UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

August 6, 2013

Jim La Spina, Energy Facility Siting Specialist
Washington Energy Facility Site Evaluation Council
P.O. Box 43172
Olympia, WA 98504-3172

Re: NMFS comments on Columbia Generating Station National Pollutant Discharge Elimination System (NPDES) Permit No. WA-002515-1 and accompanying Fact Sheet

Dear Mr. Spina:

We appreciate this opportunity to comment on the above referenced permit prior to public review and issuance. As you know, we are concerned that the cooling water intake screening system may impinge and entrain juvenile salmon and steelhead and have met with you and Washington Department of Ecology (WDOE) staff several times to express our concerns.

The permit itself is silent on this intake structure. Washington Department of Ecology/Energy Facility Site Evaluation Council (EFSEC's) determination that this facility conforms with Clean Water Act (CWA) Section 316(b) is provided by the Fact Sheet accompanying the proposed permit which includes a determination that the existing screen system is the best technology available (BTA) for minimizing adverse environmental impacts based on WDOE staff's best professional judgment. We disagree that the existing screen system is BTA.

The facility is located within the Hanford Reach of the Columbia River, which is used by spawning upper Columbia River steelhead; a distinct population segment listed as threatened under the Endangered Species Act (ESA), and is the primary spawning location for upper Columbia River summer/fall Chinook, the healthiest salmon Evolutionarily Significant Unit (ESU) in the basin. Threatened upper Columbia River steelhead and their designated critical habitat are protected under the ESA and the essential fish habitat (including spawning and rearing habitats in the project area) of upper Columbia River summer/fall Chinook salmon is protected under the Magnuson Stevens Fishery Conservation and Management Act, both of which are administered by NMFS for these species. Fry and rearing juveniles of these species would be susceptible to impingement and entrainment if they came into contact with the intake. ESA-listed upper Columbia River spring Chinook juveniles also migrate past the facility and may also be adversely affected. NMFS is charged with protecting these species and their critical habitats and promoting their recovery. We believe the continued operation of the existing intake structure in its current configuration places undue risk on these valuable resources.

We have attached a review of these facilities and a review of EFSEC's determination of BTA by Bryan Nordlund, P.E., an expert in fish passage engineering and include his comments by reference and his concerns that the existing screens represent BTA.

Specific Comments

These comments focus on the determination of BTA for this structure, beginning on page 20 of the Fact Sheet.

1. Page 21, para. 5. The design for the intakes dates from the late 1970s, nearly two decades before upper Columbia River steelhead and spring Chinook were listed under the ESA. The status of these species has obviously declined and our understanding of fish passage issues has greatly improved since that time. That is, both our concern for the species and our knowledge of how they are impacted have increased. If asked, NMFS would not approve that design today. Orifice diameters of 3/8 inch pose an entrainment risk and are not protective of all life stages of juvenile salmonids expected to be present at the site (see Nordlund memos). In addition, there is no indication of flow baffling to distribute intake flow evenly over the intake screens, nor is there a cleaning system capable of automatic debris removal. These design flaws may produce areas of localized high velocity on the screen face, which pose an impingement risk to fish. Further, at some river water surface elevations, there may not be sufficient depth over the screen face such that when maximum flow is diverted, small fish may not be able to escape the velocity produced over the screen face. With recent state-of-the-art improvements to the cooling water system (i.e. new, copper-free condenser), the intakes stand out as outdated.

2 Page 21, para. 7. We agree that the recirculating cooling water system has a lower water demand than would a once-through system and thus provides lesser adverse environmental effects.

3. Page 22, para. 3. Post-construction evaluation of the intake screens' effects on salmon were low-effort studies that did not always consider the seasonality of use – entrainment studies conducted when few juvenile fish are in the river likely underestimate the effects that would occur when many fish of a susceptible size are in the river. The attached Nordlund memos document studies that demonstrate the presence of small juvenile salmonids in a location very near and very similar to the Columbia Generating Station (CGS) intake, and the seasonal variability of fish presence.

4. Page 23, para 3. You have taken that statement out of context and thereby misconstrued our intent. The referenced statement from our Anadromous Salmonid Passage Facility Design Manual is intended to allow operation of screens designed to meet prior versions of NMFS screen criteria dated later than August 21,1989, only if can be demonstrated that there is no adverse effect on salmonids per the six bullets listed. Since the existing CGS screens were constructed prior to 1989, and do not meet any prior version of NMFS screen criteria, this statement does not apply to the CGS intake screens.

