Humboldt Bay Power Plant Decommissioning Transition to Civil Works – 15039

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ABSTRACT

Decommissioning of the Pacific Gas and Electric (PG&E) Company Humboldt Bay Power Plant (HBPP) Unit 3 nuclear facility has now, after more than three decades of SAFSTOR, completed the Plant Systems Removal Phase by removal of all radiologically significant plant systems from the buildings in June 2014. The HBPP historical design and construction, close proximity to the bay and associated tidal interactions poses unique challenges to an effective decommissioning effort as the Site transitions to a major earthwork project – designated as Civil Works.

The last significant large component removal project remaining is segmentation and disposal of the reactor pressure vessel shell and this project is now integrated and executed under Civil Works with PG&E solely in an oversight role across the site beginning 2015. The value from run-up and mock-up testing of tooling to segment the HBPP reactor vessel will be discussed. Experience obtained, especially at error prone interfaces, during start-up, systemization and operating phases for the First of a Kind (KOAK) tooling will be discussed.

Implementation of the civil scope of work commenced July 2013. Its status and experience applicable to other decommissioning efforts will be provided from an owner's perspective. Implementation of the civil work scope includes development and implementation of oversight capability including policy, procedures and deployment of skilled, experienced and trained oversight staff in the field. Challenges encountered and solutions implemented during mobilization and ramp up of the civil contractor commensurate with demobilization of the self-perform staff will be covered.

Partnering with the contractor to establish a good Client/Contractor relationship and tips on where to invest owner resources will be shared. Development of a solid baseline project schedule that incorporates regulatory constraints, client expectations and contract constraints and its importance to safe, compliant project execution will be shared.

INTRODUCTION

Background

The site on which HBPP Unit 3 is located was initially developed in around 1950 by PG&E as a fossil based electrical generating station. HBPP Unit 3 generating unit, a Boiling Water nuclear reactor, had a rated core thermal power of 220 MWth (thermal) with a corresponding net electrical output of 65 MWe (electric). It began commercial operation in 1963 and was taken off-line in 1976 to refuel and perform seismic modifications, but was never restarted.

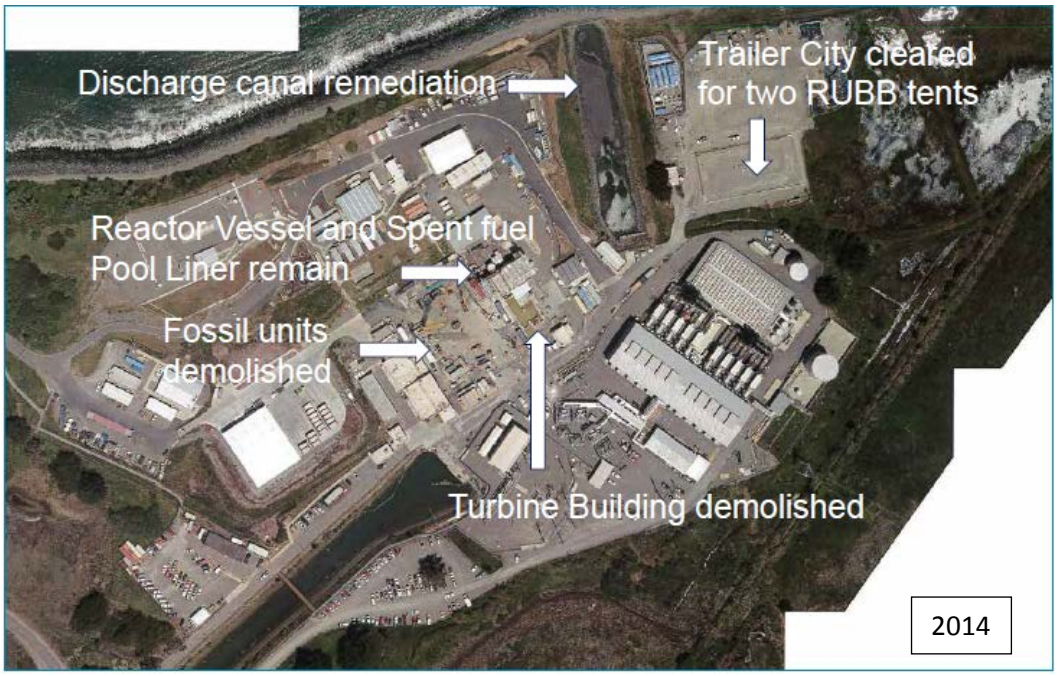
The PG&E HBPP Decommissioning Organization was formed in 2008 and initiated a pre-planning process and the self-performed portion commenced in early 2009 with staff training; stakeholder conferences; structure modifications to allow better access for personnel and activities; large component removal; and commodity removal. In May 2011 the PG&E HBPP Decommissioning Organization began a planning process to transition from self-performed to competitively bid work scope contracts with independent contractors performing work under the supervision of a PG&E Oversight Team. The Contract was awarded in July 2013, thus from initiation of the development of the specifications to contract award this effort took approximately two years to complete.

Transitioning to Civil Works Oversight

After 30 years of SAFSTOR operations the HBPP decommissioning project has made significant progress over a period of five years (2009 – 2013) including the removal of the majority of alpha contaminated systems. The plant systems removal phase of the project has been "self-performed" by a corral of contractors managed by PG&E as opposed to hiring a single large decommissioning contractor. During these past five years the decommissioning project has successfully completed fossil plant decommissioning, numerous site infrastructure improvements, removal of all large nuclear components, and safely transporting these oversized, overweight shipments to their disposal sites. Now, after two years of highly-focused planning for transition to the civil works phase - in conjunction with the years of pre-planning accomplished during the plants systems removal phase - Humboldt Bay Power Plant has transition into its Civil Works Projects phase.

It is the mission of the PG&E HBPP Oversight Team to ensure that the Civil Works Contract - the final major Contract to take the Decommissioning Project to completion - supports that vision, and does it safely, on schedule within budget, and in compliance with all regulatory requirements, while maintaining local community support. This represents a significant transition point of the project after five years of self-performing and directing the decommissioning.

