The Deputy Secretary of Energy
Washington, DC 20585

July 29, 2005

The Honorable A. J. Eggenberger
Chairman, Defense Nuclear Facilities
Safety Board
625 Indiana Avenue, NW
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is the Department of Energy's (DOE) Action Plan, "*Lessons Learned from the Columbia Space Shuttle Accident and Davis-Besse Reactor Pressure-Vessel Head Corrosion Event.*" This Plan fulfills Commitment 17 in the Department's Implementation Plan for Recommendation 2004-1. The Plan was developed with input from applicable DOE Program Secretarial Offices and several field organizations. The Office of Corporate Performance Assurance is responsible for coordinating the Department's implementation of this Plan and keeping me appraised of implementation progress.

If you have any questions, please contact Mr. Frank Russo, Deputy Assistant Secretary, Office of Corporate Performance Assessment, at (301) 903-8008.

Sincerely,

Clay Sell

Enclosure

cc: Mark B. Whitaker, Defense Nuclear Safety Board Representative
Bruce M. Carnes, Associate Deputy Secretary, 2004-1 Responsible Manager

Department of Energy Action Plan

Lessons Learned from the Columbia Space Shuttle Accident and Davis-Besse Reactor Pressure-Vessel Head Corrosion Event

U.S. Department of Energy

July 2005

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Executive Summary

The following events, which occurred within a one year period, resulted in a catastrophic loss of seven lives and a NASA Space Shuttle, and a high-consequence "near miss" at a commercial nuclear power station. These events are a wake-up call to all institutions conducting complex, high-hazard operations. The Department of Energy (DOE) reviewed the associated detailed reports to identify specific lessons learned that can be applied to DOE operations and developed corrective actions. This report documents this effort.

The Space Shuttle Columbia

On February 1, 2003, the Space Shuttle Columbia burned up on atmospheric re-entry killing all seven members of its crew. The physical cause of the loss of Columbia and its crew was a breach in the Thermal Protection System on the leading edge of the left wing. The breach was caused by a piece of insulating foam that separated from the left bipod ramp of the External Tank and struck the wing in the vicinity of the lower half of Reinforced Carbon-Carbon Panel 8 at 81.9 seconds after launch. During re-entry, this breach in the Thermal Protection System allowed superheated air to penetrate the wing's leading-edge insulation and progressively melt the aluminum structure of the left wing, resulting in a weakening of the structure until increasing aerodynamic forces caused loss of control, failure of the wing, and breakup of the Orbiter.

Davis-Besse

On March 5, 2002, a cavity with a surface area of approximately 20- to 30-square inches was found in the reactor pressure vessel (RPV) head at the Davis-Besse Nuclear Power Station. The cavity extended completely through the 6.63-inch-thick carbon steel RPV head down to the thin internal cladding of stainless steel. The stainless steel cladding had withstood the primary system pressure (~2500 psi) over the cavity region during operation; however, the cladding was not designed for this. This cavity was caused by cracking of a RPV head penetration nozzle, leakage of primary coolant water through the cracks, and subsequent corrosion of the carbon steel RPV head by boric acid in the water. Had the cavity not been found by chance while repairing the cracks in the nozzle, subsequent operation of the reactor would likely have resulted in a loss-of-coolant accident (LOCA).

Major investigations were conducted following both events. The investigators concluded that beyond the material failures which directly caused these events, significant organizational, process, and personnel contributors existed.

Ten lessons learned were identified from these events that have applicability to DOE. The first five lessons learned listed below have associated action items which are unique to this report and are described in detail. These lessons learned are those which the Working Group considers to be either not addressed in the Department's Implementation Plan to address Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2004-1 (2004-1 IP), or where additional action will enhance commitments already included in the 2004-1 IP. The working group gleaned five important additional lessons learned from Columbia and Davis-Besse that we considered to

be adequately addressed by the 2004-1 IP. The resultant actions from the DNFSB 2004-1 IP are appropriately referenced.

The following five Lessons were identified from these events and have applicability to DOE and require unique actions:

1. Operating Experience: People and organizations need to learn valuable lessons from internal and external operating experience to avoid repeating mistakes and to improve operations.

2. Mission and External Influences: Budget and schedule pressures must not override safety considerations to prevent unsound program decisions.

3. Normalizing Deviations: Routine deviations from an established standard can desensitize awareness to prescribed operating requirements and allow a low-probability event to occur.

4. Technical Inquisitiveness: To ensure safety, managers need to encourage employees to freely communicate safety concerns and differing professional opinions.

5. Focus on Planning and Prevention: Safety efforts should focus more on planning and preventive actions rather than investigations and corrective actions resulting from accidents or events.

The Office of Environment, Safety and Health will be responsible for monitoring the overall progress in implementing the actions for these five lessons learned and for reporting progress to the Deputy Secretary. A set of dynamic, high level, corporate metrics will be developed to determine the effectiveness of the actions in making the necessary organizational process and workforce cultural changes.

The working group considers the next five lessons learned to be addressed adequately in the 2004-1 IP, and no additional actions are required by this plan.

6. Organizational Structure: An effective organizational structure with clear roles and responsibilities, and appropriate checks and balances is essential.

7. Self-Assessment & Oversight: Successful operations require critical self-assessment and oversight to find problems.

8. Organization Staffing and Qualification: Robust technical capability, enhanced through ongoing technical and leadership training, is essential for complex operations.

9. Corrective Action Programs: Corrective actions that address the underlying causes of problems must be managed to resolution and verified to be effective.

10. Complacency: Management must guard against complacency brought on by good performance metrics and past successes.

1.0 Introduction

The purpose of this plan is to define lessons learned and associated actions applicable to the Department of Energy (DOE or Department) related to the loss of the Space Shuttle Columbia in February 2003 and the severe Reactor Vessel Head Corrosion at Davis-Besse Nuclear Power Station discovered in March 2002.

These events are a wake-up call to institutions, such as DOE, which conduct complex, high-hazard operations. Over the past two years, DOE program offices have performed independent reviews of the reports generated from these events and initiated some actions. In response to DNFSB Recommendation 2004-1, "Oversight of Complex, High-Hazard Nuclear Operations", dated May 21, 2004 the Department committed to developing a DOE-wide action plan to address the applicable lessons from these events.

The DOE reviewed the associated detailed reports of these events to identify specific lessons learned that can be applied to DOE operations and developed relevant corrective actions. This report documents this effort.

2.0 Background

The Space Shuttle Columbia

On February 1, 2003, the space shuttle Columbia burned upon atmospheric re-entry killing all seven members of its crew. The physical cause of the loss of Columbia and its crew was a breach in the Thermal Protection System on the leading edge of the left wing. The breach was caused by a piece of insulating foam that separated from the left bipod ramp of the External Tank and struck the wing in the vicinity of the lower half of Reinforced Carbon-Carbon Panel 8 at 81.9 seconds after launch. During re-entry this breach in the Thermal Protection System allowed superheated air to penetrate the wing leading-edge insulation and progressively melt the aluminum structure of the left wing, resulting in a weakening of the structure until increasing aerodynamic forces caused loss of control, failure of the wing, and breakup of the shuttle.

The Columbia Accident Investigation Board (CAIB) recognized early on that the accident was probably not an anomalous, random event, but rather likely rooted to some degree in the National Aeronautics and Space Administration's (NASA's) history and culture. Accordingly, the Board broadened its mandate at the outset to include an investigation of a wide range of historical and organizational issues, including political and budgetary considerations, compromises, and changing priorities over the life of the Space Shuttle Program. The Board's conviction regarding the importance of these factors strengthened as the investigation progressed. Its findings, conclusions, and recommendations, place as much weight on these causal factors as on the more easily understood and corrected physical cause of the accident. The Board's 6 volume report was issued in August of 2003.

