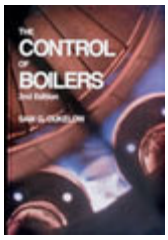

To Control Fire - BBBBB (Bonus)
The Control of Boilers
By Sam Dukelow
Reviewed by Nick Sands

Towards the end of his long career in boiler control, Sam Dukelow, PE, wrote *The Control of Boilers* to document the knowledge gained over 50+ years, including many years with Bailey Controls Company. Dukelow was president of Energy Conservation Services and a contributor to the Instrument Engineers Handbook and the Handbook of Energy Technology. Dukelow was also an ISA Fellow and the winner of ISA's Sperry Founders Award in 1991. This book has many short chapters focused on topics from start-up to combustion control by type of fuel.

The introductory chapter provides a guide to the SAMA symbology used to illustrate control strategies throughout the book, as well as a brief history on the development of boil controls. Succeeding chapters cover the basics of boiler design with illustrations of many types of boilers and the fundamentals of the mass and energy balances in boilers. Managing these balances is the purpose of boiler control. Feedback, feedforward, ratio, and cascade control are the basic tools.

Several chapters cover the control of the fireside of the boiler. First there is an overview of combustion, fuel types and fuel handling. This includes the heat values for the fuels and minimum air for combustion. There can be significant variability in both. The energy released from combustion and converted to steam is the basis for the efficiency calculations, for which there are multiple methods.

The connection between steam demand, or turbine energy demand, and the firing rate demand of the boiler is critical. There are different strategies, especially for industrial and utility boilers. The demand signals are dependent on the type of boiler and energy recovery systems, such as economizers or reheaters. In addition to the steam demand and the steam temperature control, the boiler feedwater must be controlled to prevent loss of the drum or boiler level control, which can result in an explosion. Interlocks should prevent this.

Combustion air flow, and draft control, are also critical, and connected to the firing rate demand. Forced and/or induced draft fans can be used. The total flow of air should meet the minimum for combustion and appropriate control of flue gas. This can be done using combinations of O2, CO, CO2, and opacity. Depending on the fuel and system, the method may change. The fuel flow should be coordinated with the air flow through methods such as linked positioning, parallel positioning, or metered control. Often the metered control will use cross-limiting, or lead-lag, control for safety.

The NFPA regulates burner systems in the US. The requirements in the burner light-off sequence are covered as well as flame safety interlocks. Several chapters follow that explain the control strategies for various aspects of coal fired boilers, which can be challenging to automate and may require control to determine fuel value. The final chapter predicts trends in boiler control, which we can now assess.

This book is an excellent guide to those who follow in Dukelow's footsteps and seek to control fire to produce steam. Beyond that, this book showcases so many applications of theory that it ranks among the great books of process control, but only if the reader can follow SAMA diagrams. Dukelow demonstrates many times the power of combined understanding of the process and the control system. *The Control of Boilers* is a bonus book (BBBBB) and available from ISA.org for $89 (member price).