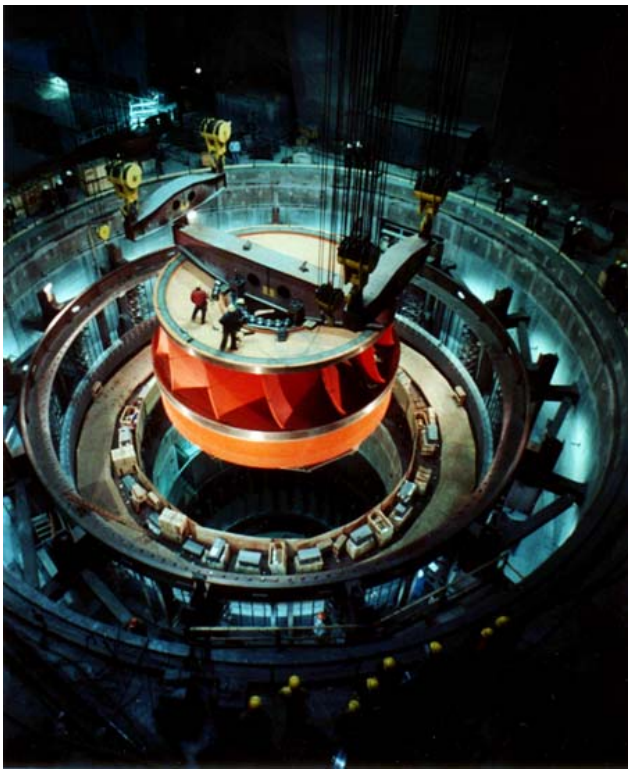
RECLAMATION
Managing Water in the West

Third Power Plant Unit Overhauls - Project Management Assistance

Project Planning Synopsis

Grand Coulee Power Office, Washington



U.S. Department of the Interior
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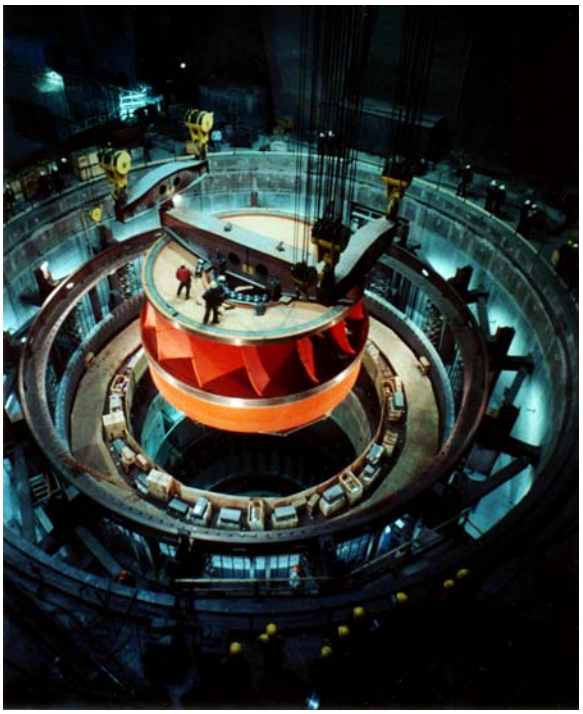
Grand Coulee Power Office - Third Power Plant (TPP) Unit Overhauls
Project Synopsis – October 2008

Overview

The unit overhaul project will involve overhauling turbines (Units G-19 through G-24) that have been in service since the mid 1970's. Units G-19 through G-21 are equipped with 820,000 HP Francis-type turbines, designed by Dominion Engineering Works, Ltd., and manufactured by Willamette Iron and Steel Co with a runner throat diameter of 34 feet. Units G-22 through G-24 are equipped with 960,000 HP Francis-type turbines, designed and manufactured by Allis-Chalmers with a runner throat diameter of 32 feet.



