Demonstration Bulk Vitrification System (Dbvs) External Review

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ABSTRACT

The Hanford mission to retrieve and immobilize 53 million gallons of radioactive waste from 177 underground storage tanks will be accomplished using a combination of processing by the waste treatment plant currently under construction, and a supplemental treatment that would process low-activity waste. Under consideration for this treatment is bulk vitrification, a versatile joule-heated melter technology which could be deployed in the tank farms. The Department proposes to demonstrate this technology under a Research, Development & Demonstration (RD&D) permit issued by the Washington State Department of Ecology using both non-radioactive simulant and blends of actual tank waste. From the demonstration program, data would be obtained on cost and technical performance to enable a decision on the potential use of bulk vitrification as the supplemental treatment technology for Hanford. An independent review by sixteen subject matter experts was conducted to assure that the technical basis of the demonstration facility design would be adequate to meet the objectives of the Demonstration Bulk Vitrification System (DBVS) program. This review explored all aspects of the program, including flowsheet chemistry, project risk, vitrification, equipment design and nuclear safety, and was carried out at a time when issues can be

identified and corrected. This paper describes the mission need, review approach, technical recommendations and follow-on activities for the DBVS program.

INTRODUCTION

The Department of Energy's (DOE) Office of River Protection (ORP) is charged with the safe management, retrieval, treatment and disposal of over 53 million gallons of radioactive hazardous chemical wastes currently stored in 177 aging underground single-shell and double-shell tanks at the Hanford site near Richland, Washington. Currently, a large Waste Treatment Plant (WTP) is under construction to separate the retrieved tank waste into high-level waste (HLW) and low-activity waste (LAW) fractions and to vitrify those separated wastes for either onsite disposal as LAW, or for offsite disposal at the proposed Yucca Mountain national repository as HLW. Completion of waste retrieval, treatment and disposal, as well as tank farm closure will eliminate much of the risk posed by the tank waste to the Hanford groundwater, the Columbia River, and the public.

With its current design capacity, WTP, once fully operational, is expected to complete vitrification of the HLW in approximately 20-25 years. However, with WTP's existing design capacity for the LAW fraction, it is anticipated that a processing period significantly exceeding 25 years will be required. Additional LAW vitrification capability could be constructed to produce a balanced system that would result in a processing duration similar to that for the HLW fraction, acceleration of risk reduction to the environment and public and potentially significant savings to the taxpayer.

DOE is considering approaches to provide this additional capability, either by expanding the existing WTP low-activity waste capability or by developing and deploying supplemental treatment technologies which might prove to be more cost effective. One of the candidates for supplemental treatment is an adaptation of In Container Vitrification ™ (ICV) technology available from AMEC Earth and Environmental, Inc. (AMEC).

DOE has contracted with CH2M HILL Hanford Group, Inc. (CH2M HILL) to design and construct a full scale demonstration system to test this technology with radioactive tank waste. This Demonstration Bulk Vitrification System (DBVS) project is currently in design and development with plans to initiate construction within the next two years.

In order to assure itself and DOE that the DBVS design is robust and likely to be successful, CH2M HILL conducted an external review of the current state of the design and development of the DBVS system prior to DOE's initiation of the formal decision process (Critical Decision-3) to start construction of the project. A group of 16 independent experts and consultants, representing a broad spectrum of technology experts, academia, and nuclear waste processing industry experts, was identified and chartered as the Expert Review Panel (ERP). ORP and DOE's Office of Environmental Management participated in the selection of the Expert Review Panel members. The Panel membership is presented in Table I.

