Seattle City Light
Skagit River
Total Dissolved Gas Monitoring

Total Dissolved Gas (TDG) monitoring on the Skagit River was conducted on July 10, 1997. Five test conditions were measured below Ross Dam. A transect was selected at Thunder Boathouse as representative of the river reach downstream of the project. Total Dissolved Gas readings were taken in the Ross Dam forebay and below Gorge Dam powerhouse.

Test Condition 1 - Both 1340 valves

Spill was provided through both 1340 valves under this test condition. A total of approximately 4,200 cfs was spilled during the test. Turbine discharge was approximately 9,475 cfs. Water from the 1340 valves projected away from the face of the dam quite a ways down into the tailrace. However, the stream of water from both valves broke from a stream into finer droplets shortly after leaving the valves. Water discharged in this manner fell relatively softly on the tailrace, with only a small amount of observable plunge. Water plunging to depth is the primary agent causing TDG supersaturation. Results of TDG monitoring are shown in Table 1.

Test Condition 2 - One 1340 valve and both spillways

Spill was provided through one 1340 valve and both spillways. One spill gate was used at each spillway. A total of approximately 4,200 cfs was spilled during the test. Turbine discharge was approximately 9,475 cfs. Water discharged from the 1340 valve is described in the previous paragraph. Water discharged from the spillways flowed in a laminar fashion down the long spill aprons, cascaded off rocks below the spill aprons, thus dissipating energy, and then plunged mildly into the tailrace. According to project operators, when 3 or more spill gates are used per spillway, water being spilled is flipped up slightly by the spill aprons, meets above the tailrace in mid-channel, and then falls relatively softly into the tailrace. Much of the "plunge" energy is dissipated from both spillways by water meeting in mid-channel under this configuration, though it was not tested. Results of TDG monitoring are shown in Table 1.

Test Condition 3 - Both spillways only

Spill was provided through both spillways. One spill gate was used at each spillway. A total of approximately 4,200 cfs was spilled during the test. Turbine discharge was approximately 9,475 cfs. Spill discharge is described in the previous paragraph. No significant increase in the depth of water plunging into the tailrace was observed. Results of TDG monitoring are shown in Table 1.

Test Condition 4 - Both spillways and one Hollow-jet valve

Spill was provided through both spillways, at approximately 1,500 cfs total, and one hollow-jet valve, at approximately 2,700 cfs. Turbine discharge was approximately 9,475 cfs. Spill discharge is described in previous paragraphs. Spill through the hollow-jet valve created the greatest amount of water plunging into the tailrace of any conditions tested to this point. The hollow-jet valves, although at much lower elevation than the 1340 valves, discharge water at a downward angle to the tailrace. Because of the significant amount of head behind Ross Dam, water "jetted" from the valve with considerable force first into the tailrace pool and then across to the far shore. Considerable plunging and mixing occurred in the tailrace during test conditions. Foaming white water was observed traveling farther downstream toward the control room and powerhouse than during previous tests. Results of TDG monitoring are shown in Table 1.

Test Condition 5 - Both Hollow-jet valves

Spill was provided through both hollow-jet valves at approximately 5,244 cfs. Turbine discharge was approximately 9,475 cfs. Spill from the hollow-jet valves is described in the previous paragraph. However, with both valves operating, plunge and mixing conditions were exacerbated. The amount of white water in the tailrace increased dramatically, and more foaming white water travelled a greater distance downstream past the powerhouse. The tailrace at the point of entry of water from the hollow-jet valves was violently agitated prior to colliding with the rock face on the far shore of the river. Results of TDG monitoring are shown in Table 1.

Conclusions

None of the test configurations measured violated the EPA water quality criterion of 110% of saturation. One reading below the Gorge Dam powerhouse was slightly higher, at 110.4% of saturation. This reading indicates that cumulative affects of spill from all three projects may be occurring, although water on the opposite side of the river flowing through the bypass reach did not support this conclusion (Table 1). The data indicate that use of the hollow-jet valves, under these test conditions, caused higher TDG in the tailrace than the other configurations tested. The data indicate that spill using the spillways and 1340 valves makes Ross Dam nearly transparent to TDG effects e.g., forebay levels at 106.0% of saturation and this spill configuration reading between 106.1% and 106.4% of saturation.

SEATTLE CITY LIGHT

TOTAL DISSOLVED GAS MONITORING

July 10, 1997

Table 1. TDG monitoring results

	Station	Time	BAR	Temp.	% N satn
Test 1 - Both 1340 valves					
Left Bank	Thunder Boathouse	9:35	729	7.6	107.7
Mid-Channel		9:20	728	7.7	107.9
Right Bank		9:30	729	7.6	108.3
Test 2 - Spillways & one 1340 valve					
Left Bank	Thunder Boathouse	10:45	728	8.1	106.2
Mid-Channel		10:50	729	8.2	106.4
Right Bank		11:00	728	8.2	106.1
Test 3 - Both spillways					
Left Bank	Thunder Boathouse	11:45	729	8.6	108.0
Mid-Channel		11:55	729	8.9	108.1
Right Bank		12:00	729	8.9	107.8
Test 4 - Both spillways & one hollow-jet					
Left Bank	Thunder Boathouse	12:40	730	8.8	108.1
Mid-Channel		12:45	730	8.4	108.3
Right Bank		12:50	731	8.4	107.7
Test 5 - Both hollow-jet valves					
Left Bank	Thunder Boathouse	13:25	730	7.7	108.7
Mid-Channel		13:35	730	7.6	109.6
Right Bank		13:40	730	7.7	108.8
Ross Forebay					
	Ross Boathouse	10:20	717	11.0	106.0
Gorge Dam tailrace					
Right Bank	Footbridge	15:05	749	9.1	107.4
Left Bank		15:20	749	8.8	110.4