PG&E's oversight of the contract work is to (1) assure that Contract Requirements and Specifications are met; and (2) facilitate the Contractor's understanding of and compliance with site specific procedures, regulations, HBPP work scheduling, and PG&E site safety and quality expectations.



UNDERSTANDING OUR SAFETY CULTURE

PRINCIPALS	DEMONSTRATE
▪ Everyone is responsible ▪ Making the work place a safe place ▪ Preemptive and defense in depth ▪ Stop work authority	▪ Management briefing prior to badging ▪ Weekly senior leadership walk downs ▪ Posters of our children throughout site ▪ Walk the talk
EXPERIENCE	**ASSESSMENT**
▪ Bring right resources at right time ▪ Continuity across successful projects ▪ Planning the work is essential ▪ Supervision and Oversight	▪ Benchmarking ▪ Field Observations ▪ Adverse Trending ▪ Continually Evaluate Risk

The HBPP Safety culture is defined through four program elements: (1) how we work to our core principals; (2) how we demonstrate the right safety practices and behaviors; (3) bringing to bear the right experience; and (4) continual assessment.

PG&E fosters a safety culture and expectation of exemplary safety performance and we expect our Bidders to partner with PG&E and embrace our vision and culture. Protection of personnel and the environment while providing a safe workplace is PG&E's the number one priority. Discovery or identification of safety issues and concerns, injuries, accidents, or near misses are to be reported immediately to PG&E. All personnel are given stop work authority for any activity they believe is unsafe or poses a risk to meeting regulatory requirements. PG&E requires all PG&E contractor personnel and all sub-tier contract personnel to adopt and implement this safety culture in all aspects of work performance, behaviors, and personnel interactions. This philosophy and the continued emphasis on safety, environment, and regulatory compliance shall form the foundation of all activities planned and performed at HBPP.

FIRST YEAR IN TRANSITION

Preparing for Major Civil Works
Installation of coffer dam at discharge canal and tents to manage wet canal sediment

The first year in transitioning to Civil Works Oversight were focused in the following areas:

- Approval of prime contractor baseline schedule;
- Revamped key programmatic programs and plans;
- Minimized overlap of self-perform and civil works;
- Major civil works field activities started May 2014
- Continuing efforts to segment the reactor pressure vessel

Approval of Prime Contractor Baseline Schedule

PG&E obtained the services of highly experienced and trained staff resources in project controls, earn value calculations and assessments, finance and schedule reviews to facilitate an in-depth review and approval including start-up of an earn value management system by the prime contractor. This work also included mentoring of PG&E financial analysts including providing guidance in developing good project controls metrics and tools to ensure success of the project.

PG&E approved prime contractor Baseline Schedule and Earned Value Management Plan which included more efficient ways to remove structural elements such as the dry well and suppression chamber liners during caisson excavation. Detail logic network checks and other important metrics were developed to insure that the submitted schedule adheres to accepted industry standards and the contract specifications. Whereas, the constructability and critical path of the schedule needs was reviewed by PG&E and its Owners' Group to ensure that that the Contractor was in compliance with any agreed upon activities, milestones, etc. that may have been established in prior meetings between the Owner and the Contractor.

Reaching a consensus early on a Work Breakdown Structure (WBS) that breaks down all authorized work into appropriate elements for planning, budgeting, scheduling, cost accounting, work authorization, measuring progress and management control was an important first step. PG&E expects the WBS to display the following attributes:

- Contain all contract line items and end items
- Identify all WBS elements specified for external reporting
- Extend at a minimum to the level at which control accounts are established
- Provide a complete definition of work scope

Earlier draft WBS submittals furnished by the prime contractor did not adequately address the scope of work in sufficient detail to ensure that the complete scope is included and to demonstrate that Contractor understands how it will integrate scope, costs and schedule for the project. PG&E expectations were a product-oriented division of project tasks depicting the breakdown of work scope for work authorization, tracking, and reporting purposes that facilitates traceability and provides a control framework. The WBS ensuring that the Statement of Work is entirely covered and allows for the integration of technical, schedule and cost information.

Revamp Key Programmatic Programs and Plans

Oversight Plan

The HBPP Oversight Plan was developed over a period of six months through a collaborative effort by the management team and it describes the framework for oversight of all work activities associated with the HBPP Decommissioning. Oversight is intended to support the safe, compliant, and effective decommissioning through all stages of the Project, including contracting, work planning, field work and any necessary owner support, management and ultimate final disposition of waste materials, demobilization from the site, and establishing the end state configuration through a site restoration program.

This plan allows PG&E to institute administrative controls to effectively manage and communicate those identified potential impacts in such a way that the HBPP Management Team can execute pre-emptive and mitigative corrective action strategies to achieve success in meeting HBPP's Decommissioning Goals and Objectives.

The organizational structure at HBPP provides for an extremely effective oversight structure that, when taken as a whole, represents a strong Owner culture that will support work execution by asking the right questions, at the right time, to keep the project on track.

Key areas for Oversight Team attention include, but are not limited to:

- The HBPP site safety and teamwork culture
- Unique project radiological and environmental issues
- Complex and unique regulatory requirements
- Current best industry practices specific to nuclear facility decommissioning

This Oversight Plan provides functional guidelines to assist PG&E Leadership in assuring the Contractor's compliance with contractual requirements, and facilitate full support of and adherence to over-arching HBPP Values. This document, with existing Site Procedures, ensures an appropriate level of PG&E review, approval, and inspection of all work scope executed.

Effective oversight understands the role of the Contractor to implement work scope effectively and efficiently. Effective oversight understands that Contractor Means, Methods, and Equipment may differ from past HBPP experience, but that the Contractor has been selected for its unique approach and expertise. Through their respective knowledge bases, effective oversight provides a Contractor with the benefit of Owner site understanding, and the Owner benefits with Contractor experience on tasks not previously undertaken at HBPP.

Work Control Program

The HBPP Work Control program outlines the work control process, defines the interface between the PG&E contract administration team and the Contractor, and describes the process employed to ensure that work planning meets Contract requirements through PG&E review and approval of Contractor submittals.

The Civil Works Contractor key submittal to execute field work is comprised of a demolition work plan, engineering evaluation and a set of work instructions (WIS). This set of documents represents a comprehensive collection of documents that may also include design change notices, drawings calculations, geotechnical reports, permits, sampling and analysis plan and process waste plans related to a specific defined scope of work.

