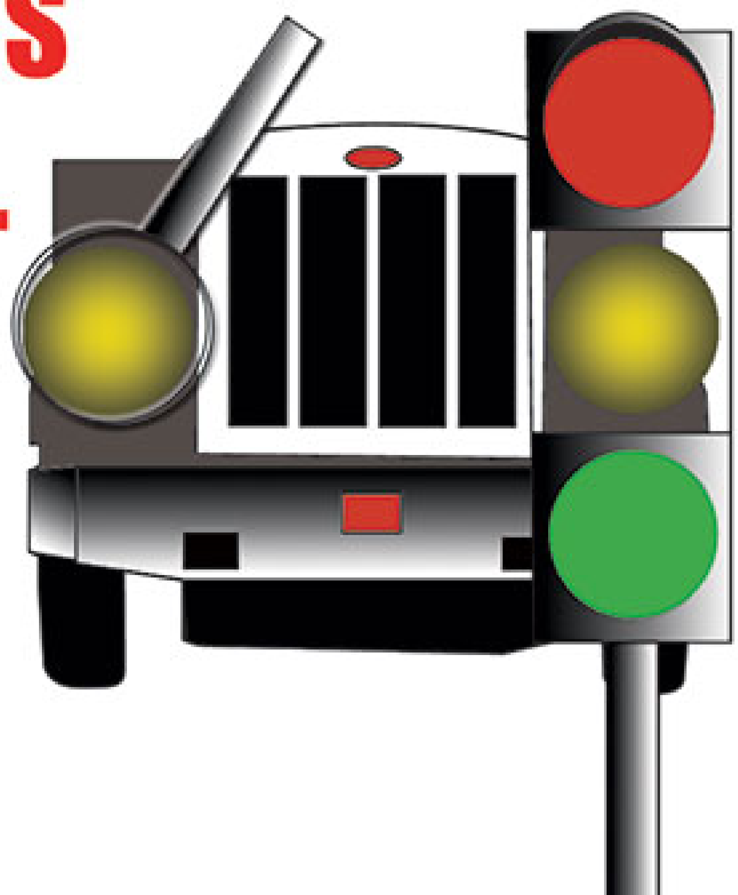
TRAFFIC ACCIDENT INVESTIGATORS' LAMP ANALYSIS MANUAL



By

R. W. RIVERS

and

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PREFACE

For many years, the majority of traffic accident investigators and reconstructionists have had a responsibility to determine vehicle lamp status for *on* and *off* conditions at the time of a vehicle collision. For the purposes of overall professionalism in the field, it is essential that these investigators be well-trained and proficient. This includes knowing what evidence to look for, how to gather and protect such evidence, and the assistance that can be provided by qualified technicians or analysts who are properly trained and experienced in lamp examinations.

This manual has been prepared to help investigators and analysts meet the high standard of performance and expertise expected of them. It has been designed not only for use as a handy reference manual, but also to be of assistance as a training manual for use in the various police training schools that teach lamp examinations as part of their curriculum or as a special topic in their various field training programs.

Each chapter provides clear definitions of and statements about the topics it contains, with graduated commentary arranged so as to present a natural development and understanding of the chapter subject matter. A number of working hypotheses using examples and photographs have been prepared with the view to assisting the examining technician or analyst in the interpretation of items of evidence that might be presented. As such, it is no mere condensation of ordinary text material but rather a comprehensive approach to determining lamp status at the time of a vehicle collision.

Various international research materials and publications have been referenced and studied, and many laboratory tests have been carried out in the preparation of this manual. Chapter references list several of these works.

In the preparation of this manual, it is recognized that at present, English does not have 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.

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 the subject matter is the exclusive preserve of men or that women are less adept than men in this particular 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.

The successful use of this manual is based upon the supposition that the reader has experience equal to or has completed at least a recognized basic traffic accident investigation course, such as those offered by the Institute of Police and Technology and Management, University of North Florida, or the Traffic Institute, Northwestern University, or offered by police in-service training programs.

R.W.R.

