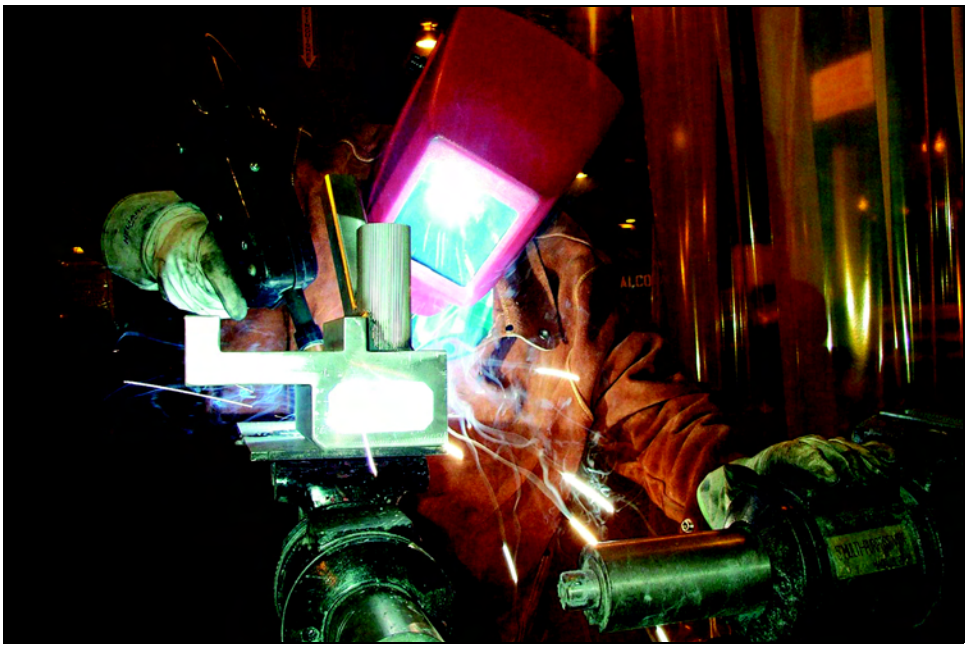
Welding Aluminum—Questions and Answers

A Practical Guide for Troubleshooting Aluminum Welding-Related Problems

by

Tony Anderson, CEng, CWEng



American Welding Society

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Reviewed by the

AWS Product Development Committee

American Welding Society

550 N.W. LeJeune Road, Miami, FL 33126

Preface

This book is largely comprised of individual Aluminum Questions and Answers that were originally published over a number of years in the American Welding Society (AWS) *Welding Journal*. The majority of the questions addressed herein originate from inquiries to me, primarily from individuals within the welding fabrication industry. Also included in this collection of material are some feature articles that I have had published previously in the *Welding Journal*. The welding processes section contains some information and parameters graciously provided by The Aluminum Association and reproduced from their outstanding publication "Welding Aluminum Theory and Practice." Many of the graphics and charts within this book have been reproduced with permission from ESAB Welding and Cutting Products and were taken from material that is used by AlcoTec Wire Corporation and ESAB Welding and Cutting Products for their aluminum welding technology training programs.

This book is not constructed in the format that is typically associated with text books pertaining to similar subjects. That is to say, because of the nature of the material source used for this book, the Aluminum Q&A columns, the individual chapters within this book have been compiled to best highlight and explain that material in a manner that reflects the original question and answer theme. For this reason the book deviates from the more traditional layout of a textbook, where typically you would see all the information on specific topics grouped together more specifically.

The idea for compiling this book originated through inquiries from individuals who followed the Aluminum Q&A column in the *Welding Journal* enthusiastically. They wondered if anyone had ever thought of collecting all the information within the Aluminum Q&A columns together into a practical guide for troubleshooting aluminum welding-related problems. I have tried to present this material in a logical format and have included a fairly comprehensive table of contents in an attempt to direct the reader to their appropriate areas of interest. If the information contained in this publication helps individuals to better understand aluminum welding and possibly assists in improving welding quality, then I will be pleased with the overall outcome.

Tony Anderson, CEng, CWEng

About the Author

Tony Anderson has 40 years of experience in the welding industry. He began his career in 1968 when he joined Vickers Shipbuilding in Barrow-in-Furness, England as an apprentice welder. While working for Vickers Shipbuilding, predominantly employed on the welding of nuclear submarines, he attended technical college for four years and received the highest qualification at that time awarded by the City and Guilds of London Institute in Welding Engineering. In his late twenties, he relocated to Southern Africa where he spent 15 years employed as a Welding Inspector, Welding Engineer, NDT Manager, Quality Assurance Manager, and Welding Engineering Consultant.

Anderson has also spent 15 years in the U.S. During this time he has been actively involved with aluminum welding technology. He was employed by AlcoTec Wire Corporation where he held the position as Technical Director before being transferred to ESAB Welding and Cutting Products as Corporate Technical Training Manager—ESAB North America.

