

**NMFS: ANADROMOUS SALMONID PASSAGE FACILITY DESIGN
AND
COLUMBIA GENERATING STATION: COOLING WATER INTAKE SYSTEM SPECIFICATIONS
REVIEW AND EVALUATION**

PREPARED BY: WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

PREPARED FOR: THE ENERGY FACILITY SITE EVALUATION COUNCIL

FINAL SEPTEMBER 2014

INTRODUCTION

Washington Department of Fish and Wildlife (WDFW) has been tasked with providing a review and evaluation of the design of Columbia Generating Station (CGS) cooling water intake structure (intake) for consistency with National Marine Fisheries Service's (NMFS) Anadromous Salmonid Passage Facility Design (Manual), dated July 2011. The review is the request of Energy Facility Site Evaluation Council (EFSEC) under contract # 13-1536 as follows.

WDFW will provide technical services to EFSEC in support of the compliance monitoring (auditing) activities at the Hanford site for the CGS. This includes inspections, review of environmental monitoring data, bioassay studies, and NPDES permit conditions.

1. Review and evaluate design of CGS cooling water intake structure for consistency with National Marine Fisheries Service's (NMFS) Anadromous Salmonid Passage Facility Design Manual, dated July 2011.
2. Review and evaluate public comments submitted by Energy Northwest for functional equivalency to the above mentioned NMFS Manual.
3. Review and evaluate technical data contained in public comments, as requested by EFSEC.

Herein, WDFW reviews the design criteria but does not address the authority to implement and enforce compliance of the Manual. The review consists of evaluating CGS intake existing conditions for consistency and functional equivalency with the Manual. The scope of the review incorporates all Pacific anadromous salmonids (salmon and steelhead) that migrate through, spawn, emerge, and rear above and in the area of the CGS intake.

BACKGROUND

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) is charged by Congress to manage, conserve, and protect living marine resources within the United States Exclusive Economic Zone. NMFS also plays a supportive and advisory role in the management of living marine resources in areas under state jurisdiction. Among these living marine resources are the Pacific anadromous salmonids (salmon and steelhead) which have tremendous economic, cultural, recreational, and symbolic importance to the Pacific Northwest (NMFS 2011 and references therein).

The Anadromous Salmonid Passage Facility Design (Manual; NMFS 2011) is intended to assist with improving conditions for salmonids that must migrate past barriers to complete their life cycle. The Manual provides criteria, rationale, guidelines, and definitions for the purpose of designing proper fish passage facilities for the safe, timely, and efficient upstream and downstream passage of anadromous

salmonids at impediments created by artificial structures, natural barriers or altered instream hydraulic conditions. Dynamic integration of fish behavior, physiology, and bio-mechanics with hydraulic analysis, hydrologic study, and engineering are factored into the criteria, rationale, guidelines, and definitions. The design standards provided in the document are very general and represent a starting point for fish passage design. Additional detail beyond the scope of the Manual are developed in consultation with NMFS.

The fish passage facilities described in the Manual not only include fish ladders, trap and haul facilities; fish handling and sorting facilities as the term suggests, but also juvenile fish screens as part of hydroelectric, irrigation, and other water withdrawal projects. The CGS intake is a water withdrawal project for cooling purposes therefore considered a “facility”. The intake consists of two passive, end-of-pipe intakes with juvenile fish screens. This review addresses criteria, rationale, guidelines, and definitions relevant to the CGS intake.

Information regarding the CGS intake was found in the following sources (source information).

- Fact Sheet for NPDES Permit WA002515-1 Columbia Generating Station DRAFT - Working Draft Date: 1/15/2014
- Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 47 Regarding Columbia Generating Station NUREG-1437
- LICENSE RENEWAL APPLICATION, COLUMBIA GENERATING STATION, January 2010, Appendix E, Applicant’s Environmental Report, Operating License Renewal Stage, Columbia Generating Station, Energy Northwest, Docket No. 50-397, License No. NPF-21
- Energy Northwest and National Marine Fisheries Service Meeting Overview of Operation of Columbia Intake Structure November 13, 2013

INTAKE SCREENING EVALUATION

The CGS intake system was designed and constructed in the late 1970’s and still exists today. The Manual Forward acknowledges that existing facilities, such as the CGS intake, may not adhere to the criteria and guidelines found in the Manual. In addition, such screens may not need to be modified specifically for compliance but rather identify features to be modified in the context of major upgrades to ensure future compliance. Additional clarification is also provided in Section 11.1 Introduction – Fish Screen and Bypass Facilities where “Unless directly specified herein, this guidance is not intended for use in evaluation of existing facilities, nor does it provide guidance on the application of the design for any particular site.” Section 11.4.1 Acceptance Criteria and Guidelines for Existing Screens provides the additional specification in that existing screens constructed prior the establishment of the 2011 Manual must meet NMFS criteria established August 21, 1989, or later and all six conditions identified in the section. If the CGS intake screens meet all the conditions found in 11.4.1, approval of the existing CGS intake screens *may be* considered by NMFS.

