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Navigating a Quality Route to a National Safety Award

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Navigating a Quality Route to a National Safety Award

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Navigating a Quality Route to a National Safety Award

Deming quality methodologies applied to safety are recognized with the National Safety Council's annual Robert W. Campbell Award.

Over the last ten years, the implementation of Statistical Process Control and quality methodologies at the U.S. Department of Energy's Hanford Site have contributed to improved safety. Improvements attributed to Statistical Process Control are evidenced in Occupational Safety and Health records and documented through several articles in *Quality Progress* and the American Society of Safety Engineers publication, *Professional Safety*. Statistical trending of safety, quality, and occurrence data continues to play a key role in improving safety and quality at what has been called the world's largest environmental cleanup project. DOE's Hanford Site played a pivotal role in the nation's defense beginning in the 1940s, when it was established as part of the Manhattan Project. After more than 50 years of producing material for nuclear weapons, Hanford, which covers 586 square miles in southeastern Washington state, is now focused on three outcomes:

1. Restoring the Columbia River corridor for multiple uses
2. Transitioning the central plateau to support long-term waste management
3. Putting DOE assets to work for the future.

The current environmental cleanup mission faces challenges of overlapping technical, political, regulatory, environmental, and cultural interests. From Oct. 1, 1996 through Sept. 30, 2008, Fluor Hanford was a prime contractor to the Department of Energy's Richland Operations Office. In this role, Fluor Hanford managed several major cleanup activities that included dismantling former nuclear-processing facilities, cleaning up the Site's contaminated groundwater, retrieving and processing transuranic waste for shipment and disposal off-site, maintaining the Site's infrastructure, providing security and fire protection, and operating the Volpentest HAMMER Training and Education Center.

On October 1, 2008, a transition occurred that changed Fluor's role at Hanford. Fluor's work at Hanford was split in two with the technical scope being assumed by the CH2M HILL Plateau Remediation Company (CHPRC) CHPRC is now spearheading much of the cleanup work associated with former nuclear-processing facilities, contaminated groundwater, and transuranic waste. Fluor is an integrated subcontractor to CH PRC in this effort. In addition, at the time of this writing, while the final outcome is being determined for the new Mission Support Contract, Fluor Hanford has had its contract extended to provide site-wide services that include security, fire protection, infrastructure, and operating the HAMMER facility. The emphasis has to be on doing work safely, delivering quality work, controlling costs, and meeting deadlines. Statistical support is provided by Fluor to the PRC, within Fluor Hanford, and to a third contractor, Washington Closure Hanford, which is tasked with cleaning up approximately

210 square miles designated as the Columbia River corridor along the outer edge of the Hanford Site.

The closing months of Fluor Hanford's 12 year contract were busy, characterized by special events that capped its work as a prime cleanup contractor, transitions of work scope and personnel, and the completion numerous activities. At this time, Fluor's work and approach to safety were featured in state and national forums. A "Blockbuster" presentation at the Washington State Governor's Industrial Safety Conference in September 2008 featured Fluor Hanford's Chief Operating Officer, a company Safety Representative, and me. Simultaneously, an award ceremony in Anaheim, Calif. recognized Fluor Hanford as the winner of the 2008 Robert W. Campbell Award.

The Robert W. Campbell Award is co-sponsored by Exxon Mobil Corporation and the National Safety Council. Named after a pioneer of industrial safety, the Campbell Award recognizes organizations that demonstrate how integration of environmental, health and safety (EHS) management into business operations is a cornerstone of their corporate success. Fluor Hanford received the award for corporations with more than 1,000 employees. Campbell Award winners undergo rigorous assessments that include site visits and comprehensive evaluations of their commitment to, and implementation of, EHS practices. Award winners work with an international partnership of 21 organizations to develop case studies that illustrate their superior EHS programs and best practices, for use by top business and engineering schools worldwide.[1]

Quality methodologies in place at Fluor Hanford played a key role in the award process. Fluor Hanford's integrated use of Statistical Process Control and Pareto Charts for analyzing and displaying EHS performance were viewed favorably by the award judges.