Mr. Anderson is the Chairman of the Aluminum Association Technical Advisory Committee for Welding and Joining and is associated with the following AWS Committees:

AWS D10.7, *Arc Welding of Aluminum Alloy Pipe* (Chair)

AWS A5.10, *Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods* (Chair)

AWS A5.3, *Aluminum and Aluminum Alloy Electrodes for Shielded Metal Arc Welding* (Chair)

AWS D3.7, *Guide for Aluminum Hull Welding* (Past Chair)

AWS D8.14, *Automotive and Light Truck Weld Quality—Aluminum* (Past Chair)

AWS D1.2, *Structural Welding Code—Aluminum* (Vice Chair)

AWS Conference Committee (Vice Chair)

Anderson has a Master of Science degree in Industrial Engineering Management and Quality Assurance and a Bachelor of Science degree in Welding Engineering. He is a Professional Member of The British Welding Institute (TWI) and a Registered Chartered Engineer (CEng) with the British Engineering Council (EC–UK). He is an American Welding Society Certified Welding Inspector (CWI), Certified Welding Educator (CWE), and Certified Welding Engineer (CWEng). He has had numerous technical articles relating to welding engineering published in many journals and magazines over the years and has presented technical papers internationally at many conferences and seminars. In 2004 Anderson was awarded the American Welding Society's "Individual Achievement Award" in recognition of excellent service to the advancement of the image of welding.

Table of Contents

Section **Page**

Section **Page**

Section **Page**

Section **Page**

Section **Page**

Section **Page**

Section **Page**

List of Questions

Question **Page**

List of Tables

List of Figures

Figure **Page**

Figure **Page**

Basic Safety Precautions

Burn Protection. Molten metal, sparks, slag, and hot work surfaces are produced by welding, cutting, and allied processes. These can cause burns if precautionary measures are not used. Workers should wear protective clothing made of fire-resistant material. Pant cuffs, open pockets, or other places on clothing that can catch and retain molten metal or sparks should not be worn. High-top shoes or leather leggings and fire resistant gloves should be worn. Pant legs should be worn over the outside of high-top shoes. Helmets or hand shields that provide protection for the face, neck, and ears, and a head covering to protect the head should be used. In addition, appropriate eye protection should be used.

Electrical Hazards. Electric shock can kill. However, it can be avoided. Live electrical parts should not be touched. The manufacturer's instructions and recommended safe practices should be read and understood. Faulty installation, improper grounding, and incorrect operation and maintenance of electrical equipment are all sources of danger. All electrical equipment and the workpiece should be grounded. The workpiece lead is not a ground lead. It is used only to complete the welding circuit. A separate connection is required to ground the workpiece. The workpiece should not be mistaken for a ground connection.

Fumes and Gases. Many welding, cutting, and allied processes produce fumes and gases which may be harmful to health. Avoid breathing the air in the fume plume directly above the arc. Do not weld in a confined area without a ventilation system. Use point-of-welding fume removal when welding galvanized steel, zinc, lead, cadmium, chromium, manganese, brass, or bronze. Do not weld on piping or containers that have held hazardous materials unless the containers have been inerted properly.

Compressed Gas Cylinders. Keep caps on cylinders when not in use. Make sure that gas cylinders are chained to a wall or other structural support. Do not weld on cylinders.

Radiation. Arc welding may produce ultraviolet, infrared, or light radiation. Always wear protective clothing and eye protection to protect the skin and eyes from radiation. Shield others from light radiation from your welding operation. The use of filtering masks or airline respirators will be required if it is determined that personnel are being exposed to excessive pollutants.

Additional information on welding safety may be obtained from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126. ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, and the AWS *Safety and Health Fact Sheets* are available online and free of charge on the AWS website: http://www.aws.org/technical/facts/.

Chapter 1
The Advancement of Aluminum within the Welding Fabrication Industry and its Many Product Design Applications

1.1 Introduction

When we consider the advancement of aluminum within the welding fabrication industry, it becomes clear that there is a definite need for a better understanding of how to weld this material.

As aluminum welding fabrication has advanced, there have been many questions to answer associated with the welding of this material.

This introduction is intended to point out just a few of the many applications where aluminum is used in the welding fabrication industry today.

The first commercial applications of aluminum were novelty items such as mirror frames and serving trays. Cooking utensils were also a major early marketed product. In time, aluminum grew in diversity of applications to the extent that virtually every aspect of modern life was directly or indirectly affected by its use.

Today, aluminum's unique characteristics of light weight, high strength, high toughness, extreme temperature capability, versatility of extruding, excellent corrosion resistance, and recycling capabilities make it the obvious choice of material by engineers and designers for a variety of welding fabrication applications.

1.2 Automotive Industry

Perhaps the most dynamic advancement of aluminum welding fabrication today is within the automotive industry. Promoted primarily through environmental issues such as increased fuel efficiency, corrosion resistance, and recycling, we are seeing more and more components manufactured in aluminum appearing within the average automobile.

Recent developments of major structural components fabricated entirely from aluminum such as engine cradles, front and rear suspension frames, drive shafts, and wheels are complementing the more traditional nonstructural components such as heat exchangers, radiators, and air conditioning units (see Figures 1.1, 1.2, and 1.3). Many of these welded structural components are manufactured using 6xxx series base alloys, making use of this material's ability to produce complex extruded shapes and