NMFS 1989 Fish Screening Criteria

The CGS intake system was constructed in the late 1970’s before the 2011 Manual was established therefore meets the first requirement to continue on the Section 11.4.1. In part, the CGS intake screens meet the 1989 criteria. The CGS intake screens are generally in line with the river flow and intake approach velocities are on the order of 0.2 – 0.4 feet per second (fps). The approach velocity meets the less than 0.4 fps criterion for salmonid fry less than 60 mm in length except when approach velocities are 0.4 fps. The 1989 screen opening criteria for salmonid fry less than 60 mm in length is less than 0.125 inch (3.2 mm) in the narrow direction and to provide a minimum of 40 percent open area. The

perforated pipe openings for the CGS intake screens are 3/8 inch in diameter (0.375 inches, 9.5 mm) and the outer sleeve has an open area of 40 percent. The CGS intake screen size does not meet the 1989 criterion and is 0.15 inches larger than the screen size criterion. The open area is at the minimum for open area.

The 2011 Manual does not specifically address the future status of fish screens that are constructed prior to 2011 and are not constructed to 1989 or later criteria such as the CGS intake. The intent of Section 11.4.1 is that if a screen was constructed prior to 2011 and was not constructed to 1989 or later criteria, then the screen would not be eligible for acceptance consideration and 2011 design criteria would apply.

Evaluation of Existing Screening Conditions

Even though the CGS intake screens do not meet all the 1989 fish screening criteria, the screens were evaluated for Section 11.4.1 Acceptance Criteria and Guidelines for Existing Screens in the 2011 Manual. Conditions found in Section 11.4.1 follow:

1. The entire screen facility must function as designed;
2. The entire screen facility has been maintained and is in good working condition;
3. When the screen material wears out, it must be replaced with screen material meeting the current criterion stated in this document. To comply with this condition, structural modifications may be required to retrofit an existing facility with new screen material;
4. No mortality, injury, entrainment, impingement, migrational delay, or other harm to anadromous fish has been noted that is being caused by the facility;
5. No emergent fry are likely to be located in the vicinity of the screen, as agreed to by NMFS biologists familiar with the site; and
6. When biological uncertainty exists, access to the diversion site by NMFS is permitted by the diverter for verification of the above criteria.

Evaluation of the CGS intake screens as defined by the six Section 11.4.1 conditions are herein.

CGS source information indicates the intake screens are functioning as designed and in good working condition (Section 11.4.1 conditions 1 and 2 above). Additional supporting information for these conditions would assist in verification that methods utilized to reach these conclusions are adequate. Screen design documentation would provide the specifications for measuring “functioning as designed”. Screen evaluation protocols such as how often the screens are checked, timing and river conditions during the evaluation, type of data collected, screen wear and approach velocity along with the actual data collected would allow for verification that the screens are in “good working condition”. Until it is determined that that screen material is worn out, condition number three is not applicable (Section 11.4.1 condition 3 above).

CGS source information also indicates no impingement or entrainment is occurring at the intake screens (Section 11.4.1 condition 4 above). According to available source information, entrainment has been tested for one season and impingement surveys conducted several times in the late 1970’s, early 1980’s. In addition, ocular assessments are made during screen evaluations. These tests only provide information for impingement and/or entrainment under conditions during the time of the test, surveys and observations. Additional tests should be conducted at various river and flow conditions before extrapolating beyond river conditions occurring at the time of past test, surveys and ocular evaluations.

Emergent fall Chinook fry are present in the Hanford Reach, both above and at the river location of the CGS intakes but CGS source information indicates fry are not present near the intakes (Section 11.4.1 condition 5 above). In addition to other migrating salmonids and resident fish, spawning steelhead are

present in the Hanford Reach. One confirmed and three suspected steelhead redds were identified between Plow and Homestead Islands by Mission Support Alliance in 2013 (Hanford Site Steelhead Redd Monitoring Report for Calendar Year 2013. HNF-56705 under Contract DE-AC06-09RL14728), verifying recent emergent steelhead fry in the area of the CGS intake.

