Development of Decommissioning Strategy Humboldt Bay Power Plant – 14527

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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 (starting May 2009). In July 2013, PG&E awarded a major contract which transitions the site during 2014 from the Plant Systems Removal Phase to the Civil Works Projects Phase, where work scope is well defined, and follows a contracting plan similar to that used for HBPP Fossil Units 1 and 2 demolition (2010 – 2011) and HBPP Turbine Building demolition (2012 – 2013).

PG&E awarded four major work scopes in 2013, the Civil Works Project Phase, to a single contractor and they include: Nuclear Facilities Demolition and Excavation, Intake and Discharge Canal Remediation, Office Facility Demobilization, and Final Site Restoration. The Civil Works Projects Phase include: a single civil works contractor who can coordinate concrete decontamination; spent fuel pool (SFP) and liner removal; above and below grade structural removals.

The HBPP historical design and construction, close proximity to the bay and associated tidal interactions poses unique challenges to planning for and executing an effective decommissioning effort.

This paper focuses on PG&E's work completed in 2013 including: completion of reactor vessel internals segmentation; preparations for reactor vessel shell segmentation; plant systems component removal; completion of turbine building demolition; and Site transition from directing self-perform work to oversight of a major civil works contractor.

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 utilizing the services of Enercon, DW James, Project Services Group and Anata Management Solutions to prepare for the initial phases of a self-performed decommissioning. 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. This effort also included the experience gained by the

PG&E Decommissioning Organization in the project management and bid specification development by CH2MHILL and execution of the adjacent HBPP Fossil Units 1 and 2 demolition projects by Silverado Contractors Inc. from January 2010 to August 2011.

The goal of the HBPP Decommissioning Project is to be the industry benchmark for the safe and environmentally sound decommissioning of a nuclear power plant, and to further PG&E's vision of being the leading utility in the United States. It is the mission of the 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.

Putting the Pre-Planning Team in-Place

In May 2011, PG&E formed an interdisciplinary and broad-based subject matter expert team comprised of many companies including CH2MHILL, Cooper Zietz Engineers, Inc., Northwest Demolition, Bartlett Nuclear, and Rosbar Enterprises, Inc. to develop and vet fifteen technical specifications accompanied by ten administrative specifications. The specifications developed by this technically focused group defined the requirements and criteria to complete the remainder of the decommissioning at HBPP, including a plan for final site restoration.

The Specifications Development Team met every week for twelve months and a Long Term Strategy Team starting December 2011 met every week for seven months developing the level 1 Long Term schedule led by RLB/CPR Group. By June 2012, PG&E captured this effort in its Decommissioning Capstone Document. PG&E developed this document to present key project tenets, principles, key internal stakeholders, and the pool of bidders who were interested in pursuing a long-term relationship with the company during HBPP Decommissioning. The Capstone document purposefully focused on the critical work that was to be accomplished.

PG&E invested a significant effort to develop Bid Specifications that were thorough and complete with clear definition of scope and strong emphasis on safety and environmental compliance. PG&E's Bid Specifications included all HBPP safety and environmental expectations and specific requirements so Bidders clearly understood the culture that is paramount to successfully perform work at the HBPP Site. PG&E expects that all work is performed with safety at the forefront and built into every aspect of work execution, and that all work is accomplished in a manner that will protect the environment and assure the local community that the HBPP Site will be left in a condition that at least meets, if not exceeds all requirements.

Turbine Building Demolition Project

In 2011, PG&E defined the scope of Turbine Building demolition as a stand-alone procurement to allow early demolition of the building as the Specification Development Team continued with the development of the scope of work for the remainder of the project. Removal of the boiling water reactor steam and condensate systems by Fluor Enterprises, Inc. from the Turbine Building was completed in early 2012. The contract for asbestos abatement and surface decontamination and demolition of the Turbine building and installation of a Waste Management Facility was awarded to Kiewit Power Constructors Co. in August 2012 with work scope planned for completion in 2013. The Request for Proposals for this scope of work was issued in April 2012. This strategy also allowed PG&E to gain experience managing another major demolition project similar to Fossil Units 1 and 2 by Silverado Contractors Inc. prior to awarding the major Civil Works Projects contract.

Demolition of the Turbine Building was originally planned for December, 2013 through February, 2014. Removal of the Turbine Building contaminated systems was completed on schedule leaving an empty Turbine Building superstructure. Project conditions afforded the opportunity for acceleration of the schedule and the Turbine Building project was pulled forward by one year. This decision also had several other benefits, including: re-establishing a leveled waste shipment campaign, in keeping with Project commitments to a key waste disposal site; provided opportunity to evaluate a demolition contractor performance on a limited-scope task prior to award of the larger demolition work (Civil Works Projects); and creating much-needed work space on the small site footprint.