The primary objective of PG&E's review is to ensure that the scope of work is adequately defined, along with appropriate means and methods, to enable safe and efficient implementation by the workforce. As such, PG&E's responsibilities when performing review of submittals is to identify and minimize overall project risk. Risk is the probability that an event, circumstance, or condition will occur that will have a negative impact on the completion of the Humboldt Bay Power Plant (HBPP) Unit 3 decommissioning. Should such an event occur, it could cause a significant adverse effect on decommissioning project safety, public safety, public relations, environmental compliance, schedule, budget, and have implications beyond HBPP affecting all of PG&E.

Quality Assurance Plan

In April 2014, PG&E revised its Humboldt Bay Quality Assurance Plan (HBQAP). The overall intent of revisions were to simplify the HBQAP for HBPP Unit 3 and HBISFSI based on the plant's decommissioning status, remaining decommissioning activities, and long-term passive operational status of the ISFSI. Radiological risk factors on site have been significant reduced as a result of Unit 3 decommissioning activities; all spent fuel and Greater Than Class C (GTCC) waste have been transferred to the ISFSI, and the last known Class B and Class C have been shipped off site for disposal.

The four significant revisions implemented in the new revision of the HBQAP included: (1) Extensive editorial changes to eliminate redundancy, provide clarity, and improve readability; (2) Replacement of Nuclear Safety Oversight Committee (NSOC) with Independent Management Review (IMR); (3) Removal of an appendix referencing the Regulatory Guides, industry standards, and exceptions to those standards. All aspects of the standards still applicable to ongoing activities have been incorporated throughout the body of the HBQAP; and (4) Changes in implementation methodology throughout the HBQAP. The implementation methodology currently existing in HBPP administrative procedures has been removed from the HBQAP to provide a higher degree of flexibility to the Quality Assurance Program, accommodate changes to the scope of decommissioning activities and the transition to a stand-alone ISFSI.

Emergency Plan

In June 2014, PG&E submitted to the NRC a License Amendment Request for Proposed Revision to Humboldt Bay Site Emergency Plan. The proposed changes are a reduction in the emergency planning function commensurate with the ongoing and anticipated reduction in radiological source term at the HB site. These changes are a revised E-Plan organization, the replacement of a dedicated on-call emergency response team with advisory personnel on an as-needed basis, the elimination of the initiating events and emergency action levels for Humboldt Bay Power Plant (HBPP) Unit 3, and a revision to the emergency action level information for the HB Independent Spent Fuel Storage Installation (ISFSI).

Minimized Overlap of Self-Perform and Civil Works

When HBPP mobilized the Civil Works Contractor, a significant effort by the project team focused on an early exit strategy for the Self Perform Contractor responsible for removing plant systems. Each remaining project was reviewed in depth and more coordination and ownership was given to the Contractor to finish early. Forecasted scheduled had the Contractor completing early 2015 and the strategies put in place had the work successfully completed by June 2014. The importance was to lessen the overlap of PG&E directly managing a Self-Perform Contractor working five projects in parallel while it ramped up its new Civil Works Contractor.

Similarly, at the end of 2014 the RPV shell segmentation project was integrated under Civil Works to begin 2015 with PG&E solely an oversight role of all work performed on-site.

Major Civil Works Field Activities Started May 2014

The Civil Works project has completed several big accomplishments in the field once it transitioned from a major planning effort to start of field work. Several above grade buildings were abated and demolished and they included the Hot Machine Shop (HMS) and the former Security Alarm Station (SAS) building (a previously hydrogen re-combiner concrete structure). These demolitions required carefully placed debris curtains and for the SAS building a closure plate to isolate SAS building from ventilation system.

First demolition - Hot Machine Shop

Several key infrastructures were completed as well including removal of trailer city and construction of two large RUBB tents to manage soils. The Guardian system was completed which allows ease of soil screening for use.

Gardian System to screen reusable soils

Divers were mobilized to isolate the discharge canal discharge piping from the power block using bladders. Once completed, they transitioned to their primary project, a radiological significant activity, to cut the spent fuel pool liner under water.

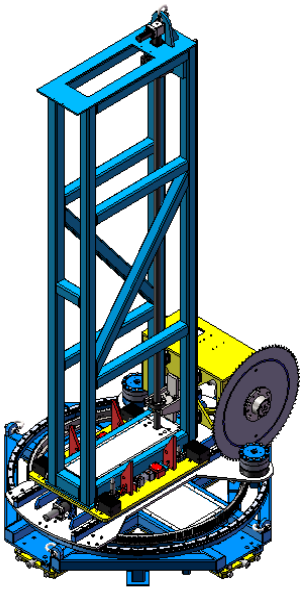
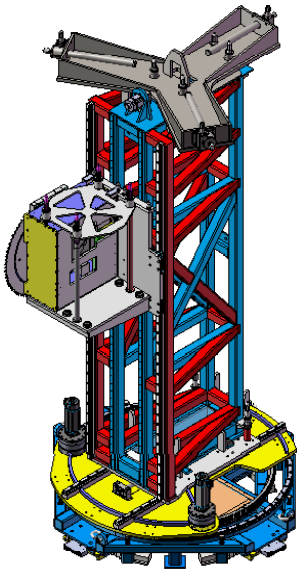
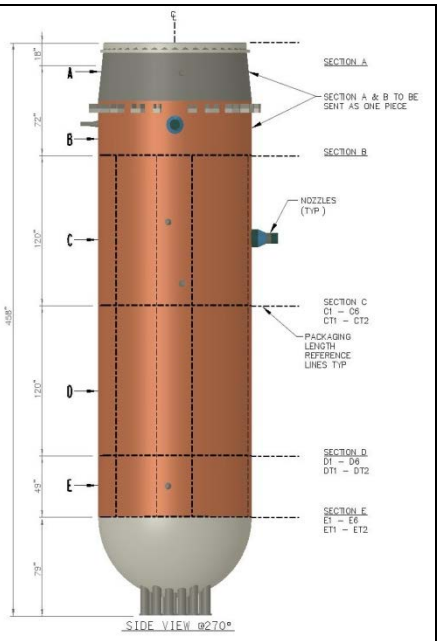
Divers removing spent fuel pool liner wet

Discharge canal remediation accomplishments included: completion of coffer dam installation; Ground Water Treatment System (GWTS) tightness test complete; and discharge canal seining complete.

