

Progress in Decommissioning the Humboldt Bay Power Plant – 13604

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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 and initial decommissioning work, transitioned to full-scale decommissioning. Decommissioning activities to date have been well orchestrated and executed in spite of an extremely small worksite with space constricted even more by other concurrent on-site major construction projects including the demolition of four fossil units, construction of a new generating station and 60KV switchyard upgrade. Full-scale decommissioning activities - now transitioning from Plant Systems Removal (PG&E self-perform) to Civil Works Projects (contractor performed) - are proceeding in a safe, timely, and cost effective manner. As a result of the successful decommissioning work to date (approximately fifty percent completed) and the intense planning and preparations for the remaining work, there is a high level of confidence for completion of all HBPP Unit 3 decommissions activities in 2018.

Strategic planning and preparations to transition into full-scale decommissioning was carried out in 2008 by a small, highly focused project team. This planning was conducted concurrent with other critical planning requirements such as the loading of spent nuclear fuel into dry storage at the Independent Spent Fuel Storage Installation (ISFSI) finishing December 2008. Over the past four years, 2009 through 2012, the majority of decommissioning work has been installation of site infrastructure and removal of systems and components, known as the Plant System Removal Phase, where work scope was dynamic with significant uncertainty, and it was self-performed by PG&E.

As HBPP Decommissioning transitions from the Plant System Removal Phase to the Civil Works Projects Phase, where work scope is well defined, a contracting plan similar to that used for Fossil Decommissioning will be implemented. Award of five major work scopes in various stages of development are planned as they include: Turbine Building Demolition, Nuclear Facilities Demolition and Excavation, Intake and Discharge Canal Remediation, Office Facility Demobilization, and Final Site Restoration. Benefits realized by transitioning to the Civil Works Projects Phase with predominant firm fixed-price/fixed unit price contracting include single civil works contractor who can coordinate concrete shaving, liner removal, structural removal, and other demolition activities; streamline financial control; reduce PG&E overhead staffing; and provide a specialized Bidder Team with experience from other similar projects.

INTRODUCTION



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 MW_{th} (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 to make seismic modifications. In 1979, prior to the completion and acceptance of the seismic modifications, the nuclear incident at Three-Mile Island occurred and, as a result, the Nuclear Regulatory Commission (NRC) mandated a comprehensive series of other modifications that would have required additional investment. The California Public Utilities Commission (CPUC) approved an early decommissioning plan for HBPP Unit 3 because the additional investments required by the NRC made restarting the plant uneconomic.

At the time that HBPP Unit 3 entered commercial service, the nuclear fuel assemblies' utilized stainless steel as the fuel rod cladding. The stainless steel-clad fuel experienced gross cladding failures during operation. These failures were severe enough that radioactive fuel was released from the cladding and dispersed throughout numerous plant systems, contaminating these systems with alpha emitting radionuclides, i.e., transuranic elements. HBPP completed the transition from stainless steel to zircaloy assemblies in 1969.

Over the SAFSTOR period, as beta and gamma emitting radionuclides have decayed, the longer lived alpha has become a more dominant factor in dose contribution. Because alpha causes more severe biological damage when internal exposure occurs, the potential radiological dose consequences are likewise more severe.

This issue leads to a unique, plant-specific concern for HBPP decommissioning. The extent of the alpha contamination required additional radiological controls, such as use of glove bags to remove steam piping shown below, and significantly reduced the efficiency of component removal activities.



Delicate glove bag operations cutting steam piping

Over the past four years, 2009 through 2012, the majority of decommissioning work has been installation of site infrastructure and removal of systems and components, known as the Plant System Removal Phase. In this phase, PG&E established a self-perform arrangement in which PG&E provided direct supervision of a contracted work force performing work on a Time-And-Material basis or on a Cost-Plus basis. This type of contracting arrangement was optimal due to several factors including: the dynamics of maintaining specific plant systems in service while others were removed from service and the configuration control that must be maintained; removal of large components with known high levels of radiation that required slow and methodical disassembly; and removal of contaminated systems under special engineering controls and requirements. Careful planning and special measures were taken to accomplish this work with maximum safety to the workers and the public. A work scope of this nature, wherein uncertainty exists as to the exact effort that is required to perform all tasks, lends itself to Time-And-Material or Cost-Plus contracting. This phase is now largely completed. PG&E is currently transitioning from self-perform to lump sum fixed cost contracting, commensurate with the change in nature of the work.