Table I -- DBVS Expert Review Panel – September 2006

ERP Member	Affiliation	Expertise
Mission Integration Team		
John Longenecker - Lead	Longenecker and Associates	Overall Team Lead- DOE Project management
Dr. Bill Ibbs	University of California-Berkeley	Risk Management
Flowsheet Evaluation Team		
Dr. Ray Wymer - Lead	Oak Ridge National Laboratory – Retired	Process Chemistry and Radio-chemical flowsheet development
Dr. Ross Thomas	BWXT	Chemical processing and technology demonstration
Eric Tchemitcheff	AREVA NC, Inc.	Process design and flowsheet development
Vitrification Team		
Dr. John Plodinec - Lead	Savannah River National Laboratory	Radioactive Waste Vitrification
Joe Perez	Washington Group International	Radioactive Waste Vitrification
Dr. Ian Pegg – team consultant	Catholic University/ Vitreous State Laboratory	Radioactive Waste Vitrification
Equipment Design, including Operations and Maintenance Team		
Dr. Chris Burrows - Lead	EnergySolutions	Radiochemical plant design and operations
Dr. Ed Lahoda	Westinghouse Research and Technical Center	Radiochemical equipment design – waste drying
Dr. Fred Zenz	Consultant	Pneumatic transport and solids handling
Richard Porco	Ellis & Watts International, Inc.	Radioactive off gas treatment system design
Dr. William Wilmarth	Savannah River National Laboratory	Tank Waste Dissolution and clarification
Doug Johnson	BWXT	Nuclear Facility Operations, and Maintenance
Dr. Arun S. Mujumdar – team consultant	National University of Singapore	Drying Equipment Design
Nuclear Safety Team		
Dr. Bruce Matthews - Lead	Perot Systems Government Services	Nuclear Plant Safety and Operations
Dr. Steve Krahn	Perot Systems Government Services	Nuclear Safety

The objective of the ERP was to determine whether the DBVS system, as designed, could be expected to:

- meet the requirements defined in the system specification
- produce a waste product that meets Hanford's Integrated Disposal Facility (IDF) disposal requirements
- receive operational approval by DOE authorities and other regulators.

PROJECT OVERVIEW

The DBVS Project has conducted an extensive set of process tests ranging from crucible melts of both simulants and radioactive tank wastes, cold (non-radioactive) and hot (radioactive) engineering scale melts, and a series of full scale cold melts. A series of supporting science and technology activities (e.g., glass formulation, investigation of unexpected second phase formation, and the pathway of technetium) have been conducted as well.

To date, the vast majority of the supporting technology development and demonstration efforts have focused on glass formulation, performance of the melter system at a successively larger scale, and testing and troubleshooting the prototypic melt system. The design of other major components of the demonstration system have largely relied on limited vendor testing or vendor performance claims, with few efforts directed towards scaled or full scale testing of feed, material handling, or off-gas systems. In the project plan evaluated at the time of this review, all integrated system testing was to be conducted as part of the cold commissioning of the DBVS system.

The project was completing the detailed DBVS design in parallel with the ERP review. The detailed design was completed by AMEC on July 28, 2006. Similarly, a revised Documented Safety Analysis was being prepared during this review. As a result, this review was a snapshot of a work-in-progress as of June 2006.

Demonstration Bulk Vitrification System Description

The DBVS is a full-scale test facility that will receive waste from single-shell tank 241-S-109, mix the waste with soil, dry the soil/waste mixture, and blend in glass former additives to produce a dried waste/additive mixture. The DBVS will then use the ICV™ process to convert the dried mixture into boxes of vitrified waste. The ICV™ boxes will be cooled and interim stored until they are transferred to the Integrated Disposal Facility for disposal onsite. The DBVS will treat the process off-gas to a level that is protective of human health and the environment and meets applicable requirements. Secondary liquid wastes will be filtered and sent to the Effluent Treatment Facility (ETF) for treatment and disposal. Figure 1 shows the relationship between the main process systems in the DBVS. These process systems include:

- Clean Soil System
- Waste Receipt System

- Waste Mixer/Dryer and Condensate Recovery Systems
- Dried Waste Handling System
- In-Container Vitrification™ System
- Off-Gas Treatment System (OGTS)
- Secondary Waste Storage System.

