PROCESS PLANT LAYOUT

Edited by
J.C. Mecklenburgh
Department of Chemical Engineering
University of Nottingham

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Chairman

J. C. Mecklenburgh	University of Nottingham
Members	
D. Armour	Babcock Woodall Duckham
K. Banks	Norsk Hydro Fertilizers
P. J. Comer	Technica
S. D. Green	BP Chemicals
D. J. Gunn	University College, Swansea
W. G. High	ICI, Petrochemicals and Plastics Division
J. Madden	Isopipe
M. J. Marks	Humphreys and Glasgow

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LIST OF ABBREVIATIONS

American Conference of Government Industrial Hygienists	ACGIH
Acceptance quota level	AQL
Automated layout design program	ALDEP
Boiling liquid expanding vapour explosion	BLEVE
Computer aided design	CAD
Computerized relationship layout planning	CORELAP
Computerized relative allocation of facilities technique	CRAFT
Cathode ray tube	CRT
Critical path analysis	CPA
Design code allowable	DCA
Emergency exposure limit	EEL
Fatal accident rate	FAR
Gas phase chromatography	GPC
Hazard and operability studies	HAZOP
Health and Safety Executive	HSE
Immediately dangerous to life and health	IDLH
Intermediate bulk container	IBC
Long-term exposure limit	LTEL
Lower flammable limit	LFL
Materials take off	MTO
National Electrical Manufacturers Association	NEMA
Net-positive suction head	NPSH
Nominal diameter in mm	DN
Plant design and management system	PDMS
Programme evaluation and review technique	PERT
Polytetrafluoroeth(yl)ene	PTFE
Short-term exposure limit	STEL
Systems Reliability Service	SRS
Time weighted average	TWA
Unconfined vapour cloud explosion	UVCE
Upper flammable limit	UFL
Visual display unit	VDU

PART I

GENERAL PRINCIPLES

1 INTRODUCTION

Layout is concerned with the spatial arrangement of process plant and its interconnections, such as piping. Good layout practice achieves a balance between the requirements for safety, economics, the protection of the public and the environment, construction, maintenance, operation, space for future expansion and process needs.

It is necessary to distinguish between the layout of the various plants in a *site*, the arrangement of process vessels, piping, etc. in a plant on a *plot* and finally the detailed arrangements of both *equipment* and *piping*. Thus, in this book, the term *plant layout* has been given a generic meaning covering all aspects of layout. In the earlier Institution of Chemical Engineers publication[1] the term *plant* was also used synonymously for *plot* reflecting the common occurrence where a plant occupies one plot. However, it has been found helpful to define the terminology more precisely.

Since the first book the principal addition to the subject has been hazard assessment. Also there has been an increase (though not as much as expected) in the use of computer-aided design in layout. With the growth of project size it has become recognized that layout execution must be formally organized along with other design activities. The amount of detailed layout information available has also grown (see, for example, Kern[2]). Consequently, the size of this book is much larger than the first book and it was thought desirable to provide introductory Chapters 1–4 giving general principles before going into detail from Chapter 5 onwards.

Chapter 2 is concerned with the general discipline of layout and details on the various approaches are presented in Chapters 5–8, which encompass planning, layout conception, aids to layout and hazard assessment of layouts.

Chapter 3 provides the principles of site layout whilst Chapter 9 discusses the transportation requirements of a site, and Chapters 10, 11 and 12 look at storage and warehousing. The layout features of effluent facilities, utilities and central services are examined in Chapters 13, 14 and 15.

The basic principles of plot layout are outlined in Chapter 4 and further details are given in Chapter 17. The special features of plant layout within enclosed buildings are listed in Chapter 18. Chapter 16 discusses construction, including the recent development of modular construction.

The layout of individual items of equipment is covered in Chapters 19–30 with piping layout occupying Chapter 31.

Besides distinguishing between site, plot and equipment layout it is necessary to differentiate between preliminary layout before contract or approval and detailed layout afterwards.

Design has become a three-stage process:

Stage One: pre-design sanction
Stage Two: between design and project sanctions
Stage Three: after project sanction.

'Preliminary' covers Stages One and Two and 'detailed' Stage Three. In the past, sanction and planning permission have been sought and given on the basis of Stage One. Stage Two has been combined with Stage Three.[3] These three stages are now used because of the escalating penalties of not having accurate cost and hazard assessments when commitment to the project is decided.

Preliminary layout involves conception, evaluation and modification with the last two being repeated until a satisfactory solution is achieved. Detailed layout involves developing the minutiae of the preliminary layout. Chapter 6 will indicate that computers have been, and will become, increasingly successful for evaluation and detailing but that process and project experience remains best for layout conception and modification. The engineer assigned to detailed layout is also involved with project planning especially since the introduction of computers for planning control. This problem will be discussed in Chapter 5.

The training, skills and experience of the chemical engineer are applied to hazard assessment which has become an essential part of preliminary layout. In the first book it was implied that layout was the province of the design office with the chemical engineer in the background. However, hazard assessment and layout are now very much a partnership between layout engineer and chemical engineer. In the first book a formal critical examination method was included though it was largely ignored and designers preferred the 'devil's advocate' committee method of examination. Since then the technique of hazard and operability studies (HAZOP) have been devised for critically examining flowsheets and, no doubt, a similar type of method will be developed for layout. The legal requirement for providing environmental impact assessment and hazard surveys of potentially dangerous processes will promote such development.

When the first book was prepared, separation distances as outlined in codes of practice, such as the Institute of Petroleum Codes, were sacrosanct. Now they are regarded as guidelines only for preliminary design and are being superseded in detailed layout by the development of methods based on mathematical models of processes such as leakage, evaporation, cloud drift and dispersion, vapour cloud explosions, thermal radiation, etc. Chapter 8 outlines the various types of calculation involved.

In this connection, the Working Party had some difficulty because this branch of chemical engineering is now developing rapidly. Appendix B gives a summary of the position in 1983 but the reader will need to familiarize himself with the latest developments. This issue is further complicated because knowledge of the behaviour after loss of containment is in itself insufficient. It is also necessary to assess what the probabilities are of a leak occurring and in order to distance the plants, to judge what risk of damage, injuries, etc. society will tolerate. The quality of data on plant reliability and on public acceptability is continually improving and will assist engineers in achieving better design solutions to layout problems.

Thus this book is intended to be a guide to good practice and although the contents give spacings and arrangements, it must be remembered that these are only typical and not mandatory. They may have to be altered to suit local conditions, plant owners' requirements and established safe practices. In particular the guide has to be largely phrased in terms of a new or 'greenfield' site, whereas most projects are involved with modifications and extensions where existing site constraints inevitably make observance of good practice more difficult.

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