The Waste Treatment Plant External Flowsheet Review (a.k.a. the "Best and Brightest" Review)

Dr. W.L. Tamosaitis, P.E.
Washington Group International
2435 Stevens Center Place MS6-P1
Richland, WA 99354, USA

R.A. Gilbert
U.S. Department of Energy
Office of River Protection
P.O. Box 450 MSIN H6-60
Richland, WA 99354, USA

K.D. Gerdes
U.S. Department of Energy
Forrestal Building
Washington, D.C., USA

ABSTRACT

With the increasing cost the Hanford Waste Treatment Plant (WTP) Project (hereafter referred to as the Project) and the schedule extending, Department of Energy (DOE) Secretary Samuel Bodman and his staff requested an intensive, independent review of the technical soundness of the WTP flowsheet and a similar review of the Project's estimate at completion (EAC). This input was needed to prepare for the Congressional budgetary reviews to be held in the spring of 2006. A review team consisting of over 50 technical experts was convened to conduct the flowsheet review. This review intensely and openly explored all aspects of the flowsheet for one of the largest projects in the Nation with an estimated cost of about $12B and taking over a decade to go from ground breaking to operation. The review identified 28 issues that needed to be addressed including specific technical issues, systemic issues, and management (contractor and DOE) issues. This intense review was completed on schedule and served as a template for following reviews. This paper describes the planning, approach, and lessons learned from this first-of-a-kind review.

BACKGROUND

The need to treat and stabilize the 53M gallons of legacy waste from the cold war era in Hanford's aging underground tanks is well known. Several attempts have been made to remove and immobilize the waste. One of the first projects for the planned treatment of the Hanford tank waste contained in the 28 double-shell tanks was the Hanford Waste Vitrification Plant (HWVP) initiated in the 1980's. The HWVP project was terminated due to system integration concerns including capacity uncertainties from DOE's decision to vitrify waste in the 149 single-shell tanks and changing waste pretreatment strategies due to the decision not to utilize B-Plant. Rising project cost and delays to the Defense Waste Processing Facility at Savannah River and the West Valley Demonstration Project vitrification facilities also contributed to the decision to terminate the HWVP.

The Tank Waste Remediation System (TWRS) project followed in the early 1990's. With costs increasing as design concepts matured and the desire to commercialize, a privatization approach was initiated in 1996. In this approach, the contractor would provide waste treatment services in a privately owned and operated facility. The contractor would be paid for each canister of vitrified waste. This project ended in about 2000 due, in part, to rapidly increasing cost estimates.

The current project, Waste Treatment Plant (WTP) project is the third major contract initiated at Hanford to treat and immobilize the tank waste thereby providing the desired protection to the environment. The conceptual design from the privatization effort was transitioned to the WTP contractor. The prime contractor for the WTP is Bechtel National, Incorporated (BNI) with the prime subcontractor being Washington Group International (WGI).

The WTP project commenced in 2001. The original cost estimate was $4.8B with startup planned in 2007 and full operations in 2011. As a result of several factors including emergent technical issues, seismic concerns, and other programmatic issues, the cost of the project is now at about $12B with startup in 2016 and full operations targeted for 2019. Despite changes in the schedule and emerging technical issues, the WTP continues to make significant progress with design and construction about 70% and 30% complete, respectively.

THE NEED

Due to the increasing cost, Department of Energy top management, wanted assurance that no significant technical issues existed that would later provide for sudden cost increases. “Significant” related to issues that could jeopardize operations or would require significant funds or time to correct. They also wanted confirmation that the current EAC was accurate and included all aspects of the project. Surprises up the road could bring an end to this very important national project, and, after two previous attempts, no one wanted that to happen. To address the two requests, planning was initiated to conduct two intensive reviews. One review would address the technical adequacy of the process flowsheet to meet throughput requirements while the other review would thoroughly review the EAC.

The technical review discussed in this paper focused on the technical adequacy of the process to meet the throughput requirements. The review did not include associated technical arenas such as structural integrity, services such as power or service water, outlining process alternatives or process optimization, or investigate tank farm delivery issues. The importance of defining “what the scope was and what the scope was not” is discussed later.

