

Bryan Leyland

# Small Hydroelectric Engineering Practice



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**Bryan Leyland**

*Leyland Consultants, Auckland, New Zealand*



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# Small hydroelectric engineering practice

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This book is dedicated to my wife Jane; without her active support throughout my career and while I was writing this book, it would never have been written.

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## Preface

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Over the last 100 years, the technologies associated with small and large hydropower have steadily diverged with most development being concentrated in the large hydropower field. One outcome is that techniques appropriate for large schemes are often being applied to small schemes with undesirable results in terms of cost and reliability. About 40 years ago the importance of small hydro schemes for supplying isolated systems in the developing world and supplementing or replacing increasingly expensive conventional power sources such as diesel or other fossil fuel fired stations began to be recognised. A more recent development is the concern centred on “climate change” that has led many governments to offer large subsidies for small-scale renewable power generation including small hydropower

My first involvement in hydropower was in West Africa in 1967 where I was responsible for commissioning a small scheme associated with a water supply dam. I returned to New Zealand in 1970 and, since then, small hydropower development has been my main occupation.

In 1974 I set up a consulting firm that merged with Sinclair Knight Merz in 1998 and I finally retired from full-time employment in 2002. Over that period, we were responsible for many small hydro projects and developed many innovative solutions. There were no experienced designers and fabricators of hydraulic steelwork in New Zealand so we were responsible for detailed designs and shop drawings for equipment such as gates, screen cleaners, penstocks and stoplogs. We also purchased turbines and generators on separate contracts and let contracts for all the power station equipment such as cranes, pumps, cooling water systems, control gear, switchgear, transformers and then co-ordinated the contracts, supervised erection and commissioned the stations. As a result, we built up a broad range of expertise in the technology and in the detail and overall design of hydropower schemes.

Since 2002, I have maintained my involvement in hydropower and often reviewed feasibility studies and small hydro stations designed by other consultants in New Zealand and overseas that, to my eyes, had serious shortcomings. This, and my involvement in the repair of stations that had suffered catastrophic failures, made me realise that Leyland Consultants accumulated experience was a valuable resource that could be of use to many other people around the world.

In 2010 I met Janjaap Blom of CRC Press/Balkema at a conference and asked if there was any interest in the book on small hydropower. He responded enthusiastically; this book is the result.

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# Acknowledgements

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I am enormously grateful to all the people who helped this electrical engineer turn into a hydropower engineer.

Chief among them are: Lloyd Mandeno, a pioneer in small hydropower who challenged me with “it stands to reason” and “there must be a better way”, Leopold Solc of Litostroj, Slovenia, who introduced me to the complexities of water turbines, Dr Emil Mosonyi whose two volume book on hydropower has been my bible, David Lynch-Watson, my original partner in Leyland and Watson, later to become Leyland Consultants, Julian Godwin, our ingenious chief draughtsman, Prof Hermod Brekke, a turbine designer and expert on many other aspects of hydropower, and Evan Dumbleton who made major contributions to the section on turbines and provided Appendix 4.

To them, and the many other people who were so generous with their time and advice, my profound thanks.

I acknowledge with gratitude the people who have contributed specialist sections and corrected and improved what I had written.

In alphabetical order, they are: Simon Carryer – geological and geotechnical, Colin McDonald – generators, John Duder – canals and environmental, Evan Dumbleton – turbines, Willie Mandeno (grandson of Lloyd Mandeno) – corrosion protection, Bruce Smith – financial and economic analysis, Lloyd Wensley – Communications.

I must also thank TrustPower for arranging for me to visit and photograph a number of stations that were designed by Leyland Consultants about 30 years ago and Trustpower for permission to use the drawings of these stations in this book.

A number of organisations have generously allowed me to use their drawings, photographs and other information. They include: Andritz, Alstom, Dulas/Aquashear, Dyrhoff (Obermeyer gates), European Small Hydro Association, Gilkes, Leffel and Hydroworks.