History of SPC and Deming at Fluor Hanford

I track the practical use of SPC and Deming methodologies to the early 1990s, when knowledge of the Deming management principles was coupled with a company-wide Total Quality Management program. I was originally hired at the Hanford site by Westinghouse to be a Maintenance Supervisor. However, I was quickly diverted into generating performance indicators and applying Dr. Deming's management principles. My first work was with a Statistical Process Control (SPC) analysis of cycle times for maintenance work packages. Phil Monroe and Bill Cooper, who were Deming consultants, were instrumental in starting this work. For three years with Westinghouse Hanford, I was primarily involved with Operations and Maintenance data. In 1996, Fluor was awarded the

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[1] National Safety Council Names Fluor Hanford and Gulf Petrochemical Industries Company 2008 Robert W. Campbell Award Recipients, http://www.nsc.org/news/campbell_award_2008.aspx.

contract for the scope of work previously assigned to Westinghouse. Fluor transferred me to Occupational Safety and Health (OS&H), and I began implementing SPC in the Safety and Health arena. This early work with OS&H was documented in the *Quality Progress* article "Cleaning Up with SPC.".[2] We had several initial successes with reducing injury rates by using Pareto Charts to break out injury characteristics during stable time intervals. We were then able to determine the effectiveness of the resulting actions taken through the SPC charts. Success was declared once a statistically significant trend was found, per the following criteria:

One point outside the control limits.
Two out of three points that are two standard deviations above or below average.
Four out of five points that are one standard deviation above or below average.
Seven points in a row that are all above or below average.
Ten out of 11 points in a row that are all above or below average.
Seven points in a row all increasing or decreasing.

By 2002, we had reduced the injury rate to 1.5 OSHA recordable cases per 200,000 hours, down from 5.2 in 1995. However, we found that our injury rates had "flat-lined," and we needed a new approach to continue the improvement. This new approach came with adopting "leading indicators" –factors other than simply the serious injuries. We developed a set of indicators from readily available data: first-aid case rates, safety inspection rates and scores, occurrence reports and near misses, employee safety-survey results, and employee safety concerns. We organized these "leading indicators" with the existing "lagging" injury rates into a color-coded dashboard. As we wanted to maintain an SPC approach, colors were set based on SPC results:

Improving trend – Green
Stable at an acceptable level – Green
Stable at an unacceptable level – Yellow
Adverse trend – Red

The proposed system was documented in "Stoplight Charts with SPC Inside" in *Quality Progress*.[3] Lessons from the implementation were included in "Lead to Succeed" for Quality Progress and also an article for the American Society of Safety Engineers national publication, "*Safety Professional*".[4] The ASSE article was received favorably by U.S. Department of Energy senior managers in Washington, D.C.

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[2] Prevette, Steven, "Cleaning Up With SPC," *Quality Progress*, September 2001, pp. 104-107.
[3] Prevette, Steven, "Stoplight Charts (with SPC Inside)," *Quality Progress*, October 2004, p. 74.
[4] Prevette, Steven, "Charting Safety Performance", *Professional Safety*, May 2006

The SPC-based dashboard became an extremely useful communications tool. In comparison to the most common dashboards, which compare the most recent result to a set of arbitrary thresholds, the SPC-based dashboard provides the information as to when a change is occurring that needs to be dealt with, or when a process is stable at an unacceptable level and must be changed. The management actions needed to correct for an adverse trend are different than those for a stable system. Generally, correcting an adverse trend requires identifying what changed and resetting the system to its previous level of performance. More difficult is the stable system that needs improvement, but has never performed in the past at a better level. Thus, innovation is needed to change the system to improve performance.

In 2002-2003, Fluor Hanford found itself with a stable system that needed to be improved. Innovation came through the SPC-based dashboard, focusing on leading indicators and implementing the "Human Performance Initiative." In the 2004-2006 timeframe, Fluor was able to reduce its injury rate from 1.5 to under 1.0 OSHA recordable cases per 200,000 hours.

