TECHNICAL TRAFFIC CRASH INVESTIGATORS' HANDBOOK

ABOUT THE AUTHOR

R. W. (Bob) Rivers is a graduate of Northwestern University Traffic Institute's traffic accident investigation and police management training programs. He completed training with the Canadian Institute of Science and Technology in technical mathematics and areas of physics, studied psychology at the Okanagan Regional College, completed police administration training programs through the Canadian Police College and the University of Minnesota, and patrol management with the IACP. He developed the traffic accident investigation and traffic law enforcement training programs of the Royal Canadian Mounted Police and course training standards for the Canadian Police College, University of Alberta, and the British Columbia Institute of Science and Technology in technical traffic accident investigation. During his 33 years service with the Royal Canadian Mounted Police, Inspector Rivers was employed extensively in general police work, highway patrol, accident investigation, research and planning, and training and development. Since his retirement, Inspector Rivers has authored various internationally-recognized textbooks, acted as a consultant and has assisted in traffic accident investigation training and research studies on an international basis. Since its establishment, he worked for many years as an adjunct faculty member and director of correspondence training with the Institute of Police Technology and Management (IPTM), University of North Florida (<http://members.shaw.ca/mudrivers>).

Third Edition

TECHNICAL TRAFFIC CRASH INVESTIGATORS' HANDBOOK

(Level 3)

A Technical Reference, Training, Investigation and Reconstruction Manual

By

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With a Foreword by

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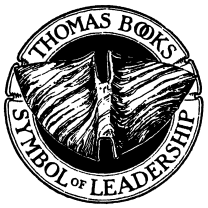
Reconstructionist and Author



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to my wife, Astrid

FOREWORD

Back in the day before traffic accidents became traffic collisions, I went through months and weeks of training at various schools to learn the business/science/art of accident reconstruction.

The first book on this topic that I possessed covered many facets of accident investigation (AI) and reconstruction (AR), from the basic at-scene material to technical AI information to a bit of actual AR how-to instruction. It was J. Stannard Baker's *Traffic Accident Investigation Manual* (The Traffic Institute, Northwestern University, Evanston, IL, 1st ed., 1975). Baker's tome was the textbook for the "long course" I took at the then "Traffic Institute" in 1976–77.

The first exclusively AR book that I became aware of was *Handbook for the Accident Reconstructionist*, written and self-published by Myron (Mike) Lofgren. This book was the workhorse textbook that got me through Lofgren's two-week recon course in Minnesota in 1980. With all the training and book learning I thought I really knew about accident reconstruction. Wrong!

In 1981, along came *Traffic Accident Investigators' Book of Formulae and Tables* and *On-Scene Traffic Investigators' Manual*, (Charles C Thomas, Springfield, IL), both by R. W. (Bob) Rivers. A couple of years later, here comes *Traffic Accident Field Measurements and Scale Diagrams Manual.*

I wondered, who is this Rivers guy? He really knows his stuff. I wanted to meet him in person. Perhaps some of his AR skill would rub off on me. As luck would have it, I had the good fortune to meet Bob Rivers at the Institute of Police Technology and Management (IPTM) at the University of North Florida back in the middle '80s. Each year, IPTM's seminar, Special Problems in Accident Reconstruction, attracts accident reconstructionists from all over the country – and from outside the United States. As luck would have it, that included Canada.

Since our meeting, I've gotten to know Bob well enough to call him a friend. I've been privileged to have my reviews published for many of his books from *Traffic Accident Investigators' and Reconstructionists' Book of Formulae and Tables* (1999) and *Traffic Accident Investigator's Lamp Analysis Manual* (2001) to *Basic Physics* (2004) and *Evidence in Traffic Crash Investigation and Reconstruction* (2006), all published by Charles C Thomas.

Bob travels around the world (United States, Canada, various European countries and throughout the Mediterranean) doing research for his assorted publications. His books are being made available by the publisher to 80 countries. His 1995 work, *Training and Reference Manual for Traffic Accident Investigation*, second edition (Institute of Police Technology and Management, Jacksonville), was translated into Japanese and consideration is being given to further translations into Arabic and Spanish.

In 1980, Bob Rivers wrote *Technical Traffic Accident Investigators' Handbook*. It was the first tome of its kind and it caused many investigators to comment that they did not know what "accident" investigation was all about until they read this manual.

Rivers kept the title for his second edition in 1997. However, for this edition, he switched the term "accident" to "crash" to, (quoting Mr. Rivers) ". . . meet contemporary thinking on the subject." While the second edition had a number of updates, this one has even more, including many new photographs that explain in greater detail the investigation and reconstruction examples that were contained in the second.

If you're new to Crash Investigation, or an old hand who thinks you know everything there is to know on the subject, Bob Rivers has probably forgotten more about the topic than most of us will ever know. You can, however, keep up with what is current on the subject and be reminded of some basics that may have fallen out of your memory banks by enjoying Bob Rivers' latest creation. (By the way, I still call them "accidents.")