Pre-trenching for the water cut-off wall and removal of underground substructures beneath and nearby were well underway during this period including removal of unit 2 foundation and timber pilings. To support this excavation effort numerous storm water and firewater design changes and field modifications had to be performed.

Pre-trenching water cut-off wall

Continuing Efforts to Segment the Reactor Pressure Vessel

		
Old vertical cutter on CHORCE	New CHORCE and vertical cutter assembly	All precuts complete

The Reactor Pressure Vessel (RPV) removal project at Humboldt Bay Power Plant has proven to be a uniquely challenging project. These challenges range from initial access to the RPV for characterization, all the way to its shell segmentation. This article will focus on the challenges and actions taken by the Utility during the shell segmentation project which started field work in February 2014.

The current physical condition of the reactor pressure vessel is as follows: all initial vertical, horizontal and rigging hole cuts have been made in Sections C, D and E. From there the first 17 of 24 windows are planned to be removed in early 2015. Once the windows are removed, the reactor pressure vessel's insulation will be removed and abated. Upon completion of insulation removal, the RPV will be severed from its piping systems that are still connected. The remainder of the reactor pressure vessel will then be removed. What's left of the reactor pressure vessel systems located in the dry well will have its insulation removed in preparation for building demolition. The completion of the dry well insulation removal marks the end of the reactor pressure vessel project.

Over the past several months, the team performed dry runs of the work to be performed as it transitioned from cutting of the vessel to removal of its windows. After many iterations and hours of practice and successful attempts, they are ready to perform the actual work.

HBPP chose to take an active role in the design verification and run up testing (RUT) process of the equipment. This role included the expansion of the project oversight team to include several new key positions. These positions were: Dedicated Project Engineer with detailed knowledge of the HBPP RPV, a System Safety Engineer familiar with the Nuclear Decommissioning and Chemical Demilitarization industry, and a Remote Tooling Design Engineer from the Chemical Demilitarization industry. This new team became intimately familiar with the segmentation equipment design and operation.

The HBPP team went to the contractors testing facility during the initial RUT. During this phase of testing, it became apparent to HBPP that the equipment would required some re-design. The HBPP Design team developed a thorough set of robust design criteria for design and additional testing for the equipment. This criterion included increased factors of safety on equipment components, vibration design limits to prevent equipment from excessive wear and tear, full scale testing of all the equipment as it would be used onsite at HBPP, and training requirements for the contractor technicians who would be operating the equipment onsite. This design criterion was accepted by the contractor who in turn effectively re-designed the equipment to bring it to the robust design standards that were necessary for the successful completion of the project. Throughout the re-design and testing phase, the HBPP Design team stayed involved with the contractor. During the final RUT and Mock Up Testing (MUT) the HBPP design team expanded to include the field supervisors who would be ultimately responsible for the execution of the project at HBPP. The Equipment went through a rigorous RUT and MUT phase before it was accepted by HBPP for use on the site. This proved invaluable to HBPP with the amount of knowledge gained by the staff and allowed for a smooth project transition into the execution onsite.

In conclusion, this process of up front involvement and verification by HBPP ensured that the FOAK equipment would indeed meet the projects expectations for robustness and reliability. Adding the right resources to the project team proved to be key aspect for ensuring what was needed by the project was delivered by the contractor.

INSIGHTS AND KEY STRATEGIES

- The right period and timing when to plan work packages
- Once started always work toward earn value
- Be flexible – things change – opportunities arise
- Having the right resources and bandwidth
- Understand work control process and oversight
- Do not underestimate site infrastructure needs
- Implementing cold and dark worked well
- Well vet your decommissioning cost estimates
- Establish a good regulatory relationship
- Mock-ups and dry runs do work and are a prudent investment
- Establish good solid community relationships
- Deliver on promise, communications and alliance

The right period and timing when to plan work packages:

Early in the project there exist a delicate balance on how much pre-planning and planning can reasonably be done effectively prior to start of physical work. Once field work commences there exist an opportunity that the right set of skills in the field and continuing on-site planning can reasonably lead-lag each other such that the work packages have the right constructability input and reviews and right focus and attention by the project team. This is important because the planning team gains a perspective from the field on the lessons learned in the early implementation phase and the project team can provide relevant input based on their expertise and knowledge about the facility. That is, the right level of detail (i.e., step-by-step instructions), appropriate means and methods (versus skill of the craft) and content of the work package (i.e., design changes, permits, etc.) are adequately defined and developed such that the work can be safely executed in the field. The optimal period is three to six months prior to physical work being performed, but this period through experience tends to drift to one to three months and possibly less to keep the project moving forward.

When the project obtains relevant field to planning experience, an assessment should be performed as to whether the remainder of the planning packages could be completed much earlier in the project lessening the overhead costs associated with a large contingent of engineers and work control personnel over the remainder of the duration of the project.

Once started always work toward earn value:

The make-up of craft labor and its percentage to total project personnel in Decommissioning is much different than during Construction. The percentage of craft during decommissioning is relatively small when compared to total project personnel, and it is opposite of that experience

during construction when the majority of labor at the job site is craft. At HBPP craft levels were at about 40- 50 personnel from the various trades while total project personnel supporting the decommissioning were approximately 400 - 500. At a ratio of one to ten it is imperative that once physical work starts the project continuously works toward project completion because overall labor force is a significant cost burden to the project. Even though the project may be 10 or more years, every year matters and the constant forward looking on how to complete the project and re-working the completion date through re-sequencing must routinely be performed.

During project execution there exist inherent distractions, initiatives to perform studies or desires to evaluate a multitude of options or better ways to execute an already approved work plan. At the field level the desire to re-work a plan for no significant benefit needs to weigh in on the long lead time necessary to change the approved planned. This is often overlooked and may not be well understood by many in the field. At the project management and department levels, constant rethinking the approach may idle the earn progress on the project. Even when there are multiple crews working in parallel, it is important that they are working toward meaningful accomplishments and not necessarily busy work while key decisions are being made.

