

BUILDING MAINTENANCE MANUALS AND THEIR
APPLICATION TO BUILDING MAINTENANCE MANAGEMENT

by

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DISSERTATION FOR M.SC COURSE IN
BUILDING MAINTENANCE MANAGEMENT

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SUMMARY

The need for comprehensive building maintenance manuals was first brought to prominence by the Building Maintenance Committee which was set up by the Government in 1965. The Committee recognised that the provision of building maintenance manuals for new buildings would be a useful starting point for the systematic recording of maintenance data which would solve many of the problems associated with this work.

This study therefore examines the factors which call for the need for maintenance manuals as well as examining their preparation, format, contents and subsequent application to the management of building maintenance. From this examination major points on these aspects are brought to light together with recommendations which should be taken into consideration in order to obtain maximum benefits from their use.

The body of the dissertation is divided into various chapters. Chapter One defines the objective of the study and the methodology adopted. The various factors which call for the need for maintenance manuals are examined in Chapter Two. These factors require consideration at the early stage of the building design. This leads to the examination of the preparation of a manual in relation to the stages of the RIBA's Plan of Work in Chapter Three.

The format of maintenance manuals is examined in Chapter Four in view of easy retrieval, storage and updating of information contained therein. This involves consideration of classification of the information using appropriate method of classification and coding. A typical structure of a manual based on that published by the Building Centre is outlined for guidance.

Chapter Five describes the sections and subsections of the manuals as well as examining their contents in general terms. Their application to the management of maintenance works is looked into in Chapter Six. The aspects covered in this examination include the formulation of maintenance policy, implementation of planned maintenance, budgetary control, labour productivity, stock control, computer use in maintenance and feedback information.

Chapter Seven is devoted to the conclusion of the study. It draws up the major points on the various aspects of the manual examined together with recommendations which should be considered in their production and application in order to obtain maximum benefits listed thereof. The present situation and the anticipated future trend with regards to the use of the manuals in building maintenance management are pointed out.

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CONTENTS

PAGE No.

1.00	INTRODUCTION	1
1.1	The Objective of the Study	1
1.2	Methodology	1
1.3	Building Maintenance Committee, 1965	2
1.4.	The Findings of the Committee	3
1.5.	Building Centre Maintenance Manual.	4
2.00	FACTORS CALLING FOR THE NEEDS OF MAINTENANCE MANUALS	6
2.1.	New Materials	6
2.2.	Complexity	6
2.3.	New Construction Techniques	7
2.4.	Technical Vocabulary	8
2.5.	Operatives' Age Factor	8
2.6.	Scarcity of Resources	8
2.7.	International Trade	9
2.8	High Specialists' Fees	10
2.9	Legal Safety Requirements	10
2.9.1.	Legal General Duties	11
2.9.2.	Implications of the Legal requirements	12
3.00.	PREPARATION OF A BUILDING MAINTENANCE MANUAL	14
3.1.	Definition of a building maintenance manual	14
3.2.	RIBA's Plan of Work	14
3.3.	Inception Stage	15
3.4.	Feasibility Stage	16
3.5.	Outline Proposals Stage	16

	Page No.	
3.6.	Scheme Design Stage	16
x3.6.1.	Cost -in-use	17
3.7.	Detail Design Stage	20
3.8.	Production Information Stage	20
3.9.	Tender Action to Completion	21
3.10	Sources of Information for the Manual	22
3.11	Problems in preparation of maintenance manuals	24
3.12	Purpose of Maintenance Manual	26
3.13.	Project Information Manual	27
4.00	<u>FORMAT OF A MAINTENANCE MANUAL</u>	28
4.1.	Classification	28
4.2.	Classification Factors	29
4.3.	Method of Classification	30
4.4.	Relevance of classification Systems	31
4.5.	The Structure of a maintenance manual	32
4.6.	Coding	34
4.7.	Comments	35
5.00	THE CONTENTS OF A MAINTENANCE MANUAL	36
5.1.	Section 1: Building General Information	36
5.2.	Section 2: General Building Fabric	38
5.3.	Section 3: Building Services	42
5.4.	Section 4: Drawings	45
5.5.	Section 5: Cleaning and User Guide	46
5.6.	Comments	47

6.00.	THE APPLICATION OF BUILDING MAINTENANCE MANUALS TO BUILDING MAINTENANCE MANAGEMENT	49
6.1.	Maintenance Manual as a basis for formulating Maintenance Policy	49
6.2.	Maintenance Manual as a basis for implementing Planned Maintenance	50
6.2.1.	Application of Building Maintenance Manual to Planned Preventive Maintenance	50
6.2.2.	Planned Maintenance and Operation of Mechanical and Electrical Services System of the DOE.	53
6.2.3.	Correlation of Maintenance Manuals contents to the elements of the PPM System of the DOE.	54
6.2.4.	Other Organisations	55
6.2.5.	Cyclical Maintenance	56
6.3.	Maintenance Manual as a tool for Budgetary Control	57
6.4.	Maintenance Manual as an aid to labour Productivity	58
6.5.	Maintenance Manual as a tool for Stock Control	59
6.6.	Maintenance Manual as a data base for Computer Use in Maintenance	60
6.7.	Maintenance Manual as a basis of Feedback Information	62
6.8.	The Present Application Limitations	62
7.00.	CONCLUSION	65
7.1.	Recommendations	67
7.2.	The Benefits of maintenance manuals.	73

LIST OF APPENDICES

<u>Appendix No.1.</u>	<u>Subject</u>	<u>Page No.</u>
1.	Schedule of floor areas and loadings	77
2.	Extracts from bills of quantities	78
3.	Services capacity and loading restrictions data in connection with Boiler, Ygnis models	79
4.	Drawing List	80
5.	Plan of the layout of the drainage and external works	81
6.	The Structure of the Planned Maintenance System as adopted by DOE.	82
7.	Work Docket for Royal Berkshire Hospital, Engineering Section	83
8.	Log Sheet for Royal Berkshire Hospital, Engineering Section,	84
9.	Planning Chart for the University of Reading, Engineering Section.	85/86/87
10.	Job Sheet for the University of Reading, Engineering Section.	88

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
3.1.	Sources of information according to the stages of RIBA's Plan of Work	23
7.1.	Typical percentage maintenance costs as against the age of the building	69

FIGURE INCLUDED

<u>Figure No</u>	<u>Title</u>	<u>Page No.</u>
3.1.	Typical Annual Occupancy Cost as per 1979.	18

1.00 INTRODUCTION

1.1. The Objective of the Study

The objective in this dissertation is to examine the factors which have prompted the need for maintenance manuals and their preparation, format, contents and subsequent application to the management of building maintenance. From this examination major points on these aspects are highlighted together with recommendations which should be taken into consideration in the production and application of the manuals with regards to their benefits.

1.2. Methodology

The Study involved a field survey to examine how building maintenance manuals are prepared in practice, their format, contents and subsequent application. Architect consultants and maintenance organisations were interviewed for this purpose, and the interviews covered those who have not hitherto used maintenance manuals to establish their opinions on the subject matter.

The relevant text books, journals and other articles have offered both useful practical and theoretical ideas which have formed the foundation of the study. The examination of the field findings and the ideas contained in different scattered publications and articles has enabled me to make conclusions and recommendations on various aspects of the subject. The conclusion and the recommendations are related to the findings of the Building Maintenance Committee of 1965 based upon the Building Centre Maintenance Manual as a model building maintenance manual in the Building Industry.

1.3. Building Maintenance Committee, 1965

The need for comprehensive building maintenance manuals was first brought to prominence by the Building Maintenance Committee which was set up in 1965 by the Minister of Public Building and Works under the chairmanship of Lord Winterbottom. The Committee's terms of reference were:

"To keep under continuous review the problems involved in the maintenance of buildings; including the relationship between design and maintenance; to make recommendations regarding the dissemination of the existing knowledge in these fields; to identify priorities for research and development; and to make proposals for studies"

The establishment of the Committee to look into maintenance problems is an indication of the concern they were causing to the Government. Huge public funds were being pumped into building maintenance without any proper accountability. In 1979 it was estimated that the annual building maintenance bill in the U.K. had reached £3500m. This cost could well be reduced at the design stage if proper attention was given to future maintenance and operational costs. D. Cornwath in his paper "Design Responsibility and Maintenance Manuals" says that the service of the design team extends beyond standing a building on its own feet. The service should see that it stays there and that its owner knows how to care for it.

1.4. The Findings of the Committee

The findings of the Committee, inter alia, include the following:

- (a) The repeated design mistakes are caused partly due to lack *Need for* of an effective relationship between the design and maintenance team .
- (b) There is no feedback from the maintenance or owner to the design team regarding the performances of the buildings.
- (c) The cost consideration at the design stage is centred on the reduction of capital costs and the saving of on-site time. The Committee agreed that cost-in-use studies should be rapidly developed so that a sensible balance between capital and maintenance costs could be struck at the design stage. This could be achieved through standardisation of costing and data collection system.
- (d) The maintenance efficiency would be achieved through collection, analysis and publication of maintenance data on materials' performance, organisational patterns, budgetary control systems, work and method study.
- (e) The Committee found out that to solve the whole or part of the aforesaid maintenance problems the provision of building maintenance manuals for new buildings would be a useful starting point for systematic recording. This was the first official recognition of the importance of building maintenance manuals to building owners or maintenance team. Since the service of the design team goes beyond standing a building on its own feet, the responsibility of the preparation of the maintenance manuals

lies with the design team. Cornwath (20) says that the incorporation of the preparation of the maintenance manuals in the Building Works Programme would allow cost-in-use to pull its full weight at the design stage. This will certainly make full use of the expertise of the design team. It will also guarantee the completion of the preparation of the building maintenance manuals at the practical completion date of the building contracts.

1.5. Building Centre Maintenance Manual

In February, 1966, Jacob Blacker with the help of Edward D. Mills was commissioned by the Building Centre Trust to design, collate and edit a building owner's maintenance manual.

The production of this project was the result of a Building Centre Forum at which Edward D. Mills formulated the need for such a manual based on the RIBA's recommendations. The Forum expressed the need for a standardised manual suitable for any sized building project.

The first maintenance manual by the Building Centre was published in September, 1966, with a total of 9000 copies. A further 5000 copies were printed on the second edition in 1968.

During the past 14 years many thousands of copies of the manual have been used by architects, estate managers, surveyors, builders and those associated with the building industry as a means of recording the vital information relating to a building so that maintenance work can be carried out regularly and efficiently. The total number of copies sold by 1980 was 14,000, a figure which represents an average sale of 1000 per annum. The resultant numbers of buildings with maintenance

manuals prepared is 7000.

In the Second National Maintenance Conference in November, 1969, Jack Blacker explained the usefulness of the maintenance manuals and they were recognised by the Conference as a useful information tool in the building industry.

Further research revealed the existence of many publications on this subject in the form of advice books to maintenance management and costing, as well as some few maintenance manuals prepared by individual companies or ministries for specific buildings. These included the Ministry of Public Building and Works maintenance manual for Jespersion Housing for the Armed Forces and the Millbank Maintenance Manual by John Mowlem and Co.

2.00 FACTORS CALLING FOR THE NEED OF MAINTENANCE MANUALS.

2.1. New Materials

Technological innovation has produced and is still producing an enormous amount of new materials about which it becomes increasingly difficult to obtain adequate information at the right time. Institutions such as the Building Research Establishment, the National Building Agency, the British Standards Institution, the Agreement Board, Trade Associations, the Building Maintenance Cost Information etc, have been established to collect, process and disseminate the data on materials performance, organisational patterns, budgetary control systems, work and method study.

The diversity of the building industry, the customers served and disciplines embraced therein make the production of building maintenance manuals at local level for specific requirements a necessity.

2.2. Complexity of Buildings.

The social changes and the rising standard of living have resulted in complicated buildings to meet complex needs;

The modern buildings are now provided with thermostatically controlled heating and hot water systems, high duty heating and air conditioning systems, complicated lifts, plant and equipment which require specialists' inspection and servicing.

The maintenance manuals help both specialists and craftsmen to trace and diagnose the faults logically and within a short time. E.N. White in his paper "Technical Information to Support Maintenance" says that diagnosis often accounts for 85% of the time taken to clear a breakdown in the mechanical and electrical installations. He says,

"sending skilled men to do a job without information can, at best, lengthen job times, and at worst, mean faulty, even dangerous work".

2.3. New Construction Techniques

The construction industry is becoming increasingly industrialised, relying more on assemblers who fit together factory made components to form an enclosure for ever increasingly complex network of internal services. The form of construction involves new techniques with special maintenance problems for which conventional maintenance practices may be unsuitable. Improved space standards and new patterns of use are some of the causes of building complexity. Buildings for aviation, industry, power, medical care and advanced education and similar others may require to be replaced with up-to-date models at more frequent intervals than in the past. The Woodbine Parish Report recognised the need that most items of maintenance should have an element of improvement so as to secure the benefits of new knowledge, products and materials in order to achieve acceptable current standards of maintenance.

The provision of maintenance manuals promote the technical development of the traditional building crafts such as bricklayers, carpenters, plasterers, etc.