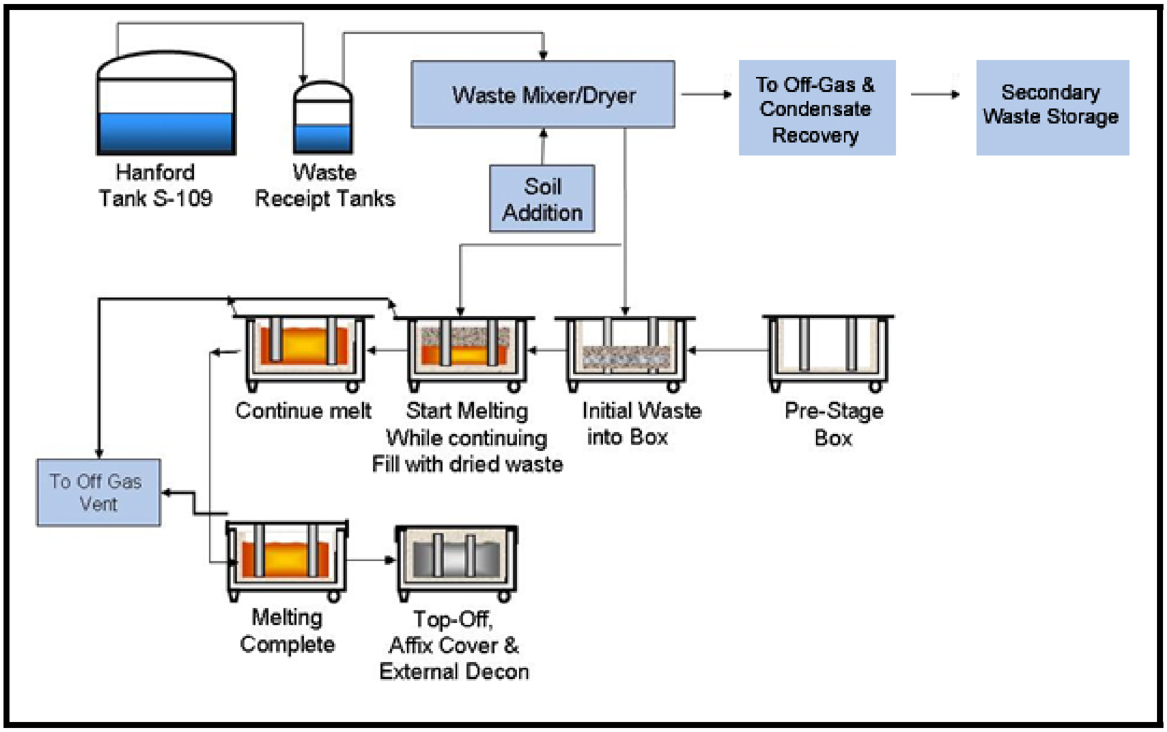

Fig. 1. Simplified DBVS flow diagram

Clean Soil System

The Clean Soil System receives and pneumatically conveys clean soil and glass forming additives to a total of six impingement tanks that allow solid materials to be fed by gravity into the waste processing vessels. One tank will feed soil to the Waste Mixer/Dryer, while the remaining three soil tanks feed top-off soil to three separate ports in the ICV™ box. Two additional tanks will feed glass forming additives to the Waste Mixer/Dryer.

Waste Receipt System

The Waste Receipt System consists of a pump skid and three waste staging tanks. This system will receive, sample, and transport waste from the 241-S-109 single-shell tank to the Waste Mixer/Dryer and Condensate Recovery Systems. The pump skid will transfer batches of waste from S-109 to one of three waste staging tanks for storage until it is needed for processing. The waste will be sampled to verify that it complies with the DBVS waste feed acceptance criteria.

Waste Mixer/Dryer and Condensate Recovery Systems

The Waste Mixer/Dryer converts waste liquid into a blended and dried feed product suitable for vitrification. Heat and vacuum will be used to dewater the waste feed/soil mixture. During evaporation the Waste Mixer/Dryer will be operated at 60 ºC (or higher) under a vacuum of approximately 660 mm Hg. The Waste Mixer/Dryer will mix its contents with rotating plows that direct the waste from the ends of the mixer/dryer towards its center. The evaporated water will be pulled through a sintered metal filter (SMF) to remove particulates before the vapors reach the Condensate Recovery System. Particulates captured in the filter will be returned to the dryer drum via back-pulsing of the filters.

Waste drying is a batch process with approximately eight dryer loads required for each ICV™ box. Each dryer load will begin with an initial charge of gravity-conveyed clean soil via the impingement tank located above the dryer. After preheating the soil, waste feed will gradually be added from the waste staging tanks until the correct ratio of waste-to-soil is achieved. Once the entire batch of waste feed is added, the product will be dried to a target water content of about 3 wt% water. Glass former additives will then be added and mixed with the dryer product. Finally, the Waste Mixer/Dryer will discharge the dried waste to the Dried Waste Handling System through a valve located on the bottom of the dryer, then the batch process will repeat.