Losing sight to the relevancy and impact that the craft in the field have on your overall project performance can make or break your ability to adequately manage overall project costs. Where and when applied, the cost of an additional crew will be a minimal impact to overall project cost of not meeting schedule if overheads or Project Management Office (PMO) costs have to be extended to finish the project. The site will have to understand their own right comfort level of how many crews it can run in parallel with direct supervision in the field reporting up to superintendents and project managers including the risk of bringing a new crew on site that have no previous site experience. Otherwise, if the lack of proper oversight or project bandwidth is spread too thin, then the unforeseen safety, environmental or regulatory mishap resulting in an extended safety stand down may become a greater loss on the return on investment by the additional crew.

<u>Be flexible – things change – opportunities arise</u>:

As with any decommissioning and at HBPP things change or they were not what you expected when work is executed and you need to quickly adapt to the changing conditions.

When the project scope changed to remove the reactor concrete caisson that is below grade, there existed better ways to remove other structural components that were being removed meticulously by the craft. Opportunities to use conventional demolition methods during the excavation of the caisson allowed the 3/16 in. steel suppression chamber liner, the 5/8 in. steel drywell liner, the 40 in. diameter suppression chamber ring and the top half of the 46 equally-spaced 14 in. diameter vent piping to be removed more effectively using safer mechanical means and methods resulting in better ways in performing the work.

Through further characterization of the building surfaces and use of subject matter experts in radiological engineering the development of an open air demolition criteria led to the reduction in the decontamination of many of the building interior surfaces.

Difficulties encountered when removing the reactor vessel internals and segmentation of the reactor vessel shell allowed the project to focus and perform other work such as early demolition of the turbine building. Preparing the turbine building for demolition was a challenging project involving many different systems and components, each presenting different issues. Despite the difficulties, the removal of alpha contaminated plant systems from the turbine building was completed under budget and without incident or unexpected radiation exposure. The systems removed from the building include the main generator, turbine, condenser, four reactor feed pumps, seal-oil switchgear, piping and valves. Dismantlement of the turbine, condenser, and the associated systems and components involved labor-intensive segmentation of highly-contaminated equipment that spanned 34 months and prepared the project team to obtain competitive bids early to demolish the building as the next phase of the work.

Experience gained in performing this demolition early allowed the project team to benchmark subcontractor demolition costs, enabled the project to ramp up from 2-4 shipments per week to approximately 12 shipments per week and to demonstrate the ability to ramp to 20 shipments per week while maintaining integrity to the overall project completion date.

Having the right resources and bandwidth:

Having the right resources and bandwidth implies the need to get things done right from the beginning and this need pertains equally to the Contractor and Utility. This applies to all aspects of decommissioning from planning to execution, from accounting to performance reporting and from public safety to environmental management. At a very high level, PG&E put in place an Executive Oversight Board (EOB) that meets quarterly which focuses on project risks and overall project status review. Its membership includes senior leadership participation within PG&E and within the prime contractor's organization. The board provides a mechanism for HBPP project management team to reach outside it site organization to get help or direction when needed. The EOB provides an avenue to obtain objective independent feedback on a periodic basis from its panel.

At the Project Management Office (PMO) level for both the Contractor and Utility additional resources with relevant experience in earn value reporting and project management with relevant construction field experience and contract management were recruited to ensure that the business aspects of the project were properly being implemented. Personnel experience in life cycle phases of a project are the right experience to bring to a project. Plants entering decommissioning are exiting Operations or SAFSTOR wherein the site is typically managed based on an annual cash

flow which is focused on operations and maintenance (O&M). Onboarding key personnel with project management capability are essential to keeping the project moving forward because of their instinctive ability to understand and work toward earn value. These key assets are capable and comfortable working in an environment that is under constant change, and they are experienced when challenged by unforeseen events; thus recovering the project well. At the business end, there's a distinctive difference between project controls personnel that have experience in maintaining an earn value management system versus the ability to develop one. The same applies to schedulers. These resources are difficult to find in the industry, but are essential to the success of any decommissioning.

Decommissioning will require demolition of structures and the right resource and field experience is important to mitigate any potential consequential damage to the environment as well as human life. There is a clear difference between companies that performs demolition as part of their core business versus ones capable of providing a competent equipment operator performing the same task. From the Utility side, the ability have the right subject matter expert available to perform reviews of the work plans as well as be observant in the field during key phases of demolition ensures proper and adequate oversight are being demonstrated to mitigate potential events from unfolding that typically bring high consequential damages if not performed per plan.

The skill sets within Safety and Environmental will change over the course of decommissioning. Early Environmental expertise in permitting is essential and when field work starts field experience relevant to Storm Water Pollution Prevention Plan (SWPPP) implementation and Best Management Practices (BMPs) are critical to success of supporting field work. Also, assigned responsibility for overall strategic water management onsite is essential to project success. Safety expertise evolves through radiological protection (i.e., contamination control best ALARA practices) to industrial hygiene (i.e., exposure to lead, silica dust, asbestos, etc.) to industrial safety (i.e., heavy lifts, heavy equipment, structural demolition, etc.).

<u>Understand work control process and oversight</u>:

Understanding the work control process was a consistent challenge to most Contractors. Particularly, the time necessary to pre-plan the work, perform walk downs, obtain constructability reviews and the need to allocate sufficient time for review and incorporation of comments required.

Engineers and work planners are not always interchangeable skill sets. Each discipline brings a unique skill set to the project through their years of experience in the industry and from multiple projects. Work planners primary responsibility is to plan the work into discrete achievable work packages and to translate engineering details into step-by-step instructions that are of sufficient detail and understood at the field level. Whereas, Engineering is primarily responsible for

developing the design and/or design changes and to delineate the relevant codes and standards and engineering requirements such as post maintenance testing criteria in the work packages. The work planner with the right experience knows well how to pre-plan and bring closure to the development of the work package to ensure it moves through the approval process. There are far and few experienced personnel that can perform these functions in unison.

