STATUS OF TRAVELING SCREEN DEVELOPMENT - 1976

by

Winston E. Farr

Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112

ABSTRACT

Recent improvements in the design of traveling screens being developed for protection of fingerling Pacific salmon, genus *Oncorhynchus*, and steelhead trout, *Salmo gairdneri*, at hydroelectric dams on the Columbia and Snake Rivers in the Pacific Northwest are described. The use of perforated plate behind the screen mesh to reduce impingement pressure and a more maintenance-free traveling screen with adjustable angles of extension are two recent developments. In addition, brief descriptions are included of two traveling screens that might be used in intakes requiring total screening.

INTRODUCTION

At the Second Entrainment and Intake Screening Workshop in 1974, a paper describing the vertical traveling screens being used for fish protection at hydroelectric dams on the Snake River was presented (Farr 1974). This brief report is an update of that traveling screen work. In addition, two possible designs are presented for traveling or non-traveling screens for intakes where total screening is required.

TRAVELING SCREEN DEVELOPMENTS

Figure 1 shows the location of traveling screens used at hydroelectric dams to prevent fingerling Pacific salmon, genus *Oncorhynchus*, and steelhead trout, *Salmo gairdneri*, from going through the turbines. You will note that the screen intercepts only about one-third of the intake flow. This is possible because juvenile salmonids migrating through the reservoirs are normally in the top 30 to 50 feet of water, and when they enter the intake, 75-80 percent of them are concentrated in the top 15 feet of the intake. Therefore, it is not necessary to screen the total intake to intercept an appreciable percentage of the migrants. As the fish approach the traveling screen and are deflected up into the gatewell, they are retained in the bulkhead slot by means of the vertical barrier screen. Fish can then move out through the orifices and into a pipeline that carries them to a facility where they are automatically sized and distributed into holding ponds. From these ponds they can be moved, by gravity, to the research facility or to transport trucks (Ebel et al 1973).

The greatest improvement in the traveling screen in the past couple of years has been the utilization of perforated steel plate in back of the screen mesh. The perforated plate reduces the amount of water going through the screen and reduces the impingement pressure.

With reduced velocity in front of the screen, fish are better able to swim away from the screen and up into the gatewell. With the reduced impingement pressure, they are able to move off of the screen and are not injured if they do come in contact with the screen mesh.

While the traveling screen developed by the National Marine Fisheries Service (NMFS) has performed quite satisfactorily, the maintenance required is too great. The Corps of Engineers has been working on a new design that would incorporate the good features of the existing screens but would require less maintenance.

Using the information furnished them by the NMFS on the perforated plate and screen combinations, the Corps of Engineers did some developmental work in their hydraulics laboratory. They found that a one-quarter-inch plastic mesh in front of a 46 percent open perforated plate gave the same head loss as the E42x36x16 continuous belting over a 48 percent open perforated plate used by the NMFS.

Figure 2 shows the Corps of Engineers screen which uses two mesh panels on the upstream face; the NMFS screen has four panels. The Corps screen is self-contained, i.e., the electric motor, hydraulic pumps, reservoir, hydraulic motors, etc., are all incorporated in the framework. This is a very compact unit, and the NMFS is now in the process of evaluating its performance.

Previously, traveling screens were used only in the bulkhead slots and had a fixed angle of extension of 45°. However, a separate fish screen slot was designed into Lower Granite Dam. Work to date indicates that the 45° angle in the fish screen slot is not acceptable. The test screen designed by the Corps is capable of being raised in 5° increments from 45° to 65°. The best angle for operation in both bulkhead and fish screen slots is now being determined.

OTHER SCREENS FOR INTAKES REQUIRING TOTAL SCREENING

Figure 3 and 4 describe some ideas that might work for other intakes when total screening is required. These two drawings are conceptual only and other engineering features, such as rock traps, would have to be incorporated.

Figure 3 shows a conveyor belt screen placed on an angle so fish and debris can be by-passed to a channel. This design incorporates the inverted syphon principle with the traveling screen.