Proposal Phases of the Civil Works Projects

PG&E conducted the request for proposal for the Civil Works Projects in two phases starting in June 2012. Phase 1 included the identified work scopes but excluded caisson removal, which was still being evaluated under the assumption that caisson removal would be addressed at a later date. Phase 2 was identified as the Best and Final Offer (BAFO) to include the Phase 1 scope, emergent scope identified during the bid and review process; and caisson removal.

In March 2012 and in parallel with development of the Civil Works Projects bid specifications, PG&E awarded a competitively bid contract with a Supplier for a "Caisson Removal Feasibility Study". The original plan was to decontaminate and abandon the -80 foot deep caisson in place. This was consistent with general industry decommissioning experiences and planning for nuclear facilities to leave in place all structures three feet or more below grade (with the exception of the contaminated SFP), including the concrete caisson surrounding the reactor vessel. The purpose of the study was to establish the feasibility for removal of the submerged caisson and the estimated costs. This scope included identification of preliminary engineering designs needed to effect the caisson removal. In December 2012, the decision was made to include caisson removal in the scope of the Civil Works Projects. The results of the study which were completed in October 2012 were included in Phase 2, BAFO Specifications, for all bidders to utilize in preparation of their revised proposals. The initial RFP or Phase 1 was issued to eight potential bidders in June 2012 and three proposals were received in September 2012. Phase 2, BAFO, was issued to all

Phase 1 bidders in December 2012 and proposals were receive in April 2013. The Contract was awarded to Chicago Bridge and Iron Company in July 2013, thus from initiation of the development of the specifications to contract award this effort took approximately two years to complete.

HBPP Unique Design

In the case of Humboldt Bay, the caisson was a first of its kind to house a nuclear containment structure, pressure suppression chamber, and nuclear steam supply system below grade. A caisson is a water tight structure used as a foundation or to carry out work below grade. Caissons have been used for centuries as building foundations and, occasionally, as structures housing activities such as garages and pump stations. The initial advantages of using a caisson included additional radiological shielding provided by the soils, physical protection being below grade and external pressure suppression in the event of an accident. The caisson was constructed by forming 13 foot concrete sections above ground and then excavating and water jetting the ground from underneath the sections, thus allowing it to “sink” into the earth. This technique allowed the work force to remain above ground and minimized the need for temporary shoring to build the structure. The construction of the caisson ultimately placed the lowest floor at approximately 66 feet below sea level, the bottom of the structure about 80 feet below grade, and most of the structure is below the water table.

To accommodate the deep structure removal, the project scope was expanded to include: installation of a cut-off slurry wall 170 feet deep surrounding the caisson to a clay layer; installation and operation of a dewatering system inside the slurry wall to remove and control water infiltration; removal or the caisson; and waste management and handling.

COMPLETED ACTIVITIES

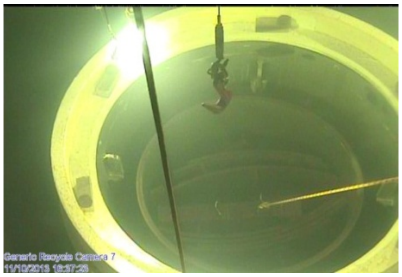
HBPP successfully completed removal of the reactor vessel internals in September 2013 by Energy Solutions and its tooling contractor Siempelkamp Nuclear Services. The transfer of Greater Than Class C (GTCC) components into Independent Spent Fuel Storage Installation (ISFSI) Cask 6 was completed in November 2013 by Anata Management Solutions and Holtec International. Throughout 2013, PG&E and its key Suppliers Fluor Enterprises, Bartlett Nuclear and Energy Solutions took on some of the most significant risk and radiological significant work activities such as Control Rod Drive Mechanisms removal, piping systems and components removal from the off-gas tunnels, suppression chamber down-comers piping removal and removal of the spent resin disposal tank and components from the Liquid Radwaste System. In addition, Turbine Building demolition was completed one year earlier than planned. Also, two new key plant systems were installed and placed into operations in 2013 - a Ground Water Treatment System (GWTS) and a Filtration and Ion Exchange System (FIXS), which replaced the existing liquid radwaste treatment system. The site continues to accomplish these scheduled tasks safely without any incidents or violations.

