# Fish Passage Plan (FPP) Change Request Form

**Change Form # & Title**: 20IHR003 – Position of Operating Gates

**Date Submitted**: July 7, 2020

**Project**: Ice Harbor Dam

**Requester Name, Agency**: Karl Anderson, USACE - NWW

**Final Action**:

**FPP Section**: IHR Section 4.3 (Turbine Maintenance)

**Justification for change**: Ice Harbor Dam operating gates are currently maintained in a raised operating position using multistage telescoping cylinders that need to be replaced due to age and condition to maintain operational reliability and safety.

Attached is a white paper *(copied below)* to provide technical information and justification to support the replacement of the existing multistage hydraulic cylinders with single stage cylinders (as originally designed) for operation of the Ice Harbor turbine intake head gates, also referred to as the operating headgates or emergency operating headgates.

We propose to replace the telescoping cylinders with single stage cylinders because of lower cost of replacement and reduced number of seals, thus providing a benefit to fish with reduced chance for oil spills. In addition, this approach improves the reliability to maintain project operations that optimize passage for adult attraction and juvenile egress. Single stage cylinders would require the operating gates be in the SOG or original stored position.

Cylinder replacement is tentatively scheduled to start in May of 2021 and complete in April of 2023.

**Proposed Change**:  Add new section 4.3.10 as follows:

**4.3. Turbine Unit Maintenance.**

**4.3.10. Head Gates.**Turbine units may be operated with head gates either in the *raised or stored* position. Once all new cylinders have been acquired, turbine units will operate with all head gates in the original design stored position to ensure the safety of project personnel and facilities.

**Comments**:

**Record of Final Action**:

Ice Harbor Dam Head Gate Cylinder Replacement

Prepared by: Karl Anderson

6/12/20

**Purpose:**

The purpose of this document is to provide background information and justification to support the replacement of the existing multistage hydraulic cylinders with single stage cylinders (as originally designed) for operation of the Ice Harbor turbine intake head gates, also referred to as the operating headgates or emergency operating headgates. The multistage cylinders are ageing and risk the inability to respond to an emergency. The single stage cylinders are significantly less expensive and have a lower risk of oil leakage due to the reduced number (~50% less) of oil seals required. The reduced number of seals provide a benefit to fish with reduced chance for oil spills. In addition, this approach improves the reliability to maintain project operations that optimize passage for adult attraction and juvenile egress.

**Introduction:**

In the early 1990’s, the original single stage hydraulic cylinders used to deploy the emergency headgates within the Ice Harbor turbine intakes were replaced with multistage hydraulic cylinders. These multistage cylinders were installed to allow for storage of the headgates in what is called the “raised” position (Raised Operating Gate; ROG) versus the original stored position (Stored Operating Gate; SOG); these also maintain the USACE required ten minute closure capability. Based on studies conducted at McNary in the late 1980’s, it was believed that raising the headgates would increase turbine intake screen guidance efficiency by as much as 10 percent. Therefore, based on the McNary study, the single stage cylinders were replaced with multistage cylinders when the Ice Harbor Juvenile Bypass System was being constructed.

Because of the multistage cylinders, Ice Harbor is able to store headgates in the raised position while maintaining the 10-minute closure requirement. The headgates at McNary, Lower Monumental, Little Goose and Lower Granite were also raised and stored at the “raised” position to increase FGE. However, due to the replacement cost of the multistage cylinders, the single stage cylinders at these projects were removed from the gates, and the turbine intake gantry crane has been used to raise and dog these head gates into the “raised” position. Unlike at Ice Harbor, these gates cannot be deployed within the required 10-minute closure time.

