

Grand Coulee Dam Third Powerplant Overhaul



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Grand Coulee Dam Third Power Plant (TPP)

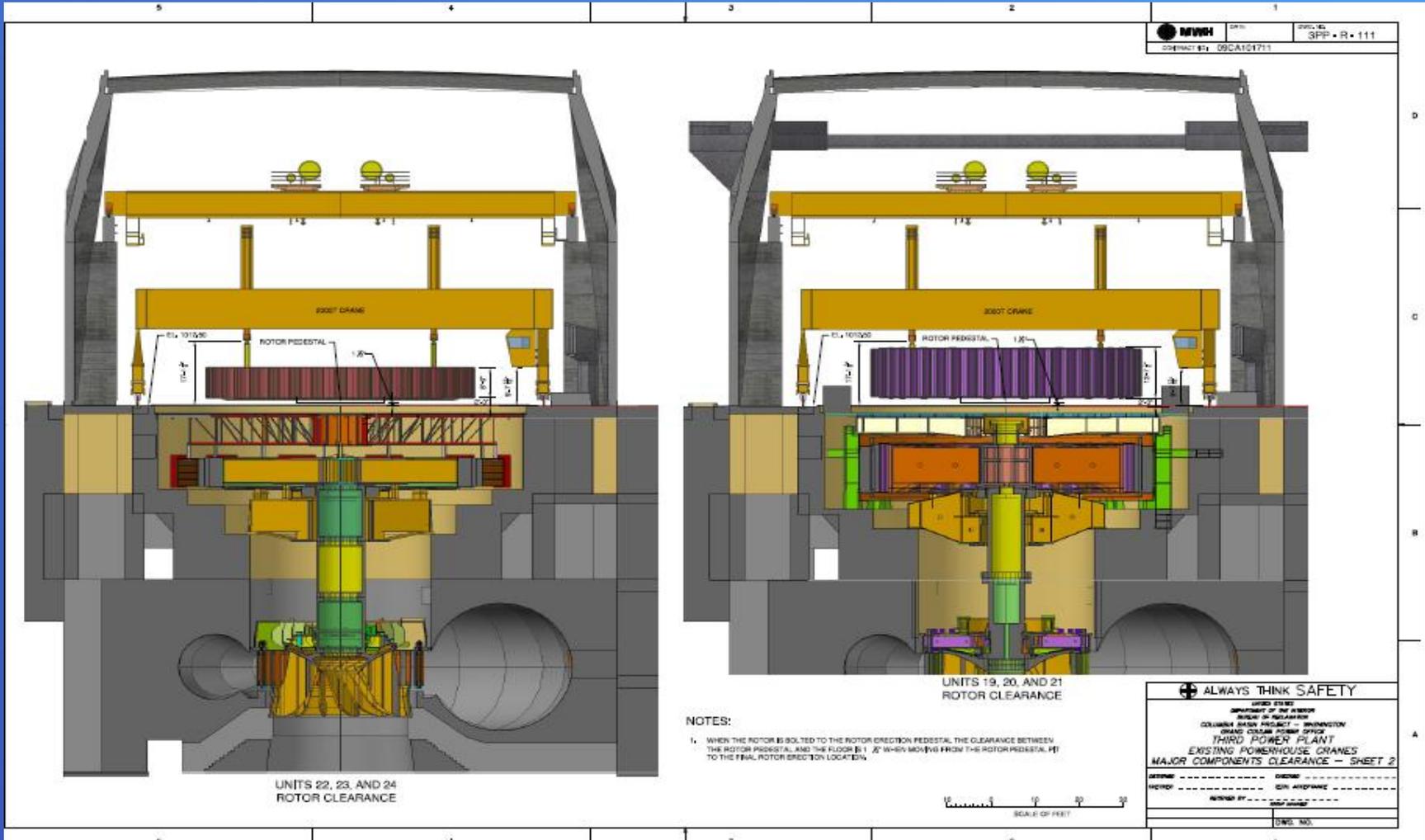
- **Six Generating Units**
 - G19-21, 690MW, Westinghouse
 - G22-24, 805MW, General Electric
- **Construction began in 1967; Last unit commissioned in 1980.**
- **Construction cost of \$730M**
- **Annual power production >\$500M**

Third Powerplant Overhaul Program

Components:

- G22-24 Mechanical Overhaul
- G19-21 Mechanical Overhaul
- Pre-overhaul projects (9)
- B-List Team projects (112)

G19-21 versus G22-24



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Why Overhaul Now?

- **Importance of a reliable TPP to the region**
- **TPP Conditions are Worsening**
 - **Shear Pin failures (operating ring wear)**
 - **Shaft Seal failures**
 - **Increased Water Leakage**
 - **Increasing unscheduled outages**
- **Extension of Overall Plant Life**
 - **Electrical power, controls, annunciators, protective relays**
 - **Unit auxiliaries (piping, valves, CO₂, stator cooling water, gates)**