No information regarding condition number six has been provided. It is unknown if access to the diversion site by NMFS for verification of Section 11.4.1 Acceptance Criteria and Guidelines for Existing Screens is necessary (Section 11.4.1 condition 6 above).

As stated above all six conditions must be met before approval of the existing screen may be considered. Conversely if one condition cannot be met then Acceptance Criteria and Guidelines for Existing Screens section has not been met. Three of the six conditions require additional information before a determination can be made regarding meeting the conditions and two conditions are not applicable at this time. The remaining condition requires further clarification on the spatial scale represented by "vicinity". Emergent steelhead and fall Chinook fry are present in the Hanford Reach, therefore, depending on the spatial representation, are in the vicinity of the CGS intake. Pursuing additional information for conditions 1, 2, and 4 conditions may not be necessary. Given that the ability of the CGS intake to meet Acceptance Criteria and Guidelines for Existing Screens section criteria and conditions is uncertain, WDFW will evaluate the CGS intake against other sections of the 2011 Manual.

Fish Screen and Bypass Facilities

Criteria and guidelines provided for the development of designs for downstream migrant fish screen facilities are applied here to the CGS intake screens. As noted above the Manual is not intended for use in evaluation of existing facilities unless directly specified. Rather than interpreting intent of the Manual for existing facilities, additional relevant criteria and guidelines for screening will be utilized to determine if the existing CGS intake system meets the Manual Section 11.6 Screen Hydraulics – Rotating Drum Screens, Vertical Screens, and Inclined Screens. Even though end of pipe systems are not listed in the section title, this section applies to all types of screens unless specifically called out in the subsections.

Understanding the rationale behind NMFS's fish screening criteria is beneficial for evaluating the CGS intake screens. A primary consideration for an effective fish screen facility is the swimming ability of fish. Research has shown that swimming ability of fish varies and may depend upon a number of factors relating to the physiology of the fish, including species, size, duration of swimming time required, behavioral aspects, migrational stage, physical condition and others, in addition to water quality parameters such as dissolved oxygen concentrations, water temperature, lighting conditions, and others. For this reason, Manual screen criteria are expressed in general terms.

Screen Hydraulics

Applicable screen hydraulics criteria and guidelines found in Section 11.6.1 are summarized below:

- The approach velocity must not exceed 0.40 fps for active screens, or 0.20 fps for passive screens.
- The minimum effective screen area is sized based on the maximum screened flow and the allowable approach velocity.
- The screen design must provide for nearly uniform flow distribution over the screen surface, to avoid localized areas of high velocity, which have the potential to impinge fish.

- Screens longer than 6 feet must have sweeping velocity greater than the approach velocity, optimally at least 0.8 fps and less than 3 fps, and must not decrease along the length of the screen.

The CGS intake system has two end-of-pipe passive screens. As such the approach velocity criterion is 0.2 fps. CGS source information indicates the approach velocity for the intake screens are on the order of 0.2 – 0.4 fps, therefore do not consistently meet the criterion. In contrast, the CGS intake screens meet the calculated minimum effective screen area. Utilizing the approach velocity criterion for passive screens and the maximum screened flow, the calculated effective screen area is 139 ft². The actual CGS effective screen area is 143 ft², which is larger than the calculated minimum effective area. The CGS intake screens are also designed to meet the uniform flow distribution criterion. The inner sleeve is designed to distribute the inflow evenly along the surface of outer sleeve. As for the sweeping velocity criterion, the intake screens are 20 ft long, meeting the larger than the 6 foot trigger point. CGS source information reports river velocities measured near the perforated pipes ranging from 4–5 fps, greater than the approach velocity but higher than the optimal range for sweeping velocity.

Screen Material

The following criteria are found in Section 11.7.1 Specific Criteria and Guidelines – Screen Material.

- Circular screen face openings must not exceed 3/32 inch in diameter.
- The screen material must be corrosion resistant and sufficiently durable to maintain a smooth uniform surface with long term use.
- Other components of the screen facility (such as seals) must not include gaps greater than the maximum screen opening defined above.
- The percent open area for any screen material must be at least 27%.

The CGS intake screens as reported in the source information, consist of an end of pipe pumped intake with an outer and inner perforated pipe sleeve. The outer sleeve has a 42 inch (107-cm) diameter sleeve with 3/8 inch (9.5 millimeter (mm)) diameter holes (composing 40 percent of the surface area). The inner sleeve has a 36 inch (91-cm) diameter sleeve with 3/4 inch (19-mm) diameter holes (composing 7 percent of the surface area). The Manual criteria for screen material states that circular screen face openings must not exceed 3/32 inch in diameter and percent open area must be at least 27%. Although the outer screen meets the percent open area, the perforations are four times larger than the Manual criterion.

