RESEARCH AT MCNARY DAM TO DEVELOP AN IMPROVED FINGERLING-PROTECTION SYSTEM FOR JOHN DAY DAM, 1981

by

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INTRODUCTION

In 1981, the National Marine Fisheries Service (NMFS), under contract to the U.S. Army Corps of Engineers (CofE), continued research to develop improved methods for protecting fingerling salmon and steelhead from losses associated with hydroelectric dams operated by the CofE on the Columbia and Snake Rivers.

A segment of the research focused on development of fingerling protection facilities and solving problems now existing in the present bypass at John Day Dam. The research was conducted at McNary Dam instead of John Day Dam for economic and practical reasons. Much of the needed test equipment was already on site at McNary Dam and the operating gate could be raised from the stored position to simulate gatewell flow conditions found at John Day Dam (demonstrated in a model study). Therefore, the results of the research obtained at McNary Dam were applicable to John Day Dam. This report summarizes the results of the study to date.

Objectives of the research at McNary Dam were as follows: (1) determine the fish-guiding efficiency (FGE) of the submersible traveling screen (STS) without a stored bulkhead gate (simulating conditions at John Day Dam), (2) evaluate the effectiveness of an airlift system for lifting juvenile fish out of the gatewell slot, (3) measure fish-passage efficiency (FPE) of a gatewell orifice submerged 8 or 17 feet, and (4) evaluate the orifice cycling operation and resultant retention and injury level for fish in the gatewell slot.

EVALUATION OF AIRLIFT SYSTEM FOR LIFTING JUVENILE FISH OUT OF GATEWELL SLOTS

Description of Dam and Experimental Equipment

Figure 1 illustrates a transverse section through a turbine intake in a typical hydroelectric dam in the Columbia River as described by Krcma et al. (1980). The experimental and standard fish guiding and handling equipment used in 1981 is also shown. The support frames shown below the STS would not normally be required in an operational situation because they were only needed to support the fyke nets used for estimating the number of unguided fish.

The airlift system tested was the "funnel" airlift pump system described by Sims et al. (1981) (Figures 2 and 3).

The dip basket used to sample the gatewells was similar to the device used by the NMFS in studies at various hydroelectric dams on the Snake and Columbia Rivers (Swan et al. 1979) (Figure 4).

The turbine intakes of McNary and John Day Dams are basically similar. One major difference is the presence of a stored operating gate in the downstream slot at McNary Dam. To simulate gatewell flow conditions found in the gatewells at John Day Dam, the operating gate in the B-slot of Unit 6 was raised and dogged off at the intake deck (Figure 4).

Experimental Design and Testing Procedures

Procedures for a typical test of the airlift system and its effect on the FGE of the STS were as follows:

1) Unit 6 was shut down.

2) The STS with attached fyke net frame was lowered into position.

3) The bypass orifices in 6-B slot were closed, and the gatewell was dipped to remove all fish.

