U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

08-TED-006 FEB 01 2008

Mr. John C. Fulton, President
and Chief Executive Officer
CH2M HILL Hanford Group, Inc.
2440 Stevens Center Place
Richland, Washington 99354

Dear Mr. Fulton:

CONTRACT NO. DE-AC27-99RL14047 – U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION (ORP) TANK FARM PROJECT ASSESSMENT OF THE TANK FARM ENGINEERING PROGRAM, A-08-AMTF-TANKFARMS-005

The ORP Tank Farms Engineering and Operations staff conducted an assessment of the ability of the Tank Farm Engineering Program to meet management expectations for compliance, rigor, and excellence in the conduct of Tank Farm engineering. The specific assessment areas included management systems, engineering and design, Nuclear Safety and licensing and requirements management. This assessment resulted in the identification of 2 Findings and 1 Observation.

Within 30 days of receipt of this letter CH2M HILL Hanford Group, Inc. should respond to the assessment Findings. The response should include:

- The causes of the Findings;
- The corrective actions that have been taken to control or remove any adverse impact from noncompliant conditions (remedial actions) and the results achieved;
- The corrective actions that will be taken to identify the extent of condition, correct the cause, and prevent further Findings; and
- The date when all corrective actions will be completed, verified, and compliance to applicable requirements will be achieved.

The assessment Observation does not identify a deficiency, but represents an experience-based observation of the team members that CH2M HILL should consider as a source of information for improving its program. Formal response to the observation is not required.

If you have any questions, please contact me, or you may contact Walter B. Scott, Acting Director, Tank Farms Engineering Division, (509) 376-0756.

Sincerely,

Delmar L. Noyes, Acting Assistant Manager
for Tank Farms Project

TED: WBS

Attachment

cc w/attach:
H. S. Berman, CH2M HILL
R. A. Dodd, CH2M HILL
M. D. Hasty, CH2M HILL
M. R. Koch, CH2M HILL
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U. S. Department of Energy, Office of River Protection

ASSESSMENT OF ABILITY OF TANK FARM ENGINEERING PROGRAM TO MEET MANAGEMENT EXPECTATIONS FOR COMPLIANCE, RIGOR, AND EXCELLENCE IN THE CONDUCT OF TANK FARM ENGINEERING

Dates of Assessment: December 3, 2007 through January 18, 2008

Assessment Team: Walter Scott, Assessment Team Leader
Ken Wade and Russ Treat; Assessors

Assessment Location: Hanford Tank Farms

Report Approval

Approved: ______________________
Delmar L. Noyes, Acting Assistant Manager
Tank Farm Project
Office of River Protection

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Walter Scott
Team Leader
Office of River Protection

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Ken Wade
Team Member
Office of River Protection

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Russ Treat
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Consultant

EXECUTIVE SUMMARY

Introduction: On July 27, 2007, the Hanford Tank Farm Contractor (Contractor) reported a spill of mixed radioactive and chemical waste in the vicinity of the TK-S-102 waste retrieval pump. Discrepancies and weaknesses in the Tank Farms Engineering Program were identified in subsequent analyses of the accident and related actions taken. The Contractor's Vice President and Chief Engineer is undertaking additional actions to institute a comprehensive and coherent Conduct of Engineering approach. To ensure the Contractor's Engineering Program is effective the Manager of the U.S. Department of Energy (DOE), Office of River Protection (ORP), directed an assessment of the Program.

The Assessment, performed by ORP's Tank Farms Engineering Division, addresses the adequacy of the Contractor's current Engineering Program, and the likely effectiveness of planned changes. The Assessment measured:

- Adequacy of the Contractor's Standards/Requirements Identification Document (S/RID) Phase 1 Assessments of functions deemed most applicable to a comprehensive Engineering Program. These include:
  - Management Systems
  - Engineering and Design
  - Nuclear Safety and Licensing
  - Training and Qualifications;
- Adequacy of the Contractor's requirements management system;
- Adequacy of the Contractor's *Engineering Management Program Plan; and*
- Ability of Contractor plans to mitigate the risks and weaknesses identified by the above assessments.

Significant Issues: The Assessment yielded two Findings and one Observation:

<u>Finding A-08-AMTF-TANKFARM-005-F01</u>: CH2M HILL Hanford Group, Inc. (CH2M HILL) did not implement S/RIDs requirements adequately in the cited Phase 1 reports.

S/RID requirements were inadequately or weakly implemented in S/RID Phase 1 reports at levels higher than expected. Deficiencies included incompleteness, vagueness, cancelled implementing documents, and incorrectly-cited implementing documents. One deficiency warrants near-term correction due to its nuclear safety ramifications.

The Finding is largely mitigated by the high experience level of the current engineering staff. The experienced engineers are likely to identify and correctly apply the requirements in any event. Concerns over inadequate implementation will increase as the experience level declines with the retirement of the aging work force.

Finding A-08-AMTF-TANKFARM-005-F02: CH2M HILL is not managing engineering requirements adequately.

Management of requirements is a life-cycle process (analogous to the ISMS process) that applies to all types of requirements. Effective management of requirements is important for all Tank Farm functions, but critical for Engineering because Engineering establishes the requirements for safe, compliant, and efficient design, construction, and operations. The Contractor has experienced numerous discrepancies and lessons learned in the recent past that are related to the management of requirements.

Requirements management is an element of systems engineering. The Contractor recently cancelled its *System Engineering Management Plan* (SEMP) as part of a Contractor initiative to eliminate plans and procedures that were not being used. The Contractor reported the SEMP was considered redundant and at too high a level to be of value to maintain. The new Engineering management team recognizes the need for a disciplined requirements management approach, however, but has not yet described the methods it will use to implement and verify an effective approach.

Observation A-08-AMTF-TANKFARM-005-O01: The CH2M Hill Engineering Program is not implementing project management systems effectively.

The Contractor is taking actions that will improve Engineering processes, capabilities, and organizational effectiveness. Few of these actions pertain to improving the overall Engineering management approach. The Contractor's *Tank Farm Contractor Project Execution Plan* identifies numerous management systems, practices, and tools that are relevant to the Engineering Program to varying degrees. Others are found on DOE's Office of Engineering and Construction Management (OECM) home page. Together, these include:

- Quality Assurance;
- Schedule Accountability;
- Cost Control;
- Interface Identification and Control;
- Risk Management;
- Documented Safety Analysis;
- Technology Development;
- Communication;
- Procurement;
- Design, Testing, Startup, and Turnover;
- Safeguards and Security;
- Information Resource Management;
- Integrated Safety Management;
- Integrated Project Teams;
- Records;
- Value Management;
- Systems Engineering;
- Performance Baseline Development; and
- Closeout.

The Contractor's *Engineering Program Management Plan* addresses only the following management systems, practices, and tools at the topical level:

- Technical Requirements Management;
- Training and Qualification;
- Engineering Processes;
- ISMS and Continuous Improvement:

- Configuration Management; and
- Roles, Responsibilities, & Authorities.

Others are addressed to a limited extent within the *Engineering Program Management Plan* and in detail in some policies, plans, and procedures. Others, such as 'grading', and 'S/RIDs' might be considered as topics to ensure consistency in their applications to engineering. In general, management systems, practices, and tools are not tied effectively to the Engineering Program's management system. The lack of definition of the comprehensive set of applicable management systems, practices, and tools (including high-level policy on how they apply to, and are integrated and implemented within the Engineering Program) poses a high risk to implementing a successful Conduct of Engineering Program. Such definition and policy, fully integrated in an overarching plan such as the *Engineering Management Program Plan*, is key for assuring a common understanding on how Engineering management expects engineering work to be managed and executed. The Chief Engineer has orally committed to generating an integrated, coherent engineering management plan that will complement the improvements he is making in engineering work processes, capabilities, and organization.

Conclusions: Actions planned by the Contractor likely will result in a highly effective Conduct of Engineering approach when completed and fully implemented. One Finding identifies an inadequately implemented S/RID requirement that warrants a near-term correction. Near-term actions also are warranted for another Finding to mitigate elevated risks associated with inadequate management of requirements. An Observation was made regarding the need for identifying and describing all management systems, practices, and tools that are applicable to an effective Conduct of Engineering Program.

1.0 REPORT DETAILS

1.1 Background and Purpose

On July 27, 2007, the Hanford Tank Farm Contractor (Contractor) reported a spill of mixed radioactive and chemical waste in the vicinity of the TK-S-102 waste retrieval pump. Numerous management, worker, and system performance discrepancies and weaknesses were identified in subsequent analyses of the accident and related actions taken before and after the accident. A number of these discrepancies and weaknesses were attributed to shortcomings in the Contractor's Engineering Program. The Contractor, U.S. Department of Energy (DOE), Office of River Protection (ORP), Richland Operations Office RL, and other Hanford contractors who experienced performance discrepancies associated with the accident developed and are implementing a plan to correct the deficiencies (*Corrective Action Plan – Type A Investigation Report – The July 27, 2007 Tank 241-S-102 Waste Spill at Hanford Tank Farms* [*Type A Corrective Action Plan*]).

The Contractor's Vice President and Chief Engineer is taking additional actions to institute a comprehensive and coherent Conduct of Engineering approach. He has developed a draft set of Success Factors for the Conduct of Engineering and prepared a Draft *CH2M HILL Hanford Group Inc. Conduct of Engineering Improvement Plan (Draft Improvement Plan)* to ensure these factors are achieved. The Success Factors are drawn largely from *Institute of Nuclear Power Operations (INPO) 90-009 Rev 02 – Guidelines for the Conduct of Design Engineering.* The current *Draft Improvement Plan,* which includes the Success Factors, is shown in Appendix B.

The corrective and improvement actions being taken and planned by the Contractor will result in changes to the Contractor's Engineering Program. To ensure the Contractor's revised Engineering Program is capable of compliance, rigor, and excellence in the conduct of engineering, the Manager, ORP, directed ORP's Tank Farms Engineering Division (TED) to assess the Program. The Assessment addresses the adequacy of the Contractor's current Engineering Program, and the likely effectiveness of planned changes.

1.2 Scope

The Assessors based the assessment of the Engineering Program on several criteria:

1. *The adequacy of the Contractor's Standards/Requirements Identification Document (S/RID) Phase 1 Assessments of functions deemed most applicable to a comprehensive Engineering Program.* The Assessors considered four of the 20 functions for S/RIDs to be most applicable. These include:

    - Management Systems;
    - Engineering and Design;
    - Nuclear Safety and Licensing; and

- Training and Qualifications.

The *Management Systems* function was selected because an effective Engineering organization must conform to the applicable requirements of other management systems. The *Engineering and Design* and *Nuclear Safety and Licensing* functions were selected because together they represent the scope of the TED. The *Training and Qualifications* function was selected based on concern about the pending retirement of the aging Engineering staff and the rigor of training necessary to ensure qualified replacements.

It is noted that the S/RIDs address only environmental and safety-related requirements, and therefore, the associated S/RID requirements do not embody a comprehensive set of engineering requirements.

2. *The adequacy of the Contractor's requirements management system.* The Assessors included this area of focus because effective management of engineering requirements (which includes Standards, the Authorization Basis, and other sets of engineering requirements) is fundamental for engineering excellence. Other reasons for including requirements management in the assessment are:

   - The numerous cases of misunderstanding and misapplication of requirements identified in the TK S-102 leak event investigations; and
   - The Observation that eight of 11 lessons learned posted on the Contractor's *Design Considerations Review* website are attributed to discrepancies in requirements management.

   The Assessors developed a set of requirements and attributes of effective requirements management by reviewing relevant DOE directives and requirements-management practices commonly employed by The National Aeronautics and Space Administration (NASA) and the Department of Defense (DoD) contractors. These requirements and attributes served as the basis for assessing the Contractor's effectiveness in requirements management.

3. *The adequacy of the Contractor's Engineering Management Program Plan (TFC-PLN-03).* This part of the assessment was based on the premise that the Plan should address all key factors important to implementing, conducting, and managing a comprehensive and effective engineering program. The key factors include *Training and Qualifications, Requirements Management*, and other functions.

4. *The potential ability of the Contractor's plans to mitigate the risks and weaknesses identified by the above assessments.* These plans include the corrective action plans associated with the spill (defined in the *Type A CAP*) and the Chief Engineer's independent actions to improve the performance of the Engineering Program (defined in the *Draft Improvement Plan*).

The Assessors reviewed the Contractor's S/RID Phase 1 Assessments and determined which individual requirements were applicable to Engineering. The Assessors then reviewed the document(s) (including references) the Contractor identified as implementing each applicable requirement. The Assessors determined if the implementing document(s) adequately reflected the intent of the requirement as it applied to Engineering. Implementation was deemed "inadequate" if the intent was essentially unmet in the cited implementation document(s). Implementation was gauged "weak" if only parts of the requirement were met.

For the Requirements Management function, the Assessors requested the Contractor to identify implementing documents for the individual requirements identified by the Assessors. The Assessors then verified the adequacy of the implementing documents. The Assessor of each S/RID requirement (and the Requirements Management list of requirements and attributes) then evaluated the risks associated with those inadequately or weakly implemented.

The Assessors also evaluated the adequacy of the *Engineering Management Program Plan* for addressing other important requirements and aspects of good engineering management under the four S/RIDs functions and the Requirements Management function. Applicable non-Environmental Safety and Health (ESH) requirements and good engineering management practices not addressed in the S/RIDs can be found in DOE orders and guidance documents, but were not considered beyond identifying their presence or absence.

The Assessors then evaluated the potential effectiveness of the Contractor's corrective actions associated with the spill and planned improvement actions for implementing an effective conduct of engineering approach.

1.3 Results

The five functional area assessments are documented in Appendix A. The overall Assessment yielded two Findings and one Observation as presented below:

Finding A-08-AMTF-TANKFARM-005-F01: CH2M HILL did not implement S/RIDs requirements adequately in the cited Phase 1 reports.

Requirements:

- Contract No. DE-AC27-99RL14047, Section J, Appendix C, "DOE Directives"
- DOE O 420.1A, *Facility Safety*, Section 4.1.3 (S/RID)
- TFC-BSM-AD-C-07, "Standards/Requirements Identification Process" – Section 4.3, "The S/RID interpretive authorities are responsible for reviewing new and revised documents which identify S/RID source requirements affecting their

functional area, to ensure each S/RID requirement continues to be properly implemented in company documentation (i.e., policies, plans, and procedures)."

Discussion:

S/RID requirements were inadequately or weakly implemented at levels higher than expected. Deficiencies included incompleteness, vagueness, cancelled implementing documents, and incorrectly-cited implementing documents. One deficiency warrants near-term correction due to its nuclear safety ramifications:

> *The requirements for discovery of a potential inadequacy of the documented Safety Analysis (PISA – 10 Code of Federal Regulation (CFR) 830, Section 203[g]) were not adequately implemented by the Unreviewed Safety Question (USQ) procedure (TFC-ENG-SB-C-03) cited in the implementation guide. The requirements appear to be implemented by a combination of the USQ procedure (TFC-ENG-SB-C-03) and the occurrence reporting procedure (TFC-OPS-OPER-C-24). However, the occurrence reporting procedure did not adequately implement Section 203(g)(1) or 203(g)(4). The occurrence reporting procedure did not specify what was needed prior to removing operational restrictions, i.e. submitting to DOE an evaluation of the safety. In addition, the USQ procedure did not provide details of what was required for a safety evaluation related to a PISA.*

The Assessors found that the S/RIDs and the Phase 1 reports were last updated 3-5 years ago and 2-3 years ago, respectively. The Assessors' decision to conduct the assessments of the Phase 1 reports despite this condition is justified by the contractually binding nature of S/RID requirements, and by the knowledge that requirements in out-of-date source documents (typically DOE Orders) have not changed significantly. The Assessors found most of the requirements in the source documents to be unexpectedly difficult to trace forward to the implementing documents cited in the Phase 1 reports due to lack of cross-referencing. The lack of cross-referencing increases the risk that those responsible for revising procedures may delete or inappropriately alter procedural text that implements specific requirements.

The Assessors' Observations are partly mitigated by their knowledge that:

- The deficient implementations involve fundamental engineering requirements that are widely understood in Tank Farm applications; and
- The high experience level of the current Engineering staff likely is sufficient to ensure compliance in any event.