Need for the Mechanical Overhaul

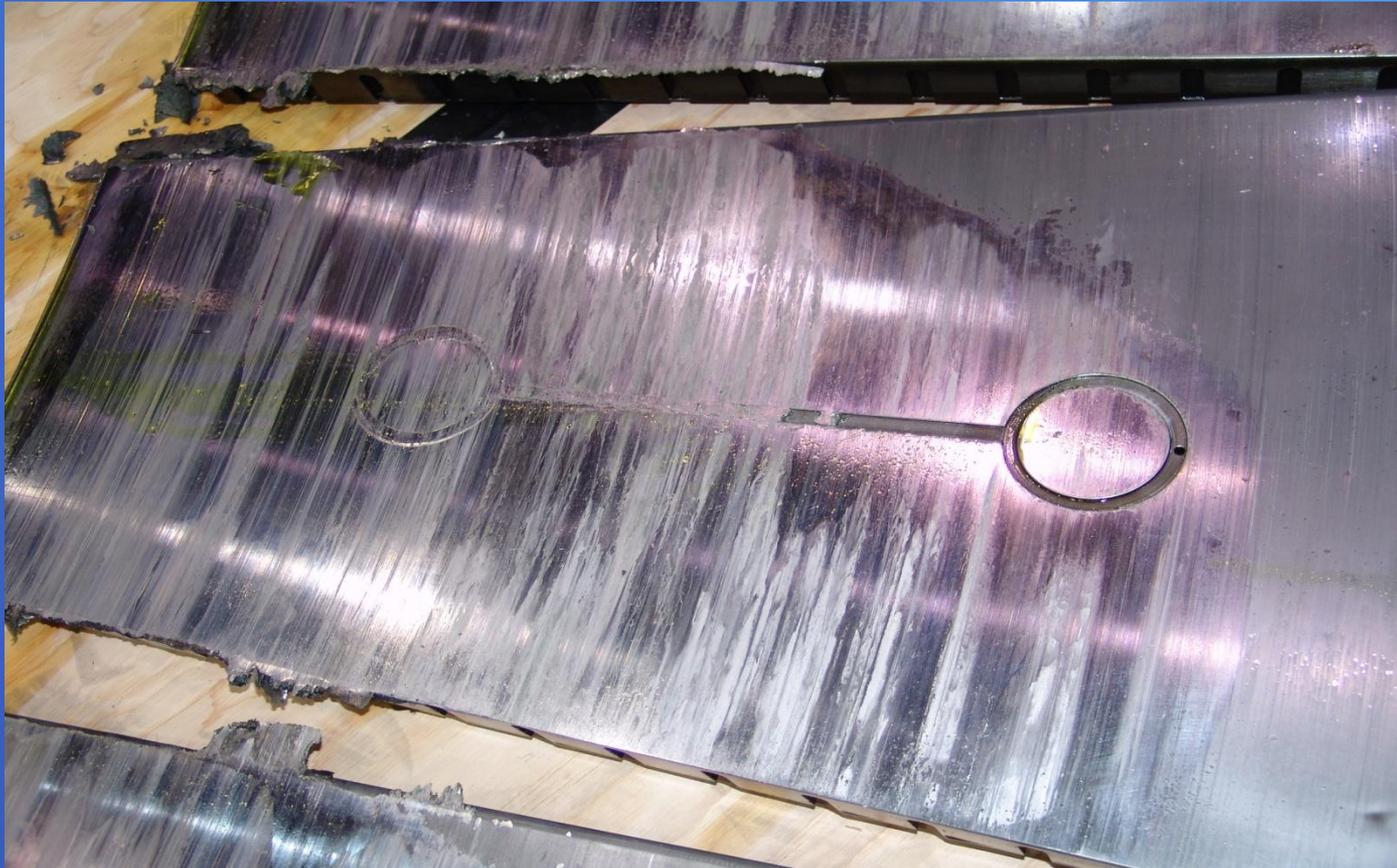
- Water leakage from shaft seal, head cover and wicket gate seals



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Need for Mechanical Overhaul

➤ Thrust Bearing Failures



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TPP Overhaul Program

Timeline

Fiscal Year	G22-24	G19-21	Fiscal Year	G22-24	G19-21
2011	Procurement	Planning	2017	Overhaul Complete	Contractor Preparing for Overhaul
2012	Contractor Preparing for Overhaul	Planning	2018		Overhaul Begins
2013	Overhaul Begins	Planning	2019		Overhaul Ongoing
2014	Overhaul Ongoing	Design	2020		Overhaul Ongoing
2015	Overhaul Ongoing	Procurement	2021		Overhaul Ongoing
2016	Overhaul Ongoing	Contractor Preparing for Overhaul	2022		Overhaul Complete

Third Power Plant Overhaul Program Project Management Approach

- **Priority is maintaining Scope, Schedule, Budget**
- **Cradle-to-Grave Project Management**
- **Customer service focus**
 - **USBR**
 - **Bonneville Power Administration**
 - **Rate Payers**
 - **Grand Coulee Operations and Maintenance**
- **Quality Management Plan**
- **Cost-based Risk Analysis**
- **Risk Register with Risk Responses**
- **Logistics Analysis**