The condition of the six units is such that a complete overhaul of the units is necessary to ensure continued operation. The planned overhaul includes work on the generator, turbine, shaft, and the auxiliary equipment. Generators G-22, G-23, and G-24 are rated to produce a total of 2,415-MVA with an annual power production value of over $100 million. The units have begun to show age-related component wear resulting in reduced reliability and increasing repair outages. The overhaul program will include inspecting and either refurbishing or replacing components of these generators from wicket gate bushings up through head cover seals, all mechanical controls and components, new mechanical seal to replace the existing packing box, and electrical wiring found to be in deteriorated condition. Stator cores or windings for Units G-22, -23 and -24 were replaced recently and should not need attention beyond inspection and cleaning. Rotor inspection will be performed and any necessary repairs accomplished. The TPP turbine runners do not appear to need

refurbishment since they receive regular cavitation repair and up-rating has been determined not to be economically justifiable. Outages are critical so management of this project will attempt to use any and all available methods to minimize their duration. The objective is to ensure these machines will be able to operate reliably for 30 more years.

There are logistical challenges as the overhauls will require lay-down space for all turbine and generator parts as they are removed. Space required during overhaul is larger than for initial construction when parts could be delivered as needed. Several large and heavy items require special consideration; Upper Bracket (dia.~83-ft.), Rotor (dia.~58-ft.), Main Support Bracket (dia.~45-ft.), Head Cover (dia.~ 35-ft.), Operating Ring (dia.~ 25-ft.) plus three Main Shaft Sections which must be stored in a vertical position. It is expected that these large parts will occupy most of the TPP floor space except for access aisles needed to move smaller components.

Projects to be Completed Prior to Beginning Overhauls

Replacing the 500kv cables with overhead lines

Condition of high voltage (HV) cables between the TPP and the 500-kV Spreading Yard (SY) constitute an unacceptable risk for unplanned loss of generation. The nine, single-phase, oil-filled cables for G-19, G-20, and G-21 have been operated near or above their continuous current rating for 30 years. There are signs of deterioration such as bulges in places along the cables. They share a common underground tunnel so that a failure of one cable has the potential to take all 3 generators out of service for at least 1 year. It was just such an event in the other tunnel carrying G-22, G-23, and G-24 cables which forced those units off line in 1981. Temporary overhead lines were installed to get G-23 and G-24 back on line 1 year later. It wasn't until 1985 when the installation of replacement cables was substantially complete.

The purpose of this cable replacement program is to remove the possibility of one cable failure causing loss of 2,100 or 2,400 MVA of generation depending upon which tunnel is affected. A conservative estimate of lost power sales revenue for 1 year of outage of three TPP units is over $139 Million. If the value of "availability" is considered, loss is estimated to be $177 Million. Both of these values assume by-pass lines can be designed and installed in 12 months. Installation of overhead transmission lines will avoid this potential loss. Preliminary concept is for three, double-circuit lines crossing above the TPP and river, terminating at the 500-kV SY take-off structure, and connecting there to the three existing double circuit lines to the 500-kV SY. It is expected that the two existing temporary single circuit lines will need to be removed in order to have adequate space for the three double circuit lines as they approach the SY. At the end of the project, all existing cables will be removed and salvaged by the overhead line installation contractor or a salvage contractor. Salvage of 10 miles of 2000 MCM and 10 miles of 2500 MCM copper conductor should be cost effective.

The Bonneville Power Administration (BPA) has tentatively agreed to undertake this project. The project will be accomplished in three segments: Phase I Scope - If BPA finds that they cannot undertake this project with their staff, one of the PN Region's two ID/IQ A&E firms will be selected to develop alternatives for GCPO to evaluate in a Value Engineering study where a preferred alternative will be selected. Phase II - Design will include design and specification development by the A&E firm. Phase III - Construction will cover purchasing, installing, and commissioning the new equipment using traditional design-bid-build procedures.