Concerns over inadequate engineering requirements will increase as the experience level declines with the retirement of the aging work force at Tank Farms.

***Finding A-08-AMTF-TANKFARM-005-F02:* CH2M HILL is not managing engineering requirements adequately.**

Requirements:

- Contract No. DE-AC27-99RL14047, Section C, "Use a graded approach to determine applicable sets of requirements in design ... with due consideration for industry standards, elimination of redundant requirements, value added, and the level of risk associated with each facility or program." Also, "Implement a systems engineering process, which supports the management and integration of workscope activities. The Contractor's selected approach to systems engineering should be based on industry practices and should utilize a graded approach as necessary."

Guidance:

- DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*, "Requirements that form the basis for the design and engineering phase of the project shall be clearly documented. Identification, implementation, and compliance with other requirements are the responsibility of line management, including the Project Director and the Integrated Project Team."

Discussion:

Management of requirements is a life-cycle process (analogous to the Integrated Safety Management System [ISMS] process) that applies to all types of requirements. Management of requirements begins with identifying the work, developing requirements for the work, developing controls to ensure requirements are met, complying with the requirements as the work is done, verifying compliance of the completed work, performing rework where necessary, and developing lessons learned to aid future work. Effective management of requirements is important for all Tank Farm functions, but critical for Engineering since Engineering establishes the requirements for safe, compliant, and efficient design, construction, and operations.

Requirements management weaknesses have occurred. Several of the discrepancies noted in the *Type A CAP* investigation report are due to weaknesses in requirements management. Discrepancies in requirements management also are evident in 8 of 11 lessons learned posted on the Contractor's *Design Considerations Review* website.

Requirements management is an element of systems engineering. The Contractor cancelled its *System Engineering Management Plan* (SEMP), TFC-PLN-06, on April 12, 2007 as part of a Contractor initiative to eliminate plans and procedures that were not being used. The Contractor reported the SEMP was considered redundant and at too high a level to be of value to maintain. The SEMP described the requirements-management approach at a fundamental level. The SEMP largely was unimplemented, and its requirements management principles apparently have not been captured comprehensively elsewhere in engineering program documents or engrained in the engineering work culture at Tank Farms.

The new Engineering management team in Tank Farms recognizes the need for a disciplined requirements management approach, which it has documented in its *Draft Improvement Plan* in Appendix B. The *Draft Improvement Plan*, which is in its early stages of development, does not yet describe the methods the Contractor will use to implement the approach and to verify its effectiveness.

Observation A-08-AMTF-TANKFARM-005-O01: The CH2M HILL Engineering Program is not implementing project management systems effectively.

Guidance:

- DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*,

  "Project Management Principles.

  > Fundamental project management principles provide a framework for successful project execution. The requirements set forth in this Order are established to ensure adherence to the following principles:
  >
  > (1) Line management accountability;
  > (2) Sound disciplined up-front planning;
  > (3) Development and implementation of sound acquisition strategies;
  > (4) Well-defined and managed performance baselines;
  > (5) Effective project management systems (e.g., quality assurance, risk management, change control, performance management);
  > (6) Implementation of an Integrated Safety Management System; and
  > (7) Effective communication among all project stakeholders".

Discussion:

The *Type A CAP* and Contractor's *Draft Improvement Plan* identify numerous actions that, when completed, will improve specific Tank Farms Engineering processes, capabilities, and organization. However, relatively few of these actions pertain to improving the overall Engineering *management* approach.

The Contractor has documented an approach to managing the overall Tank Farm Cleanup Project in the *Tank Farm Contractor Project Execution Plan* (PEP), RPP-16965. The PEP provides the execution strategy for the Project as a whole in compliance with DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*. The PEP identifies numerous management systems, practices, and tools that are relevant to the Engineering program, but not fully implemented in the *Engineering Management Program Plan*. These include:

- Quality Assurance;
- Schedule Accountability;
- Cost Control;
- Interface Identification and Control;
- Risk Management;
- Documented Safety Analysis;
- Technology Development;
- Communication;
- Procurement;
- Design, Testing, Startup, and Turnover;
- Safeguards and Security; and
- Information Resource Management.

Additional relevant practices and guidance for those practices are found on DOE's Office of Engineering and Construction Management (OECM) home page, under 'Project Management Practices'. These include:

- Integrated Project Teams;
- Records;
- Value Management;
- Systems Engineering;
- Performance Baseline Development; and
- Closeout.

The current Tank Farm Engineering Program, documented in the Contractor's *Engineering Program Management Plan*, addresses only the following management systems, practices, and tools at the topical level:

- Technical Requirements Management;
- Training and Qualification;
- Engineering Processes;
- ISMS and Continuous Improvement;
- Configuration Management; and
- Roles, Responsibilities, & Authorities.

Other relevant management systems, practices, and tools are addressed to a limited extent within the *Engineering Management Program Plan* and in detail in some Contractor policies, plans, and procedures. The associated text in these policies, plans, and procedures often is limited, dispersed, fragmented and not tied effectively to the Engineering Program's management system. The lack of elevation and emphasis of other relevant systems, practices, and tools in the *Engineering Management Program Plan* at the topical level implies a lower level of importance within the current engineering culture. It also limits the ability of the *Engineering Management Program Plan* to serve as a vehicle to present an integrated and coherent picture of the Engineering Management system.

The lack of definition of the comprehensive set of applicable management systems, practices, and tools (including high-level policy on how they apply to, and are integrated and implemented within the Engineering Program) poses a high risk to implementing a successful Conduct of Engineering Program in Tank Farms. Such definition and policy, fully integrated in an overarching plan such as the *Engineering Management Program Plan*, is key for assuring a common understanding on how engineering management expects engineering work to be managed and executed. The Chief Engineer has orally committed to generating an integrated, coherent engineering management plan that will complement the improvements he is making in engineering work processes, capabilities, and organization. This plan will provide objective evidence of a Conduct of Engineering approach (both technical and management) that is capable of achieving the Chief Engineer's Success Factor objectives.

1.4 Conclusions

The Assessors concluded actions planned by the Contractor, as documented in the *Type A CAP* and in the *Draft Conduct of Engineering Improvement Plan*, likely will result in a highly effective Conduct of Engineering approach when completed and fully implemented. This Assessment revealed three significant Weaknesses in the current Tank Farms Engineering Program, resulting in two Findings and one Observation. One Finding identifies an inadequately implemented S/RID requirement that warrants near-term correction. Although the other Finding and the Observation are likely to be addressed adequately as the Contractor refines and implements his *Draft Conduct of Engineering Improvement Plan*, the Assessors concluded that both pose sufficient risk to the Engineering Program to warrant responsive actions in the near term.

1.5 Assessment Data

Personnel Interviewed:

- Chief Engineer and Vice President Engineering;
- Engineering Standards Director;
- Process Analysis Director; and
- Designated Engineering Staff.

Documents Reviewed:

- 10 CFR 830, Subpart B – *Safety Basis Requirements*
- 10 CFR 830.203, *Unreviewed Safety Question Process*
- 10 CFR 830.204, *Documented Safety Analysis*
- INPO 90-009 Rev 02 - *Guidelines for the Conduct of Design Engineering*
- INPO-05-006, *Engineering Success Factors, 12/05*
- DOE O 420.1A, *Facility Safety*
- DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*
- DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*
- DOE O 414.1C, *Quality Assurance*
- DOE –STD-1073-2003, *Configuration Management Program*
- DOE-STD-3024-98, *Content of System Design Descriptions*
- DOE Contract No. DE-AC27-99RL14047
- ORP-11242, *System Plan*
- *Corrective Action Plan Type A Accident Investigation Report The July 27, 2007, Tank 241-S-102 Waste Spill at Hanford Tank Farms (including CHG deliverables prepared in response to their assigned actions)*

- *Assessment of ORP TF Oversight* (ORP Approval Letter 07-ESQ-222)
- HNF-SD-WM-SP-012, *Tank Farm Contractor Operation and Utilization Plan*
- TF-AOP-004, *Response to Seismic Event*
- TF-ERP-008, *Emergency Response Procedure 008 - Response to High Winds*
- TFC-BSM-AD-C-01, *Administrative Document Development and Maintenance*
- TFC-BSM-AD-C-07, *Standards/Requirements Identification Document Process*
- TFC-BSM-CP_CPR-C-05, *Procurement of Services*
- TFC-BSM-HR_MA-C-02, *Employee Concerns Program*
- TFC-BSM-IRM_DC-C-01, *Document Control*
- TFC-BSM-IRM_DC-C-02, *Records Management*
- TFC-BSM-IRM-STD-05, *Document Control Standard*
- TFC-BSM-IRM-STD-06, *Records Management Standard*
- TFC-BSM-TQ-STD-01, Revision C-7, *Technical Staff Qualification Requirements*
- TFC-ENG-FACSUP-P-01, *Conduct of System Engineering*
- TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*
- TFC-ENG-DESIGN-C-06, *Engineering Change Control*
- TFC-ENG-DESIGN-C-09, *Engineering Drawings*
- TFC-ENG-DESIGN-C-25, *Technical Document Control*
- TFC-ENG-DESIGN-C-30, *Post-Natural Phenomena Hazard Assessment*
- TFC-ENG-DESIGN-C-34, *Technical Requirements for Procurement*
- TFC-ENG-DESIGN-D-13.2, *Guidance for Applying Engineering Codes and Standards*
- TFC-ENG-DESIGN-P-07, *System Design Descriptions*
- TFC-ENG-DESIGN-P-17, *Design Verification*
- TFC-ENG-SB-C-01, Revision C-10, *Safety Basis Issuance and Maintenance*
- TFC-ENG-SB-C-03, Revision D-3, *Unreviewed Safety Question Process*
- TFC-ENG-SB-C-06, Revision F-1, *Safety Basis Development*
- TFC-ENG-STD-06, *Design Loads for Tank Farms Facilities*
- TFC-ESHQ-Q_ADM-C-01, *Graded Quality Assurance*
- TFC-ESHQ-Q_C-C-01, *Problem Evaluation Request*
- TFC-ESHQ-Q_C-C-03, *Control of Suspect Counterfeit Items*
- TFC-ESHQ-RP-STD-03, *ALARA Decision Making Methods*
- TFC-OPS-OPER-C-02, Revision B, *Safety Basis Implementation Checklist Preparation, Review, and Approval*
- TFC-OPS-OPER-C-11, *Equipment Temporary Modifications and Bypasses*
- TFC-OPS-OPER-C-14, *Critique and Event Investigation Process*
- TFC-OPS-OPER-C-24, Revision C, *Occurrence Reporting and Processing of Operations Information*
- TFC-OPS-OPER-C-28, *Lessons Learned*
- TFC-PLN-03, REV D-2, *Engineering Program Management Plan*
- TFC-PLN-05, *Operations Organization and Administration*
- TFC-PLN-06, *System Engineering Management Plan (Canceled)*
- TFC-PLN-16, *Readiness Review Program Plan*

- TFC-PLN-17, *Document Control and Records Management Program Description*
- TFC-PLN-49, Revision B-1, *Tank Farm Contractor Nuclear Criticality Safety Program*
- TFC-PLN-61, Revision A-6, *Tank Farm Contractor Qualification and Training Program*
- TFC-PLN-73, *Environmental Program Description*
- TFC-POL-15, *Information Resource Management Policy*
- TFC-POL-16, *Integrated Environment, Safety, and Health Management System Policy*
- TFC-PRJ-PC-C-11, *Performance Indicator Program*
- TFC-PRJ-PC-C-13, *Risk Management*
- TFC-PRJ-PM-C-02, *Project Management for DOE O 413.3 Projects*
- TFC-PRJ-PM-C-04, *Startup Notification Report*
- TFC-PRJ-PM-C-06, *Operational Acceptance*
- TFC-PRJ-PM-C-07, *Startup Management Self-Assessment*
- TFC-PRJ-PM-C-08, *Operational Readiness Review*
- TFC-PRJ-PM-C-09, *Readiness Assessment*
- TFC-PRJ-PM-C-11, *Project Management for Non-DOE O 413.3 Projects*
- TFC-PRJ-SUT-C-05, *Startup Plan – Development and Maintenance*
- TFC-S/RID Chapter 1, *Management Systems Implementation Guide Rev. 3d,* Revised 6/30/05
- TFC-S/RID Chapter 4, *Training and Qualification Implementation and Adherence Guide*, Revised 4/25/2005
- TFC-S/RID Chapter 7, *Engineering and Design Implementation Matrix*, Rev. 3C1, Revised 9/27/05
- TFC-S/RID Chapter 18, *Nuclear Safety and Licensing, Revision 3e, Implementation Guide,* Revised 9-30-05
- RPP-10064, *Implementation Plan for DOE O 420.1, The Facility Safety Requirements*
- RPP-16965, *Tank Farm Contractor Project Execution Plan* (PEP)
- RPP-RPT-27056, *Supporting Document Report, PHMC Compliance with Executive Order 12941, Seismic Safety of Existing Federally Owned and Leased Buildings, Contract Number MVB-SLB-A41223*
- RPP-RPT-29160, *Methodology for Equipment Safety Classification*
- *CH2MHill Hanford Group Design Considerations Review Website for Lessons Learned*
- *Draft CH2M Hill Conduct of Engineering Improvement Plan, December 2007*
- *Training Implementation Matrix - River Protection Project Tank Farms Contractor*, Revision 20A-3, dated 09/2005
- *Qualification Card for Core Engineer (350850)*, Revision 0411.1d
- *Qualification Card for Component Engineer (350867)*, Revision 2h
- *Qualification Card for Engineering Discipline Lead (351860)*, Revision 0b
- *Qualification Card for Process Engineer (350255)*, Revision 4
- *Qualification Card for Project Engineer (350886)*, Revision 5d

- *Qualification Card for System Engineer (350868)*, Revision 4

Issues from Previous Assessments: - None identified

APPENDIX A

A.1.0 Management Systems Assessment

A.1.1 Review Approach

The Assessors reviewed the S/RID Phase 1 Report (*TFC S/RID Chapter 1, Management Systems Implementation Guide, Rev. 3d)*, implementing documents referenced therein, and other relevant documents in conformance to the general approach defined in Section 1.2 of the Assessment Report. Documents reviewed included:

- INPO 90-009 Rev 02 - *Guidelines for the Conduct of Design Engineering*
- INPO-05-006, *Engineering Success Factors, 12/05*
- DOE O 420.1A, *Facility Safety*
- DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*
- DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*
- DOE O 414.1C, *Quality Assurance*
- DOE –STD-1073-2003, *Configuration Management Program*
- DOE Contract No. DE-AC27-99RL14047
- *Corrective Action Plan Type A Accident Investigation Report The July 27, 2007, Tank 241-S-102 Waste Spill at Hanford Tank Farms (including CHG deliverables prepared in response to their assigned actions)*
- *Assessment of ORP TF Oversight* (ORP Approval Letter 07-ESQ-222)
- TFC-BSM-AD-C-01, *Administrative Document Development and Maintenance*
- TFC-BSM-HR_MA-C-02, *Employee Concerns Program*
- TFC-BSM-IRM_DC-C-01, *Document Control*
- TFC-BSM-IRM_DC-C-02, *Records Management*
- TFC-BSM-IRM-STD-05, *Document Control Standard*
- TFC-BSM-IRM-STD-06, *Records Management Standard*
- TFC-ESHQ-Q_C-C-03, *Control of Suspect Counterfeit Items*
- TFC-OPS-OPER-C-14, *Critique and Event Investigation Process*
- TFC-OPS-OPER-C-24, Revision C, *Occurrence Reporting and Processing of Operations Information*
- TFC-OPS-OPER-C-28, *Lessons Learned*
- TFC-PLN-03, REV D-2, *Engineering Program Management Plan*
- TFC-PLN-05, *Operations Organization and Administration*
- TFC-PLN-16, *Readiness Review Program Plan*
- TFC-PLN-17, *Document Control and Records Management Program Description*
- TFC-POL-15, *Information Resource Management Policy*
- TFC-POL-16, *Integrated Environment, Safety, and Health Management System Policy*
- TFC-PRJ-PC-C-11, *Performance Indicator Program*
- TFC-PRJ-PC-C-13, *Risk Management*
- TFC-PRJ-PM-C-02, *Project Management for DOE O 413.3 Projects*

- TFC-PRJ-PM-C-04, *Startup Notification Report*
- TFC-PRJ-PM-C-06, *Operational Acceptance*
- TFC-PRJ-PM-C-07, *Startup Management Self-Assessment*
- TFC-PRJ-PM-C-08, *Operational Readiness Review*
- TFC-PRJ-PM-C-09, *Readiness Assessment*
- TFC-PRJ-PM-C-11, *Project Management for Non-DOE O 413.3 Projects*
- TFC-PRJ-SUT-C-05, *Startup Plan – Development and Maintenance*
- TFC-S/RID Chapter 1, *Management Systems Implementation Guide Rev. 3d Revised 6/30/05*
- RPP-16965, *Tank Farm Contractor Project Execution Plan* (PEP)
- RPP-RPT-27056, *Supporting Document Report, PHMC Compliance with Executive Order 12941, Seismic Safety of Existing Federally Owned and Leased Buildings, Contract Number MVB-SLB-A41223*
- *Draft CH2M HILLl Conduct of Engineering Improvement Plan, December 2007*

The reviewers noted that the Management System S/RID was last updated November 2, 2002 and the Phase 1 Assessment is dated March 30, 2005 according to the Contractor's posted records. The Assessors subsequently investigated the revision dates of the key S/RID requirements references to determine if Management Systems S/RIDs requirements and the Phase 1 Assessment may need updating.