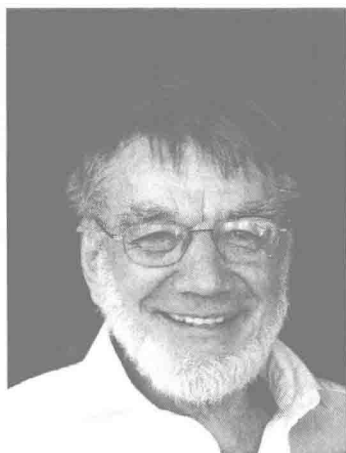
I am also grateful to Janjaap Blom of CRC Press/Balkema for his patience, support and advice during a three-year gestation period, also to my wife Jane, my son Geoff, Rod Fulford and Willie Mandeno for editing and for some very constructive criticism.

Finally, I am indebted to Nuance for the voice recognition program “Dragon Dictate” without which this book could not possibly have been written!

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## About the author

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Bryan Leyland's engineering career commenced in 1956 when he joined a New Zealand electricity supply authority as an engineering cadet. After graduation he sailed to Tahiti on a yacht and then on to Los Angeles on the sailing ship that was built for the filming of "Mutiny on the Bounty" starring Marlon Brando and Trevor Howard.

After travelling in the United States, Mexico and Canada, he continued on to England and joined consultants Preece, Cardew and Rider who employed him as a resident engineer on power projects in Africa, Cyprus and Malaysia. He met his wife Jane in Sierra Leone, got married in England and returned to New Zealand in 1970 to work for Lloyd Mandeno, a pioneer in small hydropower.

Lloyd died a few years later and Bryan and David Lynch-Watson set up their own consulting firm in 1974. Bryan spent most of the next 25 years working on the overall and detailed design and commissioning of hydropower schemes in New Zealand and overseas comprising 26 small hydropower schemes totalling 250 MW and the refurbishment of 27 schemes. Ten of the schemes won awards as "engineering projects of outstanding technical significance".

In 2002, Bryan retired from full-time employment and since then he has worked from home on a variety of projects on small hydropower schemes and on a variety of projects overseas. Since 2003 he has been involved in the 1 MW Onekaka power scheme that he largely designed and commissioned. Bryan and his wife are now majority owners and operators.

Bryan has often been employed as a consultant to the World Bank and to the Asian Development Bank on hydropower investigations and on dam safety and he has provided advice on hydropower development in Iran, Africa Bhutan and Mongolia. He has written many papers on hydropower development, power systems and electricity markets.

In 2009 Bryan was listed by Waterpower and Dam Construction as one the 60 most influential people in the hydropower industry worldwide.

Bryan and Jane have two children who graduated in engineering science. Daughter Maury has moved on to senior management and Geoff gained a Ph.D. and is now a consultant in the optimisation of complex processes.



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## List of abbreviations

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- GPS – Global Positioning System. A very accurate location system to determine latitude and longitude using information from satellites.
- GRP – glass reinforced plastic (fibreglass). A strong, light and corrosion resistant material made of glass fibre and epoxy resin
- HDPE – high density polyethylene. A strong tough plastic with a low coefficient of friction suitable for pipelines and many other uses.
- m<sup>3</sup>/s – Cubic metres per second (cumecs).  $1 \text{ m}^3/\text{s} = 35.3 \text{ ft}^3/\text{s}$
- MW – Megawatts. A measure of the rate of flow of electrical energy.  
 $1000 \text{ kW} = 1 \text{ MW}$
- MWh – Megawatt hour. A measure of electrical energy. The amount of energy delivered by 1 megawatt flowing continuously for one hour.
- PTFE – a synthetic fluoropolymer of tetrafluoroethylene (Teflon).  
A high-molecular-weight compound with a very low coefficient of friction.

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# Contents

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<i>Preface</i>	xiii
<i>Acknowledgements</i>	xv
<i>About the author</i>	xvii
<i>List of figures</i>	xix
<i>List of abbreviations</i>	xxiii
<b>1 Introduction</b>	<b>1</b>
1.1 Key features of small hydro schemes	3
<b>2 Scheme identification</b>	<b>5</b>
2.1 Preliminary study	5
2.1.1 Cost estimates	6
2.2 Feasibility study	6
2.2.1 Site survey	6
2.2.2 Hydrology	7
2.2.3 Geology	8
2.2.4 Environmental assessment	8
2.2.5 Preliminary estimates	9
2.2.6 Preliminary report	10
<b>3 Refining the design</b>	<b>11</b>
3.1 Hydrology	11
3.2 Geology	12
3.3 Headworks	12
3.3.1 Spillway options	13
3.3.2 Intakes	13
3.3.3 Canal design	14
3.4 Penstocks and intakes	16
3.4.1 Penstock intakes	16
3.4.2 Steel penstocks	16
3.4.3 Wood stave penstocks	16
3.4.4 Plastic and GRP penstocks	17
3.5 Turbine selection	17
3.5.1 Low head turbines	17
3.5.2 Medium head turbines	19
3.5.3 High head turbines	19
3.6 Powerhouse arrangement	20