CGS source information did not provide information regarding screen composition or gaps in the intake system.

Debris Management

Applicable debris management criteria and guidelines found in Section 11.10.1 are identified below:

- A written plan is in place incorporating ongoing inspection, preventative maintenance, and repair program to ensure facilities are kept free of debris and all components are functioning correctly.
- A passive screen should only be used when all of the following criteria are met:
 - The site is not suitable for an active screen, due to adverse site conditions.
 - Uniform approach velocity conditions must exist at the screen face, as demonstrated by laboratory analysis or field verification.
 - The debris load must be low.

- The combined rate of flow at the diversion site must be less than 3 cfs.
- Sufficient ambient river velocity must exist to carry debris away from the screen face.
- A maintenance program must be approved by NMFS and implemented by the water user.
- The screen must be frequently inspected with debris accumulations removed, as site conditions dictate.
- Sufficient stream depth must exist at the screen site to provide for a water column of at least one screen radius around the screen face.
- The screen must be designed to allow easy removal for maintenance, and to protect from flooding.

A written plan for ongoing inspection protocol, preventative maintenance, and repair program was not provided in the source information. A plan would facilitate the understanding of actions taken to ensure facilities are kept free of debris and all components are functioning appropriately

Similar to Section 11.4.1 Acceptance Criteria and Guidelines for Existing Screens, a passive screen should only be used when all criteria in section 11.10.1.3 are met. Conversely if one condition cannot be met then an active screen should be in place. One of the conditions above states that the combined rate of flow at the diversion site must be less than 3 cfs. The average intake is approximately 20 million gallons per day (MGD) (31 cfs) and the average makeup water withdrawal is about 17,000 gpm (1.1 m³/sec; 38 cfs) which are well above the 3 cfs. In addition the source information did not specify any adverse conditions that would prevent installation of an active screen in the Hanford Reach. Even if the screen can meet the other seven conditions, the intake does not have a combined rate of flow at the diversion site less than 3 cfs so the other conditions become irrelevant and will not be considered further.

End of Pipe Screens (including pump intake screens)

As described above the CGS intake is an end of pipe pump intake as such the following criteria found in section 11.11.1 Specific Criteria and Guidelines – End of Pipe Screens are applicable.

- End of pipe screens must be placed in locations with sufficient ambient velocity to sweep away debris removed from the screen face, or designed in a manner to prevent debris re-impingement and provide for debris removal.
- End of pipe screens must be submerged to a depth of at least one screen radius below the minimum water surface, with a minimum of one screen radius clearance between screen surfaces and natural or constructed features.

Information on the ambient velocity at the CGS intakes was not provided in CGS source information but a range for the Hanford Reach was provided. River widths and depths at the Hanford Reach can vary significantly with bathymetry, drought conditions and operations at Priest Rapids Dam. As such velocities have been reported to vary from 3 fps to over 11 fps depending on the section and flow. Another consideration is that the above criterion is addressing the re-impingement of debris removed by a debris cleaning system. The CGS intake screens are passive screens and do not have a debris cleaning system so the criterion found in Section 11.10.1 Debris Management may take precedence.

During studies conducted in 1978, 1979, and 1985 study personnel looked for—but did not find—debris impinged on the screens, indicating ambient velocity may be sufficient to sweep away debris removed from the screen face but this should be verified for all seasons and flow conditions. In addition the CGS source information indicated that impingement of aquatic organisms is unlikely because the velocity of the water across the face of the intake system is several times faster than the intake velocity.

Clearance around the intake was also not provided in the CGS source information. The outer sleeve has a diameter of 42 inches or a screen radius 21 inches. River depth is provided for normal high and flood high water events but not for low flow or drought conditions. Additional information is necessary to calculate the clearance around the intake screens.

SUMMARY

The CGS intake was designed to 1970's screen standards and constructed in the late 1970's. Scientific understanding of fish behavior, physiology, and bio-mechanics has improved since then. In addition our knowledge of hydraulics and hydrology has increased, and new engineering technology is available. The 2011 NMFS Anadromous Salmonid Passage Facility Design manual reflects those changes.

Although the CGS intake meets some of the criteria found in the Manual, it falls short on several criteria. Those criteria follow with a summary of the rationale below.