CAUTION TO INVESTIGATORS AND ANALYSTS

Halogen lamps belong to the incandescent lamp family. Special high-temperature fused silica glass or quartz glass enables halogen lamps to be operated at high wattages and to produce a very high light output from a small lamp package. The lamps are filled to high internal gas pressures to maximize lamp efficiency. The filament tubes (or bulbs) used in all halogen-cycle lamps generate intense heat, are pressurized, and could shatter if scratched or damaged, resulting in flying fragments. Some contaminations transferred to a halogen bulb, such as oils from the hand or fingers during handling, may contribute to the bulb exploding should it be later energized. The reason that surface contamination must be avoided is that fused silica is thermodynamically metastable. Given suitable nucleation sites for the reaction, at elevated temperatures, fused silica transforms to one of silica's crystalline forms, which include quartz, cristobalite, trydimite, and more. In the transformation, the structural integrity is lost and the lamp leaks or bursts.

Recommendations suggested by industry include:

A. Use appropriate protection to avoid risk of injury when examining, removing , handling, or disposing of all halogen bulbs.

B. Switch power off before removing a bulb, and allow the lamp to cool.

C. Use appropriate screening techniques to protect people and surroundings. Do not operate in close proximity to persons, combustible materials, or substances affected by heat or drying.

D. Wear protective eyeglasses and clothing when handling lamps. Lamps may shatter and exposure to ultraviolet output may cause eye and skin irritation.

E. Protect bulb against abrasion or scratches and against liquids when lighted.

F. Grasp the lamp or bulb with a cloth or glove during removal from or installation in a tight-fitting socket.

G. Wash hands after handling broken lamp.
H. Do not consume food or drink in the immediate work area.
I. Use eye protection to look at lighted headlamps or any other bright bulb or lamp. The intensely bright light from powerful bulbs or lamps can cause eye damage. Precautions similar to that necessary to look at the bright sun should be taken. Eye protection includes such things as welder's goggles and dark photographic film.

It is recommended that investigators and analysts pay particular attention to the many safety recommendations contained throughout the manual.

ACKNOWLEDGMENTS

I wish to acknowledge and extend my sincere appreciation to Professor Frederick G. Hochgraf, P.E., for the time and effort he gave in reviewing the original manuscript, and for the many and varied recommendations he made regarding the preparation of the final manuscript.

I wish also to acknowledge with thanks Wade Bartlett, P.E., Rochester NH, for his reviews of the original manuscript and the first printing of this manual and the suggestions made for amendments to this work, and to the following traffic accident investigation specialists for their time, effort, and dedication in obtaining and making available for this manual the several hundred photographs received, all of which were used for research purposes and in many cases, with their individual permission, reproduced in the manual. In many cases, an excellent photograph was received from one investigator that was duplicated by other investigators. Therefore, in recognizing this, it was decided to not acknowledge in the manual individual photographs. However, without the kind assistance of each and every one of these specialists, this manual could not have been developed.

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DISCLAIMER

Various published works and technical papers have been studied, consultations with experts in this field have taken place, and participation in many field tests made in the preparation of this manual. The information and practices set out herein are, to best of the authors' knowledge, experience, and belief, the most current and accurate in the traffic accident investigation and reconstruction profession. However, the authors, contributors, 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. 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 book.

CONTENTS

TRAFFIC ACCIDENT INVESTIGATORS' LAMP ANALYSIS MANUAL

Chapter 1

INTRODUCTION TO LAMP EXAMINATION AND ANALYSIS

LAMP ANALYST

1.001 For the purposes of this manual, the term *analyst* includes a *laboratory technician* or any *other person* who through training and experience is or can be qualified as an *expert witness* in a court of law for the purposes of lamp examination and analysis.

THE FILAMENT LAMP

1.002 The filament lamp is today's most commonly used source of illumination. Illumination occurs when a electrical current is passed through a very fine wolfram (*tungsten*) coiled wire, or filament, placed inside a glass bulb in which there is either a vacuum or a filling of some inert gas such as nitrogen. This prevents the burning-through of the filament. The function of the current is to raise the temperature of the filament to around 2,500°C where it becomes white hot. The tungsten material used for the coil has different hot and cold properties, and reacts differently to shock, vibrations, and exposure to air. In the case of a vehicle collision, a cold filament may experience a fracture without noticeable deformation, whereas a hot or incandescent filament may become elongated or stretched.