The three key requirements source documents in the Management Systems S/RID and their last revision dates are as follows:

- DOE O 5480.19, last updated October 23, 2001 (before the S/RID date);
- DOE O 440.1A, now superceded by DOE O 440.1B on May 17, 2007; and
- DOE O 425.1B, now superceded by DOE O 425.1C on March 13, 2007.

Although two of the three key requirements source documents have been updated, the Assessors elected to proceed with the review of the requirements currently documented in the Phase 1 report. This decision was based on the following factors: a) the current set of S/RID requirements are contractually approved by DOE, b) most of the applicable requirements are associated with DOE O 5480.19, which has not changed; and c) the likelihood of significant changes in updated DOE orders is relatively low.

A.1.2 Issues and Results

A.1.2.1 <u>Adequacy of Management Systems S/RID Phase 1 Implementation.</u>

The Assessors concluded that less than half the requirements identified in this S/RID are directly applicable to the conduct of engineering. Of the 70 or so that are, the Assessors found that all but three were adequately implemented in the cited documents to varying degrees of rigor. Two were deemed inadequate because it appears an incorrect implementing document was cited, and one was judged weak due to a very vague interpretation of the requirement. Several of the requirements expressed in the implementing document were superficially consistent with the intent of the source requirement, and were credited by the Assessors as adequate. The three weaknesses noted can easily be corrected by referencing other implementing documents.

The Assessors observed also that the requirements in this S/RID were not numbered and cross-referenced to the implementing documents as they are in other S/RIDs. In these other cases, the requirement numbers often are listed under the headings in which the requirements are captured. This facilitates: a) Verification that a requirement is correctly captured (and/or interpreted); and b) later modifying the requirement should the source requirement change. The lack of cross-referencing of requirements from this S/RID may have contributed to the relatively weak relationship between requirements in the source requirements and some of those in the implementing documents.

While inspecting the implementation documents, the Assessors found two additional weaknesses:

1. Implementing documents for DOE O 425.1B *Operational Readiness Review* requirements do not define responsibilities and authorities for Engineering. DOE O 425.1B describes responsibilities in detail, but vaguely assigns these responsibilities to "line management" and other generalized organizations. The Contractor's implementing documents are similarly vague on responsibilities. Engineering (and the Tank Farm Project as a whole) are at risk if Engineering does not play a key role in determining the level of readiness review and the review approach since Engineering is responsible for the overall design baseline, Technical Safety Requirements (TSRs), and operating specifications.

2. The implementing procedure for event investigative reports failed to include Engineering as a required recipient, although the Chief Engineer was shown later as a recipient in the example report at the end of the implementing document. Engineering should play an active role in event investigations and reports since the overall design baseline, TSRs, and/or operational safety requirements usually play a part in such events.

A.1.2.2 Adequacy of Current Tank Farm (TF) Engineering Management Program Plan.

The Assessors held several meetings with the Contractor's Chief Engineer, his Engineering Standards Director, and his Process Analysis Director on plans to achieve an effective Conduct of Engineering Program. One part of the Chief Engineer's plan is to develop an overarching plan to implement the Program. The overarching plan would drive cultural changes necessary to achieve his Success Factor objectives. The overarching plan also could serve as an integration tool and training basis. This is an important consideration because Tank Farm engineers are physically and organizationally dispersed, much of the engineering is performed by subcontractors with varied understandings of Tank Farm requirements, and new engineers could benefit by a plan that comprehensively and coherently describes the Engineering Program.

The current Tank Farm Engineering Program is documented in the Contractor's *Engineering Program Management Plan.* This plan adequately addresses several aspects of an effective engineering program, but is silent on the numerous management systems, practices, and tools that commonly support effective management programs. The *Engineering Program Management Plan* appears to be an adequate starting point for the Chief Engineer's overarching plan, and is amenable to expansion without significant rewrite.

Some of the important engineering management systems, practices, and tools are identified in the Management Systems S/RID, but these are focused on achieving an adequate ESH program. Other important, well-established engineering management systems, practices, and tools are included in the *Tank Farm Contractor Project Execution Plan* (PEP), RPP-16965. This document provides the execution strategy for the Tank Farm Project in compliance with DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets.* Additional relevant practices and guidance for those practices are found on DOE's Office of Engineering and Construction Management (OECM) home page, under 'Project Management Practices'.

Six key engineering management systems, practices, and tools are highlighted as topics in the current *Engineering Program Management Plan.* These include;

- Technical Requirements Management
- Configuration Management
- Training and Qualification
- ISMS
- Engineering Processes
- Roles, Responsibilities, and Authorities.

The PEP identifies 12 other key systems, practices, and tools that are not highlighted in the *Engineering Management Program Plan.* These include:

- Quality Assurance
- Schedule Accountability
- Cost Control
- Interface Identification and Control
- Risk Management
- Documented Safety Analysis
- Technology Development
- Communication
- Procurement
- Design, Testing, Startup, and Turnover
- Safeguards and Security
- Information Resource Management.

The OECM guidance addresses six additional relevant systems, practices, and tools including:

- Integrated Project Teams
- Records
- Value Management
- Systems Engineering
- Performance Baseline Development
- Closeout

Grading and tailoring and *S/RID* are other practices and tools that should be considered for articulation of the Chief Engineer's policy and expectations on their use in the *Engineering Program Management Plan.* With the exception of *grading and tailoring* and *S/RID,* these other management systems, practices, and tools have been established and used in various Hanford management applications for decades.

The Assessors noted that each of the above management systems, practices, and tools is addressed to some extent within specific Contractor policies, plans, and/or procedures referenced in the current *Engineering Program Management Plan.* The associated text on these other systems often is limited, dispersed, fragmented, and not well tied to the Engineering Program. The lack of elevation and emphasis in the *Engineering Management Program Plan* at the topical level implies a lower level of importance within the current engineering culture.

A.1.2.3 <u>Risks of Inadequate Implementation.</u>

The risks associated with inadequate implementation of the Management Systems S/RID requirements in the cited implementation documents are relatively low. The observed weakness in implementing three of the requirements can easily be corrected. A more rigorous but straightforward approach can be taken during the next S/RIDs and Phase 1 Report updates to ensure currency, traceability, and accurate translation of source requirements. A somewhat higher risk stems from the lack of stipulated Engineering participation in the readiness review process in the cited implementing documents.

The lack of clear, top-level policy on about 20 engineering-relevant systems, practices, and tools (identified above) poses a high risk to implementing an effective Conduct of Engineering program in Tank Farms. Such policy, fully integrated in an overarching plan such as the *Engineering Management Program Plan*, is key for assuring a common understanding on how Engineering management grades, balances, integrates, and applies competing methods and requirements in an effective Conduct of Engineering approach.

A.1.2.4 <u>Contractor Mitigation of Inadequacies and Risks.</u>

The Assessors assessed the adequacy of the Contractor's corrective actions and improvement plans for transforming the existing Engineering approach to an effective Conduct of Engineering approach. In this Section, the Assessors focused on management systems, practices and tools (as identified above) that <u>aid</u> the effective execution of the engineering program. Systems, practices and tools that implement engineering activities are covered in Sections A.2 and A.3 of this Appendix.

The corrective actions and improvements planned by the Contractor represent a major step toward implementing an effective Conduct of Engineering approach. The Assessors noted that most of the planned actions and improvements focus on deficiencies in the engineering processes, capabilities, and organization, in contrast to deficiencies in overarching management systems, practices, and tools that aid the execution of engineering. One exception is the action to 'Update the *Engineering Management Program Plan*' during February 2008. This action will be an opportunity for the Contractor to address other important management systems not currently emphasized and integrated in the *Engineering Management Program Plan.*

The Assessors also concluded that the planned action to "Strengthen the Design Authority function" in March 2008 is likely to assure an appropriate role for Engineering in readiness reviews, event investigations, and other activities that involve the architecture and requirements under the control of Engineering.

A.1.2.5 Residual Weaknesses.

Contractor Plans to 'Update the *Engineering Management Program Plan*' and 'Strengthen the Design Authority Function' provide the opportunity to correct all major management system weaknesses identified in this part of the Assessment. Current Contractor actions and improvement plans do not address the following minor weaknesses: a) Dated condition of the S/RID Phase 1 report; b) two inadequate and one weak requirement implementations observed; and c) marginal implementation of several other requirements.

A.2.0 Engineering and Design Assessment

A.2.1 Review Approach

The Assessors reviewed the S/RID Phase 1 report (*TFC S/RID Rev 3C1, Engineering and Design Matrix)*, implementing documents referenced therein, and other relevant documents in conformance to the general approach defined in Section 1.2 of the Assessment Report. Documents reviewed included:

- INPO 90-009 Rev 02 - *Guidelines for the Conduct of Design Engineering*
- INPO-05-006, *Engineering Success Factors, 12/05*
- DOE O 420.1A, *Facility Safety*
- DOE Contract No. DE-AC27-99RL14047
- *Corrective Action Plan Type A Accident Investigation Report The July 27, 2007, Tank 241-S-102 Waste Spill at Hanford Tank Farms (including CHG deliverables prepared in response to their assigned actions)*

- *Assessment of ORP TF Oversight* (ORP Approval Letter 07-ESQ-222)
- TF-AOP-004, *Response to Seismic Event*
- TF-ERP-008, *Emergency Response Procedure 008 - Response to High Winds*
- TFC-BSM-AD-C-01, *Administrative Document Development and Maintenance*
- TFC-BSM-AD-C-07, *Standards/Requirements Identification Document Process*
- TFC-BSM-TQ-STD-01, Revision C-7, *Technical Staff Qualification Requirements*
- TFC-ENG-FACSUP-P-01, *Conduct of System Engineering*
- TFC-ENG-DESIGN-C- 01, *Development of System and Subsystem Specifications*
- TFC-ENG-DESIGN-C-06, *Engineering Change Control*
- TFC-ENG-DESIGN-C-30, *Post-Natural Phenomena Hazard Assessment*
- TFC-ENG-SB-C-06, Revision F-1, *Safety Basis Development*
- TFC-ENG-STD-06, *Design Loads for Tank Farms Facilities*
- TFC-ESHQ-RP-STD-03, *ALARA Decision Making Methods*
- TFC-OPS-OPER-C-11, *Equipment Temporary Modifications and Bypasses*
- TFC-PLN-03, REV D-2, *Engineering Program Management Plan*
- TFC-PLN-73, *Environmental Program Description*
- TFC-S/RID Chapter 7, *Engineering and Design Implementation Matrix*, Rev. 3C1 - 9/27/05
- RPP-16965, *Tank Farm Contractor Project Execution Plan* (PEP)
- RPP-RPT-27056, *Supporting Document Report, PHMC Compliance with Executive Order 12941, Seismic Safety of Existing Federally Owned and Leased Buildings, Contract Number MVB-SLB-A41223*
- *Draft CH2M HILL Conduct of Engineering Improvement Plan, December 2007*
- CH2M-0702335 R1, *CONTRACT NUMBER DE-AC27-99RL14047 - RESPONSE TO THE U.S.DEPARTMENT OF ENERGY IMPLEMENTATION OF DOE O 420.1B, CONTRACTOR REQUIREMENTS DOCUMENT (CRD) "FACILITY SAFETY", AND ORP M 420.1-1 R1, "ORP FIRE PROTECTION PROGRAM"*, December 7, 2007

The reviewers noted that the Management System S/RID was last updated September 20, 2002 and the Phase 1 report is dated September 27, 2005 according to the Contractor's posted records. The Assessors subsequently investigated the revision dates of the key S/RID requirements references to determine if Management Systems S/RIDs requirements and Phase 1 Assessment may need updating.

The three key sources of requirements cited in the Management Systems S/RID and their last revision dates are as follows:

- DOE O 420.1A, now superceded by DOE O 420.1B on December 22, 2005; and
- DOE O 5480.19, last updated October 23, 2001 (before the S/RID date).

DOE O 420.1A is the source of all but one of the requirements sets. DOE 420.1A has been superceded, the Assessors elected to proceed with the review of the requirements currently documented in the Phase 1 Report. This decision was based on the following factors: a) The current set of S/RID requirements are contractually approved by DOE; and b) the likelihood of significant changes in the DOE order is relatively low.

A.2.2 Issues and Results

A.2.2.1 Adequacy of Management Systems S/RID Phase 1 Implementation.

By definition, all of the requirements identified in the Engineering and Design S/RID are directly applicable to the Conduct of Engineering. Of the 39 requirements identified by the Assessors that could be assessed, 11 were found to be inadequately implemented and 7 more were weakly implemented. Three of the requirements could not be assessed due to lack of ready availability of the implementing documents and time constraints. Reasons for inadequate and weak implementations included:

- Requirement or its interpretation not addressed or partly addressed in the implementation document;
- Implementing document cancelled; and
- Implementing document was a one-time evaluation rather than an implementation plan/procedure for the requirement.

The Contractor informed the Assessors that an updated Phase 1 Report on implementing the Engineering and Design S/RID was submitted earlier to ORP, and that ORP opted to delay review while it updated site-specific fire protection requirements. The Assessors reviewed that Report (Rev. 3o dated November 14, 2006) to determine if the inadequacies and weaknesses had been identified and corrected. The Assessors found that the Contractor had identified new and adequate implementing documents that address one of the inadequately implemented requirements.

Although an evaluation of the currency and comprehensiveness of the Engineering and Design S/RID was outside the scope of this Assessment, the Assessors noted that a single out-dated DOE order was the source of all but one of the Engineering and Design requirements needed for assuring environmental protection, safety and health.

A.2.2.2 Adequacy of Current Tank Farms Engineering Management Program Plan.

The Assessors reviewed the adequacies of Section 1, 'Purpose and Scope', and Section 5, 'Engineering Processes', in the *Engineering Management Program Plan.*

Section 1 adequately describes the content of the document, but falls short of describing its purpose. A key purpose of this document, when revised to meet the Contractor's February 2008 commitment to update the document, is to serve as the Chief Engineer's overarching document for implementing an effective

Conduct of Engineering Program, measured by achieving his Success Factor objectives. This document also should serve as the implementing document for applicable management systems, practices, and tools, identified in the Contractor's PEP and elsewhere. The *Engineering Management Program Plan* should identify and briefly describe how the applicable management systems, practices, and tools are implemented within the Engineering Program to achieve the Success Factor objectives.

Section 5 contains well-written summary descriptions of the various types of engineering process documents, including policies plans, charters, procedures, standards, and guidance documents. This section succinctly describes the requirements, management expectations, applicability, implementation, and responsibilities associated with the engineering process document system.