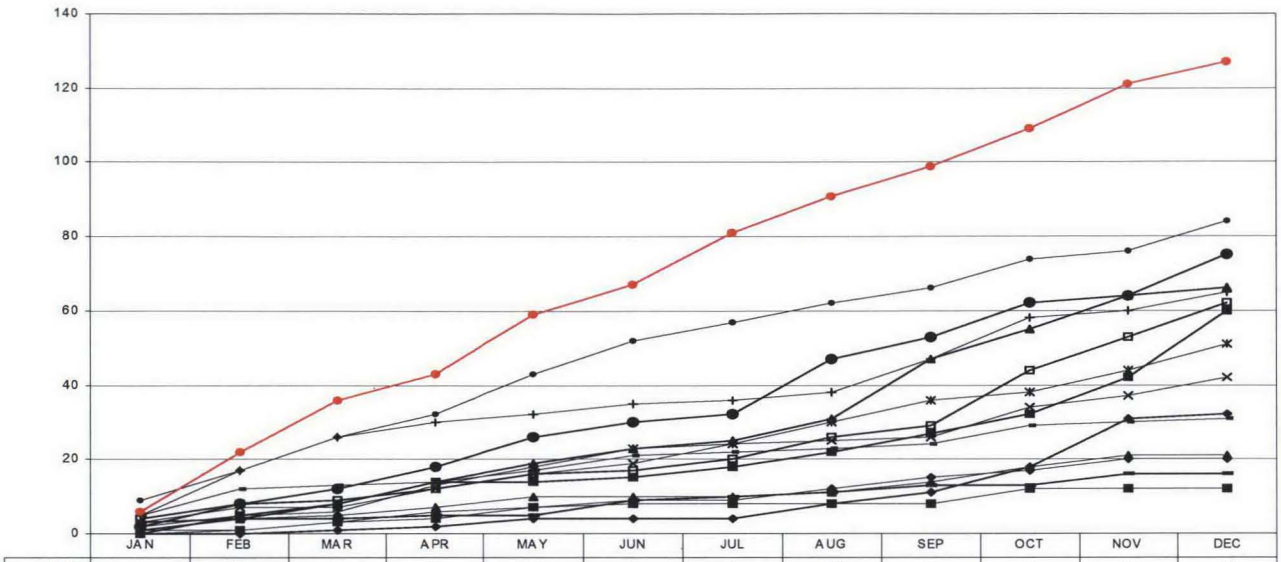
Fluor successfully implemented SPC at Hanford from 1996 to 2008. This approach provided the foundation for success in the DOE Voluntary Protection Program and the DOE Integrated Safety Management System. SPC also improved Hanford management's ability to detect and address emerging issues and constantly improve existing performance. Training on the methods used by Fluor Hanford has been provided to other organizations such as Bechtel, AREVA, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, and the University of Washington. In December 2007, the Institute of Nuclear Power Operations reprinted Fluor's "*Hanford Trending Primer*"[5] as part of a "Best Practice" for performance analysis to its members. [6]

The Statistical Process Control methodology has allowed Fluor employees to gain a better understanding of the messages in the data. For example, a recent SPC analysis was used to convert a chart of vegetation contamination incidents on the Hanford site from the following chart. Due to past nuclear operations at Hanford, much of the soil is contaminated. Although a dry environment, certain desert vegetation such as sagebrush and tumbleweeds do grow, and absorb the radioactive contamination from the soil. To prevent this, herbicides are applied and plants removed from known contaminated soil areas. Also, trends are kept on discoveries of contaminated vegetation in order to tell if the problem is increasing, decreasing, or stable.