3.7	Useful spreadsheets	20
3.8	Preliminary financial analysis	21
3.9	Outside financing	21
3.9.1	“Bankable” feasibility study	22
3.9.2	Economic and financial analysis	22
<b>4</b>	<b>Detailed design of intake works, canals and penstocks</b>	<b>25</b>
4.1	Environmental factors	25
4.2	Final optimisation	27
4.2.1	Technical optimisation	28
4.2.2	“Alab” computer program	28
4.2.3	“Hydrohelp” computer program	29
4.3	Intakes at low weirs	29
4.3.1	Coanda screen	29
4.3.2	Streambed intake	32
4.3.3	Bypassing	32
4.3.4	Settling basin	33
4.4	Conventional intakes	35
4.4.1	Screen cleaners	37
4.4.2	Intake gates	38
4.4.3	Penstock filling	42
4.4.4	Additional information on intakes	43
4.5	Spillways	44
4.5.1	Flap (fish belly) gates	44
4.5.2	Obermeyer gates	45
4.5.3	Radial gates	46
4.6	Bypass gates	52
4.7	Stoplogs and bulkheads	53
4.8	Canal regulating gates	54
4.9	Additional information on gates	56
4.10	Canals	56
4.10.1	Controlling leakage	58
4.10.2	Small unlined canals	58
4.10.3	Canal linings	58
4.10.4	Under drainage	59
4.10.5	Further information	59
4.11	Penstocks and water hammer	59
4.11.1	Water hammer	60
4.11.2	Steel penstocks	62
4.11.3	Glass reinforced plastic (GRP) penstocks	68
4.11.4	HDPE and PVC penstocks	71
4.12	Surface treatment and painting of steelwork	72
<b>5</b>	<b>Turbine selection</b>	<b>73</b>
5.1	Introduction	73
5.2	Number of turbines	73
5.3	Particulate erosion	74

5.4	Kaplan and Francis turbines	75
5.4.1	Guide vanes	78
5.4.2	Guide vane actuation	81
5.4.3	Cavitation	83
5.4.4	Hydraulic stability and rough running	86
5.5	Low head turbines	87
5.5.1	Dimensions of Kaplan turbines	88
5.5.2	Vertical Kaplan turbines	88
5.5.3	Bulb turbines	91
5.5.4	Pit turbines	92
5.5.5	Matrix turbines	93
5.5.6	Axial Kaplan turbines	95
5.5.7	Open flume Kaplan turbines	95
5.5.8	Very low head turbines	98
5.5.9	Stoplogs and emergency isolation	98
5.6	Medium head turbines	98
5.6.1	Dimensions of Francis turbines	99
5.6.2	Air admission	102
5.6.3	Vertical Francis turbines	103
5.6.4	Horizontal Francis turbines	104
5.6.5	Twin horizontal Francis turbines	107
5.6.6	Inlet valves	111
5.6.7	Relief valves	113
5.6.8	Bypass valves	114
5.7	Pelton turbines	115
5.7.1	Dimensions of Pelton turbines	115
5.7.2	Pelton turbine arrangement	115
5.7.3	Pelton turbine runners	117
5.7.4	Pelton turbine options	119
5.7.5	Turgo turbines	121
5.8	Governing systems	121
<b>6</b>	<b>Generators</b>	<b>125</b>
6.1	Overspeed	125
6.2	Synchronous generators	126
6.2.1	Stators	127
6.2.2	Corona	129
6.2.3	Excitation systems	129
6.2.4	Neutral earthing	130
6.2.5	Lightning protection	131
6.2.6	Generator cooling	132
6.2.7	Overspeed testing	135
6.2.8	Increasing generator inertia	136
6.2.9	Bearings	136
6.2.10	PTFE bearings	138
6.2.11	Bearing cooling and monitoring	138
6.2.12	Induction generators	139