Figure 4 shows a traveling screen placed horizontally with the same inverted syphon and by-pass. With this design a larger differential in supply water could be accommodated.

Traveling conveyor type screens are shown for both systems. However, other types of traveling screens could possibly be used. Another possibility for the design shown in Figure 3 would be to use a stationary screen with cleaning brushes that move (Kupka 1966).

COMMENTS, QUESTIONS, AND ANSWERS

I.

Comment - Bill Ruffner (TVA) (The following comments were in reference to screening 125 cfs of water in a three-foot deep canal. The comments were prefaced by the statement that the views presented were strictly his own and not necessarily his employer's):

For this application a continuous traveling screen could be turned on its side so it traveled horizontally. If a perforated plate was also used, 1 mm mesh could be used because the force would be taken on the perforated plate and not on the mesh. If the structure were built without the perforated plate, the 1 mm mesh would have to take the pressure caused by the differential head. Consequently, the structural members supporting the mesh would have to be large. However, if perforated plate were used in back of the mesh and the open area in the perforated plate was at least 25% less than the open area in the mesh, then the pressure caused by the differential head will be on the perforated plate. If all of this holds true, then the impingement effects on the mesh in front of the perforated plate should be reduced or eliminated and the small organisms that cannot go through the mesh should not be crushed. It would be necessary to lengthen the structure to accommodate the reduction in open area through the structure.

II.

Question - Anonym:

I am very excited about what you are proposing here. One of the objections I have heard voiced many times to either horizontal screens or continuously moving screens is the difficulty of servicing them, keeping them clean, and that sort of thing. I would be interested in both of these designs if you would comment on that aspect. Also, are you incorporating a jet wash in this type of arrangement or are you using the by-pass channel to wash fish away from the end?

Answer - Farr (NMFS):

When you go back and study what has already been done up through Model 7 of the horizontal traveling screen, you will see that the NMFS screen is essentially self-cleaning (Prentice and Ossiander, 1974). However, in regards to the system Mr. Ruffner was discussing, we would propose putting a slotted jet wash somewhere down in the corner. This jet would put out a general flow, remove any trash, and help free little fish that might be stuck. If you put a solid plate on the very ends, you would have no flow through, and it would be real easy. You've got to design your by-pass right.

III.

Question - Ruffner (TVA):

Has anybody got any comments on 1 mm mesh?

Comment - Anonym:

Just a couple thoughts on the idea of using perforated plate. The force that creates the flow through the screen mesh itself has got to be a water differential. There has to be a difference in water head from the front side of the screen to the back side of the screen, and I think that what you are doing with your perforated plate is essentially putting a dam behind the wire mesh that maintains the water level fairly constantly across the wire mesh. I think this might also be accomplished by simply putting a wier downstream from the entire screen so as to minimize the head loss that could occur through the entire screen system. The thing that's going to cause head loss across the wire mesh is going to be debris clogging, if it occurs. The thing that's going to cause head loss across the perforated plate is simply going to be a restriction in the flow that causes a difference in head that causes rushing through the screen. I would be a little bit concerned about whether you wouldn't run into debris problems that would cause sufficient head loss on the wire mesh until it was taking the head loss rather than the perforated plate. In other words, if it became 25 percent clogged, it would constitute just as much a flow restriction as the perforated plate, and then you would be having your head loss on the wire mesh.

Comment - Ruffner (TVA):

That's a good thought, and I think I tend to agree with you.

IV.

Question - Anonym:

Would you expect much wear between the screen and the perforated plate because of the interaction between the two?

Answer - Farr (NMFS):

No.--Your track is going to be carrying your screen out in front of the plate itself. There shouldn't be any wear between the screen and the plate. You would have to model it in a lab somewhere to determine the optimum distance to put your plate behind the screen.