G22-24 Overhaul Logistics



VIEW LOOKING SOUTH



VIEW LOOKING NORTH



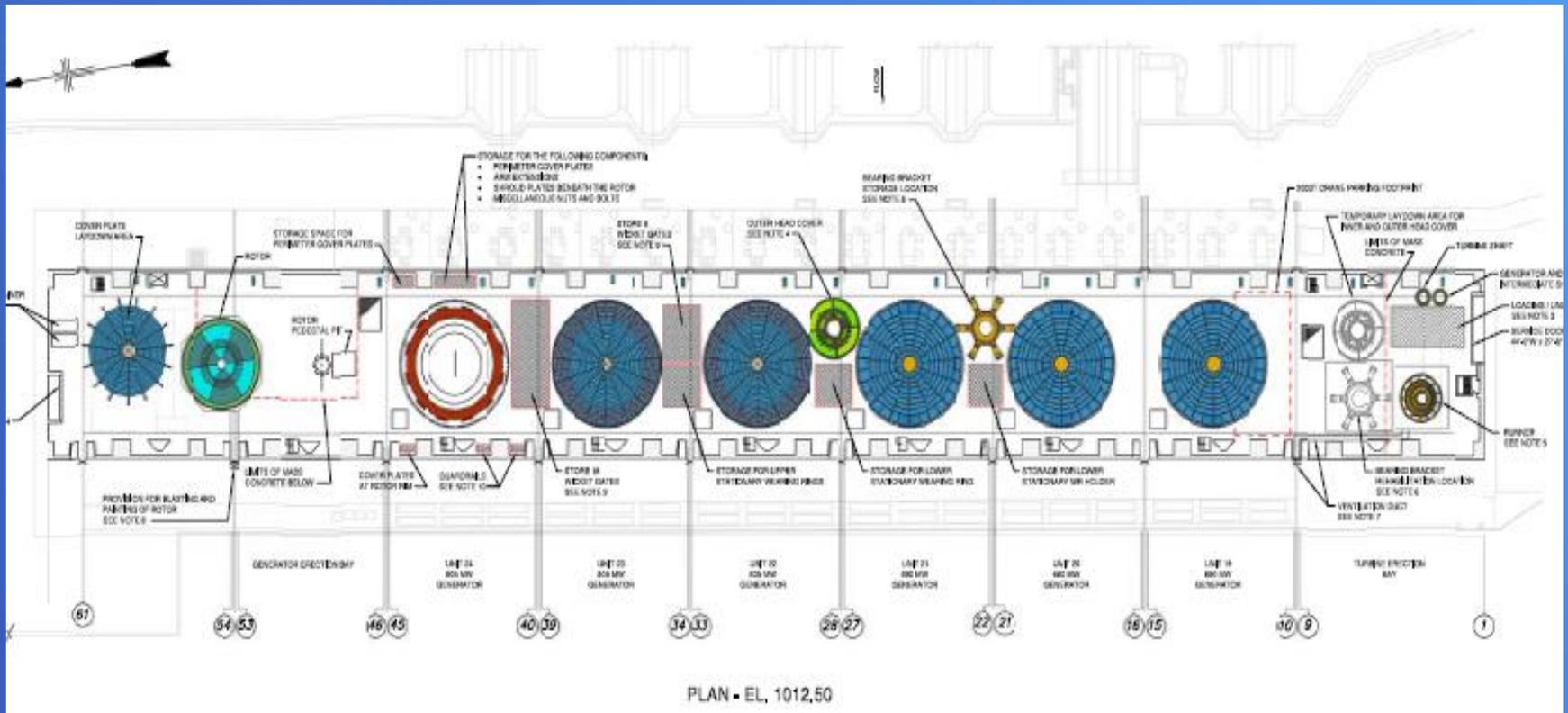
ENLARGE VIEW - LOCKING SOUTH



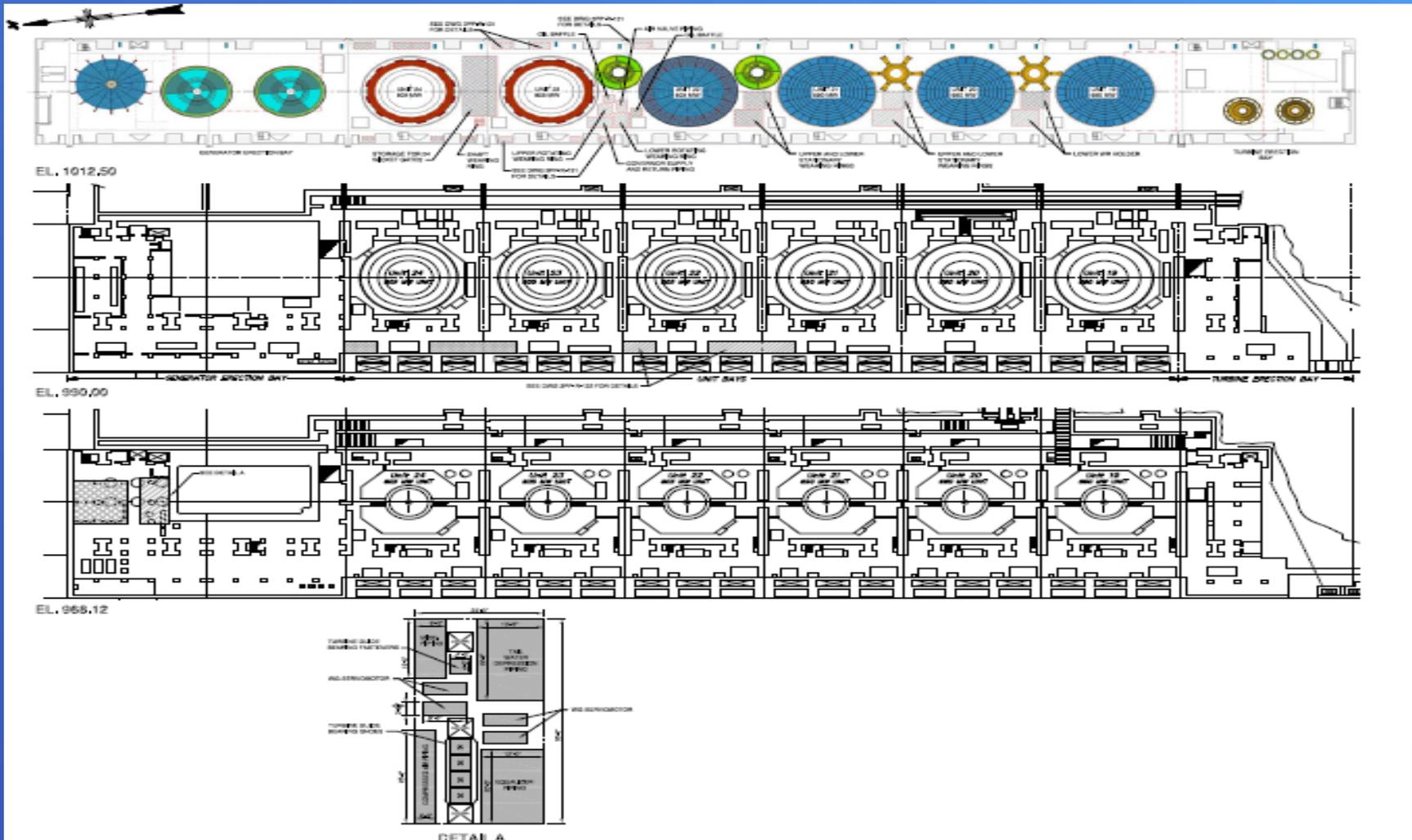
ENLARGE VIEW - LOCKING NORTH

