**Disclosure of Hydroelectric Generation and Transmission Equipment Issues**

**at Rocky Reach and Rock Island Projects.**

**ROCK ISLAND HYDROELECTRIC PROJECT:**

**Current Unit Status:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Unit | Status as of today’s date | Description | Outage Start | Expected Return |
| B1 | Out of Service | Turbine replacement |  | Aug 2021 |
| B2 | Out of Service | Turbine replacement |  | Dec 2020 |
| B3 | Out of Service | Turbine replacement |  | Apr 2020 |
| B4 | Out of Service | Turbine replacement |  | Aug 2019 |
|  |  |  |  |  |
| B5 | Out of Service | Unit Modernization |  | Sep 2020 |
| B7 | Out of Service | Unit Modernization |  | Aug 2019 |
| B8 | In Service | Unit Modernization | Sep 2020 | Oct 2021 |
| B9 | In Service |  |  |  |
| B10 | Out of Service | Thrust bearing Balancing System Oil Leak | Jan 2019 | Jun 2019 |

**Background**

Rock Island Powerhouse No. 1 consists of 10 generating units. The four original units (B1-B4) were installed in the 1930’s and an additional six units were added in the 1950’s. Three of the four original units at Powerhouse No. 1 (B1, B3 and B4) have upgraded generator stators and have their original generator rotors and turbine runners. Units B9 and B10 were rehabilitated with new stators, turbines and governor and excitation systems.

A second powerhouse (Powerhouse No. 2) was built in the late 1970’s with eight generating units.

**Rock Island B1-B4 Turbine Corrosion Fatigue**

**Issue**

During the Unit B2 generator stator replacement work, fatigue cracks were observed on the blades of the turbine. From October 2015 through January 2016, District maintenance staff made repeated attempts to grind out the cracks and repair the resulting excavations with various welding procedures. After each repair procedure, inspections resulted in the observation of new fatigue cracks. Engineering analysis indicated the B2 turbine is experiencing a phenomenon known as Corrosion Fatigue. The turbines of Units B1, B3 and B4 are of similar design and vintage as Unit B2. These three units were taken out of service and inspected to determine if similar cracking exists in their turbine runner blades. These turbines also had significant cracking due to Corrosion Fatigue. All four turbines, B1 through B4 will remain out of service until the District can design, procure and install replacement turbine runners.

**Remedy**

The District has completed the development of specifications for the procurement of turbine runners for units B1 through B4. Competitive bids were received on December 22, 2016 and the contract awarded to Andritz Hydro in a Special Commissioner meeting on December 30, 2016. Site work on unit B4 was initiated in October 2018 with an expected return to service date of August 2019. Each of the remaining three units (B3, B2 and B1) are scheduled to have the runners replaced, one at a time, at the completion of the B4 turbine replacement. Each turbine replacement is expected to require eight (8) months per unit. Each turbine replacement project also has the potential of needing discharge liner repairs that may require an additional 2 months per unit.

**1) Expected case scenario (as of February 2019)**: All four of the B1 through B4 units will remain out of service until such time the respective turbine is replaced. Each unit is scheduled for turbine replacement and will be returned to service, with the last turbine replacement being complete in August 2021. This scenario performs work on the four units sequentially resulting in the turbine replacement schedule as follows:

UNIT START DATE RETURN TO SERVICE DATE

B4 out of service until Aug 2019

B3 out of service until Apr 2020

B2 out of service until Dec 2020

B1 out of service until Aug 2021

2**) An Alternate case scenario (as of February 2019)**: An Alternate case scenario may occur if discharge liner repairs are required on each unit.. In this event, the turbine replacement schedule would likely add eight (8) weeks of outage per unit.. This schedule would result as follows:

UNIT START DATE RETURN TO SERVICE DATE

B4 out of service until Oct 2019

B3 out of service until Jul 2020

B2 out of service until Apr 2021

B1 out of service until Feb 2022

**Rock Island B6/B7 Stator-Rotor Air Gap**

**Issue**

During periodic machine condition monitoring, plant staff observed deterioration of a critical clearance measurement in the generator. This clearance, referred to as the “air gap” between the rotor and the stator of the generator, has deteriorated over time and is now below acceptable reliable operating limits. Data for units B6 and B7 was evaluated and showed a deteriorating air gap clearance. B7 is out of service and is expected to remain out of service until unit rehabilitation (new turbine, new stator, new rotor poles and rim, new exciter, new Governor digital controls) is completed in August 2019.