Two minor weaknesses in Section 5 are lack of discussion on: a) best engineering practice and b) process waivers and changes. These are two important engineering processes. Much of the Tank Farm engineering is performed using best engineering judgment outside the constraints of prescriptive plans and procedures, and within broad latitudes allowed by appropriate general plans and procedures. Discussion on waivers and changes could emphasize the Contractor's commitment to comply with plans and procedures but provide practical guidance on when waivers and changes are appropriate. The discussion of these two processes also should address requirements, management expectations, applicability, implementation, and responsibilities, just as the other processes in Section 5 are addressed.

A.2.2.3 Risks of Inadequate Implementation.

The risks associated with the inadequate and weak implementation of requirements in this S/RID function are moderate. Typical examples of the deficient implementation follow:

- Two of the inadequately implemented requirements dealt with the concept of defense-in-depth;
- Another implementation deficiency was failure to address inspectability and testing explicitly in the design;
- Another was failure to address a QA program that satisfies 10 CFR 830.120;
- Another was failure to address the use of engineering evaluations, trade-offs, and experience to develop practical designs that achieve functional confinement systems; and
- Four deficiencies were related to failure to properly address Natural Phenomena Hazards (NPH) at a planning level.

The deficiently implemented requirements represent a significant fraction of the requirements assessed in this function, each is closely related to well-established engineering principles at Tank Farms. The deficiently implemented requirements are likely to be implemented adequately during the normal course of engineering in any event. This conclusion presupposes the continuing presence of a sufficient number of engineers who are skilled in applying these principles.

The risks associated with the minor weaknesses in Sections 1 and 5 of the *Engineering Management Program Plan* are low and can easily be addressed when the *Plan* is updated.

A.2.2.4 Contractor Mitigation of Inadequacies and Risks.

The Assessors assessed the adequacy of the Contractor's corrective actions and improvement plans for transforming the existing engineering approach to an effective Conduct of Engineering approach. In this part of the Assessment, the Assessors focused on the adequacy of planned changes in engineering and design processes. The preceding section focused on planned changes in management systems, practices, and tools that are applicable to engineering.

The *Type A CAP* and Contractor's *Draft Improvement Plan* identify numerous actions that, when completed, will improve the engineering processes, capabilities, and organization. Some of these will result in improvements to administrative plans and procedures identified in the *Engineering Management Program Plan*. The Contractor's plan to update the *Engineering Management Program Plan* during February also is likely to modify the purpose and presentation of engineering processes in this plan. Inclusion of the Chief Engineer's Success Factor objectives and definition of the means to achieve them also will enhance the updated *Plan*. None of the Contractor's planned actions address needed improvements to the Engineering and Design S/RIDs Phase 1 report.

A.2.2.5 Residual Weaknesses.

Current Contractor actions and improvement plans do not address the dated condition of the S/RID Phase 1 report, and the inadequate and weak requirement implementations observed. None of these deficiencies requires near-term corrective actions because current Tank Farm Engineering knowledge provides adequate compensation until the next update. This conclusion appears to be corroborated by Contractor letter CH2M-0702335 R1, dated December 7, 2007. This letter states that there are "no cost or schedule impacts" resulting from ORP's plan to include the updated DOE O 420.1B and DOE M 420.1-1 R1 in the contract as Contractor Requirements Documents, implying few requirements have changed.

A.3.0 Nuclear Safety and Licensing Assessment

A.3.1 Review Approach

The engineering program Nuclear Safety and Licensing S/RID requirements were evaluated to determine the adequacy of implementing the requirements into procedures. The evaluation consisted of comparing the requirements identified in the S/RID to the implementation documents and determining the applicability, accuracy and depth of the implementing procedure. Weaknesses identified during the evaluation were discussed with Contractor staff to determine how the requirement is implemented. The following requirements source documents and implementing documents were reviewed and evaluated:

- 10 CFR 830, Subpart B – *Safety Basis Requirements*
- TFC-WM-CM-SRID, Chapter 18.0 – *Nuclear Safety and Licensing*
- TFC-S/RID Chapter 18 – *Nuclear Safety and Licensing, Revision 3e, Implementation Guide* Revised 9-30-05
- TFC-PLN-03, Revision D-2, *Engineering Program Management Plan*
- TFC-PLN-49, Revision B-1, *Tank Farm Contractor Nuclear Criticality Safety Program*
- TFC-ENG-SB-C-01, Revision C-10, *Safety Basis Issuance and Maintenance*
- TFC-ENG-SB-C-03, Revision D-3, *Unreviewed Safety Question Process*
- TFC-ENG-SB-C-06, Revision F-1, *Safety Basis Development*
- TFC-OPS-OPER-C-02, Revision B, *Safety Basis Implementation Checklist Preparation, Review, and Approval*
- TFC-OPS-OPER-C-24, Revision C, *Occurrence Reporting and Processing of Operations Information*

A.3.2 Issues and Results

A.3.2.1 <u>Adequacy of Nuclear Safety and Licensing S/RID Phase 1 Implementation.</u>

The Assessors concluded that the majority of the roughly 35 requirements identified in this S/RID are directly applicable to the Conduct of Engineering. A few of the requirements applicable to the operations organization were related to reporting and implementation of compensatory actions. For the most part, the applicable Nuclear Safety and Licensing requirements were adequately implemented by the engineering program procedures reviewed. The weaknesses noted during the review were:

1. The requirements for discovery of a Potential Inadequacy of the Safety Analysis (PISA - 10 CFR 830, Section 203(g)) were not adequately implemented by the Unreviewed Safety Question (USQ) procedure (TFC-ENG-SB-C-03) cited in the implementation guide. The requirements appear to be implemented by a combination of USQ procedure (TFC-ENG-SB-C-03) and the occurrence reporting procedure (TFC-OPS-OPER-C-24). The

occurrence reporting procedure did not adequately implement Section 203(g)(1) or 203(g)(4). The occurrence reporting procedure did not specify what was needed prior to removing operational restrictions, i.e., submitting an evaluation of the safety.

2. The S/RID did not include two applicable Safety Basis Requirements (10 CFR 830, Section 204(b)(1) and (2)). The Assessor found that these requirements were implemented by procedure TFC-ENG-SB-C-06. Discussions with the Contractor indicated that these two requirements were included in an S/RID update that has not been finalized.

3. The implementation guide did not accurately reflect the applicable implementing document(s) for several requirements. For example, procedures TFC-ENG-SB-C-01, C-03 and/or C-06 were identified as the implementing documents for 10 CFR 830, Sections 2, 3, 203(e) and 207(a), (b) and (c) but did not implement the identified requirements. The requirements were primarily related to definitions and issuance of the initial 10 CFR 830 compliant safety basis; and for obtaining DOE approval for taking action determined to involve a USQ. These requirements were found implemented by other documents. In some cases, the steps were not identified by the typical reference note.

A.3.2.2 Adequacy of Current TF Engineering Program Management Plan.

The Assessor concluded that the Contractor's *Engineering Management Program Plan* adequately addressed the Nuclear Safety and Licensing function. The plan provided references to the charter, training and qualification plan, roles, approval authorities and responsibilities.

A.3.2.3 Risks of Inadequate Implementation.

The potential risks were judged by the Assessors to be low to moderate for the three weaknesses noted with Nuclear Safety and Licensing. The risk associated with implementation of PISA actions (item 1 above) was moderate due to the potential to remove operational restrictions without completing an evaluation of safety prior to updating the occurrence report. The Contractor procedures did not contain adequate direction related completing an evaluation of safety before removing operational restrictions nor a description of what would be required for the safety evaluation.

The risks associated with implementation guide and S/RID weaknesses (items 2 and 3 above) were low. These types of weaknesses indicated that some improvement was needed with documenting how requirements are implemented.

A.3.2.4 Contractor Mitigation of Inadequacies and Risks.

The Contractor's existing corrective actions and improvement plans for the engineering program were reviewed. The improvement plans and corrective actions would most likely not address the specific weaknesses identified above and therefore would not mitigate the associated risks.

A.3.2.5 Residual Weaknesses.

The weakness associated with implementation of the PISA actions (item 1 above) indicates that operational restrictions associated with a PISA may be removed without completing an evaluation of safety. The USQ procedure referenced the occurrence reporting procedure for actions if a PISA exists. The occurrence reporting procedure indicated that an update report needs to be issued prior to removing operational restrictions but did not call out the requirement for completing an evaluation of safety. In addition, the USQ procedure did not provide details of what was required for a safety evaluation related to a PISA. As a result, the actions associated with removal of operational restrictions may not be implemented effectively.

The risks associated with implementation guide and S/RID weaknesses (items 2 and 3 above) were considered to have a minor to no impact of implementing requirements.

A.4.0 Training and Qualification Assessment

A.4.1 Review Approach

Training and Qualification S/RID requirements were evaluated to determine the adequacy of implementing the requirements into the Engineering Program. The evaluation consisted of comparing the requirements identified in the S/RID to the implementation documents and determining the applicability, accuracy and depth of the implementing documents. The following documents were reviewed and evaluated:

- TFC-WM-CM-SRID, Chapter 4.0 – *Training and Qualification*
- TFC-S/RID Chapter 4.0 – *Training and Qualification Implementation and Adherence Guide*, dated 4-25-2005
- *Training Implementation Matrix - River Protection Project Tank Farms Contractor*, Revision 20A-3, dated 09/2005
- TFC-BSM-TQ-STD-01, Revision C-7, *Technical Staff Qualification Requirements*
- TFC-PLN-03, Revision D-2, *Engineering Program Management Plan*
- TFC-PLN-61, Revision A-6, *Tank Farm Contractor Qualification and Training Program*
- *Qualification Card for Core Engineer (350850)*, Revision 0411.1d

- *Qualification Card for Component Engineer (350867)*, Revision 2h
- *Qualification Card for Engineering Discipline Lead (351860)*, Revision 0b
- *Qualification Card for Process Engineer (350255)*, Revision 4
- *Qualification Card for Project Engineer (350886)*, Revision 5d
- *Qualification Card for System Engineer (350868)*, Revision 4

A.4.2 Issues and Results

A.4.2.1 Adequacy of Training and Qualification S/RID Phase 1 Implementation.

The Assessors concluded that the majority of the requirements identified in this S/RID were not directly applicable to the Conduct of Engineering. The section of the S/RID for Technical Support Personnel Training (4.3.6) was found to contain the principle Engineering Program requirements. For the most part, the applicable training requirements were adequately implemented by the documents reviewed. One procedure (TFC-PLN-23) was listed as an implementing document but is no longer listed as a management plan of the procedures web page.

The one weakness noted during the review was related to the Component Engineer. The Component Engineer Qualification Card did not contain training elements related to the DSA or TSR. The S/RID identifies that DSA and TSR subject areas could be appropriate for technical staff; and TFC-PLN-03 identifies that the Component Engineer has responsibility for understanding the DSA hazards analysis and assumptions that form the safety envelope.

A.4.2.2 Adequacy of Current Tank Farm Engineering Program Management Plan.

The Assessor concluded that the Contractor's *Engineering Management Program Plan* adequately addressed the Training and Qualification attributes. The plan provided references to the Training Implementation Matrix and qualification cards; and outlines technical staff training for all engineering staff, engineering staff qualification, continue training, professional training and specialized training.

A.4.2.3 Risks of Inadequate Implementation.

The potential risk was judged by the Assessors to be moderate for the Component Engineer qualification weaknesses noted. The Component Engineer has DSA responsibilities that are not included in the qualification card. The risk associated with possible poor DSA implementation could result from the lack of, or inadequate training related to the DSA. The Contractor noted that only four engineers at present are qualified Component Engineers.

A.4.2.4 Contractor Mitigation of Inadequacies and Risks.

The Contractor's existing corrective actions and improvement plans for the Engineering Program were reviewed. The improvement plans and corrective actions may address the specific weaknesses identified above and therefore may not mitigate the associated risks.

A.4.2.5 Residual Weaknesses.

The Component Engineer's role is to serve as the design authority for assigned non-Vital Safety Systems (non-VSS) with primary responsibilities to support operational and maintenance activities. The weakness identified indicates that this classification of engineer has responsibilities related to understanding the DSA but the qualification process does not provide DSA training. This lack of knowledge of the DSA could negatively impact an engineer's ability to effectively implement the DSA responsibility. As a result, engineering decisions could be made related to non-VSS work without requisite knowledge of potential impacts to the DSA. The current Contractor actions and improvement plans may not correct this weakness.

A.5.0 Requirements Management Assessment

A.5.1 Review Approach

The Assessors reviewed the CH2M HILL contract, and several DOE Orders and Standards to extract requirements for an effective Requirement Management System. They also developed a list of Requirements Management System Attributes based on systems engineering principles and practices employed by DoD and NASA contractors. These requirements and attributes were provided to Contractor Engineering representatives who identified engineering documents that implemented the requirements extracted by the Assessors The DOE Orders and Standards, and other documents reviewed included:

- DOE O 420.1A, *Facility Safety*
- DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*
- DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*
- DOE O 414.1C, *Quality Assurance*
- DOE –STD-1073-2003, *Configuration Management Program*
- DOE-STD-3024-98, *Content of System Design Descriptions*
- DOE Contract No. DE-AC27-99RL14047
- ORP-11242, *System Plan*
- *Corrective Action Plan Type A Accident Investigation Report The July 27, 2007, Tank 241-S-102 Waste Spill at Hanford Tank Farms (including CHG deliverables prepared in response to their assigned actions)*

- HNF-SD-WM-SP-012, *Tank Farm Contractor Operation and Utilization Plan*
- TFC-BSM-CP_CPR-C-05, *Procurement of Services*
- TFC-ENG-DESIGN-C-01, *Development of System and Subsystem Specifications*
- TFC-ENG-DESIGN-C-06, *Engineering Change Control*
- TFC-ENG-DESIGN-C-09, *Engineering Drawings*
- TFC-ENG-DESIGN-C-25, *Technical Document Control*
- TFC-ENG-DESIGN-C-34, *Technical Requirements for Procurement*
- TFC-ENG-DESIGN-D-13.2, *Guidance for Applying Engineering Codes and Standards*
- TFC-ENG-DESIGN-P-17, *Design Verification*
- TFC-ENG-SB-C-06, Revision F-1, *Safety Basis Development*
- TFC-ESHQ-Q_ADM-C-01, *Graded Quality Assurance*
- TFC-PLN-03, REV D-2, *Engineering Program Management Plan*
- TFC-PLN-06, *System Engineering Management Plan (Canceled)*
- TFC-PRJ-PC-C-13, *Risk Management*
- TFC-PRJ-PM-C-02, *Project Management for DOE O 413.3 Projects*
- TFC-PRJ-PM-C-11, *Project Management for Non-DOE O 413.3 Projects*
- RPP-RPT-29160, *Methodology for Equipment Safety Classification*
- *Draft CH2M Hill Conduct of Engineering Improvement Plan, December 2007*

A.5.2 Issues and Results

A.5.2.1 Adequacy of Requirements Management System Implementation.

The Assessors concluded that several requirements for a Requirements Management System were weakly implemented in high-level engineering documents. In each case, lower level procedures, processes, or systems either do not exist or were not described in sufficient detail or rigor to reasonably conclude that the requirement could be fully and effectively implemented by an engineer without years of direct tank-farms-specific engineering experience. Of the 11 groups of requirements evaluated by the Assessors, three of the requirements groups were implemented at this level and were considered to be superficially consistent with the intent of the source DOE Order and Standards requirements. The three weaknesses noted can be corrected by moderate efforts to either reference existing documents that eluded the Assessors, or by efforts to document current practices that experienced engineers have developed over their careers at Tank Farms.

These areas included implementation of System Design Descriptions (SDDs), performing engineering work in accordance with engineering standards and administrative controls, and the development of engineering products that fully comply with specified technical requirements. With respect to SDDs, the Assessors found requirements in high-level engineering documents to prepare SDDs and a template to guide engineers in the production of SDDs. The significance of SDDs in an effective requirements management system is that all requirements and their bases are to be included in the SDD. This preserves the technical and design requirements of systems for system operations, maintenance and possible modifications. The weakness in this area is the differing levels of rigor that are applied to vital safety systems compared to non-vital safety systems. The source requirements do not distinguish between these types of systems, yet engineering implementation of requirements is focused on vital safety systems. Non-vital safety systems that have mission, efficiency or project schedule impacts are not afforded the elevated attention of more rigorous SDDs, and consequently the final system requirements and bases may not be adequately preserved to support reliable overall system operation.