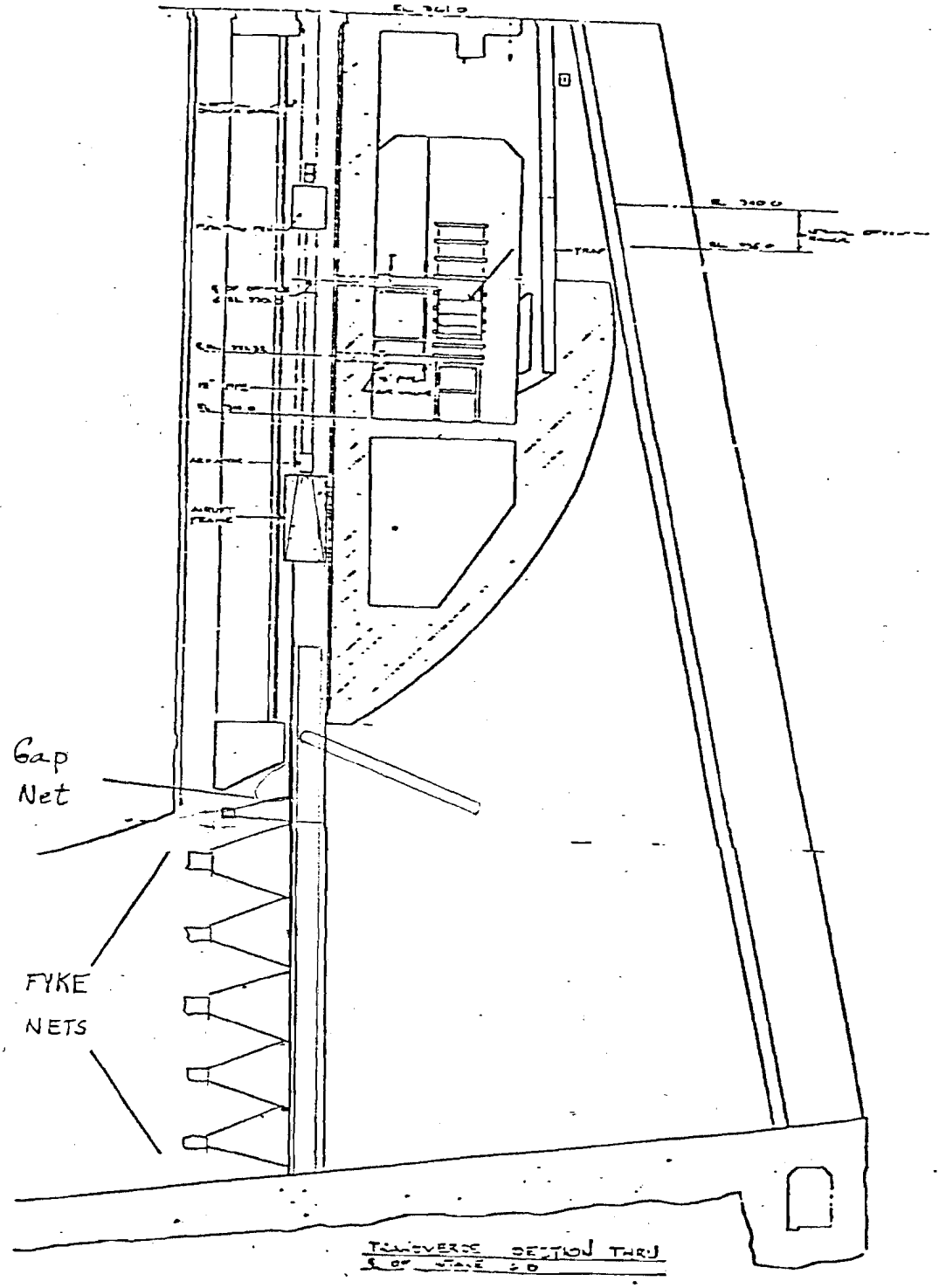


Figure 1.--Transverse section through Intake 6-B of McNary Dam showing experimental and standard fish guiding equipment used in 1981 to evaluate an airlift system.