Modifying the fixed-wheel gate chamber to accommodate blasting and painting

The TPP Fixed-Wheel Gate Chamber Modification Program will make it possible to blast and paint TPP fixed-wheel gate components and be in compliance with Life Safety and Electrical Codes. At present, the wiring is not explosion proof, ventilation is inadequate, separation from dam galleries is inadequate and lighting is inadequate. All these factors lead to potential violations of code requirements if work is undertaken during seasons when blasting and painting cannot be done outdoors. Fixed-wheel gates from the six TPP penstocks can be moved by gantry crane from their individual chambers to the Gate Servicing

Chambers at Block 119 of the Forebay Dam for repair or refurbishment. Work contemplated under this project includes making the servicing chambers' wiring explosion-proof as well as upgrading the chambers' lighting, ventilation, and material handling capabilities.

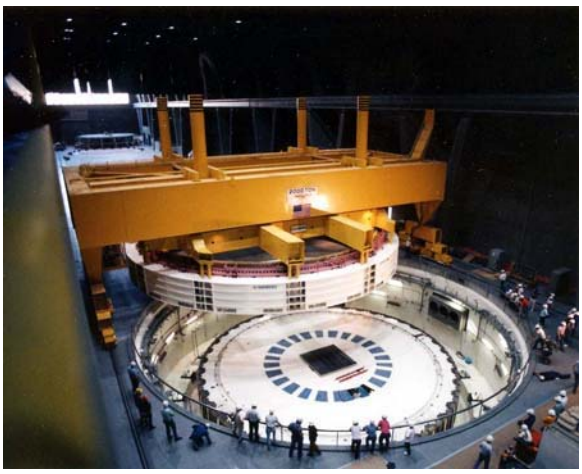
This project will be undertaken in three segments:

Phase I – Consisted of a conceptual design study that assessed the adequacy of the existing systems feeding the Gate Servicing Chamber and a review of code requirements for sand blasting and painting in the enclosed chamber. The study was completed in June 2006 and resulted in a conceptual design including mechanical, electrical, and other changes.

Phase II - Design and specification development is based upon the conceptual design study and the specifications will include the necessary features to bring the Gate Servicing Chamber and the Gate Hoist Servicing Chamber into compliance with requirements of current National Electric Code (Article 500, Hazardous Locations) [NEC], National Fire Protection Association (NFPA 101, Life Safety Code) [NFPA], OSHA, and American Conference of Governmental Industrial Hygienists (Industrial Ventilation Manual, 25th Edition) [IH]. Design is currently being accomplished by the Pacific Northwest Regional Office Design Group.

Phase III - Construction will cover purchasing, installing, and commissioning the new equipment using traditional design-bid-build procedures.

Rehabilitating all power plant cranes



There are six cranes which will be in continual use during the TPP unit overhauls. These consist of three upper bridge cranes, one 2000-ton lower bridge crane, one draft tube gantry crane, and one forebay gantry crane. It is imperative that they all be in excellent working order prior to the overhaul work for use by contractor and GCPO forces. Lack of availability could result in costly slippage of the overhaul schedule. Needed repairs and upgrades of these cranes is the subject of a crane consultants' inspection and report completed in September of 2008.

During Phase I – Scope, the consultants' recommendations have been reviewed and will undergo a VE study to determine the most cost effective approach.

Phase II – Design will include specifications to be written by an A&E firm under contract to Reclamation to detail the needed rehabilitation work and materials. This TPP work is intended to be combined with rehabilitation of other facility cranes as long as the TPP work can be accomplished prior to the generator overhaul contract.

Phase III – Construction will cover selection of a contractor who will then rehabilitate and re-commission the six cranes in accordance with specified requirements.

Design and construction of a material storage building

Overhaul of the TPP turbines and generators will require lay-down space for all turbine and generator parts as they are removed. It is expected that these parts will occupy all of the TPP floor space except for access aisles needed to move smaller components plus additional storage for the Contractor. At present there are a variety of spare parts and pieces being stored in the TPP. These must be removed to make room for overhaul activities and they need secure, covered, and heated storage space. The proposed New Storage Building will be built to provide this space in a location convenient for movement of materials to and from the TPP. Preliminary plans for this building include; 100-ft. by 200-ft floor area with 30-ft walls, 30-ft by 28-ft door (same opening as north TPP door), insulated walls and ceiling, heating and cooling, forced ventilation, power, compressed air, and life safety system with fire suppression. Forklifts and jacking and rolling of heavy items could be used to make an overhead crane unnecessary.