PROCESS DESCRIPTION

The WTP is the largest nuclear-chemical plant in the world. It consists of pretreatment facility that provides feed for a dual melter low-activity waste (LAW) vitrification facility and a dual melter high level waste (HLW) vitrification facility. The WTP is large in both throughput and physical size. The pretreatment building alone has a foot print about the size of four football fields and will be about 120 ft high. Several first-of-a-kind technologies are incorporated in the WTP design including the use of multiple melters, simultaneous LAW and HLW vitrification, use of the “blackcell” design, the use of fluidic mixing devices supplemented by air sparging, the largest bank of sintered metal crossflow ultrafiltration ever configured, first-of-a-kind ion exchange materials, and a caustic-based vitrification flowsheet for both the LAW and HLW vitrification facilties. Also, unlike West Valley and SRS that use a prepared glass frit to prep the feed for the melter, the WTP will add glass-forming constituents on a batch analysis basis.

In the pretreatment process, material delivered from the tank farm is concentrated from about three weight percent solids to twenty weight percent solids. During this concentration, the material is washed to remove salts as well as leached in caustic and permanganate to remove aluminum and chromium, respectively.

The filtrate from these pretreatment steps is sent through ion exchange to remove cesium before passing on to the LAW vitrification facility. The LAW vitrification facility currently has a rated design capacity of 30 metric tons of glass per day.

The solids which are on the tube side of the filter continue on to the HLW vitrification facility. Before entering the melter, glass former chemicals are added based on analysis of the melter feed. The HLW vitrification facility currently has a rated design capacity of 6 metric tons of glass per day.

The LAW vitrification feed is Newtonian. The HLW vitrification feed is non-Newtonian and has the characteristics of a Bingham plastic. The HLW side of the process is designed to operate with feeds with shear strength as high as 30 Pascals.

THE APPROACH

The first major aspect to decide upon was how to conduct this technical review. Several approaches were outlined for conducting the review. The five main approaches evaluated were:

- Contract the review to an external group
- Conduct the review with all internal personnel or personnel with extensive knowledge of WTP
- Conduct the review with internal personnel and an external lead
- Contract an outside independent reviewer to compile the team comprised of knowledgeable individuals.
- Conduct the review with an internal lead team and all external personnel.

Much effort went into evaluating the possible approaches. The member qualifications (academic, industrial experience, and radioactive-chemical plant experience) were viewed as a very important criterion. Contracting to an external group was not selected for scope control, timing, and possible review team member qualifications. In addition, project personnel would have to bring this team up to speed. The second option of conducting the review with internal personnel was quickly eliminated. While this approach had the inherent apparent advantage of schedule due to utilizing knowledgeable people, it was not chosen for several reasons. First, it would tax the Project labor pool and second, regardless of the findings, questions of bias would immediately arise. Utilizing an outside leader with internal personnel was eliminated for similar reasons. Likewise, contracting an independent external person (or persons) to lead the review, compile the team, and meet the schedule was questionable. The approach that was selected was the last approach listed above. A lead or coordination team compiled the review team and acted as an intermediary between the review team and the Project. The review team was comprised of outside reviewers and functioned independently. The analysis indicated that this would provide for the most thorough review with the fastest startup and potential to meet the demanding schedule requirement. As is the case in any review involving external personnel, the need to compile and convey project information in a concise and thorough manner was recognized as a challenge.

THE DIFFERENCE

While many reviews, involving many knowledgeable people have been conducted of many processes, the intent was to make this review more comprehensive and of higher caliber to ensure “no stone was left unturned”. After two false starts at processing Hanford’s waste, it was critical that this review thoroughly examine the process to ensure no surprises occurred later.

With years of reviews having been conducted at Hanford and other sites, the obvious question was, "how do you make this review better?" The initial planning had to address this question to ensure a thorough and credible review of one of the world's largest projects. Following many discussions, the following prime criteria were established:

- No member of the technical review team would be an active employee, recently retired, or close associate of the prime contractor or the prime subcontractor.
- The team would include representation from companies engaged in similar projects for the Department of Energy. Stated another way, the team members would be include representatives of the competitors of the prime contractor and its prime subcontractor.
- The team could examine any aspect of the process.
- The review team would independently identify issues as well as classify them.
- An identified technical issue could not be negated by proposed plans. Identifiable actions had to be in place and active to negate an identified issue.
- The DOE and contractor management could review and comment on the final report but not edit it.
- Proposed team members would undergo 3 levels of review prior to being selected. This included the liaison team, DOE-ORP, and DOE-HQ.
- Functional criteria were established for the review team prior to selecting members.
- Most importantly, any answer or issue identification was fair game. The team would write the complete report. There would be no qualifying comments or disclaimers included in the report from the contractors or the DOE.

