Appendix A

Annexure B

Waitaki Power Stations

Appendix A

Extracts of Waitaki Operating Rules

(9 November 1990)

As modified by an order pursuant to section 122 of the Electricity Industry Act 2010

Appendix A

Extracts from Scheme Operating Instructions

Explanation:

1. This appendix contains extracts from operating instructions for hydraulic structures that form parts of hydro-electricity generating stations in the Waitaki Catchment. These extracts have been prepared to list the external hydraulic conditions associated with these structures. Omitted portions refer to the implementation of those conditions and descriptive material, or parts of the scheme that are managed by another generator.
2. Levels unless otherwise stated are in terms of Mean Sea Level Lyttleton.
3. Flows are in m^3/s. One m^3/s is equal to one cumec.

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Contents

1. Lake Pukaki and Pukaki Canal, and Ohau A

Lake Pukaki Spillway

The following is an extract from "Lake Pukaki Spillway, Operating Instruction No. 25, Amendment B February 1981".

1.1. Levels

Design Flood Level	534.10 m
Maximum Control Level (MCL) – September – April	532.00 m
Maximum Control Level – May – August	532.50 m
Minimum Control Level	518.20 m
Extreme Minimum Control Level	518.00 m

1.2. The design flood discharge is 2200 m^3/s with a level of 534.1 m. The nominal capacity of the spillway is 3400 m^3/s with the gates fully open and a lake level of 534.1 m. The estimated 1:1000 year flood discharge is 2000 m^3/s.

1.3. The initial spillway discharge shall be 35 m^3/s and shall not be increased for at least 4 hours. The second shall be 70 m^3/s and shall not be increased for at least 2 hours.

1.4. For lake levels above MCL the total discharge from Lake Pukaki (Spillway plus canal flows) shall not be less than the value given in the table below.

Height Above MCL (m)	Total Discharge (m^3/s)
0.1	70
0.2	140
0.3	200
0.4	270
0.5	340
0.6	420
0.7	500
0.8	580
0.9	660

1.0	750
1.1	840
1.2	930
1.3	1020
1.4	1120
1.5	1220
1.6	1320
1.7	1420
1.8	1520
1.9	1610
2.0	1700

1.5 If the lake level rises more than 2.0 metres above MCL the gates should be opened in steps of 250 m^3/s for each rise of 0.1 m until the lake level begins to fall.

1.6 On a falling lake the scheduled discharge shall be progressively reduced only if the estimated inflow is lower than the next scheduled discharge.

Pukaki Canal Spillway

1.7 The Pukaki Canal spillway is provided to prevent catastrophic canal failure. Operating rules are designed around this feature. The canal spillway is not for routine use. It is there in the case of emergency only and is used on a last resort basis.

2. Lake Ohau

The following is an extract from "Flood Operating Instructions Ohau A, B, C Power Stations and associated canals and spillways dated 11 May 1988".

2.1. Levels:

Two sets of levels are provided for. The levels not in brackets apply to the following situation:

(a) Without extended weir and/or control gate or provision for environmental and irrigation releases to the Ohau River.

The levels in brackets apply to:

(b) An extended weir and/or with a control gate and provision for environmental and irrigation releases.

Lake Ohau design flood level (1000 year return period flood) 522.90 m. [524.15 m] The design flood inflow commencing at 519.75 m [520.25 m] would raise the lake to 522.9 m, [524.15m] and assumes a canal discharge of 170 m^3/s. (Review of Waitaki Hydrology, MWD, 1980).

Lake Ohau current operating range:

Design Food Level	522.90 m [524.15 m]
Maximum Control Level (MCL)	519.75 m [520.25 m]
Minimum Control Level	519.75 m [519.75 m]
Extreme Minimum Control Level	519.45 m [519.45 m]

Lake Ohau Spillweir has a sill level of 520.0 m. [520.4 m]

2.2 Operation of Lake Ohau below Minimum Control Level is seen as anticipatory drawdown on rising inflows or forecasts of significant rainfall in the catchment.

2.3 When Lake Ohau level is above 519.75 m [520.25 m] the Ohau Canal inlet must be operated to discharge 170-200 m^3/s to limit flood levels in the lake. The discharge will require the use of machine bypass facilities if the requisite flows cannot be passed through generating plant.

When Lake Ohau rises above 520.0 m [520.4 m] Ohau Canal shall be set to 200 m^3/s.