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G22-24 Overhaul Logistics



G22-24 Overhaul Logistics



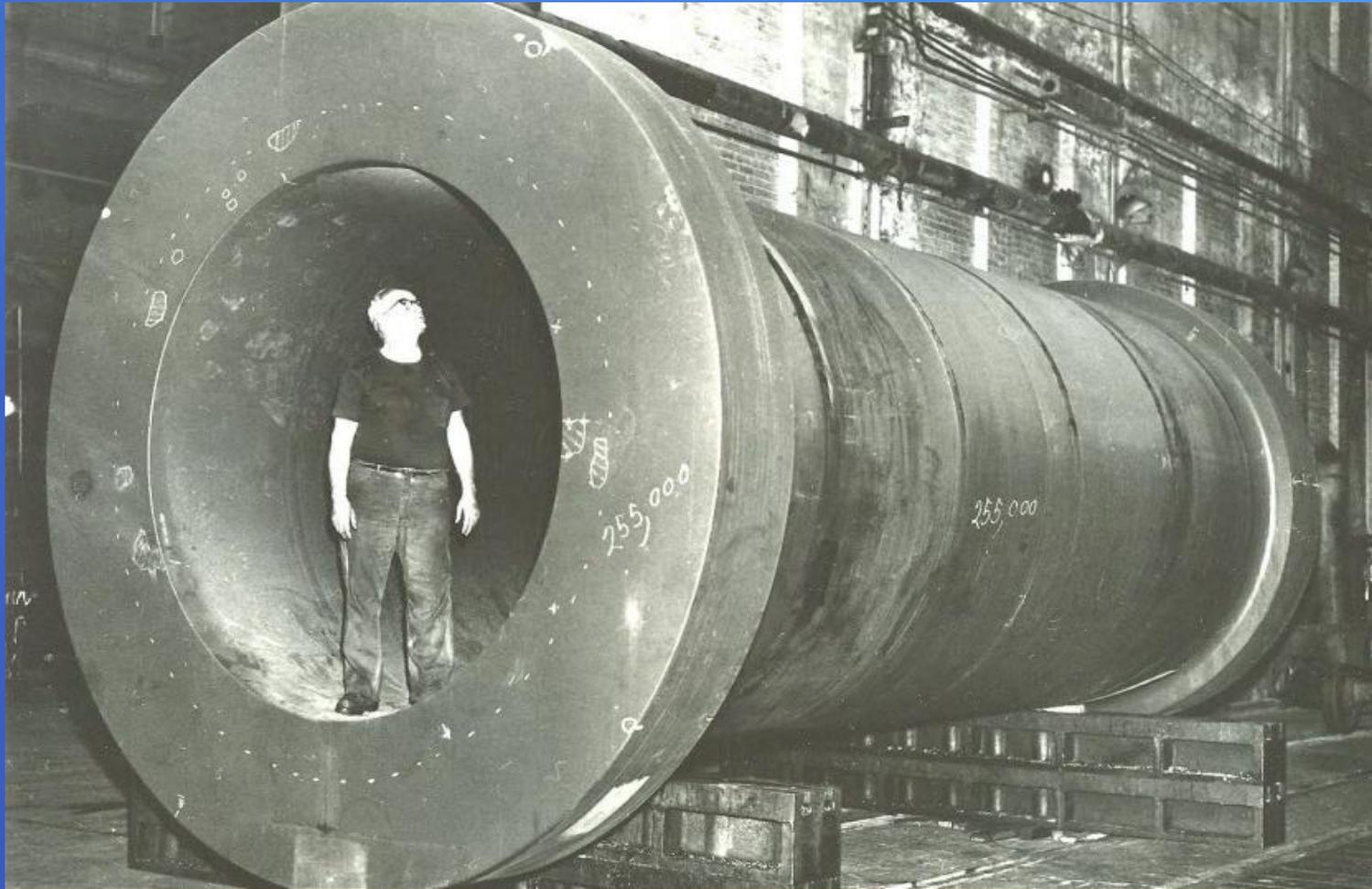
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G22-24 Overhaul: Challenges