Cost Effects of Scope Changes

The cost basis for decommissioning in 2009 included leaving the subgrade structures in place. A cost estimate was submitted to the California Public Utilities Commission (CPUC) in the form of a Nuclear Decommissioning Cost Triennial Proceedings (NDCTP) case. Since the NDCTP submittal, the site has fully transitioned into full scale decommissioning. Significant scope changes have occurred since 2009 including the increased scope of caisson removal, intake/discharge canal soil remediation quantities, and costs associated with actual vendor bids to perform the work in lieu of estimates. PG&E filed its 2012 NDCTP with the CPUC in December 2012, which reflects the changes in scope.

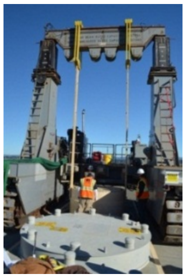
Loading the GTCC Cask into ISFSI

The GTCC cask is the sixth and final cask for placement at the Humboldt Bay ISFSI under a site specific Part 72 license. Earlier, the ISFSI was loaded with five HI-STAR HB casks between August 2008 and December 2008 containing all the spent nuclear fuel stored onsite. The GTCC cask is a HI-STAR HB using a similar design as the spent fuel casks to facilitate licensing under the existing Part 72 license. The GTCC cask was loaded in 2013 with activated metal made up of highly radioactive internal components from the reactor vessel and process waste. The cask was processed in the same manner as the spent fuel cask and with that experience was performed efficiently and without incident. PG&E also conducted a full mock-up of loading the GTCC cask in the SFP prior to actual loading operations resulting 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. The use of the mock-up and its inherent benefits were recognized by the Nuclear Regulatory Commission (NRC) regional inspector. Since the GTCC cask was being placed in the ISFSI vault adjacent to spent fuel casks, the VCT was used to ensure that single failure proof crane requirements were met.



Loading RV Internals
into GWC in the SFP

VCT Transporting GTCC Cask 6



Lowering into Vault

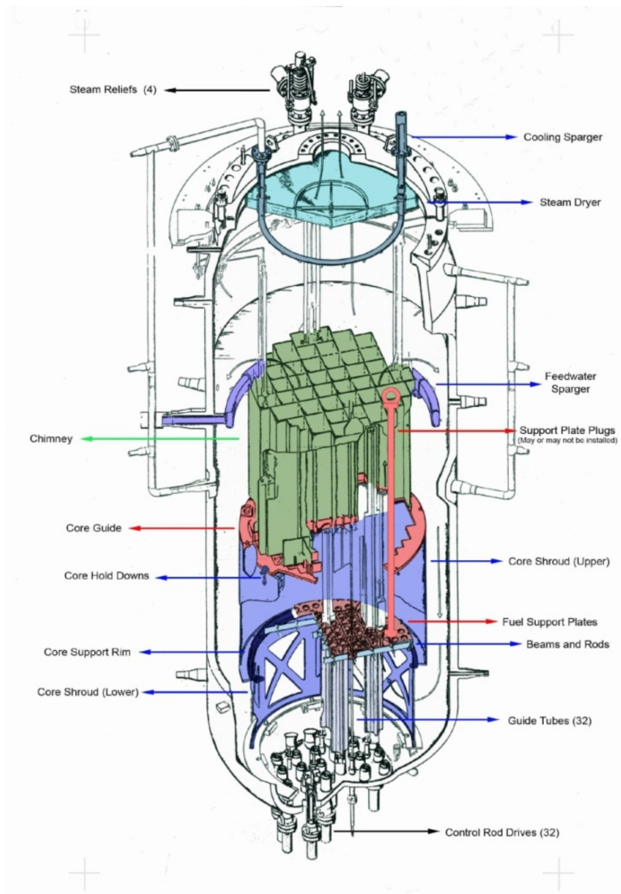
The GTCC Waste Container (GWC) contained waste from the dismantlement of the reactor vessel internals project that was completed in September 2013 and other debris that had been stored in the spent fuel pool. HBPP received NRC approval of Amendment 3 in September 2013 to its site specific license to load the GWC and place it within a HI-STAR HB for storage at the ISFSI. The Process Waste Container (PWC) loaded within the GWC contained resin and other miscellaneous special nuclear material wastes. The PWC had been previously loaded and sent to Energy Solutions for processing in 2012. This processing included placement in an industrial oven for the removal of all organic material, vacuum drying the internal space, and backfilling the container with helium.