Studies were conducted at McNary, Little Goose and Lower Monumental Dams to estimate the FGE of turbine operations with the headgates in original “stored” position versus the “raised” position. The results for all three studies showed no significant difference in FGE between the two gate positions. Since the turbine intake screens installed at McNary and Little Goose dams are the extended length submersible bar screens (ESBS) and are similar to those at the Lower Granite dam, the study results were applied to Lower Granite, and the headgates of these three dams have been or will be returned to their original stored position with 10 minute closure capability. Since Lower Monumental has the shorter submerged traveling screens (STS) and not the longer ESBSs a third FGE study of headgate “stored” versus headgate “raised” was performed at Lower Monumental Dam. This study also showed no significant difference in FGE between the two gate positions. Since Ice Harbor is similar in design to Lower Monumental and has the same STS screens installed, it is expected the headgates’ position whether “raised” or “stored” has little to no significant influence on FGE. The recommendation by the PDT is to replace the failing multistage operating gate cylinders at Ice Harbor with lower cost single stage cylinders which would return the headgates to the originally stored position and maintain the 10 minute closure requirement.

**Background:**

Submersible traveling screens (STSs) and extended-length submersible bar screens (ESBS) were installed to guide fish entering turbine intakes away from turbines upward to the gatewell slot. Vertical barrier screens (VBSs) were installed between the orifices and the operating gates, as well as turning vanes to direct flow from the upper portion of the screen into gatewells (Ham et al. 2009a, 2009b, 2009c, 2009d). Turbine operating (head) gates (three per turbine) close off the turbine unit intakes in case of emergencies or for the dewatering of the turbine unit for inspection and repairs. Originally, the operating gates were kept in the stored position on hydraulic cylinders, which allowed for efficient gate operations for the required 10 minute closure capability in the event of an emergency. Early studies like Ledgerwood et al. (1987) suggested that keeping the operating gates in the raised position instead of the stored position **(Fig. 1**) increased fish guidance efficiency (FGE), which is the proportion of fish entering the turbine intakes that are diverted into the juvenile bypass system (JBS). As a result, operating gates at Walla Walla District dams were maintained in the raised position since the early 1990’s.



**SOG**

**ROG**

**Figure 1. Side View of the Turbine Intake Stored Operating Gate (SOG) in red (left) and Raised Operating Gate (ROG) in red (right) with STS screens (~20ft in length). (From Ham and Titzler 2020).**

Recent re-evaluations of FGE using split-beam sonar at McNary, Lower Monumental, and Little Goose dams found no significant decrease to FGE from lowering the operating gates to the original stored operating position (Ham et al. 2013, 2017, 2020).

Ham and Titzler (2020) conducted a study at Lower Monumental Dam in 2019 to evaluate FGE changes in Raised vs. Stored operating gate, because Lower Monumental Dam has STS screens as opposed to the ESBS Screens at Little Goose and McNary Dams. In 2019, spill operations followed a “Flexible Spill Agreement” for Columbia River System Operations entered into by federal action agencies, the states of Oregon and Washington, and the Nez Perce Tribe; objectives include providing benefits to fish and the federal power system, as well as providing operational feasibility for USACE at federal dams. That agreement called for spill to 120% total dissolved gas in the tailrace for a minimum of 16-hours per day during the spring period (through 20 June at Snake River projects). During the remaining 8 hours per day, the agreement provides flexibility to reduce spill during limited periods of the day when hydropower production is needed most (Ham and Titzler 2020). Lower Monumental summer spill operations in 2019 was 17 kcfs while Ice Harbor’s was 30%.

Ice Harbor power house 10-year average flow (**Fig. 2**) flow is less than Lower Monumental, thus likely less of a concern for summer migrants passing into the PH. More spill flow will draw more downstream migrants through the spillway passage than turbine passage.



**Figure 2: 10-year average percent flow through the power house at Ice Harbor and Lower Monumental Dam during summer. Source: Columbia River DART, Columbia Basin Research, University of Washington. (2020).**

Ham and Titzler (2020) found that estimated spring migrants FGE for the stored operating gate (SOG) treatment was not significantly (P=0.47) lower (81.8% vs. 82.6%) than for the raised operating gate (ROG) treatment. During the summer study period, FGE for the ROG treatment was also not significantly (P=0.87) different (80.9% vs. 80.7%) from the SOG treatment. During this study no mortality events in the gatewells or orifices were seen (Chuck Barnes, Personal Communication 6/29/2020).