Joseph E. Badger

PREFACE

This revised third edition of the *Technical Traffic Crash Investigators' Handbook* (previously published under the title of *Technical Traffic Accident Investigators' Handbook*, second edition) has been prepared to meet the requirements of Level III (technical or advanced level) researchers, trainers and investigators, and reconstructionists. Included in the text is an overview of Levels I and II (basic and secondary at-scene and secondary follow-up crash investigation procedures), with advancements covering the technical level of investigation and an in-depth introduction to Level IV (reconstruction) investigations.

This revised edition is intended to serve as a reference source for students, educators and investigators in regard to the principles and techniques involved in advanced traffic crash investigation. Many of the chapters and topics appear in the previous edition, but they are now given a contemporary treatment to reflect current practices.

Each chapter provides clear definitions of and statements about the topics it contains, with graduated sets of solved problems arranged so as to present a natural development and understanding of the subject matter. As such, it is no mere condensation of ordinary text material but rather a comprehensive approach to technical traffic crash investigation through problem solving.

The handbook covers (in both written and illustrative form) those situations that confront the investigator conducting technical or advanced training and investigations. Upon proper application of the material presented, the reader should be able to investigate and testify with confidence in all the segments of Level III investigation set out in the contents pages and to conduct an accident cause analysis.

There are many other textbooks that the reader may wish to consult in order to increase his or her knowledge in the total traffic crash

investigation field. These should include the many applicable areas of physics, psychology, and vehicle mechanics – many titles of which can be found in the "Bibliography and Recommended Reading for Further Study" pages at the end of the handbook. This list is also recommended by the author as works that should be considered by the practitioner for acquisition to form part of a reference library.

Continuing the practice followed in previous editions, all mathematical references and examples are worked out in both the United States (Imperial) and the SI (metric) systems. In many of the problem examples, exact conversions from United States to the SI system are not made in order to avoid unnecessary use of multiple decimal places in the latter. The corresponding values that appear in these cases should therefore be considered approximations. To assist the reader, however, examples are worked out separately for each system and should be treated as independent of each other to avoid confusion. For persons wishing to make precise conversions from one system to the other, conversion factors and constants will be found in Appendix A.

In the preparation of this handbook, it is recognized that at present, English does not have a third-person singular personal pronoun that can be used to refer to someone of either gender. While several methods purporting to overcome this deficiency are in vogue, they tend to be either cumbersome or restrictive and are often grammatically annoying to readers of both genders, particularly when applied in a lengthy text covering many diverse topics.

It is hoped that the degree to which these subjects are covered in this work will stimulate further research and study which, with application of the principles and techniques presented here, will enable the reader to acquire an even higher degree of professionalism in the traffic crash investigation field.

In some cases, the third-person masculine singular pronoun forms *he*, *his*, *him* are used in the text to refer to a person of either gender. However, such use is in no way intended to suggest that vehicle crash investigation is the exclusive preserve of men or that women are less adept than men in this field. It is appreciated that there are a great number of women investigators, and the author asks their understanding in regard to the sometimes-grammatical usage in the text.

R.W.R.

DISCLAIMER

Various recent and recognized published books and papers have been studied, conferences attended, and participation in many field tests have been made in the preparation of this revised handbook. The information and practices set out herein are, to the best of the author's knowledge, experience and belief, the most current and accurate in the traffic crash, investigation and reconstruction profession. However, the author, publisher, and editors expressly disclaim all and any liability to any person, whether a purchaser of this publication or not, as a consequence of anything stated, done or omitted to be done, whether in whole or in part by such person in reliance upon any part of the contents of this publication. Every acceptable procedure may not be presented herein, and some of the circumstances of a given case may require additional or substitute procedures.

The views, policies and procedures expressed or implied in the handbook are not necessarily those of the Royal Canadian Mounted Police, the author's former employer. Also, since statutes, ordinances, and organizational policies and procedures differ widely in various jurisdictions, those of the particular jurisdiction should govern when there is any conflict between them and the contents of this handbook.

ACKNOWLEDGMENTS

I wish to acknowledge with thanks the permission granted by the Director, Institute of Police Technology and Management (IPTM), University of North Florida, and authors, to use selected IPTM training materials as references in the development of this revised handbook, and in selected cases, for inclusion in the handbook. Most particularly, from works prepared by John Daily, Wiley Howell, Mike Lofgren and Butch Kennedy, as well as from IPTM materials prepared by the author of this handbook.

I wish also to acknowledge my gratitude to Francis P. D. Navin, Ph.D., P. Eng., Vancouver, B.C.; Dr. R. C. Hodge, Institute of Police Technology and Management, University of North Florida; and reconstructionist Eric Brewer for their encouragement and helpful and detailed suggestions regarding this revision.

A special thanks is extended to Roberta Baranyai, Computer Systems Analyst, and to Deanne Rivers, RN (operating room specialist) for their professional input in specifically-related areas of this manual.

