UNITED STATES OF AMERICA 113 FERC ¶ 62,205
FEDERAL ENERGY REGULATORY COMMISSION

Public Utility District No. 2 of Grant County, Washington — Project No. 2114-131

ORDER AUTHOURIZING INSTALLATION OF REMAINING TURBINES

(Issued December 14, 2005)

On October 11, 2005, Public Utility District No. 2 of Grant County, Washington (Grant County or licensee) filed a report titled, *Biological Test Results for Advanced Turbine Unit No. 8* for the Priest Rapids Project (FERC No. 2114). The licensee filed the report pursuant to ordering paragraph (E) of the Commission's July 23, 2004 *Order Modifying and Approving Amendment of License Application and Revising Annual Charges* (Amendment of License Order).[1] This order addresses the licensee's test results and authorizes the continued installation of the remaining advanced hydro turbines.

The Priest Rapids Project consists of two developments on the mid-Columbia River: the upstream Wanapum dam followed by the Priest Rapids dam approximately 18 miles downstream. The project is located in Grant, Yakima, Kittitas, Douglas, Benton, and Chelan Counties, Washington.

BACKGROUND

In a license amendment application filed October 2, 2003, Grant County stated that the Wanapum turbines have reached the end of their useful life and require replacement. The licensee investigated refurbishing each unit versus replacing them. The licensee stated that the proposed advanced turbine replacement would provide increased power and hydraulic capacity, equal or improved survival of juvenile salmon passing through the units, and improved water quality by reducing the amount of spill

[1] 108 FERC ¶ 62,075 (2004).

over the dam during periods of high flows. The Amendment of License Order authorized Grant County to replace 10 turbines at the Wanapum development with 10 advanced hydro turbines in a staged sequence.

More specifically, the Amendment of License Order authorized the installation and testing of one unit prior to proceeding with the installation of the remaining nine turbine units. Ordering paragraph (E) of the Amendment of License Order stated that the licensee shall file, for Commission approval, a report (to include any comments from the resource agencies and tribes) on the results of the advanced turbine's fish passage survival study. Further, paragraph (E) stated that the licensee shall proceed with the replacement of the remaining nine units after the Commission informs the licensee that the test results are satisfactory.

LICENSEE'S REPORT ON BIOLOGICAL TEST RESULTS

The licensee's study was designed to test the hypothesis that survival of Chinook salmon smolts through a new advanced hydro turbine would be equal to, or greater than, passage survival through an existing unit. The licensee utilized a balloon tag-recapture methodology and designed a randomized block experiment for two turbines, three intake bays (within each turbine), two entrainment depths at 10 and 30 feet, and four operating flows at discharges of 9,000, 11,000, 15,000 and 17,000 cubic feet per second (cfs). Four replicate block trials were performed using 7,205 treatment fish and 1,646 control fish.

The results of the study were statistically evaluated using analysis of deviance (ANODEV) to test for differences in turbine passage survivals under alternative treatment conditions. The licensee stated that the ANODEV was used to test for the main effects of turbine type, discharge level, release depth, and intake slots. The licensee stated that the average turbine passage survival across all discharge and release depths for the new turbine was 96.95 percent for the new turbine and 97.5 percent for the existing turbine. A statistical test showed that the difference is not significant. The licensee stated that the data also shows that at the 10 foot intake/release depth, the new turbine's estimates of fish survival exceeded those of the existing turbine with an overall average survival of 98.5 percent for the new turbine and 97.9 percent for the existing turbine.

At the 30-foot entrainment depth, however, the licensee stated that the new turbine had significantly lower survival at the 9,000 cfs and 17,000 cfs discharge rates with an overall average survival of 95.4 percent for the new turbine and 97.1 percent for the existing turbine. The licensee added that it appears that the difference was primarily due to a single trial where 30 percent of the assigned fish were dead, mostly due to predation, or dead on recapture. The licensee contrasted this with the other three trials at intake bay B where only 5.8 percent of the fish fell into that category. Table 1.0 below, from the

licensee's filing, depicts the survival estimates for the two turbines at different depths and discharges.

Table 1. Turbine passage survival estimates (standard errors in parentheses) specified by turbine, discharge, and release depth. Analysis based on 48-hr mortality data. *P*-values for comparisons of turbine survivals within a discharge-release depth provided.