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G22-24 Overhaul: Challenges



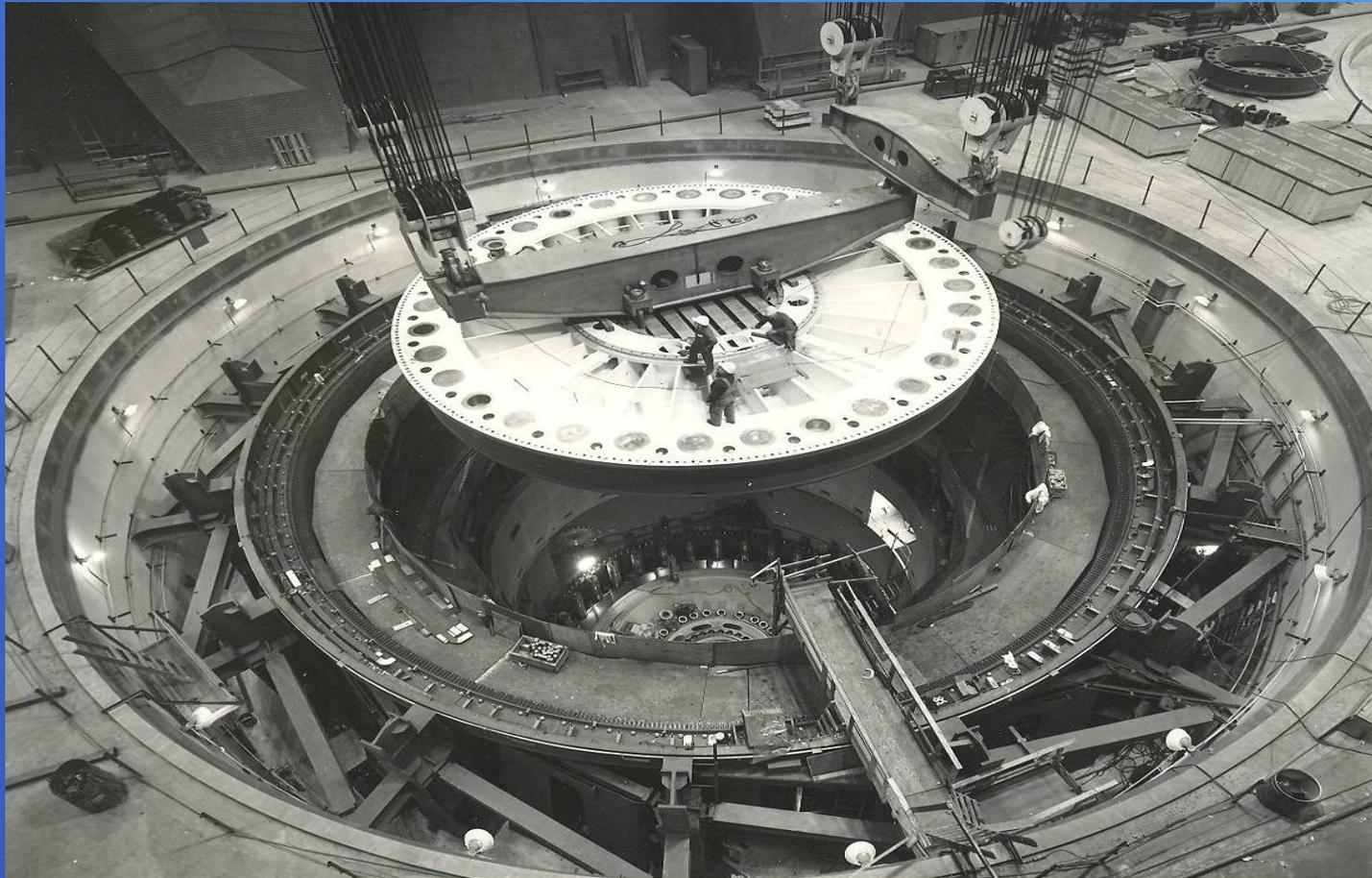
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G22-24 Overhaul: Challenges



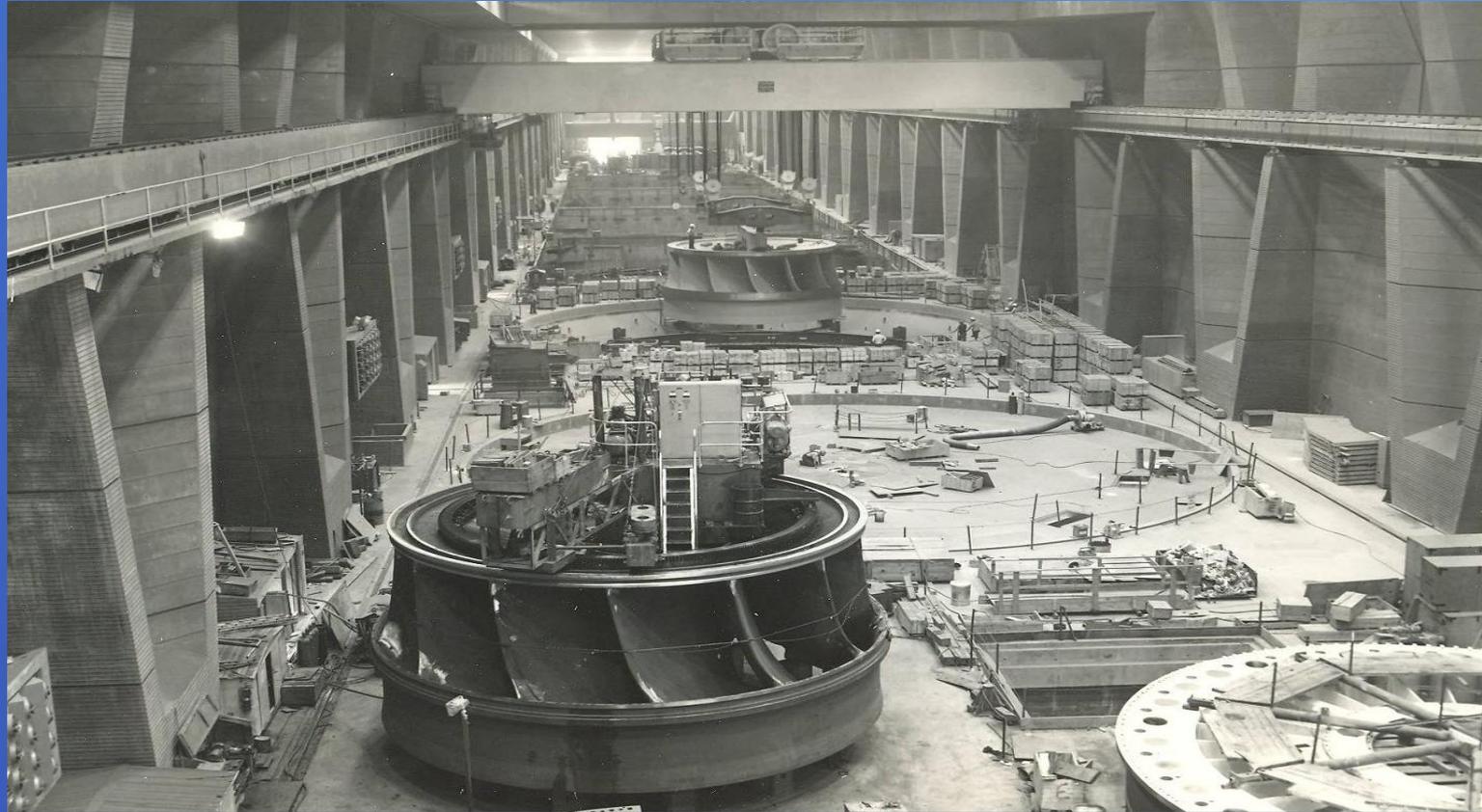
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G22-24 Overhaul: Challenges