The Grand Coulee Power Office facilities are considered part of a Historically Significant Area. As such, this new storage building cannot detract from the overall appearance of the area. We expect that the storage building will be small when compared to the TPP so the major emphasis will not be to make it appear identical to the TPP but only to be unobtrusive in appearance.

During Phase I – Scope, the size of building and its specific requirements will be established and these recommendations will undergo a VE Study to determine the most cost effective approach. A Task Order is being competed between the two current A&E IDIQ contractors to prepare preliminary cost estimates for three alternatives which include the above described building with and without a 50-ton crane and a third alternative to extend the TTP structure by 200 feet to the north.

Phase II – Design will include specifications to be written by an A&E firm under contract to Reclamation to detail the construction work and materials.

Phase III – Construction will cover selection of a contractor to furnish and make the new facility ready for occupancy.

Work on the draft tube platform

The TPP unit overhauls will provide an opportunity to inspect and, if necessary, to repair their draft tubes. The condition of the concrete, interfaces between concrete and steel, cathodic protection sytems, and surface coatings will be assessed. Any needed repairs will be accomplished during outages for turbine and generator overhauls. This work will be facilitated by having a work platform completed and ready for use when the first overhaul outage commences. This platform will be suitable for use on all three units undergoing overhauls. Only platform fabrication is needed because Reclamation has a completed design. The contractor performing the overhaul work will be responsible for the fabrication of this platform.

Testing for asbestos and lead paint; Identifying safety equipment and procedures for the various projects

The Contractors performing work on any existing equipment need to be aware that there is a possibility that they could encounter asbestos or lead paint on some of the existing components. Typically this is not an issue for components manufactured after 1980. However, these units were completed prior to that year in most part and therefore it is incumbent upon the Contractors doing work that impacts existing equipment to test and be prepared with appropriate safety equipment, procedures, and trained staff to handle and dispose of the hazardous material.

Coordinating NEPA/Section 106 Activities and obtaining any permits required for the projects

NEPA compliance needs to be considered for all activities associated with the TPP overalls. Impacts to the environment need to be defined and addressed appropriately. Additionally, the Grand Coulee Power Office facilities are considered part of a Historically Significant Area. As such, any activity that could impact the overall appearance of the area could have an adverse effect and should be avoided if possible and mitigation for the action applied if the action is unavoidable.

Developing hazardous waste handling requirements

All construction contracts associated with the project will include a requirement that all hazardous waste shall be handled and disposed as required by the applicable regulations. Certain wastes are the responsibility of the Contractors and others are the responsibility of Reclamation. These need to be identified and manifested and handled and disposed of correctly.

TPP Exciter Replacement Program

The TPP Exciter Replacement Program will replace excitation equipment for all six generators in the TPP with more robust and faster-acting equipment. Design of the present exciters was state-of-the-art when first supplied in the late 1970s but the components have become obsolete and are very difficult to replace. Recently, one of the 800 MVA generators was forced out of service for several days by failure of a small choke coil in the exciter regulator circuitry. It was a special size and inductance which required days to find and purchase. Replacing output silicon controlled rectifiers (SCRs) when they fail has also become a constant process. When the outage was forced by choke coil failure, most of the power output drawer assemblies had at least one failed SCR replaced. Normally, a separate outage is needed to replace SCR's. Lost revenue is dependent upon time of year and availability of other TPP generators. An average 1-week forced outage is estimated to cost about $250,000 if only the affected generator is out-of-service but nearly $800,000 if a second generator is also out-of-service. High value month costs (July) would be 4.3 times higher but time of failure cannot be predicted.