Completion of Reactor Pressure Vessel Internals Removal Project

The Reactor Pressure Vessel (RPV) is a large component in the Unit 3 building at HBPP. A six-month study was completed by Transnuclear, Inc. in early 2010 to determine the best removal and disposal method. The goal was to perform the work in a safe and As Low As Reasonably Achievable (ALARA) conscious manner, while optimizing the schedule and budget.

The vessel, which was drained in the mid-1980s in preparation for layup until decommissioning began, was refilled with water to limit the spread of airborne contamination and reduce radiological "shine" from activated components during the segmentation of the RPV internals.

Alternatives to remove the vessel intact were investigated but did not identify means that were both acceptable for radiological exposures and practical to implement. Additionally, means to transport the vessel within the regulatory framework had not been found. Based on the findings from the risk assessment and the lack of alternative approaches for removing the vessel intact, it was decided in November 2010 to change the approach from partial removal/segmentation of the reactor internals and no segmentation of the vessel to full segmentation of the internals and full segmentation of the vessel.



HBPP Reactor Pressure Vessel
65 MWe General Electric Boiling Water Reactor

The segmentation and packaging approach for the RPV internals included storage of Class B&C waste at the HBPP site until an off-site waste disposal facility was identified. Under this strategy, the segmented RPV internals waste was planned to be loaded underwater directly into shipping cask liners staged in the Spent Fuel Pool (SFP). This approach was deemed appropriate as it maximized the volume for waste and minimized the on-site storage requirements. Subsequent to issuance of this plan, the Waste Control Specialists (WCS) waste disposal facility in Texas opened to receive Class B&C waste; transporting Class B&C waste directly to WCS eliminated the need for an on-site storage facility.

The initial strategy planned by the RPV internals subcontractor Energy Solutions for disposal of the control rod blades (CRBs) followed industry-standard approach, i.e., processing (size-reduction via cutting and crushing), and packaging into waste containers for disposal or storage as Class B&C waste. HBPP worked with the subcontractor to revise this strategy to ship the CRBs whole using Transnuclear TN-RAM shipping casks with waste storage liners acceptable to WCS. The change from the previous plan of cutting and crushing the blades and loading the CRBs intact into these commercial casks yielded multiple benefits. Use of the casks expedited onsite source term reduction by shipping to WCS earlier than otherwise possible, and removed concerns and risks associated with controlling the CRBs' highly-activated stellite bearings. This option also eliminated issues with the anticipated introduction of tritium into the SFP. Significant cost avoidance was achieved shipping the CRBs intact: whereas processing the CRBs prior to packaging was scheduled for several weeks of field activities, packaging the intact CRBs required less than a week of field work. Preventing the introduction of tritium into the SFP also eliminated the need to process or dispose of the tritium contaminated water further saving costs.

Due to the radiological contamination and irradiation of the RV internals, segmentation of the components was most often performed under more than 8 to 10 feet of water either in the SFP or in situ in the flooded RPV. Accessing the components and maintaining the segmentation tools underwater required the use of long-handled tools. Activities such as tightening and loosening fasteners, securing rigging, aligning equipment, moving containers, and removing and replacing tools for maintenance required that long-handled tools be used. In addition to requiring specialized training and skills for the workers, efficient use of the long-handled tools underwater required good water clarity, illumination, and continual use of remote cameras.

The segmentation of RPV internals used specialized tools and equipment that were prototypes and unique to HBPP Unit 3 RPV internals segmentation. Because the contractor used different tools at different phases of the project, individual tool performance issues were limited to a specific time period. Although this prevented full use of the experience, a great deal of knowledge was gained during the internal segmentation work that was directly applied to the vessel segmentation design. Areas of focus included tooling designs and testing, tool changeover and methods, equipment maintenance intervals, and spare parts inventories.

The project team, including subject matter expert consultants, spent considerable time developing robust design criteria for the shell segmentation project awarded directly to Siempelkamp Nuclear Services. 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.

Completion of Liquid Radwaste System Tank Removal Project

Decommissioning of the Liquid Radwaste System (LRWS) Phase 1 which was awarded to Energy Solutions included removal of the two Concentrated Waste Tanks (CWTs), the Resin Disposal Tank (RDT), the Condensate Storage Tank (CST), and relevant interconnecting piping. Phase 1 work entailed radiological characterization of tank contents and piping components for end-state disposition, ventilation system modifications to allow mechanical segmentation of the tanks, and removal of selected structural elements which obstruct tank segmentation. The work involved specialty contractors, skilled trades, radiation protection personnel, engineering, planning personnel, and job-specific materials.