The maintenance manuals would enable these crafts to learn new maintenance techniques brought about by new construction techniques.

2.4. Technical Vocabulary

Technological innovation expands the technical vocabulary used in the building industry. Maintenance manual is one of the means of conveying this technical vocabulary to the owner, occupier or maintenance team.

2.5. Operatives' Age Factor

The BRE Study of operatives work in maintenance and repairs revealed that operatives for building maintenance tend to be older. It revealed that the proportion of men over 40 years of age was 58% as compared with 32% for new construction.

From the age of 40 formal education and training are not appropriate for the operatives. The provision of building maintenance manuals would therefore assist in promoting technical development of internal staff.

2.6. Scarcity of Resources

The scarcity of building resources plus the rising cost of those resources have made people aware of the need to make better use of the existing buildings and resources. This objective can be achieved through Planned Preventive Maintenance (PPM).

Building maintenance manuals provide the basis of planned preventive maintenance which prolongs the life span of buildings together with their mechanical and electrical installations.

PPM ensures economic use of scarce labour and materials. And the extension of the physical life of a building delays its replacement, hence, defers expenditure on new construction.

2.7. International Trade

This is another economic factor which has prompted the need for maintenance manuals.

Maintenance manuals assist in the transfer of technology and help to prevent misuse of the products or their parts. Guildway Ltd, for example, exports many timber prefabricated building components to over 20 countries in Europe, Africa, Middle East and Carribean. The components are just assembled on sites and the buildings completed within a matter of hours. There is no question of Defect Liability Period. It is therefore essential that maintenance manuals should be provided with these components to the importers to guide them in their maintenance. The provision of the manuals protects the property investment as well as the reputation of the manufacturer/supplier.

For plants and equipment which are incorporated into a building, there is increasing world interest in their maintenance planning and control systems, maintenance costs, plant utilisation and down time.

However, many of the techniques used to effect improvement are showing that the basic requirement is the information base on which a full understanding of the plant and equipment depends.

2.8. High Specialists' Fees

A failure to provide adequate information on buildings and their mechanical and electrical installations increases dependence on visiting specialists who usually charge exorbitant fees, hence increase in maintenance costs. The reduction in maintenance cost was the main objective of the Building Maintenance Committee of 1965.

2.9. Legal Safety Requirements

The legislation has imposed general duties in relation to health and safety on those concerned with building maintenance in respect of their employees in particular and to those persons not in their employment who may be affected by their operations.

The Health and Safety at Work Act, 1974, is a comprehensive and integrated system of law governing the health, safety, and welfare of workpeople and the health and safety of members of the public who are affected by work activities.

The Act is not in itself a complete unit, but provides for new and amended legislation in the form of Regulations to be issued in due course. Thus the familiar Factories Act, 1961, Construction Regulations, 1966, Offices, Shops and Railway Premises Act, 1963, and the Building Regulations come under the Health and Safety at Work Act, 1974, but remain in their

original form until such time as the new regulations are issued.

2.9.1. Legal General Duties.

The duties imposed on the employers and those involved with the repairs and maintenance of buildings are:

- (a) to ensure so far as is reasonably practicable, the health, safety and welfare at work of all his employees. The matters to which this duty extends, inter alia, include:
 - (i) the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health;
 - (ii) arrangements for ensuring, so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;
 - (iii) the provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees;
 - (iv) the maintenance of safe working conditions and without risks to health and provide and maintain safe means of access to and egress from it without risks to health;
 - (v) the preparation and revision of written statement of the general policy with respect to health and safety at work of his employees and the organisation and arrangement for carrying out that policy.

- (vi) conducting his undertaking in such a way that no persons not in his employment who may be affected thereby are exposed to risks to their health and safety.
- (vii) the employees to take reasonable care for health and safety of himself and others and to co-operate with the employer in complying with the statutory obligations.

- (b) A person who designs, manufacturers, imports, installs or supplies an article for use at work must ensure that the article is safe and without risk to health when properly used, and is required to carry out such tests as are necessary and to take such steps as reasonably practicable, to ensure that adequate information is available concerning the correct use of the article.

2.9.2. Implications of the legal requirements.

- (a) The legal implications have great bearing on the priorities to be afforded to certain repairs and maintenance jobs where, although imminent structural failure may not be involved, possible injury to personnel could arise.
- (b) Where a contract or tenancy agreement is in force it is the person responsible for repairs and maintenance that is, for the purpose of this Act, considered as being in control of the premises.
- (c) If instructions as to use have been issued by the supplier or the designer but not followed then the article or substance is not considered as having been properly used. This may apply in the case of replacement of the defective material.

(d)

The Act also implies strict supervision over the maintenance jobs to make sure that the requirements of the Act are achieved. This is particularly where the statutory provision puts strict responsibility on the employer. In this case it does not matter whether or not the employer delegates the responsibility. He must ensure that the work is executed in accordance with the statutory provision. This is achieved by strict supervision over the operatives or contractors undertaking such jobs.

(e)

Safe system of work calls for clear knowledge and understanding of a building. The hidden features of a building should be clearly described by all means possible.

More care for health and safety costs money. Many of the techniques which may be adopted to alleviate this high cost are showing that a basic requirement exists - the building maintenance manuals on which full knowledge and understanding of the buildings depend. Safety is partly a knowledge factor hence the importance of a maintenance manual to a building owner, occupier or a maintenance team.

3.00. PREPARATION OF A BUILDING MAINTENANCE MANUAL

3.1. Definition of a Building Maintenance Manual

A building maintenance manual is a reference handbook which guides a building owner, occupier or maintenance team on how and when to maintain the building(s). It contains information on;

- (a) Sources of information
- (b) Materials incorporated in a building
- (c) Construction techniques used
- (d) Operating instructions
- (e) Maintenance schedule
- (f) Operation and maintenance precautions
- (g) Anticipated life of the building together with mechanical and electrical installations
- (h) Anticipated operation and maintenance costs of a building throughout its life span.
- (i) servicing contracts
- (j) List of drawings

The information contained in a maintenance manual can only be used for the building it refers to and not for general application.

3.2. RIBA's Plan of Work

This defines a systematic plan of building work for the design team.

It gives the programmes of work in a logical sequential stages of work.

Each stage defines the activities involved and the preparation of a building maintenance manual can be incorporated into different stages of the plan of work. The attempt to prepare a maintenance manual after the completion of a building is a frustrating exercise with some documents lost and information hard to come by. With many contemporary buildings it is impossible even for a highly qualified engineer to assess the structural system by looking at it after construction is complete. By means of a job diary and a progress check list all items which form part of the maintenance of a building should be transferred to the manual as their construction or installation is completed.

In order that everyone connected with the project can make a contribution, specimen copies of the maintenance manual should be made available to all members of the design team.

The information to be contained in a manual may be varied and modified according to the budget, size and complexity of a building.

3.3. Inception Stage

This is the starting stage within the RIBA's Plan of Work. It is at this stage that a client briefs the designer on his requirements for detailed considerations. The need for a Manual should be put forward at this stage together with a copy of the specimen of the maintenance manual to guide the designer.

3.4. Feasibility Stage

At this stage the designer evaluates the client's requirements, checking the information required against the check list for Outline Proposals Stage. The estimated fee to be charged for the production of the maintenance manual and the form in which information for the Manual is required should be considered at this stage. The appointment of maintenance staff in advance is also essential at this stage if required.

3.5. Outline Proposals Stage

The design team develops the brief further so as to present the client with the worked out alternatives. The alternatives should provide client with cost estimates and summaries of operation and maintenance implications. The worked scope of the Manual in accordance with the requirements of the client should be well established. The fees for the maintenance manual should be incorporated in the building cost estimates for client's approval.

3.6. Scheme Design Stage

This is the final development stage of the brief with detail planning solutions in the light of further information obtained. The responsibilities of each member of the design team should be clearly defined including the broad scope of records and maintenance manual to be produced on the basis of the fees agreed on.

3.6.1. Cost-in-Use (Occupancy Cost)

The cost-in-use detail should be worked out by the engineers at this stage in the light of the standards and functional requirements of the building. The cost data should be provided on annual basis expressed in terms of unit cost per 100 m² of the gross floor area. The prevailing current rates should be used in calculating the cost on an elemental basis. The necessary data for calculation may be obtained from such sources as BMCIS, RICS, and DOE.

A typical chart for the annual occupancy cost is given in Figure 3.1. using data obtained from BMCIS for various buildings.

TYPICAL ANNUAL OCCUPANCY COST AS PER 1979

	BIG FACTORY	SMALL FACTORY	HANGER & REPAIR SHED	AIRCRAFT ASSEMBLY	OFFICES	SCHOOLS	UNIVERSITIES
Floor area in m ²	100	100	100	100	100	100	100
DECORATION	£176	£176	£ 16	£ 16	£557	£ 79	£142
FABRIC	£ 93	£ 93	£ 72	£ 72	£307	£ 84	£ 97
SERVICES	£ 73	£ 73	£133	£133	£306	£ 50	£167
CLEANING	£162	£595	£219	£219	£592	*	£331
UTILITIES	£1583	£1583	£1759	£1759	£428	£365	£761
ADM. COST	£ 28	£ 267	£ 23	£ 23	£1112	£409	£407
OVERHEADS	£812	£812	£872	£872	£1590	£413	£368
TOTAL	£2927	£3599	£3094	£2278	£4892	£1400	£2273

* No separate figure given.

FIGURE 3.1

The figures provided may be used by the maintenance Manager as a basis for preparing short, medium and long-term plans. They may enable him to make both internal and external cost comparisons. Any irregularities may be investigated and action taken where necessary. The maintenance manager, building owner or occupant may see and understand right from the beginning what he is committing himself to in maintaining and operating the building annually at the current rates.

The limitations of such cost figures are;

- (a) The deterioration rate is assumed constant for the various elements over the whole life of the building. This is unrealistic.
- (b) The calculation of the figures does not take into account the effect of change in technology, use of the building and maintenance policy. The inflation rate is assumed constant for all resources employed. These factors usually change over time and thus affect the occupancy cost.
- (c) They assume that the amount for maintenance is earmarked for maintenance only and may not be spent on other investment. For this reason the discounted cash flow technique is not employed in the calculation.

However the figures provided may just be used as a base but can be adjusted in accordance with the prevailing circumstances. The chart may be incorporated under item 5.2. of Chapter Five of this dissertation.

3.7. Detail Design Stage

This stage involves completing detailed design and specification, and the preparation of information necessary for preparing bills of quantities. All the costs should be checked and production drawings prepared. The contents and format of all information required for manuals are defined at this stage. The preparation of the pipework, electrical and control schematics for manuals should be done at this stage, and the collection of manufacturers' literature should be started. The Architect should inform all consultants and the Quantity Surveyor to include a clause in their specifications for the preparation of the maintenance manual. The clause should include such items as time limits for data sheets and information, penalties for non-completion, commissioning records, record drawings, test certificates, schedule of components, photocopies of legal documents and as-built record drawings.

3.8. Production Information Stage

This stage involves the preparation of information drawings, specifications, schedules and bill of quantities. The clause of the preparation of maintenance manual should be incorporated in the tender documents at this stage. It should set clearly the record information expected from all sub-contractors and the form in which the information has to be presented. The time limit for handing in information should be defined in the clause and it should be related to practical completion date of the building contract. Tenders for special maintenance such as lifts, escalators, boilers, etc, should be prepared at this stage.

3.9. Tender Action to Completion

This last phase involves tendering, project planning and operations on site. All the design team members should be provided with a copy of the maintenance manual sheets from the Building Centre for guidance. The relevant sheets may be incorporated into Architect's job book or diary. The clerk of Works should keep records of all site works for as-built records as the work proceeds. The main contractor should also provide a list of all sub-contractors and suppliers/manufacturers and their addresses and telephones. All members of the design team should be issued with check lists for the maintenance manual.

The main contractor is under obligation to keep records and chase all specialists for their records. The building owner should be instructed to ensure that his operatives are fully conversant with the method of operating and maintaining the building.

The Architect should collect all as-built drawings and check that all check list items are included. He should then edit all information from consultants, main contractors and sub-contractors; co-ordinate reference numbers to leaflets and instructions. The final draft to be checked by the respective members of the design team concerned.

The description of all the design objectives and systems should be prepared and checked, and their explanatory diagrams prepared.

Photocopies of all consents, commissioning record, test and fire certificates and other relevant documents should be handed over to the building owner, occupier or maintenance team, whichever is the case at

the practical completion of a building contract. All these records should be contained in the completed comprehensive maintenance manual.

A building handed to the recipient without a maintenance manual causes frustration and annoyance to the recipient in respect of future maintenance. He has got no data on which to base his maintenance decisions hence unable to formulate a concrete maintenance policy.

3.10. Sources of Information for the Manual.

The information contained in the Maintenance Manual is collected by gathering pieces of information related to the building it refers to. These pieces of information may be conveniently collected as the building project progresses. Table 3.1. shows the items on which information is required according to the stages of the RIBA's Plan of Work. For each stage the sources of information are provided. However it should be noted that the sources of information may vary with the type and complexity of the building. The items and their sources contained in the table are not arranged in any order.

