the need should be expected to rebalance resources within overall resource caps set by the Congress and DOE. The Department will likely need greater reprogramming authority within a budget cycle than the Congress has in recent years been willing to vest in DOE management. Similarly, a more systematic oversight mechanism will increase Congressional awareness of other managerial impediments to getting the job done.

[27] The appropriation actually fell somewhat short of the requested $4.5 billion, although appropriators believed the difference could be made up with uncosted balances of prior appropriations.

Finally, we hope the Congress, through its oversight function, will support the Commission's recommendations. For example, if the Congress were to share the Commission's judgment that DOE (Defense Programs) must simplify its line management structure, the Congress would need to provide the Department with more flexible tools to incentivize necessary reallocations and staff reductions. This would diminish resort to blunt instruments of mandatory reductions in force and the like.

Appendix A: Information on the Commission

I. Task

"Develop a plan for recruiting and retaining within the DOE nuclear weapons complex such scientific, engineering and technical personnel as the Commission determines appropriate in order to permit the Department to maintain over the long term a safe and reliable nuclear weapons stockpile without engaging in underground nuclear testing."

"...identify actions that the Secretary may undertake to attract qualified scientific, engineering and technical personnel into the nuclear weapons complex of the Department."

"...review and recommend improvements to the ongoing efforts of the Department to attract such personnel to the nuclear weapons complex."

Section 3162 of the National Defense Authorization Act of 1997, as modified by the National Defense Authorization Act of 1998.

II. Commission Membership

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Appendix B: Study Plan

I. Methodology

The Commission employed a variety of means to glean information and develop an accurate understanding of the state of the nuclear weapons complex and the recruiting environment it faces. The Commission received briefings and background information from DOE and the weapons facilities, as described in the table below. Documents reviewed are listed in Appendix F. In addition, the Commission met regularly throughout the year at the headquarters of Systems Planning and Analysis, Inc. (SPA) in Alexandria, Virginia. These meetings and the major agenda items are summarized below. Lastly, selected Commissioners met with commercial enterprises and laboratories and visited colleges and universities from which significant recruitment takes place. We are grateful for the time and support provided by individuals from these institutions.

Date	Subject or Activity	Principal Contacts
2 Mar 98	Background Briefings at DOE HQ	Gene Ives, DOE/DP ASDP Reis, DOE
21 May 98	Meeting in Alexandria, VA Background Briefings on DOE National Labs and Weapons Production Facilities Discussions with DNFSB	C. Paul Robinson,SNL Karen Clegg, Allied Signal/KCP
15-17 Jun 98	Site Visits to LLNL, SNL-L, and OAK	C. Bruce Tarter, LLNL Mike Anastasio, LLNL John Crawford, SNL/NM Tom Hunter, SNLL James M. Turner, DOE/OAK
22-24 Jun 98	Site Visits to SNL/NM and LANL and briefings by AL	Roger Hagengruber, SNL Pete Miller, LANL Stephen Younger, LANL Rush Inlow, DOE/AL

Date	Subject or Activity	Principal Contact
20 Jul 98	Site Visit to KCP	Karen Clegg Allied Signal/KCP
21 Jul 98	Site Visit to PANTEX	W. A. Weinreich, Mason & Hanger
10 Aug 98	Site Visit to NTS and NV	John Mitchell, Bechtel Nevada Gerry Johnson, DOE/NV
18-19 Aug 98	Meeting in Alexandria, VA SLEP U.S. Navy Perspectives on Nuclear Weapons Sustainment Lockheed Martin Naval Research Laboratory JHU/APL	 Gene Ives, DOE/DP Barry Hannah, Navy SSP Ken Disken Timothy Coffey Gary Smith
25 Aug 98	Site Visit to Oak Ridge Y-12 Plant	Robert D. Dempsey, DOE/OAK F. P. Gustavson, LMES
26-27 Aug 98	Site Visit to SRS	Greg Rudy, DOE/SRS Ambrose Schwallie, WSRC
15 Sep 98	Meeting in Alexandria, VA DOE Counterintelligence (CN) DOE Personnel	 Ed Curran, DOE/CN ASDP Reis, DOE
6 Oct 98	Commission Visit to DOE/HQ	Under Secretary Moniz, DOE
15-16 Oct 98	Meeting in Alexandria, VA	
26-27 Oct 98	Meeting in Alexandria, VA DOE Perspectives on DNFSB STRATCOM Perspectives on Nuclear Weapons Sustainment USAF Perspectives on Nuclear Weapons Sustainment	 Gene Ives, DOE/DP Ted Hardebeck, USSTRATCOM BGEN T. McMahon USAF/XON

Date	Subject or Activity	Principal Contact
29 Oct 98	Commission Visit to Dr. Gansler	Under Secretary Gansler, USD (A&T)
30 Oct 98	Commission Visit to Commonwealth Edison Company, Chicago, IL	Louis DelGeorge
9 Nov 98	Site Visit to DOE Germantown	
10-11 Nov 98	Meeting in Alexandria, VA DOE/DP Management and Planning DNFSB Issues	Under Secretary Moniz, DOE Vic Reis, DOE/DP John Conway, DNFSB
30 Nov 98	Commission Visit to JPL, Pasadena, CA	Sue Henry
14 Dec 98	Meeting in Alexandria, VA USN Perspectives on Nuclear Weapons Sustainment	RADM Shipway and CAPT Dwyer, SSP CAPT Winney, OPNAV CAPT Talbot, DCNO (Manpower and Personnel)
12-14 Jan 99	Meeting in Alexandria, VA	
13 Jan 99	Commission Visit to DOE	Secretary Richardson, DOE Under Secretary Moniz, DOE Vic Reis, DOE/DP
20-22 Jan 99	Commission Visit to DOE/ AL, SNL, LLNL, DOE/OAK	Multiple Officials
26-27 Jan 99	Video Conferences from DOE/HQ with LANL, NTS, Pantex, Kansas City, Oak Ridge Y-12, SRS	Multiple Officials
10-11 Feb 99	Meeting in Alexandria, VA	

III. Benchmarking Organizations

The following organizations provided information useful to the Commission in judging the recruiting marketplace and evaluating alternative strategies for coping with difficult workforce issues.

Organization	Location
The Charles Stark Draper Laboratory	Cambridge, MA
Commonwealth Edison Company	Chicago, IL
Jet Propulsion Laboratory	Pasadena, CA
The Johns Hopkins University/ Applied Physics Laboratory	Laurel, MD
Lockheed Martin Corporation	Bethesda, MD
Naval Research Laboratory	Washington, DC

IV. Universities and Colleges

The students, department chairs and placement officials from the institutions below provided helpful information on the attitudes of the current generation of students and teachers towards careers in the nuclear weapons field and recruiting strategies of the most successful technical organizations.

Institution	Location
Albuquerque Technical Vocational Institute	Albuquerque, NM
Colorado School of Mines	Golden, CO
Georgia Institute of Technology	Atlanta, GA
Massachusetts Institute of Technology	Cambridge, MA
New Mexico State University	Las Cruces, NM
Stanford University	Palo Alto, CA
Texas A&M University	College Station, TX
University of California	Berkeley, CA
University of California	Davis, CA
University of Illinois	Urbana, IL
University of New Mexico	Albuquerque, NM
University of Tennessee	Knoxville, TN

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Appendix C: Survey Results

I. Background

The survey was conducted to identify and prioritize the important factors in recruiting and retaining personnel for the nuclear weapons program. The survey results also served to clarify and substantiate the impressions gained during the site visits, interviews, and focus group meeting. The survey was distributed separately by each site to engineers, scientists, and technicians involved with the nuclear weapons program. Separately, placement officers, professors, and students at academic facilities from which nuclear weapons personnel have been traditionally recruited were interviewed. The main body of this report addresses the survey of current nuclear weapons personnel; the results from the academic staff and student interviews are found in Section XV of this Appendix.

Estimates of the possible number of respondents and the number of completed surveys received from nuclear weapons personnel are summarized below:

	# Possible	# Received	% Received
SANDIA	2,100	1,054	50%
LLNL	2,137	1,094	51%
LANL	1,840	1,331	72%
KCP	780	454	58%
PANTEX	1,093	801	73%
SRS	239	84	35%
Y-12	1,648	353	21%
NTS	725	358	49%
DOE	204	204	100%
TOTAL	10,766	5,733	53%

The overall response rate of 53% is higher than normally expected from a survey. The percentages of respondents by job, age, and education level reflect the actual population at each site. The analytical results are thus considered statistically significant and unbiased, i.e., they accurately represent the employed cross-section of age groups, jobs, education levels, and years of nuclear weapons related work. The survey was voluntary, anonymous, and not-for-attribution.

The survey questions addressed several themes. The first theme sought the identification of job-related factors that are important for retention of current employees. The second probed the issue of how well employees thought each important job-related factor was being provided by their employer. The third theme investigated employee interest in an exchange program and sabbatical, and where they would most enjoy going. The fourth theme revolved around current years of service in the nuclear weapons program, whether or not continued participation required non-nuclear weapons work, and interest in continuation of current work until retirement. The fifth theme involved training: modes, effectiveness, and utilization. The sixth theme addressed employee confidence in the organization's management relative to several specific issues. The seventh theme sought answers to how much non-technical work employees were performing. The eighth theme involved the respondent's level of satisfaction with new hires, and how aware potential hires are of the nuclear weapons program, facilities, and laboratories. The ninth theme involved perception of nuclear weapons program stability. The tenth theme focused on the question, "Would you recommend your laboratory, facility, or test site as a good place to work?"

The survey concluded with three open-ended questions. The first addressed recruitment and asked, "What initially attracted you to your organization and nuclear weapons related work?" The second dealt with retention and asked, "If you could change one aspect of your job, or purchase or acquire one thing to make your work easier or more efficient, what would it be?" The final question sought ideas for improving recruitment and retention by asking simply, "What more would you like to say to the Commission?" A copy of the survey questionnaire is included in Section XVI of this Appendix.

II. Importance of Job-Related Factors

The Most Important Factors

The survey requested that individuals indicate the importance of 24 different job-related factors on a scale of 1 (least important) to 10 (most important). Figure C-1 is a matrix of the results. The matrix is sorted in descending order, by overall average, across all organizations.

The definitions of the abbreviations used in the matrix are:

- Chalng Work = Interesting & challenging work
- Benefits = Benefits (insurance, vacation, sick leave, pension, etc.)
- Job Security = Employment (job) security
- Salary = Compensation/ salary
- w/ respect = Being treated with respect
- Self-improve = Opportunity for self-improvement
- QOL = The Quality of Life in the community where your job is located

- Advancemnt = Opportunity for advancement & promotion within the organization
- Inter. Comm = Quality of internal communications, i.e., how well you are kept informed
- Reputation = Professional reputation of the organization
- Smart People = Stimulation from working with smart people
- Recog. perf = Organization's policy for recognizing and rewarding outstanding performance
- Work Env. = Physical work environment
- Flex time = Company's policy on flextime or a compressed work week.
- Chg w/i Org = Opportunity for changing jobs within organization.
- Prestige = Opportunity for acquiring increased prestige or peer recognition
- Nat'l Contrib. = Opportunity to make a nationally important contribution
- Dress Code = relaxed dress code
- Travel = Work related travel opportunities
- Telecomm = Opportunity for telecommuting
- Sabbatical = Opportunity to take a sabbatical
- Publish = Opportunity to publish
- Part-time = Opportunity to work part-time or less than full-time.
- Child Care = Child care.

The assessment of the most important job-related factors display an amazing consistency across organizations. The five factors rated as most important were identical at all eight nuclear weapons sites and DoE. They are: the "Opportunity for Performing Challenging and Interesting Work," "Benefits," "Compensation (Salary)," "Job Security," and "Being Treated with Respect." See Figure C-1. On a ten-point scale, each of the five factors received an overall rating between 8.6 and 8.8, and at no site did any factor receive an average rating below 8.3. Nuclear weapons program employees at all sites believe that these top ranked factors are very important job-related factors.