The TPP generators have a major role in reacting to normal load swings and also in reacting to power system transient conditions such as loss of critical transmission paths. At present, generation dropping (Gen Drop) opens generator breakers and is used to decrease supplied power to compensate for loss of a similar quantity of load. New, faster responding exciters will allow implementation of modern power system stabilizers (PSS) which will enhance the overall stability of the units and power system. Both Gen Drop and PSS can contribute greatly to stability of the Northwest Power Pool transmission system.

This project will be undertaken in three segments:

Phase I was a scoping study to assess condition of the control and power equipment (including excitation transformers) as they related to generator excitation requirements. Reclamation developed alternatives and evaluated them in a VE Study where a preferred alternative was selected.

Phase II - Design will include design and specifications development for excitation systems and is being accomplished by Reclamation's Denver Technical Services Center (Denver TSC) staff.

Phase III - Construction will cover purchasing, installing, and commissioning the new equipment.

TPP Governor Replacement Program

The TPP Governor Replacement Program will replace governor equipment for all six generators in the TPP with more robust and faster acting equipment. As with the excitation equipment, the design of the present governors was state-of-the-art when supplied in the 1970s but the components have become obsolete and are very difficult to replace. The electric-hydraulic governors are showing problems with obsolete electronic components. The printed circuit cards used epoxy-based operational amplifiers (op amps) which are no longer being made. Op amp failures present themselves as unstable oscillations of hydraulic flow and power output and the associated outage times can be as short as 4 hours. However, repairs to the cards require finding a source and purchasing legacy parts or substituting components which must be connected by wire rather than being inserted in the card. Outage times for difficult repairs can approach 1 week, resulting in power revenue losses similar to those described above in the excitation equipment replacement program.

The governor hydraulic systems are adequate and maintainable so the governor replacement will only replace the electronic components and pilot valve. Digital technology will be specified both to modernize components and also to gain greater flexibility in load/unload rates and the ability to operate the generator stably if the plant becomes islanded. Accomplishing governor work during installation of exciters should minimize construction outage times since the exciter work will be much more time consuming.

TPP generators have a major role in reacting to normal load swings but also in reacting to power system transient conditions such as loss of critical transmission paths. At present, generation dropping (Gen Drop) opens generator breakers and is used to decrease supplied power to compensate for loss of a similar quantity of load. New, faster responding governors will allow more stable response to load rejection.

This project will be undertaken in three segments:

Phase I - Scope was a scoping study to assess the condition of the control and power equipment as they related to generator governor requirements. Reclamation developed alternatives and evaluated them in a VE Study where a preferred alternative was selected.

Phase II - Design includes design and specifications development for governor systems and will be accomplished by Denver TSC staff.

Phase III - Construction will cover purchasing, installing, and commissioning the new equipment.

TPP 236 MVA Transformer Replacement

The 236 MVA Replacement Program will replace six single-phase 236 MVA transformers comprising generator step-up transformer banks K19A and K20A at the TPP. These banks of transformers have been in continuous service since 1975. Identical transformers in bank K21A were replaced in 2002 because of deteriorating condition. One phase had a failure/2-year repair/4-month to failure/salvage sequence. Two transformers from bank K21A are being used as spares but the entire group is considered unreliable with a HydroAmp Condition Index of 6.7 (fair). Dissolved flammable gases are being monitored closely because of increasing levels of hydrogen, methane, ethane, and acetylene. Access to the transformer area is restricted for

safety reasons. An explosive failure could damage cable circuit terminations and adjacent transformers which would compound immediate power loss and lengthen recovery time.

Each time a transformer needs to have its oil processed, the associated generator is taken off-line for a minimum of 1 week, longer in very cold weather. One of the single-phase transformers on G-19 is being replaced. Its August 15, 2007, oil sample report showed 771 ppm of acetylene so when the report was received, G-19 was immediately taken off-line and all personnel were excluded from the area. The transformer was allowed to cool completely and a subsequent oil sample showed that the level of acetylene had increased to 991ppm while the previous sample was being tested. Replacement of this transformer with a spare is expected to take at least 4 weeks, depending upon availability of a transformer moving crew. Spares for these single-phase, 236 MVA, 15/545kV, generator step-up transformers are not available in the northwest.