Whole project passage and survival estimates for subyearling Chinook salmon from radio and acoustic telemetry studies with operating gates in the raised position ranged from 0.9414 to 0.9797 (Ham and Titzler 2020). When passage route proportions were adjusted to reflect a hypothetical stored gate scenario, there was little change in estimated survival, which ranged from −0.0002 (a slight reduction) to +0.0002 (a slight increase). These differences can be restated as a potential change in survival of plus or minus two hundredths of a percent. In all cases, the computed dam-wide survivals for the stored gate scenarios remained above the BiOp survival requirement of 0.93 for subyearling Chinook salmon (Ham and Titzler 2020). Raised or lowered operating gates have little effect on FGE at Lower Monumental Dam which suggests Ice Harbor Dam, which also uses STS screens, should likely have a similar result.

**Justification for change:**

Ice Harbor Dam operating gates are currently maintained in a raised operating position using multistage telescoping cylinders that need to be replaced due to age and condition to maintain operational reliability and safety. Starting around 2011, several Trouble Reports (TRs) from shift operators in the Facilities and Equipment Maintenance (FEM) database documented multiple oil leaks, desiccant filter replacements, and remote operation of the intake gate pumps failures. In the last 7 years, there have been two failures of the intake gate hydraulic system where the intake gates dropped while the units were operating. Recently there have been 4 reportable oil spills due to hydraulic seal issues (July 2017, August 2017, April 2018, and August 2018). The current hydraulic system is increasingly unreliable. Updating to the single stage cylinders improves all facets of the intake gate hydraulic system, by improving seals, spill containment, and oil handling equipment reducing both the likelihood and impact of oil discharge to the river. In addition, these upgrade benefits will restore operational safety to the plant generators by assuring timely response to cut off flow of water through the turbines in the event of failure of the water control equipment.

We propose to replace the telescoping cylinders with single stage cylinders because of lower cost of replacement, and the single stage cylinders have fewer seals that could fail. When the seals of a hydraulic cylinder fail, the unit is removed from service until repairs can be made. In addition, this approach improves the reliability to maintain project operations that optimize passage for adult attraction and juvenile egress by reducing the number of potential points of failure (the seals). Single stage cylinders would require the operating gates be in the SOG or original stored position. The recommended alternatives (**Table 1**) from the PDT are to replace the new hydraulic system, reuse existing tanks and piping and new single stage cylinders for a Contract cost of $10.2M, total project costs about $11.5M. The second preferred alternative would be to replace the new hydraulic system, reuse existing tanks and piping and new in kind telescoping cylinders for a Contract cost of $17.0M, total project costs about $18.5M. That’s a difference of 52% to 47%. The third alternative would be refurbishment of the existing telescoping cylinders at a cost of roughly $13.5M. However, maintenance and operation of the telescoping cylinder should be considered (more complex cylinders require more maintenance).

| **Alternative** | **Cost** | **O&M Benefit** | **Fish Benefit** | **Detriments** |
| --- | --- | --- | --- | --- |
| New Single Stage | $11.5M | * New cylinders
* Least expensive
* Lowest leak risks due to fewest seals
 | * Lowest oil leak risk
* Lowest outage risk that may lead to suboptimal passage conditions
 | * Potential slight reduction in FGE compared to older studies but under current spill operations have not been repeatable
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| New Telescoping | $18.5M | * New cylinders
 | * Would maintain passage condition of a perceived FGE benefit that has not been proven under current spill operations
 | * Most expensive
* Increased leak risks due to more seals
* Increased risk of unit outages with suboptimal passage conditions
* All risk increase with age
 |
| Refurb. Telescoping | $13.5M | * Least expensive that maintains ROG position
 | * Would maintain passage condition of a perceived FGE benefit that has not been proven under current spill operations
 | * More expensive than lowest cost
* Increased leak risks due to more seals
* Uncertainty that other parts may fail due to age
* Increased risk of unit outages with suboptimal passage conditions
* All risk increase with age
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**Table 1: Alternatives in the Ice Harbor Cylinder replacement project.**