Figure C-1. The Importance of Job-Related Factors (Sorted by Overall Average)

	LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS	Overall Average
Chalng Work	9.0	8.9	8.9	8.6	8.4	8.7	8.8	8.8	8.5	8.8
Benefits	8.7	8.6	8.5	9.0	9.1	8.9	8.7	8.6	8.7	8.7
Job Security	8.6	8.4	8.4	9.0	8.9	8.9	8.7	8.3	8.5	8.6
Salary	8.5	8.5	8.4	9.0	9.0	8.7	8.5	8.4	8.5	8.6
w/ Respect	8.7	8.5	8.5	8.7	8.8	8.7	8.6	8.4	8.5	8.6
Self-improve	8.2	8.0	7.9	8.2	8.0	8.2	8.4	8.0	8.2	8.1
QOL	8.5	8.1	7.5	8.0	8.32	8.5	8.4	8.0	7.8	8.1
Advancemnt	7.8	7.5	7.9	8.1	8.2	8.4	8.5	7.8	8.2	7.9
Smart People	8.3	8.1	8.1	7.4	7.1	7.7	7.8	8.0	7.6	7.9
Reputation	8.1	7.7	7.8	7.4	7.8	8.0	7.9	7.9	7.6	7.8
Inter. Comm	7.8	7.5	7.6	7.6	8.3	8.3	8.0	8.1	7.7	7.8
Recog. perf	7.8	7.7	7.9	7.8	7.7	7.8	7.8	7.7	7.6	7.8
Chg w/i Org	7.4	7.5	7.4	6.7	7.2	7.0	7.1	6.9	7.0	7.2
Work Env.	7.1	7.1	7.1	7.2	7.3	7.2	6.9	6.7	6.7	7.1
Nat'l Contrib.	7.6	7.5	7.6	6.0	6.3	6.5	6.2	7.4	6.4	7.1
Prestige	7.0	6.9	7.0	6.8	6.8	6.7	7.1	7.3	6.7	6.9
Flex time	6.7	7.1	6.0	7.9	7.0	6.7	7.7	7.1	7.0	6.8
Dress Code	6.8	6.1	6.5	6.2	6.0	5.7	5.9	6.0	6.1	6.3
Travel	6.3	5.4	5.9	5.4	6.1	5.9	5.7	6.1	5.6	5.9
Publish	6.1	5.5	6.2	4.0	3.6	4.2	4.9	4.0	3.7	5.2
Telecomm	5.0	5.0	4.6	5.3	5.2	5.8	5.2	5.5	4.8	5.0
Sabbatical	5.2	4.7	5.1	4.4	4.9	4.2	4.7	5.3	4.3	4.9
Part-time	4.7	4.5	4.0	3.9	4.0	4.0	4.4	4.2	3.1	4.2
Child Care	4.2	4.1	3.7	3.3	4.0	3.5	3.6	3.5	3.0	3.8

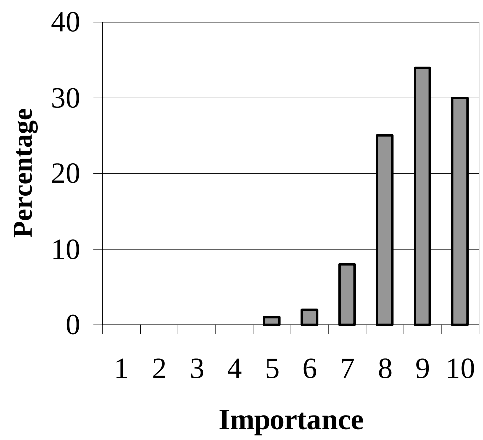
The consistency is also apparent in the small values of the standard deviations. Assuming the assessments have a normal distribution (bell-shaped curve), 99.7% of the distribution is contained within, plus or minus, three standard deviations (three sigma) from the mean. The highest rated factor, "Interesting & Challenging Work," has a mean (average) of 8.8 and a standard deviation of 0.2. This implies that 99.7% of the samples will be between 8.2 and 9.4. These values are significantly higher than the lowest rated factors with averages in the 3.8 to 5.9 range. The difference in overall ranking, between the most important and least important factors is statistically significant.

Figure C-2 is a graphical presentation of the survey responses to the job-related factor rated “Most Important.” The response scale was:

- Not Important = 1, 2, 3
- Somewhat Important = 4, 5, 6, 7
- Very Important = 8, 9, 10

The impact of the small standard deviation is clearly illustrated in the compactness of the grouping. Further sorting, e.g., by age, was not revealing. Notice that only 56 individuals out of over 5,700 (less than 1%) rated “Interesting and Challenging Work” as a 5 or lower.[C-1]

Figure C-2. The Most Important Job-Related Factor: Interesting and Challenging Work



Interesting and Challenging Work

Response	Total	Percent
1	0	0
2	0	0
3	1	0
4	10	0
5	45	1
6	115	2
7	386	7
8	1410	26
9	1835	34
10	1600	30

[C-1] In the 5,733 surveys returned, not every question was answered on every survey.

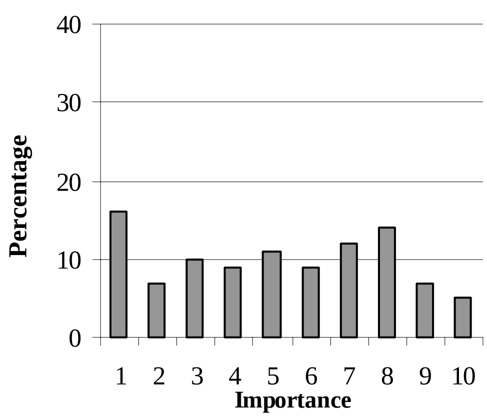
The Least Important Factors

The least important job-related factors are consistent among organizations. The three least important factors, based on overall averages, ("Child Care," "Opportunity for Part Time Work," and the "Opportunity to Take a Sabbatical") are also the least important at all of the nine sites. The next two lowest demonstrate the difference between the laboratories and the other sites. The three laboratories rated the "Opportunity for Telecommuting" as fourth lowest; the other six sites rated the "Opportunity to Publish" as the fourth lowest. The "Opportunity to Publish" has the largest standard deviation (1.02) of all the factors suggesting that several individuals or groups believe publishing to be important. The results of an attempt to group those individuals who believe publishing is important are shown in Figure C-3. The first graph in the figure shows the spread of values and the cause of the large standard deviation from all 5,733 respondents. The second graph depicts the responses from PhDs and Post-Docs only.

Figure C-3. Importance of Opportunity to Publish

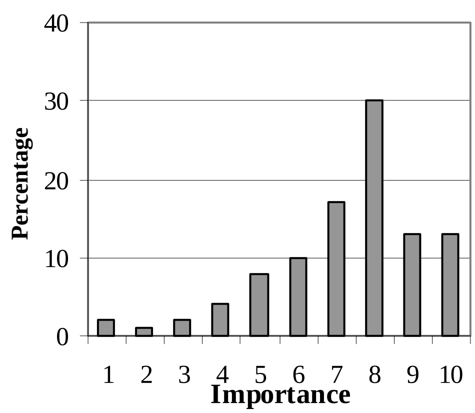
All Responses

Response	Total	Percent
1	857	16
2	346	7
3	515	10
4	454	9
5	565	11
6	464	9
7	643	12
8	738	14
9	344	7
10	291	6



PhDs & PostDocs only

Response	Total	Percent
1	23	2
2	20	1
3	30	2
4	58	4
5	110	8
6	130	10
7	223	16
8	411	30
9	180	13
10	174	13



When sorting the average values of the respondents by age groups (≤ 30, 31-40, 41-50, ≥51), job (scientist, engineer, technician) and education (MS, PhD/Post-Doc), the results are interesting. The data suggest that the individuals who most desire to publish are the scientists, with PhD degrees, regardless of their age. The opportunity to publish appears to be an important factor in recruiting and retaining PhDs and Post-Docs.

Figure C-3 (cont.). Opportunity To Publish

Scientist	Engineer	Technician	MS Degree	PhD/Post-Doc
6.8	4.8	4.2	4.8	7.3

≤ 30 Years	31-40 Years	41-50 Years	≥ 51 Years
5.3	5.2	5.2	5.2

The three other least important factors were also sorted by age, job, and education. "Child Care" is understandably more important to the younger personnel, yet surprisingly it remains one of the lowest ranking factors even when sorted by age. The results are probably impacted by the fact that there are relatively few females among the scientists, engineers, and technicians. A "Relaxed Dress Code" is more important to the younger individuals and slightly more important to technicians and engineers than to scientists. The "Opportunity to Take a Sabbatical" was rated as significantly important by the few employees below 30 years of age (an 8.7). However, since it is much less important to employees age 30 or more (4.4 to 5.5), there is a question as to whether the youngest employees truly understand the opportunity.

In summary, the highest rated factors are important for recruiting and retention, and are statistically significant relative to the lowest rated factors. Other factors, in the middle of the prioritized list, are important to smaller groups or individuals and should be offered in such a context. Facilities seeking to retain (or recruit) employees should focus on being competitive in offering:

- Interesting and Challenging Work
- Good Benefits
- Job Security
- Competitive Salary
- Recognition of Outstanding Performance
- The Opportunity for Self- Improvement
- Treating People with Respect
- Quality Internal Communications (keep employees informed)

III. How Well Important Factors are Provided

The next theme in the survey is concerned with how well, or badly, the important job-related factors are being provided. The most important factors should obviously receive the most attention. Figure C-4 shows the average value assessed by each site in response to the question, "How well are each of these job-related factors being provided by your current organization?" The response scale was:

- Below Average = 1, 2, 3
- Average = 4, 5, 6, 7
- Above Average = 8, 9, 10

Figure C-4: How Well Job-Related Factors Are Being Provided

	LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS	Overall Average
Chalng Work	7.4	7.2	7.5	6.6	6.1	6.3	6.4	6.4	6.7	7.0
Benefits	7.1	6.7	7.6	6.0	6.4	6.5	5.9	7.3	6.1	6.8
Job Security	6.6	7.1	7.2	3.4	4.9	4.5	5.5	6.1	5.7	6.1
Salary	5.6	5.4	5.2	3.8	6.0	5.0	5.6	6.5	6.0	5.4
w/ Respect	6.4	6.7	6.4	5.7	5.4	5.6	6.4	5.7	6.4	6.2
Self-improve	6.6	6.7	6.6	5.8	5.2	5.3	5.9	5.8	5.9	6.2
QOL	7.2	6.6	6.9	7.1	7.1	7.2	7.6	7.1	6.5	7.0
Advancemnt	4.8	4.8	5.2	3.3	4.0	3.7	4.5	4.1	4.8	4.5
Smart People	7.6	7.9	7.8	6.4	5.6	6.4	6.8	6.2	6.7	7.1
Reputation	7.5	7.4	7.2	6.1	5.7	6.1	6.5	5.3	6.0	6.8
Inter. Comm	5.0	6.3	5.2	5.9	4.5	4.3	5.6	4.4	5.2	5.2
Recog. perf	4.8	5.4	4.5	4.2	4.2	3.9	5.2	4.9	4.9	4.7
Chg w/i Org	6.2	6.7	6.8	4.7	5.3	4.7	5.8	5.2	5.6	6.0
Work Env.	5.4	6.5	6.8	5.7	5.4	5.0	5.5	5.2	6.5	5.9
Nat'l Contrib.	7.4	7.1	7.2	5.4	5.5	5.6	5.8	5.9	6.1	6.7
Prestige	6.0	5.8	5.5	4.7	4.2	4.2	5.2	5.1	5.1	5.3
Flex time	5.2	7.9	6.1	6.4	4.9	5.2	6.6	7.4	7.4	6.3
Dress Code	8.8	7.9	8.3	7.2	7.1	7.2	6.6	7.1	7.3	7.9
Travel	7.1	6.8	6.8	5.8	4.7	4.7	6.1	6.5	6.2	6.4
Publish	7.2	7.2	6.6	5.6	4.5	5.4	5.9	5.3	5.4	6.4
Telecomm	4.8	5.2	5.6	4.5	5.1	5.4	5.0	4.7	5.4	5.1
Sabbatical	5.0	4.6	4.8	4.0	4.0	3.6	4.9	4.3	4.6	4.5
Part-time	5.3	6.3	5.8	4.9	4.0	4.9	5.7	5.0	5.8	5.5
Child Care	3.5	4.2	6.0	4.1	3.2	4.8	4.9	6.5	4.4	4.6

Note that the average values are considerably lower than those given to "Importance." No one is ever satisfied, and the lower scores should be expected. The differences among the sites are more pronounced than the scores for "Importance" because the sites are operated by different contractors and universities.

Importance vs How Well Provided

The difference between the average values given by the respondents to "Importance" and "How Well Provided" can be compared, for each job related factor, by site. A difference of 3.0 or more was arbitrarily considered worthy of analysis and is presented in Figure C-5.

The factor with the most frequent large difference is "Advancement" (Opportunity for Advancement and Promotion Within The Organization). All sites perceive a problem except for Sandia and LLNL, where the difference between "Importance" and "How Well Provided" is 2.7. This perceived problem was also expressed in response to the open-ended question, "If you could change one aspect of your job, or purchase or acquire one thing to make your work easier or more efficient, what would it be?" The majority of the comments mentioned a perceived inequality in promotion between those in management tracks and those who chose to remain on technical/research tracks. Some technical research organizations have two career paths explicitly identified. This is not the case at the two nuclear weapon design laboratories. Survey respondents from five sites do not believe that outstanding performance is recognized (see "Recog. perf" in Figure C-5). This may also relate directly to concerns over promotion.

Figure C-5: Importance vs How Well Provided (Differences ≥ 3.0 Only)

	LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
Chalng Work									
Benefits				3.0					
Job Security				5.6	4.0	4.5	3.2		
Salary		3.0	3.2	5.2	3.0	3.7			
w/ Respect				3.0	3.4	3.1			
Self-improve									
QOL									
Advancemnt	3.0			4.8	4.2	4.7	4.0	3.7	3.4
Smart People									
Reputation									
Inter. Comm					3.8	4.0		3.7	
Recog. perf	3.0		3.4	3.6	3.4	3.9			
Chg w/i Org									
Work Env.									
Nat'l Contrib.									
Prestige									
Flex time									
Dress Code									
Travel									
Publish									
Telecomm									
Sabbatical									
Part-time									
Child Care									

The problems appear worse at sites that are, or have been, reducing the size of their work force and where employees are most concerned about their future, i.e., PANTEX, Y-12, and KCP. Job security and salary concerns were expressed during site visits as well as in response to the survey. Responses to the open-ended survey questions by KCP personnel indicated significant discontent with management's administration of pay and benefits. Examples include pay and benefit disparity within the company (working in the nuclear weapons program vis-à-vis in other programs), and a recent policy change to a 13 month, versus 12 month, performance review cycle to delay pay raises for an additional month. These management initiatives are apparently creating, or have created a chasm of management mistrust by the workers.

Overall Rating of Each Site

The survey also asked, "Overall, how do you rate your organization in providing the listed services, amenities, working conditions, and environment?" The ratings were "average," numerically ranged from 5.0 to 6.8, and indicate a general contentment with the overall conditions, presumably relative to other job opportunities they are aware of.