2.4 Total flow in any part of the Ohau River shall, where possible, be limited to 560 m^3/s (including all of Lake Ohau Spill weir flow, Lake Ruataniwha spill flow and Ohau C canal (Labyrinth Weir) spill flow).

2.4.1 When Lake Ohau level exceeds 521.0 m [521.65 m] then the flow at Ohau A Power Station shall be reduced to maintain inflows into Lake Ruataniwha at or below 1000 m^3/s by progressive lowering of Pukaki Canal Inlet gates until they are shut. The flows shall be revised at least once every half hour (i.e., it is preferable to spill directly from Lake Pukaki and endeavour to keep flows in Ohau River below 560 m^3/s). As flows in the lower river decrease to below 560 m^3/s, flows through Pukaki Canal Inlet gates may recommence.

2.4.2 It may be necessary to use the available machine bypass valves to reduce risk of spillflow to the Ohau River above Ohau C Power Station thereby preventing the river flow exceeding 560 m^3/s, i.e., the canals are to be used as flood channels in preference to the river.

3. Lake Ruataniwha and Ohau B and C Power Stations

The following is an extract from "Flood operating Instructions Ohau A, B, C Power Stations and associated canals and spillways".

3.1 Lake Ruataniwha

Design Flood Level	460.00 m
Maximum Control Level (MCL)	458.80 m
Minimum Control Level	458.50 m
Extreme Minimum Control Level	458.00 m

3.2 Spill from Lake Ruataniwha spillweir will commence when Lake Ruataniwha level rises above 459.0 m and inflow exceeds the Ohau B canal flow.

3.3 If level of Lake Ruataniwha reaches or exceeds 460.0 m the gates are to be manned and opened according to the following table:

Lake Level (m)	Approx Flow (m^3/s)
460.0-460.1	1100
460.1-460.2	1200
460.2-460.3	1300
460.3-460.4	1400
460.4-460.5	1500
460.5-460.6	1600
460.6-460.7	1700

The required gate opening shall be reset at 15 minute intervals.

34.4 Labyrinth spillweir allows excess water in the Ohau C canal to spill into the lower Ohau river. It requires no control since it is a passive structure.

3.5 If Lake Ruataniwha spillway gates are opened when lake level is below 459.0 m the initial discharge shall not exceed 20 m^3/s. The initial discharge shall not be exceeded for at least 3 hours. The second discharge shall not exceed 45 m^3/s and shall not be increased for at least 2 hours. While lake level remains below 459.0 m further increases in discharge shall ensure that:

(a) Maximum Increase in flow at each gate change shall be 20 m^3/s and

(b) There shall be at least one hour between gate changes.

3.6 Pukaki Canal inflows shall normally be regulated to make up the difference between Ohau A Power Station flow and the Ohau canal flow, which may on occasion be zero.

3.7 The mechanical gate stops shall be set to limit the maximum possible inflow to not more than 100 m^3/s more than the maximum possible discharge through Ohau A power station (i.e. up to 660 m^3/s maximum possible).

The position of the mechanical gate stops shall be reviewed at least daily (and at least once each eight hour shift, when Lake Pukaki is rising rapidly).

Note 1 An overlap between ranges is permitted to give some flexibility in following the table (4.3). However, the position of the gate stop **must** be altered before the lake level moves 0.1 metres outside the nominated lake level range. (Either with a rising or a falling lake level). The lake levels at the changing points are to be alarmed as a reminder.

4. Benmore Power Station

The following is an extract from "Benmore Power Station Operating Instruction No. 203, Amendment E: February 1981 Spillway and Spillway Channel".

4.1 Levels

Design Flood Level	362.60 m
Maximum Control Level (MCL)	361.45 m
Minimum Control Level	360.50 m
Extreme Minimum Control Level	355.25 m

4.2 The design flood for the spillway is 3400 m^3/s and this can be passed with the lake at 362.30 m and all four spillway gates fully open. The nominal capacity of the spillway is 5100 m^3/s with the four spillway gates and two dewatering sluice gates fully opened and the lake at 362.60 m (design flood level).

4.3 When the lake reaches Maximum Control Level (MCL) 361.45 m (0.05 metres above maximum operating level) discharge is approximately 600 m^3/s through spillway and turbines combined.

4.4 For lake levels above 361.45m, the total discharge from the power station (turbine plus spillway discharge) shall not be less than the value given in the table. If required discharges at intermediate levels may be interpolated.