The Assessors found that engineering documents require engineers to perform their work in accordance with engineering standards and administrative controls. The documents do not identify the standards and controls that are considered mandatory, they do not specify how the engineer is to demonstrate compliance with the standards and controls, and do not identify a process for the engineer to use when conflicting standards and controls are encountered.

Top-level Engineering documents require engineers to ensure that their design and other engineering activities comply with all specified technical requirements. The weaknesses identified by the Assessors in this area include a) Weaknesses in the systematic identification of technical requirements; b) the lack of a rigorous verification process to assure that the selected requirements are the necessary and sufficient set of requirements to fulfill the performance requirements; c) the lack of recognition, with an associated control process, that requirement sets are likely to change as designs mature, or as different alternatives are implemented; and d) the lack of specific requirements to identify and document the bases of all requirement compliances and deviations. This requires engineers to rely on their experience, expertise, guidance from peers, and their own sense of diligence to assure themselves that they have complied, and can demonstrate compliance with all applicable requirements.

The remaining eight groups of requirements will require a more intense effort to capture requirements-management system requirements and develop processes to implement the requirements and procedures to systematically fulfill the requirements. The weaknesses in these areas are discussed in the following paragraphs.

<u>Graded Approach to Requirements Management</u>. The CH2M HILL contract contains a requirement for the Contractor to use a graded approach to determine the applicable sets of requirements in design. The Assessors reviewed the documents describing the application of the graded approach provided by CH2M HILL Engineering and found that top-level engineering documents embrace the concept of graded requirements for design. The specifics of the approach, criteria for grading requirements, approvals for sets of requirements that have been tailored to conditions, and the identification and retention of the

bases for the selected set of requirements are not described in the documents provided to and reviewed by the Assessors. It appears that engineers are left to rely on their experience and specific knowledge of tank farm issues to tailor requirements to each design or activity.

Consideration of Industry Standards. The CH2M HILL contract directs the Contractor to give due consideration to industry standards in the development and tailoring of design requirements. Documents provided by CH2M HILL Engineering demonstrating implementation of this requirement to consider industry standards led the Assessors to conclude that the top-level Engineering documents acknowledge the existence of industry standards, direct engineers not to duplicate industry standards in CH2M HILL Engineering standards, and to incorporate them into technical requirements when applicable. The weakness identified by the Assessors is the absence of lower level implementing documents to define a systematic approach (e.g., checklist) to ensure that all applicable industry standards have been considered for inclusion in the technical requirements for a design, activity or analysis and to require a basis be prepared to support the selection/elimination of applicable industry standards. The fact that most designs incorporate appropriate industry standards leads the Assessors to believe that experienced engineering staff are preparing design requirements and can, through their expertise and experience correctly identify the applicable industry standards.

Elimination of Duplicate/Redundant Requirements: The CH2M HILL contract directs the Contractor to give consideration to the elimination of duplicate or redundant requirements. Documents provided by CH2M HILL Engineering addressing the elimination of duplicate/redundant requirements indicate that top-level engineering documents direct engineers to eliminate such requirements from design and other activity requirements. The documents reviewed by the Assessors provided no more specific direction or systematic process for the elimination of duplicate/redundant requirements and do not provide requirements for selecting the more restrictive of duplicate/redundant requirements or developing and documenting the basis for the elimination of the duplicate/redundant requirement. The Assessors believe that while a duplicate or redundant requirement may be eliminated from a design requirements set, for example, it is important to retain the traceability of the eliminated requirement in the event the implemented requirement (most often a regulation or DOE order requirement) is eliminated or modified such that it is no longer the most restrictive of the redundant/duplicative requirements and the previously eliminated requirement is no longer satisfied by the requirements set after the source requirement has been changed. The experience level of the current engineering staff appears to be sufficient for managing duplicate/redundant requirements without such systematic guidance or requirements for the present time.

Value Engineering. The CH2M HILL contract requires the Contractor to consider the value addition of requirements selected for design requirements. Documents provided to the Assessors indicate that value engineering, as a process, is described as a desirable process, however, no features of the engineering requirements management system acknowledges or directs engineers to consider the value of specific requirements that may appear to be applicable to designs or other engineering activities. This weakness is closely related to the weakness identified above in applying a graded approach to the selection of design requirements. This weakness can be addressed by including value engineering considerations in the selection of tailored requirements. The documentation of the selection of the graded design requirements can use value engineering principles and techniques to provide the basis for the tailoring of requirements to designs and other engineering activities.

Risk Management. The CH2M HILL contract directs the Contractor to consider the level of risk associated with each facility or program in the selection of engineering requirements. Documents provided to the Assessors referred to the Contractor's risk management program as evidence of fulfilling this requirement. The Assessors found, however, that the risk management program deals largely with programmatic, financial, environmental, and public safety risks without getting to the level of evaluating the risk impacts of implementing individual design requirements. The impact of this weakness is compounded by the weakness in documenting the bases for requirements selection, wherein facility, program, or activity risk should be a factor. The Assessors believe that appropriate consideration of risks incurred or eliminated by the selection of design requirements can be adequately addressed in a systematic requirements selection process that includes documentation of the basis for selection/rejection of specific requirements or requirement sets.

Requirements Management System Requirements. Guidance for DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*, suggests several important considerations for the selection of requirements that form the basis for the design and engineering phase of projects. These include:

- "Identification, implementation, and compliance with other requirements are the responsibility of line management, including the Project Director and the Integrated Project Team. Indeed, one of the primary purposes of the Integrated Project Team is to ensure that the breadth of requirements is included in the project scope.

- The Definition Phase comprises the iterative process that develops and analyzes the concepts and alternatives available for meeting the approved mission need. This process uses a systems methodology that integrates requirements analysis, risks analysis, acquisition strategies, and concept exploration to evolve a cost-effective solution to meet a mission need.

- The requirements analysis process develops the programmatic, system, functional or technical requirements for hardware, software, facilities, personnel, procedures, technical data, personnel training, and initial spares needed to acquire, test, deploy, operate, and maintain a capital asset. Requirements analysis provides underpinning of the conceptual design process and connects the solution to the need.

- Requirements can and do originate from many sources, including—mission need; strategic plans and objectives; legal agreements between the Federal Government and other legal entities and organizations; national codes and standards; Department Orders, Manuals and Standards; background and knowledge of project personnel; operations concepts; lessons learned from other projects; research and development activities as well as pilot plant and full-scale testing; industrial organizations and industry experts; and other organizations such as the Defense Nuclear Facilities Safety Board, citizen's groups, and stakeholders."

Documents provided to the Assessors indicated, in general, a top-level identification of each of these principles and a commitment to implement them. The Assessors found that lower level details in the form of procedures, processes, or engineering practices are not developed to ensure systematic, effective implementation of this guidance. The Assessors found little information or definition of Integrated Project Team make-up and processes. An iterative process to manage and control requirements identification as design concepts and alternatives are explored was not discovered by the Assessors.

A systematic requirements analysis process to develop programmatic, system, functional and technical requirements for designs and activities has some implementing detail described in the development of system and subsystem specifications engineering procedures; however, the extent of the specifications does not appear to extend through the deployment, operation, and maintenance of the capital asset. This is particularly evident in the lack of interface definition and coordination of responsibilities between subcontracted engineering resources managed by the Project Engineer and the System or Component Engineer when project turnover to operations occurs. The Assessors found sufficient evidence that engineering documents acknowledge that technical requirements originate from many sources, however, as noted above, a systematic approach to ensure all sources are adequately considered is lacking.

Functional Requirements Management. Guidance for DOE O 413.3A, also suggests several important considerations for the management of functional requirements for capital assets designed, constructed and delivered by projects. These include:

- "Functional requirements are developed, describing the functionality of the asset and how the identified functions relate to each other. In many cases, functional requirements may be augmented with specific standards, design requirements, safety, quality, and other parameters that have some legal basis for their inclusion.

- System Functional Requirements include sufficient detail to establish the criteria or limits against which the actual capability of the as-built or remediated system can be accepted.

- Specific requirements required of component, subsystem, or subelement within an alternative provide the individual specification required of the subsystem or component that are necessary for the item to appropriately support the larger system.

- Requirements define and describe the extent to which a function is to be executed and are generally measured in terms of quantity, quality, coverage, timelines, safety, and products. The requirements documentation provides the traceability throughout the entire acquisition process and connects the performance and operational testing to mission need to provide verification of having met the need.

- The earlier project requirements can be identified and defined, the more effectively and efficiently a project will progress through the various phases, and meet project baselines, agreements, and commitments.

- As a project progresses from mission need through concept exploration, development, and design, the process of identifying, analyzing, and refining requirements is continual and is always traceable to specifications and designs. Because the requirements are the foundation for the entire acquisition process, they are part of the baseline and are placed under an established change control system.

- As a project progresses through concept exploration and design, the requirements evolve into increasing levels of detail and specificity."

Documents provided to and reviewed by the Assessors showed that the source and structure of functional requirements are addressed in top-level engineering documents. Additional requirements for systems and subsystem specifications address the development and application of requirements to project design. The Assessors found weaknesses in the management of functional requirements primarily in the failure of the requirements management system to acknowledge and manage the dynamic nature of requirements as designs and alternatives mature and are selected and in the documentation of the bases for requirements selection. The Assessors believe, based on these weaknesses identified above, that the configuration management process should be evaluated for its ability to manage and control requirements sets that may change as project work is performed.

Requirements Management for New Construction: DOE-STD-1073-2003, *Configuration Management Program,* provides guidance for the development and implementation of design requirements for new construction activities. For new construction:

- "The design requirements must be identified and documented as part of the design process and incorporated into a formal configuration management process before start of construction.

- A template or checklist may be used as a tool to help verify that the design requirements are complete.

- The template should be comprehensive and include both the expected and possible design requirements for various types of SSCs.

- When the design requirements are initially established for the configuration management process, the contractor must perform a technical management review to determine the adequacy of these requirements. Subsequent changes to project design and supporting documents must be made by means of a formal change control program.

- The contractor must maintain the design requirements for configuration-management throughout the life of the nuclear activity."

In documentation provided to the Assessors, the requirements for managing new construction are assigned to Project Engineers. The design activities are typically subcontracted to engineering companies to provide design services, or design/build services. The documentation reviewed did not establish threshold levels of design completion that must or should be attained before proceeding to construction or procurement. The only control that could be found was in the area of safety system design, where the Nuclear Safety Rule and DOE Project Management requirements specify that DOE approval must be obtained to begin construction or procurement prior to DOE's approval of a PDSA, now required at Critical Decision 3 (CD-3).

For non-safety related construction projects, no engineering requirement for design maturity could be found upon which to base the start of construction or procurement. This weakness has been demonstrated to have deleterious impacts on project cost and schedule in both safety and non-safety projects. The Assessors could not find any requirement that implemented a systematic process (such as a template or checklist) that was used to assure that the design requirements set was complete prior to start of construction or procurement. The weaknesses already identified with respect to the development, documentation of requirement bases, configuration management through changing design requirements may impede the CH2M HILL engineering organization from realizing the benefits of the guidance provided in this DOE standard.

A.5.2.2 Adequacy of Current Tank Farm Engineering Program Management Plan.

The Assessors met with the Contractor's Chief Engineer and several engineering staff members on plans to achieve an effective Conduct of Engineering Program. One part of the plan is to strengthen the engineering requirements management process.

The current Tank Farm engineering program defines engineering requirements in the *Engineering Program Management Plan* (TFC-PLN-03), but does not describe the management system for the requirements that are defined.

Engineering requirements are derived from a hierarchal flowdown of technical requirements beginning with scope of work as defined in the *River Protection Project System Plan* (ORP-11242). Planning cases to execute the scope of work are identified in the *Tank Farm Contractor Operation and Utilization* (TFCOUP). Tank Farms Engineering owns the integration and configuration control of the technical baseline, as defined in the TFCOUP. From the technical baseline, that includes two scenarios, the "Target Case," and the "Stretch Case," the Contractor develops the TFC mission, end states, interfaces, functions, requirements, facilities/systems, and projects necessary to conduct the work. The results are the development of waste retrieval scenarios, process flow sheets, tank waste volume projections, single-shell tank retrieval sequences, product estimates and assumptions.

The functions and requirements to support this work are allocated to major Tank Farm facilities. Once the functions and requirements for major facilities are defined, System Function and Requirements Analyses are performed to develop system functional and performance requirements. These requirements are placed in the System Specifications. If further subdivision is needed, function and requirements analyses identify subsystem requirements that are documented in Subsystem Specifications. Statements of work, interface agreements, procurement specifications, etc. are developed to meet the System and/or Subsystem Specifications. A design baseline is prepared for engineering work to be completed.

The system and subsystem design baselines are comprised of three groups of requirements that are applied to the design process. These are Design Inputs, Design Constraints, and Design Analysis and Calculations. A description of these groups and their interrelationship is best shown in Figure A.5-1 (Figure 2 of the *Engineering Program Management Plan*).

The *Engineering Program Management Plan* defines a hierarchy of the Technical Requirements Documents is shown in Figure A.5-2 (from Figure 3 of the Engineering Management Program Plan).

The Assessors found one minor weakness in this definition of requirements in the *Engineering Program Management Plan*. Requirements from the DSA and the TSR derivation can include requirements that must be addressed in the design of equipment (e.g., safety classification requirements, diversity, redundancy).

A more significant weakness identified by the Assessors is the absence of a management process for engineering requirements. Such a process was previously identified by the TFC in TFC-PLN-06, *Systems Engineering Management Plan for the Tank Farm Contractor*, but was canceled. While the *Systems Engineering Management Plan* described the structure of a very good