IV. Interest in Exchange Program or Sabbatical

Assuming that exchange programs and sabbaticals would be popular retention incentives, the survey sought information on where individuals would most like to go. Recall, however, that the opportunity to take a sabbatical was rated among the least important job-related factors. The locations and job options offered were:

- a nuclear weapons job at another DP site
- a non-nuclear weapons job outside your current organization
- a non-nuclear weapons job within your current organization
- a university
- DOE Headquarters
- industry
- a DOD facility

The average values, for all locations and job options, from every site, were between 3.8 and 6.5, which were identified as being "of average interest" in the survey. The interest level in sabbaticals and exchange programs is likely influenced by the lack of job stability across the nuclear weapons program (afraid to leave for fear of losing their job upon return) and the recent cut-backs and lay-offs (already too few people to perform the necessary work).

Of possibly more significance, DOE was rated as the location of least interest at every site, as well as when the responses were sorted by age or position (scientist, engineer, and technician.) The lack of respect for DOE personnel was a recurrent theme in the open-ended questions. Comments such as, "Need better educated reviewers," and "need better DOE and HQ (Headquarters) attitude," were frequent. In response to the open-ended question, "If you could change one aspect of your job, purchase or acquire one thing to make your work easier or more efficient, what would it be?" DOE respondents seemed to express a similar sense of shortcoming. They frequently requested (1) more education (presumably because they are supervising scientists with PhDs), (2) less DOE HQ emphasis on paperwork and administrative issues, and (3) promotions based on merit rather than politics and who knows whom.

Someone Else to Perform Your Job?

A related question asked, "Is there someone else in your organization (other than your boss or someone currently similarly employed) who could perform your work if you took an extended sabbatical?" Of the 5,330 respondents who answered the question the distribution was:

Response	Number	Percent
Yes	3451	65
No	1879	35

The responses from the NTS were highest with 43% responding "No." At the three laboratories, between 35% and 39% responded "No." At the four production sites, between 29% and 33% responded "No." Sorted by age, the numbers remained between 33% and 37% for all age groups. Sorted by job, 40% of the scientists indicated "No," while engineers and technicians reported 34% and 33% respectively. The data thus indicate that there are many individuals at each site who believe they have unique skills, with scientists and NTS personnel leading the rest.

V. Long Term Intentions

Remain with current organization until retirement?

The first question under this theme asked, "How interested are you in working for your current organization until you retire?" The response scale was:

- Of No Interest = 0
- Of A Little Interest = 1, 2, 3
- Of Average Interest = 4, 5, 6
- Above Average Interest = 7, 8, 9
- Very Interested = 10

The results are shown in Figure C-6 and indicate a general desire for job security and a reasonable display of organizational loyalty. The data suggest that individuals are more inclined to remain in their current position as they grow older and that technicians are more interested than other disciplines in remaining with their current organization.

Figure C-6. Interest in Working for Current Organization Until Retirement

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
7.6	6.0	7.6	7.4	6.9	7.5	7.3	6.4	7.2

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
7.1	5.7	6.4	6.9	8.1	7.1	6.9	7.6

Nuclear weapons work until retirement?

Another question asked, "Do you intend to perform nuclear weapons related work until you retire?" The results from all sites are encouraging. See Figure C-7. Sorted by age group, individuals over 40 years of age want to remain with nuclear weapons work more than younger individuals. Sorted by jobs, technicians once again indicated more interest in stability. Responses to this question indicate that retention of the youngest individuals, in all job disciplines, is currently (and is likely to remain) the biggest problem. The lowest level, from the individuals at the NTS, is likely attributed directly to their recognition of the consequences of the test moratorium.

Figure C-7. Do you intend to perform nuclear weapons related work until you retire?
(Percent responding "Yes")

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
74%	65%	70%	74%	74%	79%	70%	65%	64%

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
71%	44%	55%	71%	84%	71%	68%	76%

Necessity of non-weapons work

A related question asked, "Does your continued participation in the weapons program depend upon having to do non-weapons specific work?" The responses vary rather wildly by site, job, and age group. See Figure C-8. The results indicate that a considerable number of individuals believe they will need to perform non-nuclear weapons specific work in order to remain in the weapons program. Notice the consistency of responses from the NTS. They have the highest value among the sites (requiring non-nuclear weapons work to remain in the program) and the lowest value in response to their expectation of performing nuclear weapons work until they retire (see again Figure C-7).

Figure C-8. Must you perform non-nuclear weapons work to remain in the weapons program?
(Percent responding "Yes")

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
46%	41%	38%	32%	29%	36%	27%	18%	48%

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
39%	37%	42%	50%	35%	47%	35%	37%

VI. Training

The training questions probed the availability and effectiveness of training modes. It is an important theme because of the prospective retirement of individuals with unique experience and the need to train replacement personnel.

Tuition assistance/reimbursement programs and Advanced Degree programs were unanimously deemed the most popular at all sites and should be considered important recruiting and retention incentives. On-the-job training was rated the most effective means of improving daily performance. The Career Development Programs were generally rated as the least valuable and evaluated as "ineffective" or "marginally effective."

No conclusion can be reached from the survey data concerning the effectiveness of mentoring programs in transferring experience. The mentoring programs at the various sites are very different, both in intent and execution. At PANTEX and Y-12, mentoring programs are viewed as ineffective, but are rated as slightly "above average in effectiveness" at the laboratories and the KCP. Site visits confirmed programmatically different mentoring programs that ranged from providing Big Brother/Sister assistance in integrating into the facility for a new hire to focused transfer-of-knowledge programs.

The effectiveness of different training programs appears to be site and program unique. No universally optimal method was suggested by the survey results. In response to the open-ended question, "If you could change one aspect of your job or organization…." training related matters were mentioned with some regularity and by individuals at all sites. Specific suggestions included: improve engineering training, improve career path awareness, begin a skill rotation program, increase technical training, and increase educational opportunities.

The available programs were generally used between three and four times during the past three years. They were used slightly more by individuals between 30-50 years of age than people younger or older. There was no difference in usage among scientists, engineers, and technicians.

Skill Maintenance

The survey also asked, “Does your current position offer you the opportunity to use and maintain your technical capabilities and skills?” The answer was “Yes” by a significant majority of the individuals from each site. See Figure C-9.

Figure C-9. Does your current position allow you to use and maintain your technical competence and skills? (Percent responding “Yes”)

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
70%	71%	74%	74%	66%	65%	61%	55%	65%

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
70%	77%	69%	69%	70%	68%	68%	75%

VII. Confidence in Management

The survey asked, “What is your level of confidence in your organization’s management actions and statements with regard to (six categories)?” The response scale was:

- Lack Confidence = 1, 2, 3
- Confident = 4, 5, 6, 7
- Very Confident = 8, 9, 10

The responses indicate that the workplace is a safe place to work (ES&H was the highest) and a general confidence in management. The categories and results are shown in Figure C-10A from all respondents and Figure C-10B by site.

Figure C-10 A. Level of Confidence in Management (Overall Average)

ES&H	7.1
Commitment to stewardship program	6.9
Programmatic focus & mission support	6.4
Technical focus & Issues	6.2
Policies, procedures and practices	5.7
Administrative issues	5.2

Despite this apparent confidence in management, a significant number of survey respondents mentioned disappointment with internal management (as opposed to oversight from outside) in response to the question, "If you could change one aspect...." The complaints included: need better management, need smarter supervisors and managers, stop the internal micro-management, need better leadership, need a long-term plan from management, need timely decisions from management, reduce the number of managers, need management commitment, need better communications from management, get rid of the nuclear Navy's procedure writing mentality (unique to Y-12), and management doesn't understand the technical aspects of what their workers are doing.

Figure C-10 B. Level of Confidence in Management's Actions

	LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
ES&H	7.0	7.3	7.2	7.9	7.4	6.5	7.3	5.9	7.0
Stewardship	7.1	6.8	7.6	6.8	6.4	5.5	5.7	6.2	6.5
Prog & Msn	6.1	6.0	6.9	6.8	6.5	6.2	6.6	5.9	6.2
Tech	6.3	6.3	6.7	5.7	6.0	5.5	5.9	5.4	6.0
Policy	5.5	5.7	6.0	6.2	5.9	5.4	5.7	4.9	5.3
Admin	4.9	5.2	5.6	5.9	5.1	4.7	4.9	4.6	5.2

Notice again that DOE management received the lowest value for each category except for "Commitment to the Stewardship Program."

VIII. How Do You Spend Your Time?

The question's intent was to identify areas where individuals were concerned about spending too little or an exorbitant amount of time. The question asked was, "How much time do you routinely spend with the following necessary functions?" The response scale was:

- Not Enough = 1
- Less Than Expected = 2 , 3
- About The Right Amount = 4, 5, 6
- An Excessive Amount = 7, 8
- A Discouragingly Excessive Amount = 9, 10

and the response functions were:

- Hiring = Hiring new people.
- ES&H = ES&H process.

- Short handed = Performing the work that would be done by others if there were enough people.
- Presentation = Giving presentations to visitors or on-site review teams.
- Admin = Administrative and reporting tasks.
- Funding = Finding funding and budget issues.
- Travel = Business travel.
- Justifying = Justifying your task or program.
- Tech = Doing technical work.
- Mng & Dir = Managing and directing the work of others.
- Review = Reviewing and critiquing the work of others.

Although individuals may have legitimate complaints, no site had an average value of 7.0 or above to indicate an "excessive amount of time" spent in any category. Respondents do not believe they are spending enough time "Recruiting and Hiring" and would like the luxury of performing more "Technical Work." The category that is closest to becoming a problem is time spent doing the work of others because of shorthandedness. Respondents from all sites expressed this feeling of shorthandedness in response to the open-ended question, "If you could change one aspect…." The requests were for all types of support, from administrative and clerical to technical. There was no significant difference in the response to the question of how time is spent when sorted by age group or job. The response summary is shown in Figure C-11.

Figure C-11. How Much time Do You Routinely Spend Doing . . . ?

	LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
Hiring	4.1	4.0	3.9	2.9	2.9	2.6	2.8	3.1	3.5
ES&H	6.5	5.8	5.8	5.6	5.0	5.5	5.4	5.3	5.0
Shrt Handed	6.7	6.0	6.1	6.7	6.8	6.3	5.7	6.2	6.1
Presentation	5.1	5.1	5.1	4.6	4.4	4.5	4.3	4.8	4.6
Admin	6.0	6.2	5.7	6.4	5.8	5.9	5.7	6.3	5.8
Funding	5.7	6.4	5.1	5.7	5.4	5.3	5.0	5.8	5.2
Travel	4.6	5.1	4.9	4.3	3.0	3.8	3.9	5.2	4.4
Justifying	5.4	5.7	5.3	5.3	5.8	5.5	5.0	5.6	5.4
Tech	3.8	3.7	4.0	3.7	4.0	4.3	3.7	3.6	4.1
Mng & Dir	4.7	4.6	4.5	4.6	4.1	4.8	4.5	4.4	4.5
Review	4.7	4.5	4.4	4.4	4.4	4.9	5.0	4.9	4.4

IX. Skill Level of New Hires

This theme addresses recruiting and the quality of new hires. The scale for rating new hires was:

- Very Discouraged = 0, 1
- Disappointed = 2, 3
- Acceptable = 4, 5, 6
- Pleased = 7, 8
- Beyond Expectations = 9, 10

Not unexpectedly, new hires are best at technical and computer skills, and weakest at writing. The overall level of satisfaction is acceptable at 5.7, and each site is relatively pleased with values ranging from a high of 5.9 to a low of 4.7. There was no indication that quality recruits are unavailable; the problem is with the competition.

The survey also asked, "In general, how aware is the individual you typically try to recruit, with respect to your facility's capabilities, program sophistication, talent of employees, and general appeal as a place to work?" The response scale was:

- Unaware = 0,1
- Knows the name = 2, 3, 4
- Knows some facts = 5, 6, 7, 8
- Has a lot of data = 9, 10

The overall average value is 4.1. Understandably, the laboratories have higher name recognition than the production sites; the values below 5.0 indicate that new recruits seldom know more about the organization than its name. This lack of awareness could be a problem.

Figure C-12. Awareness of New Recruits

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
4.6	4.4	4.7	3.1	3.3	3.5	2.4	3.5	3.2

X. Nuclear Weapons Program Stability

The survey asked, "How do you rate the career stability offered by the nuclear weapons stewardship program?" The response scale was:

- Unstable = 0, 1
- Poor = 2, 3
- Average = 4, 5, 6
- Good = 7, 8
- Excellent = 9, 10

As shown in Figure C-13, all sites rate career stability as "poor" or at the bottom of the "average" range.

The youngest age group appears hopeful. Personnel at the production facilities are less optimistic about career stability than those at the laboratories.

Figure C-13. How do you rate the stability of the program?

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
4.9	4.7	4.9	2.5	3.4	2.9	4.3	4.3	3.9

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
4.3	4.9	4.3	4.2	4.3	4.7	4.0	4.4

Job security and job stability were frequently mentioned in response to the open ended question, "If you could change one aspect...."

XI. Would You Recommend Your Organization?

The survey asked specifically, "Would you recommend your laboratory, facility, or test site as a good place to work?" Overall, 75% responded positively, and over half of the respondents from each site replied, "Yes." The laboratories were more positive than the other sites; however, there was little difference between age groups. See Figure C-14.