Depth	Discharge (kcfs)	Survival Estimates		Survival Difference	
		New Turbine	Existing Turbine	$\left(\hat{\tau}_{\text{New}} - \hat{\tau}_{\text{Existing}}\right)$ (SE)	*P*-value*
10 ft	9	0.9956 (0.0067)	0.9779 (0.0092)	+0.0177(0.0114)	0.9401
	11	0.9947 (0.0062)	0.9933 (0.0068)	+0.0014 (0.0092)	0.5605
	15	0.9804 (0.0094)	0.9787 (0.0100)	+0.0017 (0.0137)	0.5493
	17	0.9687 (0.0109)	0.9650 (0.0110)	+0.0037 (0.0155)	0.5944
30 ft	9	0.9465 (0.0127)	0.9765 (0.0096)	–0.0300 (0.0159)	0.0298**
	11	0.9672 (0.0111)	0.9523 (0.0121)	+0.0149 (0.0164)	0.8179
	15	0.9628 (0.0108)	0.9736 (0.0096)	–0.0108 (0.0144)	0.2274
	17	0.9404 (0.0127)	0.9825 (0.0089)	–0.0421 (0.0155)	0.0033**
Average		0.9695 (0.0071)	0.9750 (0.0049)		

* *P*-value associated with the one-tailed test of $H_o : \tau_{\text{New}} \geq \tau_{\text{Existing}}$ versus $H_o : \tau_{\text{New}} < \tau_{\text{Existing}}$.

* **P*-value less than 0.05.

In the licensee's filing, the licensee also discussed turbine passage survivability based on weighted vertical distribution from a 1984 study.[2] The licensee stated that, assuming the observed vertical distribution of Chinook at turbine Unit 8 is the same for both the new and existing turbines, and that the vertical distribution has not changed through time, a weighted estimate of passage survival can be calculated based on the

[2] Olson, Forrest W. 1984. Vertical distribution of juvenile salmonids entering the turbine intakes at Wanapum Dam. CH2M Hill. Report prepared for Public Utility District of Grant County, Ephrata, Washington.

turbine-by-depth survival results. The licensee stated that after weighting for the vertical distribution of the Chinook, the new turbine had an overall survival estimate of 97.8 percent, compared to the survival estimate of 97.7 percent for the existing turbine. The increase estimate of survival at the new turbine is due to the fact that a majority of the fish in the distribution study (i.e., 78.4%) pass through the upper portion of the water column where the new turbine had higher survival. The licensee added that the vertical weighting had little effect on the overall estimated survival through the existing turbine, where passage survival was similar between depth levels (Table 2).

Table 2. Average turbine passage survival weighted by vertical distribution for Chinook salmon. Standard errors are in parentheses.

Turbine	(50% top : 50% bottom) equal distribution	(78% top : 22% bottom) vertically distributed
New	0.9695 (0.0071)	0.9782 (0.0052)
Existing	0.9750 (0.0049)	0.9771 (0.0048)

In conclusion, the licensee stated that, whether using weighted or un-weighted data, the statistical analysis shows that the hypothesis of equal survival through the two units could not be rejected. The licensee further stated that there are additional benefits such as increased turbine efficiency for the new turbine (2.3 percent at 8,900 cfs; 3.8 percent at 10,900 cfs; and greater than 4 percent at 14,800 cfs; and 16,700 cfs.) Based on the study results, the licensee requested to continue with the installation of the new turbines as proposed in its approved amendment application.

AGENCY CONSULTATION

The licensee provided a draft copy of the study results to the Priest Rapids Coordinating Committee (PRCC) that is comprised of the licensee and the National Marine Fisheries Service (NOAA-Fisheries), the U.S. Fish and Wildlife Service (FWS), the Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation, the Yakama Nation, and the Confederated Tribes of the Umatilla Reservation. Written comments on the report were received from NOAA Fisheries, WDFW, FWS and the Columbia River Inter-Tribal Fish Commission (CRITFC) which is comprised of elected and appointed tribal officials of the Yakama Nation, the Confederated Tribes of the Umatilla Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Nez Perce Tribe. The licensee's filing contained responses to all of the comments received.