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G22-24 Overhaul: Challenges



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G22-24 Overhaul Contract

- **Awarded to Andritz Hydro for \$102M**
- **Schedule: March 2013 – June 2017**
- **17 months/unit**
- **Components to be overhauled:**
 - **Wicket Gates, Bushings**
 - **Head-cover, Operating Ring**
 - **Servos**
 - **Lubrication Systems**
 - **Cooling Water Systems**
 - **Brake and Jack Systems**
 - **Wear Rings**
 - **Bearings**
 - **Shaft Seals**

G19-21 Overhaul and Uprate

- Similar to G22-24 overhaul, but will likely include an uprate from 690MW to 770MW
- 2009 Uprate Study by Reclamation showed 770MW was achievable, but a need for:
 - Generator rewind
 - New shaft
 - Runner rehab or new runner
 - Uprated transformers
 - New 500kV Overhead Lines
 - \$38M for Generator specific work/unit
- 2011 G19-21 Runner Replacement Study showed:
 - Positive cost-benefit

G19-21 Overhaul and Uprate

- 2012 A/E (MWH) study showed 770MW is achievable, but will require:
 - New Core, Winding and Frame (\$31M/unit)
 - Sole Plates (\$500k/unit)
 - Re-shrink rims (\$1.2M/unit)
 - New Shaft (\$5M/unit)
 - New Thrust Bracket (\$1.5M/unit)
- Study concluded the following components would not need replacement: rotor poles, spider, thrust bearings, guide bearings, coolers, auxiliary brackets, brakes

G19-21 Overhaul and Uprate

- **Cost: Approximately \$75M/unit**
- **Benefits:**
 - Additional 80 MW/unit
 - Increased peaking capacity
 - Increased ancillary services (load following, spinning reserve)
 - Increased generation in time of spill
 - Decreased Maintenance
- **Cost benefits begin in Y3, with full benefits beginning in Y4.**
- **Economic Internal Rate of Return: 20.2%.**

G19-21 Overhaul and Uprate

Next:

- FEA and Fatigue Analysis on the stator core, stator frame, rim, spider, and thrust bracket.
- Complete planning by August 2013.
- Begin design in September 2013, complete by August 2014.
- Logistic Analysis, Cost/Risk Analysis, Risk Register, Quality Management Plan during design.
- Award contract by April 2016.
- Begin construction by January 2018.

Pre-Overhaul Projects- Why?

- During the TPP Overhauls, one unit will be out-of-service for 10 years.
- Critical the other five units are reliable as possible.
- **Unscheduled Outage Analysis Showed:**
 - G19-21 Transformers Gassing
 - G19-24 Excitation Systems Failures
 - G19-24 Governor Systems Failures & Erratic Behavior
 - G22-24 Thrust Bearing Failures
 - G22-24 Shaft Seal Failures
 - G19-24 Misc. Piping Leaks (water & oil)

TPP Pre-Overhaul Projects

- **500kV Overhead Lines**
- **Material Storage Building**
- **Crane Controls**
- **Fixed Wheel Gate Chamber Modifications**
- **Elevator Modernization**
- **Excitation Replacement**
- **Governor Upgrades**
- **K19A, K20A Transformer Replacement**
- **Mechanical Shaft Seals**

500kV Overhead Lines

- 18 underground oil-filled cables transmit all electricity from the TPP to the switchyards.
- G19, G20, G21 share a common tunnel; G22, G23, G24 share a common tunnel.
- 1981- one G-24 conductor destroyed all cables in the common tunnel (2400MW loss from the grid).
- 1983- Temporary by-pass towers and conductors erected, allowing G-23 and G-24 to sync to the grid.
- 1985- Underground cables replaced; temporary overhead lines abandoned.
- 2008- Significant age-related issues discovered with the oil-filled cables.

500kV Overhead Lines

- **Determination made that another tunnel fire was imminent.**
- **Tunnel fire would reduce the ability of Grand Coulee to pass water for flood control and cost >\$200M/year in lost revenue.**
- **Decision made to remove the oil-filled cables and install overhead lines.**
- **USBR approached BPA to help design and construct new overhead lines.**