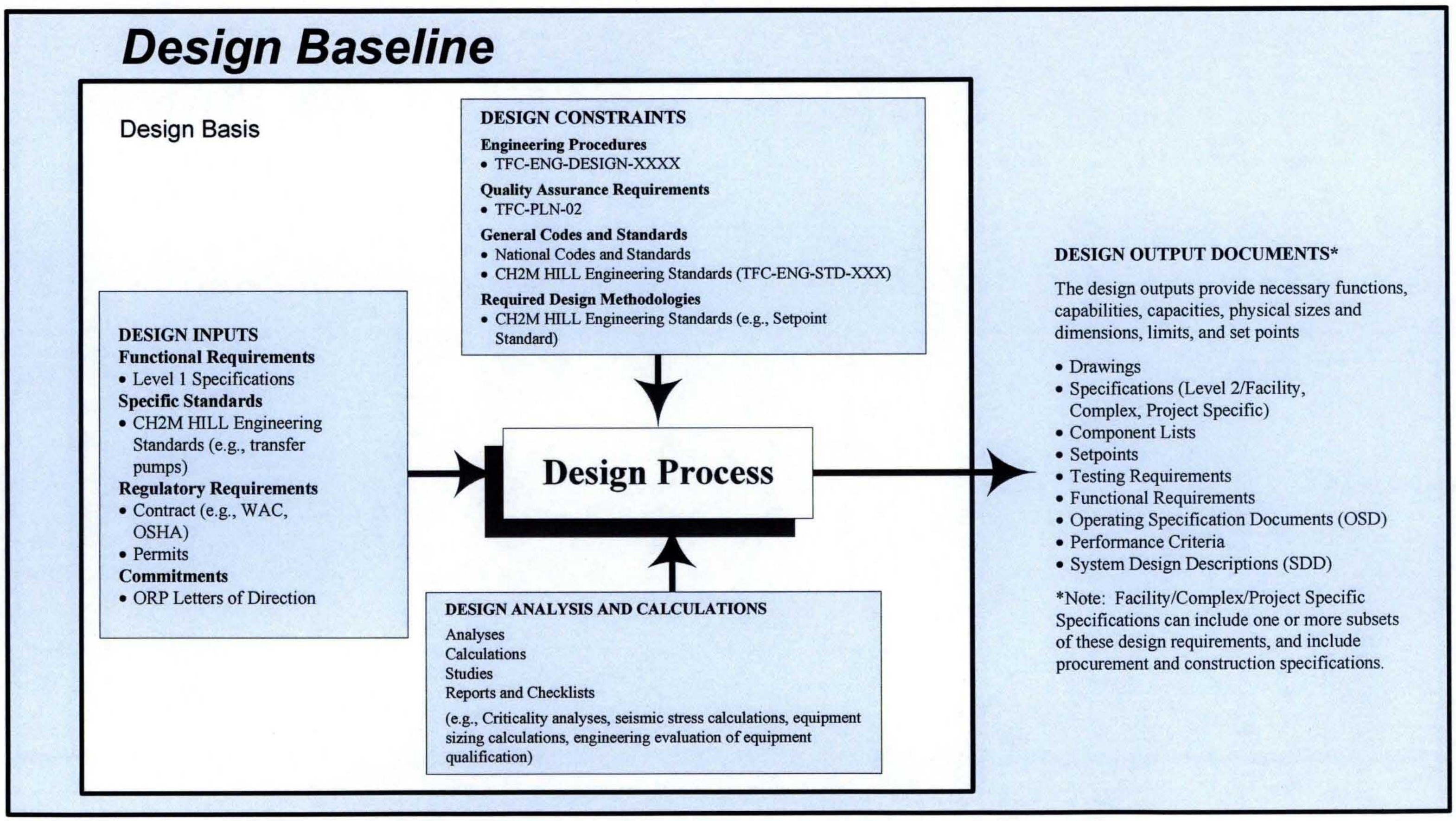

Figure A.5-1-- Elements of the Design Baseline

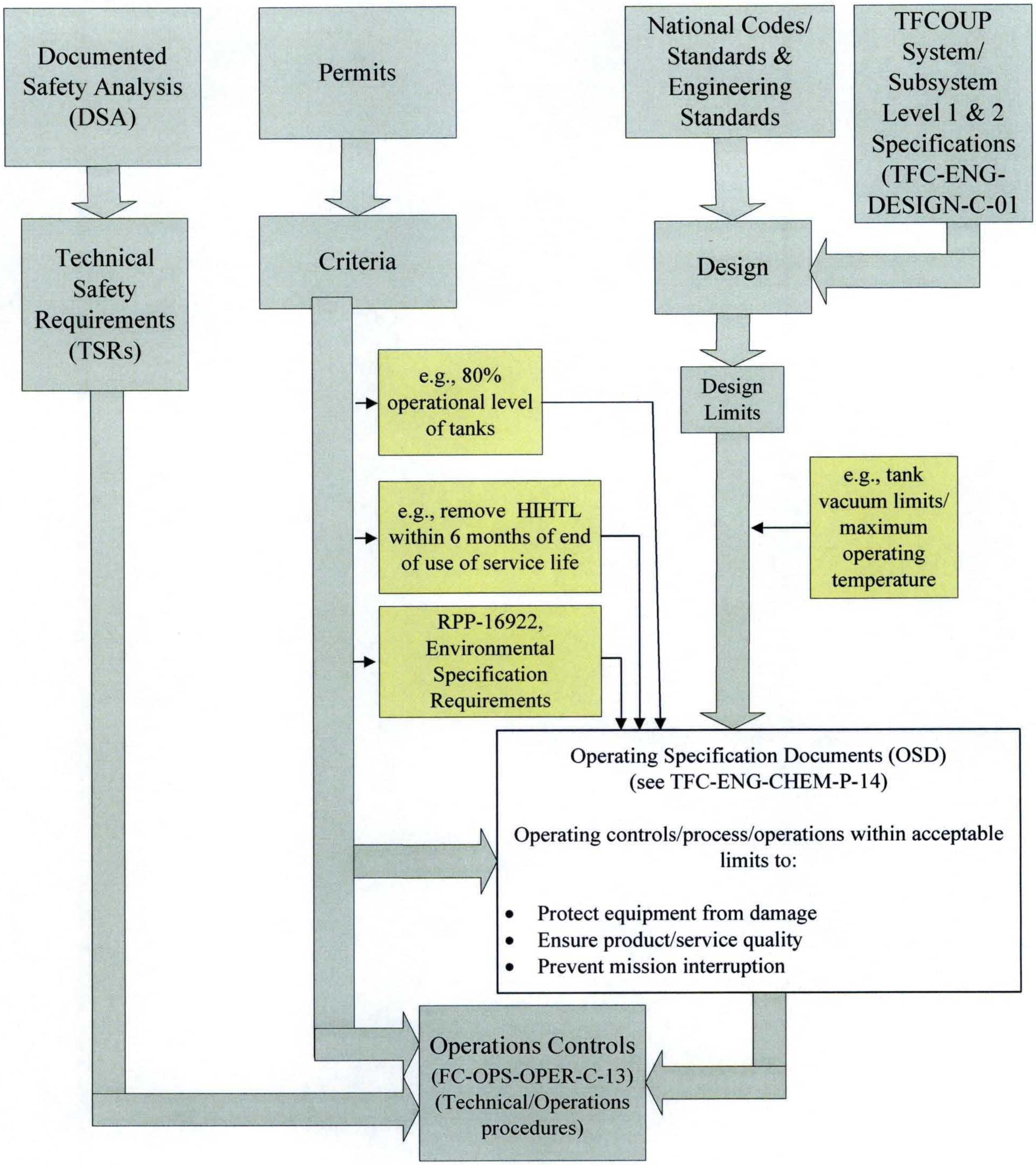

Figure A.5-2 – Hierarchy of Technical Requirements Documents requirements system, it did not provide detailed implementation procedures or guidance for use by engineers.

A.5.2.3 Risks of Inadequate Implementation.

The risks of inadequate implementation of a requirements management system are significant. The potential for proceeding with engineering designs, calculations, analyses, or other engineering activities with incomplete, outdated, or obsolete requirements could result in systems, structures, or components that fail to meet intended safety functions, performance requirements, and design constraints. Not only are the possibilities of cost increases, schedule delays and risk impacts magnified for projects, there can be serious safety and environmental consequences resulting from inadequate identification of requirements, failure to comply with requirements, and verification that the necessary and sufficient set of requirements has been used. The Assessors observed that these consequences in most cases have been mitigated by the expertise and experience level of current engineering staff. A number of recent events have been caused in part by inadequate management and implementation of engineering requirements, including the C-202 radiation contamination event, the S-102 waste leak, a TSR violation associated with the AZ-301 condensate pumping system, poor valve actuator designs discovered in the AW-B and other valve pits, incorrectly positioned breather filter valve actuators, and the inadvertent start of the 242-A Evaporator main recirculation pump.

A.5.2.4 Contractor Mitigation of Inadequacies and Risks.

The Chief Engineer has developed a *Draft Improvement Plan* that addresses the remainder of the weaknesses identified by the Assessors. In his plan, the Chief Engineer adapts the Integrated Safety Management core functions to engineering work. This concept was previously implemented by the TFC as part of the *Systems Engineering Management Plan for the Tank Farm Contractor* (TFC-PLN-06), canceled in April of 2007. The Chief Engineer is re-implementing these concepts as follows:

1. Identify Work

   - Identify/define engineering problem and review related lessons learned.

2. Identify Requirements

   - Identify, grade, tailor, analyze, and derive applicable Engineering requirements.
   - Identify interim Engineering requirements and assumptions needing refinement and/or validation as work progresses – include associated Engineering actions in the Baselines.

- Document bases for Engineering requirements (retained and discarded) and assumptions.
- Analyze Engineering requirements and assumptions for compatibility with other applicable requirements and assumptions – reconcile conflicts.

3. Develop and Maintain Controls

- Establish Engineering Program and Technical Baseline, and associated controls.
- Continuously update Engineering Program with new best-management practices, standards, and lessons learned.
- Control changes to the Technical Baseline, maintain its configuration, and verify its continuing integrity with system aging and other factors.
- Acquire/retain necessary Program and Function Engineering capabilities, organize and train them, and assign roles, responsibilities, and authorities.
- Provide Engineering input to Scope, Cost, Schedule, and Technical Baselines.
- Participate in IPT planning - include resulting Engineering actions in Baselines.
- Identify, analyze and prioritize Engineering risks and opportunities for improvement - include associated handling actions in Baselines.
- Develop technical interface management documents. Include associated Engineering actions in Baselines.
- Establish Engineering performance metrics.
- Prepare, contribute to, and approve execution plans designed to meet all requirements.

4. Perform Engineering and Control Functions

- Perform and manage design, technical analysis, and other Engineering work in conformance to the Scope, Schedule, Cost, and Technical Baselines.
- Support changes to the Scope, Cost, and Schedule Baseline – confirm changes are consistent with requirements and do not compromise necessary technical functions.
- Periodically review and verify compliance with Engineering requirements
- Refine, change, and/or validate Engineering requirements and assumptions – analyze cross-cutting impacts and verify acceptability of refinements and changes.

- Participate on IPTs, resolving technical issues, managing risks, and recommending opportunities for improvement.
- Prepare and implement corrective action plans for defective Engineering.

5. Assess Performance and Feedback Lessons Learned

- Perform, report internal, external, and independent engineering performance assessments.
- Input results to Tank Farm lessons-learned system
- Communicate lessons learned to potentially impacted Tank Farm staff.
- Verify and report completed work satisfies all requirements.

The Assessors concluded that implementation of the *Draft Improvement Plan* with these process steps incorporated will result in an engineering requirements management system that will resolve the weaknesses identified in the current *Engineering Program Management Plan.*

A.5.2.5 Residual Weaknesses.

The implementation of the proposed requirements management system is a complex and lengthy tasks. The Assessors are recommending that rigorous interim compensatory measures be implemented to assure necessary and sufficient requirements are identified, implemented, and verified in engineering activities during the time the requirements system is developed and implemented.

A.5.3 Further Opportunities for Improvement

As part of the assessment, the Assessors developed a list of attributes of an effective Requirements Management System and compared the existing program against those attributes. These attributes have been drawn from previous Systems Engineering experience of the Assessors and practices employed by DoD and NASA contractors.

The Assessors found that few of the attributes were fulfilled by the current *Engineering Management Program Plan.* This is not considered a formal assessment weakness, since these attributes are considered good practices and not requirements. The *Draft Improvement Plan* does an excellent job of incorporating many of the attributes. The attributes are included in this assessment report to assist the Contractor in the effective implementation of the *Draft Improvement Plan* by suggesting additional areas for evaluation and consideration.

The attributes developed by the Assessors are:

1. The Chief Engineer is responsible for: a) Establishing and maintaining current a set of Engineering Standards and other engineering requirements documents, b) integrating and

maintaining the configuration of all technical requirements and documents that constitute the Technical Requirements Baseline (i.e., the comprehensive set of technical requirements and documents that assure safe, available, and efficient operations and maintenance for the life cycle of the Tank Farm Facility); c) resolving conflicts and gaps in the Technical Requirements Baseline; and d) periodically assessing the effectiveness of requirements management within the Engineering Program.

2. Engineering requirements include both technical requirements and applicable related requirements important to engineering customers and affected entities.
3. Engineering requirements also include interim technical requirements and their underlying assumptions, interim technical requirements needing quantification, and the bases for all requirements and assumptions.
4. Engineering requirements (mandatory) are clearly distinguished from guidance (optional).
5. Engineering requirements are defined and documented for nearly all engineering work; a procedure defines conditions for working to undocumented requirements.
6. Engineering requirements are developed to the level of detail needed to ensure a) the design and safety functions are met by the designs; b) workers comprehend the requirements; and c) gaps and overlaps with the work of others, and misfits with interfacing systems, are prevented.
7. The developed requirements are traceable (in writing) from the source requirement to the product and service.
8. The engineer uses an established process(es), documented in a procedure(s), to generate a complete, accurate, graded, and balanced set of engineering requirements.
9. A designated authority (e.g., manager, IPT, DOE) approves the engineering requirements and usually documents the approval before the work is initiated; a procedure defines conditions for oral approval and post-approval documentation.
10. The engineer understands all applicable engineering requirements and assumptions before initiating work.
11. Those who flow engineering requirements to others, including subcontractors, are responsible for verifying the others understand the requirements before the work is initiated and after it is executed.
12. Upon request, the engineer performing engineering work immediately is able to provide his set of engineering requirements, assumptions, and their bases for the work being conducted.
13. The engineer resolves gaps and uncertainties in requirements and assumptions as engineering progresses, resulting in new final requirements that are timely approved by the designated authority.
14. The engineer is proactive in ensuring currency of the engineering requirements with changes that occur within related programs and systems.
15. The engineer is proactive in evaluating alternatives and recommending changes in approved requirements that would reduce cost while satisfying all other engineering requirements.
16. Both the engineer and his manager are held accountable for meeting all approved requirements; the engineering manager is responsible for periodically verifying the engineer's approach will meet all engineering requirements.

17. The engineer is responsible for maintaining the configuration of his requirements in accordance with approved procedures.
18. The engineer is responsible for notifying management when compliance with an approved requirement would violate another requirement or compromise safety, quality, operational availability or effectiveness, or other important performance measure.
19. Qualified engineers, with the support of appropriate Subject Matter Expert, review all completed engineering work to verify requirements have been met.
20. The engineer prepares a closure document for completed engineering work; the closure document contains a certification that all requirements have been met or identifies all exceptions and provides a justification for each exception.
21. Independent reviews of the selection and application of engineering requirements are conducted.

Appendix B

Draft
CH2M HILL Hanford Group, Inc.
Conduct of Engineering
Improvement Plan

December 2007

1. Background and Purpose

Based on performance issues uncovered as a result of the events of the S-102 Tank Retrieval incident and a special review of the engineering design process, CH2M HILL Hanford Group, Inc. (CH2M Hill) has implemented an Engineering Improvement Plan (EIP). This plan is aimed at enhancing Engineering excellence in the performance of technical tasks, and fixing Engineering program weaknesses as identified in the following documents:

- DOE Type A Accident Investigation Report, dtd 18 Sep 2007
- CH2M Hill Root Cause Analysis Report, dtd 17 Sep 2007
- EM-60 Review Report, dtd Aug 2007
- Engineering Design Program Review Report, dtd 9 Oct 2007
- DOE Conduct of Operations Letter, dtd 21 Nov 2007

This EIP is based on overall Company goals and intentions, and is intended to provide a platform for achieving engineering technical excellence, as part of the overall Company improvement initiatives in the Conduct of Operations.

2. Mission

CH2M Hill, under contract with the U.S. Department of Energy (DOE), Office of River Protection (ORP), is responsible for safely managing, retrieving and disposing of the high-level mixed radioactive wastes stored in tanks in the 200 Area of the Hanford Site. Specifically, CH2M Hill is charged to:

- Safely and efficiently retrieve, clean up, and close aging waste tanks
- Deliver waste feed to the WTP
- Receive and disposition treated waste from the WTP
- Provide analytical services and chemical consulting to the Hanford Site
- Implement environmentally responsible and cost effective supplemental waste treatment and processing techniques

Engineering is responsible for developing and maintaining a technically defensible, integrated, and cost effective engineering program and technical baseline, assuring all engineering designs and procedures are in accordance with applicable and sound engineering principles, to support the overall Tank Farm Contractor (TFC) mission.

3. Vision

To achieve Engineering excellence as part of becoming the best operating company in DOE.

4. Goals

Near Term – Improve engineering performance by correcting those areas of deficiencies noted in the documents listed in Section 1.

Long Term - Transition the department (and company) to an excellence in Conduct of Engineering (and Conduct of Operations) more rigorously based on a formal nuclear safety culture.

The remainder of this EIP provides specifics for achieving these goals, including actions designed or already underway for the near term goal, and processes, structures, products and the actions to establish a formal nuclear safety culture.

5. Action Plan

Problems identified with the Conduct of Engineering and Operations over the last several months encompass a broad spectrum of areas and require many varied actions to correct. Many of these actions are directly related to the leak of waste during the S-102 transfer operation, but there are other equally significant problem areas that came to light as a result of the careful scrutiny paid to engineering activities and processes in the succeeding months. The following list of issues summarizes the engineering problem areas that the near and long-term actions are designed to address.