The DOE/BNI/WGI management endorsed all criteria.

Regarding the pedigree of the personnel, 22 of 31 on the main team had Ph.D. degrees. Other aspects of the review included open attendance for status presentations and crossties of team members with other key groups. Attendance in all status presentations included representation from groups such as Washington State Department of Ecology, the Defense Nuclear Facilities Safety Board, and the U.S. Army Corp of Engineers. Crossties with other groups included team members who were in the National Academy of Sciences, participating in the WTP Hydrogen in Piping and Ancillary Vessel (HPAV) study, and had been on prior Corp of Engineer reviews of WTP. A balance of participation from academia and industry was also sought. Finally, team planning included having sufficient depth to allow for unexpected events such as sickness, family emergencies, and even death of a team member, especially a lead. The organizational structure for the review will be discussed later.

Other important aspects of the review included:

- The team would compose interim status presentations.
- The report would be made public
- All 31 members of the core team would be required to sign the report indicating that they were in agreement with the findings.
- Identified issues could relate to the contractors or the Department of Energy

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The participants were told that all members of the core team would be required to sign the final report thereby eliminating any post review concerns that the report was written or edited by an "inner circle"

The liaison team was established in August 2005 and program planning was initiated. After the criteria and functional requirements were established, a list of potential members was compiled and contacts began. A four-day kickoff meeting was held in October 2006. When the team assembled, some of the members did not know any of the other members, some only knew a few of the others, no members knew all other members, and some members were not familiar with the WTP Project. Prior to the meeting, a couple members had to be told where the Hanford site was. This diversity of familiarity resulted from emphasis being placed on experience, qualifications, and "new eyes" when selecting team members. While this mixture and varying degree of familiarization with the Project and other team members was anticipated, it provided ample leadership challenges to ensure a fast start and thorough review. The initial planning, staffing, and contract administration took approximately 2 months. The actual review took five months.

PLANNING

A very critical aspect of the planning (as it is in any project) was the scope definition. Figure I shows the system transform depiction of the scope and roles. The system transform model led to the overall organizational structure for the review with three teams forming the review team. One team would examine the research and technology efforts. This team would review the adequacy of transforming basic data to engineering input. Another team would focus on the operability and maintainability arena. Their role is to ensure operating and maintenance requirements were conveyed to design and to examine if the design enabled these. The third team, and the main team, would focus on engineering and the transform of all design input into the final product: the design.

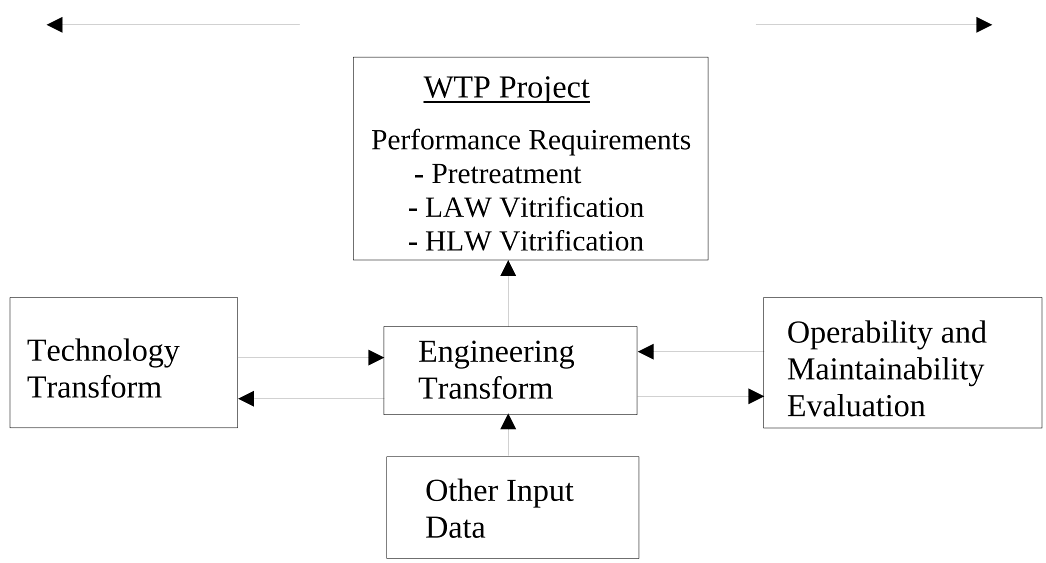

Figure I. The system review transform description of scope

Since this review would focus on the process technology a very clear definition had to be developed. To ensure a thorough understanding, the scope was provided in three forms. And, possibly more importantly, to provide additional clarity a definition of what the scope "was not" was provided.