TABLE 3.1

PREPARATION STAGE	INFORMATION REQUIRED ON;	SOURCES OF INFORMATION
1. Inception Stage	<ul style="list-style-type: none"> - Name and address of the client and his representatives - Type and content of the manual - Name and address of the Architect - Details of the site - Authorities, consents and approvals to be obtained. 	Client Maintenance consultant Architect
2. Feasibility Stage	<ul style="list-style-type: none"> - Format of the manual - Estimated Cost for Manual - Site conditions - Estimated cost of building project - Schedule of elements, finishes - Services and fixtures - Title of the job 	Client Maintenance Consultant Architect Engineers Quantity Surveyor
3. Outline Proposals Stage	<ul style="list-style-type: none"> - Scope of the manual - Estimated cost of building project for client's approval - Estimated cost for manual - Operation and maintenance Implications 	Client Maintenance Consultant Architect Engineers Quantity Surveyor
4. Scheme Design Stage	<ul style="list-style-type: none"> - Scope of records and maintenance manual to be produced - Cost In Use - Responsibilities of the Design Team - Statutory requirements 	Client Maintenance Consultant Architect Engineers Quantity Surveyor Statutory and approving authorities Building institutions
5. Detail Design Stage	<ul style="list-style-type: none"> - The contents and format of the manual - Authorities, consents and approvals obtained. - Working drawings - Time limits for submitting information for the manual 	Maintenance Consultant Architect Engineers Quantity Surveyor Contractor (if appointed)
6. Production Information Stage	<ul style="list-style-type: none"> - Records and their form expected from the contractor and sub-contractor - Time limit for handing in the said records - Special Maintenance Contracts - Tender documents and bills of quantities - Relevant drawings - Invited subcontractors and suppliers 	Maintenance Consultant Architect Engineers Quantity Surveyor Contractor (if appointed)
7. Tender Action to Completion	<ul style="list-style-type: none"> - Contractual agreements - Materials and components' performance - Maintenance and operation requirements - Check list - As built records - Emergency contact - Addresses of design team - The details of all the authorities, consents and approvals obtained 	Client Maintenance Consultant Architect Engineers Quantity Surveyor Contractor Sub-contractors Clerk of Works

3.11. Problems in preparation of Maintenance Manuals

The preparation of maintenance manuals encounters the following problems;

- (a) the budget for the preparation of a useful maintenance manual is not usually considered by the client during the initiation of the project. One Architect interviewed said that the preparation of maintenance manuals is a tedious and costly exercise he would never attempt to do unless it is well paid for. Jacob Blacker (9) says that the work involved in the preparation of a maintenance manual is additional to the architect's usual design and supervision contract. The principle of its preparation and a fee for the work should therefore be negotiated with the building owner before the beginning of the contract.
- (b) It is also a problem to convince some clients on the useful need of providing a maintenance manual for a building. They are reluctant to pay for the service to be rendered for the preparation of the maintenance manuals. Some pay less than what would be enough for a comprehensive maintenance manual. One of the major benefits of the manual is that it encourages Planned Preventive Maintenance. The saving effected as a result of the implementation of Planned Preventive Maintenance outweighs the cost of preparing the manual by a large margin. The reader is referred to Chapter Seven for the benefits listed as compared with the rate of fee recommended for the preparation of the manuals.
- (c) The basis on which to formulate the format and contents is usually lacking. On many projects the maintenance manuals consist of suppliers' data, collected into large folders and presented to

the user without any balanced structure. Some parts of the manuals are partially completed while some are not completed at all. This is partly due to lack of a guiding specimen manual and partly due to the fact that its intended purpose is not well thought out.

- (d) The design team also encounters problems due to lack of proper specification of the scope and form of presentation of operating and maintenance information from the client. The subcontractors usually say that they can do what is necessary if only they are told clearly what is needed.
- (e) The unavailability of manufacturers' trade literature on some materials incorporated into the buildings is another problem. Some trade literature is only for sales promotion while some literature is out of date and therefore does not offer any useful operation and maintenance guidance on those materials.
- (f) Improper specifications also bring problems in the preparation of the maintenance manuals. Technical information is only effective if it provides a correct blend of words and pictures. Some of the specifications lack defined quality control and quality assurance regimes to support them hence they are useless as a basis of maintenance manuals.
- (g) Some firms are so small that they lack capable personnel who can be able to do the paperwork involved in the preparation of the maintenance manuals. These firms would not be able to provide any useful maintenance manuals by themselves.
- (h) The remote relationship between the design team and the maintenance team has contributed a great deal to the problems.

The maintenance problems to be solved by the use of maintenance manuals are not usually brought to light at the design stage. This blurs the real purpose for the manuals.

- (i) The prediction of the life span of various elements and of components of the buildings is a crucial problem due to various reasons. The determination of the life spans of the elements and components is usually guess work and may be far from the actual situation.
- (j) The operational and maintenance costs in relation to the age of the buildings are also difficult to determine due to various factors involved.

The solutions to all or some of the aforesaid problems are pointed out in Chapter Seven of this dissertation.

3.12. Purpose of Maintenance Manual

The purpose of a maintenance manual is to provide all building users with a common system of maintenance information recording and retrieval for the proper guidance of maintenance operatives, building owners, occupiers, maintenance team and architects. It assists in establishing standardised maintenance procedures which lead to efficiency in building maintenance. Like any other information tool it is used for:

- (a) prediction of the future maintenance of a building
- (b) comparison between what is anticipated with what is actually taking place. The actual building's performance can be compared with what is anticipated by the design team. Any abnormal deviations can be investigated and corrective action taken where and when necessary and the report on the design faults be passed to the design team for future considerations.

Instruction or explanation of what has to be done and how it is to be done. It is, in fact, a source of knowledge.

Project Information Manual

A Project Information Manual is commonly used as a synonym of Building Maintenance Manual. These two terms are technically different in their purpose. Project Information Manual should refer to the Manual containing information which guides the design team in the building production process. A Building Maintenance Manual on the other hand is a Manual which contains information which instructs the building owner, occupier or maintenance team on what to maintain, how and when to maintain it. Project Information Manual does not contain operational and maintenance instructions. However, the Project Information Manual is used as a basis for preparing a Building Maintenance Manual, but it is not a Building Maintenance Manual in itself.

4.00. FORMAT OF MAINTENANCE MANUAL4.1. Classification

Classification is the grouping of information in Libraries, information stores and documents generally so that like ideas and concepts come or can be brought together in the same groups.

There are two basic types of information;

(a) General Information

Is the information which is freely available in published form and is useful for a variety of purposes.

(b) Specific information

Is the information which has restricted application and which may be derived entirely from internal sources or consist of a unique collection of general information. A building maintenance manual falls under this category. The source of information contained in a manual is the members of the design team and institutions associated with the building. The information is collected by gathering data related to the building into a purpose information. The data are on:

- (i) those persons or institutions associated with the building
- (ii) physical aspects of the building
- (iii) maintenance of the building
- (iv) operation of the building
- (v) use of the building.

The structure for specific information, like a building maintenance manual, allows for manipulation and processing of information for a defined purpose.

The rigid distinction between general and specific information is sometimes blurred. General information can exist as specific information and vice versa. What matters is the nature and the application of the information.

4.7. Classification Factors

For effective application of the information in maintenance manuals the following factors should be considered:

- (a) ease of storage and retrieval
- (b) convenience for both storage and retrieval
- (c) flexibility for updating
- (d) standardisation of the technical information to be contained therein
- (e) brevity and precision of the information to be contained therein.

Maintenance manuals are used by those who use or occupy the building and those who maintain it. It is therefore important that the information required by either party be easily found. The maintenance manuals should therefore be divided into relevant sections to serve both parties effectively.

Bulky maintenance manuals are difficult to store and use properly. In practice bulky manuals are rarely used by both the operatives and management because they do not have the time to scan through them.

Flexibility of the maintenance manuals is achieved by the use of loose-leaf binding, allowing for the removal or addition of sheets according to the size and complexity of the building.

The documents should be prepared on a standard A4 sheet of international paper sizes. The drawings to be incorporated into the manuals should be those which can be reduced to A4 or A3 sheets for convenience.

The standardisation of the technical information is achieved through proper definition of the content and its purpose. This role is played by the Building Centre Maintenance Manual as a model maintenance manual.

The brevity and the precision of the technical information is achieved through use of restricted vocabulary in which each word has a single meaning. Synonyms and colloquialisms should be avoided. But all this will depend on how proper the specification contained in the project tender documents and trade literature is.

4.3. Method of Classification

There are various methods of classifying information. These methods include:

- (a) Dewey Decimal Classification. This is a classification in which the whole body of knowledge is divided into 10 groups and these ten groups are further divided into subsections. This type of classification puts both artificial scientific and numbering constraints on the expansion of the information.
- (b) Universal Decimal Classification. This type of classification is a modification of Dewey Decimal Classification. In this case the body of knowledge is divided into 10 primary groups, each primary group is subdivided into tertiary groups and so on. The disadvantage of this type of classification is that the division into classes is fixed and does not permit regrouping under different heads.

- (c) Faceted classification. The aforesaid types of classification are not applicable to the classification of information contained in maintenance manuals. CfB, CI/SfB and CIT classifications employ the principle of faceted classification. These types of classification used in the construction industry are based on a framework determined by rigorous analysis of the terms and items used by the construction industry.

The system of faceted classification assists in indexing and coding; coding is essential for some aspects of the maintenance manuals.

With the faceted classification the whole information contained in the manuals can be divided into broad sections for flexibility, easy retrieval and coding. The sections also cater for possible combinations of a wide range of characteristics of the buildings.

4.4. Relevance of Classification Systems

The systems of classification already described are relevant in the preparation of building maintenance manuals. They enable the design team to consider the contents and the format of the manuals which will meet the requirements of the users. The sections decided on should be able to meet the following requirements;

- (a) to allow relationships to be built up between relevant groups of information. For example the classification of the building into elements may enable the user to analyse maintenance costs according to the elements. The performance of the elements can therefore be expressed in terms of cost.

- (b) To identify resources with regard to performance, availability and price.
- (c) To facilitate the preparation of relevant documents e.g. work orders and other maintenance records.

The system of classification to be used will depend on the requirements to be met by the manuals.

4.5. The Structure of a Maintenance Manual.

The amount of information contained in a maintenance manual will vary with the nature and complexity of the building, as well as the requirement of the client. The Building Centre has prepared a model building maintenance manual which defines the scope and the items to be included. It is subject to modification as may be required and the format is as follows:

Section 1 - Information. Items to be included in this section are:

- (a) Description of the building
- (b) Emergency contacts
- (c) Ownership and contact consultants
- (d) Authorities, consents and approvals
- (e) Sub-contractors and Suppliers
- (f) Maintenance Contracts

Section 2 - General Building Fabric. Items to be included in this section are:

- (a) floor loadings and restrictions
- (b) General maintenance instructions
- (c) General maintenance log sheets
- (d) Annual guide chart
- (e) Inspection reports
- (f) Manufacturer's instructions leaflets index
- (g) Fittings and components

Section 3 - Building Services. Items to be included in this section are:

- (a) Services capacity and loading restrictions
- (b) Services instructions
- (c) Services log sheets
- (d) Manufacturer's instruction leaflets index
- (e) Fittings and components schedule index
- (f) Annual summary chart
- (g) Commissioning records and test certificates list.

Section 4 - Drawings - Items to be included in this section are:

- (a) Consultancy checklist
- (b) Drawing list

Section 5 - Cleaning and User Guide - Items included in this section are:

- (a) User guide notes
- (b) Cleaning instructions
- (c) Cleaning guide chart.

4.6. Coding

This is an exercise which has never been attempted in the preparation of maintenance manuals in practice. Even the Building Maintenance Committee of 1965 did not mention it in its findings. But, with the growing use of computers in the maintenance organisations, it is now an important factor to consider.

A code may be defined as a set of symbols used to facilitate the storage, retrieval and processing of information and data. The codes may be numerical, alphabetical or mnemonics of natural language words. Numerical codes are usually more convenient for machine and computer processing. Alphabets limit the number of classes to 26 and therefore may not be appropriate for building maintenance manuals.

The Department of the Environment, in Maintenance Manuals for Buildings, R & D Bulletin, 1970, recommended the section of the manual dealing with maintenance and repairs to be represented on an elemental basis. It recommended that the classification produced for the Interdepartmental Building Intelligence Group (IBIG) could be used for this purpose.

This is a faceted type of classification in principle. In the case of our model, the Building Centre Maintenance Manual, parts of sections 2 and 3 may be broken down into building elements and then coded.

Each maintenance organisation may choose the coding system to use according to its needs and available resources. A building owner who does not have any complicated accounting system may not need the coding of a maintenance manual.