As HBPP Decommissioning transitions from the Plant System Removal Phase, where work scope was dynamic with significant uncertainty, to the Civil Works Projects Phase, where work scope is well defined, the remaining decommissioning work has been analyzed and then described in

major, well defined Civil Works Projects. These Civil Works Projects include Turbine Building Demolition, Nuclear Facilities Demolition and Excavation, Intake and Discharge Canal Remediation, Office Facility Demobilization, and Final Site Restoration. Detailed bid specifications were developed for each project and then bids were solicited from multiple vendors. The use of competitively bid, fixed price contracts assures PG&E that the costs are fully understood and provides for some financial risk mitigation.

At the same time PG&E was commencing decommissioning of HBPP Unit 3, it also was decommissioning fossil plants located on site to provide access and lay-down for the Unit 3 nuclear decommissioning. With respect to Fossil Decommissioning, the work scope was well defined with little uncertainty associated with system and component removal requirements. Accordingly, PG&E elected to perform Fossil Decommissioning with a principal Firm Fixed-Price contract for the majority of the work. Fossil Decommissioning was very successful, achieving all safety, schedule, and budgetary goals and objectives. The model established for the Fossil Decommissioning is being adopted for decommissioning HBPP Unit 3.

PG&E evaluated the management options for decommissioning and removal of out-of-service electrical production units. Fossil decommissioning included demolition of Units 1 and 2, with a capacity of 53 MW(e) each, and removal of the two 15 Mw(e) combustion turbine units. A single decommissioning organization was chosen. It provided a better means to plan work activities, coordinate space usage, levelize staffing needs, and control and monitor costs. From the early planning efforts of defining the project scope to development of the technical and administrative specifications to obtaining competitive bids and managing the execution of the project, the project team successfully managed this project within budget and seven months ahead of schedule.



Fossil Units 1 and 2 being demolished



Above grade demolition completed

Completed Activities

HBPP successfully completed the transfer of spent nuclear fuel assemblies from the spent fuel pool in five casks to the independent spent fuel storage installation (ISFSI) in December 2008. Since the 2009 Nuclear Decommissioning Cost Triennial Proceedings (NDCTP), the site has fully transitioned into full scale decommissioning. During this period, PG&E took on some of the most challenging and laborious projects involving significant risk and radiologically significant work activities.

To support full scale-decommissioning, a significant number of required plant modifications, site improvements and infrastructure were put in place. The changes to the site and facilities included: a new 2,000 ft² radiological control access; 4,000 ft² environmental count room facility; truck portal monitors and scale; 5,000 ft² tented enclosure for radwaste handling; and 25,000 ft² of office space constructed from ten new trailers, nine re-powered trailers and six re-used trailers from Humboldt Bay Generating Station (HBGS); re-powering and implementing cold and dark program on all three units fossil and nuclear; and, 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.

PG&E completed removal of all large nuclear components, excluding the reactor vessel, and safely transported these oversized, overweight shipments to distant radiological disposal sites without incident. These large nuclear components included spent fuel pool racks, high and low pressure turbines, turbine crossover, main condenser halves, reactor head, heat exchangers, and low and intermediate heaters. The project received PG&E's highest safety award, the Sibley award, for excellence in health and safety performance in 2008, 2009, and 2010.



Removal of the Low Pressure Turbine

The 2009 Cost Study estimated a 34 month schedule for removal of the Turbine Building systems. Even though PG&E faced difficult challenges such as dealing with alpha contaminated plant systems, PG&E successfully completed component removal from the Turbine Building within the

planned 34 months. This work involved removal of many different systems and components, each presenting different challenges. By February 2012, the main steam piping, feed water piping and other plant systems had been removed from the turbine building. To add a margin of radiological safety, a multiple barrier approach was used to protect the workers and minimize the potential for spread of contamination. Multiple layers of protective clothing and respiratory protection were provided for personnel in the work area, and multiple containment boundaries such as sleeves, fixatives, and glove bags were used on the components. The concentrations and quantities of alpha contamination were of such concern to HBPP management that they felt compelled to inform the NRC due to associated risks. The alpha contamination levels have been compared to high levels found at DOE nuclear weapons sites.

A testament to the rigor of the processes implemented to control the extreme levels of alpha contamination was that the entire Turbine Building Preparation project was completed without a single incident of a worker becoming contaminated; there were no significant radiation exposures; there were no unplanned exposures; and there were no releases of contamination to the environment.

Staying on schedule has enabled PG&E to plan to demolish the turbine building one year ahead of schedule. Through a thorough competitive bid process based on technical merit and commercial terms, the demolition contractor is now mobilized, trained and preparation activities are underway to start decontamination and physical turbine demolition work in December 2012.