Scope statements which accompanied the system model were:

- Conduct a comprehensive review of the chemical and mechanical engineering systems relating directly to the process capability of the WTP flowsheet.
- The objective is to review process technology and its transformation to engineering application, review system interfaces and evaluate the overall system operability to meet design requirements.

Figure II depicts the role of the liaison team. The establishment of the three aspects of the review led to the organization for the review. The main responsibilities of the coordination team were:

- Ensure the review team receives an appropriate orientation
- Coordinate the delivery of Project information to the review team
- Facilitate internal and external reviews
- Ensure the scope of the review team is controlled
- Provide for adequate and timely statusing of the review
- Logistics coordination
- Ensure the schedule is met.
- Act as an interface with all external groups to help ensure the review team was not distracted.

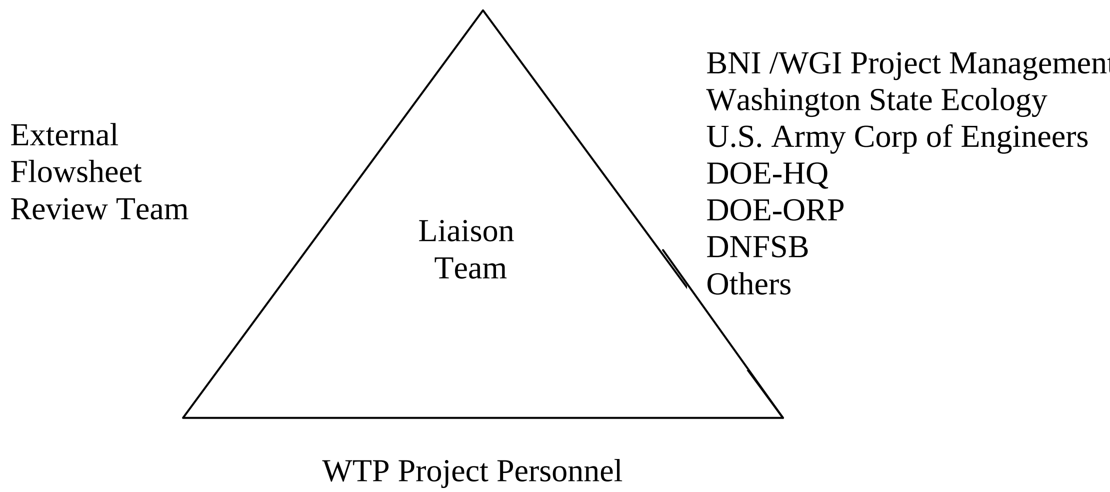

Figure II. Liaison team role and interfaces

To ensure consistent focus on the scope, an additional scope statement was developed and shown in Figure III.

> "Conduct a comprehensive review and analysis of the WTP flowsheet with the intent of identifying its capability, and any risks associated with meeting the contract deliverables. The review will focus on the chemistry and chemical/mechanical systems as currently designed and incorporated into the design. The review will incorporate the lessons learned and observations of other companies operating or designing similar processes. The review will focus on the adequacy of the technology and engineering efforts to provide an adequate design (adequate defined as meeting the contractual throughput and loading criteria). The review will not focus on areas external to the flowsheet such as cost, schedule, seismic criteria, tank farm capability, authorization basis, optimization, alternate processes, and waste forms and qualification. The review will utilize the findings of prior WTP reviews. A final draft of the report is due to the Department of Energy February 28, 2006".

Figure III. The Scope Statement

In addition to the scope descriptions, three questions were posed to the team were:

- Are there any major issues that will prevent the WTP from operating?
- Are there any major issues that will prevent meeting the contract rates with commissioning and future feeds?
- Are there any potential issues that could prevent meeting contract rates with commissioning and future feeds?

With a 31 member core team and another 20 supporting the review, controlling scope was viewed as critical. To aid what the scope was, a definition of what the scope was not was provided. This is shown in Table I.