Figure 1. Vegetation Contamination Chart as Found

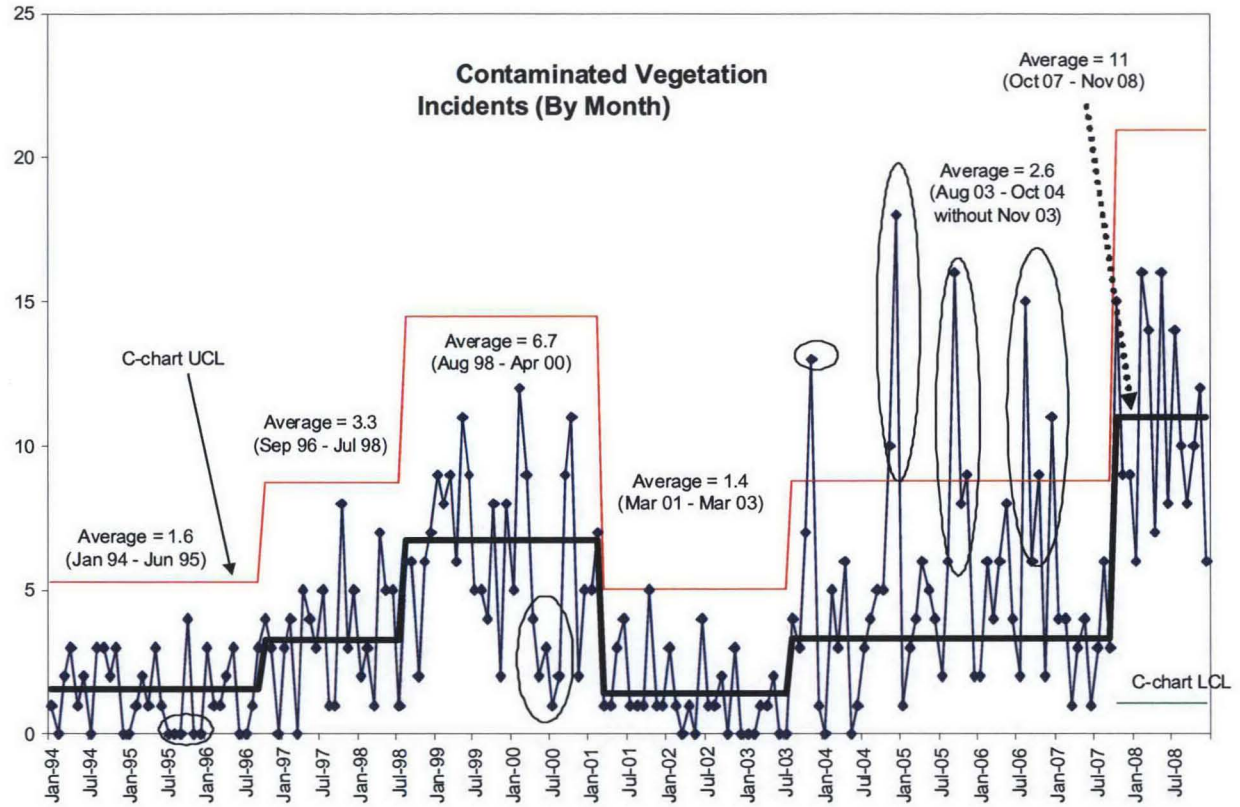
[5] http://www.hanford.gov/rl/?page=1144&parent=169

[6] Institute of Nuclear Power Operations, "Performance Assessment and Trending - General Practices for Analyzing and Understanding Performance," INPO 07-007 Good Practice, December 2007



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1994	1	1	3	6	7	9	9	12	15	17	20	20
1995	0	1	3	4	7	8	8	8	8	12	12	12
1996	3	4	5	7	10	10	10	11	14	18	21	21
1997	3	7	7	12	16	19	24	25	26	34	37	42
1998	2	5	6	13	18	23	24	30	36	38	44	51
1999	9	17	26	32	43	52	57	62	66	74	76	84
2000	5	17	26	30	32	35	36	38	47	58	60	65
2001	5	12	13	14	17	21	22	23	24	29	30	31
2002	3	4	4	5	5	9	10	11	13	13	16	16
2003	0	0	1	2	4	4	4	8	11	18	31	32
2004	0	5	8	14	14	15	18	22	27	32	42	60
2005	1	4	8	14	19	23	25	31	47	55	64	66
2006	2	8	12	18	26	30	32	47	53	62	64	75
2007	4	8	9	12	16	17	20	26	29	44	53	62
2008	6	22	36	43	59	67	81	91	99	109	121	127

Figure 2. Vegetation Incidents converted to SPC



The SPC version allows us to see a steady buildup of events from 1994 to 2000, a significant decrease through 2002, and another buildup through 2004 to 2008. These data have allowed owners of the vegetation control program to focus efforts on removing new sources of vegetation (such as tumbleweeds) that tend to accumulate radioactive contamination from the soil in contaminated areas on the Hanford site.