Other key accomplishments include a reactor vessel removal contract that is in place to remove the internals and a separate contract to segment the shell has been awarded. Removal of more than 65% of the reactor internals has been achieved to date. After twenty five years, the drywell was re-opened and the reactor head removed. The vessel was flooded, water filtered, an extension tank installed, and thirty-two control rods removed. Surveys and characterization of the reactor vessel were completed. To date, the internals removed from the reactor include the chimney and chimney clamps, upper core guide, fuel hold downs, core support plate, and specimen baskets. Current forecasts indicate the balance of reactor internals removal will be completed by second quarter 2013.

Prior to 2012, there were no licensed facilities available to PG&E to ship class B&C Low Level Radioactive Waste (LLRW). In 2012, the NRC issued a license to Waste Control Specialists (WCS) in Texas. Anticipating the very strong industry demand for access to WCS, PG&E proactively managed the process so that HBPP was at the top of the queue for the facility's acceptance of out-of-state waste. HBPP commenced its first shipment of B&C LLRW to the newly licensed facility, in October 2012 using an 8-120 A Cask containing RPV internals. HBPP worked closely with the disposal site to obtain timely State approval of import petitions, waste profiles, certifications, procedures, etc. This success eliminated the need to construct and operate

an on-site interim Class B and C waste storage facility that was applied for as a contingency plan and approved by the California Coastal Commission in October 2011.

HBPP successfully completed its fourth designated “Radiological Significant Decommissioning Activity” (RSDA) by transferring the contents of ISC-18 (remnants of spent nuclear material) into a shipping cask and shipped it to Barnwell, SC for processing in October 2012. This process waste container has been vacuum dried, helium leaked tested, and was delivered back to PG&E by end of November to be placed in the Greater Than Class C (GTCC) cask. The GTCC cask is the sixth cask and final cask. It is scheduled to be loaded in 2013 with this process waste container and highly radioactive internal components from the reactor vessel, and moved to the ISFSI for storage.

PG&E executed a contract in 2011 to remove the abandoned, out-of-service liquid radwaste tanks. To date, three of the four tanks have been removed and this resulted in a significant reduction of high-risk alpha contaminated system tanks. The remaining spent resin tank is expected to be removed early 2013.

Project Challenges as the Site Transitions to Major Civil Projects

A Request for Proposal (RFP) bid package was completed mid-2012 and issued to perform the major civil works scope for decommissioning. The RFP process is still in progress and during this period an evaluation of the need to remove the deep reactor vessel caisson structure, and a feasibility study for its removal, were also completed. The conclusion of this evaluation and study was to recommend removal of the caisson. The major civil works RFP is currently being updated to include this new scope of work. As HBPP Decommissioning transitions into this new phase of Civil Works, the site’s challenges will change, and the following are key challenges that the site will work through in its preplanning efforts:

- Weather;
- Site Coordination and Congestion;
- Installation of a Slurry Wall;
- Below Grade Obstructions;
- Deep Excavations;
- Demolition Debris, Soil, Sediment, and Cross Contamination Control; and
- Intake and Discharge Canal Remediation.

Weather: Eureka receives about 75 percent of its average annual rainfall during the rainy season, generally October through April, with greatest monthly totals in December and January. Eureka's average annual rainfall over the 110-year period is 38.87 inches. The rainy season will affect the Contractor's ability to load waste into shipping containers. A covered waste management facility will be constructed and will be available for packaging and shipping demolition debris and soils. However, the size of the facility, the area available for staging empty and filled intermodals, and the ability for PG&E to ship intermodals during the rainy season may affect the rate at which the structures can be demolished.

Site Coordination and Congestion: The site footprint is extremely small and constricted. There will be other contractors onsite for previously contracted or planned, scope-specific decommissioning activities through 2014. Coordination between all parties performing work onsite is critical for success. Very little space is available onsite for laydown areas, soil stockpiling, demolition debris, and equipment operation, including demolition machines and truck traffic. Significant delays or inefficiencies may be unavoidable due to interference and coordination with other site activities. The constricted space may limit the pace of demolition and excavation. A well-developed traffic plan is essential to optimal demolition sequencing and material handling/management.

Installation of a Slurry Wall: The removal of the Spent Fuel Pool Liner and concrete Spent Fuel Pool are within the baseline scope of work being sought by PG&E. The Reactor Caisson and Foundation Piles removal is part of a six-month feasibility study to develop a practical conceptual plan, schedule, and estimated cost. This study has been completed and a decision to remove the massive concrete structure has been made by PG&E. However, from the investigative work completed to date, it appears that a slurry wall to approximately one hundred and seventy (170) feet below grade to the Unit F clay layer will be necessary in order to manage groundwater for the removal of the concrete Spent Fuel Pool and/or Reactor Caisson. An early installation of the slurry wall should be considered to mitigate in-leakage to support the Spent Fuel Pool Liner removal in 2014. Additionally, depending upon the geometry of the slurry wall, large-scale open excavation groundwater control would not be required for removal of the Unit 3 Turbine Building foundation or equipment and floor drains.