Lake Level (m)	Spillway and Turbines Combined Discharge (m^3/s)
361.50	850
361.55	1000
361.60	1175
361.65	1350
361.70	1525
	Maintain 1525 m^3/s total discharge until lake level falls to 361.65 m or rises to 361.95 m
361.95	1700

362.00	1875
362.05	2050
362.10	2225
362.15	2400
362.20	2575
362.25	2750
362.30	2925
362.35	3100
362.40	3300

Above 362.40 m the total station outflow shall be raised to not less than the inflow and the lake shall not be permitted to rise above 362.60 m.

Note: For lake levels of 361.70 m and above if preferred, spillway discharges can be considered independently of powerhouse discharges. In this case the spillway discharges shall be 300 m^3/s less than the combined discharges tabled above.

4.5 On a falling lake the scheduled discharge shall be progressively reduced only if the estimated inflow is lower than the next scheduled discharge.

5. Aviemore Power Station

The following is an extract from "Aviemore Power Station, Spillway Operating Instruction No. 203, Amendment C: February 1981".

5.1	Design Flood Level	269.20 m
	Maximum Control Level (MCL)	268.30 m
	Minimum Control Level	267.70 m
	Extreme Minimum Control Level	265.25 m

5.2 The spillway design flood is 3400 m^3/s which can be passed at lake level 269.20 m with all five gates opened 5.5 m. The nominal capacity of the spillway is 4500 m^3/s with all five gates fully opened.

5.3 When the lake level fluctuates within the range 268.30 m to 268.75 m no water need be discharged over the spillway. However, the spillway may be operated within this range, to maintain down river flows or reduce their fluctuation.

5.4 When the combined discharge of Benmore turbines and spillway exceeds the Aviemore turbine discharge, and Aviemore lake has risen to 268.80 m, the total discharge shall be brought equal to inflow by increasing the discharge by 175 m^3/s for every 25 mm rise in lake level as illustrated in the following table.

Lake Level (m)	Spillway and turbines combined discharge (m^3/s)
268.800	850
268.825	1025
268.850	1200
268.875	1375
268.900	1550
268.925	1725
268.950	1900
268.975	2075

269.000	2250
269.025	2425
269.050	2600
269.075	2775
269.100	2950
269.125	3125
269.150	3300

Above 269.15 m the total station outflow shall be raised to not less than the inflow and the lake shall not be permitted to rise above 269.20 m.

5.5 On the falling lake the scheduled discharge shall be progressively reduced only if the estimated inflow is lower than the next scheduled discharge.

6. Waitaki Power Station

The following are the operating procedures for Waitaki Power Station (September 1990).

6.1 Levels

Design Flood Level	234.50 m
Maximum Control Level (MCL)	230.80 m
Minimum Operating Level	228.70 m
Extreme Minimum Operating Level	227.00 m
Dam Crest Level	230.82 m

6.2 Operating Procedure

~~The normal minimum flow is 120 m³/s (20 MW).~~

~~With the agreement of the Manager, Operations and Rural Services, Canterbury Regional Council, an extreme minimum flow of 90 m³/s (15 MW) is permitted.~~

When reducing flow downstream of Waitaki, for flows below 200 m³/s, the maximum change in any one hour should be limited to 10% of the previous hours flow.

When increasing the flow downstream of Waitaki, for flows less than 200 m³/s, the maximum change in any one hour should be limited to 30 m³/s (5 MW).

When it is apparent that water will be spilled over the weir, the station should be put on maximum load, with load changes not exceeding 5 MW per hour.

6.3 Flood Operation

During period of high inflows the station should be brought to maximum load at normal operating rate and at the same time available storage at Benmore and Aviemore used to buffer short duration floods.

During a major flood all alternative water bypassing methods should be put into full discharge. This includes the power station being put on full load, and both sluice gates being opened. This provision should be initiated on any flood exceeding 2 m head over the spillway (A level of 232.82 m).

Flood magnitudes will be notifiable from further up the river, but should contact be lost with these other stations, or the South Island Control Centre, then the procedures above should be followed.

6.4 Earthquake

In the case of an earthquake of felt intensity of VI or greater on the Modified Mercalli scale, best endeavours should be made to lower the lake to the minimum operating level of 228.70 m, and then generally held about this level until advice of normal operations is received.