

The Practical Welding Engineer

By **J. Crawford Lochhead**
and **Ken Rodgers**



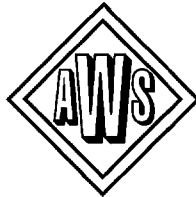
American Welding Society

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**Brown and Root McDermott
Fabricators, Ltd.,
Inverness, Scotland.**



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Preface

When we, the authors, decided to write this book, we had a definite aim in mind — to present a “practical” approach to the application of welding theories.

Over recent years universities and colleges have recognized the previous lack of attention paid to the welding fraternity and subsequently greatly improved teaching capabilities and lecture contents. As a result, the modern engineer is well versed in basic metallurgical behavior; he is aware of the application of electronic wizardry to modern equipment; fracture mechanics is not just an obscure theory but a practical everyday tool; and, modern materials and consumables have apparently eliminated many of the problems of the past. What the modern welding engineer lacks is the knowledge of how to apply this knowledge in a practical sense. What we have attempted to write is basically a distillation of almost 60 years (between the two of us) of hard-gained realism in heavy engineering fabrication.

The basis of the book is therefore an assumption that the reader is already knowledgeable of basic welding and metallurgical theory. He is most likely a metallurgist, materials science or mechanical engineering graduate who, during his or her university career has stumbled, or been fortuitously directed, into the welding field. It is obviously a biased view, but in the opinion of the authors, welding is one of the most exciting fields available to a young graduate. It is both vibrant and dynamic with new avenues to be explored becoming available on a regular basis. Synergic gas metal arc welding and inverter power sources, electron and laser welding, magnetic-impelled arc butt-joint welding (MIAB), robotic welding, and diffusion bonding are careers in themselves. It is difficult to identify another discipline where the range of possibilities are as diverse, broad, and exciting, and where the potentials for exploration and discovery stretch enticingly into the future.

However, enough of such esoteric digressions. This book was not written from that approach. It is intended to present the inexperienced welding engineer with some “sage” advice on some of the pitfalls awaiting in the hard commercial world that awaits. Be under no illusions; it is not sufficient to be the best theoretical welding engineer in your company. You must know how to apply that knowledge in an almost “street-wise” manner.

Welding is regarded by many employers as a “black art.” Some of this reputation has been due to welding engineers camouflaging their inadequacies, or uncertainties, with professional jargon. Telling one’s employer that the problem is one of “cracking initiated in a highly tensile stressed region of hard martensite or body centered cubic microstructure of poor crack resistance surrounded by material of similar sensitivity to crack propagation into which atomic hydrogen has diffused, and that until the diffusion rate is beneficially altered the problem will persist,” is not clear. Telling him that you have identified the problem to be “one of delayed hydrogen cracking and that increasing the preheat temperature by 25°C will resolve it” will undoubtedly raise your standing in the company — unless you have an enlightened employer who asks you why you didn’t recognize that a higher preheat was necessary in the first place.

The book is entitled “The Practical Welding Engineer.” We hope you find it to be practical. We also hope that, although you may not totally or even partially agree with its contents, you find it readable and interesting.

Good Reading

J. C. Lochhead and K. J. Rodgers

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Chapter 1

Contracts and the Role of the Welding Engineer

This may appear to be a strange starting point for a book intended to assist a welding engineer. However, it must be appreciated at an early stage that, as is common with most disciplines, decisions based on technical judgments must be tempered with economic awareness. In general, there can be several possible solutions (and hence several possible costs) for any one problem. The principle behind every commercial venture is to make a profit, and the welding engineer must always remember that what leaves the factory gates is what pays his wages. It may leave in a timely manner, and it may be of the finest quality; but it also must be profitable.

Commercial awareness usually is presented as an unessential part of the welding engineer's discipline. This thinking is misguided because in most fabrications welding plays a primary role of cost containment. If it is not right, either technically or commercially, the company's profitability will suffer. This is an aspect that still is not sufficiently recognized by many companies and engineers.

This chapter will deal with two aspects in some detail — commercial awareness, and dealing with specifications.

1.1 Commercial Awareness

This section is not intended to be a detailed study of the commercial management of a project. It is intended simply to make you, the welding engineer, aware and appreciative of the key links and actions in the chain of events that will ensure your company is fully compensated for everything it does for a client — or, conversely, receives everything it is paying for as a client.

The following subjects will be discussed:

1. What is commercial awareness?
2. Making a profit.
3. The key elements of a contract.
4. Ensuring the company is fully compensated (or receives a full service).
5. Variations and claims.

In all of these elements there are fundamental points applicable to the welding engineer, regardless of the size of the company in which he operates. They may not be instantly recognizable under the descriptions given. However, they will exist in some form, and the welding engineer should play a leading role in all these aspects.