Prior to installation of the slurry wall, any remaining utilities, such as fire protection, would be relocated outside the slurry wall or, in the case of cold and dark power, re-routed to pass over the slurry wall. In addition, any radiological contaminated soil, including industrial contaminants along the slurry wall alignment, would need to be removed before the wall is installed to avoid contamination spread to lower levels.

Below Grade Obstructions: Underground utilities and other underground commodities that have not been appropriately documented may be encountered during installation of a support of excavation system (e.g., slurry wall or piling) or during open-cut excavation. Original plant design drawings of underground utilities and commodities are available, but the installed configurations may not match the design drawings. Systems may have been added or altered without corresponding as-built documentation. Obstructions should be anticipated and contingency plans will be developed for unexpected obstructions in the excavations.

Previously unidentified areas of radiological or non-radiological contamination associated with unidentified underground commodities may also be encountered during excavations. This may require additional measures, including soil sampling and segregation of soil stockpiles, to be applied to appropriately manage potentially contaminated soil that was unexpected and will require increased coordination with PG&E in responding to such discoveries. Contingency plans developed by the Contractor should also anticipate previously unidentified areas of contamination during excavations.

Deep Excavations: Excavations deeper than (+) 8-foot elevation (approximately 4 feet below grade) will require water control. Numerous excavations will be deeper than 4 feet and the Contractor will be responsible for collecting and pumping the water into holding tanks provided by PG&E. Due to the depth of these excavations, shoring may be required for water intrusion and for stabilization of trenches.

Excavation spoils have to be sampled for hazardous constituents before disposition for reuse or offsite disposal. Spoils shall be stockpiled until sample results are received, generally a 14-day turnaround. Soil piles shall be maintained and managed to prevent water runoff and potential cross-contamination. Due to the small footprint of the Site, there is limited space for stockpiling soils. Additionally, PG&E's ability to ship soils will be a factor. Soil stockpiles may accumulate faster than PG&E can package and ship the soil offsite. An integrated plan for soil stockpile management and transportation on and offsite are key to optimal use of resources. In addition, PG&E is required to periodically report to state regulatory agencies on soil management activities, including tracking of soil from initial excavation, through stockpiling, onsite reuse, or offsite disposal. In addition, the Contractor may be limited to the size and depth of excavations by water intrusion, if the volume of water exceeds PG&E's capacity for processing groundwater (~300 gpm).

Demolition Debris, Soil, Sediment, and Cross Contamination Control: Demolition debris, soil, and sediment from the canals are likely to accumulate faster than PG&E can characterize, package, and ship the debris for disposal. To reiterate previous challenge statements, limited space for stockpiles could constrain the pace at which buildings can be demolished. Because of the small

usable plant site, the Contractor is expected to have controls in place to prevent recontamination of previously cleared areas. This requirement may restrict work at times.

Intake and Discharge Canal Remediation: Contractor challenges include excavation of contaminated sediment and soils in a wetland and coastal condition. This scope of work includes installation of a cofferdam or temporary water control structure to prevent influx of water from Humboldt Bay and other water during excavation and final status survey (FSS) activities. This water control structure shall remain in place until work is substantially complete and storm water, groundwater, and liquid from dewatered sediment must be managed. Dewatering sediment, containing drip along the shoreline, and preventing cross contamination in a congested construction zone will be a challenge. The outfall pipes to the Bay include asbestos-containing materials that will require special handling and disposal. The Discharge Canal is actively filling with sediment from the Bay and the volume of sediment to be removed and disposed has tripled in the past year. Permits and restrictions on work in wetlands will dictate what the Contractor must perform. These permit applications, which are yet to be prepared, must be submitted for approval.

CONCLUSIONS

After 30 years of SAFSTOR operations the HBPP decommissioning project has made significant progress over a period of four years 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 four years the decommissioning project has successfully completed fossil plant decommissioning, numerous site infrastructure improvements and removal of all large nuclear components and safely transporting these oversized, overweight shipments to their disposal sites. Now, after a year 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 successfully transitioned into full-scale decommissioning.

With the removal of plant systems phase now largely completed, the nuclear decommissioning effort will build upon the success of the fossil decommissioning project as it proceeds with this final phase of the project. The remaining nuclear building demolition work or civil works effort is similar in nature to the fossil decommissioning project with scope-specific work, proven methodologies, and predefined boundaries. Detail planning efforts and request for proposals are in place to transition from self-perform to lump sum fix cost contracting to a single civil works contractor.