Davis-Besse

On March 5, 2002, a cavity with a surface area of approximately 20- to 30-square inches was found in the reactor pressure vessel (RPV) head at the Davis-Besse Nuclear Power Station (DBNPS). The cavity extended completely through the 6.63-inch-thick carbon steel RPV head down to the thin internal cladding of stainless steel. The stainless steel cladding had withstood the primary system pressure (~2500 psi) over the cavity region during operation; however, the cladding was not designed for this. This cavity was caused by cracking of an RPV head penetration nozzle, leakage of primary coolant water through the cracks, and subsequent corrosion of the carbon steel RPV head by boric acid in the water. Had the cavity not been found by chance while repairing the cracks in the nozzle, subsequent operation of the reactor would likely have resulted in a loss-of-coolant accident (LOCA).

Davis-Besse is a Nuclear Regulatory Commission (NRC) licensed nuclear power plant in Ohio that generates electricity. As a condition of licensing, periodic inspections of the plant are required to assure piping and reactor vessel integrity. Surveillances are done primarily when the plant is shutdown for refueling through visual inspections to assure no leakage of the primary coolant. The primary coolant is treated with boric acid. When leakage occurs, boric acid deposits result. During the mid 1990's, such indications of leakage were identified and corrective steps taken. During a refueling outage in April 2000, boric acid deposits were identified on top of the RPV head. Due to the inaccessibility of portions of the RPV head without significant equipment removal and the "low probability" of significant corrosion, the plant resumed operations. In fact, the corrosion of the vessel head by the boric acid was extremely severe. A large (20-30 sq. in.) cavity was created in the carbon steel RPV head, resulting in total reliance on a thin layer of internal cladding of stainless steel to provide the pressure boundary for the primary coolant. In February 2002, the plant was shutdown for refueling, a more detailed inspection of the RPV head was performed during this outage which identified cracks in three RPV head penetrations. During the repair of these cracks, the severe corrosion of the head was identified.

The technical attributes of the Davis-Besse event that directly caused the physical deterioration of the plant, as well as the underlying organizational and management causal issues, have been addressed over the past several years. The utility has issued several reports, the Institute of Nuclear Power Operations (INPO) has issued several proprietary notices and bulletins to the nuclear reactor industry, and the NRC has issued publicly available notices, bulletins and an enforcement action in April 2005. Major lessons learned from these reviews are: inadequate management involvement in plant activities, ineffective implementation of known requirements and standards, lack of responsiveness to external reviews, and inadequate follow-up to corrective actions from the industry lessons learned program.

3.0 Technical Approach

In early January 2005, the Office of Environment, Safety and Health (EH) formed a Working Group comprised of representatives from all headquarters program offices and several field offices to capture and consolidate corporate lessons learned from the Columbia and Davis-Besse events and identify action items applicable across the Department. A listing of the Working

Group members is provided in Attachment 1. The Working Group relied on the primary reports of these events, as well as reviewing the previous reviews performed by various DOE elements.

The overall process used by the Working Group was to review NASA's CAIB Report and INPO Significant Operating Experience Report (SOER) 02-4, "Reactor Pressure Vessel Head Degradation at the Davis-Besse Nuclear Power Station" as the two primary source documents and to compare the lessons learned derived from these events side by side. Other primary source documents reviewed included the NRC's "Davis-Besse Reactor Vessel Head Degradation Lessons-Learned Task Force Report" of September 30, 2002; and the INPO Significant Event Report 2-02, "Undetected Leak in Control Rod Drive Mechanism Nozzle and Degradation of Reactor Vessel Pressure Head". The comparison of lessons learned revealed the striking similarity between the organizational deficiencies identified in the ten major Columbia lessons learned to the 8 Warning Flags of Davis-Besse.

In addition, the ten lessons learned described in the "NNSA Lessons Learned and Recommendations from Review of NASA's Columbia Accident Investigation Board Report", dated February 9, 2004, were compared against the primary Columbia/Davis Besse lessons learned to determine any unique lessons or areas of emphasis. Each Energy, Science and Environment (ESE) organization provided input on the status and results of their individual reviews of these incidents. The lessons were considered for applicability to DOE operations and the combined lessons learned were collapsed into the overall lessons learned described in this report. A table showing a comparison of the ten DOE lessons learned with those from the NASA CAIB, SOER 02-4, and NNSA's review of the CAIB is provided as Attachment 2.

Despite significant variations in the type, nature, and technical complexity of operations undertaken by DOE and its contractors on a daily basis, the working group extracted ten lessons learned that resonate throughout the complex. Although the primary focus was on nuclear safety in response to DNFSB Recommendation 2004-1, it was recognized these lessons are applicable to all DOE operations. Corrective actions will use a graded approach.

Because the potential DOE organizational deficiencies identified by the working group involved the way the Federal workforce manages the various contractors, the primary emphasis of this action plan is on evaluating and correcting these organizational deficiencies. However, certain actions impact the way the entire DOE complex conduct operations, including both the federal and contractor organizations.

The following lessons were identified from these events and have applicability to DOE. The first five lessons learned listed below have associated action items which are unique to this report and are described in detail. These lessons learned are those which the Working Group considers to be either not addressed in the Department's Implementation Plan to address DNFSB Recommendation 2004-1 (2004-1 IP), or where additional action will enhance commitments already included in the 2004-1 IP. Associate 2004-1 IP actions are described in Section 4.0. The working group gleaned five important additional lessons learned from Columbia and Davis-Besse that we considered to be adequately addressed by the 2004-1 IP. The resultant actions from the 2004-1 IP are appropriately referenced in Section 5.0.

The five lessons learned that have unique action items are:

1.0 Operating Experience: People and organizations need to learn valuable lessons from internal and external operating experience to avoid repeating mistakes and to improve operations.

2.0 Mission and External Influences: Budget and schedule pressures must not override safety considerations to prevent unsound program decisions.

3.0 Normalizing Deviations: Routine deviations from an established standard can desensitize awareness to prescribed operating requirements and allow a low-probability event to occur.

4.0 Technical Inquisitiveness: To ensure safety, managers need to encourage employees to freely communicate safety concerns and differing professional opinions.

5.0 Focus on Planning and Prevention: Safety efforts should focus more on planning and preventive actions rather than investigations and corrective actions resulting from accidents or events.

The Office of Environment, Safety and Health will be responsible for monitoring the overall progress in implementing the actions for these five lessons learned and for reporting progress to the Deputy Secretary. A set of dynamic, high level, corporate metrics will be developed to determine the effectiveness of the actions in making the necessary organizational process and workforce cultural changes as addressed in Section 6.0 of this plan.

The working group considers the next five lessons learned to be addressed adequately in the 2004-1 IP, and no additional actions are required by this plan.

6.0 Organizational Structure: An effective organizational structure with clear roles and responsibilities, and appropriate checks and balances is essential.

7.0 Self-Assessment & Oversight: Successful operations require critical self-assessment and oversight to find problems.

8.0 Organization Staffing and Qualification: Robust technical capability, enhanced through ongoing technical and leadership training, is essential for complex operations.

9.0 Corrective Action Programs: Corrective actions that address the underlying causes of problems must be managed to resolution and verified to be effective.

10.0 Complacency: Management must guard against complacency brought on by good performance metrics and past successes.

4.0 Lessons Learned and Associated Actions

For DOE lessons learned derived from the Columbia accident and Davis-Besse event requiring action, the Working Group developed action items to support incorporation of the lessons learned principles in DOE programs' work practices. To ensure implementation of these action items, responsible DOE organizations are identified and completion dates are established for each. Corrective actions will use a graded approach.