5. Page 23, para.4. You reference Nuclear Regulatory Commission (NRC) safety requirements as an impediment to modifying the intake screening system to protect fish, yet present no evidence of such impediment. We are fully aware that such safety considerations are imperative and see no reason NRC safety requirements would prevent modification of the intake system to protect fish.

6. Page 24, para. 1. You state, "EFSEC will reevaluate this determination when final rules applicable to the facility are issued and may modify this proposed permit on the basis of new information." This statement is quite vague. If EFSEC is intent on ensuring conformance with new rules, the statement should read, "EFSEC will reevaluate this determination when final rules applicable to the facility are issued and, if necessary, would modify this permit to conform with the new rules." We are confident that an intake designed to meet NMFS juvenile fish screen criteria would also meet EPA's pending new CWA Section 316(b) rules. Furthermore, the pendency of new rules does not excuse compliance with existing rules for cooling water intake structures.

Requested Remedy.

EFSEC should revise the proposed permit to include a requirement for Energy Northwest to work in cooperation with NMFS, the Washington Department of Fish and Wildlife, and NRC to develop and implement a design for the intake screening system that meets NMFS juvenile fish screening criteria within two years of permit issuance. Please see Mr. Bryan Nordlund's memo of July 31, 2013 on Columbia Generating Station (CGS) – Intake Screens Assessment and Recommendations for Modifications, for details on existing inadequacies and recommended modifications.

Should you need additional information to support your action on this matter, please contact Richard Domingue (503-231-6858 or richard.domingue@noaa.gov), or, for additional information on fish protection engineering, please contact Bryan Nordlund (360-534-9338 or Bryan.Nordlund@noaa.gov). Thank you this opportunity to review your proposed permit and fact sheet.

Sincerely,

Bruce Suzumoto
Assistant Regional Administrator
Hydropower Division

Enclosures

cc: **Dennis Logan, NRC**
Dan Opalski, USEPA

July 31, 2013

MEMORANDUM FOR: Hydro Division Files

CC: Rich Domingue

FROM: Bryan Nordlund, P.E.

SUBJECT: Entrainment and Impingement Potential for Salmonids at the Columbia Generating Station (CGS) Intake Screens

Screen Design Expertise

The following is an assessment of the potential for impingement and entrainment of ESA listed and unlisted salmonids at the CGS intakes for cooling water. This assessment provides my best professional judgment as a fish passage engineer, experienced with the design and operation of fish screens and other fish passage structures in the Upper Columbia River Basin for the past 22 years, and in the Pacific Northwest in general for the past 26 years. I am the primary author of the NMFS' Anadromous Salmonid Passage Facility Design document (NMFS, 2011), which includes screen and bypass design guidance in Chapter 11 (NMFS Screen Criteria). I've collaborated and consulted with all state Federal and tribal fisheries agencies and with NMFS staff to regularly update NMFS Screen Criteria, through the Fish Screen Oversight Committee (FSOC) of the Columbia Basin Fish and Wildlife Authority which oversees fish screening issues in Washington, Oregon, Idaho and Montana. I also am the current chair of FSOC.

Site Specific Screen Entrainment Study Requirements

The option for a paper assessment, such as provided hereafter, is a physical entrainment study. To comprehensively study this issue at the CGS screen site would entail covering the entire salmonid migration period from emergence of fall Chinook fry in the Hanford Reach, to the outmigration of ESA listed spring Chinook and steelhead, to the outmigration of zero age fall and summer Chinook. Typically, around 95% of the outmigration occurs between April 1 and Aug 30. This would need to be conducted over a variety of Columbia River flow conditions across the outmigration, typically between the 5% and 95% exceedence flow levels, and it may take several years to complete the study. In addition, because fish body size and water temperatures vary throughout the year and both of these directly impact swimming ability, it is difficult to achieve conclusive comprehensive results. These studies are always expensive and rarely result in demonstrable evidence that fish are not impinged or entrained at a site with inadequate juvenile fish screens. Since these CGS screens do not meet NMFS screen criteria, or Washington Department of Fish and Wildlife (WDFW) screen criteria, and small juvenile salmonids are present in the vicinity of the intake, there is no question in my mind that entrainment risk always exists and varies with fish presence, depending on the time of day and time of year.