Responsibility for reviewing the technical aspects including means and methods delineated in work packages submitted by Contractor rests with PG&E's oversight team. Job functions include performing day to day oversight activities of civil work activities including canal remediation and deep ground excavations or other field work. To assure Contractor's compliance with contractual requirements in the performance of their work, the oversight team would regularly verify that appropriate work control documents are available and being utilized as required. They are capable of making on-the-spot determinations as to in-scope and out-of-scope work elements. Their work requires them to systematically examine each aspect of the project from planning through execution and site closure, to identify the specific times, places, conditions, and coordination points where adverse impacts to safety might occur.

Oversight functions also include observing pre-job briefs and tailboards, including those required by the specifications for Contractor compliance with the three-phase quality program (preparatory phase, initial phase, and follow-up phase) as included in the contract specifications. Provide tailboard performance feedback to the Contractor to enhance tailboard quality. Develop lessons learned for planning future work and document and track significant issues that require the Contractor to take corrective actions to avoid non-compliance with federal, state, local, or PG&E permit or procedural requirement.

Do not underestimate site infrastructure needs:

While decommissioning planning is primarily focused on removing equipment and demolishing building, don't lose sight of infrastructure needs during decommissioning. To support full scale-decommissioning a significant number of required plant modifications, site improvements and infrastructure were put in place. In particular, additional office space, including facilities for breaks, restrooms, and storage of records for support personnel as they ramp up on-site. The increased staffing to support the decommissioning activities requires the purchase/leasing of additional trailers and installation of services such as telephone, computer, water, and electrical. This amounted to ten new trailers, nine re-powered trailers and six re-used trailers from Humboldt Bay Generating Station (HBGS) for a total of 25,000 ft^2 of office space.

At HBPP, the large number of samples needed to adequately assess the extent and concentration of alpha contamination combined with the requirement to achieve very low background radiation levels resulted in the decision to construct a new counting facility rather than attempting to salvage

existing facilities. Additional RP facilities included a 5,000 ft^2 enclosure ("RUBB Tent") for packaging radioactive materials for shipment and a 4,000 ft^2 new access control facility for personnel and material access and egress to and from the radiologically controlled areas of the facility. The RUBB tent was constructed to facilitate packaging in inclement weather and to control potential airborne release during packaging. The access control facility was expanded to more efficiently accommodate large number of workers during peak transit times to and from their work areas.

In addition, expect road repairs because of the heavy repetitive traffic from hauling waste off-site. This work includes the engineering, surveying, geotechnical, permitting, materials testing, and inspection needed to complete design of the access road and monitor construction. To mitigate the environmental challenges with provisions of the new construction storm water general permit, a significant upgrade and paving project was completed to the main road.

Implementing cold and dark" worked well:

One of the most difficult challenges is decommissioning when live electrical systems may be inadvertently discovered or cut. For that reason, many decommissioning projects have completely disconnected their original electrical supply systems, (referred to as going "cold and dark"), and used new, temporary, completely separate, and tightly controlled, systems for remaining services.

Several recent incidents have initiated a discussion of should HBPP Unit 3 be placed in a cold and dark state, to complete the decommissioning and demolition process. Three options to safety considered at HBPP were:

- Continue the current approach, augmented by additional procedural and safety practices to reduce the likelihood of a serious safety incident
- Implement an Area by Area cold and dark approach
- Implement a plant wide complete cold and dark approach.

HBPP ultimately implemented plant wide cold and dark approach because it would reduce potential hazards, increasing safety for employees and contractors doing this project, and it would reduce the time consuming and difficult design development required for all activities related to electrical power using the current processes. Re-powering and implementing cold and dark program was executed on all three units fossil and nuclear. Benefits and design considerations included: (1) avoids the potential electrical hazards hidden within walls, floors, ceilings or the machinery, due to unexpected intra area and "sneak circuit" wiring, along with the inter-area issues addressed in the area by area cold and dark approach; (2) provides the highest level of personnel protection; (3) reducing the time consuming processes and difficult design development otherwise required for all activities related removing electrical and mechanical services from the plant, thus eliminating the need to develop extensive design change packages; (4) reduced

clearance coordination and staffing including engineering design changes supporting plant modifications to mechanical and electrical services; (5) separating the plant operating loads from the construction power, thus allowing the construction electrician to have full control of their construction power and use of construction power stands for all construction loads, including temporary lighting; and (6) whenever power cables are routed through the plant, they should be clearly mark to distinguish them from abandoned cables and should not be run in, on or near abandoned raceways.

Well vet your decommissioning cost estimates:

Site-specific cost estimates were prepared for PG&E prior to commencing decommissioning of the HBPP unit 3 facility. In 2009, PG&E hired a consulting company to prepare its cost study for decommissioning HBPP Unit 3. The methodology used to develop the 2009 decommissioning cost estimates for HBPP Unit 3 followed the basic approach originally presented in the "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates, (AIF/NESP-036, May 1986)". This reference describes a unit factor method for determining decommissioning activity costs. The estimates were based on the unique features of the facility, previous studies and accounted for lessons learned at other facilities that had undergone similar decommissioning.

As PG&E identified efficiencies and discovered issues that affected work processes, and therefore costs, changes to implementation methodologies were researched, planned and reviewed by management. Using actual decommissioning experience combined with a comprehensive evaluation of the remaining activities, costs, bid pricing and schedule to decommission Humboldt Unit 3, PG&E prepared its own Decommissioning Project Report (DPR) delineating costs estimates to complete its decommissioning. The cost estimate was backed by competitive bids and four years of successful decommissioning.

After devoting substantial time and effort to the decommissioning planning and bidding process, further expansion of the scope of decommissioning Humboldt Unit 3 resulted from changes in two key assumptions: (1) the removal of the reactor caisson and associated structures beyond the generic assumption of leaving all remaining structures three feet and more below grade level; and (2) use of lower values of residual radioactive material associated with unrestricted use of the site following license termination (i.e., a change from Industrial Worker Scenario to Residential Farmer Scenario).

Establish a good regulatory relationship:

One important measure that PG&E senior leadership has conveyed to the HBPP project is the priority and investment of establishing a good regulatory relationship with its key stakeholders. HBPP has done well in being very transparent with its regulators on safety, environmental, project

status and early identification of challenges. HBPP actively embraces use of its corrective action program which describes the process for identifying, evaluating, resolving, tracking, and trending conditions adverse to quality, safety, security, the environment and regulatory compliance.