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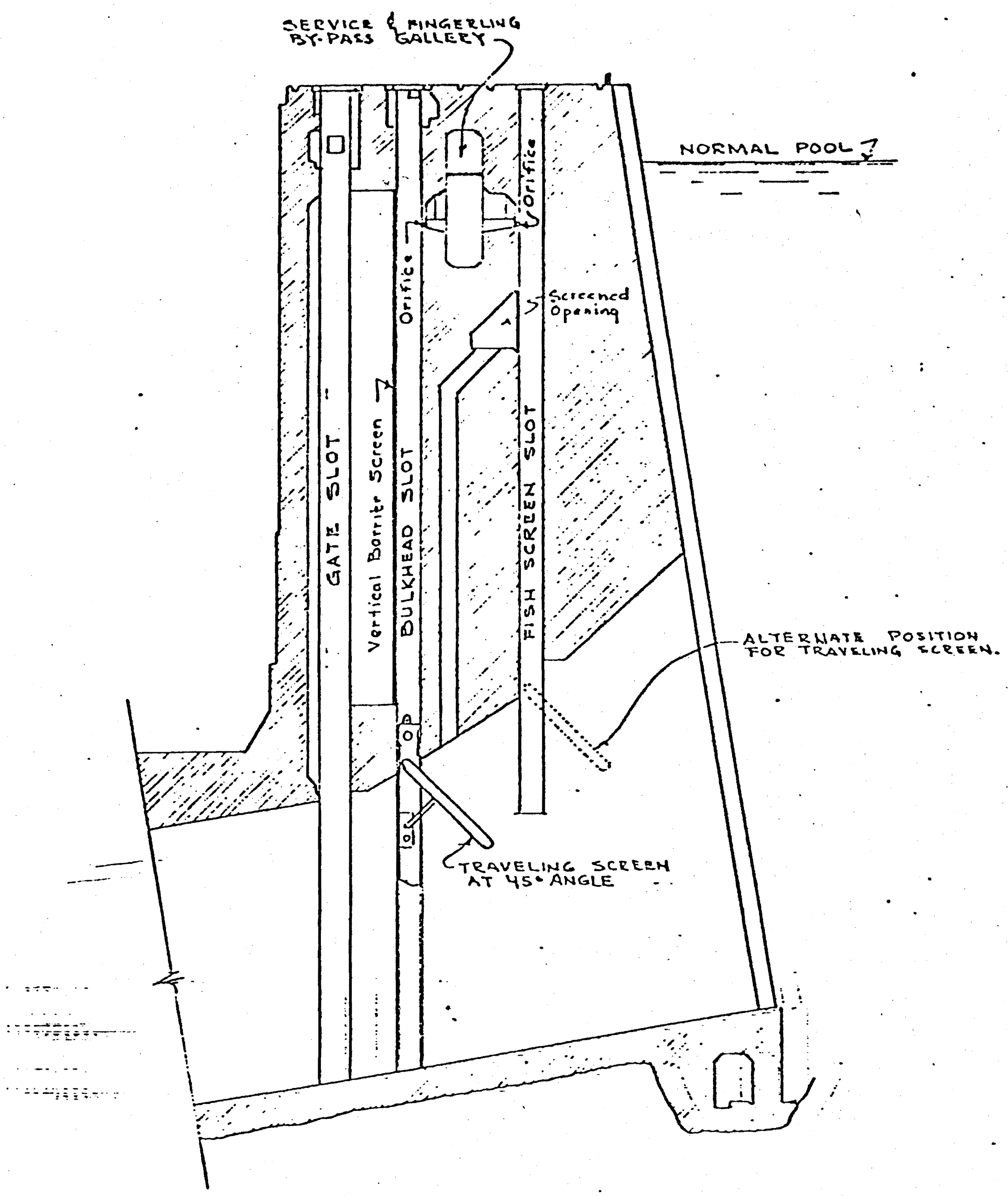

FIG. 1.--Transverse section of Lower Granite Dam showing locations of traveling screens.