**Remedy**

Unit B6 has had a new stator and poles installed, rim reshape and alignment work completed and was returned to service in 2018.

To correct the deterioration of the “air gap “ in unit B7, the District intends to install a new stator, replace rotor poles and rim and reshape and align the unit to within industry standards for normal operation.

**Schedule**

Replacement of the stator in B7 is underway and will completed in August 2019.

**Rock Island Tentative Generator Upgrade Outage Schedule**

UNIT START DATE RETURN TO SERVICE DATE

B6 repair completed in 2018 and now in service.

B7 replacement underway Aug 2019

**Rock Island B5-B8 Stay Ring Crack Indications**

**Issue**

During the turbine replacement project of unit B6, several local areas on the Stay Ring required machining to provide sufficient clearance for the wicket gates and their associated movements. After the machining was complete, many crack indications were observed and noted in the machined surfaces.

To date, the stay ring crack indications have only been observed on unit B6. If the turbine replacement work for B5, B7 and B8 also require machining of the stay ring to provide adequate clearance for the wicket gates, stay ring crack indications similar to those observed on B6 may or may not be discovered. Inspections for crack indications will occur as early as possible in the existing outages and the repair work completed with little if any impact on project schedules.

**Remedy**

Our initial assessment is the stay ring crack indications are casting flaws from original manufacturing and they are being observed for the first time because of the recent machining that removed up to 0.75” of material in some locations.

The B6 repairs included excavation of the crack indications and weld repairs to those locations. The weld repairs required approximately 3 weeks duration to complete. The District will schedule short outages at a 6 month or annual frequency to inspect the repairs and then determine if follow up repairs are needed.

**Schedule**

The analysis and weld repairs described above are expected for the remaining modernization projects (B7, B5 and B8) to be completed within the existing planned outages.

**Rocky Reach Hydroelectric Project:**

**Background**

Rocky Reach Powerhouse consists of 11 generating units. The seven original units (C1 - C7) were installed and in commercial operation by 1961. The remaining four units (C8 - C11) were added and in operation by 1971. All turbines, generators, main transformers and control systems were replaced in major upgrade projects beginning in 1995 and completed in 2006.

Current Unit Status:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Unit | Status as of today’s date | Description | Outage Start | Expected Return |
| C-1 | Out of Service | Out for planned turbine hub bushings and wicket gate stem repairs. |  | Aug 2019 |
| C-2 | In Service |  |  |  |
| C-3 | Out of Service | Out for investigation of the trunnion bushings on the turbine hub to determine the extent of wear and whether it requires repair or replacement. | 2/19/2019 | 6/28/2019 |
| C-4 | In Service |  |  |  |
| C-5 | In Service |  |  |  |
| C-6 | In Service |  |  |  |
| C-7 | In Service |  |  |  |
| C-8 | In Service |  |  |  |
| C-9 | Out of Service | Turbine Rehab |  | Aug 2019 |
| C-10 | In Service | Turbine Rehab | Jun 2019 | Aug 2020 |
| C-11 | In Service | Turbine Rehab | Aug 2020 | Oct 2021 |

**Rocky Reach C8-C11 Large Unit Turbines**

**Background**

As part of ongoing maintenance of District hydro projects, seven Kaplan style turbines (C1-C7) were rehabilitated and four fixed blade turbines (C8-C11) were converted to adjustable blade (Kaplan) at the Rocky Reach Powerhouse from 1996 to 2003 by RIVA HydroArt/Voith Hydro. The purpose of the project was modernization of the turbines to provide higher efficiency while incorporating fish friendly features with a runner blade design life of 50 years.

**Issue**

On March 25, 2013, the District’s unit C10 tripped off-line due to a blade deviation from setpoint. Initial investigation revealed an internal oil bypass condition in the turbine blade servo-motor system along with deposits of metal in the oil return basin. A partial in-place turbine disassembly identified significant wear to internal servo-motor seal rings and bushings as well as to blade trunnion bushings.