Strong regulatory compliance and risk reduction initiatives throughout pre-planning, planning and field execution convey and instill confidence to regulators that project priorities and fundamentals are properly aligned. This investment upfront to execute on excellence provides an inherent return on investment with regards to project metrics such as safety, schedule and costs performances. As mentioned early, with such a significant cost burden built into day to day operations during decommissioning, any potential lengthy regulatory shutdown or any lost in public confidence would become an undesirable outcome with many negative impacts to the success of the project.

HBPP had its second NRC Commissioner visit in 2010. The NRC Commissioner was impressed with the professional attitude of personnel and high quality of work during his site tour. He commented that HBPP receiving the Sibley award two years in a row appeared to be justified and was reflective of the performance of the entire plant's staff. An earlier visit in the year by another NRC Commissioner was a very positive experience as well.

Mock-ups and dry runs do work and are a prudent investment:

Known throughout many industries, dry runs offer an invaluable tool to the operators toward developing best work practices. In particular, dry runs of First of the Kind Equipment (FOAKE) in an inhospitable workspace (i.e., the nature of the facility and the work has resulted in a constricted and congested workspace) may present challenges to the crews as they work through alignments, clearances and fit-up details.

The use and investments in mock-ups during decommissioning provide inherent benefits that are well recognized by the crew once they were performed. Supported by Safety, they consistently convey that whenever a team can visualize the task that they plan to execute the more likely they are able understand the complexity of the work they plan to perform (i.e., the ability to break down evolution into meaningful tasks that are well understood by the project team).

HBPP management team continually supported recommendations by the crew and/or developed expectations on high risk evolutions to perform such mock-ups and/or dry runs. Management believes that this effort has resulted in the following positive outcomes:

- All stakeholders of the evolution have come together and worked through a solid understanding of the task to be performed.
- The individual work groups supported collaboration and input from the composite make-up of the crews across multiple departments and Suppliers.

- A clear understanding of the potential hazards that they may encounter through the course of executing the work.
- Knowledge that there may be known unknowns that they may experience when they execute a complex undertaking.

The purpose of the mock-ups and/or dry-runs is to identify and address potential issues and challenges associated with the uniqueness of the equipment interfaces, work environment and conditions (e.g., small footprint, congested work area, coordination between multiple job functions and organizations).

The primary objectives of the performing mock-ups and/or dry runs are:

- Allow people to work in an environment that is relatively free of industrial hazards and accumulate no dose. The mock-up and/or dry runs give staff an opportunity to become familiar with hazards and develop mitigation plans under less stressful conditions.
- Allow experimentation with methods and tools prior to the evolution so we know we're undertaking the actual evolution with the most ideal system and tools.
- Allow very accurate time dose estimates to be generated based on actual cut times and overall time of removal evolution.
- Make everyone more comfortable and efficient with the team, processes and procedures.

During exit meetings with the Nuclear Regulatory Commission (NRC) regional inspector, the inspector often recognized the benefits of PG&E performing mock-up during decommissioning and their worthy investment in the task at hand. Examples of key mock-ups that were conducted at HBPP included:

A full mock-up of loading the GTCC cask in the SFP prior to actual loading operations. This resulted in minor modification to the pieces to facilitate a much more efficient loading sequence. A heavy load dry-run with the single failure proof Vertical Cast Transporter (VCT) and HI-STAR cask was also performed.

Removal of the Control Rod Drive Mechanism (CRDM) project led to several successes and improvements. Two key improvements in the removal process were creation of a yoke system vs. the planned problematic dual winch and a decision to segment drives below the RPV in lieu of taking them to refueling floor in one piece.

The RPV project team, including subject matter expert consultants, spent considerable time developing robust design criteria for the RPV shell segmentation project. This included additional time and resources at the subcontractor's home office during initial tooling startup and testing to better understand the equipment. The project team then reviewed additional lessons

learned from the industry from different tooling supplies and further developed criteria that would enhance the segmentation equipment. The results of this research and testing became the enhanced and extensive robust design acceptance criteria. These criteria were used by the subcontractor to increase the robustness and modification of the equipment. An example criterion was setting maximum vibration tolerance (to minimize vibration) on the cutting equipment which resulted in modifications to stabilize and reduce flexure of the equipment.

During the RPV campaign changeover from running cutting equipment to pulling RPV windows the RPV crew completed a detail step-by-step safety hazards analysis that was focused on identification of potential hazards and necessary controls to mitigate the hazards. This was a comprehensive effort performed by four groups, consolidated into one and presented to management. The project team updated the work plan to include additional controls for identified hazards and potential error traps (e.g., precautions, hold points, activities that require use of error prevention tools). The first dry run duration was approximately 7 hours and the final dry run observed by Management was approximately 2.5 hours.

To add a margin of radiological safety in the conduct of the work being executed, PG&E applied foaming and fixatives inside piping, and instituted other controls including delicate glove bag operations and oversight by radiation protection personnel. The work was completed with no radiological violations from the NRC, low external exposure of personnel to date, and no uptakes of radioactive material. Prior to performing this campaign, a full mock-up and dry run of the operation was done in the Reactor Feed Pump Room including many dress rehearsals before the first cut was performed including additional cutting iterations to be implemented as a learning tool for other WACHS cutter qualified personnel.

Expectations of the mock up were: (1) provide the pipe cutting team with practical hands on experience with the pipe cutting process prior to performance of pipe cutting activities on radiological significant systems; (2) allow for the performance of a full dress rehearsal of the pipe cutting process to demonstrate readiness to cut pipe on radiological significant systems. The full dress rehearsal included use of a glove bag, PC`s, Respirators and full Radiological controls; and (3) to define the task performance assignment responsibilities from start to finish for the pipe cutting process between WACHS/craft and decontamination/radiation protection personnel.

Benefits of performing this operation included: (1) continued testing of alternative fixatives and methods; (2) trial of additional cutting equipment and additional cutting methodologies (i.e. blue line cutting); (3) evaluating different spray systems; (4) developing an acceptance criterion for the various foam products.