4.7. COMMENTS

In practice a lot of factors to be considered and items to be included still leave a lot to be desired for effective manuals. Most of the maintenance manuals in existence lack the following:

- (a) Ease of storage and retrieval. This is due to lack of proper structure of the manuals. The data are collected into large folders and presented to the user without regard to balanced structure.
- (b) Flexibility. The presented manuals are in the form of well bound handbooks which do not give room for future updating.
- (c) Standardisation of the technical information to be contained therein; there is much variation in the information contained in the manuals. Some sections of the manuals are incomplete while some are not completed at all.
- (d) Brevity and Precision. The existing manuals are full of detailed general descriptions, including operation and maintenance instructions. This makes the manuals lack effectiveness in building maintenance.

The aforesaid shortfalls contribute a lot to lack of effective application of building maintenance manuals to building maintenance management.

5.00. THE CONTENTS OF A MAINTENANCE MANUAL

The contents of a maintenance manual are determined by the nature and complexity of the building and the requirement of the user.

The body of the contents is divided into sections to enable easy retrieval, updating and for convenience. Most of the sections are further broken down into subsections as may be found necessary, and these sections are discussed here below;

5.1. Section 1 - Building General Information

This section of a maintenance manual contains the record of the particulars of the building which can be considered under the following subsections;

- (a) Description of the building; This is just a brief description of the building giving its name, address and type.
- (b) Emergency Contact; The information is given for use in the event of emergency e.g. fire or burglary, gas, electricity or water failures or leaks; lifts, boilers or pump failures. The names, addresses and telephone numbers of contacts should be provided and any other necessary particulars which would speed up emergency action to be taken.
- (c) Ownership and Contract Consultants The particulars of the site, the nature of tenure and any easements, rights of way or other restrictive covenants pertaining to the building should be provided for future reference. In some manuals these particulars are provided under item 5.1. (a). The names, addresses and telephone numbers of the design team are provided for feedback purposes, but they may also serve the purpose of emergency contact.

- (d) Authorities, consents and approvals. These are authorities, consents and approvals obtained from the various local authorities or public utilities. They impose maintenance obligations on the owners, occupiers or maintenance team in respect of their buildings. Reference can be made to these statutes in deciding maintenance standards required or when change of use or physical alterations are to be effected. Their effective dates and references should be provided.
- (e) Subcontractors and Suppliers; The names, addresses and telephone numbers of the subcontractors and suppliers should be provided together with their respective services or items incorporated in the building. These particulars enable the building owner, occupier or maintenance team to channel any enquiries to the right person or persons on any maintenance problems which may arise later in the building. The particulars also provide those concerned with maintenance of the building the sources of maintenance materials which may be required from time to time.
- (f) Maintenance Contracts: In the event of building owners or occupiers not having their own maintenance staff it is recommended that regular maintenance contracts should be obtained. The following specialist maintenance should be considered for maintenance contracts;
1. Mechanical equipment and plant
 2. Electrical installation and plant
 3. Heating installation
 4. Gas installation
 5. Oil installation
 6. Lightning Protection

7. Fire and burglar alarms
8. Floor springs and door closures
9. Drains and plumbing
10. Landscape and gardening
11. Lift installation
12. Window cleaning equipment, etc.

The list of any maintenance contracts, their dates of commencement and duration should be provided. Maintenance instructions should be extracted from the relevant instructions sheets of the manual, together with any relevant drawings to form part of the contract instructions.

5.2. Section 2 ; General Building Fabric

The items included in this section may be considered under the following subsections;

- (a) Floor Loadings and restrictions; The maximum loadings of the floor should be well defined to avoid future overloading. These loadings should be expressed in terms of unit per square metre for each floor. A practical example is given in Appendix 1 of this dissertation. Any other restrictions, be it statutory, structural or spatial should be clearly defined. These pieces of information are important as far as safety and efficiency of the use of the building are concerned. Infringements of such restrictions may cause high insurance claims and premiums on the part of the owner, occupier or maintenance team.
- (b) General Maintenance Instructions; These are maintenance operating

instructions provided to the operatives to the level required and should be suitable for production as a separate document or as instruction cards for the operative's usage. They specify the maintenance tasks to be done, complete with the criteria and acceptable tolerances. A brief description of the construction of the component or fitting should precede the operating and/or maintenance instruction. Their maintenance frequency which specifies the periodical routine maintenance of each operation is an important provision for completing Guide Charts. Its provision should take into account the following factors:

- (i) Design requirements
- (ii) Legal Requirements
- (iii) Maintenance policy
- (iv) Environment
- (v) Use

The aforesaid factors determine the standard of maintenance required which in turn dictates the frequency of maintenance.

For the sake of clear specifications and easy retrieval the building may be classified into elements and coded where necessary. It is advisable for the codes provided to tally with the financial accounting codes for compatibility. Extracts from bills of quantities should be provided for various elements where necessary e.g. areas of floor, wall and ceiling finishes which are regularly required by the maintenance manager. They provide data for producing maintenance bills necessary for control and costing of maintenance works. An example is given in Appendix 2 of this dissertation. The example shows the list of items to be maintained, maintenance specification, quantity, the location of the items and maintenance frequency.

The item numbers may be replaced with the required codes if necessary.

(c) General Maintenance Log Sheet: These are sheets in which the following information is recorded by the maintenance operative;

- (i) the date when a job is done
- (ii) the result of doing the job
- (iii) the description and cause of a defect or failure and the remedial action taken
- (iv) the initials of the maintenance operative who has done the job.

The major items of repair, replacement or extension including redecoration are to be recorded in the log sheets. The log sheets will serve as a check to ensure that the other sections of the manual are updated. Each item may have its own log sheet depending on its nature and complexity.

(d) Annual Guide Chart: The purpose of the chart is to assist management in the assessment of financial and labour projections for the financial year. It ensures that all parts of the building fabric receive appropriate maintenance and repair at suitable times. It is prepared with the information obtained from general maintenance instructions discussed in item 5.2 (b). It enables a maintenance manager to have an instant visual check on progress of the work, as well as forming the basis of the preparation of the log sheets discussed in item 5.2 (c). Appendix 2 serves as a typical example.

- (e) Inspection Reports: The inspection report should be used for regular annual inspections and its format should be similar to the prepared building maintenance manual for the sake of compatibility and easy updating of the manual. The two should therefore be kept together, In some cases the log sheets may be used for the purpose of inspection and so eliminate the need for a separate report.
- (f) Manufacturers' instruction leaflet index: The trade literature should be incorporated as pages of the manual. The data sheets may or may not contain maintenance instructions, but their value may come from the full description of the material or its components. They could take the form of leaflets specially prepared as an "after sales" services to a standard format and size giving all the required technical information on cleaning, operating, maintaining, and repairing the product. The provision of the leaflets complete with guarantees, if any, is the responsibility of the subcontractors.
- (g) Fittings and Components: A list of building fittings and components e.g. ironmongery, doors, windows, sanitary fittings, bricks, tiles, paving, mosaic, marbles, frames, glass, precast concrete, flooring materials, carpets, roofing, etc, should be provided with information on their location, suppliers/manufacturers, catalogue numbers, guarantee periods and their expected life. These data would assist the maintainer in preparing maintenance programmes. The expected life data would enable the maintainer to formulate a cyclical maintenance chart for major items. The following data may be used as a guide for the purpose;-

<u>Building Fabric</u>	<u>Life (years)</u>
Roofs: slates	60
tiles	50
felt	10
asphalt	20
Floors: wood 25mm and over	50
Lino, pvc sheets	25
3.2mm tiles	15
Brickwork Pointing: 1st pointing	50/60
subsequent	25

5.3. Section 3 - Building Services

The section provides detailed information on mechanical and electrical installations incorporated into the building to enable them to be used in the most effective and economical manner. The information on these installations is more detailed than the information on General Building Fabric, although the format of the contents is similar. This is due to the fact that engineering maintenance differs from building maintenance in one significant aspect. When a piece of machinery fails it generally requires immediate attention, which cannot be postponed without loss of valuable production time. Buildings, on the other hand, do not usually fail catastrophically, and can continue to function long after they might objectively be judged to have failed. For this reason, engineering maintenance requires detailed information for planned preventive maintenance to eliminate or reduce loss of the valuable production time.

The detailed information in this section may be considered under the

following subsections:

- (a) Services capacity and loading restrictions. The information is required on the description of the installations, their design requirements and performance characteristics. Most services have been designed to cope with specific maximum loads and capacities, together with limitations on user performance. An example of the data is given in Appendix 3, in connection with Boiler, Ygnis Models, for light distillate oils and medium and heavy fuel oils.
- (b) Services Instructions: These are operating instructions provided to the operatives to the level required and should be suitable for production as a separate document or as instruction cards for the operatives usage. These instructions should be provided on:
- (i) description of operating models;
 - (ii) operative procedures with safety notes;
 - (iii) operatives fault diagnosis;
 - (iv) procedures for monitoring and reporting failures
- Any safety note referring to a particular action should precede the instruction for that action. In some manuals safety notes are provided after the instruction for action. This serves no purpose for it can be realised after the damage has been caused.
- (c) Services log sheets: These serve the same purpose as the one discussed in 5.2 (c), except that it is more detailed than the one referred to, hence, more entries.

(d)

Manufacturers' instruction leaflets index: The information contained in the leaflets is usually related to individual items of equipment and not installed systems. It is the responsibility of the service consultants to collate the scattered data and decide on the appropriate order and numbering. It may be advisable to include a copy of the services system diagrams at the head of each section with identification of the various items of equipment for large and complex buildings. This allows for quick reference to be made.

(e)

Fittings and Components Schedule Index: A list of electrical and mechanical fittings and components should be provided with detailed information on their location, suppliers/manufacturers, catalogue numbers, guarantee periods and their expected life. The data would enable the maintainer to prepare a planned preventive maintenance, as well as cyclical replacement of plant and equipment. The following data for the expected life of various items may be used as a guide for the purpose;

<u>Plant</u>	<u>Life (years)</u>
Lifts	30
Boilers ; Sectional	20
Shell	35
Calorifiers	40
Coal and ash hoists	15
Overhead hoists	30
Piped mains (buried)	35
Piped mains (subways)	50

<u>Plant</u>	<u>Life (years)</u>
Electrical installations	25
Electrical mains	40
Ventilation Plant	20
Refrigeration plant	15

- (f) Annual Summary Chart: The content and the purpose of this chart are similar to the one discussed in item 5.2(d) with the exception that it has more entries than the other one.
- (g) Commissioning records and test certificate List: Commissioning records usually refer to systems and test certificates to components. They are vital records for the maintenance contractor as they will determine the performance specifications and quality of the performance at the time of completion of the building and therefore enable a proper performance monitoring record to be kept. The commissioning of a Ygnis Boiler, for example, provides a list of items to be tested after its installation, including the records to be maintained and the procedure to be followed.

5.4. Section 4 - Drawings

The as-built drawings should be provided to amplify the written instructions and descriptions provided or to complement them. They assist in identifying the physical characteristics incorporated in the building. Complete sets of drawings of appropriate scales and detail will allow for easy information retrieval. Plans showing location of control points and access should be

provided. In the case of a large and complex building special drawings and schematic axonometrics or isometrics of the complex systems and services installation should be provided.

A schedule of the drawings provided should be prepared because all drawings cannot be incorporated into the manual. Only those which may be used regularly and are capable of being reduced to size A4 or A3 sheets should be incorporated into the manual. The schedule provided should specify the drawing number, subject of the drawing, scale of the drawing, and where it is obtained from. Appendix 4 shows a typical example while Appendix 5 shows the layout of the drainage and external works.

5.5. Section 5 - Cleaning and User Guide

The information in this section is meant for the general use of the occupants, tenants and cleaners - all are laymen in the building maintenance operation. It is not meant for the professional maintenance team. This section provides guidance on the general maintenance of the items incorporated in the building including the cleaning frequencies. It provides First Aid Maintenance Instructions which cover windows, glass, doors, ironmongery, water supply, gas and electricity supply, dry rot and woodworm, flood and burst pipes, rainwater flooding and drainage, paths and roads, roofing (pitched), roofing (felt), walls and structure, services, energy saving, fire safety, care and means of escape, etc. The information specifies the maintenance procedures to be followed and the steps to be taken to ensure their proper functioning condition. For convenience and easy retrieval the section is divided into:

- (i) user guide notes
- (ii) cleaning instructions
- (iii) cleaning guide chart.

5.6. Comments

The contents of the manual already discussed are not exhaustive but they, together with the examples given, provide guidelines for those responsible for the preparation of the manual. The format of the contents of the manuals will be the same regardless of the type and complexity of the building. The details to be included will depend on the nature and complexity of the building, as well as the user requirements. But since a building is an asset which can change hands and functions during its life time, it would be advisable for comprehensive information on a building to be provided. C. West Churchman (43) says that failure to keep information that later on would have proved useful is an inexcusable error. The development of the technology of information storage on microfilms, tapes and disks yearly reduces the cost of storage and retrieval.