<b>7</b>	<b>Electrical systems</b>	<b>141</b>
7.1	Single line diagram	141
7.1.1	Transformers	142
7.1.2	Station earthing	143
7.1.3	Transmission	144
7.2	Control	145
7.2.1	Control philosophy	145
7.2.2	Communications	146
7.2.3	Programmable Logic Controllers	147
7.2.4	Programming instructions	148
7.3	Protection and instrumentation	150
7.4	Synchronising	152
<b>8</b>	<b>Auxiliary plant</b>	<b>153</b>
8.1	Auxiliary AC power supplies	153
8.2	DC power supplies	153
8.3	Water piping	154
8.4	Sump pumping	155
<b>9</b>	<b>Specifications and contracts</b>	<b>157</b>
9.1	Conditions of contract	158
9.1.1	General Conditions of Contract	158
9.2	Specifications for major generating plant	160
9.2.1	Turbine specifications	161
9.2.2	Governing systems	164
9.2.3	Inlet and bypass valves	165
9.2.4	Generator specifications	165
9.2.5	Tender schedules	166
9.2.6	Sample specifications	166
9.3	Specifications for other mechanical and electrical plant	167
9.4	Surface preparation and painting	167
9.4.1	Background	167
9.4.2	Specification requirements	168
9.5	Assessment of tenders	169
<b>10</b>	<b>Powerhouse layout and design</b>	<b>171</b>
<b>11</b>	<b>Construction and commissioning</b>	<b>175</b>
11.1	Project construction	175
11.2	Commissioning	176
<b>12</b>	<b>Operation</b>	<b>179</b>
12.1	Generating plant	179
12.2	Civil works	181
12.3	Safety and environmental requirements	181

<b>13 Lessons from failures</b>	<b>183</b>
13.1 Civil engineering failures	183
13.1.1 Ruahihi canal collapse	183
13.1.2 Wheao canal and head-pond breach	184
13.1.3 Aniwhenua canal leak	185
13.1.4 Lessons from civil engineering failures	186
13.2 Generating plant failures	186
13.2.1 Station in the Pacific, 1990	186
13.2.2 Mangahao power station	188
13.2.3 Tuai power station	189
13.2.4 Duffers power station	190
<b>14 Appendix 1: Useful spreadsheets and computer programs</b>	<b>191</b>
14.1 Hydro scheme data and cost estimates	191
14.2 Intake screen head losses	192
14.3 Turbine dimensions	192
14.4 Cost estimates for turbines and generators	193
14.5 Financial analysis	195
<b>15 Appendix 2: Financial and economic considerations</b>	<b>197</b>
15.1 Objectives of financial analysis	197
15.2 Objectives of economic analysis	197
15.3 Approach and methodology	198
15.3.1 Financial evaluation	198
15.3.2 Levelized Cost of Electricity	199
15.3.3 Overview of economic cost benefit analysis	200
<b>16 Appendix 3: Environmental issues with two hydropower schemes</b>	<b>201</b>
16.1 Aniwhenua	201
16.2 Onekaka	202
<b>17 Appendix 4: Making the most of hydro specifications</b>	<b>205</b>
17.1 Introduction	205
17.2 The tenderer/contractor – an interesting species	206
17.3 Specifications	207
17.3.1 Performance specifications	207
17.3.2 Performance specification vs prescriptive specification	207
17.3.3 Getting the “A” team	208
17.3.4 Life cycle cost analysis	209
17.3.5 Is the specification tough enough?	209
17.3.6 Interfacing with existing equipment	209
17.3.7 Warranties	210
17.3.8 Drawings	210
17.3.9 Innovation vs conservatism	210
17.3.10 Contract inspection	210
17.3.11 Works acceptance vs Site acceptance	211
17.3.12 Project schedule	211

17.4	Looking beyond the specification	212
17.4.1	Educating our masters	212
17.4.2	Legal advice	212
17.4.3	Commercial advice and instruction	213
17.4.4	General Conditions of Contract	213
17.4.5	Special Conditions of Contract	213
17.4.6	Instructions to tenderers	214
17.4.7	Partnering	215
17.4.8	Tender evaluation	215
17.5	Conclusion	216
	<i>References</i>	219
	<i>Subject index</i>	221
	<i>Contents of CD</i>	225