Table I. The Scope is Not to Evaluate

▪ Seismic Criteria
▪ Tank Farm Programs
▪ Authorization (safety basis)
▪ Building design and shielding
▪ Support systems such as electrical supply and secondary water
▪ Waste form type and qualification
▪ Cost and schedule
▪ Optimization
▪ Process alternatives
▪ Ability to complete Hanford mission by 2028
▪ Solutions

The objective of the review was for the team to identify issues, not to focus on solutions and alternatives. It was very important to clarify this since the tendency of technical personnel is to solve problems and improve the process. Discussing solutions and alternatives would not only detract from the scope of the review but also lead to sub-optimized suggestions due to inadequate time to evaluate them.

EXECUTION

With the team assembled, a four-day kickoff meeting was held with all participants and key stakeholders attending. During this meeting the review team discussed the scope and objective thoroughly, was given a description of the process, provided the key Project documents and information, and held breakout meetings to discuss issues and establish the review format. Team member responsibilities were discussed as were dates for interim reviews. The breakout sessions were also structured to increase team camaraderie.

The review team then launched their review. Numerous meetings were held with Project personnel. Meetings with other key suppliers, such as the national laboratories, were held independently by the team. Team members met with project personnel as individuals and teams. Wherever or whenever an obstacle was encountered or information was needed, the liaison team immediately injected themselves to resolve it.

The review team held several private meetings so that they could review and examine their findings. Interim status presentations were held several times during the course of the review. All presentations were prepared by the review team and were not edited by others.

When the study moved into the last two months, the review team initiated writing the report. Much debate occurred on the best format for the final report. A two-part report was decided upon. The first part was a summary report and contained an executive summary, the findings, and the conclusion. The second part would contain background information including team member resumes and their individual reports. The leads for the three respective groups took responsibility to cull all the input and develop the final report.

Technical writers and editors were assigned to assist the review team. Upon completion of the report, all participants of the main review team were asked to review and sign the report. Although the liaison team planning allowed for exceptions, all participants signed the report and it was issued February 28, 2006.

THE FINDINGS

The final report was issued as scheduled six months earlier. Most importantly, while 17 major issues and 11 potential issues were summarized, no fatal flaws were identified. In addition, no unforeseen chemistry issues were uncovered. The review team summarized their findings by stating “The EFRT believes that all issues have solutions and do not require development of new technologies”.

The list of the 17 major findings and the 11 potential findings are shown in Tables II, III, and IV. A major issue was defined as one that *would* prevent the WTP from operating consistently and would prevent it from meeting contract throughput rates. Also, major issues affected more than one plant area. Major issues were also subdivided into systemic issues and process area issues. Systemic issues were issues that affected more than one plant process area or were programmatic in nature. A potential issue was defined as an issue that *could* prevent the plant from meeting contract throughput rates. No potential systemic issues were identified.

Table II. Major Systemic Issues (11)

1- Potential for line plugging	7- Inconsistent long-term focus
2- Revaluation of Erosion Allowances	8- Limited remotability demonstrations
3- Inadequate design of mixing systems	9- Lack of comprehensive feed testing during commissioning
4- Design for commissioning wastes (not mission wastes)	10- Critical Equipment purchase reviews
5- Feed prequalification testing requirements	11- Loss of WTP expertise basis
6- Process limits not defined	-----

Table III. Major Process Issues (6)

<u>Pretreatment</u>	<u>LAW Vitrification</u>	<u>HLW Vitrification</u>
1- Inadequate filter area and flux	5- Misbatching of melter feeds	6 - Plugging of the film cooler and transition lines
2- Undemonstrated leaching process	-----	------
3- Instability of the baseline ion exchange resin	-----	------
4- Plant availability, operability, and maintainability	------	------

Table IV. Potential Issues (11)

Pretreatment		Vitrification	Other Plant Areas
Evaporators	Ion Exchange	LAW	Laboratory
• Undemonstrated DF factor	• Inadequate process development	• Lack of spare melters**	• Undemonstrated sampling system
• Effect of recycle on capacity	• Questionable column design*	HLW	Balance of Facilities
• Adequacy of the control scheme	• Concern on cross contamination	• Lack of spare melters**	• Lack of glass former analysis
Ultrafiltration	• Valving complexity	-----	Control Systems
• Potential for gelation and precipitation	• Cesium breakthrough monitoring	-----	• Incomplete process design

* Included by the EFRT as a potential issue but served as an added example of major issue # 10
** Included by the EFRT as a potential issue but served as an added example of major issue # 7

A couple of the major systemic issues were addressed to both project and the DOE management. These included the need for a more consistent longer term focus as well as the need to address the loss of the expertise base. The EFRT also commented that the WTP lacked a shared vision and clear definition of mission requirements.

