2018 Fish Passage Plan

Appendix C

Bonneville Power Administration's System Load Shaping Guidelines Regarding Turbine Operation & Peak Efficiency

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1. INTRODUCTION

1.1.1. Out-migrating juvenile salmonids have several potential routes of passage past hydroelectric dams on the mainstem Columbia and Snake rivers, including turbines, mechanical bypass, sluiceways and spillways. Fish passage survival varies depending on the route of passage. As a result of reported higher mortality rates for fish passage through turbines (Iwamoto and Williams 1993), regional efforts have focused on providing non-turbine passage routes for juvenile fish as a means to improve fish survival through the Federal Columbia River Power System (FCRPS). Nevertheless, substantial numbers of juvenile fish will continue to pass through turbines, thus efforts to minimize turbine-related mortality is a priority of fishery agencies and Indian Tribes, the National Oceanic & Atmospheric Administration's Fisheries Service (NOAA Fisheries, formerly National Marine Fisheries Service [NMFS]), U.S. Army Corps of Engineers (Corps), and Bonneville Power Administration (BPA).

1.1.2. Kaplan turbine operating efficiency has a relatively direct effect on fish passage survival. The relationship between survival of juvenile fish passing through Kaplan turbines is positively correlated and roughly linear to the efficiency at which the turbines are operated. Bell (1981) recommended making every effort to operate turbines at peak efficiency at a given head during periods of peak fish passage to minimize fish mortality.

2. TURBINE EFFICIENCY

2.1.1. For the purposes of this document, peak turbine efficiency operation shall be based on tables of operating ranges within ±1% of peak efficiency (1% range) provided by the Corps for each project in the Fish Passage Plan (FPP). The Corps shall ensure that 1% ranges are based on the best available information and that updates are coordinated with BPA, the Fish Passage Operations & Maintenance (FPOM) Coordination Team, and operating agencies. The tables will be distributed to all operating agencies prior to implementation, allowing up to two weeks after receipt of the tables for implementation.

2.1.2. Operating efficiency of turbines is a result of wicket gate opening and blade angle for a given head (Bell 1981). As a result, there is a family of turbine efficiency curves for each project (or turbine design) for various head differentials. Operational decisions affecting turbine operations are based on efficiency curves for incremental changes in head, as provided by turbine manufacturers or empirical testing.

3. GUIDELINES

3.1. Objective.

3.1.1. To reduce mortality of out-migrating juvenile salmonids, BPA will provide the Corps hydrosystem projects with generation requests that allow turbines at the Lower Snake (LSN) and Lower Columbia (LCOL) projects to operate within ±1% of peak turbine efficiency (1% range), or as otherwise specified, during the Peak Efficiency Operating Period of April 1 through October 31, in accordance with the guidelines below.

3.2. In-Season Peak Efficiency Operating Period (April 1–October 31).

3.2.1. During this period, 24 hours/day, BPA will maintain generation requests at all Lower Columbia (LCOL) and Lower Snake (LSN) hydroelectric projects to allow turbines to operate within the 1% range in accordance with these guidelines. Excursion outside of the 1% range during this period will be tracked using the codes in **Table C-1**.

3.3. Off-Season (November 1–March 31).

3.3.1. While not required to do so in the off-season, turbines will normally run within the 1% range since it is the optimum point for maximizing energy output of a given unit of water over time. Operation outside the 1% range is allowed if needed for power generation or other needs. For more information on the 1% operation, see the project-specific chapters of the FPP for *Turbine Unit Operation & Maintenance*. There are no reporting requirements for this period.

3.4. Unit Priorities.

3.4.1. The Corps should make every effort to adhere to unit operating priorities specified in the FPP (the order in which turbines are put on- or taken off-line). The Corps shall follow a unit priority list that specifies which units at each LSN and LCOL project should be operated within the range of peak efficiency to minimize impact to salmon stocks. The Corps through the FPOM process will develop a sequence for operating units outside of the 1% peak efficiency range if necessary during the fish migration season. Both unit priority sequences will be based on the best available fish passage and turbine efficiency information in the FPP.

3.5. Project Priorities.

3.5.1. If units must be operated outside of the 1% range, BPA will make every effort to assure that generation requests to Corps projects adhere to project priorities (emergencies, spill management, research, etc). These priorities may be developed weekly, based on in-season fish passage information, by the Action Agencies through the Technical Management Team (TMT).