Access to the RDT and CST vaults needed to be improved for decommissioning by cutting through their concrete containment walls. Removal of the CWT and the CST tanks were executed as planned with no significant unplanned issues. However, radiological conditions and concrete handling limitations necessitated radiological controls and changes in the wall cutting strategy between the CWT and the RDT that increased the complexity and/or duration of the work. Contaminated standing water in the RDT vault and uncharacterized radiological conditions on the RDT side of the vault wall led to additional HEPA-filtered ventilation equipment, containment barriers, and personal protective equipment which were not foreseen during planning.

After RDT vault access was created, the physical and radiological conditions inside the RDT vault required changes to the planned RDT segmentation approach. The space between the RDT and the vault walls was not sufficient to allow the same approach as the CWTs to be followed. Abandoned materials discovered in the RDT vault included a mercury-containing instrument line that, if broken, would create significant quantities of mixed waste. Removal of the materials and instrument line before RDT tank removal mitigated potential waste concerns and helped keep radiological exposures ALARA.

Once the vault floor was cleared of standing debris, and leaked resin and sludge, surveys showed the RDT contained several unforeseen high-dose areas as well as significant quantities of removable contamination. Several applications of fixative were needed to maintain contamination control. A revised approach (to segment the RDT from one side to the other versus top down) took into consideration ALARA and waste handling considerations. Inspection of the RDT during segmentation found that its structural integrity had been compromised due to corrosion. Additional engineered controls were developed and implemented to ensure personnel safety during final segmentation activities.

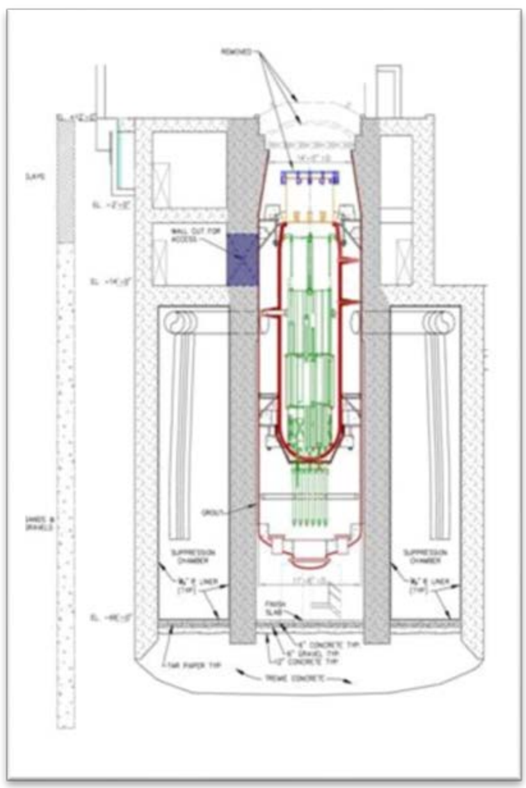
After initial segmentation activities, the RDT was more thoroughly cleaned, however several high-dose areas remained. Further radiological controls (e.g., additional shielding) and refinements to the approach (e.g., removing RDT interior piping earlier) were able to keep radiological exposure levels within forecast limits.

Accounting for the above issues and the attainment of ALARA and safety goals, the project was successfully and safely completed.

Suppression Chamber Down-comers Piping Removal

Access to the Suppression Chamber for decommissioning utilized a previously established opening at the bottom of the caisson installed during SAFSTOR. PG&E with Fluor Enterprise providing site labor services for HBPP decommissioning successfully completed the removal of the bottom portion of the down-comers inside the suppression chamber. The work required extensive scaffolding to reach the upper areas of the suppression chamber and rigging to lower the segmented pipes to the bottom of the chamber for further size reduction and staging prior to release in containerized bags for disposal.

As discussed earlier, the reactor containment is located in a caisson, which is entirely below grade and is comprised of the reactor containment (drywell) and suppression chamber. The suppression chamber is located concentrically around the drywell with the exception of a vertical access shaft. The suppression chamber extends 49 feet from the bottom of the caisson at elevation 66 ft. to the underside of a three foot thick concrete roof at elevation -17 ft. During plant operation the suppression chamber contained water to a depth of about 17 feet.



Reactor inside Concrete Caisson Below Grade

Six 40 in. diameter radial pipes connect the drywell vessel to a common 40- in. diameter, equalizing ring header near the top of the suppression chamber. From the bottom of the ring header, 46 equally-spaced 14 in. diameter pipes extend down to elevation -54 ft., which was approximately 6 feet below the surface of the water.