Dried Waste Handling System

The Dried Waste Handling System transfers the dried waste and soil mixture from the dryer to a waiting ICV™ box. The dried waste will be transferred into a discharge chute at a rate controlled by a rotary valve. As the rotary valve rotates, dried waste will enter a vacuum transfer line where gas velocities will ensure that waste particles remain suspended and transported to one of two Dry Waste Receivers. The dried waste will then be gravity fed from the Dry Waste Receivers into the ICV™ box. Both Dry Waste Receivers will be used to provide an even distribution of dried waste to the two entry points in the ICV™ box. The process is repeated for each dryer batch.

In Container Vitrification™ System

The ICV™ system is designed to receive a waste/soil mixture, contain the bulk vitrification process, and serve as the final disposal container for the product. The ICV™

box will provide primary confinement for dried waste received from the dryer, molten glass during processing, and final waste product.

The soil/waste mix will be melted within the box, using electric power supplied through graphite electrodes. A starter path will be used to initiate the melt. On completion of the melt and after a cooling period, sufficient top-off soil will be added to ensure that the box is at least 90 percent full and a nominal 10-in. soil layer covers the melt. Once the chutes, electrical connections, ventilation and instrument harness have been disconnected, the ICV™ Box will be moved to the storage pad using an air pallet.

Off-Gas Treatment System

The OGTS is used to cool, filter, scrub, and chemically treat the various process off-gas and vent streams before exhaust fans discharge them through a monitored exhaust stack to the atmosphere. Off-gas produced during the ICV™ process will be drawn through two sintered metal/mesh filters (SMFs) connected in series and the collected particulates returned to the dryer by vacuum transfer and re-introduced into the melt process.

Additional air drawn from the waste staging tank vents will be combined with ICV™ process off-gas after the SMFs and fed into the off-gas wet scrubber treatment skid. The gas will be quenched with a caustic solution to cool it before entering the scrubber. This will remove most of the acidic gases (e.g., NO_x, CO_2) and particulates. After the scrubber, the off-gas will be passed through a mist eliminator, cooled in the condenser, and passed through a second mist eliminator. Ambient air, air from the secondary waste storage tank vents, and air from the dryer off-gas is combined with the scrubbed off-gas, then heated and passed through a series of two high-efficiency particulate air (HEPA) filters.

The filtered off-gas will then be drawn through a high-efficiency gas adsorber (HEGA) filter and polishing filter. The HEGA filter is used to remove residual radioactive iodine and organic carbon from the off-gas stream. The polishing filter will capture filter media particles that may exist in the HEGA filter effluent and will prevent them from entering the selective catalytic reduction (SCR) unit.

After passing through the HEGA filter skid, the off-gas will be mixed with filtered ambient air and drawn into the SCR unit, where it is preheated to bring it to the required operating temperature before entering the SCR reactor. As the off-gas passes through the SCR, NO_x will be reacted with ammonia in a catalyst bed to produce water vapor and nitrogen gas. A second catalytic bed will oxidize any remaining CO to CO_2. Hot off-gas from the SCR reactor will pass through the exhaust side of the air-to-air heat exchanger to preheat the incoming off-gas before being discharged through the exhaust stack.

After the stack monitor has sampled and measured the off-gas for the discharge flow, temperature, and contaminants being exhausted to the atmosphere, the treated off-gas will be discharged through the stack by one of two exhaust fans.

Secondary Waste Storage System

The Secondary Waste Storage System provides for the storage of the secondary liquid waste effluents from the dryer condensate and off-gas scrubber solution, and load out of these effluents for transfer to the ETF. Two staging tanks will be provided for interim storage of each of these secondary waste streams, and will be sized such that the secondary waste generated during the production of a single ICV™ box can be contained in two of the tanks (one for dryer condensate and one for off-gas scrubber solution). This approach will provide time for secondary waste sampling prior to transfer to the ETF.

REVIEW PROCESS

The members of the ERP divided into five focus areas:

- mission integration
- overall process flowsheet
- vitrification and product qualification
- equipment design, including operations and maintenance
- safety.