Note: The Office of Civilian Radioactive Waste Management (OCRWM) is currently pursuing a Nuclear Regulatory Commission (NRC) license to construct a repository for spent nuclear fuel and high-level waste at Yucca Mountain, Nevada. OCRWM has conducted its own analysis and has issued formal Lessons Learned based on the Davis-Besse and Columbia incidents. In addition, OCRWM has implemented management improvement initiatives in the areas of corrective actions, safety conscious work environment, and quality assurance that specifically correspond to the lessons learned and are consistent with NRC's requirements of its licensees. Also OCRWM has a proceduralized Differing Professional Opinion Program that has been implemented for over ten years. OCRWM has documented its process and identified action items in a report entitled Lessons Learned Actions from the Columbia Space Shuttle Accident and Davis-Besse Reactor Pressure-Vessel Head Corrosion Event (DOE/RW-0578).

Lesson Learned #1: Operating Experience

People and organizations need to learn valuable lessons from internal and external operating experience to avoid repeating mistakes and to improve operations.

Background:

The CAIB Report states,

- "Human space flight and submarine programs share notable similarities. Spacecraft and submarines both operate in hazardous environments, use complex and dangerous systems, and perform missions of critical national significance… Both Naval Reactors and the SUBSAFE Program have "institutionalized" their "lessons learned" approaches to ensure that knowledge gained from both good and bad experience is maintained in corporate memory…. NASA has an impressive history of scientific discovery, but can learn much from the application of lessons learned, especially those that relate to future vehicle design and training for contingencies. NASA has a broad Lessons Learned Information System that is strictly voluntary for program/project managers and management teams. Ideally, the Lessons Learned Information System should support overall program management and engineering functions and provide a historical experience base to aid conceptual developments and preliminary design."

- "The Naval Reactor Program has yet to experience a reactor accident. This success is partially a testament to design, but also due to relentless and innovative training, grounded on lessons learned both inside and outside the program. For example, since 1996, Naval Reactors has educated more than 5,000 Naval Nuclear Propulsion Program personnel on the lessons learned from the Challenger accident. Twenty three Senior NASA managers recently attended the 143rd presentation of the Naval Reactors seminar entitled "The Challenger Accident Re-examined."

- "NASA has not focused on any of its past accidents as a means of mentoring new engineers or those destined for management positions."

Although Davis-Besse received, distributed, and reviewed industry operating experience, it failed to compare and apply these operating experiences to its own programs or procedures. It also did not use these operating experiences to heighten management awareness of the increased potential for leakage. The NRC's Davis-Besse Lessons Learned Task Force (LLTF) Report states:

- "Interviews of licensee personnel revealed that they were generally unaware of operating experience involving other PWR plants in which the level of corrosion was much more extensive than anticipated because there was a presence of highly corrosive boric acid solution rather than the expected, dry boric acid crystals. For example, they were generally unaware of the lessons from the Turkey Point, Unit 4 event in March 1987, and the Salem, Unit 2 event in August 1987. Some DBNPS personnel believed that boric acid corrosion on the RPV head would not result in significant wastage because of the elevated temperature of the RPV head, which would result in dry boric acid deposits. Given this, there was a presumption that boric acid deposits would not be a concern because the corrosion rates would be extremely low. This indicates that one of the past lessons, namely, the inability to predict environmental conditions, etc., particularly inside the containment building, was forgotten or never fully appreciated."

- "Reviewing Davis-Besse's own operating experience with boric acid leakage and corrosion reveals a long history of leakage events, many of which were not thoroughly reviewed, assessed, and effectively corrected. Several of these issues, which are documented in corrective action documents, also indicate damage to components inside containment… Davis-Besse retained few boric acid corrosion control program leakage records, and tracking and trending of important issues were not performed."

Operating experience is more than just occurrence reporting. An effective operating experience program must identify underlying reasons for poor safety results or performance, and include identification and implementation of effective corrective actions that address the root cause to deter recurrence. The Program must analyze multiple events to diagnose common issues and provide systemic corrective actions. Identified weaknesses in procedures, training or work planning should result in upgrading the underlying program that allowed such lapses to occur rather than solely fix a specific symptom. Noteworthy practices and processes need to be identified for the benefit of the complex at large. The information must be effectively promulgated to all appropriate personnel and reinforced.

<u>How these issues relate to DOE Operations</u>:

DOE uses many standard program requirements across the complex, e.g., the radiological control and quality assurance programs as prescribed in DOE directives, that lead to common causes, practices, and lessons learned. However, DOE must also deal with a myriad of operations that involve differing technologies and unique organizations applicable to that project or technology. Accordingly, a problem may manifest itself in one site or plant, e.g., Mixed Oxide (MOX) fuel production, but it is not readily apparent how the problem and its solution apply to other DOE activities, e.g., cleanout of K-Basin, or operation of Defense Waste Processing Facility (DWPF). Accordingly, DOE needs to implement a stronger operating experience program that is able to examine underlying technical, organizational or safety culture issues to enhance feedback and continuous improvement to all DOE operations.

DOE must pay attention to its own "weak signals", e.g., near misses, equipment failures, minor conduct of operations problems, etc., that can be precursors to more significant events if the underlying causes are not identified and corrected. Benchmarking should be encouraged as a way to evaluate the lessons of good work practices from other organizations so that these practices can be applied to improve operations.

Action Items for Lesson Learned # 1:

The primary action for this Lesson Learned, to enhance the current DOE Corporate Operating Experience (OPEX) Program, is addressed in 2004-1 IP, Section 5.2, "Learning from Internal and External Operating Experience", which requires issuance of a DOE Order to institutionalize the DOE corporate operating experience program by January 2006. The enhanced DOE OPEX Program will have multiple levels of actionable operating experience patterned after NRC and INPO. It will enable program offices, field offices and contractors to better identify, diagnose, and report site technical and management problems, and noteworthy practices, and provide central compilation, analysis, and distribution of the lessons. EH will assist line managers to ensure effective action is taken by DOE program offices and field elements. Progress will be reported to the Secretary.

The following are additional actions, beyond the DNFSB 2004-1 IP, to enhance the DOE OPEX Program:

1. **Action Item # 1.a.1:** EH will develop and demonstrate new advanced analytical tools for use by DOE program offices and field personnel to improve identification and communication of operating experience.

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — January 2006

2. **Action Item # 1.a.2:** At least two DOE Field Sites, one from NNSA and one from ESE, will conduct pilot programs to further develop and demonstrate the use of newly developed advanced analytical tools. Upon successful piloting of the analytic tools, EH will provide the tools for use at all DOE sites to facilitate better evaluation of operating experience.

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — Begin First Pilot - July 2006

3. **Action Item # 1.b:** EH will evaluate department-wide operating experience to identify problem areas that are candidates for the development of Good Work Practices. For such problem areas, efforts will be made to identify "Best Sites", then document and disseminate their good work practices (e.g., procedure sharing).

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — October 2006

4. **Action Item # 1.c:** DOE will also establish an Operating Experience Committee to facilitate management and worker communications as part of the DOE OPEX Program. DOE program office and field representatives will serve on this committee.

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — October 2005

5. **Action Item # 1.d:** DOE will conduct a video conference to share lessons learned from the Columbia and Davis-Besse Events with DOE program offices and field elements.

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — October 2005

6. **Action Item # 1.e:** The DOE OPEX Program will sponsor periodic safety forums (at least once yearly) to discuss safety trends, issues, lessons learned and good work practices.

   Office of Corporate Performance Assessment
   Office of Environment, Safety and Health — April 2006

Lesson Learned #2: Mission and External Influences

Budget and schedule pressures must not override safety considerations to prevent unsound program decisions.