500kV Overhead Lines



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500kV Overhead Lines



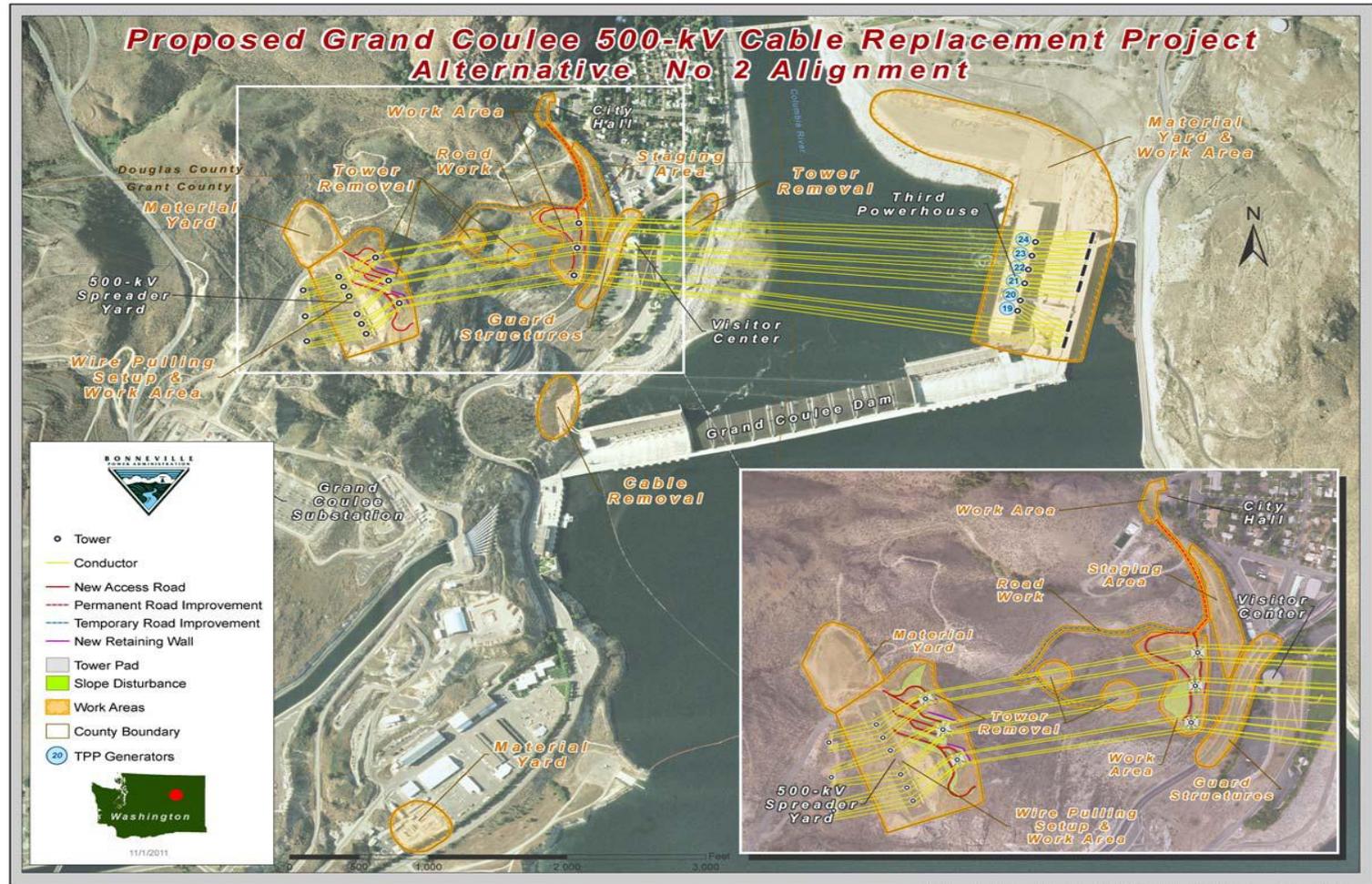
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500kV Overhead Lines



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500kV Overhead Lines



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500kV Overhead Lines

- **\$18.5M contract awarded to Wilson Construction**
- **Construction of overhead lines will be complete by December 2012**
- **Removal of oil-filled cables will take place between December 2012 to December 2013.**

500kV Overhead Lines



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500kV Overhead Lines



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500kV Overhead Lines

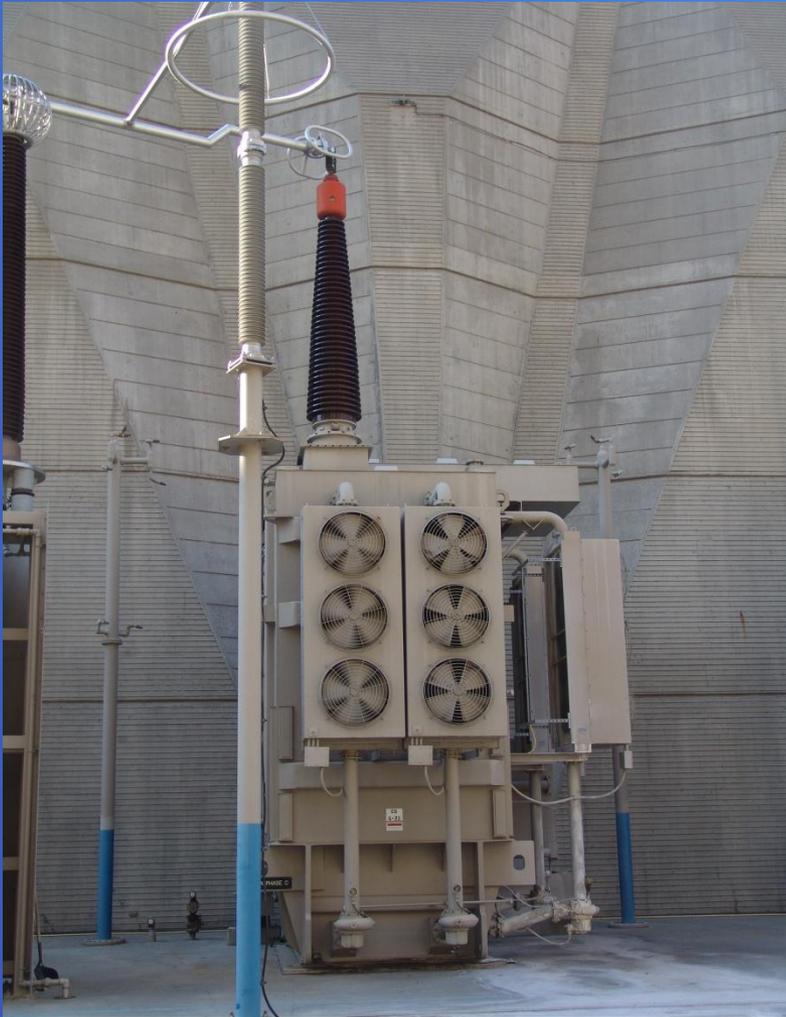


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K19A, K20A Transformers

- G-19 and G-20's main unit transformers have shown age-related issues including gassing.
- G-19 and G-20's transformers need to be updated from 236MVA to 276MVA to support uprate.
- \$26M contract awarded to Gardner Zemke.
- Project was substantially complete on December 30, 2011.