Work in this area included installation of a plant ventilation system modification to provide better air flow and quality to the work locations, removal of two elevated personnel platforms, and removal of pipe 20 in. diameter and smaller. The scope of work initially included the removal of the 40 in. diameter radial drywell vents and ring header piping. However, subsequent radiological surveys showed piping above the water level in the Chamber could be removed during open-air demolition of the caisson. Thus, the drywell vent piping ring header and down-comer piping above the Chamber water line was subsequently re-sequenced and integrated in April 2013 with the removal of the concrete caisson. Therefore, with the decision to remove the caisson and the as found radiological conditions there was no need to continue with surgical removal of the ring header and upper portion of the down-comers.

Off-gas Tunnel Piping Systems Removal and Decontamination

Congestion and Contamination levels in the Tunnels Posed Many Challenges
The Above Photos Show a Before and After Condition

In 2013 PG&E with Fluor Enterprise successfully removed all piping and components from East-West and North-South Off-gas tunnels. The off-gas holdup tunnel, a portion of which runs under the Refuel Building grade slab, provided an enclosed route for liquid and gaseous radwaste piping running between the Refuel Building and the LRW Building.

During the planning and execution of the work, additional access to the off-gas tunnel for decommissioning was created by cutting into the wall below grade from the off-gas re-combiner vault. In addition, a monorail and metal containment structure was built over an existing access hatchway to the tunnel in the north yard to allow ease of lifting the piping and components from the tunnel below.

Difficulties working in the tunnels included confined space entries and use of respirators. The job supervisor and crew assigned to this work had previously undertaken a similar complex confine space entry. They were also responsible for segmentation and size reduction of the steel plate “condenser elbow” (which connected the turbine to the condenser). Their experience and diligence are credited for the early and safe completion of the off-gas tunnels.

With the success of this effort by a highly focused crew, the work was expanded to include the much smaller liquid radwaste tunnel measuring 3 ft. 4 in. by 2 ft. 6 in. and 56 feet in length. Because of the contamination levels, confined space and highly congested areas, initial plans considered filling the tunnels with grout and concrete wire sawing the tunnel out in sections.

Once all piping systems were removed, the tunnels were decontaminated, MARSAME surveyed, coated. They are planned to be removed by the Civil Works Projects contractor.

Installation of Groundwater and FIXS

Design, engineering, permitting and project management of new process systems that were required to facilitate decommissioning in 2013 were developed by Kahler Engineering, Whitchurch Engineering and CH2MHILL.

Installation of the new GWTS completed 2013

The decommissioning of the HBPP will eventually involve removal of subgrade structures, or portions thereof, which will require excavations below the water table. Work within such excavations will require that the excavations be pumped to maintain a safe environment for work and allow efficient removal of subgrade structures. Currently, excavation dewatering activities have been mostly limited to minor trenching activities. In preparation for this work, the GWTS was designed and installed in 2013.

The presence of shallow groundwater at HBPP is known and when excavations for demolition of Unit 3 structures and utilities begin, the volume of groundwater to be addressed is expected to exceed the capacity of existing method for disposal of ground water via a permit with the Humboldt County Sewer District (HCSD) with a limit of 10,000 gallons per day. The GWTS system capacity is 300 gallons per minute and will treat for pH, sediment removal, hydrocarbon reduction and dissolved Nickel and Copper reduction, sufficient to meet the California Toxics Rule for discharges into Humboldt Bay. For deeper excavations near the caisson, the GWTS assumes that a water isolation wall (i.e., a slurry wall) is constructed to significantly reduce groundwater in leakage into those excavations.

In addition, to prepare for removal of the LRWS, a Filtration and Ion Exchange System (FIXS) was installed in 2013. This system was also required to prepare for shipping liquid radwaste off site for disposal when the normal discharge pathway through the outfall canal is lost during its decommissioning. When Fossil Units 1 and 2 shutdown in 2010, the silting of the canals increased with the potential to block the path for liquid radwaste discharges through the outfall canal. The new system installed in the Refueling Building collects and processes waste water that is collected from the Turbine Building Drain Tank, Reactor Equipment Drain Tank, and Caisson Sump. The water is pumped through the FIXS to the Spent Fuel Pool (SFP), then cleaned and recycled for release to an offsite disposal location. A significant advantage of the new FIX system is that it is not dependent upon the Radioactive Liquid Effluent Monitoring System (RLEMS) which allowed release of this previously designated safety system for decommissioning.