WAS IT WORTH IT?

Many questions have been asked about this first-of-a-kind review. The most important question is: Was the review worth it? Simply stated, yes, without a doubt *if* the findings are addressed and resolved. The WTP Project had evolved to basically focusing on cost and schedule and may have lost sight of technical adequacy to meet long-term mission goals. Confusion existed on the goals of the plant, i.e., the throughput requirements. The EFRT review identified several issues that may have otherwise not been confronted. In addition, by not identifying any fatal issues or issues related to basic chemistry and technical soundness, the WTP project received a vote of confidence and continues forward with greater confidence. The review team made it clear in their final presentations to DOE management, the DNFSB, WTP project management, and BNI-WGI corporate management that all issues were solvable. The final value of the review will be determined as the years unfold and startup commences.

LESSONS LEARNED

No intense effort can be conducted, let alone a first-of-a-kind effort, without there being lessons learned. This WTP External Flowsheet Review was no exception. The lessons learned totaled over 60. These lessons were passed on to subsequent reviews including the Hanford Bulk Vitrification review and the Savannah River Tank 48 review. A discussion of some of the more interesting and significant lessons learned follows.

The lessons learned start with the initial name given to the review. While this might seem as a minor factor, it was a significant item in the early stages of the review and shows that no aspect of a review of this magnitude can be ignored. Initially the review was titled the Best and Brightest Review of the WTP Flowsheet. While this title has a catchy ring to it, the “best and brightest” title created issues within the project and to some degree within the review team. The internal project reaction involved both technical personnel and managers. The comment was made “if they are the best and brightest, then who are we?” Concern arose that the title could impact working relationships. Also, there is an influence on future reviews. If this was indeed a review by the “best and brightest”, how could there be any subsequent review? As a result the title was changed to the External Flowsheet Review of the WTP Process. The review team was named the External Flowsheet Review Team (EFRT). Lesson learned: names and titles can influence support.

Establishing the coordination (liaison) team is critical to a successful review. The team needs to be very knowledgeable about the project or program being reviewed while knowing where and whom to for information for the review team. The liaison team has to remain unbiased while ensuring the review team maintains focus on the scope. The liaison team also serves as a buffer between the review team and the project so that the review team in not distracted by opinions and bias from project personnel as to what is or is not an issue. In addition to the liaison team, establishing a dedicated procurement team to place contracts is vital to an efficient start. The liaison team responsibilities include everything from coordinating information flow, to aiding infrastructure needs including travel and logistics, to controlling scope, acting as a mediator on issues, to, and most importantly, ensuring the scope is addressed while maintaining the schedule. Selection of the liaison team and its lead is critical to conducting a successful review. Lesson learned: Don’t underestimate the effort, details, and leadership required by the liaison team.

An immediate issue the liaison team had to address was the timing (duration) of the study. Initially the request was for the review to be complete by the end of 2005. Upon evaluation of the task, the liaison team evaluated the amount of information that would need to be reviewed, the potential size of the review team, timing for a successful kickoff meeting as well as many other issues including the time and complexity of developing the final report. After this evaluation, the liaison team recommended that the completion date be changed to February 28, 2006. However, meeting this date proved to be very challenging. Work had to continue over weekends and holidays as well as travel and vacations rescheduled. Lesson learned: Don’t underestimate the time required to conduct the study and develop the final report.

In a similar lesson learned, estimating the time involvement is critical. Initially the liaison team estimated that the team leads would spend about 50% of their time over 5 months on the study. As the review unfolded, this grew to nearly, if not, 100%. Had the reviewers been given this estimate in the beginning, it is questionable if all would have signed up. Recognizing the need, importance, and sponsorship of the review caused the review team to extend much extra effort beyond what they originally envisioned. Lesson learned: (similar to above) Don’t underestimate the time required to conduct the study.

Another lesson learned involved the scope definition. All projects, programs, and reviews describe the objective and provide a scope definition. In addition to this, a description of what the “scope was not” was provided to the EFRT. The statement of what the scope was not proved to be more important than the description of what the scope was. Discussing this in the kickoff meeting proved to be very important as the review progressed. Another aspect of the reviews was separating scope and cost from the technical review. By enabling the technical personnel on the technical review team to focus on technical issues provided for a through, undiluted review. Lesson learned: clear and concise scope definition is critical.