Figure C-14. Would you recommend your organization?
(Percent responding "Yes")

LANL	SANDIA	LLNL	KCP	PANTEX	Y-12	SRS	DOE	NTS
85%	78%	84%	57%	70%	51%	67%	51%	68%

Overall Average	≤30 years	31-40 years	41-50 years	≥51 years	Scientist	Engineer	Technician
75%	77%	78%	72%	76%	80%	71%	79%

The overall distribution was:

Response	Number	Percent
"Yes"	4,006	75%
"No"	1,310	25%

XII. What Initially Attracted You to Your Organization?

The first open-ended question probed the recruiting issue by asking, "What initially attracted you to your organization?"

The primary motivating factor at every site was interesting and challenging work. This included the opportunity to work with smart people, to work on nationally important issues, and to solve problems that contribute to the country's well being and the national mission. The reputation of the organization was also frequently mentioned as being important. The survey responses implied, and discussion with university students explicitly revealed, the assumption that the challenging and interesting work would be accompanied by competitive salaries.

This was followed, in different sequences at different sites, by salary and benefits, location, or Quality of Life. Many respondents mentioned that they were recruited with offers of very competitive salaries and benefits. Interviews with university professors and placement officers revealed that very high salaries and/or lucrative benefits packages could outweigh challenging and interesting work for some graduates. The importance of salaries and benefits was also evident in responses that complained about pay compression and the current lack of competitive pay. These responses were often joined with "job security." These respondents admitted to the importance of job security, and then added that, when they accepted their position, the nuclear weapons program was a growth area and considered a long-term program.

There is apparent appeal in working in a location that is familiar. Several respondents replied that they selected their employment because it was in their home town, where they grew up, near family and friends, where they were currently living, where they had worked as a summer intern/research assistant/on a co-operative program, or where they had had a tour-of-duty while in the military. This response was often coupled with an appreciation of the Quality of Life in the community where they would be living.

Several respondents reported being “recruited” by family members or friends, e.g., “it was recommended by a friend,” “my friend (or a relative) worked there and recommended it to me,” “my spouse worked there.” According to the students interviewed, awareness of the organization can also be effectively achieved by technical presentations on campus (considered a very credible source of information) or participation in teaching a course. Finally, the opportunity for career development and additional education were frequently mentioned as important reasons for accepting an employment offer.

In summary, recruiting can be significantly enhanced by offering interesting and challenging work on meaningful problems, competitive salary and benefits, the opportunity for self improvement, and being reasonably well known to those you are trying to recruit.

XIII. If You Could Change One Thing

The survey explored the retention issue by asking, “If you could change one aspect of your job, or purchase or acquire one thing to make your work easier or more efficient, what would it be?”

Change in management and oversight was the most popular response. There were numerous and repetitive requests for more streamlined management, more technically competent reviewers, less micromanagement, timely management decisions, better recognition by management for a job well done, better communication of vision and objectives, the elimination of redundant reviews, less administrative and more technical focus during reviews, and a better attitude by reviewers. The comments were directed, approximately equally, at the local internal management and the DOE personnel. The most frequent criticism of DOE personnel was their apparent lack of technical expertise for the project they were reviewing and that their role was not clear. Interestingly, survey comments by DOE personnel seemed to reflect the same problem. DOE personnel routinely requested: better education and training, less Headquarters’ emphasis on administration and paper work, and a reduction in the number of the DOE personnel.

Another major group of responses addressed the working environment, including requests for a stable budget so that planning could be meaningfully accomplished, a sufficient number of people to perform the current workload, and money for needed equipment, facility repair and maintenance. The stable budget issue effects both morale and the ability to make plans. Individuals, at all levels and at all sites, commented on the negative effect of budget instability. The survey results clearly suggest that managers need a stable or long-term budget commitment from DOE, that supervisors need a similar commitment from their managers, and that the workers need assurance that funding for basic project needs will be forthcoming.

According to the survey data, the budget problem is pervasive, and it appears that correction must begin at the top. The other two working-environment issues relate indirectly to the budget. The elaborate procedures and numerous approvals required to expend project funds were reported as inhibiting, regardless of the size of the expenditure. Other comments for improving work efficiency and effectiveness had to do with the actual facilities and equipment, e.g., replace outdated equipment, conduct needed maintenance and repairs. Individuals, who came to work to solve challenging problems, are now complaining that their outmoded tools and working environment are hampering their ability to perform.

The final, but equally important issue, dealt with personnel. There were several comments that the amount of technical work being done is decreasing because too much time is being spent on a variety of other tasks, but especially on doing work that someone else would be doing if the project was not under staffed/ shorthanded. The requests were for all types of personnel support, from administrative support and a program assistant to technical and professional personnel. The lack of new hires was also a concern because of the fear that there was no one to train for their job, because the older individuals were retiring without numerical replacement, and simply because young new hires brought enthusiasm and ideas to the workplace.

Job instability was mentioned as the reason few people were recruited, and the frequent inability to quickly negotiate and offer a competitive salary and benefit package the reason that several recruits were lost to competitors. Promotion discrimination was another personnel issue mentioned with some regularity. The issue is the perception that managers have a decidedly unfair promotion advantage over professionals, who decide to continue technical pursuits or conduct research.

XIV. What More Would You Like To Tell the Commission?

Significantly fewer individuals responded to this question than the previous two. The assumption is that they had little left to say.

The request for additional government support for the nuclear weapons program was a recurrent theme. In some cases the respondents may have been uninformed, ("we need a national mission statement," "more public and positive statements from government"); however, the fact that the nuclear weapons program employees are not aware of government support should not be taken lightly. Pronouncements in high-level government documents and speeches may not be sufficient.

The additional responses to this question were relatively unique and usually offsetting, e.g., "consolidate the facilities," "don't consolidate the facilities."

XV. Results From Academic Staff and Student Interviews

The objective of academic staff and student interviews was to determine whether the current students had values and aspirations similar to those of the personnel currently employed in the nuclear weapons program (and determined from the survey) or as described in some "Generation X" reports. Department heads, professors, placement officers and students were interviewed at academic institutions where nuclear weapons personnel are recruited.

The student population of interest (students in fields such as information technology, electrical engineering, physics, mechanical engineering, and material sciences) is becoming increasingly female, especially at the undergraduate level. Between 18% and 59% of the undergraduates, in the fields of interest at the institutions contacted, were women. Foreign students, non-US citizens, are a significant fraction of the graduate programs of interest, but not of the undergraduate programs. It was not unusual to find nearly half the students in a graduate curriculum to be non-US citizen, but seldom were they over 8% of the undergraduate population.

The number of students who have worked part-time or as an intern with a company before graduating ranged from a low of 15% to a high of 70%, with a weighted average of approximately 50%. According to one placement officer, 60% of the students who participate in internship programs or part-time work become employees of that company. It was viewed by all as an effective recruiting technique.

All the students in the curricula of interest, except possibly physicists, are in great demand and expect to receive multiple offers of employment. The demand forecast for physicists is below other disciplines. The interviews revealed that the overall placement rate for all graduates of interest is approximately 96%, and less than 3% are having difficulty finding employment.

The most successful student recruiting methods are campus visits, technical presentations on campus, internships, and referrals by friends. These are followed closely by faculty introductions and endorsements, visits/periodic participation by technical individuals with professional student groups. Other successful methods include the posting of job announcements with the placement officers, web pages and e-mail. The last two are becoming more popular, and some students reported personal contact by an interested company via e-mail.

Professors and placement officers reported that students typically intend to remain with the first employer about three to five years. The students gave similar reports, but with much less conviction. The impression is that they are hearing "three to five years" from academic administrators and professors, but do not indicate that it is their desire. They expressed a desire for long term stable employment and, during one student focus group, the consensus was, "that we will be moved around during our career." The implication is that they will be "forced" to change employment about as often as they will initiate a change. One placement officer observed that the "very best" students go to start-up companies, the "very good" students go to small, established firms, and the "next best" go to large commercial firms. That distribution may impact the three to five year expected duration of first employment, but may not apply to the laboratories.

The most important job-related factors for the students are not noticeably different from those reported in the survey. Interesting and challenging work was the highest and usually accompanied by an understanding that a competitive salary would be offered. Placement officers commented that today's students are acutely aware of salaries and signing bonuses and that very high salaries have overtaken interesting and challenging work as the primary motivator on more than one occasion. Reputation of the organization, job security, and geographical location all ranked among the most important factors. Students want to work with state-of-the-art equipment on meaningful problems.

A number of factors were perceived as either extremely important or totally unimportant to a small number of respondents. For example, relaxed dress code, the opportunity for telecommuting, and the opportunity to publish were cited as being very important to some people.

There were no negative feelings expressed about the nuclear weapons program. More common were comments that very little is known about the nuclear weapons program (e.g., "We were told that it involves dismantling nuclear weapons, but I don't know what that means either."), or that defense work has a reputation for having a lot of bureaucracy.

Placement officers and department heads noted that nuclear weapons program recruiters need to advertise, participate with student groups or teach a cutting edge class when possible, to overcome the perception that "bombs are passé." Recruiters should pay specific attention to attracting women, and become known to professors and placement officers who have significant influence on the students. Finally, the comment was made that currently many student graduates are in economic need and, therefore, hiring decisions must be made rapidly, or the candidate will likely be lost to a competitor.

XVI. Commission Survey

The survey submitted to the nuclear weapons complex is included in its entirety. Over 10,700 surveys were distributed by the facilities. Over 5,700 (about 53 %) were completed and returned.

COMMISSION FOR MAINTAINING US NUCLEAR WEAPONS EXPERTISE: DATA SURVEY
PLEASE MARK ALL ANSWERS ON THE ANSWER SHEET

A. How important to you are each of the following job related factors and how well are they provided by your current organization?

1&2. Compensation (salary)
3&4. Benefits (e.g., insurance, vacation, sick leave, pension, and holidays)
5&6. Employment (job) security
7&8. Physical working environment
9&10. Stimulation from working with smart people
11&12. Interesting and challenging work
13&14. Being treated with respect
15&16. Opportunity for self improvement
17&18. Opportunity to take a sabbatical
19&20. Organization's policy for recognizing and rewarding outstanding performance
21&22. Opportunity to work part time or less than full time
23&24. Company's policy on flextime or a compressed work week
25&26. Professional reputation of the organization
27&28. Opportunity for telecommuting
29&30. Quality of internal communications, i.e., how well you're kept informed
31&32. Opportunity for acquiring increased prestige or peer recognition
33&34. Opportunity for advancement and promotion within the organization
35&36. Work related travel opportunities
37&38. Relaxed dress code
39&40. Child care
41&42. The Quality of Life in the community where your job is located
43&44. Opportunity to publish
45&46. Opportunity to make a nationally important contribution
47&48. Opportunity for changing jobs within your organization
49. Overall, how do you rate your organization in providing the above listed services, amenities, working conditions, and environment?

B. If you could participate in an exchange program or sabbatical, how interested would you be in going to each of the following places?

50. A nuclear weapons related job at another Defense Program site
51. A non-nuclear weapons related job outside of your current organization
52. A non-nuclear weapons related job within your current organization
53. A university
54. DOE Headquarters
55. Industry

56. A DOD Facility
57. How interested are you in working for your current organization until you retire?

C. Please indicate whether or not your organization offers the following training modes and, if you have used them, how effective you consider each one to be?

58. The Mentoring Program, as a mentor
59. The Mentoring Program, as someone who has been mentored
60. The Advanced Degree Program
61. Advanced Technology and Manufacturing short courses and workshops
62. Distance Learning courses (video link, correspondence, audio cassettes)
63. Tuition Reimbursement or Assistance Program
64. Leadership and Management courses
65. Career Planning and Development courses and material
66. Basic on-the-job training
67. Guest lecturers and symposia
68. Apprenticeship programs
69. Within the past three years, how often have you used the voluntary training/formal education opportunities offered by your organization?

D. What is your level of confidence in your organization's management actions and statements with regard to: (note any particular comments in your response to question # 112)

70. Commitment to the Stewardship Program
71. Technical focus and issues
72. Programmatic focus and mission support
73. Administrative issues
74. Policies, procedures and practices
75. Environment, Safety & Health (ES&H)

E. How much time do you routinely spend with the following necessary functions:

76. Hiring new people
77. The environmental, safety, and health process
78. Performing work that would be done by another if there were enough people in your "group"
79. Giving presentations to visitors or onsite review teams
80. Administrative and reporting tasks
81. Finding funding and budget issues
82. Travel
83. Justifying your task or program
84. Doing technical work

85. Managing and directing the work of others
86. Reviewing and critiquing the work of others

F. How satisfied are you with the skill level of new (scientific, engineering, technical) hires/employees in each of the following areas?

87. Writing skill
88. Organizational skill
89. Basic communications skill
90. Leadership skill
91. Problem solving skill
92. Computer skill
93. Technical competence and skill
94. Ability to work as part of a team
95. What is your overall satisfaction with new hires?

G. Miscellaneous Questions

96. How do you rate the career stability offered by the nuclear weapons stewardship program?
97. In general, how aware is the individual you typically try to recruit, with respect to your facility's capabilities, program sophistication, talent of employees, and general appeal as a place to work?
98. Do you intend to perform nuclear weapons related work until you retire?
99. Does your continued participation in the weapons program depend upon having opportunities to do non-weapon specific work?
100. Is there someone else in your organization, (other than your boss or someone currently, similarly employed) who could perform your work if you took an extended sabbatical?
101. Does your current position offer you the opportunity to use and maintain your technical capabilities and skills?
102. Would you recommend your Laboratory, Facility, or Test Site as a good place to work?
103. For how many years have you been involved with the Nuclear Weapons Program?
104. How much time have you spent in the design, development, production, or testing of nuclear weapons currently in the stockpile?
105. How much of your time do you currently spend working on the Nuclear Weapons Program vis-à-vis non-nuclear-weapons-related tasks?
106. What is your highest level of education?
107. At what level of your education did you first begin to interact (summer employment, research assistant, thesis project, post-doctorate program, etc.) with your current facility?
108. Indicate all those that apply to you, your current position, and your skills
109. What is your age?