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## List of figures

---

Figure 1	Barbegal Mill	2
Figure 2	Dillmans Scheme	3
Figure 3	Flow/duration curve	7
Figure 4	Application Range	18
Figure 5	Coanda intake	30
Figure 6	Coanda screen	31
Figure 7	Streambed intake	32
Figure 8	Scour/bypass gate	33
Figure 9	Settling basin	34
Figure 10	Badly designed settling basin	34
Figure 11	Duffers intake vortex	35
Figure 12	Intake screen	37
Figure 13	Differential level detector	38
Figure 14	Onekaka screen cleaner	39
Figure 15	Aniwhenua screen cleaner	40
Figure 16	Paerau intake	41
Figure 17	Gate with cracking levers	43
Figure 18	Flap gate and emergency operating system	45
Figure 19	Obermeyer gate (Dyrhoff)	46
Figure 20	Patea Radial gates	47
Figure 21	Radial gate angled seal and side guide	48
Figure 22	Radial gates and lifting gear	51
Figure 23	New spillway gate lifting system	51
Figure 24	Float controlled radial gate	52
Figure 25	Stoplog slot and seal	54
Figure 26	Canal level regulating gate	55
Figure 27	Canal sections	57
Figure 28	Penstock pressure profiles	61
Figure 29	Paerau penstock line with bolted couplings	63
Figure 30	Paerau penstock bend	64
Figure 31	Ruahihi penstock installation	65
Figure 32	Branch penstock supports	66
Figure 33	Paerau penstock crossing river	67
Figure 34	Manhole cover	69
Figure 35	Branch bifurcation	70



Figure 36	Draft tube options	77
Figure 37	Guide vanes (Hydroworks)	78
Figure 38	Guide vane clutch (Hydroworks)	79
Figure 39	Wairau bending links and cover drain for cooling water	80
Figure 40	Speed ring with breaking links (Andritz)	81
Figure 41	Linked guide vane levers with clutches (Kvaerner)	82
Figure 42	Speed ring with push/pull rods (Voith)	83
Figure 43	Cavitation damage	84
Figure 44	Axial flow turbine efficiency curves	88
Figure 45	Argyle Kaplan turbine (Voith)	89
Figure 46	Bulb Turbine (Andritz)	91
Figure 47	Mini bulb turbine (Andritz)	92
Figure 48	Pit turbine (Alstom)	93
Figure 49	Straflo Matrix turbine (Andritz)	94
Figure 50	Horizontal axial turbine (Alstom)	95
Figure 51	Vertical axial turbine (Alstom)	96
Figure 52	Tubular or S turbine (ESHA)	97
Figure 53	Open flume Kaplan Turbine	97
Figure 54	Very low head turbine (MJ2 Technologies)	98
Figure 55	Francis turbine cross-section (Hydroworks)	100
Figure 56	Shaft seal (SM Seals)	102
Figure 57	Labyrinth shaft seal (Hydroworks)	103
Figure 58	Semi-embedded turbine	104
Figure 59	Paerau turbine and flywheel	105
Figure 60	Francis turbine with intake above centreline	107
Figure 61	Wyangala end and side views	108
Figure 62	Wyangala plan	109
Figure 63	Patearoa twin turbine	110
Figure 64	Wairau twin turbine powerhouse	111
Figure 65	Glenmaggie powerhouse	112
Figure 66	Relief valve curves	113
Figure 67	Patearoa bypass valve	115
Figure 68	Vertical 4 jet Pelton (Alstom)	116
Figure 69	Jet deflector types (Hydroworks)	117
Figure 70	Large Pelton runner cast in one piece (Andritz)	118
Figure 71	Hooped Pelton runner (Alstom)	119
Figure 72	Three Jet Pelton (Andritz)	120
Figure 73	Turgo principle (ESHA)	121
Figure 74	Twin jet Turgo (Gilkes)	122
Figure 75	Generator stator (Andritz)	126
Figure 76	Generator stator and rotor (Andritz)	127
Figure 77	Paerau neutral earthing	131
Figure 78	Cooling water systems	134
Figure 79	Paerau generator and flywheel	137
Figure 80	Paerau single line diagram	142
Figure 81	Onekaka PLC logic	150
Figure 82	Jet pump	155