- "Stove piped" Operations project teams
- Engineering alignment not balanced for effective Operations support
- Continuity of Engineering experience and expertise challenged
- Lack of complete formal documentation and independent review of engineering designs and technical decisions
- Process Control Plans not maintained current or effectively used
- HAZOP assessments need to improve in thoroughness and detail
- Management of Change (MOC) Process not geared for rapidly evolving situations
- Response to Off-Normal situations too informal or reactive
- Process Hazard Analysis not well integrated into the design process
- Safety Significant primary containment for waste transfers
- Design Authority function diluted

5.1. Near Term – Correcting deficiencies noted since July 2007.

Many actions have been taken to fix problems and improve the engineering program since July 2007, and many more are planned. (The complete action sets generated as a result of the S-102 event reports are documented, along with due dates and responsible personnel, in the Problem Evaluation Request (PER) system.)

Some of the key corrective actions completed, underway or planned include:

- An independent review of the Engineering Design Program was completed.
- A procedure has been written and a team (Waste Transfer Confinement Review Board) has been chartered to support formal and independent TFC waste leak path evaluation.
- No SST retrieval operations can proceed without a new detailed and formal process hazards analysis.

- Process Hazards Analysis training has been conducted, and additional enhanced training is planned for the near term.
- A Management Assessment of the Process Control Plans (PCPs) was completed, and all PCPs were cancelled pending improvements.
- Design review procedures have been revised to document all comments and resolution.
- Revise PCP procedure, TFC-ENG-CHEM-C-11 to require an independent, senior process engineer review of PCPs and changes to the PCP. (Dec 07)
- Develop process hazards analysis (PHA) procedures and processes to ensure identification of all hazards, and appropriate controls for TSR level hazards and higher frequency, lower consequence hazards. (Jan 08)
- Establish and implement an engineering Management of Change process consistent with 29 CFR 1910.119. (Jan 08)
- Develop a graded approach and process that maintains formality in responding to upset conditions and off-normal events associated with any waste disturbing or transfer activity. (Jan 08)
- Update the Engineering Program Management Plan (Feb 08)
- Establish an engineering process for the conduct of PHA for new waste retrieval and processing activities. Integrate the PHA process (owned by engineering) with the design, nuclear safety, process control, and management of change processes. (Jan 08)
- Develop ways to utilize local retirees to aid in technical/design reviews and mentor new engineers. (Feb 08)
- Evaluate the Engineering organizational structure and personnel availability/distribution to maximize independence and experience in design reviews and project support. Modify the organizational structure as necessary. (Feb 08)
- Strengthen the Design Authority function. (Mar 08)
- Initiate a New Engineer Program. (Mar 08)
- Conduct a gap analysis of the current roles and responsibilities for the design authority function. (Mar 08)
- Ensure that performance goals for engineering personnel, related to completeness of reviews, technical rigor, and adherence to requirements are a significant part portion of the evaluation. This includes having the Chief Engineer provide significant input into the performance appraisals for all engineering directors resident in projects/operations. (Mar 08)
- Development of a comprehensive engineer recruitment, training and retention program. (Jul 08)
- Evaluate recommendations and implement corrective actions of independent review of engineering design program. (Jul 08)

5.2. Long Term – Conduct of Engineering (COE) Program that Drives a Formal Nuclear Safety Culture.

A successful engineering program must enhance and reinforce performance factors, while establishing key elements necessary to achieve excellence in the design process, implementation of modifications, and engineering support of operations. It must also provide for the systematic and graded support of engineering design activities, work control systems, engineering performance assessments, and engineering training. The formalization of this approach is a Conduct of Engineering (COE) Program. The components of this COE program are the process/structure, tools, products and measurable success factors. The desired result is a nuclear safety culture of technical expertise that drives excellence in design and operations support.

5.2.1. Process/Structure

Since changing an established culture is a long and detailed process, the best first step is to align it with something already established and familiar. CH2M Hill has a superb safety culture based on company wide knowledge of and adherence to the principles of the Integrated Safety Management System (ISMS). The five Core Functions of ISMS and seven Guiding Principles, provide an appropriate structure for a COE process. This new COE process will include activities that will be mapped against the following five ISMS-based core functions:

1. Identify Work
    - Identify and clearly define the engineering problem, the exact engineering scope, and review related lessons learned.

2. Identify Requirements
    - Identify, grade, tailor, analyze, and derive applicable Engineering requirements.
    - Identify interim Engineering requirements and assumptions needing refinement and/or validation as work progresses – include associated Engineering actions in the Baselines.
    - Document bases for Engineering requirements (retained and discarded) and assumptions.
    - Analyze Engineering requirements and assumptions for compatibility with other applicable requirements and assumptions – reconcile conflicts.

3. Develop and Maintain Controls
    - Establish Engineering Program and Technical Baseline, and associated controls.
    - Continuously update Engineering Program with new best-management practices, standards, and lessons learned.
    - Control changes to the Technical Baseline, maintain its configuration, and verify its continuing integrity with system aging and other factors.

- Acquire/retain necessary Program and Function Engineering capabilities, organize and train them, and assign roles, responsibilities, and authorities.
- Provide Engineering input to Scope, Cost, Schedule, and Technical Baselines.
- Participate in IPT planning - include resulting Engineering actions in Baselines.
- Identify/analyze/prioritize Engineering risks and opportunities for improvement - include associated handling actions in Baselines.
- Develop technical interface management documents - include associated Engineering actions in Baselines.
- Establish Engineering performance metrics.
- Prepare/contribute to/approve execution plans designed to meet all requirements.

4. Perform Engineering and Control Functions
    - Perform and manage design, technical analysis, and other Engineering work in conformance to the Scope, Schedule, Cost, and Technical Baselines.
    - Support changes to the Scope, Cost, and Schedule Baseline – confirm changes are consistent with requirements and do not compromise necessary technical functions.
    - Periodically review and verify compliance with Engineering requirements
    - Refine, change, and/or validate Engineering requirements and assumptions – analyze cross-cutting impacts and verify acceptability of refinements/changes.
    - Participate on IPTs, resolving technical issues, managing risks, and recommending opportunities for improvement.
    - Prepare/implement corrective action plans for defective Engineering.

5. Assess Performance and Feedback Lessons Learned
    - Perform/report internal/external/independent engineering performance assessments
    - Input results to TF lessons-learned system
    - Communicate lessons learned to potentially impacted TF staff.
    - Verify/report completed work satisfies all requirements

5.2.2. Tools and Product

Key to achieving success in this engineering program is the proper use of available tools. Fundamentally our tools include personnel and supporting documents and systems. But we must be judicious in the proper acquisition, use and maintenance of these tools. For personnel, this includes the following as a minimum:

- Trained and Qualified Staff
- Appropriate Staffing Levels
- Efficient Organization

- Continuing Program for Training/Certification
- Clear Roles, Responsibilities, and Authorities

For supporting documents and systems, the following must be properly utilized:

- Work Plans and Procedures
- Issues/Risk Management Systems
- Lessons Learned/Best Practices Systems
- Interface Management Documents
- Applicable Requirements, Standards, and Assumptions
- Technical Baseline Documents and Supporting Bases
- Scope/Schedule/Cost Baselines
- Records/Configuration Management Systems
- Hardware/Software

Incorporating this culture and employing this process will allow us to dramatically improve our overall performance and produce a result in a more efficient, safer and more prosperous manner. This level of performance and ethic should be apparent in every document and service, including:

- Designs and Drawings
- Analyses, Calculations, Estimates and Specifications
- Reviews and Assessments
- Technical Plans and Procedures
- Closeout Documentation

5.2.3. Success Factors

In consonance with INPO documents,[1] there are seven Engineering organization success factors necessary to ensure an engineering environment that promotes a healthy respect for the unique technology and opportunities represented at a nuclear facility such as Hanford Tank Farms, and to promote great care and thoughtful decision making by the engineers. CH2M Hill will endeavor to build a nuclear safety culture based on these seven success factors as expanded below.

1. Expectations, Roles, Responsibilities and Authorities
    a. Establish, communicate and reinforce high expectations and standards of performance, and hold personnel accountable for implementing these standards.
    b. Clear organizational lines of responsibilities
    c. Well defined relationships and cooperation between engineering groups, and other interfacing groups
    d. Low tolerance for, and quick response to equipment problems and degradation. Fixes aimed at correction of causes, not symptoms. Maintain

[1] INPO 05-006, *Engineering Success Factors*, December 2005, and INPO 90-009, *Guidelines for the Conduct of Design Engineering*, September 2004.

design safety margins rather than justify long-term operation with deficient equipment.

e. Robust direction and monitoring of engineering activities to ensure the right work is being accomplished.
f. Integration of engineering work with site priorities, balanced between resolving immediate technical problems, system monitoring, corrective action and maintenance.
g. Authorities and thresholds defined for critical decision making, grading, and standards selection.

2. Technical Conscience
    a. Engineering managers are the technical conscience of Tanks Farms, and ensure a high degree of precision, accuracy, completeness, and continuous improvement.
    b. Technical independence is established and maintained, no matter the organizational structure.
    c. Engineering ownership of the design basis and safety basis, by rigorously controlling all changes, and evaluating non-conforming conditions, or uncertain conditions due to aging, damage or process change.
    d. Engineering leadership models and reinforces the value on differing opinions and encourages critical thinking.
    e. Engineering provides operations and maintenance with clear direction with respect to design and Tank Farm operations.
    f. Engineering errors are not tolerated. If errors occur, the causes are rigorously determined, including organizational problems.
    g. A passion for superior engineering work is promoted, and worst-case outcomes are identified and understood.
    h. Engineering supports Tank farm operations by providing timely, high-quality service, and where possible anticipate when and where their services will be needed; rather than waiting to be asked for help.

3. Configuration Management
    a. The design authority is clearly defined and understood, and engineers are knowledgeable of industry codes and standards, and safety and regulatory requirements.
    b. Engineering accepts the responsibility for ownership, control, and understanding of the design bases and margins to ensure safety and efficiency.
    c. Design basis and performance information is maintained current and accessible.
    d. Engineers are expected to either find the necessary design inputs or to reconstruct the design bases.
    e. Designs are changed with great care and attention to detail. Inputs from other cognizant or affected organizations are solicited.
    f. Safety and mission critical SSCs are identified and configuration controlled.

4. Learning Environment
    a. Engineering leaders value and create a balanced learning environment that rewards critical thinking and fosters innovation.
    b. Critical thinking is valued and treated as both a behavior and process, and management encourages engineers to seek help and share causes for mistakes.
    c. Self-assessments are critical, to compare actual performance to established targets and expectations, as well as to other high-performing organizations, standards of excellence, and regulatory requirements.
    d. Operating experience and lessons learned are used to avoid equipment failures, design and modification errors.
    e. Engineers learn from designs, changes and modifications from other engineering groups, other sites and industry working groups.
    f. Engineers actively seek improvement opportunities, and initiate corrective action process actions as necessary.

5. Personnel Development and Staffing
    a. Engineering leaders value, recruit and develop technically competent staff.
    b. Engineering leaders compile the necessary and sufficient set of technical skills required to support Tank Farm operations, and to competently review and control engineering work out-sourced to external engineering firms.
    c. Engineering leaders guard against the erosion of technical competencies by monitoring staffing levels, expected losses to retirement, and overall expertise. Future needs are included in staff and program planning.
    d. Engineers demonstrate extensive knowledge of assigned systems or components.
    e. Engineers' expertise is broadly developed among the design bases, codes, and standards necessary to maintain Tank Farms safe, compliant, and operational.
    f. An engineering career path is available and recognized by the engineering population, and that supports development of highly experienced and qualified staff.
    g. An environment is created that indoctrinates new hires and encourages high retention rates for those that show promise.
    h. A hiring strategy is developed that considers continual hiring of engineers as resources permit.
    i. Engineers are mentored by experienced engineers to broaden individual and organizational capabilities; along with a technical development program.
    j. Engineering leaders establish technical performance criteria for engineer evaluations.

6. Communications
    a. Engineering actively communicates and engages others on emerging issues, including communication across organizational lines.
    b. Engineering management practices encourage communication and collaboration among groups that operate, maintain or support Tank Farms.
    c. Engineering priority items receive high management visibility, and resources for their support; while at the same time balancing necessary routine engineering resources for standard tasks and configuration management work.
    d. Communication practices encourage engineers to view themselves as part of the overall team, with safe and successful Tank farm operations being the goal.
    e. Engineering requests a wide range of feedback, inputs and reviews from all elements of the Tank Farm organization (e.g., operations, maintenance), and cognizant oversight organizations.
    f. Diverse and critical opinions are valued, and high standards of critical thinking are demanded for all technical reviews.

7. Engineering and Project Management
    a. Project management fundamentals provide a structure for work on engineering tasks; with discrete schedule, scope and budget.
    b. A disciplined and structured approach to engineering tasks that identifies requirements and specifications, plans the work and defines the scope, avoids rework, and minimizes unmet assumptions and omissions.
    c. Successful engineering projects will have well thought out problem statements, so resources are properly focused.
    d. Project goals and responsibilities are clearly communicated to all personnel that have a stake in the outcome.
    e. Training and change management plans are developed to ensure site understanding of the project scope and objectives.
    f. Clear project roles and responsibilities reflect ownership and accountability for project team members.
    g. Cost estimates include all assumptions, and are looked at cross-functionally.
    h. A resource-loaded schedule is developed to establish confidence that appropriate resources are being applied, or to accurately judge the effects of emergent changes in priorities.
    i. Oversight and assessment techniques are applied throughout the duration of a project, to ensure we meet requirements, and remain on track to meet deliverables and expectations.
    j. Multidisciplinary Integrated Project Teams are used routinely, commensurate with complexity, priority and risk.

5.2.4. Nuclear Safety Culture

Ultimately, the goal of these actions and changes in process, is to foster a nuclear safety culture commensurate with the "OSHA-focused" safety culture already in place at CH2M Hill. Although workplace safety is extremely important, a comprehensive safety culture in a nuclear facility needs to go beyond that. Essentially, nuclear safety is about protecting:

- The nuclear material
- The site and facilities
- The worker
- The public
- The environment

To paraphrase Dr. Jonathan Wert, President of Management Diagnostics, Inc., this culture should represent a work environment where a nuclear safety ethic permeates the organization and people's behavior focuses on accident and incident prevention through critical self-assessment, pro-active identification of management and technical problems, and appropriate, timely and effective resolution of problems before they become crises.

Through this process and structure, we are looking to build a program characterized by:

- Centralized technical control
- Personal responsibility for technical, safety, radcon and environmental issues
- In-depth technical understanding of all aspects of the work at all levels
- Prompt reporting, evaluation and correction of problems
- Emphasis on close, frequent, technical oversight
- Rigorous continuing training at all levels
- Conservative designs with ample safety margins
- Rigorous quality assurance
- Formality, discipline and precision
- Skepticism, frankness, self-criticism, integrity and attention to detail

This is the desired end result, and it will likely take several years to achieve. However, it is the only result that supports our vision.

6. Conclusion

Our general approach will be to prevent the big problems by focusing on the small ones. And to avoid problems, big and small, we must first determine the technically correct answer. After that we can evaluate cost and schedule implications of pursuing this path.

This needs to be our standard way of doing business – an enduring, deep, fundamental core value, not a short term program or add-on. Accomplishing this will not only ensure our success in the safe and efficient retrieval of tank waste at Hanford, but it will make us the company of choice throughout the industry for nuclear related work.

Appendix B

Draft
CH2M HILL Hanford Group, Inc.
Conduct of Engineering
Improvement Plan

December 2007

1. Background and Purpose

Based on performance issues uncovered as a result of the events of the S-102 Tank Retrieval incident and a special review of the engineering design process, CH2M HILL Hanford Group, Inc. (CH2M Hill) has implemented an Engineering Improvement Plan (EIP). This plan is aimed at enhancing Engineering excellence in the performance of technical tasks, and fixing Engineering program weaknesses as identified in the following documents:

- DOE Type A Accident Investigation Report, dtd 18 Sep 2007
- CH2M Hill Root Cause Analysis Report, dtd 17 Sep 2007
- EM-60 Review Report, dtd Aug 2007
- Engineering Design Program Review Report, dtd 9 Oct 2007
- DOE Conduct of Operations Letter, dtd 21 Nov 2007

This EIP is based on overall Company goals and intentions, and is intended to provide a platform for achieving engineering technical excellence, as part of the overall Company improvement initiatives in the Conduct of Operations.