FIXS installed inside Refueling Building

Completion of Turbine Building Demolition

Demolition of the Turbine Building
First of Five Major Civil Works Projects Underway

Turbine Building-work included asbestos abatement in all areas, erection of exterior scaffolding for shrink wrap containment enclosure, installation of shrink wrap, and installation of a Waste Management Facility. Open-air demolition of the PCB and lead-coated concrete of the Turbine Building, if not monitored and controlled, has the potential to adversely impact the environment on many fronts. During the execution of the work from planning to implementation, due-diligence was applied to protect the site, the workers, and the public; and to comply with all appropriate environmental regulations and permit requirements. The project was successfully completed in September 2012. Management methods and practices utilized on this work will be carried forward to the civil works contract.

WASTE DISPOSAL

An integral aspect of the overall decommissioning plan at HBPP has been a well thought out waste disposal strategy implemented by CH2MHill, Newex, LLC, and North Coast Fabricators. Strategies focused on disposal options and alternatives that were well integrated into long term planning. Disposal pathways and means and methods were built into the work packages in the field. Primary focus and drive of the waste disposal strategy was to remove higher activity components of the plant in a disciplined manner so that the remaining plant can be effectively and safely removed as a "civil works" effort. The HBPP site has transitioned from SAFSTOR through fuel movement to component removal and is now focusing on bulk demolition activities. The initial focus of the internals and process component effort results in source reduction and enhanced worker safety but also requires higher activity waste to be packaged, shipped and disposed in a fully compliant manner.

B/C Waste being loaded in Energy Solutions Cask

Cask loaded on truck for shipment to Texas WCS facility

The project has successfully removed GTCC items and moved to storage at the ISFSI. The project has also removed from the plant, packaged and shipped for disposal all B/C waste. The campaign to ship the B/C waste included components from the reactor pressure vessel as well as sludge like material that was concentrated in the various processes at the plant. The campaign to remove from the plant, characterize, package for disposal, transport to the Waste Control Specialist (WCS) disposal facility in Texas and dispose was recently completed.

Since the closure of Barnwell, SC, to non-Compact states, HBPP commenced its first shipment of B&C LLRW to WCS in Texas, 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. 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. 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.

The B/C shipping campaign represented removal of approximately 75% of the total radioactivity shipped for disposal since decommissioning began. This culminated a coordinated effort from establishing contracts with the disposal and transportation contractors, segmentation of the waste in the plant, loading the shipping liners, cask receipt, and loading, documentation preparation, multi-state shipping permits, security arrangements and ultimately the disposal of the waste.

The project team identified and implemented several innovative approaches to packaging, shipping and disposal for the identified B/C waste material. The control rod blades were planned to be size reduced in the spent fuel pool, packaged and transported in either 8-120A or B casks. The team continued to review plans and was able to identify a cask for shipment that enabled the project to avoid size reduction of the blades. On-going characterization identified a portion of the chimney as type A waste that had been planned for B/C disposal. This resulted in less in plant work to size reduce the chimney for B/C disposal and the associated reduced risk to workers as well as the ensuring that the countries B/C disposal capacity is utilized effectively.

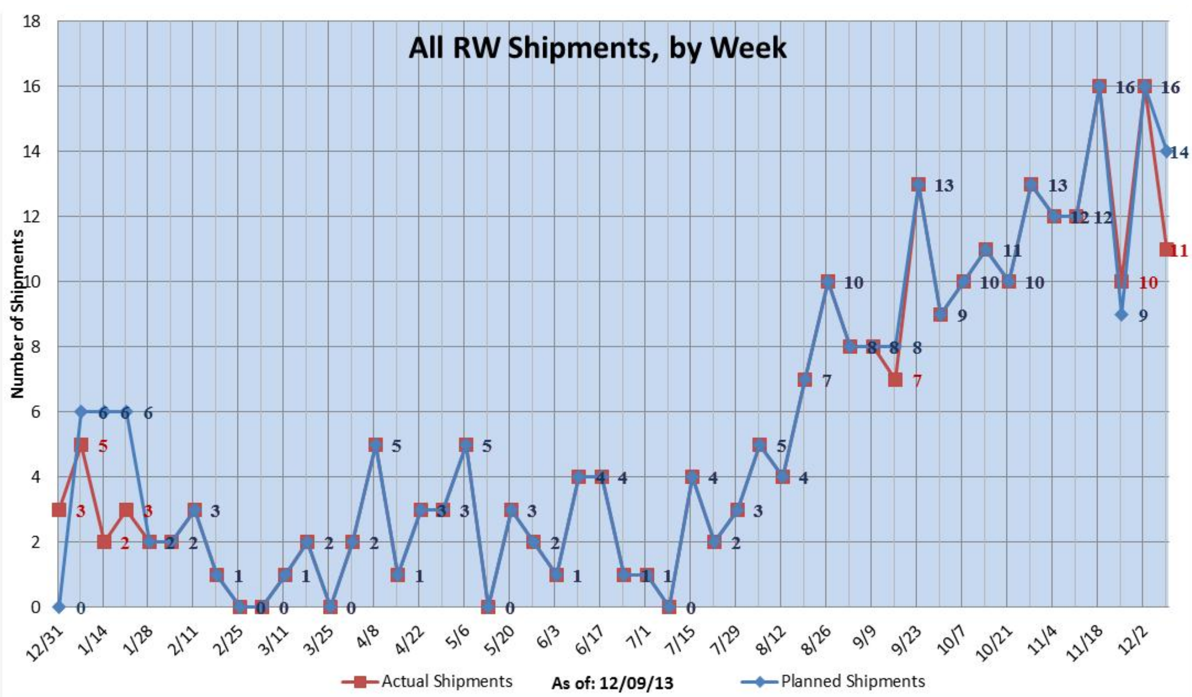
2nd TN RAM of Control Rods Shipment to WCS