Background:

When NASA was challenged by budget constraints in the 1990s, they opted for a "better, faster, cheaper" operating philosophy instead of eliminating major programs. The budget squeeze intensified when the Space Shuttle Program exhibited a trait common to most aging systems: increased costs due to greater maintenance requirements and deteriorating infrastructure. Additionally, during the 1990s, increased demand for shuttle flights was felt due to construction and maintenance of the International Space Station on top of other national priorities. When faced with cost and schedule pressures, NASA technical engineers were told that cost and schedule were paramount and directed not to cause delays by asking questions.

At Davis-Besse, corporate incentive programs were aligned toward short-term production. In combination with other incentives, such as rewards for meeting or exceeding outage goals, emergent work and repairs that did not affect generation were often deferred. This was particularly true for tasks associated with reactor pressure vessel head cleaning. During the refueling outage in May 2000, plant management had received at least three deficiency reports documenting the presence of significant deposits of boric acid on the reactor vessel head. The situation during this refueling outage was not uncharacteristic. Inspectors had experienced difficulty when conducting complete inspections of the reactor vessel head in 1994 and 1996. An inspection during the 1998 outage resulted in another report stating there were old boric acid deposits on the vessel head. This apparently conflicting information is further compounded by statements that provisions identified in 1994 to allow access to view the entirety of the head were not put in place as stated by Davis-Besse reports.

The Working Group recognizes that that there are always cost and schedule pressures. Organizations conducting high-hazard operations must demonstrate a strong safety bias in operational decisions. Proceeding must be determined to be safe, not requiring "proof of unsafe" to halt operations.

How these issues relate to DOE Operations:

The Department, like other government agencies, has extensive program activities in support of national requirements and desires. It is also bound to a congressional budget process which attempts to balance funds across broad priorities. Efforts to improve the productivity of operations must be carefully weighed against changes to the infrastructure and processes that have prevented a high-consequence event in the complex for decades. This is not to say that enhancements are not possible, but that safety must be the top priority. DOE has long recognized the potential for cost and schedule pressures to have an undesirable impact on the safe conduct of work. Line organizations have the responsibility for ensuring there are adequate resources to conduct work safely.

The language in two of the Department of Energy Acquisition Regulations (DEAR) contract clauses DEAR 48 CFR 970.5223-1, "Integration of Environment, Safety and Health (ES&H) into Work Planning and Execution", and DEAR, 48 CFR 970.5215-3,"Conditional Payment of Fee, Profit, and Other Incentives" was drafted to ensure all contractors are applying the appropriate resources to accomplish work safely with adequate ES&H funding. However, all DOE contracting officers may not have effectively used the budget related provisions of the annual update process, nor the Conditional Payment of Fee, Profit and Other Incentives clause in levying award fee penalties.

Many line programs have established processes to manage ES&H funding requirements in their budgets and work plans. Some of these processes are formalized like the Office of Environmental Management's Integrated Planning and Budgeting System (IPABS). However, not all programs are equally effective in managing ES&H resource requirements.

Even where there is effective DOE management of resources necessary to conduct work safely, organizational pressures to meet performance deadlines, e.g., qualify for award fee, can result in workers using shortcuts or performing unsafe acts to complete work faster. Management must be aware that their actions speak louder than words, i.e., if they are stressing the schedule versus safety and reliability, the work force will deliver on-time no matter the cost in terms of safety.

Action Items for Lesson Learned # 2:

As part of 2004-1 IP, Section 5.1.1, Instituting Central Technical Authorities (CTA), DOE established CTAs for both NNSA and ESE that have the responsibility and authority to ensure program managers do not let cost and schedule override safety. This includes ensuring there are adequate Federal Full Time Equivalents and resources necessary to accomplish the mission safely. The CTAs are scheduled to have adequate support for their responsibilities by April 2006. As part of 2004-1 IP Section 5.3, Revitalizing Integrated Safety Management (ISM) Implementation, the Department will strengthen the implementation of ISM with attributes associated with High-Reliability Organizations (HRO). An ISM Manual, describing the expectations and requirements, is scheduled for December 2005.

The following are additional actions, beyond the 2004-1 IP, to enhance the DOE response to this lesson learned:

1. **Action Item # 2.a:** DOE Contracting Officers need to make effective use of the existing contractual remedies in ensuring the contractor is performing work safely. DOE will institute a training program and provide materials tailored for DOE Field Element personnel, particularly the Heads of Contracting Authority (HCA), on the "Meaning and Effective Use of the DEAR 48 CFR 970.5223-1, "Integration of Environment, Safety and Health into Work Planning and Execution" and DEAR, 48 CFR 970.5215-3,"Conditional Payment of Fee, Profit, and Other Incentives" clauses in managing contractor safety."

Office of Facility Safety, Office of Environment, Safety and Health	Included as a module in the Nuclear Executive Leadership Training Course - Ongoing

Lesson Learned #3: Normalizing Deviations

Routine deviations from an established standard can desensitize awareness to prescribed operating requirements and allow a low-probability event to occur.

Background:

NASA had a published technical standard that prohibits a launch if foam shedding occurs. For the 112 launches before Columbia, each launch showed evidence of foam shedding. However, no action was taken in response. As the CAIB report noted "the unexpected became the expected, which became the accepted." In the Columbia disaster, foam strikes on the orbiter during takeoff were considered routine and were not evaluated after 82 percent of its missions dating back to STS-1 (1981). When the space shuttle Columbia launched on January 16, 2003, there were 3,233 Criticality 1/1R critical item list hazards that were waived. Hazards that result in Criticality 1/1R component failures are defined as those that will result in loss of the orbiter and crew. In both the Challenger and Columbia accidents: "The machine was talking to us, but nobody was listening." Deviations from requirements had become normal business for NASA. The CAIB report referred to this as the "normalization of deviations".

Davis-Besse maintenance personnel were required to conduct periodic surveillance of pressure vessel head integrity as part of a comprehensive pressure boundary integrity check required by the original NRC Davis-Besse operating license. Over a period of several years, surveillances were not properly performed that were specifically oriented toward boric acid corrosion control. These surveillances were a regulatory requirement contained in plant procedures.

How these issues relate to DOE Operations:

Appendix 3 to the NNSA CAIB Lessons Learned Report (2004), Minority Opinion, states in part, "We have at least one major contractor who does not have an approved Quality Assurance Plan to comply with a nuclear safety rule (10 CFR 830) promulgated in 1994." Other discrete examples of facilities within the DOE complex where requirements are not fully implemented or routinely followed exist. Effort is needed to identify these non-compliances and resolve them. The Working Group is not certain to what extent "normalization of deviations" is an issue for other DOE operations. However, an action to establish a safety exemption baseline is included in this plan.

Action Items for Lesson Learned #3:

1. **Action Item # 3.a:** Each DOE program office, including NNSA, will describe a process and ensure a system is in place to know, at all times, the current set of safety requirements and standards in their current and proposed prime operating contracts. EH will work with all affected programs, including the CTAs, to develop a common departmental structure and set of data requirements.

Energy, Science and Environment Programs	January 2006
National Nuclear Security Administration	January 2006

2. **Action Item # 3.b:** DOE needs to establish and maintain an ongoing safety exemption baseline. Program Officers will issue direction to Site Managers, working with their contractors, to identify and document all existing exemptions granted from safety requirements. EH will work with all affected programs, including the CTAs, to develop a common departmental structure and set of data requirements.

Energy, Science and Environment Programs	April 2006
National Nuclear Security Administration	April 2006

3. **Action Item # 3.c:** Program offices will develop procedures and schedules for periodic on-site performance assessments to verify, using appropriate assurance techniques, that nuclear safety requirements are effectively implemented at nuclear sites.

Office of Environmental Management	July 2006
National Nuclear Security Administration	July 2006
Office of Nuclear Energy, Science and Technology	July 2006
Office of Science	July 2006

Lesson Learned #4: Technical Inquisitiveness

To ensure safety, managers need to encourage employees to freely communicate safety concerns and differing professional opinions.