Additionally, I wish to acknowledge with thanks for the many photographs supplied for research purposes, with permission to reproduce, by:

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CONTENTS

TECHNICAL TRAFFIC CRASH INVESTIGATORS' HANDBOOK

Chapter 1

INTRODUCTION TO TRAFFIC CRASH INVESTIGATION

ACCIDENT DEFINED

1.001 Webster defines an *accident* as an undesirable or unfortunate happening, unintentionally caused and usually resulting in harm, injury damage or loss.[1] However, in unfortunate happenings or mishaps involving vehicles and pedestrians, common usage and understanding of the term *accident* by investigators, the news media, and in many traffic engineering and other professionally prepared textbooks, as well as by schools teaching the investigation of vehicle mishaps, give the word a much broader meaning. In a contemporary sense, when related to a traffic mishap, it can be said that the word *accident* implies that when a series or sequence of events fall into place, whether intentionally or unintentionally, an unfortunate happening occurs that usually results in harm, injury, damage and/or loss.

TRAFFIC ACCIDENT, CRASH AND RECONSTRUCTION DEFINED

1.002 For the purposes of traffic accident investigation and reconstruction, the term *traffic accident* is defined as follows:

> A *traffic accident* is "*that occurrence* in a series of events which usually produces *injury*, *death* or property *damage*."

Also, for the purposes of this Handbook, the term *traffic crash* is synonymous with the terms *accident*, *collision*, and *incident* or any other similar, applicable term used in various jurisdictions and in many published works. Many departments now use the term *crash* to the exclusion of other terms. For the purposes of this manual, however, the term *accident*, which has been a mainstay in the traffic crash investigation and reconstruction fields for many years, will be used most often to describe the event. The investigator should be aware of this and be prepared to use either term interchangeably in order to meet local jurisdictional policies, dictates or legislative requirements.

SERIES OF EVENTS

1.003 An investigator should be familiar with the various events that make up a traffic accident and ensure that the investigation covers all those events. For the purposes of traffic accident investigation, these various events are referred to as the *series of events.*

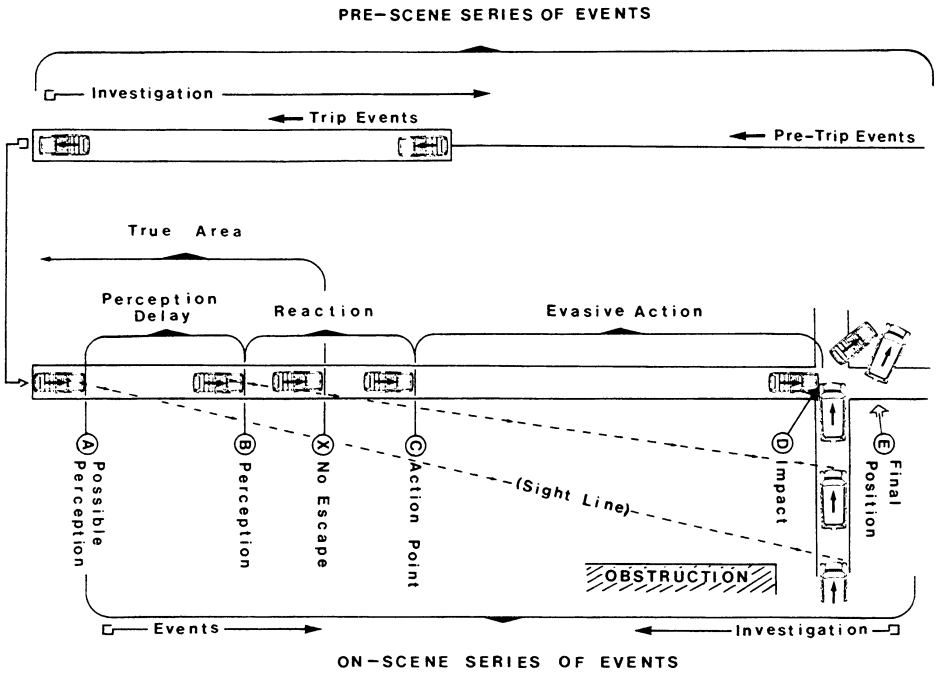

Figure 1–1.

Series of Events Defined

1.004 For the purposes of traffic accident analysis, the *series of events* for a traffic accident includes *situations* that are in place or may at any time arise, all of which may be divided into two distinct categories:

1. *Pre-Scene Series of Events.* The events that lead up to the driver's point of possible perception of a hazard.
2. *At-Scene Series of Events.* The events that occur within the on-scene area, including the point of possible perception.

1.005 The *pre-scene series of events* can be further divided into two areas, namely (1) pre-trip events, and (2) trip events.

1. *Pre-trip events.* Generally, those events that occur *before* and include situations that exist *before* the trip is started. They may be considered as backgrounds of the driver and vehicle. Examples of pre-trip events and situations are:

   Driver
   a. Driver experience
   b. Driver training
   c. Intelligence
   d. Alertness
   e. Reaction
   f. Habits
   g. General health condition, including age, an illness and permanent or temporary injury or disability
   h. Fatigue
   i. A happening that. caused emotional upset, stress, depression or preoccupation
   j. Attendance at a party
   k. Limited sleep or no sleep
   l. Consumption of alcohol or drugs

   Vehicle
   a. Defective headlights, steering, brakes, windshield wipers, tires, etc.
   b. Overloaded

As the trip is made, many of these pre-trip events or situations may carry on into the *at-scene series of events*, e.g., a situation such as the dri-