1.003 Incandescent lamps function according to a well-known principle, which is clearly described in the book by N. Piron and L. Blanckaert entitled *Equipment Electrique* (Electrical equipment) in the series *Technique Automobile* (1) On page 127, they write:

> The transformation of electrical energy into light energy is produced, in light bulb, by passing an electric current through a fine

> tungsten filament (melting point = 3300° C) heated until it becomes incandescent. This filament is placed in a glass envelope which contains no air. It is linked by two electric leads to the base of the lamp. The base fixes into a socket which connects up with the electricity source.[1]

And at page 128:

> At present, the filament is in metal, usually tungsten, whose electric resistance is much lower than that of carbon, so that the filament must be longer and thinner and the lamp is much more sensitive to vibration. For the same consumption of energy, the light output increases with the temperature; however, this increase in temperature consumes the filament more quickly, resulting in a shortening of the bulb's life and a decrease in its light power.

FUSED SILICA OR QUARTZ GLASS HALOGEN LAMPS

1.004 In a report presented to the Canadian Society of Forensic Science (1986), Greenlay et al. stated that quartz (fused silica or quartz glass) halogen headlamps, unlike the older types of sealed beam headlamps, often have filaments oriented parallel to the forward direction of travel of the vehicle. Both compression and stretching of filament coils may be observed when vehicles equipped with quartz halogen headlamps are involved in collisions. The conditions under which these distortions occur have been studied by conducting impact tests on quartz (fused silica or quartz glass) halogen lamps under known conditions of velocity, illumination, and impact angle. The results show that filament coil compression distortion was produced by the *head-on* impact of illuminated filaments, whereas coil stretching distortions were produced by impact of illuminated filaments at any angle. Further, if impact forces are of sufficient magnitude, an illuminated filament in an intact quartz halogen lamp can break.[2]

FILAMENTS

1.005 A filament is made of tungsten wire, bright in color, manufactured in the shape of a small, tight, somewhat evenly-spaced, smooth coil, secured at each end into steel wire supports. *During the filament manufacturing process, the filament's crystalline aspects (crystallization) are modified to allow for the fine, thin wire that is needed for filament* *structure.*[3] In some lamps, the filament has one or more supports between terminals. In most lamps, the tungsten coil goes straight across from one support to the other. In some lamps, particularly very small lamps, the filament is formed in the shape of an arc or curve. Some lamps have two filaments. Each filament is generally to serve a different purpose. For example, one filament may be for a taillight, the other for a brake light or turn signal.

1.006 The halogen lamp operates on a regenerative cycle in which tungsten, evaporating from the filament, reacts with halogen vapor in the vicinity of the fused silica or quartz glass walls. The compound formed is decomposed near the filament, resulting in redeposition of the tungsten. For this cyclical reaction to occur, the filament must heat the walls to over 250°C. Thus, the bulb must be small in order for the walls to be heated sufficiently, and the walls must be thick to withstand the high temperature and pressure.

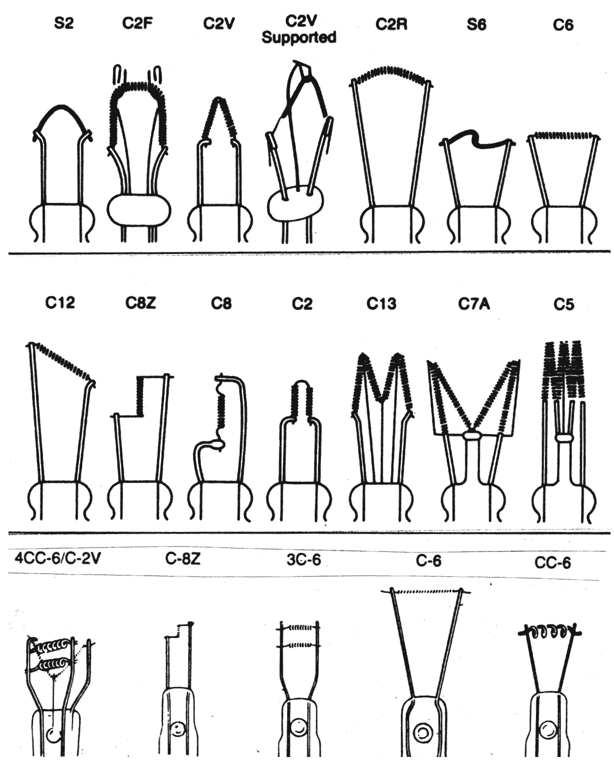

Figure 1-1. Design features and configurations of various filaments. Filaments may be straight wire, a coil, or a coiled coil (indicated by the letters S, C, and CC respectively), and may run straight between posts or may be arched. Additional configurations and designations may also be found with individual manufacturers.