Screen Entrainment

Milo Bell, authored a handbook titled "Fisheries Handbook of Engineering Requirements and Biological Criteria" by Milo C. Bell for the North Pacific Division of the Army Corps of Engineers, 1990 (Bell 1990). Among the extensive array of material that can be found in Bell's Handbook, are a set of equations that are used to predict juvenile salmonid entrainment through screens based on the dimensions of the fish's body. For the CGS screens with 3/8-inch screen openings, these equations predict entrainment of anadromous salmonids smaller than 75 mm body length. In addition, a variety of studies in the lab (Bates and Fuller, 1992) and in the field (Beecher, 1993) (PNNL, 1994) were used to establish the anadromous salmonid criteria for maximum screen face openings, which are 1.75 mm for slotted openings, or 3/32-inch for round or square openings. The NMFS and FSOC (including WDFW) currently use these studies as the basis for criteria for any screen face opening that could allow fish entrainment, including wire mesh screens, slotted screens, link belt screens and perforated plate screens, as well as any other opening in the screen face (for example, seal tolerance).

The equations (page 26.2) in Bell's handbook use fish body length (L) and body depth (D) to calculate the maximum screen opening that will preclude entrainment for a specific fish size, based on the ratio F, which is L divided by D. There are different equations for ranges of F, which generally cover the spectrum of fish species, life stages and fish sizes that are present in the Hanford Reach near the CGS intake. Table 1 below shows the results of using the equation found in the Bell Handbook to calculate entrainment potential for a variety of fish species and life stages, based on body morphology data from a variety of studies. These calculations do not include any consideration of the flexibility and mobility of juvenile salmonids, which can allow entrainment through openings even smaller than those predicted by body morphology.

Table 1: Screen mesh entrainment potential, as predicted by equations from Bell's Handbook.

Species	Body Length and Depth (mm)	Ratio L/D	Predicted minimum mesh size to preclude entrainment (inches)	Entrainment protection with NMFS screens criteria?	Entrainment protection with CGS Screens?	Species/life stage present at CGS site?
Emergent steelhead and Chinook fry	L=25, D=2.5	10.0	1/16th inch	maybe	no	unlikely
Button-up steelhead and Chinook fry	L=35, D =5	7	7/64th inch	yes	no	unlikely
Chinook zero-age	L=50, D=7.5	6.7	1/8th inch	yes	no	yes
Chinook sub-yearlings	L=75, D=12	6.25	3/8th inch	yes	maybe	yes

Chinook sub-yearlings	L=100, D=17	6.3	5/8th inch	yes	yes	yes
Wild steelhead pre-smolt	L=125, D=22	5.7	3/4th inch	yes	yes	yes
Hatchery Steelhead smolt	L=150, D=25	6.0	1 inch	yes	yes	yes

The second is "Spatial Distribution of Juvenile Salmonids in the Hanford Reach, Columbia River", authored by Dennis D. Dauble, Thomas L. Page and R. William Hanf, Jr., and published in 1989 in Fishery Bulletin, U.S. 87:775-990 (Dauble report). The Dauble report consists of study results showing fish capture from deployment of fyke nets in the Hanford Reach in the vicinity of the CGS intake screens, with the fyke nets set in an array representing the entire cross section of the Columbia River.