The contents of a maintenance manual should make the building policy clear. They should provide full instructions for the policy to be successfully implemented. Their immediate usefulness should be realised by their users. Comprehensive data should be provided to make the users more independent of outside sources. The points to look for in deciding on the type of information to be contained in the manual are;

- (i) clear presentation of the information
- (ii) consistency of the information given in relation to the actual physical characteristics of the building with its mechanical and electrical installations
- (iii) clarity and brevity of the operating instructions.
- (iv) provision of maintenance schedules for both cyclical and planned preventive maintenance

- (v) completeness of the information to avoid cross-references between the pages which cause delay and inconvenience.
- (vi) absence of ambiguity to make translation and interpretation simple.
- (vii) technical documentation to be user-orientated and suitable for the personnel employed.

6.00 THE APPLICATION OF BUILDING MAINTENANCE MANUALS TO BUILDING MAINTENANCE MANAGEMENT

6.1. Maintenance Manual as a basis for formulating Building Maintenance Policy.

The Building Maintenance Committee defined maintenance as *"work undertaken in order to keep, restore or improve every facility, i.e. every part of a building, its services and surrounds, to currently accepted standard and to sustain the utility and value of the facility"*.

Maintenance policy lays down strategies within which maintenance decisions are taken to achieve currently accepted standard. It involves laying down objectives and identification of the main jobs to be carried out and the standard to be achieved.

Speight (4)) says that the aim is to maintain buildings in appropriate condition for suitable period using minimum capital expenditure.

Properly prepared maintenance manuals lay down the base on which building maintenance policy may be formulated. The guide charts summarise the workload to be carried out complete with their frequencies. Maintenance and operating instructions specify clearly the tasks to be carried out and the procedure to be followed together with safety notes. The commissioning records determine the performance specifications and quality of performance at the time of the completion of the building.

The compliance with the maintenance frequencies, maintenance and/or operation instructions and the commissioning records provided in the manuals will

achieve the appropriate building maintenance standard for the intended use. The log sheets will assist in changing the maintenance policy in the light of practical experience, hence the importance of updating of the manuals. Planning of maintenance would be based on data in the Guide Charts and the given workload and frequencies will determine the mode of execution and the size and type of manpower required, as well as the appropriate organisation structure.

6.2. Maintenance Manual as a basis for implementing Planned Maintenance.

Planned Maintenance is work organised and carried out with forethought, control and the use of records to a pre-determined plan. The object is to ensure that work considered necessary is carried out with maximum economy to satisfy the criteria for cost effectiveness and efficiency.

The use of a comprehensive building maintenance manual is more applicable to Planned Preventive Maintenance and cyclical Maintenance, both of which form specific categories of work under Planned Maintenance.

6.2.1. Application of Building Maintenance Manual to Planned Preventive Maintenance.

Planned Preventive Maintenance is work done in anticipation of failure.

Although it is more readily applicable to electrical and mechanical engineering, the principle is now extended to cover certain building elements e.g. doors, floor springs, windows, gutters, down pipes, gullies, flat roofs, cleaning, certain building inspections, etc.

The implementation of Planned Preventive Maintenance involved the following procedures;

- (a) Formulation of building maintenance policy which defines-
 - (i) the expected life of the building as well as the electrical and mechanical installations incorporated therein.
This should be given under items 5.2(g) and 5.3 (e) in Chapter Five of this dissertation for guidance.
 - (ii) the standard of maintenance required. This is reflected on the data provided under items 5.1(d), 5.2(a)(b)(d)(f), 5.3 (a)(b)(d)(e)(f)(g) and 5.5. in Chapter Five of this dissertation. Item 6.1 of this Chapter should be referred to for more explanation on this aspect.
 - (iii) the criteria by which repair and replacement decisions are based. This may be based on the data given under items 5.2 (a)(b)(d)(f)(g), 5.3 (a)(b)(d)(e)(f)(g) and 5.5. in Chapter Five of this dissertation.
 - (iv) the method of execution of the work. This can be decided by analysing the workload summarised in the Annual Guide Charts of the manual. The maintenance and/or operation instructions provided will assist in determining the work contents of the jobs listed in the Annual Guide Charts. From this analysis the amount of work to be carried out by contract and by direct labour may be determined. This is made easier where work study has been undertaken.
- (b) Preparation of Building Inventory: A Building inventory is a document listing the facilities to be maintained, their location and physical condition. This is prepared after physical survey of the facilities. The provision of building maintenance manuals will eliminate the need for preparing a building inventory, but if it has to be prepared, its preparation will be based on the contents

of the manual. The required information is contained in sections 1, 2, 3 and 4 of the manual.

(c) Planning Chart: This document gives a schedule of jobs to be done and when and where they are to be done. It can be prepared by the information under items 5.1(f), 5.2(b)(d)(f)(g), 5.3 (a)(b)(d)(e)(f)(g), 5.4 and 5.5 in Chapter Five of this Dissertation.

(d) Work Order: This is the document used for controlling the work input. It is used to:

- (i) direct a tradesman to the site where a preventive maintenance function is required
- (ii) specify the task to be done by the operative,
- (iii) record the time taken and the stores required to complete the task,
- (iv) record the maintenance condition of the facility.

All the information required for the completion of the work order is contained in the Job Sheets described under item 6.2.2(a) of this Chapter. The data recorded in work order after the completion of the job may be transferred to log sheets for future reference.

The information contained under items 5.2 (a)(b)(d)(f)(g), 5.3 (a)(b)(d)(e)(f)(g), 5.4. and 5.5. in Chapter Five of this Dissertation may be used to complete the work order. In some cases it may not be necessary to specify the task in the work order. The operative may just be provided with the reference numbers of the manual sections in which the maintenance tasks are specified for the facility, together with any procedural and safety notes. The provision of the manuals eliminates the need for the Job Sheets (bring-up cards).

The information recorded in the log sheets will be used as a basis for making decisions affecting maintenance operations. It can be

used to amend the planning chart when and where necessary.

6.2.2. Planned Maintenance and Operation of Mechanical and Electrical Services System of the DOE.

The Mechanical and Electrical Section of the Department of the Environment (DOE) has adopted a planned maintenance system which involves the following elements;

- (a) Job Sheets A job sheet is a document which lists the following information:
 - (i) the jobs to be done
 - (ii) the detail sheet to be used
 - (iii) the frequency at which a job is to be carried out
 - (iv) the procedure to be followed in carrying out the job
 - (v) the criteria to be applied to a measurement or inspection
 - (vi) the remedial measures
 - (vii) the forms required for the log book pages.
- (b) Detail Sheets: A detail sheet lists essential particulars of an installation.
- (c) Planning Chart: A planning chart is a schedule of jobs to be done, and of times when and places where the jobs are to be done.
- (d) Work Docket: This is a device used to issue maintenance and/or operating instructions to the operative. It specifies the job to be done, the procedure to be followed, the materials to be used and the estimated time for the job.
- (e) Order Form: This is a device used to issue maintenance and/or operating instructions to a maintenance contractor.
- (f) Forms W.1745 and W 1746: The completion and results report for the job undertaken by direct operative is entered on Form W 1745, while contractor's report is entered on Form W 1746.
- (g) Log Books: A log book is used for recording;

- (i) the date when a job is done
 - (ii) the result of doing the job
 - (iii) the description and cause of a defect or failure and remedial action taken
 - (iv) the initials of the man who did the job.
- (h) Buildings List: This is a record of the buildings in which there are mechanical and/or electrical services for which a Depot is responsible. The aforesaid elements form the body of a planned preventive maintenance system as adopted by the Department of the Environment.

6.2.3. Correlation of Maintenance Manual's contents to the elements of the PPM System of the DOE.

The main object of citing PPM System as adopted by the DOE is to correlate the contents of the manual to the elements of the system to find out how useful a maintenance manual may be in serving the system.

The contents of the job sheet correspond to the contents of the manual under item 5.3 (b), Services Instructions and both contents serve the same purpose. The Detail Sheet serves the same purpose as item 5.3(e), fittings and Components Schedule Index and the contents under the said item may be more comprehensive than the contents of the Detail Sheet. Item 5.3(a) may complement item 5.3(a) for PPM's purpose if need be. The data contained in the Annual Summary Chart would form a basis for preparing the Planning Chart. The Work Docket and Order Form can be completed with Services operating and/or maintenance instructions contained under items 5.3(b) and/or item 5.3(g), commissioning records, accompanied with relevant drawings and flow charts as may be found necessary.

The log books for the PPM and Services log sheets of the manual are the same in purpose and therefore any direct substitution of one for another may be effected without any amendment. The record listing buildings in

which there are mechanical and/or electrical services can be prepared on the basis of the information contained in the manual instead of carrying out physical inspection which is costly and time-consuming. The provision of a comprehensive building maintenance manual would therefore provide the necessary data required for the Planned Preventive Maintenance System as adopted by the DOE. The purpose served by the Job Sheets, Detail Sheets, and Log Books will be served equally by the relevant sections of the manual and thus reduce the paperwork involved in the existing system. The Planning Chart would be easily prepared with data from the Guide Chart while standardised Services operation and/or maintenance instructions would be used to complete Work Docket and Order Form and thus assisting in standardising maintenance procedures. Appendix 6 shows the structure of the Planned Maintenance System as adopted by the Department of the Environment.

6.2.4. Other Organisations. Other organisations like Royal Berkshire Hospital and University of Reading, follow the same principles as the DOE for their Engineering Works.

Both organisations have inventories for both mechanical and electrical installations prepared after the field survey. The planning charts are prepared from the information found in the field, using their practical experience. However, at the Royal Berkshire Hospital they refer to the provided maintenance manuals, if necessary, in preparing planning chart. The Work Docket which is sometimes completed with instructions from the manuals contains job specification, the type of equipment or plant to be attended, tools, spares data references, the area in which the equipment is situated, estimated time period for the job, operative's reference (MAN.REF. M1-1), and frequency reference (FREQ.S) and the columns for entering tools and spares used. Appendix 7 is an example of the Work Docket

for the Royal Berkshire Hospital, and Appendix 8 is an example of the Log Sheet of the same organisation. It contains test result, spares required, spare used and action taken are recorded and signed by the man who has carried out the job.

For the University of Reading the Planning Chart is linked with the Work Docket and Job Sheet by the use of reference numbers of the file of the plant or equipment concerned, a link which can be achieved through the coding of the manuals. The file number is quoted in the Planning Chart against each relevant item and the same reference file number is quoted on the job sheet, as well as the Work Docket. Appendix 9 is an example of the Planning Chart for the University of Reading and Appendix 10 is the Job Sheet for the same organisation.

All this paperwork may be reduced or eliminated and the maintenance procedures standardised by the use of comprehensive maintenance manuals as has been discussed under item 6.2.2. of this dissertation.

6.2.5. Cyclical Maintenance. This covers items which regularly recur and must be carried out as a routine to maintain the structural characteristics of the building as a suitable environment. Maintenance Works like internal redecoration, external painting, cleaning, wall repainting, re-roofing of flat roofs, certain building inspections, etc, are covered under this subsection. The Greater London Council, for example, has laid down the following frequencies for painting and redecoration;

Painting and Redecoration

<u>External</u>	<u>Frequency</u> <u>(years)</u>
(i) Normal external painting of all property	5
(ii) New property external painting	3-4
(iii) Short life property external painting	5
(iv) Clubrooms external painting	5

Painting and Redecoration

<u>Internal</u>	<u>Frequency</u> years
(v) . Main entrances to all blocks of flats, including hallways and internal corridors together with staircases to blocks of flats without lifts	2½
(vi) House or maisonette	5
(vii) Flat or bungalow	5
(viii) Sashes and frames	5
(ix) Special cases	5

Most of the given data would be covered under items 5.2(b) and 5.3 (b) and summarised in items 5.2.(d) and 5.3(f) for planned maintenance programme purposes. Economic life spans of the items provided would assist in determining their renewal and replacement cycles.

6.3. Maintenance Manual as a tool for Budgetary Control.

A budget is a plan for financing an organisation or an activity over a given time span to meet certain objectives. It is a discipline by which the expenditures of an organisation can be planned, co-ordinated and controlled to some purpose. As a plan it stimulates the use of the enterprise's available funds over the projected time span towards the various objectives and opportunities within the total plan.

The purpose of the Guide Chart provided in the manual is to assist management in the assessment of the financial and labour projections for the financial year. From the schedule of the jobs specified in the Guide Chart the maintenance manager can calculate the work content, which will in turn, determine the size and type of labour and materials required, and which

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50

can be expressed in terms of financial cost. The Guide Chart is prepared with an aim of ensuring that all parts of the building fabric and services receive appropriate maintenance and repair at suitable time.

It enables a maintenance manager to have instant visual check on progress of the work. Work measurement will be based on specifications extracted from relevant sections of the manual. This leads to standardisation of maintenance procedures hence effective budgetary control.

Maintenance manual, therefore, assists in the preparation of a comprehensive budget, as well as controlling it. Guide Chart, Log sheets and extracts from bills of quantities provided in the manual are important tools for budgetary control.

6.4. Maintenance Manual as an aid to Labour Productivity

The factors which account for the relatively low productivity in maintenance, and which can be wholly or partly solved by the provision of a comprehensive maintenance manual are;

- (a) the small scale of the individual jobs, resulting in a high proportion of non-productive time
- (b) the diversity of the work content of the jobs.
- (c) the adoption of inappropriate maintenance methods
- (d) the tendency to execute work only when it becomes a matter of urgency
- (e) the difficulty of drawing up a detailed programme of work before a fairly extensive exploratory survey has been carried out to determine the extent of the damage.