Results of the study at Lower Monumental Dam and the similarities in design (both have STS Screens) between Ice Harbor and Lower Monumental Dams along with both being adjacent on the Snake River, make it reasonable to expect that changing gate position would not significantly effect FGE at Ice Harbor Dam. Plus, less flow passes through the Ice Harbor power house than Lower Monumental therefore the number of fish effected is anticipated to be less than at Lower Monumental. Intake elevation differences show both intakes are close in height: Lower Monumental at 75.78 ft and Ice Harbor at 73.13 ft. Ice Harbor and Lower Monumental have similar distributor elevations (19 ft and 19.5 ft) from the intake floor. The operating gates at Ice Harbor and Lower Monumental are located approximately 74 ft and 65 ft from the distributor respectively. The general shape and configuration of the intakes are similar with nothing so different about them that we would expect a difference in FGE. Using study data from one project to inform a decision for a similar project has been an acceptable protocol at Lower Snake and Columbia River dams. For instance, findings at Little Goose Dam were acceptable by FPOM to apply findings to Lower Granite Dam. Costs for a study at Ice Harbor Dam would range from $700-770k, and would be redundant.

USACE recommends replacing the telescoping cylinders with single stage cylinders. The project is scheduled to start construction in May of 2021 and complete in April of 2023. Installation of cylinders will take place via already scheduled outages.

**References:**

Ham KD, CII Arimescu, MA Simmons, JP Duncan, MA Chamness, and AA Solcz. 2009a. Synthesis of Biological Research on Juvenile Fish Passage and Survival 1990-2006: Lower Granite Dam. PNWD-4059 Final, Battelle-Pacific Northwest Division, Richland, WA.

Ham KD, CII Arimescu, MA Simmons, JP Duncan, MA Chamness, and AA Solcz. 2009b. Synthesis of Biological Research on Juvenile Fish Passage and Survival 1990-2006: Lower Monumental Dam. PNWD-4061 Final, Battelle-Pacific Northwest Division, Richland, WA.

Ham KD, CII Arimescu, MA Simmons, JP Duncan, MA Chamness, and AA Solcz. 2009c. Synthesis of Biological Research on Juvenile Fish Passage and Survival 1990-2006: McNary Dam. PNWD-4035 Final, Battelle-Pacific Northwest Division, Richland, WA.

Ham KD, CII Arimescu, MA Simmons, JP Duncan, MA Chamness, and AA Solcz. 2009d. Synthesis of Biological Research on Juvenile Fish Passage and Survival 1990-2006: Ice Harbor Dam. PNWD-3976. Final, Battelle-Pacific Northwest Division, Richland, WA.

Ham KD, PS Titzler and DM Trott. 2013. Evaluation of the Effect of McNary Dam Operating Gate Position on Fish Guidance Efficiency. PNNL-22857, prepared for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington, by Pacific Northwest National Laboratory, Richland, Washington.

Ham KD, PS Titzler and RP Mueller. 2017. Evaluation of Juvenile Salmon Fish Guidance Efficiency at Little Goose Dam: The Effect of Operating Gate Position. PNNL-25829, prepared for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington, by Pacific Northwest National Laboratory, Richland, Washington.

Ham KD, and PS Titzler. 2020. Effect of Operating Gate Position on Juvenile Salmon Fish Guidance Efficiency at Lower Monumental Dam. PNNL-29106, prepared for the U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington, by Pacific Northwest National Laboratory, Richland, Washington.

Krcma RF, MH Gessel, and FJ Ossiander. 1983. Research at McNary Dam to Develop and Implement a Fingerling Protection System for John Day Dam, 1982. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest and Alaska Fisheries Science Centers, Seattle, Washington. (Report to U.S. Army Corps of Engineers, Contract DACW57-82-F-0373).

Ledgerwood, RD, WT Norman, GA Swan, and JG Williams. 1987. Fish Guiding Efficiency of Submersible Traveling Screens at Lower Granite and Little Goose Dams1986. Annual Report to U.S. Army Corps of Engineers by National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, WA 98112. Delivery Order DACW68-84-H-0034.