

HIGHER TECHNICAL INSTITUTE
ELECTRICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

DESIGN OF THE ELECTRICAL
SERVICES OF A CLINIC

TZIORTZI D. YIANNIS

E/1009

1996

HIGHER TECHNICAL INSTITUTE

ELECTRICAL ENGINEERING COURSE

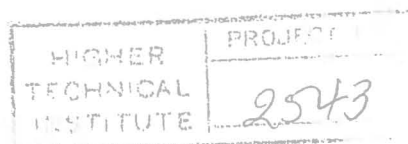
DIPLOMA PROJECT

**DESIGN OF THE ELECTRICAL
SERVICES OF A CLINIC**

E/1009

TZIORTZI YIANNIS

JUNE 1996



HIGHER TECHNICAL INSTITUTE

DESIGN OF THE ELECTRICAL SERVICES OF A CLINIC

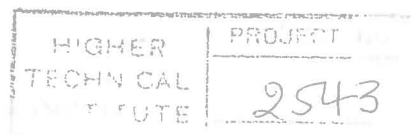
PROJECT REPORT SUBMITTED BY

YIANNIS D. TZIORTZI

In part satisfaction of the conditions for the award of Diploma of Technician Engineer in Electrical Engineering of the Higher Technical Institution, Cyprus.

Project Supervisor: Mr. G. Kourtellis
Lecturer in Electrical
Engineering, H.T.I.

JUNE 1996



CONTENTS

	Page
Acknowledgements	1
Summary	2
Introduction	3
PART A	5
ELECTRICAL SERVICES	
CHAPTER 1	6
ILLUMINATION DESIGN	
1.1 Introduction	7
1.2 Advantages of good illumination	7
1.3 Symbols used in illumination design	8
1.4 Units and definitions used in illumination design	9
1.5 Glare	12
1.6 Flicker and stroboscopic effect	12
1.7 Light sources	12
1.8 The lumen method of design	13
1.9 Spacing of fittings	13
1.10 Example of illumination design	14
1.11 Total results for illumination design	17
CHAPTER 2	21
LIGHTING SERVICES	
2.1 Introduction	22
2.2 Lighting installation	22
2.3 Luminaires	22
2.4 Final connection to lighting fittings	23
2.5 Lighting switches	23
2.6 External sign	23
2.7 Lighting circuits design	24
2.8 Examples of lighting design	27
2.9 Total results for the lighting services of each floor	38
CHAPTER 3	44
POWER SERVICES	
3.1 Incoming supply	45
3.2 Type of system and protection against direct and indirect contact	45
3.3 Main MCCB	45
3.4 Mains switchgear panel	46
3.5 Sub main cables	46

3.6	Distribution boards	46
3.7	Cable size and MCB ratings	47
3.8	Small power installation	47
3.9	Socket outlets	47
3.10	Fan coil units	48
3.11	Extract fans	48
3.12	Refrigerator and washing machine	48
3.13	Chiller	48
3.14	Ring circuits for s/o design	49
3.15	Example for socket outlet design (ring circuit)	50
3.16	Radial circuits for s/o design	53
3.17	Example for socket outlet design (radial circuit)	56
3.18	Further protection of socket outlet	59
3.19	Conduits	59
3.20	Comparison of plastic and steel conduit	60
3.21	Installation of motors	60
3.22	Design procedure	61
3.23	Machine circuits	64
3.24	Example for cooker circuit	68
3.25	Example for fan coil units	71
3.26	Calculations for chiller unit	73
3.27	Total results for power services	76
CHAPTER 4	FINAL CIRCUIT ARRANGEMENTS	79
4.1	Introduction	80
4.2	Main panel	80
4.3	Feeders	81
4.4	Distribution boards	81
4.5	Protective devices	81
4.6	Load analysis and three phase balancing	81
4.7	Diversity applied	82
4.8	Total results for diversity	82
4.9	Examples for D/B supply cables design	85
4.10	Total results for D/B supply cables	87
CHAPTER 5	FAULT LEVEL CALCULATION	88
5.1	General	89
5.2	Total results for fault level calculations	90

CHAPTER 6	TELEPHONE SERVICES	93
6.1	General	94
6.2	Design of the internal wiring	94
6.3	Procedure to be followed for planning an internal wiring system	95
6.4	Earthing	95
6.5	Installation of the telephone lines	96
6.6	Conduit schematic diagram	97
6.7	Wiring schematic diagram	98
6.8	Telephone network	99
CHAPTER 7	NURSE CALL SYSTEM	100
7.1	General	101
7.2	The nurse call system operation	101
CHAPTER 8	TV SERVICES	102
8.1	General	103
8.2	Equipment and materials	103
8.3	Operation	103
8.4	Wiring	103
8.5	Testing and commissioning	104
8.6	Operation and maintenance manual	104
CHAPTER 9	FIRE ALARM SERVICES	105
9.1	General	106
9.2	Selection of the required fire detection system	106
9.3	Selection and erection of equipment	107
9.4	Control unit	107
9.5	Break - glass alarm buttons	107
9.6	Automatic detectors	108
9.7	Alarm bells	108
9.8	System operation	109
CHAPTER 10	PROTECTION AND SAFETY ✓	110
10.1	Requirements for safety	111
10.2	Types of protection	111
10.3	Overcurrent	111
10.4	Overcurrent protection	112