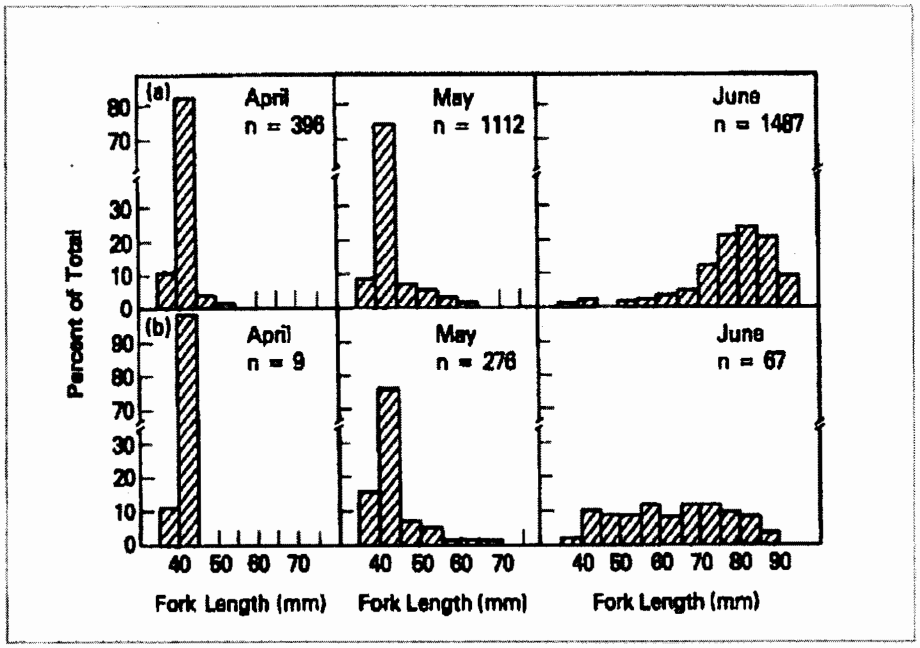

Figure 1. - Length-frequency of 0-age fall Chinook salmon collected with fyke nets: a) barge sets and b) shoreline sets (from Dauble et al, 1989)

NMFS Screen Criteria

In 2011, FSOC adopted NMFS Screen Criteria regionally (Oregon, Washington, Idaho and Montana). NMFS Screen Criteria requires that screen face openings be no greater than 3/32-inch for square or round opening, or 1.75 mm for slotted opening. This criterion for screen face material was derived from laboratory screen mesh tests conducted for a variety of juvenile

salmonids in the early 1990's (Bates and Fuller, 1992) (Beecher, 1993), and later modified by considering the results of a screen evaluation at the Dryden canal (Mueller et al, 1995) (PNNL, 1994). When applied, these criteria generally provide protection to greater than 98% of the juvenile salmon, for fish larger than the button-up fry life, under the coldest water temperatures likely to exist when these fish are present. Generally, Chinook and steelhead fry are not migratory, but are sometimes prone to be swept downstream by freshet flows, and will also move around to forage. Occurrence of either of these events could place fry in the vicinity of the CGS intake screens and vulnerable to entrainment. Zero-age juvenile Chinook and steelhead are actively foraging, moving from shallow waters to deeper waters depending on a number of factors. In a fyke net study conducted in the vicinity of the CGS intake, zero-age fall Chinook salmon occurred primarily in shoreline areas of reduced current velocity (see Figure 1), but were present throughout the river cross section during their early rearing and outmigration period (Dauble et al, 1989). These fish are susceptible to entrainment through the CGS intake screens.

References

Bates, Ken, and Fuller, R. 1992. Salmon Fry Screen Mesh Study. WDFW, Olympia,WA.

Beecher, H. 1993. Draft Report - Screen Mesh Evaluation for Water Diversions. WDFW, Olympia, WA.

Bell, Milo C. 1990. Fisheries Handbook of Engineering Requirements and Biological Criteria. Prepared for the North Pacific Division of the Army Corps of Engineers, Portland, Oregon.

Dauble, Dennis D., T.L. Page, and R.W. Hanf Jr.. 1989. Spatial Distribution of Juvenile Salmonids in the Hanford Reach, Columbia River. Fishery Bulletin, U.S. 87:771-790, Environmental Sciences Department, Pacific Northwest Laboratory, Richland, WA.

Mueller, R.P., Abernathy, C.S. and Neitzel, D.A. 1995. A Fisheries Evaluation of the Dryden Fish Screening Facility. Pacific Northwest National Laboratory. Prepared for Bonneville Power Administration, Portland, Oregon.

NMFS. 2011. Anadromous Salmonid Passage Facility Design. Portland, Oregon. http://www.nwr.noaa.gov/hydropower/hydropower_northwest/hydropower_in_the_nw.html)

Page, T. L., D. A. Neitzel, and R. H. Gray. 1977 data. Comparative Fish Impingement at Two Adjacent Water Intakes on the Mid-Columbia River. Ecosystems Department Battelle-Northwest Laboratories Richland, Washington 99352 S. Energy Research and Development Administration (now U. S. DOE) under Contract EY -7 6-C-06-1 83 0, Richland, WA.

PNNL. 1994. Data Summary for the Dryden Screens Fisheries Evaluations. Unpublished Report.