Based on initial findings, District staff determined a full generator and turbine disassembly was required to determine all possible causes of the blade deviation, oil bypass and wear conditions. During the turbine disassembly, a crack was discovered in the main servo-motor operating rod. Through engineering analysis and review with District staff, Voith Hydro and MWH Engineering, the cause of the crack was determined to be a design flaw.

On September 23, 2013, units C8, C9 and C11 were removed from service to protect the public, employees, equipment and environmental safety due to having the same turbine design and internal construction. District staff, with Voith and MWH review, proposed a temporary solution for interim operations as fixed blade (propeller) units that allows generator use until a permanent solution is designed and implemented.

This condition is unique to generating units C8-C11 and **does not** include units C1-C7.

**Remedy**

On November 8, 2013, District crews commenced with interim repairs on unit C11 consisting of welding blocks onto the turbine runner hub to lock the blades in the full steep position providing safe reliable operation as a propeller turbine. Successful operational and index testing was performed on unit C11 and modifications continued to C8, C9 and C10. Units C8-C11 will be operated as interim repaired propeller turbines until final designs and permanent repairs return them to full Kaplan operation. In September 2014, a plan was approved by the District’s Board of Commissioners to restore adjustable blade capability to C8-C11, enhancing power generation and assuring continued successful fish passage at Rocky Reach.

**Schedule**

The implementation of the interim repair program (propeller operation) was completed in April 2014. The final turbine repairs will require unit outages that are estimated to last 14 months and will include the installation of new governor control and exciter systems. The final repair work was completed on unit C8 in Dec 2017. Until all permanent repairs are complete on C9, C10 and C11, each interim repaired turbine will require an inspection at approximately 3800 hours of run time. It is estimated, but not assured, that each inspection requires a unit outage of one week (5 days).

**Remedy and Future Schedule**

All four units have turbine repairs planned for the final repair discussed earlier in the “C8-C11 Servo-Motor Rod” section to return to variable pitch blade Kaplan operation. These planned outages are currently scheduled to be done one at a time. The outage schedule for turbine repairs and rewinds is as follows:

**1) Rocky Reach Tentative Outage Schedule (as of December 2017):**

UNIT DESCRIPTION START DATE RETURN TO SERVICE DATE

C8 Complete in Dec 2017.

C9 Turbine repairs out of service until Aug 2019

C10 Turbine repairs June 2019 Aug 2020

C11 Turbine repairs Aug 2020 Oct 2021

**Rocky Reach C1-C7 Small Unit Turbines**

**Background:**

In January 2018, it was noticed that unit C1 had a leak so it was removed from service to investigate the cause. The investigation determined that the trunnion bushings on the turbine hub were worn and required repair or replacement. The wicket gate stems may also require repair or replacement. C2 through C7 are of similar design to C1, it is anticipated that these small units may require trunnion bushing replacements and potentially wicket gate stem repairs or replacements.

Unit C1 is out of service and is being disassembled to replace the trunnion bushings. This C1 trunnion bushing replacement outage is currently scheduled to be completed by August 2019. The District is evaluating the condition of the wicket gate stems and it will be decided if the outage will be extended for the wicket gate removal, inspection and potential repairs or replacements.

C3 was removed from service on February 19th, 2019 to investigate the trunnion bushings on the turbine hub to determine if the trunnion bushings are worn and require repair or replacement. The investigation performed in March 2019 of the C3 trunnion bushing determined that it the trunnion bushing needs repair or replacement and will remain out of service until the repair or replacement is complete.

C2, C4, C5, C6 and C7 are in service; however, the trunnion bushings on these units are the same design as C1 and C3 and may be near the end of their useful life and may require replacement.

**Remedy and Future Schedule:**

The District is working on unit C1 to replace the trunnion bushings and evaluate the wicket gates for wear or damage. The District will be inspecting the wicket gate stems in mid to late April to determine the condition. If it is determined that a wicket gate stem repair is required, it is anticipated the work associated with the wicket gate stem repair will require approximately 6 additional months to complete and the C1 return date may be extended from Aug 2019 to Feb 2020.