- The intake screens do not meet NMFS fish screening criteria established August 21, 1989 therefore are not eligible for evaluation of existing screens;
- Emergent steelhead and fall Chinook fry are present in the Hanford Reach, potentially violating the existing screen condition number 5, but it is unclear if they will be considered in the "vicinity" of the CGS intake;
- The intake screens do not meet the 2011 Manual screen size criterion; and
- The intake does not meet the criteria for passive screens.

The CGS intake was constructed prior to the establishment of the 2011 Manual but does not meet NMFS fish screening criteria established August 21, 1989. The 1989 screen opening criteria for salmonid fry less than 60 mm in length is less than 0.125 inch (3.2 mm) in the narrow direction whereas the perforated pipe openings for the CGS intake screens are 3/8 inch in diameter (0.375 inches, 9.5 mm), therefore consideration for the approval process found in Section 11.4.1 Acceptance Criteria and Guidelines for Existing Screens is not applicable. The 2011 Manual does not specifically address the fate of fish screens that are constructed prior to 2011 and are not constructed to 1989 or later criteria such as the CGS intake.

Because the Manual does not clearly state the fate of fish screens that are constructed prior to 2011 and are not constructed to 1989 or later criteria, the CGS intake screens were evaluated utilizing the Acceptance Criteria and Guidelines for Existing Screens. The ability of the CGS intake to meet section criteria and conditions is uncertain. To meet condition 5, no emergent fry may be located in the vicinity of the screen. Emergent steelhead and fall Chinook fry are present in the Hanford Reach, but it is unclear if they would be considered in the "vicinity" of the CGS intake. Even if all six conditions were met, the Manual indicates the existing screens will be considered for approval, not that they will be approved.

As with the 1989 Fish Screening Criteria, the CGS intake screens do not meet the 2011 Manual screen size criterion. The 1989 and 2011 maximum specifications are 0.125 inch (3.2 mm) and 3/32 inch (0.094 inch, 2.3 mm) diameter openings respectively. The CGS intake screen size is 3/8 inch (9.5 mm) diameter holes. The size of the screen openings will determine the potential for fry to be entrained into the intake system. Fry are defined in the Manual as a young juvenile salmonid with absorbed egg sac, less than 60 mm in length. Width and depth of fry are a function of the length and the screen size criterion is based on the circumference of fish longer than 60 mm not fitting through a 3/32 inch diameter opening.

The CGS intake screens are passive screens. One of the requirements for determining if a passive screen is appropriate is the combined rate of flow at the diversion site, which must be less than 3 cfs. The

average intake is approximately 31 cfs and the average makeup water withdrawal is about 38 cfs, both of which are well above the 3 cfs indicating an active screen is required to keep the screens free of any debris that will restrict flow area.

After critical review, WDFW has determined that the CGS intake screens do not meet the functional equivalency of the 2011 Anadromous Salmonid Passage Facility Design document. WDFW bases this determination on the CGS intake screen size and type. The probability of fry impingement is a function of approach velocity and entrainment of screen size. The CGS intake screen size of 3/8 inch diameter openings will not prevent entrainment of emergent fry. As designed and without debris impingement, the CGS passive intake screens will range at or above the acceptable approach velocity. When screens become occluded with debris the effective screen size is reduced and approach velocity increases, thereby increasing the probability of impingement. The CGS intake screens do not meet the diversion criteria for passive screens indicating the need for active screens. A debris cleaning system found on active screens moves debris from the surface of the screens, maintaining a consistent approach velocity and reducing the chances of impingement.

SOURCES

Energy Northwest and National Marine Fisheries Service Meeting Overview of Operation of Columbia Intake Structure November 13, 2013

Fact Sheet for NPDES Permit WA002515-1 Columbia Generating Station DRAFT - Working Draft Date: 1/15/2014

Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 47 Regarding Columbia Generating Station NUREG-1437

LICENSE RENEWAL APPLICATION, COLUMBIA GENERATING STATION, January 2010, Appendix E, Applicant's Environmental Report, Operating License Renewal Stage, Columbia Generating Station, Energy Northwest, Docket No. 50-397, License No. NPF-21

Mission Support Alliance. 2013. Hanford Site Steelhead Redd Monitoring Report for Calendar Year 2013. HNF-56705 under Contract DE-AC06-09RL14728

NMFS (National Marine Fisheries Service). 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 1989. Fish Screening Criteria, August 21, 1989. NMFS, Environmental & Technical Services Division, Portland, Oregon