By letter dated July 28, 2005, NOAA-Fisheries expressed concern about the lower survival estimate for the new turbine versus the existing turbine at 9,000 and 17,000 cfs

flow rate at the 30 foot entrainment depth. NOAA-Fisheries stated that before installing another advanced turbine, it should explore why this is occurring. In a subsequent email dated September 13, 2005, NOAA-Fisheries stated that it reviewed an addendum to the report that provided information on the vertical distribution of salmon from a fyke net study conducted at the Wanapum development in 1984. NOAA-Fisheries concluded that given the new test results and Grant's commitment to continue biological investigations of the advanced turbines,[3] NOAA-Fisheries is agreeable to the installation of another advanced turbine at Wanapum dam.

By letter dated July 29, 2005, CRITFC stated that the study does not provide a robust foundation for management decisions regarding further installation of the new turbines. In general, CRITFC stated:

- additional studies and evaluations are need to resolve survival uncertainties before additional new turbines are installed;
- the methodology of using balloon tagged fish resulted in biased survival estimates;
- the study did not achieve sufficient precision to detect meaningful differences in juvenile salmon survival between the existing and new turbine because of a low statistical power;
- the formulation of the null hypothesis assumed that the new turbine would provide equal or better survival than the existing turbine which reverses the burden of proof;
- evaluation of delayed mortality in the study was insufficient; and
- the increased hydraulic capacity of the new turbine could decrease spill or surface bypass which may be superior to turbine passage.

CRITFC's July 29 letter expanded considerably on each of these comments.

[3] NOAA-Fisheries stated in its email that during a July 2005 PRCC meeting, Grant County stated it would investigate the feasibility of using acoustic tags in future advanced turbine biological testing to determine fish location and behavior in the scroll case.

By letter dated August 23, 2005, the WDFW provided its comments regarding the licensee's report. Generally, the WDFW comments were centered on the study design. The WDFW stated that, if it is important that the new turbine design provide safer passage than the existing turbines, then the null and alternative hypotheses are stated backwards. Further, the statistical power analysis should have been conducted before the study using a proposed sample size to yield detectable differences for given levels of power and significance. Lastly, the WDFW stated that an analysis that nested the intake bays within each turbine would have improved the power of the study over cross-classification of these two main effects.

In a letter dated September 1, 2005, the FWS provided seven comments. Each comment listed below was more fully explained in its letter. The FWS stated:

- it appreciates Grant's willingness to replace aging turbines with advanced turbines designed to reduce fish mortality while improving energy production;
- the comparison of the fish survival of the existing turbines and the advanced turbines followed the guidelines of the study plan approved by the PRCC and the results indicate that the survival is generally similar between the two turbine types;
- the FWS urges Grant to proceed cautiously with the remaining installations and questions the actual survival that can be expected with the advanced turbines;
- problems can be associated with direct release studies in that they do not provide a good representation of what the survival rate would be for untagged fish passing through the new or old turbine as they would under normal operation;
- the FWS recommends that Grant examine the mechanisms behind the lower survival rate at the two, 30-foot discharge rates and use the information for possible design modifications and in developing operating guidelines; and
- the advanced turbines have a higher hydraulic capacity thus potentially passing more fish downstream through the turbines and this issue, coupled with the previous one, suggests that Grant should explore these uncertainties before moving to full replacement of all the old turbines.

Lastly, on August 24, 2005, the Priest Rapids Coordinating Committee held a meeting in which a draft of the final quantitative evaluation of the advanced turbine's performance at the Wanapum development was distributed. The minutes noted that the committee indicated its support of moving forward with installation of the turbines, but requested future input and involvement with the structure of planned studies.

DISCUSSION

The comments received in response to the study can be grouped into two categories: those dealing with the design of the study and those concerning the results of the study.

In the licensee's October 2003 application for amendment of licensee (to replace the existing 10 turbines at the Wanapum development with 10 new advanced turbines) the licensee included a proposed study designed to be used to compare fish passage survival through the new turbine versus an existing turbine. The proposed study indicated that it would use a balloon-tag mark-recapture methodology which has been implemented successfully at many Snake and Columbia River hydroelectric projects and is an acceptable industry standard for determining fish survivability through a turbine. The study design also described the proposed statistical analyses to be used to evaluate the data.