TPP K19A, K20A Transformers



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TPP K19A, K20A Transformers



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TPP Excitation System

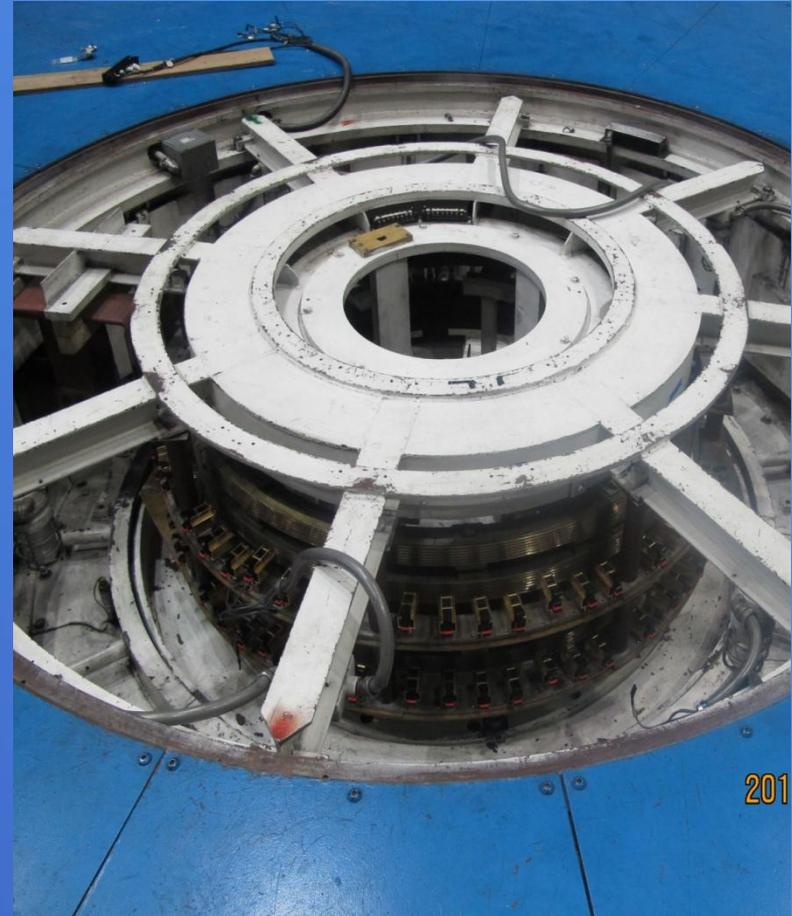
- G19-24 Excitation systems have been experiencing system failures creating forced unit outages.
- Scope of project is to replace the entire excitation system, power potential transformers, power circuit breakers, rectifier bridges, and isophase busses.
- \$17M project awarded to ABB, Inc.
- Project will be complete May 2013.

TPP Excitation System



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TPP Excitation System



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TPP Governor Upgrades

- **G19-24 Governor systems were experiencing failures & erratic behavior**
- **Scope limited to digital control system and new pilot valves.**
- **\$1.7M contract awarded to American Governor.**
- **Project will be complete by May 2013.**

TPP Governor Upgrades



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Material Storage Building

- **TPP floor space is limited.**
- **TPP floor space needed to accommodate lay-down areas for Overhaul Contractor.**
- **Analysis showed need for a minimum 200,000 s.f. temperature/climate controlled building.**
- **First design-build contract for Reclamation's Pacific Northwest Region.**
- **LEED certified- federal mandate.**
- **\$6.1M project awarded to Graham Construction.**
- **Project will be complete by October 2012.**
- **Under budget and ahead of schedule.**

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Material Storage Building



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Material Storage Building



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Material Storage Building



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Fixed Wheel Gate Chamber Modifications

- The TPP Fixed Wheel Gates will be rehabilitated during the TPP Overhaul project.
- The TPP Fixed Wheel Gate Chamber does not meet current life safety standards.
- Project scope is to bring the Chamber up to current life safety standards, including explosion proof lighting, fire mist system and new ventilation.
- \$3.5M project awarded to Knight Construction.
- Project will be complete by October 2012.

Fixed Wheel Gate Chamber Modifications



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TPP Elevator Modernization

- TPP Elevators have become unreliable.
- TPP Elevators are designed for both freight and personnel.
- The elevators will be completely replaced.
- \$1.5M project awarded to ThyssenKrupp.
- Project will be complete by January 2013.

TPP Crane Controls

- **Six TPP Cranes:**
 - 275 Ton Bridge Crane (2)
 - 50 Ton Bridge Crane
 - 2,000 Ton Gantry Crane
 - 70 Ton Draft Tube Gantry Crane
 - 275 Ton Forebay Dam Gantry Crane
- **All cranes need to be in excellent operation during the TPP Overhauls.**
- **\$11M project awarded to Dix Corporation.**
- **Project will be complete by December 2012.**

TPP Crane Controls



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TPP Crane Controls



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TPP Crane Controls



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July Crane Incident

- **Three contractors working on the Forebay simultaneously**
- **Wind event caused the Forebay Crane's anchor to fail (1.5 inch nylon strap, 3500LB rating)**
- **Forebay Crane continued down tracks, colliding with a vehicle, a crane truck, a mobile crane, and an ecology block before striking the crane stops.**
- **Crane reared and bounced twice before settling of its rails.**

B-List Team/Projects

- 112 smaller projects
- Overhaul Crew (1 Sup, 4 Electricians, 4 Mechanics)
- All 30+ year old items that need to be overhauled, which were not included in the overhaul contract (air valves, water valves, governor motors, special tools, etc.)
- Assists pre-overhaul contractors and overhaul contractor

TPP Overhaul Program- Summary

- Program focused on maintaining scope, schedule and budget, with attention to quality and risk.
- One TPP unit will be offline for ten years, beginning in 2013.
- Pre-overhaul projects reduce the risk of schedule slippage and increase the probability of five TPP units being available for ten years.
- Program will ensure a reliable TPP for another 30 years of service to the Northwest.

Questions?

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