August 7, 2013

MEMORANDUM FOR: Hydro Division Files

CC: Rich Domingue

FROM: Bryan Nordlund, P.E

SUBJECT: Columbia Generating Station (CGS) – Intake Screens Assessment and Recommendations for Modifications

In the course of my work on the Coordinating Committees for the hydroprojects in the Upper Columbia River, I have reviewed numerous reports and studies on juvenile salmonid migration from below Chief Joseph Dam to McNary Dam. In addition, the Coordinating Committees are currently in the process of developing information on the life history of fall Chinook salmon, particularly when they enter the migratory stage of their life cycle. In addition, a sub-committee established through Clean Water Act license conditioning requirements from the Washington Department of Ecology is specifically researching Hanford Reach fall Chinook (HRFC) spawning and rearing, and periodically reports to the Priest Rapids Coordinating Committee. Finally, I have spent the majority of my 29 year Federal service career with the National Marine Fisheries Service involved in fish facility design development and assessment, including fish screens that range in capacity from a fraction of a cubic foot per second (cfs) to 6,000 cfs. All of these efforts provide information that pertain to applying best professional judgment regarding the potential of the CGS intake to affect fish listed under the Endangered Species Act (Upper Columbia River spring Chinook and steelhead and Mid Columbia River steelhead) as well as salmonids protected by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), which include all Chinook and coho salmon in the Columbia River Basin).

As such, I offer my professional opinion of the CGS intake system.

Fish Presence

Salmonids spawn, rear and migrate through the vicinity of the Columbia River occupied by the CGS intake. Portions of each life stage of the HRFC occupy the vicinity of the site. Per material provided by Washington Department of Ecology CGS Screen Design Report:

> "This intake was selected to minimize the impact of the make-up water withdrawal from the Columbia River, with particular emphasis on salmonid fry. Two characteristics of this intake minimize fish entrainment. First, the intake location is well offshore where the number of downstream salmonid fry are expected to be relatively small. Second, the low

intake approach velocities near the perforated pipe are on the order of 0.2 – 0.4 feet per second (fps)."

While these facts likely prevent some fish from being impinged or entrained, the screen design could be further improved to markedly lessen the potential for salmonid entrainment or impingement to nearly zero, as evidenced in many evaluations of juvenile fish screens designed and operated to NMFS (and Washington Department of Fish and Wildlife) screen design standards.

Screen Design

I reviewed the CGS screen design report, at least most of it. I could not read the small faint font describing most features on the two sheets of drawings, but I think the rest of the document fills in enough detail for me to assess whether these screens achieve NMFS design standards. The CGS screen does not meet NMFS screen design standards, as described below.

Screen Cleaner

There is no automated screen cleaning system on the Columbia Generating Station (CGS) intake screens, which is a required NMFS design criterion for most screens.

> **11.10.1.2 Screen Cleaning (Active Screens):** *Active screens* must be automatically cleaned to prevent accumulation of debris. The screen cleaner design should allow for complete debris removal at least every 5 minutes, and operated as required to prevent accumulation of debris. The head differential to trigger screen cleaning for intermittent type cleaning systems must be a maximum of 0.1 feet over clean screen conditions or as agreed to by NMFS. A variable timing interval trigger must also be used for intermittent type cleaning systems as the primary trigger for a cleaning cycle. The cleaning system and protocol must be effective, reliable, and satisfactory to NMFS.

For small flow screens (less than 3 cfs) with specific design features, a passive screen design (i.e. no automated cleaner) may be acceptable. However, the CGS intake screens divert up to 25,000 gallons per minute, or about 56 cubic feet per second (cfs), so these screens would not qualify for consideration as a passive screen by NMFS standards.

> **11.10.1.3 Passive Screens:** 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.

Screen Submergence

The water surface elevation (341.75 feet) at minimum tailwater does not provide sufficient submergence of the top of the screen (elevation 341.0 feet). With only 0.75 feet of submergence, the water velocity directly between the water surface and the top of the screen can exceed the juvenile salmon swimming ability, and could potentially capture fish in the screens flow net fish until they fatigue, or become prey.

To demonstrate this risk, assuming half of the flow (28 cfs) enters the top half of the screen, the flow area would be 0.75 feet by 3.5 feet (2.6 square feet) at the top of the screen, and 2.5 feet by 3.5 feet (8.7 square feet) at the screen mid-point elevation, and the corresponding water velocity ranges between 10.7 fps and 3.2 fps. Fish that pass above the screen would be required to escape these velocities to escape the flow path above the screen. Since salmonid fry can swim at burst velocity of about 1.3 fps (Bell 1991), the only means for escape is if river velocity dominates the velocity produced by the flow net into the screens. This is not certain and not a constant. Larger juvenile fish face a similar risk - parr sized salmonids can swim at burst speeds up to 2.1fps (Bell 1991), and smolts a bit faster. Since the CGS screens are 42 inches in diameter, they should be submerged at least one screen radius, or 21 inches at minimum water elevation, per the criterion below.

