

# **Locating Buried Utilities:**

A PROFESSIONAL APPROACH

BY

JEFF AMBROSE MITCHELL

CHRISTOPHER KOCH

**Second Edition**



## FOREWARD

Like postal workers, locate technicians are expected to “deliver” in rain, sleet and snow. They work on city streets, state highways, residential neighborhoods, business districts, airports, railroad terminals, military bases, inside manholes, across farmland, lakes, rivers, mountains and deserts. In fact, locate technicians can be found in just about every urban, suburban and rural setting imaginable because there are more buried utility lines out there than most people realize.

There are laws governing property rights, safety restrictions limiting access and federal regulations for military bases and airports that affect how a technician performs the job. Although the technician needs access to almost every kind of property in existence, he also needs to be aware of, and respect, private property rights. A technician may need access to airport or railroad property, but she needs to understand that these areas have rules that can be very strict. Even utility operators can have restrictions on high profile utility lines or buildings. There are standards and best practices for marking utilities, covering everything from the color to the shape of the mark (although these marks can vary from company to company and region to region).

Locate technicians are employed by utility companies, municipalities, contract locating companies, private locating firms, engineering firms and, more and more frequently, excavation companies. Each employer is likely to have specific objectives, requirements and expectations for the position.

These three factors, location, regulation and employer all combine to create widely divergent practices and terminology. It would be impossible to cover all variations in restrictions, regulations and procedures affecting the technician in a single source. For this reason, compiling information for inclusion in this textbook was challenging. Every effort was made to be inclusive. In the development of this text, we relied on commonly accepted methodology and practices, although regional variations are included when appropriate. Appropriate technical terms are used rather than regional jargon. I believe this book marks a first-of-its-kind effort within the field of underground utility locating; a comprehensive look at all facets of electromagnetic underground utility locating with the most common electromagnetic locate equipment in use today: the transmitter/receiver with separate peak/null modes.

Diligent readers may discover errors or omissions throughout these pages; just as those skilled in the art and science of underground utility locating may find they hold a difference of opinion on specific points subtle or substantial. I welcome any corrections, criticisms or suggestions you may have for possible inclusion in future editions. Please send all correspondence to:

**Jeff Ambrose Mitchell**  
*[jambrosemitchell@gmail.com](mailto:jambrosemitchell@gmail.com)*



## ABOUT THIS BOOK

The intent of this textbook is to provide a comprehensive analysis and general instruction of key topics and issues within the field of underground utility locating.

Readers are encouraged to utilize other resources noted within the text and to familiarize themselves with their employer's processes and procedures, Common Ground Alliance's most current Best Practices (available free at <http://www.commongroundalliance.com/best-practices-guide>), state One Call laws and the manufacturer's operating instructions for any equipment used in performance of the jobs. Where discrepancies exist between this textbook and an employer's policies and procedures, current CGA Best Practices, actual One Call statutes or manufacturer's operating instructions for locating equipment, those materials should supersede this text.

## ACKNOWLEDGEMENTS

Most locate technicians rely on three sources to do their job: 1) A well-thumbed photocopy of the instruction manual for the equipment being used, the only real source of information on the technical aspects of locating. 2) Utility technicians who could provide specific information regarding the utility on which the locate technician must perform his duties. 3) Other locate technicians who could provide not only advice and knowledge based on years of experience in the field, but could also understand and commiserate regarding the challenges and obstacles facing the technician in the field. The purpose behind crafting this textbook was one of need. There simply was nothing else out there.

A project of this magnitude is one that develops over the course of a career; with the help and input of all of the people who were a part of the learning process. Each of them helped contribute to this book to some degree and helped increase the accuracy and scope of the content. My thanks and deepest appreciation are extended to all of them, too numerous to list here, who in some way shared their knowledge and experience with us.

Special thanks are extended to the following people. As a group they represent a wide variety of praise, criticism, knowledge, advice, corrections and encouragement in the development of this manuscript: Mark Benner, Utility Mapping Services, Inc.; Troy De Souza, Sensors & Software; David Dodd, Pipehorn; Bob Ebberson, Schonstedt Instrument Company ; Drew Greer, SPX Radiodetection; Ellen Hamburger, Ditch Witch; Rod Kent, Utility Mapping Services, Inc.; Jeri Lamerton, Subsite; Bill Lovdahl, Utility Mapping Services, Inc; Peter Mann, SPX Radiodetection; Lisa Miller, Utah Department of Transportation; Ron Peterson, Peterson-Baker, LLC; John Rippingale, Hollow Tree; J. Scott Racki, NorthWestern Energy; Denise Watkins, ELM Locating; Corey Willson, 3M.



---

# Contents

---



## **FUNDAMENTALS OF THE INDUSTRY / 2**

THE LOCATE TECHNICIAN / 3

THE ONE CALL SYSTEM / 23

UTILITY MARKINGS & PRINTS / 33

SAFETY / 52



## **LOCATING PRINCIPLES / 68**

ELECTROMAGNETIC THEORY / 69

THE INSTRUMENT / 83

LOCATING PROCEDURES / 102



## **COMMUNICATION CABLE UTILITIES / 122**

TELEPHONE SYSTEMS / 123

TELEPHONE CABLE CODES / 151

FIBER, COAXIAL & TOWER SYSTEMS / 179



## **ELECTRIC CABLE UTILITIES / 216**

ELECTRIC POWER SYSTEMS / 217

TRAFFIC SYSTEMS / 245



## **PIPE UTILITIES / 270**

NATURAL GAS SYSTEMS / 271

PRESSURIZED WATER SYSTEMS / 297

GRAVITY SYSTEMS / 325

PIPES / 343



## **REFERENCES AND RESOURCES / 360**

TOOLS & TECHNOLOGY / 361

COMMON TERMS / 377

ACRONYMS & ABBREVIATIONS / 393

RESOURCES / 401

BIBLIOGRAPHY / 411