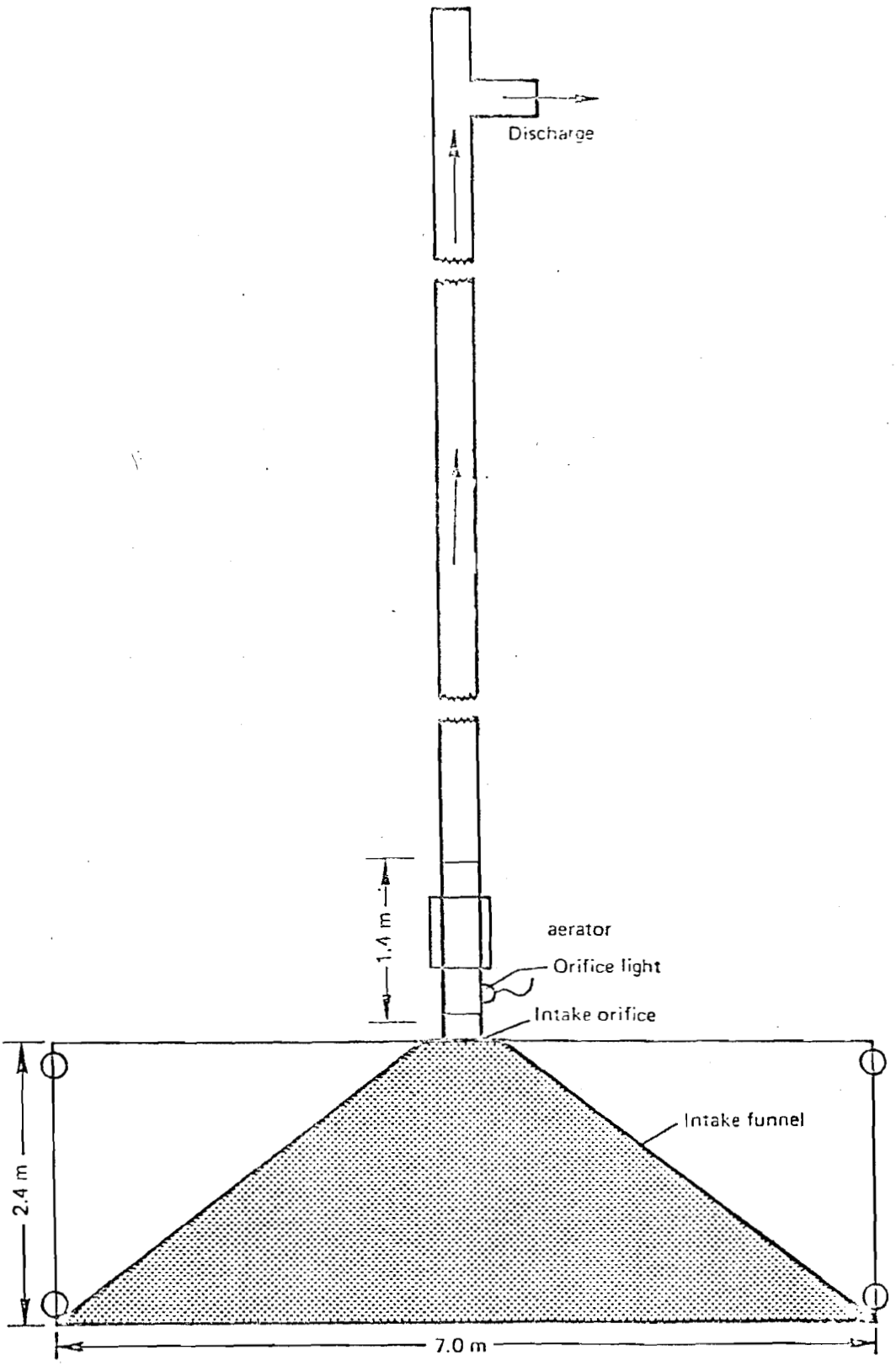


Figure 2.--The "Funnel" airlift pump system tested at McNary Dam in 1981.