Item (a) can be solved by adequate spread of jobs over the 52 weeks of the year within the Guide Chart. Close maintenance frequencies can be matched together so that small jobs at one place are carried out at the same time. Item (b) can be solved by employing handymen who can make proper use of the manual instead of employing costly highly skilled tradesmen for low skilled jobs, particularly in dwelling houses. Item (c) may be caused by lack of understanding of the building and partly by lack of clear operating and/or maintenance instructions which the manual is intended to achieve. Items (d) and (e) can be solved by the application of Guide Chart. The provision of a comprehensive maintenance manual minimises the need for inspection of defects. The defects reported by the tenants can be intelligently discussed by telephone, using the manual as a basis of reference, thus saving time consuming and costly visits and pre-inspections. The manuals, therefore, increases labour productivity as well as technical knowledge of the internal staff.

6.5. Maintenance Manual as a tool for Stock Control.

Stock control is a means by which materials of the correct quantity and quality is made available as and when required, with due regard to economy in storage and ordering costs, purchase prices and working capital.

The objectives of purchasing would therefore be:

- (a) to purchase the right quality material
- (b) to purchase the materials at the right time
- (c) to purchase the right quantity of materials
- (d) to purchase materials from the right source
- (e) to purchase the materials at the right price

The achievement of the aforesaid listed objectives involves, inter alia, the proper linkage between the work programme and the budget, and maintaining effective relationships with existing sources and by developing other sources of supply either as alternatives or to meet emerging or planned needs.

The provision of a comprehensive building maintenance manual provides proper basis which can be linked to the budget. The Guide Chart and the Schedule of fittings and components can be used as criteria for preparing a maintenance works programme. A summary of the workload contained in the Guide Chart multiplied by the material content of the maintenance jobs, as given in the job specification, will show the material requirements for a period of the budget.

The maintenance of effective relationships with existing sources is achieved by the provision of a list of subcontractors and suppliers together with their telephones and addresses. This settles the question of the right source of materials. The provided catalogue numbers of the items together with the manufacturers' leaflets will ensure that the right quality is ordered. The Guide Chart will guide on the time to order. Some of the urgent orders can be made by telephone and thus reduces paperwork, delay and storage cost. The Guide Chart will also assist in deciding on materials which can be obtained by open competitive tendering so that the right prices are obtained. Updating of the manuals would assist in developing other sources of supply either as alternatives or to meet emerging or planned needs.

6.6. Maintenance Manual as data base for Computer Use in Maintenance

The increasing use of computers in building maintenance requires the necessary

data as facilities which can be provided on a computer as shown below;

- (a) the information on building particulars provided in different sections of the manual would be processed by computer into a Master Property File for easy storage and retrieval.
- (b) the maintenance and/or operation instructions can be used in the computer for raising job cards and thus producing Job File. The manual would help to standardise job descriptions. This is particularly important where there is Incentive Bonus Scheme. The coding of the descriptions is necessary for computer use and for feedback purposes.
- (c) The data contained in the Guide Chart would be used by the computer to draw up Maintenance Works Programme. The preparation of Planning Chart would be based on the drawn-up programme. Both the Works Programme and Planning Chart may be rescheduled by the computer in the light of information recorded in the Log Sheet without interfering with long-term plan.
- (d) The Guide Chart data can be used in the computer to draw-up a budget for labour and materials. The Stock Control File, if linked to the asset, jobs and history modules, may be used for more than simply stock control. The use of materials on certain building elements can be assessed easily; the material job costs can be provided and thus providing essential feedback for planned maintenance work.

The provision of a building maintenance manual would eliminate the need for costly physical survey of the property for the sake of collecting the necessary data for the implementation of computer system in the building maintenance.

6.7. Maintenance Manual as a basis of feedback Information

A maintenance manual contains the necessary data for comparison purposes. It describes all the design objectives which the maintenance and/or operation instructions are intended to achieve. The records on the log sheets will enable the maintenance manager to assess whether or not the design objectives are achieved by the laid down instructions. Any serious deviations from the objectives should be investigated and the result, if design fault, be reported to the design team for their future reference. The names, addresses and telephone numbers of the design team are provided for this purpose. The feedback information would be more effective if proper record system is maintained. The provision of annual cost-in-use on elemental basis, expressed in terms of unit per gross floor area will assist in comparing the intended annual cost in use with the actual cost-in-use. This can be analysed in conjunction with the table showing percentage maintenance costs as against the age of the building. Any high cost areas can be investigated and necessary action taken. The dissemination of the information on design faults is made easy in big organisations where Maintenance Section and Design Section are existing side by side. Small organisations are limited by their information storage capacity. This restriction is more on the side of small designers who are expected to receive feedback information from various clients. But, because of their small sizes, they would not be expected to have too many clients.

6.8. The Present Application Limitations

The application of building maintenance manuals is limited in practice for the following reasons;

- 63
- (a) the contents of the manuals are not usually designed for a comprehensive application in the building maintenance management. Project Information Manual for Oxford Regional Authority, for example, is a mere building inventory with its defined limited use as a handover document. It does not contain maintenance and/or operation instructions, Guide Chart and User Guide Notes. The incompleteness of the manuals' contents limit the application of building maintenance manuals.
- (b) Bulky manuals with general and detailed descriptions are not appropriate for busy operatives and managers as those employed in the maintenance organisations. This characteristic is usually accompanied with unbalanced structure which makes retrieval difficult. Lack of brevity and precision hinders the use of manuals in completing work dockets and planning charts. These types of manuals are not user-orientated.
- (c) The contents of the manuals are usually based on ideal data which are seldom verified from real records of buildings in use hence may be unrealistic for practical application. This covers data on life spans, of the various components and fittings, maintenance frequencies and commissioning records.
- The existing maintenance procedure and documentation may be quite different from that included in the manual. But this problem can be solved if the preparation of the manual takes into consideration the existing maintenance policy. Some data, e.g. drawings, are not usually consistent with actual physical characteristics of the building. These frustrate the users for they do not provide proper guidance.

- (d) Many of the operatives are unable to read and understand the provided data in the manuals particularly the consultant and architectural drawings and flow charts. This has restricted the use of the manuals.
- (e) The attitude of the technical personnel in maintenance organisations has tended to be negative towards the use of the manuals. Although they think that their experience is so great that they can make day-to-day decisions without guidance of the manuals, the quality of all decisions can only be as good as the quality of the knowledge of facts (or assumptions) upon which they are based. One of the most important functions of a maintenance manual is to provide a factual basis for control.
- (f) Late provision of the manuals to the clients also limit their use. Most of the manuals are not provided to the clients at the practical completion of the building contracts when the actual building maintenance starts.

These limitations may largely be eliminated or reduced by considering the major points and recommendations given in Chapter Seven of this dissertation regarding the production and application of the manuals.

7.00. CONCLUSION

The study of maintenance manuals in the context of their need, preparation format, contents and application brings to light certain major points.

The technological, economic and social factors which call for the need of such manuals require careful consideration in order to control the rising building maintenance costs. The careful consideration would be more effective at the early stages of the building development.

The preparation of maintenance manuals should, therefore, be incorporated into the RIBA's Plan of Work stages for effective consideration of the factors calling for their need. This will enable all those involved in the building design to contribute to their preparation at the appropriate stage. The items which form the foundation of the manuals will be considered in details at the appropriate stages of the Plan of Work by the respective members of the design team. The Client, maintenance consultant, architect, engineers, quantity surveyor, contractor, subcontractors, and clerk of works are all members of the design team at various stages. Their contribution would eliminate or reduce the present financial and technical problems associated with the preparation of the manuals. The definition of the purpose of the manual is important. It makes up a distinction between Project Information Manual and Building Maintenance Manual. These two documents which have been commonly treated as the same document are technically different in purpose. Their format and contents are therefore different.

56

The diversity of the users of the manual at various levels of details and the changing factors which call for their provision necessitate thorough consideration of the format of the manuals. The format should enable easy retrieval, storage and updating of the information contained therein. Easy retrieval and storage are achieved by classification and coding of the information while the use of loose-leaf binding offers flexibility for the updating of the manuals. Classification factors should be taken into account for the sake of effectiveness of the manuals in their application. A faceted type of classification is appropriate and relevant to the design of the format of the manuals for reasons of flexibility of the required structure. The resultant structure should be divided into sections as may be appropriate. The use of a computer in maintenance or the existence of an advanced accounting system may necessitate sections 2 and 3 (General Building Fabric and Building Services sections) of the manuals to be broken down into elements and coded as may be required. The coding system to be adopted is a matter of the needs and availability of resources of the maintenance organisations concerned. But the coding should be consistent with the existing maintenance procedure and documentation to facilitate the application of the manuals.

While the format of the manual will remain the same for any building, the contents of the manual will be determined by the nature and complexity of the building as well as the requirements of the user. Any essential information in respect of maintenance, operation and use of the building should be entered into the relevant section or subsection of the manual with utmost brevity and precision.

The maintenance and/or operation instructions should reveal clearly the required building maintenance policy.

67

The contents should be user-orientated and suitable for the personnel employed for easy application of the manuals.

The extent of the application of the manuals to building maintenance management is determined by their format and contents as well as the ability of the personnel employed to interpret them for solving maintenance problems. The examination of their application suggests that they are more applicable and useful to planned maintenance whose specific categories include Planned Preventive Maintenance and Cyclical Maintenance. This is due to the fact that the data contained in the manuals are the maintenance data which form the basis of such system. They provide a means to determine maintenance priorities, allocate resources, organise labour and facilitate costing. This ensures that work considered necessary is carried out with maximum economy to satisfy the criteria for cost effectiveness and efficiency. This is a proof to the finding of the Building Maintenance Committee of 1965 that the provision of manuals for new buildings would be a useful starting point for the systematic recording of maintenance data which would solve many of the problems associated with this work.

7.1. Recommendations

While the aforesaid points are important in various aspects of the manuals examined, the following recommendations are made to improve the usefulness of the maintenance manuals:

- (a) The Building Centre Maintenance Manual should be regarded as a model maintenance manual to guide the building design team in the preparation of the manuals for their clients. This will result in consistency of the format and contents of the manuals throughout the U.K. This consistency will lead to their uniform application in building maintenance management. As a result of this the

maintenance procedures may be standardised.

- (b) The Building Centre should incorporate a clearly defined intended purpose and use of maintenance manuals in its existing Building Centre Maintenance Manual and Job Dairy. The definition should be inserted within the subsection titled, "Instructions for the Compilation and Completion of the Manual". This will enable the design team to be aware of the purpose and use the manuals are supposed to serve and the data necessary for the service.
- (c) The contents of the building maintenance manuals should incorporate the anticipated maintenance profile of the building, assuming normal use of the building. A typical example is given on Table 7.1. showing typical percentage maintenance costs as against the age of the buildings. The percentage is expressed on the basis of the initial costs of the buildings. The building category may be provided in building type e.g. residential building, industrial building, office, school, etc. The table should be used in conjunction with Annual Occupancy Cost Chart as given in Figure 3.1. This chart should also be incorporated in the contents of the manuals. They can be used for both internal and external comparison of maintenance expenditure. The data can also assist in determining the future cost of maintenance. Serious departure from these data should be investigated and necessary action taken when and where required. They would form a basis for determining whether or not the fault is a design fault.

TABLE SHOWING TYPICAL PERCENTAGE MAINTENANCE COSTS AS AGAINST THE AGE OF THE BUILDING

CATEGORY OF BUILDING	0-10 years	10-20 years	20-30 years	30-40 years	40-50 years	50-60 years	60-70 years
Temporary Building	4%	6%	9%	13%	18%	24%	
Class I Low Cost Building	1%	2%	3½%	5½%	8%	11%	
Class II Average Good Construction Building	½%	1%	1½%	2½%	4%	5½%	
Class III High Class Finish Building	½%	1%	1½%	2¼%	3%	4%	

TABLE 7.1.

Source: Ministry of Works - Kenya.

- (d) The building specifications contained in the tender documents should have quality control and quality assurance regimes of the materials and components incorporated in the buildings. Performance specifications define a component, product or system by the needs of the user. They are used for establishing the required maintenance standards and therefore can be incorporated in a maintenance manual with little modification to suit the purpose they are required to serve. They enable the subcontractors to know clearly what sort of information is required from them.
- (e) A Maintenance consultant should be appointed as one of the members of the design team to represent the client on matters related to the building maintenance to be considered at the design stage. His functions, inter alia, would include:
- (i) the disclosure of practical design data for reference. His practical experience would enable him to provide the design team with realistic data on building performance in use e.g. the cost in use data, maintenance frequencies, life spans of various materials, and components, commissioning records, etc.
 - (ii) the introduction of the concept of planned maintenance at the design stage and the ways in which it may be served by the completed maintenance manual.
 - (iii) the definition of the scope and the form of presenting maintenance and/or operation instructions as well as their purpose.
 - (iv) acting as a link between the design team and maintenance teams to their mutual benefit. The maintenance problems to be considered at the design stage may be brought to light for solution. This will enable the design team to understand

the maintenance problems to be eliminated or reduced at the design stage and thus producing better buildings for maintenance. The maintenance team will benefit from the cut in maintenance cost due to better design on new buildings.