Phase I - Design included design and specifications development for governor systems and was accomplished by the Denver TSC staff.

Phase II - Construction will cover purchasing, installing, and commissioning the new equipment.

TPP Elevators (2) Rehabilitation

There are two freight and personnel elevators which will be in continual use during the TPP overhauls. One elevator is in the Turbine Erection Bay at the southern end of the TPP and the other in the Generator Erection Bay at the northern end of the TPP. It is imperative that they both be in excellent working order prior to the overhaul work in order to be available for use by contractor and GCPO forces. Lack of availability could result in costly slippage of the overhaul schedule. Needed repairs to, or upgrades of, these elevators will be the subject of an elevator consultant's inspection and resulting report. The rehabilitation work could include such items as: replacement and modernization of control systems; replacement of motors; replacement of traveling electrical cables; replacement of wire ropes; making elevators ADAAG compliant; HVAC work for the elevator machine room; HVAC work for the elevator shaft; wiring work for power supplies; and disposal of removed equipment.

This project will be accomplished in three phases:

Phase I/II – Scope/Design, an A&E firm under contract to USBR will be selected to conduct: performance operational testing of the system; physical inspection of the elevators; and, inspection of related elevator components. During Phase II the Contractor will provide designs, drawings and specifications with a likely follow-on Task Order to provide construction management assistance.

Phase III – Construction will cover selection of a contractor who will then rehabilitate and re-commission the two elevators in accordance with specified requirements.

TPP – New Sand Blast and Painting Facility

The TPP overhauls will involve inspection and refurbishment of all parts before they are re-installed. It's assumed that in most cases this will involve sand blasting and coating. TPP parts are larger than can be accommodated in the existing sand blasting and painting facilities in the Grand Coulee Power Office Industrial Area.

Reclamation contemplates a new, temporary Blasting and Painting Building that will provide space for these activities adjacent to the TPP. Preliminary dimensions for the two rooms are 60-ft square, making the overall metal building 60-ft by 120-ft. Doors to the outside and between blasting and painting rooms will be wide enough to be able to handle the same width parts as the 30-ft main north door of the TPP. Parts larger than the Operating Ring (dia.~ 25-ft), such as the Head Cover, will need to be separated at assembly splits before being moved and refurbished. Depending upon the Contractor's schedule, finished parts will either be returned to the TPP for immediate installation or stored in the adjacent storage building. The Contractor

performing the overhaul work will be responsible for the design, and installation of this building. Reclamation may have NEPA/Section 106 responsibilities related to the temporary building.

On-Going Maintenance Programs in TPP

Throughout the numerous contracts leading up to and during the overhauls of the TPP hydropower generating units there will be operation and maintenance (O&M) work being performed by Reclamation staff. Units will be taken out of service for routine maintenance needs. Some of this work requires the use of power plant cranes and the need for designated areas for storage of parts and equipment. Cavitation repair of turbine runners will be performed as a part of the routine maintenance and electrical testing of various components will also be performed with repair work done as needed.

Reclamation is evaluating all the components and systems within the TPP units for inclusion as an item of work in the overhauls. Some components may be replaced or repaired by maintenance forces during routine maintenance outages prior to the overhauls. This work will impact space, utilities usage, and equipment usage in the plant and could affect Contractors' work. O&M activities may also impact equipment outage requests depending on the specific configuration the systems in the plant may be in to accommodate O&M needs.

TPP Operational Constraints

There are operational constraints regarding outages for the six units in the TPP. Typically, five of the six units need to be operational during the spring months to pass inflows in order to prevent total dissolved gas in excess of allowable amounts from being generated by spills. There are additional outage limitations during times of high power demand in July and August and the during winter months between mid-November through mid-February.