Overall process improvements included: (1) a more stable base below the glove bag; (2) extra tools such as side cutters or dykes should be placed in the tool bag inside the glove bag to be available, if

needed; (3) research in to and evaluation of different work gloves to identify and purchase the best possible glove for cut and puncture resistance for use in radioactively contaminated work areas; (4) worker ergonomics; (5) purchase of radios for RP to improve communications between the field technicians and foremen/supervision; and (6) development of several capture hoods such as shroud coverings for a saber saw, an online ventilation shroud to support a pipe cutter, catch pans for use inside of glove bags to protect the glove bag from cutting chips and ribbons and a HEPA in line pre-filter housing to use in conjunction with portable HEPA ventilation units.

Similarly, prior to performing work atop the reactor vessel head, radiation protection personnel worked closely with local craft performing dry runs and dress rehearsals to ensure a comfort level was obtained from the craft while working in a radiological controlled work for the first time.

Establish good solid community relationships:

From the beginning with permitting of the Independent Spent Fuel Storage Installation (ISFSI) to present decommissioning spanning more than 10 years the HBPP site and the Community Advisory Board (CAB) has developed an excellent and productive relationship with transparency. CAB Members were encouraged to provide as much feedback as possible in order for management to incorporate the concerns and ideas of the community in the decision making process. CAB Members were requested to specifically provide feedback on this issue as it will be a crucial in finalizing the decommissioning schedule and end state.

Insights about what has made the CAB successful during the decommissioning thus far included: (1) ensuring local neighbors and community members as well as elected representatives and officials participate, maintaining transparency with all possible paths to proceed; (2) committing to include as many technical experts from HBPP as possible at every meeting; (3) simplified design illustrations and presentation slides distilling through complexity of the work to easy concepts to understand; (4) field trips to the plant and inside areas remediated for the CAB members in order to examine the work completed; (5) keeping CAB members informed of events and challenges enabling them to respond back to their constituents first hand when inquiries are made about the site; and (6) an effective liaison for the committee in terms of being approachable and responsive to any questions, concerns or requests for information.

Having established a good and transparent relationship with the CAB can be helpful when working with the numerous permitting agencies. The CAB has repeatedly provided positive letters of support during the submittal of key permits.

Deliver on promise, communications and alliance:

PG&E desires to establish a positive, cooperative relationship with its Contractors based on openness, fairness, and agreement to work as a mutually productive, project focused team.

PG&E believes the work can be performed as a partnership, with both organizations focused on supporting each other to complete the work activities and tasks in a safe, efficient, cost-effective, and compliant manner. PG&E feels that this type of working relationship can be developed through mutual trust, open communications, and establishment and tracking of clear expectations and deliverables, coupled with development and maintenance of a detailed activity-based schedule. This relationship will reflect each organization's good business practices and ethics, and focus on developing fairness to each other.

Similar to establishing a good and transparent relationship with the community, the same type of relationship needs to be well developed between the Utility and site Contractors. Partnering with Contractors to establish a good client/contractor relationship and knowing where to invest your resources are essential to the success of the project. There are many phases that this relationship transitions through from bidding the work to mobilization to execution and when the project is closed out. Upfront investments and constant productive communication on both sides are needed to ensure both teams can deliver on excellence.

One key area to focus on when delivering on promise is the transition from bidding to contract award. There are details in the proposals that convey how work will be performed and an understanding of the work scope from the Contactor. Contractor proposals are developed from a set of specifications developed by the Utility defining the requirements to perform the work. Once Best and Final Offers (BAFO) are received, the next best step is for the Utility technical team to re-evaluate the proposals statements and BAFOs to ensure that the contract (i.e., technical specifications) are updated reflecting any insights or expectations or any agreed upon work scope expectations. Once the contract is awarded, the contract in lieu of the proposal defines the agreed upon scope of work.

Once this step is complete, it is important that the Contractor's proposal team that developed the proposal spend time with their field execution team conveying its commitments and expectations prior to mobilization and have periodic follow-up through their line of business to ensure services that re to be provided are meeting client expectations. Depending on company size and value of the contract, those that won the bid are not necessarily the ones performing the work. Other possibilities are the proposal team expects to execute the work, but their skill set are more appropriate to business management than project management. For much broader scopes of work with very large companies at higher values, there are inherent advantages to have the project management team responsible for executing the work to be part of the proposal team. Including key project personnel being proposed make commitments to be on the project once the contract is awarded. Once awarded and executed challenges include minimizing the turnover rate of key personnel may become a challenge resulting in a loss of continuity.

Initial mobilization should consider multiple team buildings offsite to ensure early alliance. Focus should be on development of measurable and practical milestones leading to success of the project. Setting the right work environment should emphasize relevance to the workers. That is, the coming to work is rewarding opportunity.

CONCLUSIONS

The HBPP Site Vision is to "complete the decommissioning of HBPP in a manner that establishes a new benchmark for the nuclear industry." The Vision is aligned with the corporate vision to yield a leading position in the decommissioning realm for HBPP and to promote the corporate position of a leading utility.

PG&E views the HBPP Decommissioning Project as a long-term opportunity to develop a cohesive team that will accomplish many things. As one of the county's prominent employers, maintaining the company's standing in the local community is critical. In developing a close Partnering relationship that accomplishes our Decommissioning goals, PG&E and the Contractor teams will represent both of our business interests, relationships, and most importantly, reputation. As we move forward together, PG&E and the Contractor will develop and share mutual values that address the corporate Vision, Goals, and Strategies.

Developing a strong alliance with its Contractors at the onset of work will reap many benefits and return on investments for both the Utility and its Contractors. Both teams need to work in unison to meet its objectives to safely complete its decommissioning.

Insights and key strategies conveyed throughout this paper focus on having the right resources and right bandwidth to execute this decommissioning. That is, a competent and capable team able to work through challenges. As with any decommissioning and at HBPP things change or they were not what you expected when work is executed and you need to quickly adapt to the changing conditions. Having the right team, assets and right attitude is essential through these challenges.

And first and foremost, working to sustain an exceptional relationship and standing with regulators and the community. Ensuring local neighbors and community members as well as elected representatives and officials participate, maintaining transparency with all possible paths to proceed as decommissioning.