Please respond to the open-ended questions on the answer sheet.

COMMISSION FOR MAINTAINING US NUCLEAR WEAPONS EXPERTISE
DATA SURVEY ANSWER SHEET (VOLUNTARY AND NOT FOR ATTRIBUTION. DO NOT IDENTIFY YOURSELF)

	IMPORTANCE											HOW WELL PROVIDED											
	Not Important			Somewhat Important					Very Important			Not Available	Available But Not Used	Below Average				Average				Above Average	
	1	2	3	4	5	6	7	8	9	10				1	2	3	4	5	6	7	8	9	10
1	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	2	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
3	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	4	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
5	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	6	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
7	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	8	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
9	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	10	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
11	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	12	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
13	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	14	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
15	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	16	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
17	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	18	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
19	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	20	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
21	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	22	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
23	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	24	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
25	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	26	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
27	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	28	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
29	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	30	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
31	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	32	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
33	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	34	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
35	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	36	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
37	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	38	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
39	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	40	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
41	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	42	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
43	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	44	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
45	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	46	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
47	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	48	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
											49			❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Of No Interest		Of a Little Interest			Of Average Interest			Above Average Interest		Very Interested
	0	1	2	3	4	5	6	7	8	9	10
50	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
51	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
52	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
53	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
54	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
55	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
56	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
57	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Not Offered	Available But Not Used	Not Effective 1	2	3	4	Of Average Effectiveness 5	6	7	8	9	Very Effective 10
58	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
59	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
60	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
61	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
62	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
63	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
64	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
65	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
66	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
67	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
68	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	never	once	twice	three times	four times	five times	six times	seven times	eight times	nine times	ten or over
69	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Lack Confidence 1	2	3	4	Confident 5	6	7	8	9	Very Confident 10
70	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
71	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
72	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
73	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
74	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
75	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Not Enough 1	2	Less Than Expected 3	4	About The Right Amount 5	6	An Excessive Amount 7	8	9	A Discouragingly Excessive Amount 10
76	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
77	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
78	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
79	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
80	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
81	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
82	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
83	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
84	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
85	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
86	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Very Discouraged		Disappointed			Acceptable		Pleased			Beyond Expectations
	0	1	2	3	4	5	6	7	8	9	10
87	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
88	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
89	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
90	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
91	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
92	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
93	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
94	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
95	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Unstable		Poor			Average		Good		Excellent	
	0	1	2	3	4	5	6	7	8	9	10
96	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	Unaware		Knows the Name				Knows Some Facts				Has a Lot of Data
	0	1	2	3	4	5	6	7	8	9	10
97	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	YES	NO
98	❍	❍
99	❍	❍
100	❍	❍
101	❍	❍
102	❍	❍

	<1 yr.	1 – 4	4 – 8	9 – 12	13 – 16	17 – 20	21 – 24	25 – 28	29 – 32	>32
103	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
104	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	None		One Quarter			One Half		Three Quarters			Full
	0	1	2	3	4	5	6	7	8	9	10
105	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍

	High School	Assoc. Degree	Bachelors Degree	Masters degree	Ph.D.	Post-Doc
106	❍	❍	❍	❍	❍	❍
107	❍	❍	❍	❍	❍	❍

108	**Sandia, CA** ❍	**Sandia, NM** ❍	**LLNL** ❍	**LANL** ❍	**Nevada Test Site** ❍
	PANTEX ❍	**Savannah River** ❍	**Oak Ridge/Y-12** ❍	**Kansas City** ❍	
	Scientist ❍	**Engineer** ❍	**Technician** ❍		
	Federal Employee ❍	**Prime Contractor** ❍	**Retiree rehired as consultant or subcontractor** ❍	**Subcontractor (Not a retiree)** ❍	**Consultant (Not a retiree)** ❍

109	**<20 yrs.** ❍	**20-25** ❍	**26-30** ❍	**31-35** ❍	**36-40** ❍	**41-45** ❍	**46-50** ❍	**51-55** ❍	**56-60** ❍	**≥61 yrs** ❍

110. What initially attracted you to your organization and nuclear weapons related work?

111. If you could change one aspect of your job, or purchase or acquire one thing to make your work easier or more efficient, what would it be?

112. What more would you like to say to the Commission (use back of page if necessary)?

Thank you for assisting the Commission for Maintaining US Nuclear Weapons Expertise.

Appendix D: Workforce Demographics and Market Dynamics

The Commission visited each site in the nuclear weapons complex to gain an understanding of the facility's missions and workforce, to gather information on recent experience with hiring, training, and retaining workers, and to discover its perspectives on workforce challenges. Each facility provided briefings to the Commission, as well as written responses to questions. This demographic data guided the Commission in its deliberations, and provide a basis for the recommendations offered in the text of this report; a summary is provided in this Appendix.

The sections that follow describe the roles of the eight facilities that comprise the weapons complex, discuss the alternative definitions of the workforce that arose in various contexts, describe the fragile skill areas identified by the facilities, outline the long-term challenge posed by the demographic distortions created during the downsizing of the complex, assess the future hiring needs implied by the current demographic makeup of the facilities, and briefly describe major trends in the national labor market for scientific, engineering, and technical graduates.

The data show that the weapons complex has undergone substantial workforce reductions. The pattern of cuts reflects the changing roles of the facilities as the nation evolves from Cold War weapons production to science-based stockpile stewardship. The downsizing process has skewed the age profile of the workforce, increasing the average age, and reducing the experience level. The reductions have created some "fragile" skill areas, where there is one or only a few experienced workers in the complex.

The data point to three challenges: (a) Recruiting, training, and retaining sufficient numbers of capable workers over the next decade to replace the large number of expected retirees; (b) Adapting management practices tailored to younger generations of workers and to high-demand careers such as information technology, electrical engineering, and materials science; and (c) Providing on-the-job training to new generations of "weapons specialists" while current specialists are still available to the complex.

I. The Weapons Complex Facilities

Eight government-owned, contractor-operated facilities comprise the weapons complex. A description of each facility and its roles is presented in Figure D-1.

Figure D-1. Weapons Complex Facilities[D-1]

Facility	Prime Management Contractor	Major Roles
Los Alamos National Laboratory (LANL)	University of California	Conduct R&D in basic sciences, mathematics, and computing Conduct experiments exploring the physics of nuclear weapons Maintain the ability to design and certify nuclear explosive packages Provide safety and reliability assessments of the stockpile Design and test advanced technology concepts Conduct pit surveillance, modifiy for reuse, and fabricate pits
Lawrence Livermore National Laboratory (LLNL)	University of California	Conduct R&D in basic sciences, mathematics, and computing Conduct experiments exploring the physics of nuclear weapons Maintain the ability to design and certify nuclear explosive packages Provide safety and reliability assessments of the stockpile Design and test advanced technology concepts
Sandia National Laboratory (SNL)	Lockheed-Martin Corporation	Conduct R&D on non-nuclear weapons components and computing Conduct weapons tests and experiments on nuclear weapons effects Design and engineer non-nuclear components and systems Manufacture neutron generators and selected non-nuclear components Provide safety and reliability assessments of the stockpile
Nevada Test Site (NTS)	Bechtel Corporation	Maintain the capability to conduct and evaluate underground tests Conduct experiments on the physics of nuclear weapons Support emergency response and radiation-sensing activities
Kansas City Plant (KCP)	Allied-Signal Corporation	Produce or procure non-nuclear components (electrical, mechanical, materials) Conduct surveillance testing on and repair of non-nuclear components
Pantex Plant	Mason-Hanger Corporation	Assemble, surveil, and maintain warheads Disassemble warheads that are being retired Fabricate chemical high-explosive components Provide interim storage for plutonium pits from dismantled weapons
Oak Ridge Y-12 Facility (Y-12)	Lockheed-Martin Corporation	Maintain capability to produce secondaries and radiation cases Conduct surveillance on secondaries Dismantle secondaries for warheads that are being retired Store and process uranium and lithium materials and parts Provide production support to the weapons labs
Savannah River Tritium Facility (SR Tritium)	Westinghouse Corporation	Recycle (unload, purify, reload) tritium from dismantled warheads Conduct surveillance on tritium reservoirs Support tritium source projects

Los Alamos, Lawrence Livermore, and Sandia laboratories are responsible for the basic scientific underpinnings of the weapons program, for weapons design and engineering, and for certifying the safety and reliability of the weapons stockpile. The production plants each perform specialized tasks requiring high volumes of precision manufacturing or assembly, often involving nuclear materials and explosives. The Nevada Test Site provides the infrastructure supporting a wide range of tests and experiments.

The facilities' roles are evolving as the SSP is being instituted. Because DOE has made the most progress in defining and implementing the scientific elements underlying the SSP, the laboratories have been provided a fairly clear view of their future roles. The laboratories are taking on major new scientific experiments and developing advanced supercomputers to implement the SSP. The production of neutron generators and small-scale plutonium pit production also have been assigned to the laboratories.

The roles in the production complex are also evolving, but the lack of a completed plan for SLEP leaves considerable uncertainty over the production plants' future workloads. In general, the lack of future requirements is hampering the production facilities in their human resource planning.

As the data in the following sections will show, demographic trends across the complex reflect the facilities' evolving roles as the SSP is implemented. The weapons complex is growing in some areas at the same time that it continues to shrink in others. While there are many workforce management challenges and problems that are common across the complex, the individual facilities also face challenges unique to them.

II. The Workforce

The Commission sought to delineate the nuclear weapons workforce in ways that would highlight the state of health of the complex as well as the management challenges faced by the managers of the complex. Three definitions of the workforce arose in different contexts, each appropriate for examining specific issues. These definitions and their relationships are presented here to clarify their meaning and their usage in the main body of this report.

1. Total facility workforce: The total workforce employed by the eight facilities comprising the weapons complex encompassed about 47 thousand people in

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[D-1]Summary Stockpile Stewardship and Management PEIS and Record of Decision, 1996. Also, Briefings and data submissions prepared for the Commission by each facility.

October 1998. This number included permanent employees; it excluded sub-contractors and such limited-term employees as interns, post-doctoral appointees, and visiting professors.

2. Weapons program workforce: This definition includes the portion of each facility's workforce that is funded to support the weapons program. The estimated size of the weapons program workforce is about 17 thousand people, slightly more than one-third the total number of people working in the complex.

This estimate is based on a degree of judgment, since facilities sometimes have to allocate workers who share their time between weapons program work and other work. The laboratories and NTS have based their estimates on the number of scientists, engineers, and technicians that work on the weapons program, or are in organizations that primarily support the weapons program. They exclude indirect or administrative staff. These estimates differ from official DOE data on the weapons program workforce, because DOE includes overhead workers as well as scientists, engineers, and technicians. The production facilities use a definition that is more comparable to DOE's, in that they have reported all their workers that support the weapons program, including direct and indirect workers.

The fraction of the workforce that supports the weapons program varies across the complex, as shown in Figure D-2. The weapons program accounts for most of the employment at Kansas City, Pantex, and Oak Ridge Y-12. These facilities specialize in weapons program work, but they also perform related tasks dealing with special nuclear materials and their storage. An important example of other work is uranium disposition and storage at Y-12. Other work at the production plants also includes environmental assessments and cleanup. This is especially important at Savannah River, where the Tritium operation is the only active weapons program activity. It operates as a discrete "island" within a large Environmental Management site with more than 12 thousand employees.

Figure D-2. Weapons Program Workforce (1998)

	LANL	LLNL	Sandia	NTS	KCP	Pantex	Y-12	SR	Total
Total facility (all direct & indirect employees)	6,866	6,367	7,573	2,273	3,239	2,837	5,740	12,505	47,400
Weapons program[D-2]	2,182	1,698	2,926	893	3,239	1,795	4,018	448	17,199
Weapons specialists	2,182	1,698	2,926	243	1,018	153	723	51	9,094

In contrast to the plants, the laboratories have more diverse roles. The laboratories conduct a broad range of scientific and engineering research and development with multiple sponsors from DOE and DOD, other government agencies, and government-private cooperative research. The laboratory directors told the Commission that it is essential that the weapons program be able to draw on the broad foundation provided by this multi-mission laboratory environment.

3. Weapons specialists: Weapons specialists include those workers identified by each facility who have specialized knowledge that can be acquired only through extensive on-the-job experience within the weapons program. This definition includes roughly nine thousand workers throughout the complex.

The NTS and production facilities identified roughly two thousand weapons specialists within their facilities. The workers identified as weapons specialists in the production facilities, and their areas of expertise, are listed in Figure D-3.

The laboratory directors define everyone within their weapons program workforce as a weapons specialist; it is their view that laboratory scientists, engineers, and technicians all require specific knowledge gained through on-the-job training, working with an experienced expert. This definition implies there is a total of just under seven thousand weapons specialists in the laboratories.

[D-2] The laboratories and the Nevada Test Site include in the Weapons Program Workforce the scientists, engineers, technicians, and technical managers that are funded by Defense Programs Stockpile Stewardship Program. The Production facilities include all of their employees that are funded by the Defense Programs Stockpile Stewardship Program.