Although not scheduled at this time, it is anticipated similar repair work to C1 and C3 may be required for the remaining small units C2, C4, C5, C6 and C7; each requiring approximately 6 months to complete the trunnion bushing repair and possibly an additional 6 months to complete the wicket gate stem repair if the inspection reveals a repair is needed.

Repair scenario 1: Unit C1 returns to service as scheduled. The District is attempting an interim repair to address the trunnion bushing issue. If the interim repair is successful, unit C3 will to return to service as scheduled in Jun 2019.

Repair scenario 2: Unit C1 returns to service as scheduled. If the interim C3 trunnion bushing repair is unsuccessful, unit C3 trunnion bushing repair outage will begin immediately after C1 returns to service as scheduled in Aug 2019.

Repair scenario 3: If the unit C1 wicket gates require repair, unit C1 scheduled outage return date will be extended by six months (Feb 2020). If the interim C3 trunnion bushing repair is unsuccessful and If the unit C3 the wicket gates require repair, the unit C3 scheduled outage return date will be Feb 2021.

Potential impacts to Rocky Reach spring fish spill requirements:

C3 repair may not begin until Feb 2020 when C1 is returned to service. If the C3 repair requires both the trunnion bushing repair and the wicket gate stem repair, C3 may not be complete until Feb 2021.Spring fish spill at Rocky Reach could possibly be implemented if 2 of the 3 units (C1, C2, and C3) are out of service at the same time. C1, C2 and C3 provide the attraction water flow to the Juvenile Fish Bypass which transports juvenile outmigrating fish around the dam as an alternative travel path through the dam. If 2 of these 3 units (C1, C2, and C3) are out of service, it may result in Chinook, steelhead, and sockeye smolts using other passage routes over the dam (turbines) which have slightly measured lower survival. While staff believe the overall survival standard metric of 91 percent combined adult and juvenile survival would still be met, parties to the Rocky Reach Habitat Conservation Plan (HCP) could request spring time spill to supplement the Juvenile Fish Bypass operation (currently Rocky Reach is the only dam on the Columbia that does not spill for fish passage in the spring) since the proposed operation of having at least 2 of the 3 units (C1, C2, and C3) not operational during spring outmigration is different than what was tested under survival studies. At this point, the District’s fish biologists have not discussed this issue with outside stakeholders but plan to do so when more information is known from the March C3 outage investigation. Historical Rocky Reach spring fish spill has been zero since 2007. Prior to 2007, the Rocky Reach spring fish spill was between 0 and 25%. If 2 of the 3 C1-C3 units were out of service during the spring spill season the possibility of spring fish spill, and the appropriate spill percentage, would need to be negotiated and approved by the HCP Coordinating Committee.

**OTHER ISSUES:**

**Transmission out of Rock Island Project:**

**Background and Issue**

Due to the December 2015 curtailment of a major industrial load near the Valhalla and McKenzie substations, the District has revised its operational protocols.  The curtailment of the large load in this vicinity requires the McKenzie - Valhalla substation 115kV tie line to be operated in an ‘open’ (disconnected) configuration when the ambient temperature is approximately 68F or higher.

This ‘open’ configuration allows the District to operate the Rock Island project normally except when Rock Island generation is above 465 MW and the ambient temperatures are above 86F (dependent on regional generation patterns, planned or emergency line outages, etc.).  The District’s preliminary studies show this condition could happen approximately 20 hours per year based on 10-years of historical data.

When the McKenzie – Valhalla 115kV tie line is operated in the ‘open’ condition and the ambient temperature is above 86F, the BPA Valhalla Substation (Rock Island) Point of Delivery will be limited to approximately 200 MW.  The other Points of Delivery will not be limited due to these conditions.

It is unknown if the major industrial load will return or remain curtailed during the term of the contract.

**Remedy**

The District has developed and implemented emergency transmission line ratings for the 115kV transmission lines that leave McKenzie substation. With the implementation of these emergency transmission line ratings, it is expected when in this ‘open’ configuration **and** the ambient temperature is above 86F, Rock Island generation may likely not have to be limited to 465 MW based on historical information for an all lines in-service condition. The District is currently working on a longer term solution to install a Remedial Action Scheme (RAS) by the end of 2020 that will alleviate Rock Island generation restrictions for the all-lines in service condition.