Background:

Neither NASA nor Davis-Besse had communications processes that allowed or encouraged personnel with safety concerns, or who knew of potential safety issues, to raise them to senior managers. They also lacked a Differing Professional Opinion (DPO) process that facilitates dialogue and resolution on differing technical interpretations. It should be noted that a DPO is substantially different than a traditional employee concerns program.

In the case of Columbia, a Debris Assessment Team was formed to evaluate the foam shedding identified during the launch. This team was not given "Tiger Team" status, which would have given the team a formal status and reporting relationship. Concerns regarding the lack of specific information regarding the condition of the impact area were informally forwarded along with multiple requests for imagery. Managers with insufficient technical background made poor decisions based upon generic knowledge and a lack of significant problems with past foam shedding. There was no established recourse for the Assessment Team members.

As evidenced by multiple examples of quality reports, completed work packages and surveillance packages documenting problems with boric acid corrosion, Davis-Besse systems engineers, quality assurance staff, and maintenance personnel, and local NRC Representatives, were aware of the individual symptoms and potential implications of severe corrosion of the vessel head. These individuals apparently did not seek or gain access to senior management who could have taken precautionary actions.

How these issues relate to DOE Operations:

In organizations as large as the DOE complex, voices can be missed. Efforts must be taken to encourage personnel to speak out and ensure that paths are readily available to communicate safety issues. Managers must take any safety concerns seriously and, if necessary, take action to address them prior to allowing operations to continue. In addition, DOE has no formal Differing Professional Opinion process, one is required.

When NNSA reviewed the CAIB report, it found situations in DOE where some line managers presume operations are safe unless proven otherwise. As such, the onus is frequently placed on safety professionals to prove that operations are unsafe, rather than requiring line managers to demonstrate that they are safe. Early identification of evolving problems is necessary not only to resolve the issue as soon as possible, but also to re-establish a stable and safe nuclear configuration.

Action Items for Lesson Learned # 4:

1. **Action Item # 4.a:** Develop and issue a DPO Policy describing the applicable process for DOE personnel to address technical issues and facilitate resolution. The policy will

include a requirement for management to act on expressed concerns and, if necessary, to stop work operations until the issue has been resolved. The framework will be applicable to contractors.

Office of Facility Safety, Office of Environment, Safety and Health	January 2006

2. **Action Item # 4.b:** Senior DOE management will issue their implementing guidance and communicate their expectations to DOE line managers to encourage employees to communicate differing opinions and concerns.

Under Secretary of Energy for National Nuclear Security / Administrator, National Nuclear Security Administration	April 2006
and	
Under Secretary of Energy for Energy, Science and Environment	April 2006

3. **Action Item # 4.b.1:** After issuance of the DPO Policy and implementing guidance, DOE will hold an implementation workshop to further communicate Senior DOE Management's DPO process expectations to DOE Line Managers (i.e., on Methods of Encouraging (versus discouraging) employees to communicate differing opinions and concerns).

National Nuclear Security Administration	May 2006
Energy, Science and Environment Programs	May 2006

4. **Action Item # 4.b.2:** DOE Line Managers will be responsible to actively communicate the DPO Process and Implementing Guidance to all DOE Employees.

National Nuclear Security Administration	September 2006
Energy, Science and Environment Programs	September 2006

5. **Action Item 4.c:** Senior management will set an expectation for DOE contractors to institute a DPO process by amending the Department of Energy Acquisition Regulation (DEAR) contract clause entitled *Integration of ES&H into Work Planning and Execution* to incorporate a requirement to institute a DPO process for safety matters.

Office of Management, Budget and Evaluation, and Office of Corporate Performance Assessment Office of Environment, Safety and Health	December 2006

6. **Action Item # 4.d:** DOE will establish a DOE Safety Council, sponsored by the Deputy Secretary, to foster periodic communication of safety related issues among Program Secretarial Officers, DOE Field Office Managers and the EH Assistant Secretary (EH-1).

Office of Corporate Performance Assessment Office of Environment, Safety and Health	October 2005

7. **Action Item # 4.e:** Each PSO will designate a DPO Champion for the program office and at each Field Element to ensure the DPO policy and contract requirements are effectively met.

Energy, Science and Environment Programs	Designation Made by October 2006
National Nuclear Security Administration	Designation Made by October 2006

Lesson Learned #5: Focus on Planning and Prevention

Safety efforts should focus more on planning and preventive actions rather than investigations and corrective actions resulting from accidents or events.

Background:

NASA experienced foam shedding to some degree on every shuttle launch. However, these events were examined individually and were not read by engineers as indications of danger. In a similar fashion, NASA failed to respond appropriately to the series of o-ring failures that ultimately led to the catastrophic loss of the shuttle Challenger shortly after launch on January 28, 1986. These recurring anomalies were precursors of low probability, high consequence events that went unresolved – eventually resulting in preventable losses of life.

At Davis-Besse, numerous indications of increasing primary coolant leakage were apparent during the years preceding the discovery of RPV head corrosion:

- Increasing coolant makeup water requirement
- Increasing fouling of Containment Air Conditioning unit with boric acid
- Increasing fouling of containment air sampling filters with boric acid
- Boric acid deposits reported on the RPV head during outages in 1996, 1998, and 2000.

These indications, as well industry operating experience that was received, were not properly analyzed and addressed. They did not result in changes to programs or procedures or heighten management's awareness of the increased potential for leakage at the station. This neglect resulted in significant corrosion of the RPV head and a near-miss of a major loss of coolant accident (LOCA).

A principal deficiency that led to both the Columbia and Davis-Besse events was the failure to recognize and take appropriate corrective action on "weak signals," i.e., small recognizable problems (such as the foam strikes and boric acid consumption) that were indications of abnormal situations that were either not recognized for their significance or dismissed entirely. In both the Columbia accident and the Davis-Besse event, the failures to recognize the accident precursors and to make changes that would have prevented the events resulted from organizational cultural factors. Organizational culture refers to the basic values, norms, beliefs, and practices that characterize the functioning of a particular institution. At the most basic level, organizational culture defines the assumptions that employees make as they carry out their work. An organization's culture is a powerful force that persists through reorganizations and the departure of key personnel.

How these issues relate to DOE Operations:

The Department is an organization which performs complex, high hazard operations. The prevention of high consequence events in this type of organization, know as a High Reliability Organization (HRO), has been an area of much research over the past fifteen years. INPO has been a key participant in this effort and has developed several relevant publications. For the past year, the Office of Environment, Safety and Health has offered voluntary training on INPO's Excellence in Human Performance. This Human Performance Initiative (HPI) is intended to promote behaviors throughout an organization that support safe and reliable operation. Progress toward excellent human performance requires a work environment in which individuals and leaders routinely exhibit desired behaviors. Such behaviors must be clearly described, communicated, and -- most importantly -- reinforced. Peer pressure, open communication, and positive reinforcement can establish a culture in which individuals, leaders, and organizational processes eliminate obstacles to excellent human performance. This situation will reduce or even eliminate events due to human error.

Action Items for Lesson Learned # 5:

The corrective actions for this lesson include both improvements to the corporate operating experience program, as addressed in the actions for Lesson Learned #1, and the following actions directed at changing work culture.

1. **Action Item # 5.a:** DOE will actively promote implementation of the INPO Excellence in Human Performance Initiative (HPI). EH will offer INPO Excellence in Human Performance training to all DOE Sites.

   Office of Facility Safety,
   Office of Environment, Safety and Health — Ongoing.

2. **Action Item # 5.b:** DOE will apply INPO's HPI criteria to evaluate potential problem programs for the application of HPI principles, and select a focus site or facility to pilot and demonstrate the application of a focused HPI process to these programs.