2. Mission

CH2M Hill, under contract with the U.S. Department of Energy (DOE), Office of River Protection (ORP), is responsible for safely managing, retrieving and disposing of the high-level mixed radioactive wastes stored in tanks in the 200 Area of the Hanford Site. Specifically, CH2M Hill is charged to:

- Safely and efficiently retrieve, clean up, and close aging waste tanks
- Deliver waste feed to the WTP
- Receive and disposition treated waste from the WTP
- Provide analytical services and chemical consulting to the Hanford Site
- Implement environmentally responsible and cost effective supplemental waste treatment and processing techniques

Engineering is responsible for developing and maintaining a technically defensible, integrated, and cost effective engineering program and technical baseline, assuring all engineering designs and procedures are in accordance with applicable and sound engineering principles, to support the overall Tank Farm Contractor (TFC) mission.

3. Vision

To achieve Engineering excellence as part of becoming the best operating company in DOE.

4. Goals

Near Term – Improve engineering performance by correcting those areas of deficiencies noted in the documents listed in Section 1.

Long Term - Transition the department (and company) to an excellence in Conduct of Engineering (and Conduct of Operations) more rigorously based on a formal nuclear safety culture.

The remainder of this EIP provides specifics for achieving these goals, including actions designed or already underway for the near term goal, and processes, structures, products and the actions to establish a formal nuclear safety culture.

5. Action Plan

Problems identified with the Conduct of Engineering and Operations over the last several months encompass a broad spectrum of areas and require many varied actions to correct. Many of these actions are directly related to the leak of waste during the S-102 transfer operation, but there are other equally significant problem areas that came to light as a result of the careful scrutiny paid to engineering activities and processes in the succeeding months. The following list of issues summarizes the engineering problem areas that the near and long-term actions are designed to address.

- "Stove piped" Operations project teams
- Engineering alignment not balanced for effective Operations support
- Continuity of Engineering experience and expertise challenged
- Lack of complete formal documentation and independent review of engineering designs and technical decisions
- Process Control Plans not maintained current or effectively used
- HAZOP assessments need to improve in thoroughness and detail
- Management of Change (MOC) Process not geared for rapidly evolving situations
- Response to Off-Normal situations too informal or reactive
- Process Hazard Analysis not well integrated into the design process
- Safety Significant primary containment for waste transfers
- Design Authority function diluted

5.1. Near Term – Correcting deficiencies noted since July 2007.

Many actions have been taken to fix problems and improve the engineering program since July 2007, and many more are planned. (The complete action sets generated as a result of the S-102 event reports are documented, along with due dates and responsible personnel, in the Problem Evaluation Request (PER) system.)

Some of the key corrective actions completed, underway or planned include:

- An independent review of the Engineering Design Program was completed.
- A procedure has been written and a team (Waste Transfer Confinement Review Board) has been chartered to support formal and independent TFC waste leak path evaluation.
- No SST retrieval operations can proceed without a new detailed and formal process hazards analysis.

- Process Hazards Analysis training has been conducted, and additional enhanced training is planned for the near term.
- A Management Assessment of the Process Control Plans (PCPs) was completed, and all PCPs were cancelled pending improvements.
- Design review procedures have been revised to document all comments and resolution.
- Revise PCP procedure, TFC-ENG-CHEM-C-11 to require an independent, senior process engineer review of PCPs and changes to the PCP. (Dec 07)
- Develop process hazards analysis (PHA) procedures and processes to ensure identification of all hazards, and appropriate controls for TSR level hazards and higher frequency, lower consequence hazards. (Jan 08)
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- Develop ways to utilize local retirees to aid in technical/design reviews and mentor new engineers. (Feb 08)
- Evaluate the Engineering organizational structure and personnel availability/distribution to maximize independence and experience in design reviews and project support. Modify the organizational structure as necessary. (Feb 08)
- Strengthen the Design Authority function. (Mar 08)
- Initiate a New Engineer Program. (Mar 08)
- Conduct a gap analysis of the current roles and responsibilities for the design authority function. (Mar 08)
- Ensure that performance goals for engineering personnel, related to completeness of reviews, technical rigor, and adherence to requirements are a significant part portion of the evaluation. This includes having the Chief Engineer provide significant input into the performance appraisals for all engineering directors resident in projects/operations. (Mar 08)
- Development of a comprehensive engineer recruitment, training and retention program. (Jul 08)
- Evaluate recommendations and implement corrective actions of independent review of engineering design program. (Jul 08)

5.2. Long Term – Conduct of Engineering (COE) Program that Drives a Formal Nuclear Safety Culture.

A successful engineering program must enhance and reinforce performance factors, while establishing key elements necessary to achieve excellence in the design process, implementation of modifications, and engineering support of operations. It must also provide for the systematic and graded support of engineering design activities, work control systems, engineering performance assessments, and engineering training. The formalization of this approach is a Conduct of Engineering (COE) Program. The components of this COE program are the process/structure, tools, products and measurable success factors. The desired result is a nuclear safety culture of technical expertise that drives excellence in design and operations support.

5.2.1. Process/Structure

Since changing an established culture is a long and detailed process, the best first step is to align it with something already established and familiar. CH2M Hill has a superb safety culture based on company wide knowledge of and adherence to the principles of the Integrated Safety Management System (ISMS). The five Core Functions of ISMS and seven Guiding Principles, provide an appropriate structure for a COE process. This new COE process will include activities that will be mapped against the following five ISMS-based core functions:

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   - Identify and clearly define the engineering problem, the exact engineering scope, and review related lessons learned.

2. Identify Requirements
   - Identify, grade, tailor, analyze, and derive applicable Engineering requirements.
   - Identify interim Engineering requirements and assumptions needing refinement and/or validation as work progresses – include associated Engineering actions in the Baselines.
   - Document bases for Engineering requirements (retained and discarded) and assumptions.
   - Analyze Engineering requirements and assumptions for compatibility with other applicable requirements and assumptions – reconcile conflicts.

3. Develop and Maintain Controls
   - Establish Engineering Program and Technical Baseline, and associated controls.
   - Continuously update Engineering Program with new best-management practices, standards, and lessons learned.
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- Provide Engineering input to Scope, Cost, Schedule, and Technical Baselines.
- Participate in IPT planning - include resulting Engineering actions in Baselines.
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- Develop technical interface management documents - include associated Engineering actions in Baselines.
- Establish Engineering performance metrics.
- Prepare/contribute to/approve execution plans designed to meet all requirements.

4. Perform Engineering and Control Functions
    - Perform and manage design, technical analysis, and other Engineering work in conformance to the Scope, Schedule, Cost, and Technical Baselines.
    - Support changes to the Scope, Cost, and Schedule Baseline – confirm changes are consistent with requirements and do not compromise necessary technical functions.
    - Periodically review and verify compliance with Engineering requirements
    - Refine, change, and/or validate Engineering requirements and assumptions – analyze cross-cutting impacts and verify acceptability of refinements/changes.
    - Participate on IPTs, resolving technical issues, managing risks, and recommending opportunities for improvement.
    - Prepare/implement corrective action plans for defective Engineering.

5. Assess Performance and Feedback Lessons Learned
    - Perform/report internal/external/independent engineering performance assessments
    - Input results to TF lessons-learned system
    - Communicate lessons learned to potentially impacted TF staff.
    - Verify/report completed work satisfies all requirements

5.2.2. Tools and Product

Key to achieving success in this engineering program is the proper use of available tools. Fundamentally our tools include personnel and supporting documents and systems. But we must be judicious in the proper acquisition, use and maintenance of these tools. For personnel, this includes the following as a minimum:

- Trained and Qualified Staff
- Appropriate Staffing Levels
- Efficient Organization

- Continuing Program for Training/Certification
- Clear Roles, Responsibilities, and Authorities

For supporting documents and systems, the following must be properly utilized:

- Work Plans and Procedures
- Issues/Risk Management Systems
- Lessons Learned/Best Practices Systems
- Interface Management Documents
- Applicable Requirements, Standards, and Assumptions
- Technical Baseline Documents and Supporting Bases
- Scope/Schedule/Cost Baselines
- Records/Configuration Management Systems
- Hardware/Software

Incorporating this culture and employing this process will allow us to dramatically improve our overall performance and produce a result in a more efficient, safer and more prosperous manner. This level of performance and ethic should be apparent in every document and service, including:

- Designs and Drawings
- Analyses, Calculations, Estimates and Specifications
- Reviews and Assessments
- Technical Plans and Procedures
- Closeout Documentation

5.2.3. Success Factors

In consonance with INPO documents,[1] there are seven Engineering organization success factors necessary to ensure an engineering environment that promotes a healthy respect for the unique technology and opportunities represented at a nuclear facility such as Hanford Tank Farms, and to promote great care and thoughtful decision making by the engineers. CH2M Hill will endeavor to build a nuclear safety culture based on these seven success factors as expanded below.

1. Expectations, Roles, Responsibilities and Authorities
   a. Establish, communicate and reinforce high expectations and standards of performance, and hold personnel accountable for implementing these standards.
   b. Clear organizational lines of responsibilities
   c. Well defined relationships and cooperation between engineering groups, and other interfacing groups
   d. Low tolerance for, and quick response to equipment problems and degradation. Fixes aimed at correction of causes, not symptoms. Maintain

[1] INPO 05-006, *Engineering Success Factors*, December 2005, and INPO 90-009, *Guidelines for the Conduct of Design Engineering*, September 2004.

design safety margins rather than justify long-term operation with deficient equipment.

e. Robust direction and monitoring of engineering activities to ensure the right work is being accomplished.
f. Integration of engineering work with site priorities, balanced between resolving immediate technical problems, system monitoring, corrective action and maintenance.
g. Authorities and thresholds defined for critical decision making, grading, and standards selection.

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   b. Technical independence is established and maintained, no matter the organizational structure.
   c. Engineering ownership of the design basis and safety basis, by rigorously controlling all changes, and evaluating non-conforming conditions, or uncertain conditions due to aging, damage or process change.
   d. Engineering leadership models and reinforces the value on differing opinions and encourages critical thinking.
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   f. Engineering errors are not tolerated. If errors occur, the causes are rigorously determined, including organizational problems.
   g. A passion for superior engineering work is promoted, and worst-case outcomes are identified and understood.
   h. Engineering supports Tank farm operations by providing timely, high-quality service, and where possible anticipate when and where their services will be needed; rather than waiting to be asked for help.

3. Configuration Management
   a. The design authority is clearly defined and understood, and engineers are knowledgeable of industry codes and standards, and safety and regulatory requirements.
   b. Engineering accepts the responsibility for ownership, control, and understanding of the design bases and margins to ensure safety and efficiency.
   c. Design basis and performance information is maintained current and accessible.
   d. Engineers are expected to either find the necessary design inputs or to reconstruct the design bases.
   e. Designs are changed with great care and attention to detail. Inputs from other cognizant or affected organizations are solicited.
   f. Safety and mission critical SSCs are identified and configuration controlled.

4. Learning Environment
    a. Engineering leaders value and create a balanced learning environment that rewards critical thinking and fosters innovation.
    b. Critical thinking is valued and treated as both a behavior and process, and management encourages engineers to seek help and share causes for mistakes.
    c. Self-assessments are critical, to compare actual performance to established targets and expectations, as well as to other high-performing organizations, standards of excellence, and regulatory requirements.
    d. Operating experience and lessons learned are used to avoid equipment failures, design and modification errors.
    e. Engineers learn from designs, changes and modifications from other engineering groups, other sites and industry working groups.
    f. Engineers actively seek improvement opportunities, and initiate corrective action process actions as necessary.

5. Personnel Development and Staffing
    a. Engineering leaders value, recruit and develop technically competent staff.
    b. Engineering leaders compile the necessary and sufficient set of technical skills required to support Tank Farm operations, and to competently review and control engineering work out-sourced to external engineering firms.
    c. Engineering leaders guard against the erosion of technical competencies by monitoring staffing levels, expected losses to retirement, and overall expertise. Future needs are included in staff and program planning.
    d. Engineers demonstrate extensive knowledge of assigned systems or components.
    e. Engineers' expertise is broadly developed among the design bases, codes, and standards necessary to maintain Tank Farms safe, compliant, and operational.
    f. An engineering career path is available and recognized by the engineering population, and that supports development of highly experienced and qualified staff.
    g. An environment is created that indoctrinates new hires and encourages high retention rates for those that show promise.
    h. A hiring strategy is developed that considers continual hiring of engineers as resources permit.
    i. Engineers are mentored by experienced engineers to broaden individual and organizational capabilities; along with a technical development program.
    j. Engineering leaders establish technical performance criteria for engineer evaluations.

6. Communications
    a. Engineering actively communicates and engages others on emerging issues, including communication across organizational lines.
    b. Engineering management practices encourage communication and collaboration among groups that operate, maintain or support Tank Farms.
    c. Engineering priority items receive high management visibility, and resources for their support; while at the same time balancing necessary routine engineering resources for standard tasks and configuration management work.
    d. Communication practices encourage engineers to view themselves as part of the overall team, with safe and successful Tank farm operations being the goal.
    e. Engineering requests a wide range of feedback, inputs and reviews from all elements of the Tank Farm organization (e.g., operations, maintenance), and cognizant oversight organizations.
    f. Diverse and critical opinions are valued, and high standards of critical thinking are demanded for all technical reviews.

7. Engineering and Project Management
    a. Project management fundamentals provide a structure for work on engineering tasks; with discrete schedule, scope and budget.
    b. A disciplined and structured approach to engineering tasks that identifies requirements and specifications, plans the work and defines the scope, avoids rework, and minimizes unmet assumptions and omissions.
    c. Successful engineering projects will have well thought out problem statements, so resources are properly focused.
    d. Project goals and responsibilities are clearly communicated to all personnel that have a stake in the outcome.
    e. Training and change management plans are developed to ensure site understanding of the project scope and objectives.
    f. Clear project roles and responsibilities reflect ownership and accountability for project team members.
    g. Cost estimates include all assumptions, and are looked at cross-functionally.
    h. A resource-loaded schedule is developed to establish confidence that appropriate resources are being applied, or to accurately judge the effects of emergent changes in priorities.
    i. Oversight and assessment techniques are applied throughout the duration of a project, to ensure we meet requirements, and remain on track to meet deliverables and expectations.
    j. Multidisciplinary Integrated Project Teams are used routinely, commensurate with complexity, priority and risk.

5.2.4. Nuclear Safety Culture

Ultimately, the goal of these actions and changes in process, is to foster a nuclear safety culture commensurate with the "OSHA-focused" safety culture already in place at CH2M Hill. Although workplace safety is extremely important, a comprehensive safety culture in a nuclear facility needs to go beyond that. Essentially, nuclear safety is about protecting:

- The nuclear material
- The site and facilities
- The worker
- The public
- The environment

To paraphrase Dr. Jonathan Wert, President of Management Diagnostics, Inc., this culture should represent a work environment where a nuclear safety ethic permeates the organization and people's behavior focuses on accident and incident prevention through critical self-assessment, pro-active identification of management and technical problems, and appropriate, timely and effective resolution of problems before they become crises.

Through this process and structure, we are looking to build a program characterized by:

- Centralized technical control
- Personal responsibility for technical, safety, radcon and environmental issues
- In-depth technical understanding of all aspects of the work at all levels
- Prompt reporting, evaluation and correction of problems
- Emphasis on close, frequent, technical oversight
- Rigorous continuing training at all levels
- Conservative designs with ample safety margins
- Rigorous quality assurance
- Formality, discipline and precision
- Skepticism, frankness, self-criticism, integrity and attention to detail

This is the desired end result, and it will likely take several years to achieve. However, it is the only result that supports our vision.

6. Conclusion

Our general approach will be to prevent the big problems by focusing on the small ones. And to avoid problems, big and small, we must first determine the technically correct answer. After that we can evaluate cost and schedule implications of pursuing this path.

This needs to be our standard way of doing business – an enduring, deep, fundamental core value, not a short term program or add-on. Accomplishing this will not only ensure our success in the safe and efficient retrieval of tank waste at Hanford, but it will make us the company of choice throughout the industry for nuclear related work.