The Chemical Laboratory: Its Design and Operation

A Practical Guide for Planners of Industrial, Medical, or Educational Facilities

Sigurd J. Rosenlund

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Preface

It is my hope that this book will fill a gap on the technical library shelf by offering help to those involved with either planning new laboratories or expanding existing ones. It is based on over thirty years of laboratory experience, including day to day operation, design of new facilities, supervision of construction, and consultation. I have witnessed the fruits of good planning and the unfortunate consequences where planning was inadequate.

Who can profit from such a book? The supervising chemist who must define the needs of a new laboratory will find many practical suggestions. So will the administrator looking for ways to justify a facility that will not become outdated in a few years. The designer or engineer will be better able to see things from a client's viewpoint, as will the contractor in charge of certain aspects of construction. The doctor or dentist setting up a laboratory facility next to the office will discover suggestions for making the best use of limited space. The supplier of laboratory furniture and equipment will find new ways to advise his customers. Finally, the young chemist who finds himself charged with starting up a new operation will have the reference I wished for when I was in that position many years ago.

Above all, this book is intended to be a *practical* guide to laboratory planning. It will not go into the more sophisticated

areas of science and technology, Instead, it will deal with a broad variety of more common matters, some of which may be overlooked or underestimated by the laboratory planner.

Perhaps an explanation should be offered here for my use of "he" throughout the book in referring to the person in charge of daily laboratory operation. This pronoun is used in its traditional sense to refer to either a man or a woman. The newer "he or she," while more accurate, considering the many women in charge of laboratories today, is also more cumbersome and has been avoided for that reason.

I would like to thank all those who have given their time and thoughtful comments. Benjamin F. Naylor, chemistry professor emeritus of San Jose State University, read the manuscript in its early stages and contributed valuable information on educational laboratories. Alan C. Nixon, past president of the American Chemical Society, along with other members of Calsec Consultants, Inc., offered helpful suggestions from their diversified experiences. Numerous laboratory personnel guided me through their facilities, and distributors of laboratory products kept me informed about their latest products. Plumbers, electricians, and others in the building trades had many practical hints.

Finally, I would like to thank my wife, Barbara, for her encouragement, suggestions, and countless hours of editing.

January 1987 Sigurd J. Rosenlund

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Introduction

A laboratory may come in any size or shape. It may be a room in an industrial plant, a wing of a hospital, or a whole building on a college campus. All of these present similar problems and decisions at the planning stage. Where should the laboratory be located? How much space is required? Will a proposed layout contribute to smooth traffic flow? What utilities are needed? What safety factors should be built in? These are just some of the major questions planners must address.

The results of poor planning usually do not show up until a facility has been in operation for some time. By then, correcting them is invariably expensive. Anyone who has worked in a laboratory for even a short period has seen some of these problems. There may be overcrowded workbenches, where permanent equipment and set-ups leave little or no room for non-routine work, or inadequate wiring which requires the use of cumbersome and hazardous extension cords on a permanent basis. Poor ventilation is a common problem, causing both discomfort and hazards. Improperly chosen bench tops may be stained by chemicals or damaged by heat. Many laboratories have awkward traffic patterns, resulting in wasted time during performance of routine tasks. Storage areas may be inadequate or poorly located. The list goes on and on.

Many will blame such problems on lack of funds when the laboratory was built. This may not be the case. A well-planned and efficient laboratory does not have to cost more than a poorly planned one. It is mostly a matter of putting the available money to work where it counts most. This book gives many examples where money can be saved without causing operational problems later. It also presents cases where additional money spent at the outset has paid off in a safer and more efficient operation for years to come.

Who plans and builds a laboratory? In a small facility the whole job is often handled by in-house talent. I have seen many cases where such talent was capable of taking on the challenge. I have also seen numerous cases where professional assistance should have been employed. This book will help the do-it-yourselfer decide when such assistance is needed. At the other end of the spectrum, a design or engineering firm may be hired to do the job on a turn-key basis. Such a firm can guarantee professional results, but will these be specifically tailored to the needs of this particular laboratory? Examples of both underdesign and overdesign, usually resulting from poor communication between designer and client, are given.

Throughout the book, the person in charge of day-to-day operations is referred to as the *laboratory operator*. This is not an administrator or supervisor located in an office down the hall or in another building. The laboratory operator must be heavily involved in all aspects of planning. Only he can estimate space requirements, check a proposed layout for practical and safe operation, and recommend allowances for future expansion. Regardless of the amount of professional assistance available, the laboratory operator can expect to burn much midnight oil. During construction he must be available at all times to take care of those numerous problems nobody had predicted.

This book not only deals with major matters, such as laboratory size and location, layout, and utilities. It also includes seemingly minor topics, such as choice of paints and floor coverings, money saving hints for utility hookups, and types of ceiling treatment.

Safety and waste disposal are treated in detail because of their ever increasing importance.

Planning and building a laboratory requires a cooperative effort involving administrators, designers, equipment supply houses, contractors, and the laboratory operator. A laboratory designed for efficient operation can be achieved only if all of them work together with mutual respect and the best possible communication.

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Preliminary Planning

Once it has been decided that a new laboratory should be built, some important basic planning must be done. Whether or not an architect or designer is to be called in later, those in charge of the laboratory operation will need to consider questions such as these:

What types or work will be performed both initially and in the foreseeable future?

Will any of this work create special hazards?

What equipment will be required?

Will any of the work produce excessive fumes, heat, dust, or noise?

Should any of the jobs be performed in isolated areas or in separate rooms?

Will any tasks require a controlled environment?

How much room will be taken up by permanently installed equipment?

How much space will be needed for undesignated work areas?

Where should the laboratory be located relative to other facilities?

Are there any special security requirements?

Facing such questions head-on from the earliest planning stages and making notes as information is gathered will help to avoid unpleasant surprises later on.

LISTING OPERATIONS

It is important to make a list of every task that will be performed in the laboratory, down to the smallest detail. Operations such as pH measurements, transfer of flammables from safety storage to shelf bottles, or recording observations must not be overlooked. Even in a small laboratory, the number of individual tasks will be quite substantial.

Each operation on the list should then be evaluated for problems it might create and for any special requirements. These might include the following:

Hazards the operation may create and what precautions must be taken (fume hood, separate room, etc.)

Non-hazardous nuisance it may cause (odor, dust, heat, noise, steam, etc.)

Possible contamination of other work being performed.

Vibration or other disturbance of other operations.

Special environment needed (controlled temperature, clean-room conditions, absence of drafts, etc.)

Security requirements (controlled access to certain instruments or operations, etc.)

It will take time to come up with all of this information, particularly in cases where new types of work are contemplated. If