- (f) The provision of maintenance manuals is no substitute for proper basic training of the operatives. They should 'undertake' the training to enable them to read and understand the architectural and engineering drawings, flow charts and other necessary information provided in the manuals. The training should enable them to learn the new techniques of maintenance brought about by technological innovation. The knowledge of paperwork involved in planned maintenance is a necessity for the operatives. Also the techniques of diagnosing maintenance problems should be acquired during the training. The safety training for the operatives is of paramount importance according to the requirements of the Health and Safety Act, 1974.

The types of training to cater for the listed purposes should inter alia, include:

- (i) off-job training which takes from one month to six months and should be a general purpose training. This will cater for unskilled and semi-skilled operatives who are usually engaged as labourers without basic technical skills and those engaged as handymen.
- (ii) Vocational training which should take from six months to twelve months for skilled crafts who may be up-graded to technicians after passing the designed examinations at the end of the courses.

- (g) The training of highly qualified maintenance managers is an important requirement in maintenance organisations. The upgraded technicians who have hitherto been running many maintenance organisations are suitable for technical supervision in the field, but are rarely suitable for the present scientific management. Higher courses awarding diplomas and degrees in maintenance management should be offered. This step is already being taken by various educational and commercial institutions. Proper management skills will solve the problem of negative attitudes towards the use of maintenance manuals by the present technicians controlling maintenance in a number of maintenance organisations. With proper management skills an efficient recording system will be possible for feedback purposes.
- (h) The feedback information should be passed to the design team for their future reference. This is easier in big organisations which have both maintenance and design teams side by side. In the case where design team is outside the organisation it should be the responsibility of the design team to visit the building periodically to check whether there are any design faults noticed by the maintenance team. This will enable them to produce better buildings as far as maintenance cost is concerned. The information recorded in the log sheets in the light of practical experience should assist in updating of the manuals when and where required.
- (i) The fee for preparing a maintenance manual should form part of the whole fee to the architect's usual design and supervision contract. The fee should be on a sliding scale similar to that charged for architectural fees, starting at $\frac{1}{2}\%$ on small projects and reducing to $\frac{1}{10}\%$ for large projects as was recommended by the Building Maintenance Committee in their publication, Maintenance Manuals

for Buildings, 1970. This is a reasonable rate bearing in mind that the maintenance cost of a building throughout its lifetime is usually 2 to 4 times the initial cost.

7.2. The Benefits of Maintenance Manuals

The resultant well-prepared comprehensive maintenance manuals would offer the following benefits:

- (a) They will provide knowledge and understanding of the buildings which contribute to the safety and security of maintenance operatives as well as other persons as statutorily required. The amount of dangerous works would be reduced or eliminated completely. These are repair and maintenance works where, although imminent structural failure may not be involved, possible injury to personnel or any other persons could arise. The compliance with the maintenance priorities provided in the manuals would result in the safety and security required. The accidents encountered by the operatives in the course of their work due to lack of clear instructions on the procedure to adopt, and the necessary safety warnings should be reduced as a result of the use of maintenance manuals.
- (b) They encourage the implementation of planned maintenance which leads to efficient use of maintenance resources. This reduces maintenance costs. The diagnosis of the maintenance problems would be done within a short time. Inspections for the purpose of understanding the building design will be reduced. The nature of the reported maintenance problem may be determined by reference to the manuals and thus cutting down unnecessary expensive site visits.

The unnecessary storage of materials would be cut down. Economy in the use of materials due to the adoption of the right maintenance techniques will be effected.

(c) They will enable the life spans of the buildings to be extended and thus defer expenditure on new buildings. The prolonged life spans of the buildings increase their values. This is achieved by compliance with the maintenance and/or operation instructions provided in the manuals which in turn reduce the rate of deterioration of the buildings.

(d) They may reduce insurance premiums in cases where insurance premiums are based on the facilities provided to reduce risks. The possibility of risks may be considered in terms of the likelihood of operatives carrying out the work in a way which may render the building dangerous to its users and occupants. Another possibility of risks may be considered in terms of the operative causing accidents to himself or any other person(s) in the course of execution of the maintenance work due to lack of clear instructions or knowledge of the building itself.

The maintenance and/or operation instructions provided in the manuals in respect of the works to be done to meet the requirements of the insurance policy may influence the amount of insurance premiums. These instructions may cover items such as fire fighting equipment, lifts, boilers, etc.

(e) They will promote technical development of the traditional building crafts like bricklayers, carpenters, plasterers, etc. These operatives will be able to learn new maintenance techniques brought about by new construction methods by the use of manuals. This should lead to greater efficiency in building maintenance.

- (f) They will provide a link between the design team, maintenance team and owners or occupiers for their mutual benefit. The maintenance problems which would be better solved at the design stage may be brought to light for consideration by all concerned. This will lead to the designers producing better new buildings which may be cheap to maintain.
- (g) They may reduce dependency on expensive technical experts and thus allowing the engagement of lower grade staff for maintenance who can do certain maintenance tasks equally well. This may cover maintenance tasks such as diagnosis of certain maintenance problems, certain building inspections, etc. Close technical supervision over the operatives on certain jobs may be reduced and thus minimising supervision costs.
- (h) They will enable the standardisation of maintenance procedures. This will enable maintenance management to assess the efficiency of the operatives. The implementation of the use of computers to aid maintenance management can be possible with much ease. The paperwork in some stages in the maintenance organisations may be reduced by the use of manuals e.g. the job sheets may be eliminated and thus reducing the clerical staff involved in the exercise of completing the job sheets.

The aforesaid benefits of the manuals leave no doubt that the production and use of maintenance manuals should be advocated to the building owners, occupants, maintenance team and architects. Their present limited application is due to lack of consideration of the points brought to light on the various aspects of the manual examined in the study. The preparation problems and the application limitations of the manuals would largely be solved by consideration of the aforesaid points together with the implementation of the recommendations provided. The end result would be a well prepared comprehensive maintenance manual whose application would realise the

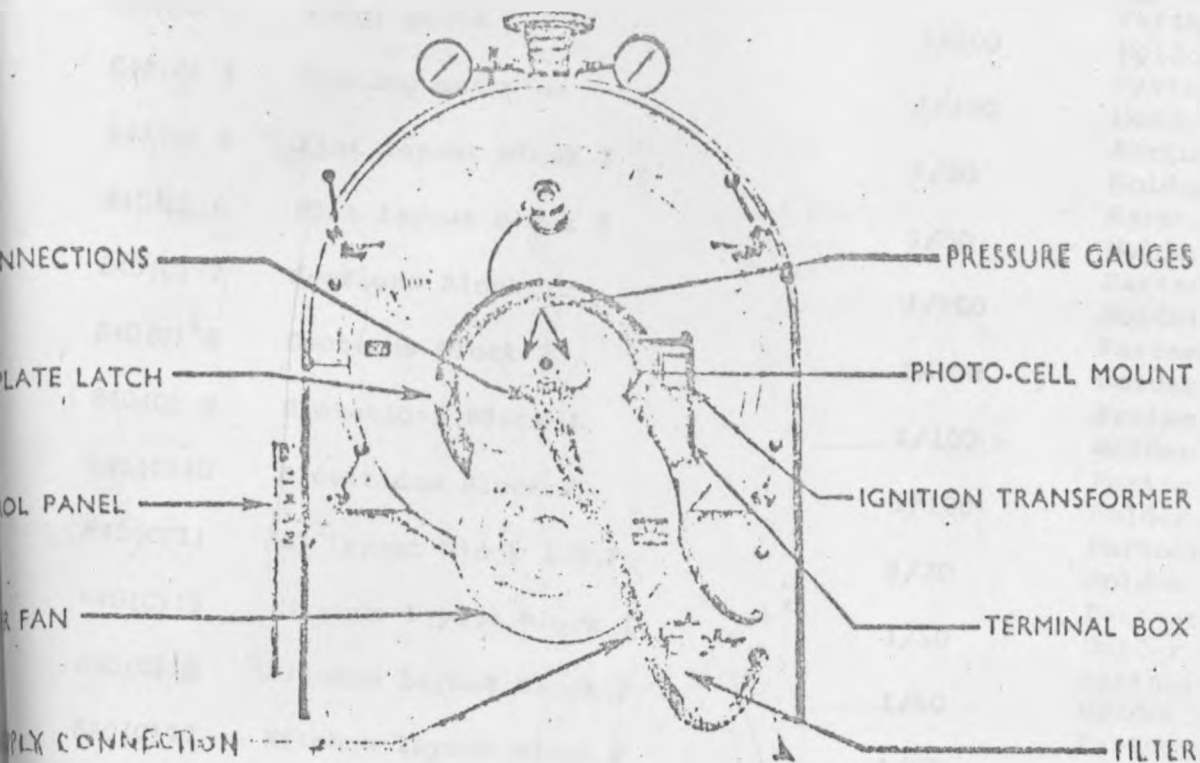
aforesaid benefits.

With the growing awareness of the benefits of the manuals and of the need for planned maintenance, it is anticipated that there will be an increasing use of the manuals. However, the data provided in the manuals should be used as guidance and should be constantly updated in the light of experience.

Floor	Location	Gross area	Net lettable area	Maximum live load
G.F.	Block 1	247.55 m ²	--	1.5 kN/m ²
F.F.	Block 1	247.55 m ²	--	1.5 kN/m ²
F.F.	Block 1	247.55 m ²	--	1.5 kN/m ²
G.F.	Block 2	138.4 m ²	--	1.5 kN/m ²
F.F.	Block 2	138.4 m ²	--	1.5 kN/m ²
F.F.	Block 2	138.4 m ²	--	1.5 kN/m ²

ELEMENT NUMBER 2 (FLOORS, CEILINGS)

Item no	Item	Maintenance Specification	Quantity	Location	Maintenance Frequency							
					Twice Daily	Day	Week	One month	Three month	Six month	One year or longer	
2/1	Acoustic Tile	Vacuum clean with brush attachment	2300 SF	Basement Access								Vacuum. 1 Year
			1125 SF	Stairs 1, 2, 3, 4. (roof slab)								
		Replace as necessary.	70938 SF	All office areas and associated circulation								
2/2	Asphalte Flooring and Skirting	Wash with clean water and wipe dry.	729 SF	Escape Corridors			Wash					
		Sweep clean and hose down.	247 SF	Tank Room						Wash		
			74 SF	Air Extract Area						Wash		
			362 SF	Cooling Tower Well						Wash		
2/3	Carpet Tile	Vacuum.	53400 SF	Offices and associated rooms		Vac.			Clean			
		Shampoo clean with proprietary carpet shampoo and report wear.	14092 SF	Circulation		Vac.			Clean			
			2331 SF	Conference Rooms		Vac.			Clean			
			1115 SF	Library		Vac.			Clean			
2/4	Concrete Ceilings	Repaint to Specification	742 SF	Escape corridors to Stairs 6, 7. Stores under 5, 6, 7.								Repaint 5 Years
			4720 SF	Basement plant rooms Service Core								Repaint 3 Years Repaint 3 Years
			189 SF	Air Intake Room								Repaint 5 Years
			130 SF	Air Extract Area								Repaint 3 Years



PERFORMANCE AND CONSUMPTION Data for Light Distillate Oils

Pyrotherm Model No.		Boiler Rating B.T.U./Hour	Nu-way Burner Model No.	Fuel Pump H.P.	Fan Motor H.P.	Run Current Amps/Ph.	Start Current Amps/Ph.
Model No.	"Pyrotherm"						
40		400,000	P1 LA-5	1	1	3.7	14.8
65	AYP 65	650,000	P1 LA-5	1	1	3.7	14.8
125	AYP 125	1,000,000	P1 LA-5	1	1	3.7	14.8
150		1,250,000	P1 LA-5	1	1	3.7	14.8
175		1,600,000	P1 LB-5	1	1	3.7	14.8
200	AYP 200	2,000,000	P1 LC-8	1	1 1/2	4.5	18.0
		2,500,000	P1 LC-8	1	1 1/2	4.5	18.0
	AYP 325	3,250,000	P2 LA-5	2	2 1/2	6.0	24.0
		3,500,000	P2 LA-9	2	4	8.2	32.8
	AYP 400	4,000,000	P2 LA-9	2	4	8.2	32.8