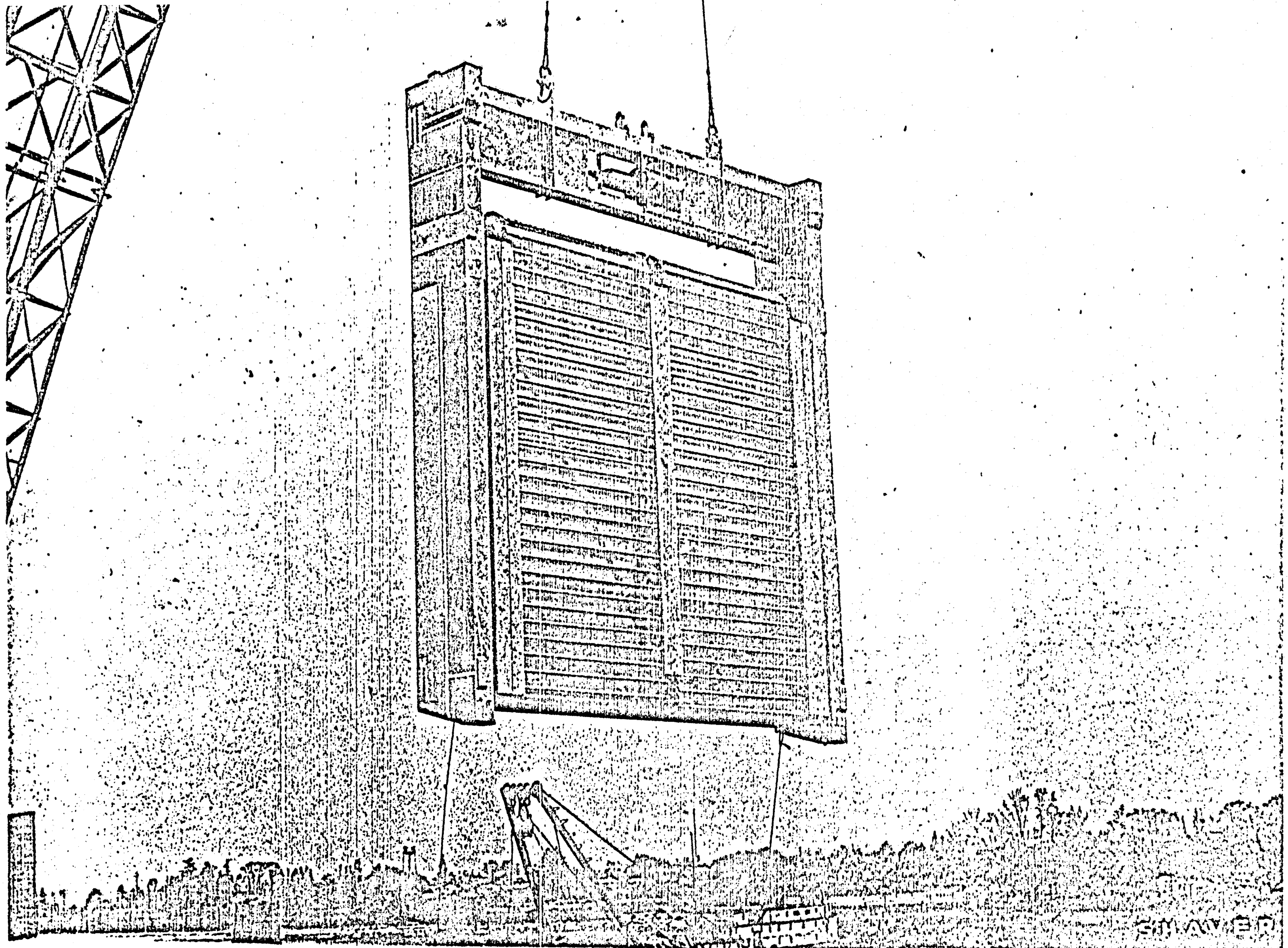

FIG. 2.--Improved traveling screen being developed by the U.S. Army Corps of Engineers and the National Marine Fisheries Service.