3.6. Coordination.

3.6.1. Coordination will occur through existing interagency mechanisms, such as the in-season management process described in the 2004 Updated Proposed Action prepared by the Corps, U.S. Bureau of Reclamation, and BPA (Action Agencies).

3.6.2. Coordination is also intended to allow the Action Agencies sufficient time to include system operational changes in their planning activities. Sufficient time is defined as the time needed to enter the information into GDACs (COE) and the Columbia Vista model (BPA). This can take up to two weeks to accomplish. If an emergency situation exists, implementation will begin as soon as practical given concurrent operations, hydraulic situations and loads.

3.6.3. Reasonable and prudent operations outside of the 1% range for limitations listed in **sections 4.1** (**System Reliability**) and **4.2** (**Routine Starting**) are at the discretion of BPA and

the Corps. BPA and the Corps will coordinate with NOAA Fisheries when operation of turbines outside of the 1% range may be appropriate under provisions in **section 4** below. Additional coordination may also occur during the next scheduled TMT meeting.

3.6.4. Emergency situations described in **4.1** that require an immediate change in FCRPS operation will be coordinated directly by the Action Agencies with NOAA Fisheries as soon as practicable. If coordination of an emergency change in FCRPS operation cannot be completed immediately, information will be supplied to TMT as soon as practicable. The Action Agencies shall establish points of contact with the appropriate agencies to allow such emergency coordination to occur.

3.7. Grand Coulee (GCL) and Chief Joseph (CHJ) Flexibility.

3.7.1. Within system reliability and firm load limitations, flexibility at GCL and CHJ will be fully used whenever possible before generation requests to LCOL and LSN projects are outside the 1% range.

4. IN-SEASON LIMITATIONS (APRIL 1 – OCTOBER 31)

Occurrence of the conditions described below may limit the ability of the Action Agencies to operate turbines continuously within the 1% peak efficiency range.

4.1. System Reliability.

4.1.1. BPA's ability to operate the power system in a manner that enables the Corps to maximize operation of turbines within the1% range will be constrained by requirements to maintain system reliability (including requirements necessary for transient and voltage stability of the transmission system), and the ability to meet system response criteria. Additionally, it is necessary to maintain a margin of resource generation on-line to fulfill Northwest Power Pool (NWPP), Western Electricity Coordinating Council (WECC) and the North American Electric Reliability Council (NERC) reliability requirements. If BPA overrides BiOP operations for system reliability, BPA will provide an automated e-mail to the Corps. For longer term emergencies, see the current *Water Management Plan,* Appendix 1 (Emergency Protocols).

4.1.2. System response criteria and margin of resource generation are defined in the following documents: *Reliability Criteria for Operations (BPA)*, *Northwest Power Pool Operating Manual, Western Systems Coordinating Council Operations Committee Handbook*, and *North American Electric Reliability Council Operating Manual*. According to the Regional Act, the Power Sales Contract with the DSIs and *House Report 96-976*, dated September 16, 1980, "the total DSI load will be considered firm for purposes of resource operation."

4.1.3. Predictable instances of deviation from the 1% range as a consequence of prudent utility operation for control of short-term system dynamics include:

> **(i)** Routine responses to loss of generation, load or transmission within the interconnection including delivery of “Operating Reserve Obligation” to NWPP members

upon request. The duration of these deviations is minimal but dependent upon recovery by the interconnection member with the problem.

(ii) Deliberate dropping of generation (i.e., instantaneous interruption of output) to preserve system integrity. This dropping could cause a brief excursion.

4.2. Routine Starts and Stops.

4.2.1. Routine starting and stopping of generation units are unavoidable deviations, usually short duration but on occasion can extend beyond the 5 minute reporting window (see **section 5**).

4.2.2. Operations in **sections 4.3–4.8** will include notification to NOAA Fisheries at least 2 working days before implementation to allow sufficient time to evaluate effects of proposed actions (non-emergency situations).