10.5	Overload protection	114
10.6	Electric shock considerations	114
10.7	Protective conductor	115
10.8	EEBADOS	115
10.9	Protective devices used	116
10.10	Disconnection time concept	116
10.11	Control and excess current protection	117
CHAPTER 11	EARTHING ✓	118
11.1	General	119
11.2	Earthing system	119
11.3	Earth fault loop impedance (E.F.L.I.)	120
11.4	Bonding	120
11.5	Definition of earthing terms	120
11.6	Methods of earthing	122
CHAPTER 12	INSPECTION AND TESTING ✓	123
12.1	General	124
12.2	Visual inspection	124
12.3	Testing	125
PART B	SAFETY SERVICES	128
CHAPTER 1	STAND-BY GENERATOR	129
1.1	Introduction	130
1.2	Stand-by distribution board supply cables	131
1.3	Generating set	133
PART C	COSTING	134
CHAPTER 1	COSTING	135
1.1	The importance of costing	136
1.2	Methods available for proper costing	136
1.3	Estimating procedure	137

Appendices
Drawings
Bibliography

APPENDICES

- Appendix 1: Symbols and abbreviations
- Appendix 2: Tables for illumination design
- Appendix 3: Types of luminaires
- Appendix 4: Tables for lighting and power design
- Appendix 5: Table for diversity
- Appendix 6: Tables for D/B supply cables
- Appendix 7: Fault level calculations
- Appendix 8: Nurse call system
- Appendix 9: Earthing system
- Appendix 10: Stand-by generator
- Appendix 11: Chiller
- Appendix 12: Types of switches and socket outlets
- Appendix 13: M.C.B.s
- Appendix 14: M.C.C.B.s

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to my project supervisor Mr. G. Kourtellis for his valuable help and guidance given to me throughout the project period.

I would also like to express my thanks to everybody from industry who helped me, in any way, to carry out and complete this project.

This project is dedicated to my family.

SUMMARY

This project deals with the electrical services of a clinic regarding:

- (i) illumination design work in order to decide the quantity, type and luminaires in accordance with the CIBS code.
- (ii) lighting and power services based on the 16th edition of the IEE wiring regulations and the local EAC conditions of supply.
- (iii) also on telephone services were based on CYTA requirements.
- (iv) means for communication between the patients and the nurse staff is achieved via the nurse call system, which is explained in detail.
- (v) a brief explanation on t.v. and fire alarm services according to the relevant regulations.
- (vi) stand-by emergency supply will be designed in such a way so as the clinic to be able to continue its operation even if the main supply fails.
- (vii) costing of the work is achieved, regarding all the equipment we use, labour cost and according to Cyprus values.
- (viii) finally this project includes also some appendices, which outline the information given by the manufacturers of the equipment used in this project.

INTRODUCTION

This project as it was noted before refers to the electrical services of a clinic.

Nowadays the clinics must have all the necessary facilities to offer to the people better medical care and to their staff, better conditions of work.

The main body of the project is divided into four parts which examine all the possible solutions for the different concerned.

PART A: deals with the electrical services of the clinic. This part is divided into twelve chapters.

Chapter 1: this chapter analyzes the illumination work and examines the need for the appropriate illumination levels, colour rendering, and division of the number of lamps calculated into groups, in order to provide adequate illumination in the medical centre rooms.

Chapter 2: This chapter deals with the lighting installation and gives details for each light circuit.

Chapter 3: This chapter explains in detail all concerning power services of our building, explanation of the equipment used and sample of calculations for the equipments. At the end of the chapter total results for power services are tabulated on tables.

Chapter 4: This chapter shows how load distribution is done, and what diversity is applied. Tables at the end of this chapter give details for each distribution board and also for each circuit.

Chapter 5: In this chapter fault level calculations are carried out. The short circuit fault current and the power factor for each circuit breaker was determined.

Chapter 6: This chapter gives details for the telephone installation. It also gives a description of the telephone system and diagrams for the connection in each distribution case.

Chapter 7: This chapter gives information and explanations for the operation of the nurse call system, but more explanation of the system may also arise from the appendices.

Chapter 8: This chapter gives brief explanations of t.v. services of the clinic.

Chapter 9: This chapter examines the need for safety services, the solutions adopted for fire alarm system and the system operation.

Chapter 10: In this chapter as the name implies, deals with the requirements for safety and protective devices used.

Chapter 11: This chapter describes the earthing design and the protection that must be taken into consideration in an electrical installation.

Chapter 12: This chapter deals with the testing that must be done to the installation after the finishing of it, so that to ensure that there is no fault.

PART B: Deals with the safety services of the clinic. This part gives and examines the reasons for the need of a stand-by generator and also shows calculation for the D/B supply cable of the generating set.

PART C: This part describes the importance of costing and gives the methods available for proper costing and finally estimates the cost of the electrical installation by the analytical method.

PART D: In this part the conclusions of the whole project are represented.

Finally at the end of this project, all the necessary appendices and drawings are included for a better understanding of the solution given to the problem.