# AN INTRODUCTION TO ELECTROSTATIC MEASUREMENTS

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# INTRODUCTION TO ELECTROSTATIC MEASUREMENTS

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**PREFACE**

I have had an involvement with static electricity for over 50 years, on and off. Over the last 20 years or so I have been involved full time in running my own company, John Chubb Instrumentation, whose business is electrostatic measurements. Over the years and a variety of experiences I have developed an appreciation of ways to think about and tackle questions that arise in relation to static electricity. Much of this has been a personal view. I have presented and published a number of papers on the work I have done and written quite a number of reports for commercial clients. I have also tried to influence the course of events via presentation of papers and drafting of Standards. I have felt that the problems I have faced and the results of trying to deal with questions that arise in electrostatic measurements may well be of interest and help to people who find a need to develop an interest in static electricity as well as those already involved. I have therefore tried to bring together my thoughts and experience on electrostatics and to present these in a way that will be helpful. As I say, this is a personal view – the way I have found that matches my appreciation of how the world works and my practical experience. This is not aimed to be an academic treatise or a balanced comparison of work in the field!

My involvement in electrostatics started with the work for my PhD thesis in the Electrical Engineering Department at University of Birmingham. I gained a degree in Physics at Birmingham in 1954. I had expressed the view (in an interview of four final year students for BBC TV) that I did not want to go into research but 'wanted to do something useful'! However, when I was approached by Jim Higham from the Electrical Engineering Department it seemed there was a project that would be both interesting and also useful. The project was to explore the proposal that had been made by Bill Bamford (of British Cast Iron Research Association, at Alvechurch) to Jim Higham that if one took a stream of dusty air, split it into two halves, charged one half positive and the other negative then after combining them the oppositely charged particles would agglomerate and be collected with usefully enhanced efficiency in a cyclone type dust collector. Once I started work it was very soon evident that if was difficult to electrostatically charged airborne particles without electrostatically precipitating them! It was also evident, in those days before computers, that it was not feasible to do any sensible mathematical modeling of agglomeration. The work then turned to examining the factors that affected the process of electrostatic precipitation – and much of the thesis was concerned with the approach I developed for observing and analyzing the relative influence of electrostatic and aerodynamic (ionic wind) forces on the behaviour of individual airborne particles. Despite the frustrations of research I found I had enjoyed meeting the challenges of developing ways to make observations and measurements in real situations and to analyse and assess the results.

I then spent quite a time away from electrostatics. After a Graduate Apprentiship at English Electric in Stafford I was involved in the development of high power vacuum circuit interrupters (over 10,000A at over 10,000V). After moving to the UKAEA Culham Laboratory in 1962 I investigated and developed liquid helium cooled cryopumping for the high performance high vacuum pumping of large quantities of hydrogen for the controlled fusion studies at Culham. In 1967, and during the following year, there were explosions on a number of the new very large crude oil tankers (VLCCs) during the time they were cleaning their tank by washing with high pressure water jets. These explosions caused massive damage and loss of one tanker. Bob Carruthers, head of the Applied Physics Division, suggested that as I had some experience in electrostatics surely I could surely contribute to solving the problem! This led to quite a major involvement in the international investigation into the causes of the problem. My contribution was development of instrumentation and approaches to observe the electrostatic conditions

created in cargo tanks of tankers during tank washing operations and with radio detection, linked to triggered flash photography, to understand the conditions associated with the occurrence of spark type electrostatic discharges. These studies were carried out during a number of tanker voyages.

My other main electrostatic project at Culham was development of a novel monitor for airborne fibres – aimed in particular to provide opportunity for portable on-site assessment of asbestos risks. This involved use of electrostatic forces to align fibres with scattering of laser illumination to detect and size classify fibres selectively.

After I left Culham in 1978 I worked for a couple of years on computer typesetting at Linotype Paul in Cheltenham. After being made redundant (the first of the many!) I took on the job of Managing Director at a small company, IDB, at University College of North Wales, in Bangor. This got me back into electrostatics both for developing and making instruments and for consultancy work. After 2½ years I resigned and set up John Chubb Instrumentation.

The business of JCI has been chosen to be electrostatic measurements. This has involved the development of proprietary instruments and methods of testing with manufacture and marketing as well as some consultancy work and testing of materials. A number of contributions have arisen from this work and these will become evident in the body of this book.

My experience in electrostatics, and the other areas in which I have had opportunity to work, have taught me the importance of identifying and focusing on what users and customers are trying to achieve. It has also taught me the importance of retaining an appropriately skeptical view of theory and of received ‘wisdom’ and the value of learning from experience.

**Acknowledgements**

I would like to acknowledge my debt to all the people who have worked with me over the years for their help, encouragement and support. I would particularly like to thank Ian Pollard, Len Gowland and Herbert Watson for their help while I was at Culham Laboratory and John Harbour, Peter Folland, John Miles and Katy Hand for their efforts in making the business of John Chubb Instrumentation Ltd a success. I also wish to acknowledge my debt to the UKAEA Culham Laboratory, where I worked 1962 to 1978, for the opportunities to investigate topics in depth and in an atmosphere of searching after truth without need for expediency. Finally, I wish to acknowledge all the help and encouragement given to me over the years by my wife, Patricia. Without her support this book would not have been written.

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Chapter 4: Practical electrostatic measurements 4. PRACTICAL ELECTROSTATIC MEASUREMENTS 4.1 Introduction This chapter is concerned with the use of electrostatic instruments, such as described in Chapter 3, for practical and experimental investigations and for measurements relevant to decisions on the suitability of materials and/or on the safety of situations.Â  4.2 Fieldmeter measurements Electrostatic fieldmeters are the workhorse instrument for electrostatic measurements. They provide the way to identify if, when, where and why there is an electrostatic problem. In many cases qualitative measurements are quite adequate to get a feel for where things are highly charged and to what features of an operation or activity does this charging relates. This lecture gives an introduction to measurement science and measurement systems. the lecture starts with a general overview of the course. After this, important aspects such as calibration and measurement uncertainty are explained. The structure of the measurement system is also discussed, introducing the conversion of information from the physical world around us to a usable electrical output signal, and errors that can occur in this conversion. Introduction to Measurements and Measurement Systems. Introduction to Measurements and Measurement Systems. Exercises lecture 1. Readings Measureme... on methods for calibration of electrostatic measuring instruments. Experience is described from a variety of practical studies of electrostatic problems. Discover the world's research. 15+ million members.Â  Measurements of the atmospheric electric field strength made by an electrostatic fluxmeter with a unique threshold sensitivity for such devices (6 Ã— 10â€“2â€“10â€“3 V mâ€“1 Hzâ€“1/2 in the 10â€“3â€“25 Hz frequency range) and wide dynamic (120 dB) and spectral (0â€“25 Hz) ranges, are presented. The device parameters make it possible to observe the electric component of global electromagnetic Schumann resonances and long-period fluctuations in the atmospheric electric field strength.