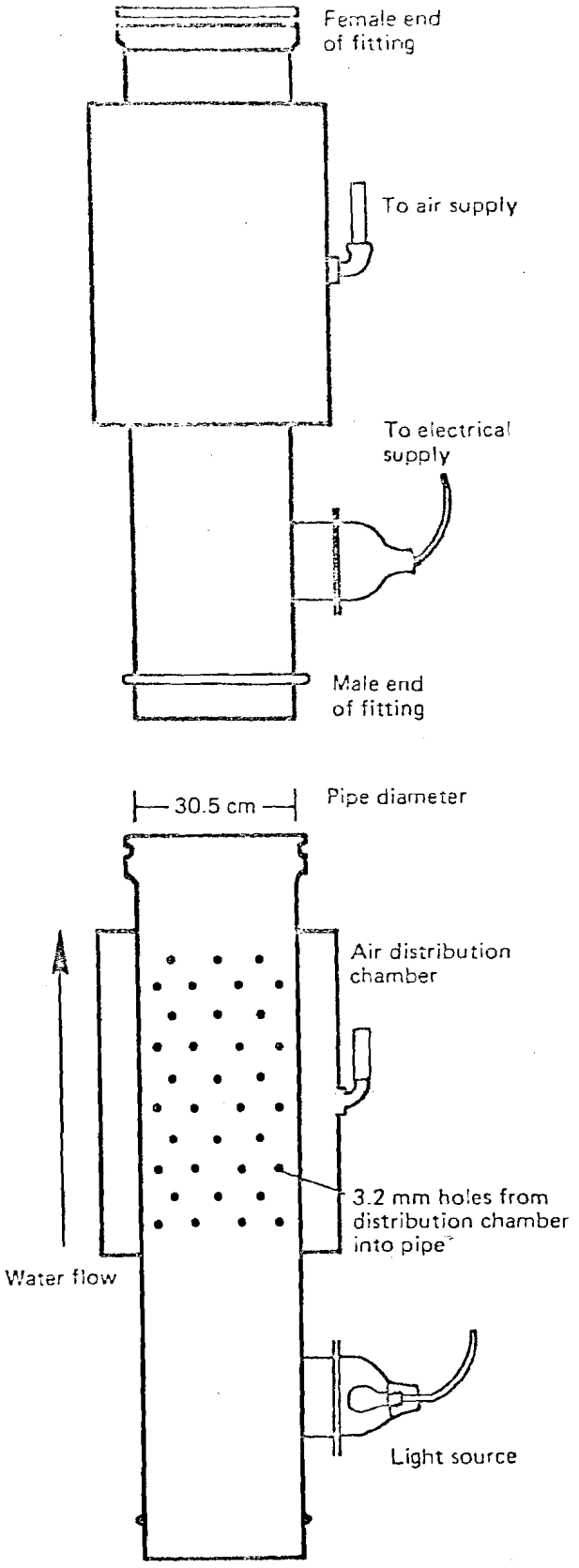
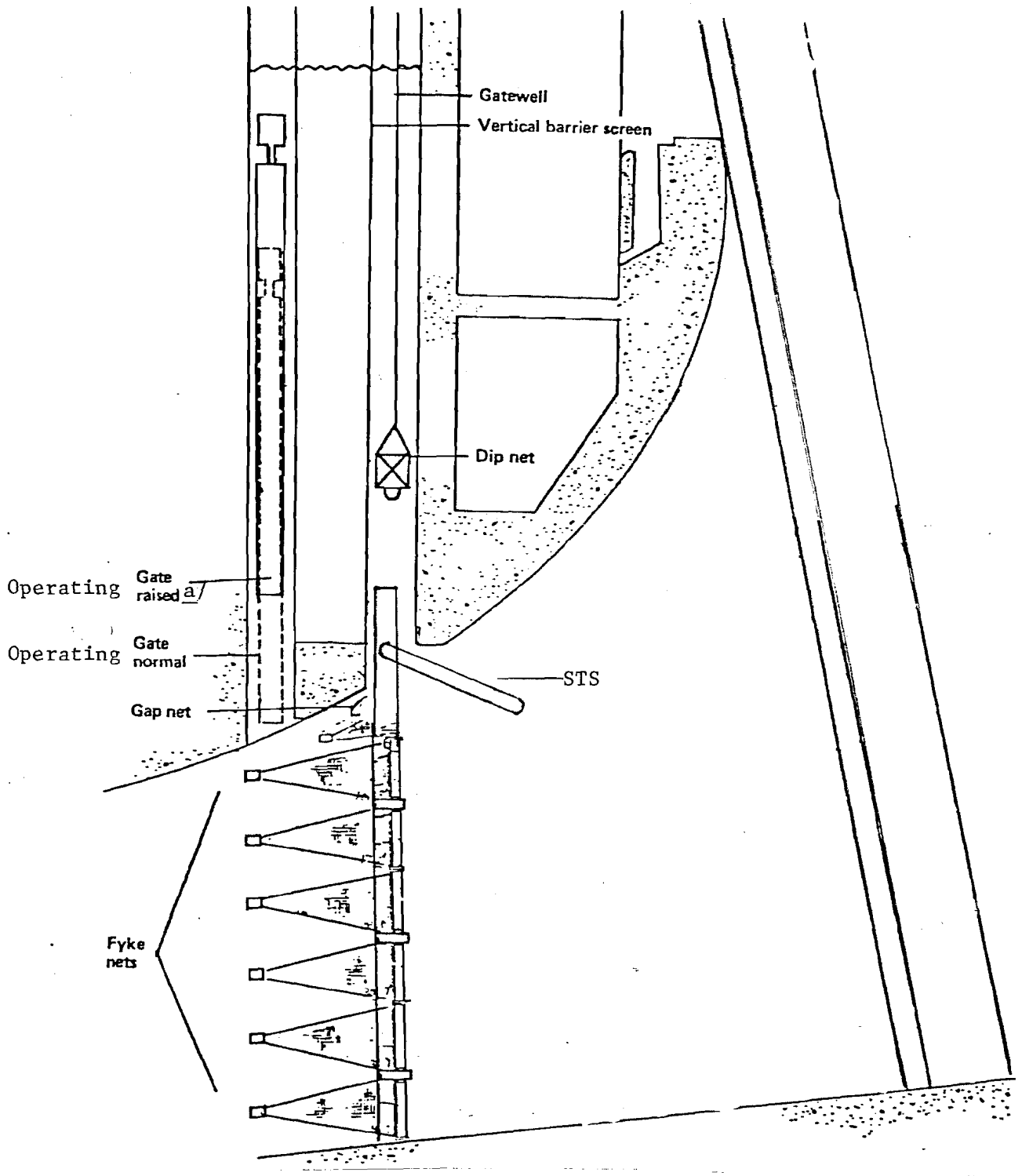