Prior to filing the amendment application with the Commission, the licensee consulted with the resources agencies, tribes and non-governmental organizations concerning the installation of the new turbines and the study to be used to evaluate the new turbines efficiency in downstream fish passage. There were no major objections to the licensee's study plan or the statistical methods proposed to analyze the results at that time. Comments of the licensee's technique and interpretation of the results are valid, and recommendations regarding any future testing or operational concerns are valuable; however, the time has past to suggest a different hypothesis or methodology should have been used to test the turbine types. Review of the licensee's report indicates that the study plan was implemented as proposed and evaluated as approved.

In regard to the comments centered on the results of the study, the main focus was on the lower survivability of the juvenile salmon that occurred at two discharge rates (9,000 and 17,000 cfs) at the 30-foot entrainment depth. At two of the eight discharge rates and depths tested, the results showed a statistical difference between the new turbine and existing turbine. However, the licensee conducted a literature review that indicates that most of the surface oriented juvenile salmonids enter turbines in the upper water column. That review is consistent with the licensee's 1984 study in which they examined the vertical distribution of Chinook salmon at the Wanapum development using fyke nets. The study showed that 78.4 percent of the sampled fish were captured in the top 18 feet of the water column and 21.6 percent were captured below that. Therefore, when taking practical considerations into account, the overall survival estimate was statistically the same at 97.8 percent survival for the new turbine versus 97.7 percent for the existing turbine.

Concerns were also raised that the increase hydraulic capacity of the new turbine would entrain more fish thereby decreasing spill or surface bypass passage of the juvenile or adult salmonids. However, in 2001-2003 the licensee compared passage of radio-tagged Chinook yearlings over the spillway versus turbine passage and found that between 85-88 percent survived passage over the Wanapum spillway while 91-98 percent survived passage through the turbine. The licensee also noted that with the increase in hydraulic capacity, the problems associated with supersaturation, such as gas bubble disease,[4] may decrease due to less spill occurring. The 10 new turbines could decrease the amount of spill by approximately 23,000 cfs at certain times of the year.

The licensee stated that it is continuing to investigate the possible cause of the lower survival estimates for the advanced new turbine at the 30-foot depth. Grant also stated that it is looking into the possibility of a future study that specifically looks at the locations that yielded survivability estimates (for the new turbine) that were below the estimates than the existing turbine. The licensee should keep the Commission apprised of its continued biological investigations of the advanced hydro turbine and any future passage studies as they relate to the replacement of the existing turbines with the advanced turbines.

CONCLUSION

The 2005 biological study results suggests that at five of eight discharge rates and entrainment depths, the new turbine achieved equal or better juvenile salmon passage than the existing turbine. After weighting the results to reflect probable distribution of juvenile salmonids in the water column, the new turbines would have a 97.8 percent efficiency rating for passage survival compared to 97.7 percent efficiency for the existing turbines. Given the anticipated improvement in water quality (by slightly reducing total dissolved gases through less spillage) and the increased generation potential for the new turbines, it appears prudent that the old turbines, which are in need of complete

[4] Gas-bubble disease is characterized by the formation of gas bubbles in the body cavities of fish, such as behind the eyes or between layers of skin tissue. Small bubbles can form within the vascular system, blocking the flow of blood causing tissue death. Bubbles can also form in the gill lamellae and block blood flow resulting in death.

refurbishment, be replaced with advanced hydro turbines that overall are as efficient as the existing turbines in passing migrating juvenile salmon.

The advanced hydro turbines were developed to improve survivability of juvenile salmon through the units. Based on the results of the study, which was satisfactorily implemented and completed, the licensee should be authorized to continue with the installation of the remaining nine advanced hydro turbine units at the Wanapum development in accordance with the approved schedule.

The Director Orders:

(A) Public Utility District No. 2 of Grant County is authorized to continue with the installation of the remaining nine advanced hydro turbine units at the Wanapum development of the Priest Rapids Project, FERC No.2114.

(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to 18 C.F.R. § 385.713.

J. Mark Robinson
Director
Office of Energy Projects