In preparing for the review, the infrastructure needed to support the review was established. Infrastructure for the review team included offices, computers, admin support, and most importantly identifying who within the Project would provide the information on what areas. This preparation was vital to enabling the review to be completed on the original schedule. Recognizing that the team was comprised of members who knew about the WTP project to those who did not know where Hanford was, posed a major issue for the kickoff meeting orientation. Establishing the balance between foundational information and an adequate process review while not swamping the reviewers in tons of paper requires much forethought. Some participants felt the kickoff meeting was too long and detailed while others thought it was appropriate. Others Lesson learned: do not underestimate the preparation time and the amount of support the project has to provide the review. Also consider providing background information on a more individual basis.

Team composition is another key to a successful review. Establishing functional requirements for positions, maintaining a balance between scientists and engineers, and having the right mix of academia and industrial personnel all play a key role in a successful review. Establishing the criterion that the team would have no members from the prime contractor or prime subcontractor on the team removed concerns of bias. The team membership also included a technical advisor for the review team. This person's function was to offer guidance and act as a mediator to the team if and when internal debates arose. This role was also very important during the writing of the report by taking a broader view of issues. Lesson learned: team membership, pedigree, and experience are critical.

Sponsorship for the review is another key factor. Clearly, by having the need for the review generated at the upper levels of the Department of Energy increased the importance of the review. The lesson learned is that sponsorship and publicity of the review aid execution. On the other hand these alone are not sufficient to generate the belief in everyone that the review was needed. In order to emphasize the importance of the review, upper management from both the project contractors attended the kickoff meeting and all interim reviews. Lesson learned: Both project and DOE management need to see value in, and clearly support, the review.

In the Project that is possibly the biggest chemical plant and certainly the biggest radioactive chemical plant in the world, enabling technical information to be easily obtained was a challenge. While enabling access is one issue, identifying key documents and personnel to discuss the flowsheet with is another issue. Clearly, the review team did not have the time to read through all project technical documents. Again the liaison team plays a critical role by knowing who the review team should talk to and what documents serve as a starting basis for a comprehensive review. In addition, establishing the web page where these would be located was important as was enabling access to them in a relatively easy manner. Lesson learned: Provide simple access to documentation and facilitate communication with appropriate experts.

A detailed summary of the WTP External Flowsheet Review and the lessons learned was presented to DOE upper management on April 18, 2006. That presentation also included a checklist of planning actions for future reviews. Table V provides an abbreviated summary of the overall lessons learned:

Table V. Abbreviated Summary of Lesson Learned (no order or priority implied)

• Liaison Team Credibility and Process knowledge are critical. Fill the liaison team lead position carefully.	• Carefully structure the orientation meeting	• Define during or before the review how issues will be addressed after the review.
• Establish functional requirements and criteria for the review team	• Address logistical needs before the review starts and establish a logistics person.	• Access the state of the program to be reviewed before deciding on the scope.
• Provide clear definitions of "what the scope is and what the scope is not".	• Plan on how to convey info during the review	• Carefully evaluate the duration before beginning
• Network to compile the list of potential candidates and make careful selections	• Don't underestimate the time demands on project personnel.	• Identify how issues will be resolved post review.
• Hidden agendas need to be watched for.	• Customer understanding and management support are needed.	• Evaluate the name given to the review.
• Advisors to the review team are beneficial	• Involving other stakeholders in the review improves credibility.	• The Executive Summary is critical and should be no longer than one page.
• Define who and how the report will be written in the beginning.	• Project personnel need to know how to say "I don't know rather than offering speculation".	• Promote two-way dialogue in the interim reviews.
• Have backup leads and personnel identified for unexpected occurrences	• Provide technical editors and report writing assistance early in the report writing.	• Monitor for misinformation

POST REVIEW ACTIONS

Prior to the conclusion of the review, discussions were initiated on how the issues would be addressed and resolved. To eliminate the potential for bias in issue resolution, an external resource was assigned to lead issue resolution. A formal Issue Resolution Plan (IRP) was established. Individual response plans were written for each issue. The DOE reviewed and approved these. Resolution involved the participation and concurrence of EFRT members who were integral to issue resolution. Some issues have been closed and others are actively being worked to resolution.