   Office of Facility Safety,
   Office of Environment, Safety and Health — January 2006

3. **Action Item # 5.c:** Upon successful completion of these pilot HPI programs, DOE will hold a Workshop to share the lessons learned and to encourage application of HPI to other sites and programs.

   Office of Facility Safety,
   Office of Environment, Safety and Health — October 2006

5.0 Lessons Learned Addressed by the DNFSB Recommendation 2004-1 Implementation Plan

The working group considers the next five lessons learned to be addressed adequately in the 2004-1 IP, and no additional actions are required by this plan.

Lesson Learned #6: Organizational Structure

An effective organizational structure with clear roles and responsibilities, and appropriate checks and balances is essential.

Background:

The Columbia Accident Investigation Board determined that organizational failures were as much to blame as technical failures for the Columbia accident. They identified the NASA culture as an organizational flaw that led to unintentional blind spots, group think, and silent safety. NASA's organizational structure for the Space Shuttle Program (SSP) utilized matrixed work forces and complex, geographically separated operations that hindered effective communication. The SSP's pyramid leadership structure allowed unqualified SSP Managers to waive any/all technical requirements. In particular, the organizational structure and hierarchy blocked effective communication of technical problems, and was not conducive to upchanneling concerns over foam/debris strike on launch. Signals were overlooked, people were silenced, and useful information and dissenting views on technical issues did not surface at higher levels. What was communicated to parts of the organization was that foam debris strikes were not a problem. Often key decisions were made based on abbreviated PowerPoint briefings, not on thorough, data-supported research.

Organizational structure had similar impacts at Davis-Besse. At the Davis-Besse nuclear power station, management did not follow up to ensure that industry and NRC-mandated surveillances of vessel head integrity were conducted properly. The plant executive management team apparently relied too heavily on NRC's resident inspectors to identify issues rather than conduct their own in-depth follow-up of operational data, work orders, and maintenance. The NRC inspectors did not communicate plant surveillance discrepancies to their management. The Davis-Besse independent oversight function did not identify the deteriorating condition of RPV heads as evidenced by the presence of boric acid deposits over a period of years. System engineers failed to assimilate the secondary effects that were indicative of a serious problem with leakage of primary coolant. Neither the Davis-Besse Quality Assurance organization nor the independent Davis-Besse Nuclear Safety Review Board was effective in detecting or identifying adverse trends that were indicative of a deteriorating situation.

How these issues relate to DOE Operations:

The Department of Energy has the responsibility to ensure that operations at its facilities are conducted safely. The DOE Safety Management Functions, Responsibilities, and Authorities Policy, DOE P 411.1, defines the DOE safety management functions, responsibilities and authorities to ensure that work is performed safely and efficiently, and succinctly defines the Department's expectation regarding DOE employees' responsibilities for safety management.

Action Items for Lesson Learned # 6:

This Lesson Learned is fully addressed in the 2004-1 IP:

- Section 5.1.1, Instituting Central Technical Authorities, commits to having support staffs for the NNSA and ESE CTAs in place by April 2006.
- Section 5.1.4, Establishing Clear Roles, Responsibilities, and Authorities, commits to improving the process for delegation of safety responsibilities and verifying compliance by February 2006; and conducting biennial self-assessments of program office safety functions beginning by September 2006.
- Section 5.1.5, Ensuring Technical Capability and Capacity to Fulfill Safety Responsibilities, commits to:
    - Developing a report describing structured training for safety professionals, senior managers, and decision makers responsible for nuclear safety by August 2005,
    - Developing a plan to improve recruiting, developing, training, qualifying, maintaining proficiency, and retaining technical personnel by August 2005, and
    - Completing technical staffing of positions needed to perform federal safety assurance in nuclear facilities by December 2006.

Lesson Learned #7: Self-Assessment & Oversight

Successful operations require critical self-assessment and oversight to find problems.

Background:

Budget reductions for NASA in the 1990s led management to reduce staff and outsource many Shuttle Program responsibilities, including safety oversight. The redundant NASA and contractor engineering teams at the Kennedy Space Center which cross-checked each other to prevent errors were terminated. Oversight at the NASA program office was limited. Its oversight of the space shuttle program consisted of monitoring selected checklists and reports. Contractors did not perform adequate audits or quality assurance assessments of their own organizations and did not exhibit ownership for ensuring safety. The CAIB determined that these organizational failures were as much to blame as technical failures.

At Davis-Besse, plant executive management lacked a self-critical perspective and relied too heavily on NRC's resident inspectors to identify issues rather than conduct their own in-depth follow-up of operational data, work orders, and maintenance. Safety reviews were cursory and ineffective. The Davis-Besse independent oversight function did not identify the deteriorating condition of RPV heads as evidenced by the presence of boric acid deposits over a period of years, nor did inspectors detect any of the secondary effects that were indicative of a serious problem with leakage of primary coolant. Neither the Davis-Besse Quality Assurance organization nor the independent Davis-Besse Nuclear Safety Review Board was effective in detecting or identifying adverse trends that were indicative of a deteriorating situation. Davis-Besse also experienced significant operating budget reductions in the 1990s and responded by staff reductions. The engineering group was reduced by over 40%. System Engineers were consolidated – giving them more systems to monitor than they could effectively handle. All plant problems were not reported because typically the one reporting the problem was tasked with its resolution. The Independent Safety Engineering Group (ISEG) formed to provide technical oversight of the plant was dissolved. Strong emphasis was placed on production and treating symptoms versus identifying and solving the root cause.

How these issues relate to DOE Operations:

Like NASA, DOE contracts for its operations. Like the NRC, DOE establishes the standards and regulates these operations. DOE's oversight guidance must establish clear guidelines and an unambiguous framework (i.e., frequency, technical focus and bases, reporting, synthesizing findings, and communications) for oversight of ES&H topics. The DOE Nuclear Safety Rule, 10 CFR 830, *Nuclear Safety Management,* identifies management processes required for nuclear safety. These processes include configuration control, maintenance (including system surveillances), lessons-learned programs, and use of lessons learned in training and qualification. These programs are not uniformly implemented and should be monitored in an operations environment.

Action Items for Lesson Learned # 7:

This Lesson Learned is fully addressed by 2004-1 IP:

- Section 5.1.2, Providing Effective Federal Oversight, commits to a new DOE Order on Oversight by June 2005 (currently awaiting approval) and an Oversight Manual by September 2006. The Order and Manual will address self-assessment at the contractor, field element, and headquarters levels; oversight of subordinate level(s); and independent oversight at all three levels.

Lesson Learned #8: Organization Staffing and Qualification

Organization Staffing and Qualification: Robust technical capability, enhanced through ongoing technical and leadership training, is essential for complex operations.

Background:

In the 1990s, the overall NASA workforce was reduced by 25 percent through normal attrition, early retirements, and buyouts – cash bonuses for leaving NASA employment. NASA operated under a hiring freeze for most of the decade, making it difficult to bring in new or younger people. Various budgetary pressures, competing mission priorities, and administration efforts to reduce the size of government, fueled the workforce reductions instituted by NASA. NASA Headquarters was particularly affected by workforce reductions. More than half its employees left or were transferred in parallel with the 1996 transfer of program management responsibilities back to the NASA centers and the new consolidated Space Flight Operations contractor. The

Space Shuttle Program's headquarters civil service staff working on the Space Shuttle Program went from 120 in 1993 to 12 in 2003. By early 2000, internal and external studies convinced NASA leaders that staff reductions had gone too far and the workforce needed to be revitalized. These studies noted that "five years of buyouts and downsizing have led to serious skill imbalances and an overtaxed core workforce.

