Bryan Leyland

Small Hydroelectric Engineering Practice

CRC Press
Taylor & Francis Group
A BALKEMA BOOK

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CRC Press
Taylor & Francis Group
Boca Raton London New York Leiden

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

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Cover credits:

Front cover:

Coanda intake photograph provided by Dulas Ltd, UK

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CRC Press/Balkema is an imprint of the Taylor & Francis Group, an informa business

Typeset by MPS Limited, Chennai, India
Printed and Bound by CPI Group (UK) Ltd, Croydon, CR0 4YY

Library of Congress Cataloging-in-Publication Data

Leyland, Bryan.
Small hydroelectric engineering practice / Bryan Leyland, MSc
Leyland Consultants, Auckland, New Zealand.
pages cm
Includes bibliographical references and index.
ISBN 978-1-138-00098-8
1. Small scale hydropower. I. Title.
TK1081.L475 2014
621.31'2134—dc23

2013042304

Published by: CRC Press/Balkema
P.O. Box 11320, 2301 EH Leiden, The Netherlands
e-mail: Pub.NL@taylorandfrancis.com
www.crcpress.com – www.taylorandfrancis.com

ISBN: 978-1-138-00098-8 (Hardback)
ISBN: 978-1-315-81653-1 (eBook PDF)

Small hydroelectric engineering practice

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.

Preface

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.

Acknowledgements

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.

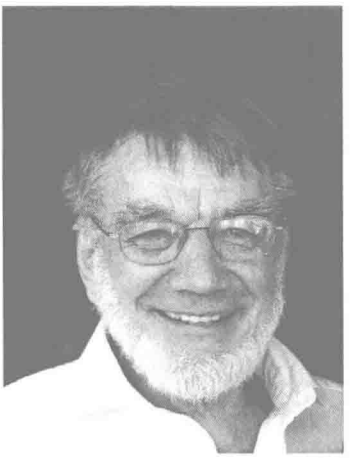
I must also thank TrustPower for arranging for me to visit and photograph a number of stations that were designed by Leyland Consultants about 30 years ago and Trustpower for permission to use the drawings of these stations in this book.

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!

About the author



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 totaling 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.

List of abbreviations

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^3/s – Cubic metres per second (cumecs). $1\ m^3/s = 35.3\ ft^3/s$

MW – Megawatts. A measure of the rate of flow of electrical energy. $1000\ kW = 1\ MW$

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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