4.3. Total Dissolved Gas (TDG) Supersaturation.

4.3.1. TDG levels will be monitored at each project during the fish passage season. Signs of gas bubble disease will be monitored at all Smolt Monitoring Program sampling sites and selected in-river sites. Peak turbine efficiency operation may be modified if representative monitoring data indicate that TDG is affecting fish survival. Necessary operational modifications will be coordinated through the process outlined in **section 3.6**.

4.4. Coordinated Fishery Operations.

4.4.1. In the event that coordinated fishery operations and approved fish research are not in accord with operating turbines in 1% ranges, operational modifications will be coordinated through processes outlined in **section 3.6**.

4.5. Flow Augmentation Operations.

4.5.1. Flow augmentation requests for flows at McNary (MCN) are primarily met by water releases from GCL. The decision whether to use GCL flexibility to provide MCN inflow at the level necessary to meet the week's LCOL flow request when fish collection is maximized for transport during the flow augmentation period shall be made through coordination processes outlined in **section 3.6**. The TMT flow augmentation requests may exceed the 1% range at LCOL/LSN projects. Meeting this flow request will take precedence over 1% operations.

4.6. Transport Projects.

4.6.1. Resolution of conflicts between spill management and turbine operation within 1% ranges at transport projects during transport season shall be determined through the coordination process in **section 3.6**, and in accordance with transportation guidelines based on in-season flow and fish passage information. Care should be taken during transition periods close to the upper flow boundary to avoid frequent switching of priorities between spill and generation.

4.7. Routine Maintenance and Testing.

4.7.1. All units at all projects must undergo maintenance and associated testing. The testing necessitates deviation from the 1% ranges for periods of 15 minutes to 8 hours. Scheduling of maintenance testing will be coordinated through the process outlined in **section 3.6** to ensure that it is conducted during times of low fish passage within a day to minimize impacts on fish.

4.8. Flood Control.

4.8.1. The FCRPS provides multiple regional benefits and flood control is the primary function of many of the projects on the Columbia River. In the event that river flow conditions require flood control operations, operation of turbines within the 1% ranges may be modified or suspended based on the Corps' direction. Allowing excursions outside the 1% ranges for flood control operations would facilitate transportation, reduce excessive TDG levels, and lower the risk of gas bubble disease in fish. Coordination of flood control operations will occur as outlined in **section 3.6**. See also **sections 4.3** (**TDG**) and **3.7** (**GCL and CHJ Flexibility**).

4.9. Other.

4.9.1. In the event that the excursion was not explainable or caused by human error.

5. QUALITY CONTROL

5.1.1. Significant deviations outside of the 1% range will be recorded. Data on unit status will be compiled by BPA during the 1% operating season and provided to the COE monthly. Documentation will be kept when excursions:

(i) exceed 15 minutes in duration; and/or

(ii) occur 5 or more times exceeding 5 minutes within 1 calendar day.

5.1.2. The reason (limitation or other factor) for the excursions will be kept in project logs at each dam as well as inserted into the spreadsheet provided by BPA using the reason codes listed in **Table C-1**. The COE will annually provide a report to NOAA Fisheries of reportable excursions from the 1% operating range during the 1% operating season.

5.1.3. Upon request of TMT, a case-by-case brief explanation of the reason(s) for unit operation outside the 1% range, the date and length of time of the excursion, will be provided by the appropriate parties. For the report, the following numerical codes will be used to explain excursions outside the 1% range. The codes provide a more simplified method of tracking excursions than using the listed limitations in **section 4**.

Table C-1. Codes for Reporting Excursions Outside the 1% Peak Efficiency Range.

Code	Reason
1	Equipment reporting errors, including lack of data (GDAC or AGC not operating correctly and not recording readings, dead-band and precision issues, etc.)
2	Modified spill operations in support of BiOp or court order (requested flow augmentation, coordinated fish operation)
3	O&M requirements (fish screen inspection, trash raking, Doble testing, dam safety, etc.)
4	Operational tests (index testing, testing or calibrating new or repaired equipment)
5	BPA requested operation (request operation via AGC)
6	Turbine start-up or stops longer than 5 minutes
7	Emergency conditions or system failures, including transmission system emergencies, remedial action schemes (RAS), or others as described in 4.1. *System Reliability*.
8	Fish research
9	Human error
10	Unknown causes
11	Other (Please specify)
12	Flood control
13	TDG reduction