Figure 3.--Construction detail of the aerators used in the airlift pump system tested at McNary Dam in 1981.



a/ Simulated John Day condition.

Figure 4.--Cross section of a turbine intake and associated structures in the McNary Dam powerhouse.

4) The airlift funnel and connecting pipe were lowered into place.

5) Unit 6 was returned to service and brought to peak efficiency speed.

6) A floating pen was lowered into the gatewell to receive the pumped fish, and the airlift system was started.

7) The airlift pump was turned on, and the test was conducted for a specified period of time.

8) The test was terminated by shutting down the unit and reversing the above procedures.

9) The fish in the pen and those dipped from the gatewell were kept separate and sorted by species, counted, and examined for descaling and injury.

10) The STS with attached fyke nets and frames was brought to the surface, and the fish were removed from the nets for enumeration and identification.

Fish Guiding Efficiency of Traveling Screen

The FGE of the STS was measured during a series of tests with fyke nets mounted below the STS to provide information on numbers of fish passing under the STS and on through the turbine. The number of fish guided was obtained by dipnetting the gatewell. The number of fish guided compared to the total number of fish guided and unguided provided the FGE. The average FGE for chinook salmon and steelhead was 75 and 79%, respectively (Table 1). Due to insufficient numbers of fish, information on other species was not obtained.

The FGE of the STS with the airlift system in place for lifting fish from the gatewell is given in Table 2. Placement of the aerator at the 20-ft depth did not adversely alter the FGE. After the effect of the

Table 1.--Fish guiding efficiency of the STS with fish being removed from the gatewell by dipping.

Replicate no.	Chinook			Steelhead		
	Guided (no.)	Total (no.)	FGE (%)	Guided (no.)	Total (no.)	FGE (%)
1	339	486	70	49	55	89
2	70	85	82	16	25	64
3	126	186	68	32	44	73
4	173	185	94	49	61	80
Overall	708	942	75	146	185	79

Table 2.--Fish guiding efficiency (%) of the STS with an airlift system in place for lifting juvenile salmonids out of the gatewell.