RV Internals Chimney being Shipped

The HBPP Decommissioning project waste volumes requiring shipment will increase approximately 10 fold as the project transitions from internals and component removal to large scale civil work activities. The project has historically completed 2-4 waste shipments a week. The shipments included a full range of disposition pathways including limited recycle and re-use, specialty processing prior to disposal, source recovery and direct to disposal. The project is now ramping up the volume of waste being generated to an estimated 20 shipments per week.

The ramp up requires that contracts be in place, infrastructure is in place both on site for waste movement, loading and dispatch as well as the various transporters and processing and disposal facilities and staff qualified. This requires additional due diligence to ensure the people, infrastructure and documentation are in place to assure high quality along the entire chain from waste generation, characterization, packaging; shipment to final disposition. The project recently demolished the site Turbine Building resulting in approximately 200 waste shipments over a period less than 6 months. This has 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.

Turbine Building asbestos abatement generated more than 350 bags



Newly Constructed Waste Management Facility where Fossil Units Bulk Storage Tank Resided

Rail transportation is not available in Humboldt County where HBPP is located. Geologic conditions along railway access routes into the county proved uneconomic to maintain and rail service was discontinued years ago. Barge transportation is available but ultimately requires transfer to a rail and/or truck transportation for delivery to a disposal site. Truck hauling has been chosen as the preferred method of transportation, although even this mode has significant limitations and risks.

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 is approximately 40 inches. To mitigate this known risk and to enable the ability for PG&E to ship intermodals during the rainy season, a new Waste Management Facility (WMF) was constructed. This facility was built in the former Liquid Fuel Oil (LFO) area which provided bulk fuel storage to Fossil Units 1 and 2. The building is about 100 feet by 125 feet with approximate 24 foot eave height. The structure was installed on an area that has been "cleared" through the Final Site Survey process. Various sediment and erosion control best management practices (BMP's) have been installed to comply with storm water pollution prevention plan (SWPPP).

The scope of work included design engineering, foundation preparation, and erection of a Waste Management Facility (WMF) for containerization and preparation of demolition debris in a weather-protected space. Concrete from Fossil Units 1 and 2 turbine generator pedestals was recycled as engineered backfill inside the LFO area resulting in a savings of more than a million dollars to the project.

PROJECT CHALLENGES AS THE SITE TRANSITIONS TO CIVIL WORKS

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.

The Project scope, technical criteria, and performance requirements that were developed are specifically detailed in the Contract and Specification documents. These technical aspects of the project will be familiar to the Contractor and do not generally require interpretation or clarification by the Oversight Team. Key areas for the PG&E Oversight Team attention include, but are not limited to: the HBPP site safety culture; unique project environmental issues; complex and unique regulatory requirements; and performing all work to the highest standards or above to support the goal of being the benchmark for decommissioning a nuclear power plant.

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.

CONCLUSIONS

After 30 years of SAFSTOR operations the HBPP decommissioning project has made significant progress over a period of five 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 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 is ready to transition into its Civil Works Projects phase.

With the removal of plant systems phase now largely completed, the nuclear decommissioning effort will build upon the success of the fossil and turbine building demolition projects 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 these two earlier demolition projects with scope-specific work, proven methodologies, and predefined boundaries. A contract has been awarded by PG&E in July 2013 to execute the final phase of the project with physical work starting early 2014.