> **11.11.1.2 Submergence:** *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.

Screen Face Material

The outer CGS screen face material is perforated plate with 3/8-inch diameter perforations. NMFS design standards require a maximum 3/32-inch diameter hole for perforated plate. From studies at the Cowlitz Trout Hatchery (Beecher, 1993), we know that 1/8th inch diameter perforated plate openings will entrain steelhead fry. Presumably, the 3/8th inch perforations at the CGS screen could entrain larger juvenile salmonids. Using an equation to predict fish entrainment (Bell, 1991), 3/8th inch openings could potentially entrain juvenile salmonids as large as 70-80 mm, depending on the body height of the fish. Coupled with the shallow depth of water above the screen face as described above, at low levels of Columbia River stream flow juvenile fish could be entrained. A 3/8th inch perforated plate screen has never been tested for salmonid entrainment that I'm aware of, because it intuitively makes sense that any diameter hole larger than 3/32nd inch would entrain small juvenile salmon.

The CGS screen report states that no impingement has been observed since 1978, but this observation is limited to semiannual inspections. If fry are present (presumably they are, since Chinook spawning occurs in the Hanford Reach just upstream of the CGS), they would likely be entrained through the 3/8th inch openings rather than be impinged on the screen face. If fish fatigue near the screens, larger juvenile salmon might be impinged, and unobserved, especially at low river water surface elevations.

11.7.1.1 Circular Screen Openings: Circular screen face openings must not exceed $^{3}/_{32}$ inch in diameter. Perforated plate must be smooth to the touch with openings punched through in the direction of approaching flow.

Screen Approach Velocity

The information provided in response to our Additional Information Request states that the screen approach velocity (i.e. water velocity perpendicular to the screen face) is 0.5 feet per second (fps). NMFS screen criteria requires a screen approach velocity of less than 0.4 fps. However, based on my calculations using the provided screen dimensions and the maximum diverted flow amount, the screen approach velocity is less than 0.2 fps. I suspect the approach velocity provided in the CGS screen report was calculated based on the screen open area, which is 40%. NMFS screen criterion for approach velocity does not deduct for the percent open area. If the velocity I calculated for the CGS screens is divided by 40%, the result is 0.5 fps, matching the CGS screen report value. Therefore, the CGS intake screen does meet NMFS criterion for screen approach velocity.

11.6.1.1 Approach Velocity: The *approach velocity* must not exceed 0.40 ft/s for *active screens*, or 0.20 ft/s for *passive screens*. Using these approach velocities will minimize screen contact and/or impingement of juvenile fish. For screen design, *approach velocity* is calculated by dividing the maximum screened flow amount by the vertical projection of the *effective screen area*. An exception may be made to this definition of *approach velocity* for screen where a clear egress route minimizes the potential for impingement. If this exception is approved be NMFS, the *approach velocity* is calculated using the entire *effective screen area*, and not a vertical projection. For measurement of approach velocity, see Section 15.2.

Effective screen area - the total submerged screen area, excluding major structural members, but including the screen face material. For rotating drum screens, *effective screen area* consists only of the submerged area projected onto a vertical plane, excluding major structural members, but including screen face material.

Conclusion

Overall, the CGS falls short of achieving NMFS screen design standards. Fry and parr sized salmonids could be entrained through 3/8-inch diameter perforated plate screen, or become fatigued and more susceptible to predation and/or entrainment if they swim near the screens.

The minimum screen submergence violation may or may not be an issue, depending on the frequency and timing of occurrence of the minimum water surface elevation relative to the life stage and swimming ability of salmonids present near the screen when low water surface elevation occurs.

Although the CGS report states that debris is not an issue on the screens and the screens self-clean, I doubt this would remain the case if the screen mesh were replaced to achieve NMFS criterion to provide protection for juvenile salmonids, especially fry from the Hanford Reach. All intakes on the Columbia and Snake rivers should meet this standard, especially those immediately downstream of the most productive Chinook spawning areas on the mainstem at Hanford Reach.

To correct design deficiencies, I would recommend:

1) Design and installation of a waterjet back spray cleaning system.
2) Replacement of screen mesh with 3/32" stainless steel perforated plate.
3) Balance of screen approach velocities by installing an internal baffle with porosity varied to distribute flow evenly over the entire screen surface.
4) Install the screens at a lower elevation, if feasible.