Figure D-3. Weapons Specialists at NTS and the Production Plants

Facility	Skill Areas
Nevada Test Site	NTS identifies 243 weapons specialists as part of the Test Readiness Program. Areas: canister & rack preparation; diagnostics; containment evaluation arming & firing; control room (timing & control); emplacement site preparation; device delivery and insertion; area control stemming; readiness briefings; emergency response test execution; re-entry; hole selection & characterization post-shot activity; post-shot analysis
Pantex	Mason Hanger identifies 153 weapons specialists. Areas: assembly & disassembly; tester design; weapons tooling vacuum technology; non-destructive evaluation; risk assessment authorization basis; fire protection; security assessments high explosives; nuclear explosives safety; explosives safety information systems
Kansas City	Allied Signal identifies 1018 weapons specialists. Areas: product & process engineering: --electronic --mechanical --materials design definition; quality assurance; purchased product engineering test equipment; program management; information systems
Oak Ridge (Y-12)	Lockheed-Martin identifies 723 weapons specialists. Areas: analytical science & eng.; nuclear safety eng.; chemical process eng. radiological control; chemistry and material scientists; safeguards specialists inspection engineers chemical operators; production and scheduling; instrumentation machinists metallurgical engineers; mechanical systems mechanical engineers; radiographer
Savannah River Tritium	Westinghouse identifies 23 weapons specialists in the tritium program. Areas: tritium processing & handling; authorization basis; environmental shift tech. support; configuration management; weapon boost system control systems; programmers; mass spectroscopy Westinghouse identifies 28 weapons specialists in the SR Technical Center. Areas: instrument developers; high pressure technician; electronics technician ultrasonics; high pressure systems; digital radiography structural mechanics; environmental conditioning; welding non-destructive evaluation; process development; metallurgists materials scientists; process development scientists; R&D facility specialist

III. "Fragile" Skill Areas

In its meetings with facility managers, the Commission was told of the emergence of "fragile" skill areas throughout the complex. The Commission therefore asked facility managers to identify those areas where, in their judgement, the small number of skilled workers is a concern. The facilities identified 43 such areas (see Figure D-4).

Figure D-4. "Fragile" Skill Areas Identified by the Facilities

	Fragile Skill Areas
LANL (6)	High explosives safety testing Test and measurement device installation High explosives press operations Neutron vulnerability analysis and modeling Hydrotest pin dome assembly Stress-wave modeling of test cavity size and geology
LLNL (5)	Stockpile use control Weapon effects, vulnerability, and hardening Tritium handling Underground experiments containment Weapon system studies
Sandia (3)	Weapons Evaluation Test Connectors Specialized electronic components
NTS (10)	Electro-optics Laser diagnostics Arming, timing, and firing control Data film reading and analysis Photo-tube development Streak camera design, characterization, and fielding Large system sub-nanosecond timing design Electronic PINEX camera system design and fielding High bandwidth analog and pulse circuit design CCD imaging camera design and characterization
Kansas City (10)	Vacuum systems and deposition processes Plating chemistry for metal plating lines Plasma cleaning Advanced fireset development Fireset production engineering Radar production engineering Hazardous materials management Cellular silicone fabrication Machine control applications
Oak Ridge (Y-12)	Mechanical engineers (especially fabrication process engineering) Metallurgists Material scientists (especially ceramics) Organic chemists (especially adhesives and electrochemistry) Production schedulers

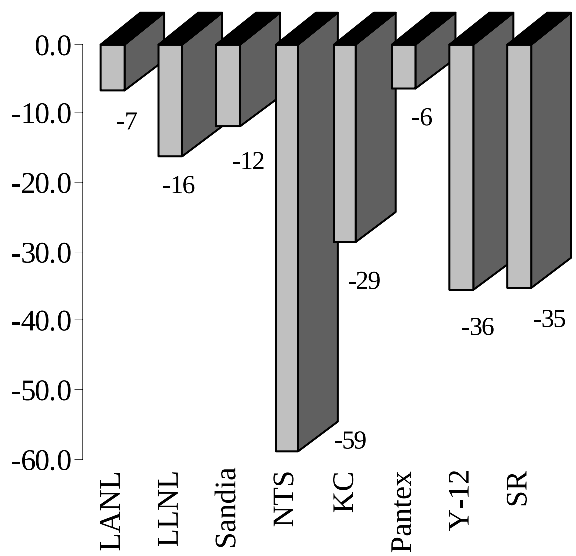
Figure D-4 (cont.) "Fragile" Skill Areas Identified by the Facilities

	Fragile Skill Areas
Pantex (4)	Linear accelerator Mass property X-ray Weapons testing area
Savannah River (Tritium) (0)	

IV. Workforce Downsizing and Demographics

Employment in the nuclear weapons program reached its peak in 1990. It declined 15 percent between 1990 and 1993, and an additional 43 percent between 1993 and 1998. Total facility employment at the eight nuclear weapons facilities, shown in Figure D-5, has fallen by somewhat smaller percentages.[D-3] For example, 1998 Los Alamos employment declined 6.6 percent relative to 1993. The figure shows that Lawrence Livermore has experienced the largest cuts of the laboratories, having shrunk by over 16 percent.[D-4]

Figure D-5. Total Facility Employment in 1998 versus 1993



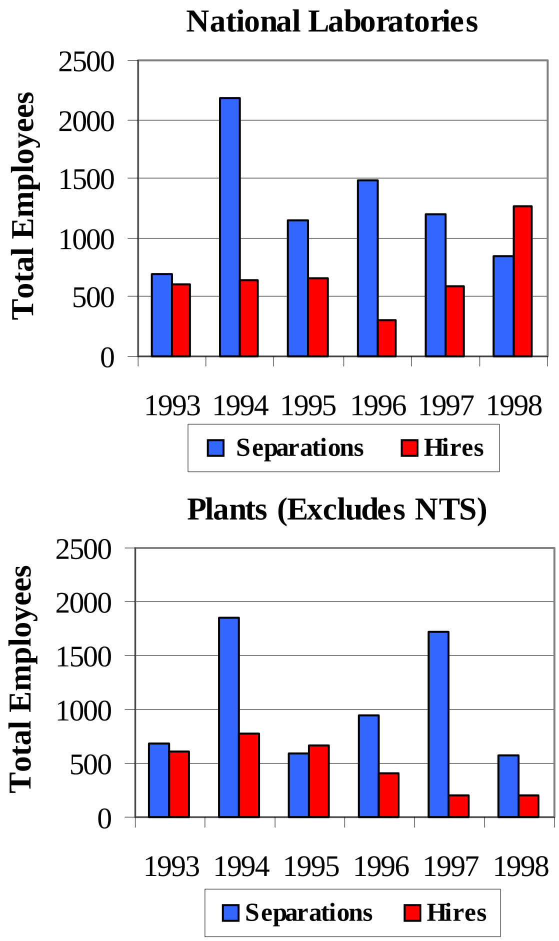
[D-3]Total facility employment at the eight facilities that now comprise the complex fell by smaller percentages for two reasons. First, some weapons program employment reductions reflect transfers of personnel out of the weapons program and into Environmental Management and other missions within a facility. Second, weapons program reductions or transfers of nearly nine thousand workers were taken at sites that no longer support the weapons program: Mound, Pinellas, and Rocky Flats. In the eight facilities we studied, total facility employment fell from 62,500 to 62,000 between 1990 and 1993, and from 62,000 to 47,000 in 1998.

[D-4]During this period, both Los Alamos and Sandia experienced growth in their weapons program workforces. The weapons workforce grew at Los Alamos (13.5 percent) and Sandia (2.3 percent), countering the trend througout the rest of the complex. At least in part this is due to the addition of production missions there, as discussed earlier.

Among the production plants, only Pantex has maintained relatively stable employment. Pantex has been cut by only six percent, reflecting its ongoing weapons maintenance and dismantlement workload. In contrast, both Kansas City and Y-12 are in the midst of downsizing in place, and have undergone reductions of 29 percent and 36 percent, respectively. Total facility employment at Savannah River has continued the declines stemming from the shut down of reactor operations in the 1980s, declining an additional 35 percent between 1993 and 1998. Tritium operations have remained relatively stable, declining about nine percent since 1993. The Nevada Test Site has been cut by more than 50 percent, reflecting major reductions associated with the termination of the undeground test program.

Organizations that undergo downsizing typically manage the process, in part, by encouraging voluntary separations or early retirement and, in part, by cutting back on new hires. The overall approach to downsizing is illustrated in Figure D-6. Significant reductions in force occurred in 1994, 1996, and 1997, as can be seen from the high rates of departures relative to the new hires in those years. New hires reached a minimum in 1996 and 1997. Hiring rebounded within the laboratories in 1998 but has continued to decline in the production facilities.

Figure D-6. Total Complex Hires and Separations[D-5]



Most of the facilities did little hiring between 1993 to 1998; the average rate of hiring ranged between 2.9 and 3.8 percent of the workforce at the three laboratories. There was far more variability within the plants: Y-12 and Savannah River each hired at rates below 1.5 percent. Kansas City and Pantex hired at average rates of about five and seven percent, respectively.[D-6]

The impact of the weapons complex downsizing on the workforce can be seen in the age distributions. Figure D-7 shows the composite age profile for the three laboratories (top panel) and for the production plants and NTS (bottom panel). The age distributions are quite similar: in both the plants and the labs, a predominant fraction

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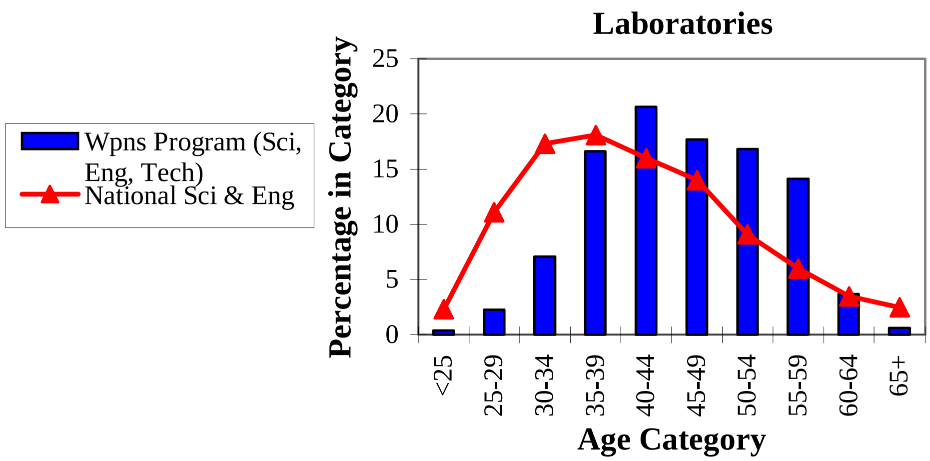
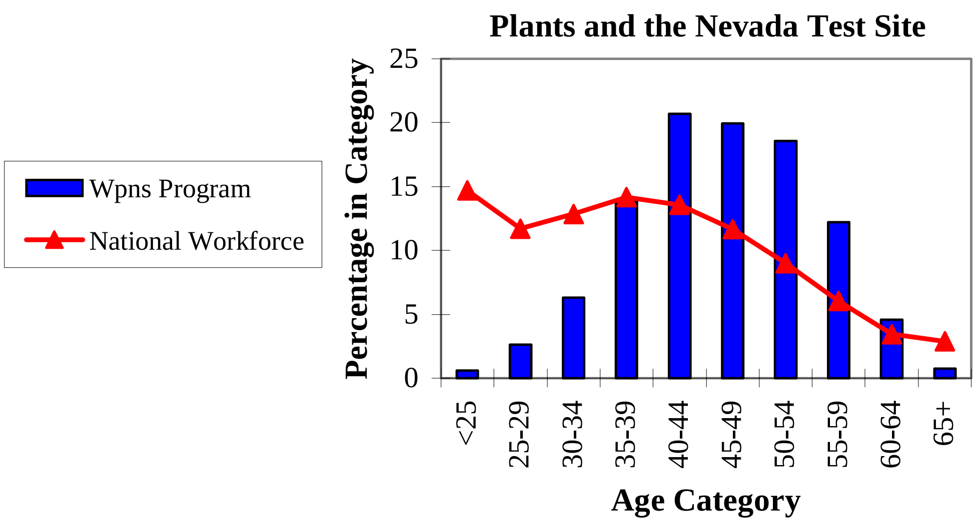
[D-5]The Nevada Test Site was excluded from this figure, because the new contractor could not provide historical statistics on workforce hiring and separations.

[D-6]The average percentage rate of employee separations over the period were: LANL (6.0%), LLNL (6.2%), Sandia (5.9%), NTS (22.6%), KCP (11.3%), Pantex (8.1%), Oak Ridge Y-12 (7.9%), and SR (tritium) (6.3%). These data include retirements, reductions in force, and other voluntary worker separations. The Nevada Test Site ordinarily does a significant amount of hiring and firing within the ranks of its construction force, and so it customarily has high rates of hiring and turnover; thus the NTS hiring are not comparable to those of the other sites.

of the workforce is in the age band of 40 to 60 years old. In both cases, the oldest age categories (60+ years) have been thinned through early retirement incentives (Figure D-13, shown in the addendum of this Appendix, depicts the age distributions for the individual facilities; Figure D-14 in the addendum shows how the average age of the workforce has changed).

Figure D-7. Weapons Complex and National Workforce Age Distributions[D-7]





To provide a basis for comparison, Figure D-7 superimposes a line showing the age distribution of a benchmark national workforce. For the laboratories, this is the age distribution of currently employed degree holders in the fields of science and engineering. For the production facilities and the NTS, we use the age distribution of the overall national workforce. The figure shows that, for both the laboratories and the plants, the weapons complex workforce is older on average, and has far fewer people in the younger age cohorts than does the comparable national population.

[D-7]Laboratory scientists, engineers, and technicians are compared against the age distribution of the nation's employees holding degrees in science and engineering. Source: National Science Foundation's Surveys of Science and Engineering College Graduates, in *Science and Engineering Indicators – 1998*. Plant weapons program workforce data are compared against the Bureau of Labor Statistic's age profile for total U.S. employment. Source: *Current Population Survey*.