Each focus area developed lines of inquiry and review plans based on the approved charter. The charter posed five primary questions to be addressed by the ERP.

- Are there any flaws in the current design or operational plans that would prevent the DBVS system from meeting safety or technology demonstration objectives?
- Will the DBVS system meet minimum product quality and demonstration production rate requirements?
- Is the technical basis of the DBVS flow sheet sound?
- Is the DBVS Equipment and Facility design basis adequate to bound the construction and operating costs for the demonstration?
- What are the primary outstanding safety and technical risks/uncertainties for the DBVS?

Relevant DBVS Project management, technical basis, and design documents provided by the project were reviewed. DBVS Project management, technical, and operations staff were then interviewed and provided additional information and clarification of the data originally provided to the team. Since the design and development efforts of the project were ongoing, the DBVS Project team typically provided information that bridged the gap between the released project documents and the current state of the project. In this way the ERP was able to consider the most up-to-date information available for this review. Preliminary draft information developed by the ERP was provided to the project staff for factual accuracy reviews prior to finalizing this report.

Even though the project was in the midst of a major project design completion effort, staff and subcontractors from ORP, CH2M HILL, and AMEC were very open and cooperative. Individuals from the project spent many hours with the ERP and were very responsive to requests for additional information and briefings. Without this cooperation, the ERP would not have been able to complete a quality review in the time available.

REVIEW OF THE DEMONSTRATION BULK VITRIFICATION SYSTEM TECHNICAL BASIS

After the initial document review and onsite meetings, the ERP review subteams prepared an initial set of findings and issues which were reviewed with the project staff for factual accuracy, and in some cases additional clarification. Based on the results of these discussions, issues, areas of concern, and recommendations for improvement were documented in a draft version of this document. This document draft was also provided to the project for factual accuracy review. The document was finalized in September 2006.

The ERP established four categories for grouping of issues.

- Fatal flaws – the issue will cause failure of the DBVS, and cannot be resolved (no fatal flaws were identified)
- Technical issues – the identified issue will result in a failure of the DBVS to meet established DBVS system, mission, or safety performance requirements unless addressed prior to start of hot operations of the DBVS facility (see Table II)
- Areas of concern – the identified concerns may result in a change to design, or may require additional testing to determine if the design is adequate (now or later) (see Table III)
- Suggested improvements – improvements that the project should consider to improve safety, cost, schedule, or efficiency during the test operations

The report discusses each of the five focus areas, emphasizing specific points within each area including: mission integration of the DBVS Project with the overall completion of the ORP mission and the projects overall risk management approach; flowsheet technical basis; equipment design and specifications review; the secondary waste system; operations and maintenance approach and impact on design; and finally, the strategy for the development and approval of the facility authorization basis and safety management programs.

The ERP produced two primary review documents. The ERP review itself was published as RPP-31314 in September, 2006 [1]. The original detailed team reports are included in a companion document, RPP-31337 [2]. These individual team reports include more detailed analysis used to prepare the summary findings of the DBVS Project. All of the team leads, together with some of the team members, participated in the categorization of issues in the main body of the report. The main body of the report (Volume 1) represented a consensus of the ERP.

Tables II and III summarize the technical issues and areas of concern that the team identified. The order of the issue presentation does not necessarily reflect their relative importance.

Table II. DBVS-ERP Technical Issues.

Technical Issue	Statement of Technical Issue
#1	The DBVS, as currently planned, will not completely meet all objectives assigned it in the Justification of Mission Need
#2	Insufficient integrated system testing prior to radioactive DBVS operations
#3	There is no plan at present for recovery from off-normal conditions.
#4	The entire DBVS (flowsheet, system design and operations) is too complex.
#5	The sampling and data acquisition system (plan and hardware) is not designed to gather important process and design information.
#6	The soil may not transport as currently designed.
#7	The soil may bridge in the hopper and not feed the dryer.
#8	Because of the uncertainty in the particle size, moisture content, etc. of the as-dried material, it is difficult to evaluate the solids feed system design.
#9	There is considerable uncertainty with regard to the consistency of the dried material and how it will be controlled.
#10	Formation of secondary phases is not sufficiently understood for reliable process control.
#11	Failure to close the technetium mass balance threatens the viability of bulk vitrification as a supplemental treatment technology.
#12	Design criteria for the OGTS have not been clearly defined.
#13	Testing requirements in equipment specifications have been inadequately defined.
#14	Potentially large variations in system component pressure losses and the hysteresis within the control system could result in unacceptable response time to achieve proper flow.
#15	The sintered metal filters will frequently blind, with a significant risk of release of contamination.
#16	Testing and safety analysis have not adequately addressed the ICV melt box performance for containment of the melt product, volatile radionuclides, and generated NO_x.
#17	The safety performance of the DWTS to contain the dried waste under normal and accident conditions is not yet fully understood and defensible.
#18	The DBVS Project plans to assign operational responsibility to a sub-contractor who has little formal nuclear facility operating experience.
#19	Project uncertainty with various portions of the unit operations and process chemistry may heighten safety vulnerability under abnormal conditions.