In addition to the staff reductions at Davis-Besse discussed in the previous lesson learned, the turnover of System Engineers and the resultant lack of experience was significant. By 2002, 11 of 21 engineers had less than three years experience. Contributing to the failure to assimilate the various indicators of increasing primary coolant leakage from 1996 to 2002 were the numerous changes to the engineers responsible for the system and the Boric Acid Corrosion Control Program.

How these issues relate to DOE Operations:

DOE has undergone a number of organizational changes, most notable the creation of NNSA and their stand-up of the NNSA Service Center. A significant percentage of DOE personnel are eligible for retirement in the next few years. Ensuring the proper number and qualification of DOE staff is essential to fulfill the complete spectrum of Department responsibilities. DOE operates complex and hazardous facilities. DOE personnel responsible for monitoring contractor performance and observing work in progress are required to have, at a minimum, a level of technical competency that reflects a working knowledge of engineering and scientific fundamentals. Managers, supervisors, and field personnel must be technically competent, be technically aware of plant conditions, and possess sufficient practical experience and skills to demonstrate requisite technical inquisitiveness to oversee operations and pursue anomalous conditions.

Action Items for Lesson Learned # 8:

This Lesson Learned is fully addressed by the 2004-1 IP:

- Section 5.1.4, Establishing Clear Roles, Responsibilities, and Authorities, commits to improving the process for delegation of safety responsibilities and verifying compliance by February 2006; and conducting biennial self-assessments of program office safety functions beginning by September 2006, and

- Section 5.1.5, Ensuring Technical Capability and Capacity to Fulfill Safety Responsibilities, commits to:

    - Developing a report describing structured training for safety professionals, senior managers, and decision makers responsible for nuclear safety by August 2005,
    - Developing a plan to improve recruiting, developing, training, qualifying, maintaining proficiency, and retaining technical personnel by August 2005, and
    - Completing technical staffing of positions needed to perform federal safety assurance in nuclear facilities by December 2006.

In meeting these commitments, the Working Group recommends the Federal Technical Capability Panel (FTCP), responsible for developing the technical training requirements, institute a training program and provide materials tailored for safety oversight staff and management in matters related to the acquisition process, program management, contract management, and interactions with the CTA's technical staff.

Lesson Learned #9: Corrective Action Programs

Corrective actions that address the underlying causes of problems must be managed to resolution and verified to be effective.

Background:

NASA had completed more than 50 major incident investigations and had identified corrective actions for each investigation prior to the Columbia accident. Each action plan consisted of several sub-items, which taken collectively, would have resolved the issue. Although some elements of each action plan were addressed, none of the corrective actions were completed and NASA did not follow up to ascertain whether remedial measures were put into effect or assess their effectiveness. The CAIB Report identified 50 past NASA assessments, singling out deficiencies in nine areas: Infrastructure, Communications, Contracts, Risk Management, Quality Assurance, Safety Programs, Maintenance, Security and Workforce. The Board found mishap factors in all nine areas during the Columbia investigation. The Board also found that the information systems that support the Shuttle Program problem reporting and corrective actions are extremely cumbersome and difficult to use in decision-making at any level.

At Davis-Besse, the evaluation and correction of deficiencies identified during reactor pressure vessel head inspections were not given high priority. Corrective action reports were not reviewed for recurring problems or for long-standing problems that were left uncorrected. The station identified and documented boric acid accumulation on the RPV head in Refueling Outages 10 through 12 (1996 – 2000). The corrective action documents that identified boric acid accumulation on the head were ultimately downgraded to routine reports that did not require root causes or corrective actions. A major factor in downgrading these documented problems was the organization's consensus that the boric acid deposits on the RPV head were caused by control rod drive mechanism (CRDM) flange leakage and that there was no commitment to inspect the CRDM nozzles. Station managers did not verify that corrective actions were being completed on time or if completion dates were being extended or that an evaluation of the potential consequences of not correcting the problems was done.

Corrective action requests were sometimes closed out by referencing actions to another corrective action document, as was the case for the repetitive documents identifying boric acid accumulation on the RPV head. By issuing a work order to remove the deposits, the station was able to close out the condition report and remove the outage constraint. The work order was closed out after partial cleaning of the head, and the plant was started up with boric acid deposits remaining in the center portion of the RPV head.

How these issues relate to DOE Operations:

Organizations at every level within the DOE complex have one or more systems for tracking corrective actions. Yet, internal and independent assessments routinely report recurring deficiencies that have been ineffectively addressed. The ISM Function of Feedback and Improvement is not uniformly and effectively implemented throughout the Department.

Action Items for Lesson Learned # 9:

This Lesson Learned is fully addressed by the 2004-1 IP, Section 5.3, Revitalizing Integrated Safety Management Implementation, and specifically Section 5.3.3, Integration and Use of Feedback Mechanisms to Produce Improvement, The Department commits to developing Site Office Action Plans to improve Feedback and Improvement by February 2006 and reviewing assessments of the effectiveness of these actions by March 2007. Additionally, the Department will begin headquarters comprehensive Site ISM Assessments by July 2006.

Lesson Learned #10: Complacency

Management must guard against complacency brought on by good performance metrics and past successes.

Background:

The CAIB Report described how NASA became conditioned by success stating "The unexpected became the expected which became the accepted." In the Columbia disaster, foam strikes on the orbiter during takeoff were considered routine after 82% of its missions, back to STS-1 (1981). After 111 successful landings, averaging over 100 debris strikes per mission, NASA became complacent and the mission success reinforced its confidence that foam strikes were acceptable. Most debris strikes were classified as minor and were considered to be only a maintenance burden (no safety of flight risk). No one believed foam could bring down the shuttle. The CAIB report indicated that in both the Challenger and Columbia accidents, "the machine was talking to us, but nobody was listening."

Likewise at the Davis-Besse Nuclear Power Station, corporate incentive programs were aligned toward short-term production within the organization. In combination with other incentives, such as rewards for meeting or exceeding outage goals, emergent work and repairs that were not considered to affect generation were often deferred. This was particularly true for tasks associated with reactor pressure vessel head cleaning. During the refueling outage in May 2000, plant management had received at least three deficiency reports documenting the presence of significant deposits of boric acid on the reactor vessel head. The situation during this refueling outage was not uncharacteristic.

How these issues relate to DOE Operations:

Since the Rocky Flats fire in 1969, the Department has not experienced a catastrophic accident near the magnitude of the Columbia. This decades-long success record might lead one to a level of comfort with DOE operations. The Department must actively work to enhance safety to prevent a degradation of acceptable safety performance and an unacceptable high-consequence event.

The language in the Department of Energy Acquisition Regulations (DEAR) contract clause, 48 CFR 970.5223-1, "Integration of Environment, Safety and Health into Work Planning and Execution", establishes the contractual requirement for ISM and the governing requirements for contractor programs. In addition, DEAR clause, 48 CFR 970.5215-3, "Conditional Payment of Fee, Profit, and Other Incentives" – Facility Management Contracts provides DOE Contracting Officers with a tool to avoid complacency. The clause requires the DOE Contracting Officer to reduce a contractor's fee payment should they not meet their agreed upon annual environment, safety and health program requirements, established as a result of the annual update process of the DEAR 48 CFR 970.5223-1 (e), or if they experience significant adverse events.

Action Items for Lesson Learned # 10:

This Lesson Learned is fully addressed by the 2004-1 IP, Section 5.3, Revitalizing Integrated Safety Management Implementation, where the Department commits to reinvigorating ISM through the following commitments:

- Develop and implement expectations for ISM implementation, institutionalized by a new ISM Manual issued by December 2005, including a requirement for federal ISM System Descriptions,
- Develop Site Office plans to improve work planning and control by February 2006,
- Develop Site Office plans to improve feedback and improvement by February 2006, and
- Schedule headquarters level comprehensive Site ISM Reviews and complete the initial NNSA Site and EM Site Reviews by July 2006.