While the overall U.S. workforce is not a perfect benchmark of comparison for the weapons complex workforce — because the latter should be better educated, and probably somewhat more mature than the former — this pattern nevertheless supports the observations shared with the Commission by several plant and laboratory directors; that is, the overall mix of their workforces has aged more than is desirable.

The age distribution within the complex creates no immediate crisis — at least from an overall demographic perspective — but the relative concentration of the workforce in the 40 to 60 year-old age band does pose a long-term challenge that needs to be addressed. The normal process of hiring and training was interrupted during the downsizing. The facilities must ensure that an adequate flow of new talent is recruited, hired, and trained before the more senior members of the current workforce begin to retire.

A comparison can place this challenge in context: About 21 percent of the U.S. workforce is over 50 years old; in six of the eight weapons facilities, more than one-third of the workforce is in this category. Nearly half the workers at NTS are over 50. The management of the Oak Ridge Y-12 plant told the Commission that 75 percent of its workforce is currently eligible to retire. Annual losses due to retirement will be roughly 60 percent to 150 percent higher on average in the weapons program than in the economy at large, and the facilities must be prepared to hire and train an adequate number of replacements.

In addition to the planning required to meet this broad demographic trend, managers must identify and address those specialized areas within the weapons complex where the aging of the workforce creates more pressing problems than these overall trends suggest. These include the 43 "fragile" skill areas discussed earlier. There are, in addition, other areas where a large fraction of the current workforce is over 50 years old, and the development of capable new talent will require several years of hands-on experience working with a senior, experienced person who can "teach the trade."

Perhaps most significantly, there is concern with the age distribution of weapons designers. For example, 22 of Lawrence Livermore's 56 weapons designers are over 50 years old, and there are currently only three designers under the age of 35. Given the lengthy experience required to gain proficiency, and managers' concerns that designers are already stretched thin, there is a need to begin now to develop designers who can step in when the most senior current designers begin to retire.

Another example from the labs is the area of environmental testing, which attempts to identify the electrical, mechanical, and thermal vulnerabilities of warheads. Lawrence Livermore reports that 24 of the 44 people in this area are over 50 years old. Moreover, three of the five specialists in electromagnetic response are over 50, as are 14 of 17 specialists in the area of mechanical response.

One example from the production plants is presented by the machinists at Y-12. More than half are over 50 years old, and there are no machinists under the age of 35. As in most other skill areas in the complex, a machinist's skills and knowledge are gained through several years of informal on-the-job training, akin to an apprenticeship. The concern is that the "apprentices" must be hired soon, in order to provide sufficient overlap with the current generation of senior workers to thoroughly learn the trade.

V. Projections of Future Weapons Program Hiring Needs

The compression of the workforce into the 40 to 60 year-old age band, and the relatively large numbers of workers over 50, mean that workers will be retiring in large numbers over the next decade. In addition, changing demographics and job market factors will likely accelerate the rates of employee turnover within the complex. To evaluate the implications, this section provides the results of a simple model used to project the hiring rates that will be required over the next decade to sustain the currently sized weapons program workforce (approximately 17 thousand).

These projections provide a rough gauge to judge whether current hiring rates are adequate to meet future requirements. They also help to place the complex's hiring needs in perspective relative to the relevant pools of talent available in the national labor markets for scientists and engineers.

The projections make two assumptions. First, in projecting the expected annual number of retirements, it is assumed that all of the current workers over the age of 50 will retire within the next 12 years. This assumption is roughly consistent with the age distributions data presented earlier in Figure D-7. These retirements are spread uniformly over the period.

Second, in projecting the expected annual rates of turnover among non-retiring employees, it is assumed that the current rate of voluntary, non-retirement turnover will continue. Figure D-8 presents these rates for each facility. In order to suggest the bounds of expected turnover rates, the facility-wide turnover rate is provided to indicate the expected current rate, and the rate for employees under 35 years old is provided to give some indication of the degree to which the turnover rate might increase as more younger workers are hired.

Figure D-8. Workforce Turnover Excluding Retirements and RIFs (1998) (Percentages)

	LANL	LLNL	Sandia	NTS*	KCP	Pantex	Y-12	SR (tritium)
Total Facility	2.1	2.0	2.9	8.1	2.7	4.5	2.9	1.8
Total Facility (Age 35)	3.5	3.9	8.0	11.7	17.5	8.2	8.0	n.a.

*NTS data exclude construction craft workers

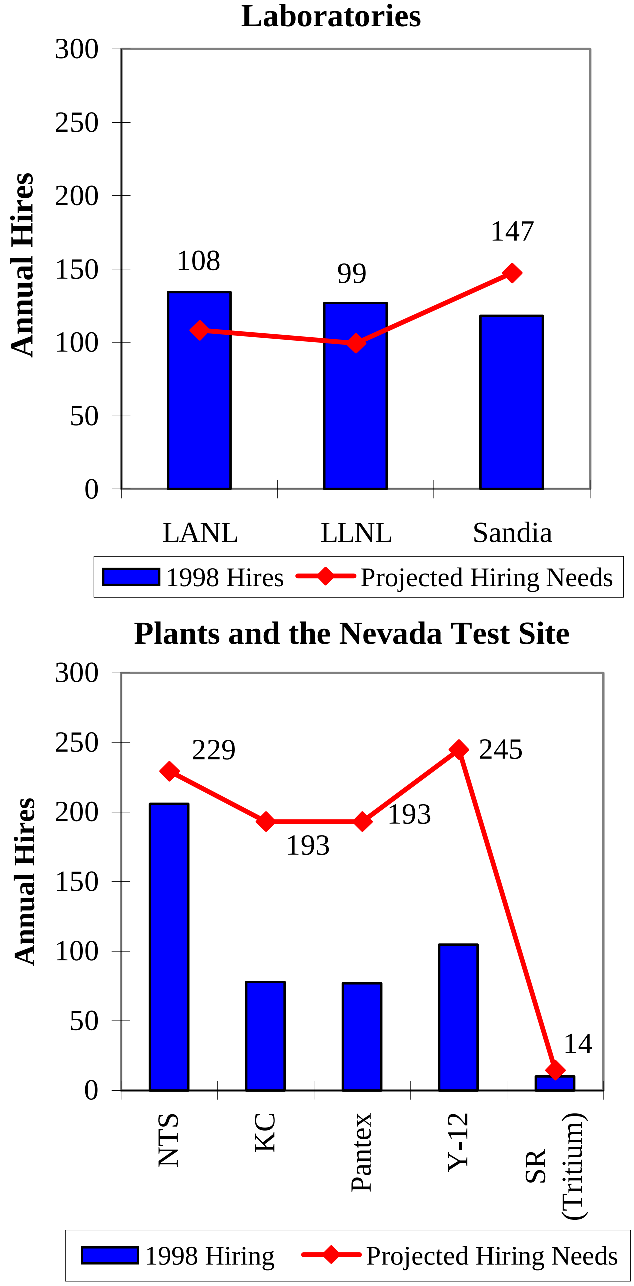
The weapons facilities have very low turnover rates. In part, this reflects the demographic composition of the workforce, which is predominately composed of mature, stable workers. Total facility turnover rates are three percent or less at every facility except Pantex (4.5 percent) and NTS (8.1 percent). Note that the NTS data exclude the high level of annual turnover of the construction craft workers.

Higher turnover rates can be expected among the incoming generation of younger workers, especially in high-demand technology areas such as information technologies and materials science. Even so, Los Alamos and Lawrence Livermore have turnover rates among their young workers (<35 years old) that are remarkably low, both under four percent. Sandia, NTS, Pantex, and Y-12 have rates on the order of eight to 12 percent. These rates are not out of line with the economy-wide experience for this generation of workers. The rate at Kansas City (17.5 percent) reflects both the relatively small number of workers that are under 35, and the difficulty they have in retaining younger workers in the facility.

Several facilities also noted higher rates of turnover in skill areas where national labor markets are highly competitive. Particular areas of concern are information technology and materials sciences. Several facilities have introduced targeted pay adjustments to improve retention in these areas.

The projected average annual levels of new hires needed to replace projected losses are shown by the lines in Figure D-9. The upper panel includes the three laboratories; the lower, NTS and the production sites. The laboratories need to hire about 350 scientists, engineers and technicians per year. The production facilities and NTS need to hire about 850 total workers per year. As seen in Figure D-7, the rate of retirement will accelerate in the coming years. Hiring rates should exceed these averages in the near term in order to ensure that new employees are brought on board in time to be adequately trained before the retirements take place.

Figure D-9. Projected Weapon Program Hiring Needs Compared with Recent Experience



In order to gauge the extent to which recent hiring efforts are meeting these needs, we compare recent hiring levels against projected hiring requirements in Figure D-9. The columns in the figure include the number of new hires made in 1998.

All three laboratories increased hiring in the last year. LANL and LLNL both hired at rates more than double the average of the 1993-1998 period. LANL's and LLNL's weapons program hiring rates in 1998 were roughly adequate to maintain their current workforces. A gap persists between projected hiring needs and 1998 hiring levels at Sandia.

The 1998 turnaround in hiring at the laboratories reflects the growing demands associated with the implementation of the SSP, and the resulting improvement in the laboratories' budget outlooks. Not surprisingly, many of the human resource mangement issues raised with the Commission by the laboratory directors were associated with the challenges they face in sustaining the larger inflows of new hires.

In contrast to the laboratories, the production facilities hired at significantly lower levels in 1998 than for the period overall, and all were hiring at well below sustaining rates in 1998. The managers of these facilities continue to be hampered by uncertainties regarding their workload in the evolving SSP. The lack of a detailed SLEP has undermined their ability to specify their future workload and plan their workforces accordingly. Savannah River, which has a relatively well-understood workload associated with tritium replenishment, has not suffered from the same problems as have the other production facilities.

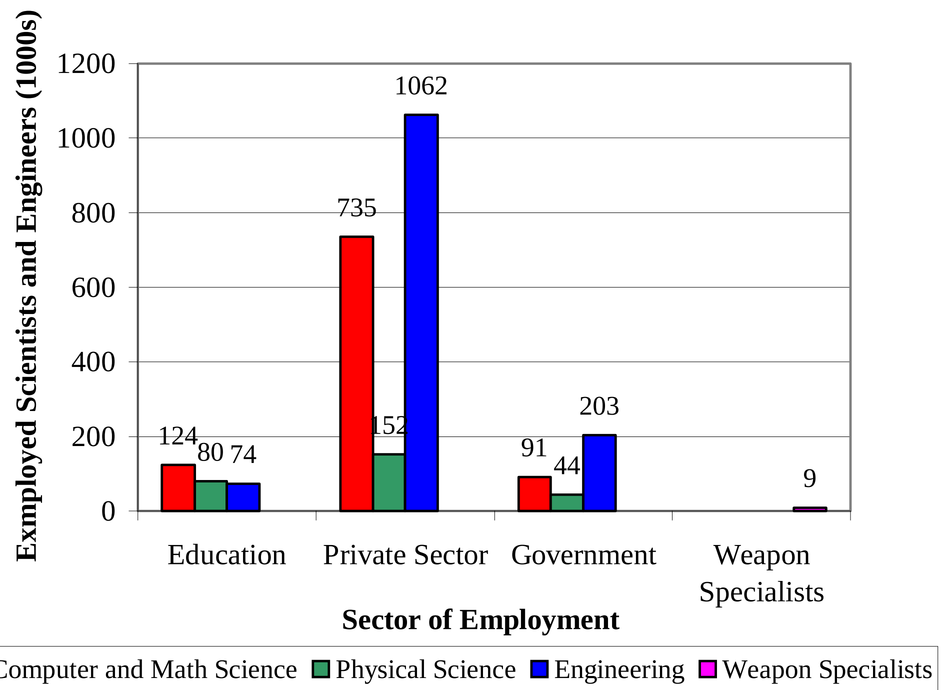
VI. Weapons Complex Hiring Needs in the Context of National Labor Markets

One question posed by the Commission was whether the labor pool of available talent in the nation would be adequate to meet the needs of the weapons complex. The Commission has reviewed data on the national science and engineering workforce, and trends in the education of scientists and engineers. Based on this review, whose results are very briefly summarized below, the Commission finds that the available national pool of talent is not a principal limitation in sustaining the nuclear workforce.

The real challenge, as emphasized in the body of our report, is to compete effectively to attract and retain the top-quality people from this broad labor pool. It is this challenge that has been the subject of the Commission's deliberations and the focus of our recommendations. The Commission has not made recommendations relating to national education programs for scientists and engineers.

One perspective on the magnitude of the weapons program's needs relative to the national pool of scientific and engineering talent is provided in Figure D-10, which compares the number of weapons specialists at work in the complex against the total number of scientists and engineers that hold a bachelors, masters, or doctorate degree in relevant fields. The total number of computer scientists, mathematicians, physical scientists, and engineers employed in the U.S. numbers approximately 2.5 million. A significant fraction works in each of the three broad sectors: academia, the private sector, and government. The nine thousand weapons specialists (defined earlier in this appendix) represent less than one-half of one-percent of this total workforce. This comparison suggests that — at least in terms of raw numbers — the nation has a huge pool of talent that could be drawn on to sustain the weapons program.