Airlift position	Replicate no.	Chinook			Steelhead		
		Guided (no.)	Total (no.)	FGE (%)	Guided (no.)	Total (no.)	FGE (%)
Shallow (20 ft deep)	1	180	204	88	9	15	60
"	2	193	208	93	12	15	80
"	3	41	53	77	128	149	86
Overall ——		414	465	89	149	179	83
Mid-depth (30 ft deep)	1	99	120	83	74	95	78

airlift cone on FGE was established, the fyke nets were removed from the support frame of the STS and were not fished during the remainder of the tests of the airlift FPE.

Fish Passage Efficiency of Airlift System

The FPE of the airlift pump was tested with the STS and simulated John Day Dam flow conditions in the Turbine Intake 6-B. An inverted porous cone funnelled all fish entering the gatewell to the airlift pump (Figure 2).

The FPE of the airlift system is shown in Table 3. The FPE of the airlift pump at the 20-ft depth (the number of fish entering the floating pen divided the total number of fish entering the gatewell) was considerably lower than desirable. The test at the 30-ft depth, however, indicated a potential for more favorable FPE.

Condition of Fish

The condition of the fish passed by the airlift system was determined by comparing the descaling rate of residual fish in the test gatewell and fish passed through the system to fish in control gatewells. Fingerlings with ≥0% of their scales missing were considered descaled. Gatewells 7-B and 8-B with STS's operating were used as the controls throughout the test period. Fish were also sampled for condition in Gatewell 14-B, a gatewell with no STS. The airlift system did not appear to increase descaling significantly (Table 4).

EVALUATION OF SUBMERGED ORIFICES FOR PASSAGE OF JUVENILE SALMONIDS FROM GATEWELLS

Experimental Equipment and Testing Procedures

The operating depth of the standard bypass orifices in each gatewell at McNary Dam ranges from 5 to 10 feet during the spring season. The

Table 3.--Fish passage efficiency of the airlift system tested with a traveling screen and gatewell flow condition simulated for John Day Dam.

Duration of tests	FPE			
	Chinook (%)	Steelhead (%)	Sockeye (%)	Coho (%)
Shallow depth--20 ft				
4 hours (evening)	61	72	73	a/
24 hours (night termination) b/	51	60	51	a/
24 hours (day termination) c/	52	67	56	45
Mid-depth--30 ft				
4 hours (evening) (Only one replicate)	75	68	80	a/

a/ Insufficient numbers of fish to validate tests.

b/ Tests started and stopped at about midnight.

c/ Tests started and stopped at about noon.

Table 4.--Condition of fish expressed as percent descaled.

	% descaled			
	Chinook	Steelhead	Sockeye	Coho
Fish passed by the airlift system	7	9	11	6
Control--with STS	6	10	7	5
Control--without STS	6	6	4	3
Residual fish in test gatewell	8	8	9	7

standard orifice tests were conducted at an average depth of 8 feet. To simulate the John Day condition, an additional deep submerged orifice was drilled through the concrete wall between Gatewell 6-B and the ice and trash sluiceway (Figure 5). The deep orifice located directly underneath the existing north orifice was 17 ft below the surface during the tests. The diameter of both orifices was 12 inches. The existing orifice and the deep orifice of 6-B were connected to a trap facility in the sluiceway by separate 12-inch diameter pipes with valves for opening and closing the orifices. Figure 6 shows the configuration of the trap.

The FPE's of the deep and shallow orifices were measured over periods of 24 h for both the McNary Dam (operating gate in place) and John Day Dam (operating gate raised) flow conditions. To determine FPE, the number of fish passing through the orifice was compared to the total number entering the gatewell. The airlift system was not operated during these tests.

Orifice Fish-Passage Efficiency

The overall FPE was not acceptable. The only FPE greater than 75% was for steelhead (Table 5). In general, the FPE was better for the McNary condition than for the John Day condition.

Fish Passage Efficiency for Orifice Cycling

Two orifice cycling time periods for the John Day conditions were tested: (1) 8 h off and 4 h on and (2) 5 h off and 2 h on. Neither period produced an acceptable FPE (Table 6).

Condition of Fish

The results of the descaling tests (fish condition) are summarized in Tables 7 and 8. Descaling rates were generally unacceptable for the John