Role of the Employees

No amount of charts on the wall will reduce the injury rate, or effect other quality improvements. Improvements require the efforts of managers and affected workers. Fluor has been very active in the DOE's Voluntary Protection Program (VPP) that is based on OSHA's Voluntary Protection Program. The program promotes safety and health excellence through cooperative efforts among labor, management, and government at the Department of Energy's sites across the nation. Partnerships have been formed with other Federal agencies and the private sector for both advancing and sharing experiences and preparing for program challenges in the next century. DOE-VPP also includes coverage of radiation protection/nuclear safety and emergency management because of the type and complexity of DOE facilities. DOE-VPP provides several proven benefits to participating sites, including improved labor/management relations, fewer workplace injuries and illnesses, more employee involvement, improved

morale, reduced absenteeism, and public recognition.[7]

In addition to the VPP, the U.S. DOE has supported two additional programs – Integrated Safety Management System and Human Performance Initiative. Of Integrated Safety Management, DOE said, "The Department and Contractors must systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment. This is to be accomplished through effective integration of safety management into all facets of work planning and execution."[8]

The DOE model of Human Performance Improvement (HPI) was derived from performance-improvement approaches adopted in the U.S. commercial nuclear power industry and similar high-performance and demanding operations. HPI's focus centers on examining the processes and the organization rather than finding blame with workers involved in incidents. HPI is rooted in the concept of "high reliability organizations" – those organizations that continuously perform high-risk activities while experiencing few adverse events. These organizations have developed strong cultures, organizational systems and processes designed to enable people to conduct hazardous work safely and effectively. Individuals are trained and coached in performance behaviors and provided tools necessary for their work. Even more importantly, the organization's systems and processes are designed to support performance and prevent events that could be triggered by inadvertent human action.[9]

These programs have helped to focus management and worker efforts on improving safety and performance overall. Statistical Process Control analysis of program data support maintenance and improvement performance. All of these programs had an influence on the decision of the judges for the Robert W. Campbell Award to select Fluor Hanford.

The Robert W. Campbell Award Process

The review panel for the Robert W. Campbell award consists of internationally known experts and leaders in the fields of business, education, safety, health, and environment. These reviewers are nominated by the Global Partners and represent management, labor, academic, and government perspectives from the various regions of the world.

The review process includes comprehensive evaluations and site visits to organizations that have been selected as finalists for the Award. At least three reviewers will evaluate each submission that passes the initial screening process. Applicants designated as finalists will qualify for site visits. The

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[7] http://www.hss.energy.gov/HealthSafety/WSHA/vpp/basics/basics.html.
[8] US Department of Energy, DOE P 450.4 Safety Management System Policy
[9] http://www.efcog.org/wg/ism_pmi/ism_pmi_hpi/docs/White_Paper_HPI_and_Safety_Culture_Final.pdf.

Executive Review Committee will examine the results of site visits and information provided through submissions to determine a combined score. This score will determine the winners of the award.[10]

Fluor Hanford first submitted a review package to the Robert W. Campbell Award in 2007. Similar to the Baldrige Award, each participating organization receives a critique of its input. The "Reviewers' Evaluation Feedback Report" contained several positive statements about Fluor's use of SPC, including the following:

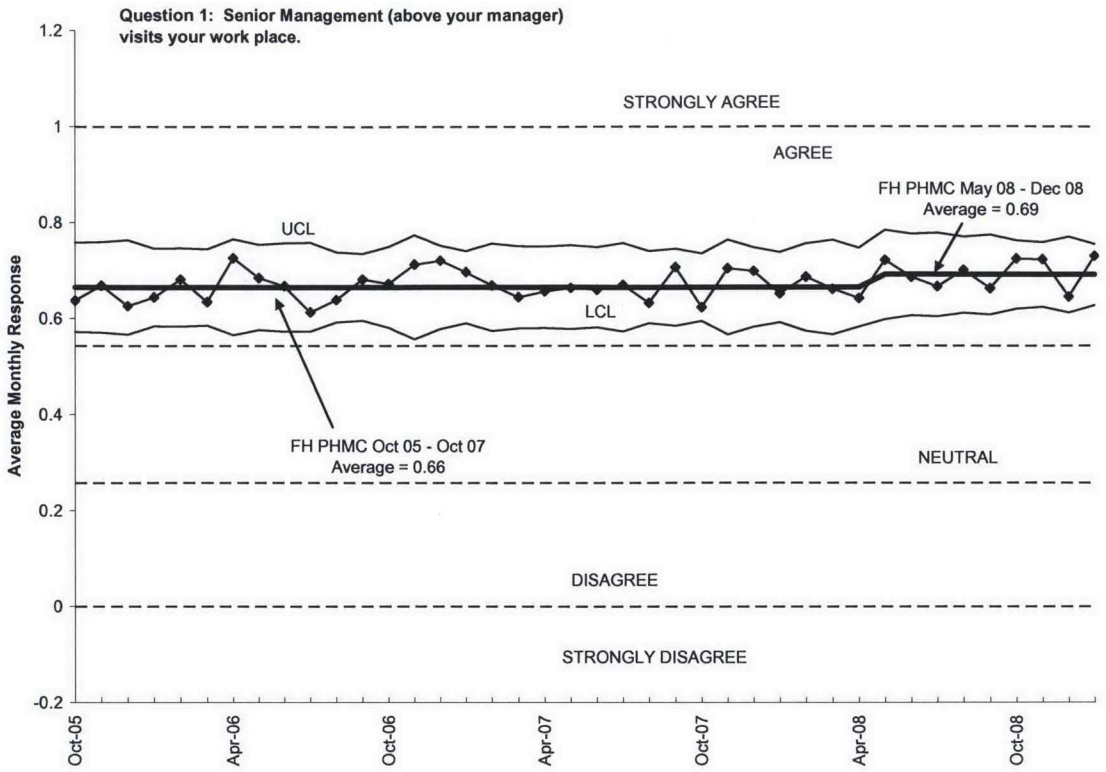
> "Extensive data collection, highly automated, analyzed using SQC [sic] and presented to management in summary form with detailed data charts available. An exemplary system."

Some concerns were noted that perhaps there were "too many" metrics! This was counterbalanced by the use of the SPC-based dashboard to organize the charts and provide a quick overview by senior management.

Fluor Hanford strengthened the submission in 2008, covering some weak areas noted by the 2007 review, and we were very excited to receive the Award in 2008. The Award Committee visited the Hanford site in the summer of 2008. This visit included a review of the SPC process and some of the data processed. The judge conducting the performance measure review was especially interested in our use of a safety-perception survey during annual employee training. The 17 questions in the survey are focused on the tenets of the Voluntary Protection Program and help to estimate the state of the safety culture at Fluor Hanford. One question, for example, asks, if "Senior management (above my manager) visits my place of work." The relative agreement to the question is plotted on a control chart and trended for the company overall, and for major organizations within the company. The current chart of the question is shown below in Figure 3.

Figure 3. Analysis of one of the 17 questions on the Fluor Hanford Employee Survey

[10] http://www.campbellaward.org/index.php/site/index_review.



This question has traditionally been one with the lowest level of agreement. Recent actions taken to encourage management presence in the field have generated a significant increasing trend, seen by the new May 2008 to December 2008 baseline added. The survey is analyzed using a methodology from the U.S. Naval Postgraduate School documented at http://www.hanford.gov/rl/uploadfiles/VPP_AnaSurveyData.pdf.

Path Forward at Savannah River, Another DOE Site

Savannah River Nuclear Solutions (SRNS) is in the initial stages of implementing SPC at DOE's Savannah River site. Key existing performance metrics have been identified for the potential shift to SPC. Currently, 12-month moving averages and year-to-date values are used to track most Site-level metrics. In addition, most existing performance analysis tends to focus solely on lagging indicators. There is currently a great deal of interest in the DOE for the use of leading indicators. The interest will be addressed by using the established techniques from Hanford for SPC and implementation of leading indicators. As the Fluor Government Group statistician, I am supporting the implementation of SPC at SRNS. An incumbent statistician, a certified Six Sigma Black Belt, is leading the effort to accomplish implementation for SRNS.