Figure D-10. Weapons Specialists and the National Pool of Scientists and Engineers

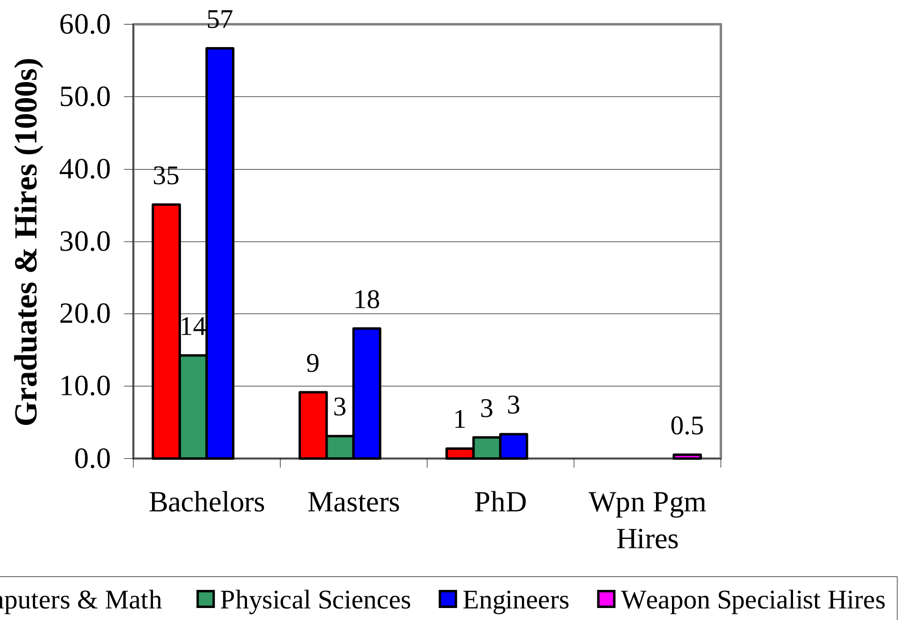


Another perspective on the adequacy of the national pool of scientists and engineers is provided by comparing the hiring needs of the complex against the flow of new graduates into the workforce. The hiring needs projections presented above indicate the weapons program will need to hire on the order of 1200 new employees each year on average to sustain the workforce at its current size. Of these, the total number of weapons specialists is on the order of 500 per year (this includes 350 scientists, engineers, and technicians to be hired by the laboratories and roughly 150 to be hired into weapons specialist positions in the production sites).

Figure D-11 compares the projection of weapons specialist hires against recent National Science Foundation data on degrees granted in relevant fields of science and engineering. These data are adjusted to exclude degrees granted to temporary residents of the U.S., to account for the fact that a significant fraction of graduate degrees are earned by foreign citizens who are not eligible to do classified work within the weapons complex. Just over 140 thousand U.S. citizens earn degrees each year in the physical sciences, mathematics and computer science, and engineering. About 75 percent of these are bachelors degrees.

Weapons specialist hiring represents less than one-half of one-percent of this total pool of graduates. If compared to just the pool of new doctorate graduates, weapons specialist hiring would represent about six percent. The relationship of the weapons complex hiring needs tells the same basic story as the comparisons above of the relative size of the weapons complex workforce compared with the national pool of scientists and engineers: The size of the national pool of scientists and engineers is not a principal limiting factor in sustaining the weapons complex workforce.

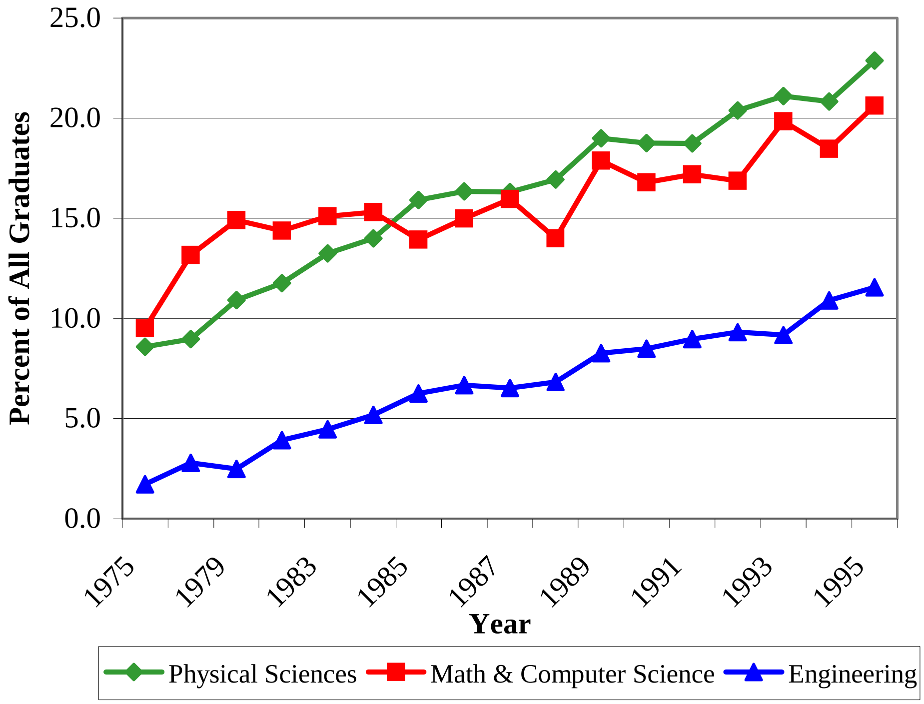
Figure D-11. Weapons Program Hires and the Pool of New Graduates (U.S. Citizens and Permanent Residents Only)[D-8]



One noteworthy trend in the national labor market is the continuing rise in the proportion of female scientists and engineers. Figure D-12 illustrates this trend toward doctorate degrees granted.

[D-8] These data are adjusted using NSF data on the proportion of degrees granted to US citizens and permanent residents. Reported data are specific by field. For bachelors degrees, the percentage of degrees granted to U.S. citizens and permanent residents are: physical science (95%), math (90%), and engineering (90%). For masters degrees, the corresponding percentages are: 74%, 61%, and 62%. For doctorates, the percentages are: 76%, 63%, and 56%.

Figure D-12. Trend in Doctorates Granted to Females (Percentage)



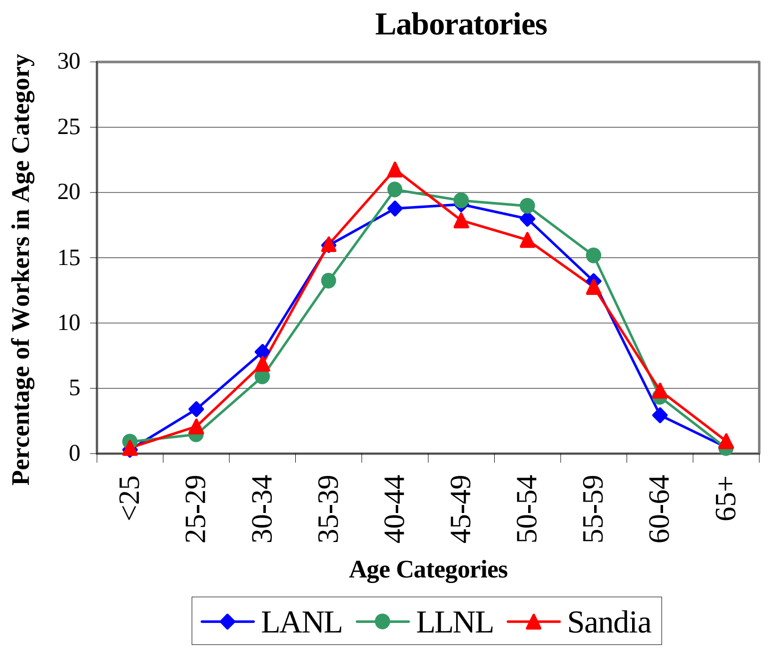
The data show that the proportion of doctorates granted to women has grown continuously since the mid 1970s. The trends are generally similar for masters degrees.[D-9] The implication of these trends is that women constitute an increasing share of the national pool of scientists and engineers.

[D-9]A comparison of masters degrees granted to women in 1995 versus 1985 shows that women represent a significantly increasing share of graduates in physical sciences (from 23% to 31%) and in engineering (from 10.7% to 16.2%). Women's proportion of math and computer science masters degrees remained constant at roughly 31%.

VII. Addendum to Appendix D

Figure D-13 provides the age distribution for each facility in the weapons complex. Figure D-14 provides the data reported on the changes in the average age of the workforce.

Figure D-13. Age Distributions For Individual Facilities



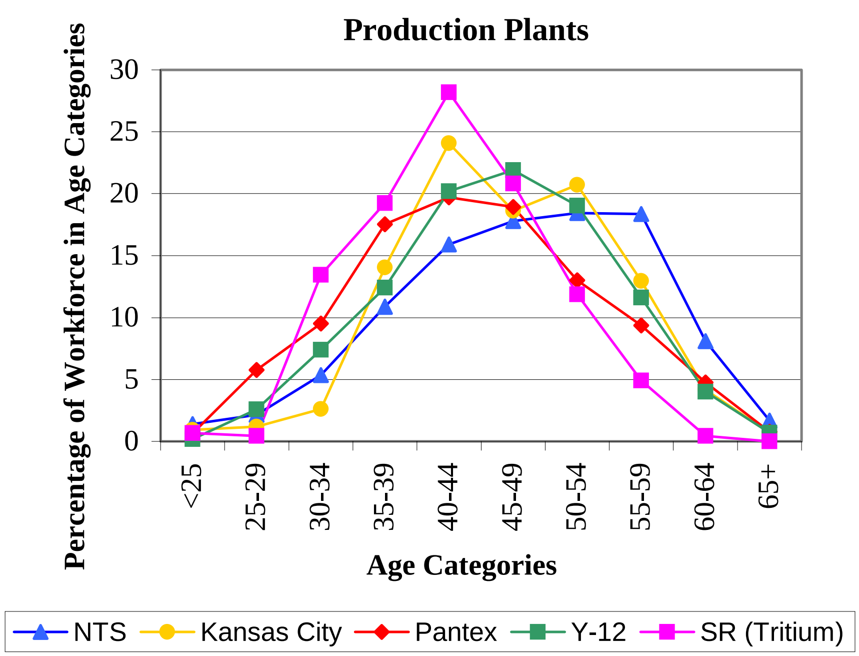


Figure D-14. Representative Data on Workforce Aging*

Facility	Average Age (Base Year)	Average Age (Current Year)
LANL (technical staff)	44 (1993)	46 (1998)
LLNL (scientists & engineers)	44 (1990)	47 (1998)
Sandia (technical staff)	42 (1987)	44 (1997)
Kansas City	42 (1988)	47 (1998)
Oak Ridge Y-12	43 (1989)	48 (1998)

* Includes those facilities that have historical data on average age. NTS data were excluded because, as noted elsewhere, they reflect the high rates of turnover and hiring within the construction crafts.

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Appendix E: List of Acronyms

Name	Acronym
Albuquerque Operations Office	AL
Assistant Secretary for Defense Programs	ASDP
Bureau of Labor Statistics, U.S. Department of Labor	BLS
Comprehensive Test Ban Treaty	CTBT
Defense Nuclear Facilities Safety Board	DNFSB
Defense Programs	DP
Department of Defense	DOD
Department of Energy	DOE
Enhanced Surveillance Program	ESP
Environment Safety and Health	ES&H
Institute for Defense Analyses	IDA
Kansas City Plant	KCP
Lawrence Livermore National Laboratory	LLNL
Lockheed Martin Energy Systems	LMES
Long Range Planning Assessment	LRPA
Los Alamos National Laboratory	LANL
National Academy of Sciences	NAS
National Center for Educational Statistics	NCES
National Science Foundation	NSF
Navy Strategic Systems Programs	Navy SSP
Nevada Area Office	NV
Nevada Test Site	NTS
Nuclear Posture Review	NPR
Nuclear Weapons Stockpile Memorandum	NWSM
Oakland Operations Office	OAK
Oak Ridge Y-12 Facility	Y-12
Pantex Plant	PANTEX
Programmatic Environmental Impact Statement	PEIS
Quality of Life	QOL
Sandia National Laboratory	SNL
Sandia National Laboratory/Livermore	SNLL
Sandia National Laboratory/New Mexico	SNL/NM
Savannah River Site	SRS
Stockpile Life Extension Program	SLEP
Stockpile Management Restructuring Initiative	SMRI
Stockpile Stewardship Program	SSP
The Johns Hopkins University/ Applied Physics Laboratory	APL
Theoretical Institute for Thermonuclear and Nuclear Studies	TITANS
Westinghouse Savannah River Company	WSRC

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Appendix F: List of Documents

Congress/Congressional Research Service

CRS Report for Congress-Nuclear Weapons Production Capability Issues: Summary of Findings, and Choices, October 1997

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Albuquerque Operations Strategic Plan Fiscal Year 1998 Update

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Baseline External Assessment of DOE Efforts to Increase the Technical Capability of Its Civil Service Technical Workforce in Defense Nuclear Facilities, August 1994

Benchmarking Report Annex: Baseline External Assessment of DOE Efforts to Increase the Technical Capability of it's Civil Service Technical Workforce, August 1994

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Data on Scientific Technical and Management Personnel at each site, June 1998

Data on University of California Appendix A – DOE Approval Requirements, September 1998

Defense Programs Recent Funding History, October 1998

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Draft Report on Stockpile Stewardship Recruitment and Training Program, March 1995

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Laboratory Operations Board – Third Report of the External Members – Attachment III: Letter from John McTague on Contract Reform

Laboratory Operations Board-Third Report of the External Members to the Secretary of Energy Advisory Board, September 1997

Laboratory Operations Board-Third Report of the External Members – Attachment 1: R&D Program Management Reviews

Laboratory Operations Board-Third Report of the External Members – Attachment 2: Measuring Productivity Improvements in the Department of Energy's National Laboratories, September 1997

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