6.0 Assessing Implementation Effectiveness

It is of critical importance that the department's senior management be able to determine the effectiveness of the corrective actions in achieving the desired organizational improvements and cultural changes addressed by the lessons learned in this plan. This can be only accomplished by monitoring and evaluating the department's performance in implementing these corrective actions. EH will work with the affected line programs and outside organizations (e.g., INPO, NASA, NRC, corporate entities) to develop the right metrics to measure this plan's effectiveness. Such metrics may include:

- Are feedback systems established and working?
- Are lessons learned identified and shared effectively?
- How effective are the lessons learned in preventing recurrence of similar events on site?, at other sites?
- Are human error prevention techniques understood and used to reduce event frequency and/or consequence?
- Are employees familiar with error precursors and how they apply to work?
- Are employee concerns being acted upon?

Once established and the plan is being implemented, the measures must be dynamic and utilize continuous improvement processes to ensure they are useful. Achieving the actions in this plan will also require a commitment by each affected program office to ensure sufficient resources (budgetary and personnel) are applied to implement the actions they are responsible for. EH will assume the responsibility for monitoring the overall progress of the responsible departmental organizations in meeting the actions described for lessons learned 1 through 5 of this plan. Actions for the remaining lessons learned will be tracked through the 2004-1 IP.

1. **Action Item # 6-1:** DOE will establish corporate level performance metrics to assess the effectiveness of corrective actions implemented per this plan.

   Office of Environment, Safety and Health — February 2006

2. **Action Item # 6-2:** Report on Implementation Progress to the Deputy Secretary.

   Office of Environment, Safety and Health — Semi-Annual, first report to be provided August 2006

Attachment 1.

Columbia / Davis-Besse Working Group Members

Member	**Organization**
Frank Russo (Work Group Leader)	Deputy Assistant Secretary, Office of Corporate Performance Assessment (EH-3), Office of Environment, Safety and Health
Frank Tooper	Office of Environment, Safety and Health
Raymond Blowitski	Office of Environment, Safety and Health
Rich Mallory	Office of Environment, Safety and Health
Patty Bubar	Office of Environmental Management
Charlie O'Dell	Office of Environmental Management
Richard Crowe	National Nuclear Security Administration
Gene Runkle	Office of Civilian Radioactive Waste Management
John Serocki	Office of Nuclear Energy, Science and Technology
Gary Staffo	Office of Energy Efficiency and Renewable Energy
Matt Cole	Office of Science
Don Harvey	Office of Fossil Energy
Robert McMorland	Office of the Departmental Representative
Karen Harness	DOE, Golden Field Office
Harry Marc Worrell	DOE, Idaho Field Office
Jan Wachter	National Energy Technology Laboratory
Harold Monroe	DOE, Oak Ridge Field Office
Joel B. Hebdon	DOE, Richland Field Office

Attachment 2.

Lessons Learned Comparison Table

DOE Columbia / Davis-Besse Action Plan Lessons Learned	NASA Columbia Accident Investigation Board Report Lessons Learned	INPO Significant Operating Experience Report (SOER) 02-4, "Reactor Pressure Vessel Head Degradation at the Davis-Besse Nuclear Power Station"	NNSA Lessons Learned and Recommendations from Review of NASA's Columbia Accident Investigation Board Report
1. <u>Operating Experience</u>: People and organizations need to learn valuable lessons from internal and external operating experience to avoid repeating mistakes and to improve operations	**CAIB 3.** Organizations, like people, must always be learning, especially from past mistakes	**DB5.** Benchmarking is seldom done or is limited to "tourism," without implementation. As a result, the plant is behind the industry and doesn't know it	
2. <u>Mission and External Influences</u>: Budget and schedule pressures must not override safety considerations to prevent unsound program decisions.	**CAIB 6.** Leaders must ensure external influences do not result in unsound program decisions.	**DB3.** Important equipment problems linger, and repairs are postponed while the plant stays on line	
3. <u>Normalizing Deviations</u>: Routine deviations from an established standard can desensitize awareness to the prescribed operating requirements and allow a low-probability event to occur.	**CAIB 1.** Well-intentioned people and high-risk organizations can become desensitized to deviations from the norm.		
4. <u>Technical Inquisitiveness</u>: To ensure safety, managers need to encourage employees to freely communicate safety concerns and differing professional opinions.	**CAIB 7.** Leaders must demand minority opinions and healthy pessimism. **CAIB 8.** Stick with the basics	**DB6.** Employees are not involved and not listened to, and raising problems is not valued. **DB8.** Event significance is unrecognized or underplayed, and reaction to events is not aggressive	**NNSA M-4:** Willingness to accept criticism and diversity of views is essential. **NNSA M-2:** Proving operations are safe instead of unsafe. **NNSA M-1:** Oversimplification of technical information could mislead decision-making.
5. <u>Focus on Planning and Prevention</u>: Safety efforts should focus more on planning and preventive actions rather than investigations and corrective actions resulting from accidents or events.	**CAIB 10.** Safety efforts must focus on the "front end" of mishaps (prevention) vice the "back end" (investigations)		**NNSA TC-1:** Workforce reductions, outsourcing, and loss of organizational prestige for safety professionals can cause an erosion of technical capability.

Attachment 2

Lessons Learned Comparison Table (Continued)

DOE Columbia / Davis-Besse Action Plan Lessons Learned	**NASA Columbia Accident Investigation Board Report Lessons Learned**	**INPO Significant Operating Experience Report (SOER) 02-4, "Reactor Pressure Vessel Head Degradation at the Davis-Besse Nuclear Power Station"**	**NNSA Lessons Learned and Recommendations from Review of NASA's Columbia Accident Investigation Board Report**
6. <u>Organizational Structure</u>: An effective organizational structure with clear roles and responsibilities, and appropriate checks and balances is essential.	**CAIB 4**. Poor organizational structure can be just as dangerous to a system as technical, logistical, or operational factors	**DB1**. Organizational Changes and Staff Reductions Are Initiated Before Their Potential Effects Are Fully Considered	**NNSA OI-3**: Effective communications along with clear roles and responsibilities are essential to a successful organization. **NNSA OI-1**: Effective centralized and de-centralized operations require an independent, robust safety and technical requirements management capability.
7. <u>Self-Assessment & Oversight</u>: Successful operations require critical self-assessment and oversight to find problems.	**CAIB 9**. High-risk organization safety programs cannot remain silent or on the sidelines—must be visible, critical, empowered, and fully engaged.	**DB4**. Senior managers are not involved in operations and do not exercise accountability or follow-up	**NNSA OI-2**: Assuring safety requires a careful balance of organizational efficiency, redundancy and oversight.
8. <u>Organization Staffing and Qualification</u>: Robust technical capability, enhanced through ongoing technical and leadership training, is essential for complex operations.	**CAIB 5.** Leadership training and system safety training are wise investments in an organization's current and future health	**DB1**. Organizational Changes and Staff Reductions Are Initiated Before Their Potential Effects Are Fully Considered	**NNSA TC-3**: Technical training program attributes must support potential high consequence operations.
9. <u>Corrective Action Programs</u>: Corrective actions that address the underlying causes of problems must be managed to resolution and verified to be effective.		**DB2.** Self-assessment processes do not find problems or do not address them.	**NNSA TC-2:** Technical capability to track known problems and manage them to resolution is essential.
10. <u>Complacency</u>: Management must guard against complacency brought on by good performance metrics and past successes.	**CAIB 2.** Past successes may be the first step toward future failure	**DB7.** The "numbers" are good, and the staff is living off past successes	**NNSA M-3:** Management must guard against being conditioned by success.