Table III. DBVS-ERP Areas of Concern.

Area of Concern	Area of Concern
#1	Decontaminations calculated for Technetium and Cesium across the DBVS are questionably large.
#2	There is a lack of a basic understanding of the process chemistry.
#3	The hydrocyclone may not provide adequate separation of the smaller particle size solids expected in the S-109 feed.
#4	Given that there is no mechanical agitation in the DBVS feed tanks, solids could build up over time
#5	The epoxy coating on the waste storage tanks may not provide adequate corrosion protection.
#6	The batch drying time may exceed the specified 8-hour duration by as much as 1-1/2 hours.
#7	Temperatures predicted in the mixer/dryer container during hot weather may not allow for the proper operation of controls and equipment.
#8	The lack of a validated approach for control of the ICV™ process puts the project's ability to proceed to radioactive operations at risk.
#9	A feed qualification step is needed as part of the process control plan.
#10	The lack of prototypic testing prevents the project from predicting future compliance from post success.
#11	Equipment manufacturers' standard practice appears to have taken precedence over code compliance for the OGTS.
#12	The Wet Scrubber specification does not require performance testing to demonstrate the specified removal efficiencies
#13	Design Criteria for the HEPA filters have not been established.
#14	Carbon cells for HEGA filters do not meet the required residence time as specified in the Procurement Specification and ASME AG-1 Code.
#15	There exists a potential for a charcoal fire due to concentrations of NO_x in the HEGA skid.
#16	The OGTS emergency by-pass filter system could quickly load with particulate during upset conditions, resulting in a filter failure and release of contaminants to the atmospheres.
#17	There appears to be little, if any, design optimization
#18	The scrubber system may not be able to treat unexpectedly large amounts of gases and solids, resulting in unacceptable amounts of material being directed to the ETF
#19	Assumptions about types and amounts of chemical entering the Secondary Waste Treatment System
#20	The potential for future use of the DBVS facility as a single line production facility and gap filler capability might not be adequately addressed in the existing design.
#21	An adequate maintenance strategy has not been developed and incorporated into the demonstration facility requirements.
#22	Readiness requirements for ultimate hot operations may be underestimated
#23	Insufficient consideration to accumulation of radioactive materials throughout the DBVS could lead to avoidable radiation exposure during operations and extra complexity of the decontamination and decommissioning effort.
#24	Safety Control Strategy Complexity – The large number of TSR-level safety systems and DBVS-specific administrative controls may be excessive from the standpoint of human factors and operational complexity.
#25	The documented rationales fro the revised Hazard Categorization is insufficient.
#26	Identification of Potential Chemical Hazards – Safety documentation and analysis does not provide for a complete accounting of chemicals used and generated by the DBVS

The ERP team also identified 13 suggested improvements the project should consider to enhance safety, cost, schedule, or efficiency during the test operations, and the potential transition to a production system downstream.

CH2M HILL is in the process of developing a Project Implementation Plan to address all of the identified technical issues, areas of concern, and suggested improvements. The results of this review will result in additional research and technology development, additional technical basis development, changes to cold testing and integrated test plans, and modifications to the initial design to address the results of this review and additional testing conducted as part of the implementation of the PIP. It is expected that this Project Improvement Plan should be completed by March 2007.

In the end, the overall risk of successfully constructing and operating the demonstration facility should be substantially reduced by the review conducted by the ERP. DOE expects to conduct its evaluation of the Critical Decision-3 process in the summer of 2007.