To date, several control charts have been made of Savannah River data. These include events from the Occurrence Reporting and Processing System (ORPS) and injuries and illnesses from the Computerized Accident and Injury Reporting System (CAIRS). SPC charts have also been developed for site vehicle

accidents, security infractions and the maintenance program.

Once the key existing metrics are shifted, the worth of the metrics will be evaluated, and an individual determination made as to whether or not to keep producing the charts.

Conclusion

Fluor Hanford employees have been extremely pleased to be honored by the Robert W. Campbell Award. The use of Statistical Process Control at Fluor Hanford was one of the features that captured the interest of the Award committee. Statistical Process Control will continue to promote improved safety and performance at the Hanford site, and will be making its appearance in the coming year at the Savannah River Site.

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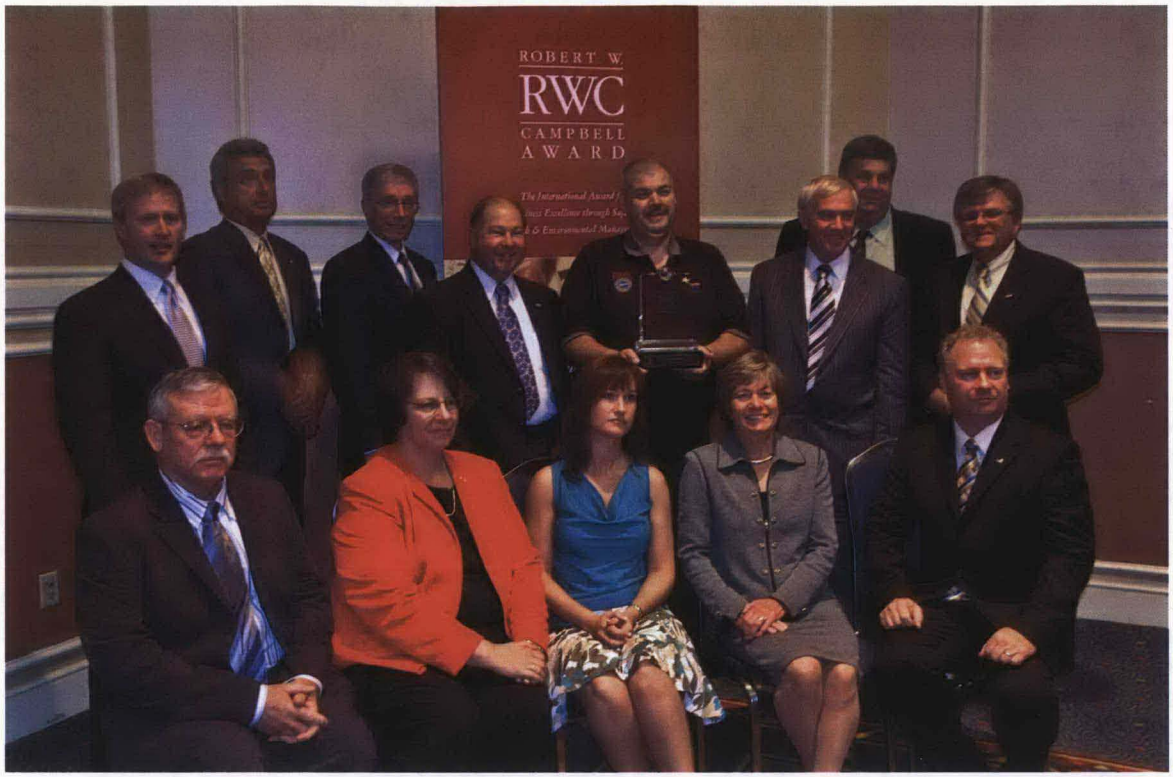

The Fluor Hanford and Fluor corporation safety team at the receipt of the award. Holding the award is John Jeskey, the lead union safety representative for Fluor Hanford.