LESSONS LEARNED

In conducting this external review the project team identified a number of general lessons learned that could be useful to other DOE technology demonstration programs, and other independent reviews that contractors or DOE offices might elect to conduct. These include:

- Begin an external review process early enough to impact the project before too much design is committed to concrete and steel.
- Tailor the review to match to stage of the project design/construction. Retaining experts to review portions of the design or project planning that are in very early stages of development can only result in general comments that will improve the overall planning, but aren't particularly cost-effective as compared to other review areas that are ripe for evaluation. Suggested review phases for effective external review might include:
    - Technology basis and flow sheet design, prior to start of preliminary design
    - Preliminary Design Completion, prior to start of detailed design
    - Review of preliminary safety analysis
    - Complete Detailed Design, prior to the start of construction
    - Planning for cold and hot commissioning
    - Review of results of design, construction, cold commissioning prior to hot startup
- Seek the most capable review team members available for the phase of the review undertaken. Plan to pay for the expertise you need. Without a team with impeccable experience and credentials; the external review will be unlikely to be more effective than the project team already working the project.
- Allow an adequate time frame to conduct the review. The DBVS external review was conducted over the course of 5 months after a 6 week organizational period.

Often there is a strong desire to demonstrate responsiveness by starting an aggressive review schedule, but this time is often wasted due to the team's need to assimilate enough information to formulate and ask the right questions needed to get to the real status of the technical information. "Fly-by reviews" of only a few days create a significant risk of selective information being provided by the projects to create a favorable impression, in contrast to the actual project status. It takes time to move past the normal human reflex to be defensive of the work done to establish a constructive relationship between the reviewers and reviewees.

- The effort should be chartered by the senior management of the sponsoring organization, with review leadership reporting to senior management above the project organization. Without this senior management charter, the natural tendency of the project is to become defensive about the work already underway, resulting in a review without the freedom to be truly independent.
- The review effort needs to have a senior executive from the sponsoring organization assigned to manage the review. The senior executive needs to be credible to the project team, sponsoring and customer organizations. Without committing a significant management resource to the effort, the review team will not readily gain access to the necessary personnel and resources to assure that a quality review can be conducted in a timely manner.
- Plan adequate budget and support personnel to facilitate the external review. In addition to the costs of the external review team membership, and the time needed by the project organization to support the review, adequate support personnel to support the senior executive and the review team are essential. Supporting personnel typically include technical coordinators who facilitate the organization of information from the project, coordinate necessary meetings of the review team with the right project staff, etc.; clerical and administrative support of the team as they are planning and conducting onsite and/or offsite meetings, arranging for conference rooms, computer resources , etc. Plan to dedicate contract and procurement staff to establish the contracts with the review team and supporting staff, if necessary. Plan to have an experienced documentation production staff with the needed technical editing and graphics capabilities to generate a document that communicates with all parties.
- Develop a detailed charter for the review effort and have it approved by the sponsoring organization, the project and the customer organizations before the review starts. This charter should include the primary questions and issues that the review team is expected to answer, establish the initial review timeline, and define the working relationships between the team, the sponsoring organization, the customer, and the project that is being reviewed.
- Spend some time organizing the technical and design information before the review team starts its work. Paying the review team members to sort and organize needed project information is a waste of their time and talent and is not cost effective. Spend time organizing the technical and design information to make it readily accessible, index it manually or electronically, and think of how information will be made easily accessible to the review team. A typical project will have a mass of technical, design, and vendor information that make it

difficult for an external review team to dig through the mass of data and find the important kernels needed to evaluate the project status.

- Establish a working and meeting schedule early in the review and develop working procedures and work-arounds when the inevitable schedule conflict develops. The most desirable review team members will already have their plates nearly full and some flexibility will be necessary for them to participate. On the other hand, once the working schedule is established, status and keep to it or the review will drag on.
- Plan for the likely eventuality that some of your team members will become unavailable during the course of review. Individuals may be reassigned, may become ill, become unavailable for travel, or have family situations that prevent them from participating to the extent desired in the ongoing review. Back-up team members may be identified, additional team members might be added to the team to provide some flexibility, or some overlap in expertise might be useful when the team is originally set up.

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