PERFORMANCE AND CONSUMPTION Data for Medium and Heavy Fuel Oils

Pyrotherm Model No.		Boiler Rating B.T.U./Hour	Nu-way Burner Model No.		Fuel Pump H.P.	Fan Motor H.P.	Oil Heater Kw.	Run Current Amps/Ph.	Start Current Amps/Ph.
Model No.	"Pyrotherm"		Model No.	Model No.					
		400,000	P1 MA/5	P1 HA/5	1	1	3	10	19.7
65	AYP 65	650,000	P1 MA/5	P1 HA/5	1	1	3	10	19.7
		1,000,000	P1 MA/5	P1 HA/5	1	1	3	10	19.7
125	AYP 125	1,250,000	P1 MA/5	P1 HA/5	1	1	3	10	19.7
		1,600,000	P1 MB/5	P1 HB/5	1	1	4 1/2	10	19.7
200	AYP 200	2,000,000	P1 MC/8	P1 HC/8	1	1 1/2	4 1/2	11	24.5
		2,500,000	P1 MC/8	P1 HC/8	1	2 1/2	4 1/2	12	30.5
325	AYP 325	3,250,000	P2 MA/5	P2 HA/5	2	2 1/2	6	19	37.0
		3,500,000	P2 MA/9	P2 HA/9	2	4	6	21.2	45.3
400	AYP 400	4,000,000	P2 MB/9	P2 HB/9	2	4	7 1/2	23.4	48.0

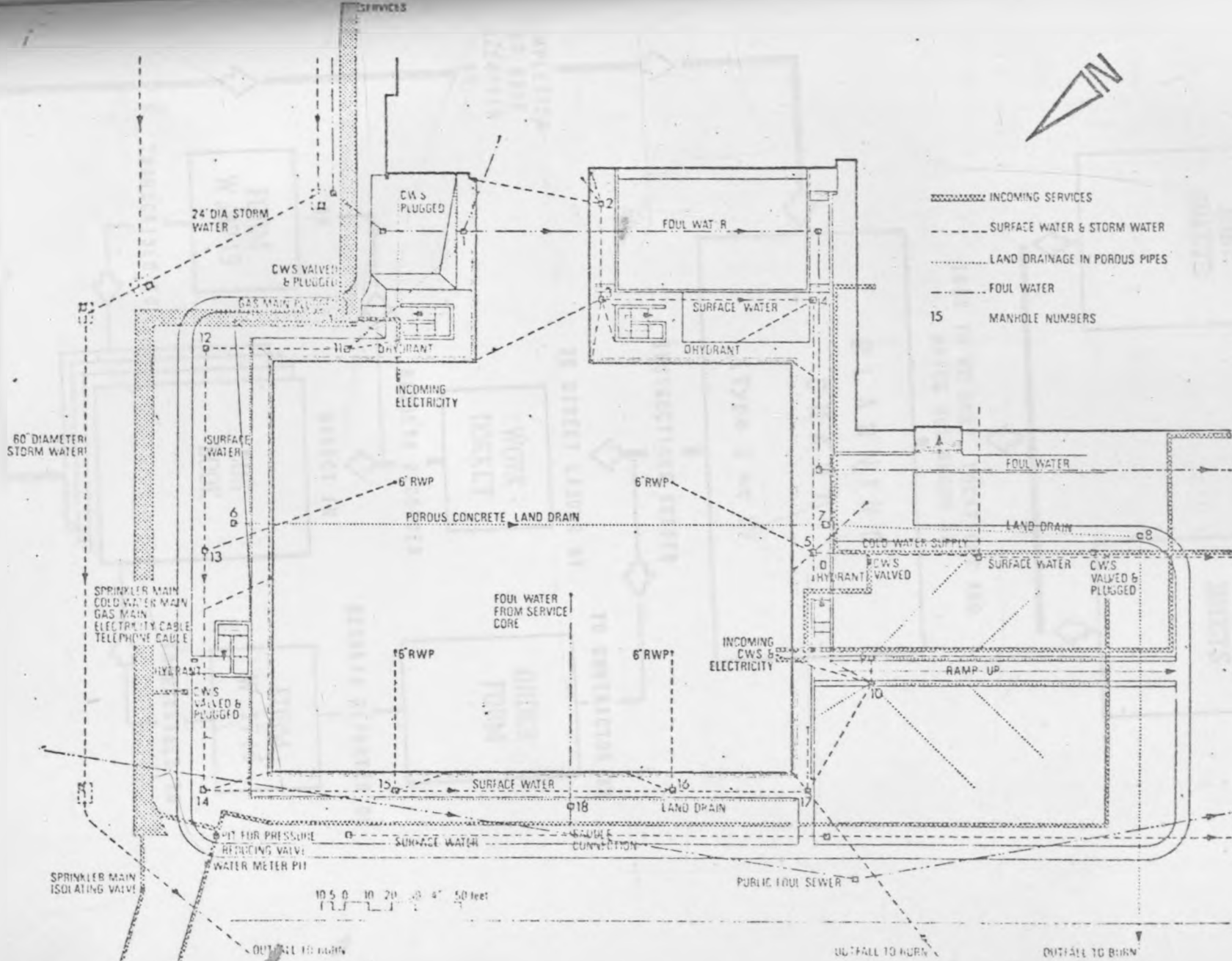
VISCOSITIES —
MODELS
30 seconds R.1 at 100 F.
60 seconds R.1 at 100 F.
90 seconds R.1 at 100 F.
120 seconds R.1 at 100 F.

2. For burning fuel oils having viscosities up to 3,500 secs R.1 at 100 F., special versions of Models P-H are available (designation Models P-X); — further details available upon request.

3. ELECTRIC LOADINGS in above tables based on 240 V./3/50 A.C. Units of 240 V. for 380-440 volts/3/50 A.C. only.

Architects-Structural engineer-Mechanical engineer-Drawing engineer-Heating engineer-Electrical engineer-Specialist

Drawing no.	Subject of drawing	Scale of drawing	Obtainable from
840(C) 2	Site layout	1/200	Holder and Mathias Partnership
840(C) 3	Floor plans	1/100	Holder and Mathias Partnership
840(C) 4	Setting out plan	1/100	Holder and Mathias Partnership
840(C) 5	Flat layout block 1	1/50	Holder and Mathias Partnership
840(C) 6	Flat layout block 2	1/50	Holder and Mathias Partnership
840(C) 7	Sections Block 1	1/100	Holder and Mathias Partnership
840(C) 8	Sections Block 2	1/100	Holder and Mathias Partnership
840(C) 9	Elevations Block 1	1/100	Holder and Mathias Partnership
840(C) 10	Elevations Block 2	1/100	Holder and Mathias Partnership
840(C) 11	WC layout Block 1 G.F.	1/20	Holder and Mathias Partnership
840(C) 15	Kitchen layout Block 1	1/50	Holder and Mathias Partnership
840(C) 16	Kitchen layout Block 2	1/50	Holder and Mathias Partnership
840(C) 17	Kitchen layout Block 2	1/50	Holder and Mathias Partnership
840(C) 18	Colour/finishes schedule	1/100	Holder and Mathias Partnership
M.1263/1	Mechanical Services General layout	1/100	McCann & Partners
/2	Mechanical Service flat layouts	1/50	McCann & Partners
1263/E1	Electrical Services site plan	1/100	McCann & Partners
1263/E2	Electrical Services Block 1	1/50	McCann & Partners
1263/E3	Electrical Services Block 2	1/50	McCann & Partners
1263/E4	Electrical Services wiring diagrams	-	McCann & Partners
1767/B1	Block 1 Foundation plan	1/50	Veryard & Partners
B2	Block 1 Ground floor plan	1/50	Veryard & Partners
B3	Block 1 F.F. plan	1/50	Veryard & Partners
B4	Block 1 S.F. plan	1/50	Veryard & Partners
B5	Block 1 Roof plan	1/50	Veryard & Partners
B6	Block 1 Staircase details	1/50	Veryard & Partners
B7	Block 1 Cross Sections	1/50	Veryard & Partners
B8	Block 2 Foundation plan	1/50	Veryard & Partners
B9	Block 2 G.F. plan	1/50	Veryard & Partners
B10	Block 2 F.F. plan	1/50	Veryard & Partners
B11	Block 2 S.F. plan	1/50	Veryard & Partners
B12	Block 2 Roof plan	1/50	Veryard & Partners
B13	Block 2 Staircase details	1/50	Veryard & Partners
B14	Block 2 Cross section	1/50	Veryard & Partners
B15	Blocks 1 and 2 Lintel schedule	1/50	Veryard & Partners



- INCOMING SERVICES
- SURFACE WATER & STORM WATER
- LAND DRAINAGE IN POROUS PIPES
- FOUL WATER
- 15 MANHOLE NUMBERS

10 5 0 10 20 30 40 50 feet

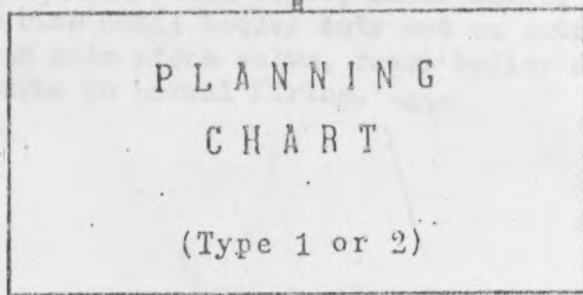
DRAINAGE BY ORIGINAL METHODS

THE PLANNED MAINTENANCE SYSTEM

INSTRUCTIONS ON WORK TO BE DONE AND FREQUENCY TAKEN FROM INSTALLATIONS TO BE MAINTAINED DESCRIBED ON



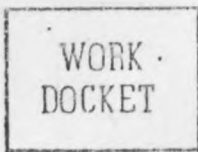
JOB TO BE DONE, LOCATIONS AND DATES DUE SHOWN ON



INSTRUCTIONS ISSUED

TO DIRECT LABOUR BY

TO CONTRACTOR BY

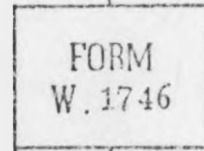
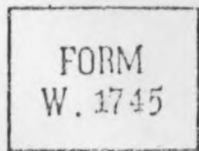


RESULTS RECORDED

RESULTS REPORTED ON

ON

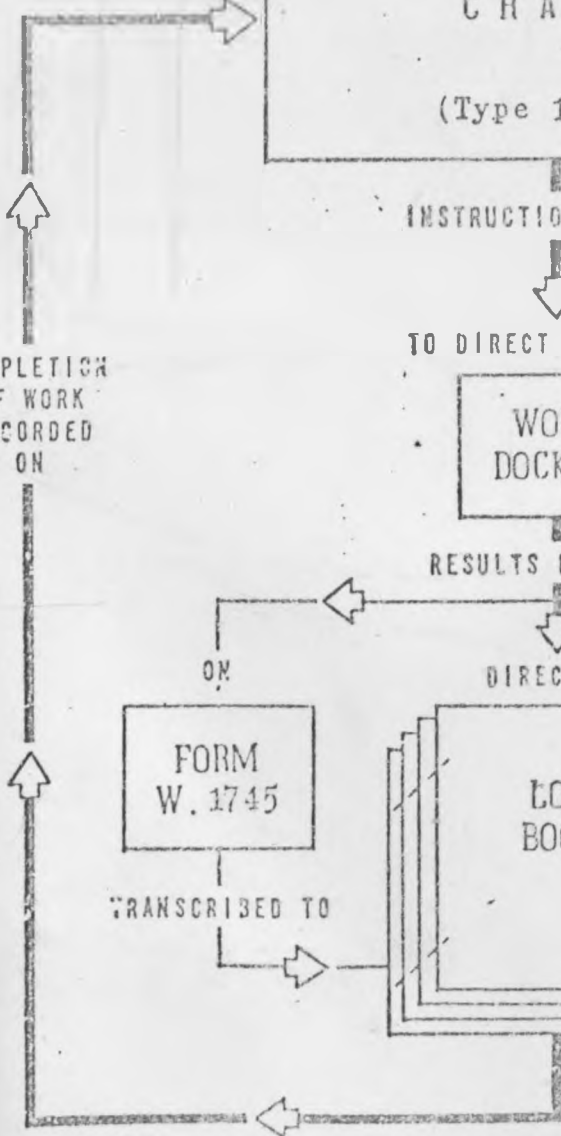
DIRECT IN



TRANSCRIBED TO

TRANSCRIBED TO

COMPLETION OF WORK RECORDED ON



WORKED 4. Sm Hrs	AREA No. Q 01	New Boiler House	MAN. REF. Y1-1
EQUIPMENT TYPE Central Boiler Plant (Boiler 1)			TOOLS - SP DATA - REFC
EQUIPMENT	No. OFF	MAINTENANCE SPECIFICATION	
Boiler valves	19	Test valves for free travel and check for leaks.	
Water strainer	1	Remove and clean.	
Linkages		Check for loose joints and lubricate.	
Closing line liner.	1	Remove and clean.	
Feed pump	1	Check feed pump gland for leaks.	
High pressure		Close main steam valve, allow boiler pressure to rise until boiler cuts out on extra high pressure. Open main steam valve, reset boiler and ensure it returns to normal firing.	

43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

PPM 11-1		Central Rail House		SCOPE NO.	
DATE	TEST RESULT	SPARES REQUIRED	SPARES USED	SIGNED	ACTION TAKEN
1-2	OK			<i>[Signature]</i>	M 25/1/21
4-7	OK			<i>[Signature]</i>	M 21/2-79
2-7				<i>[Signature]</i>	
6-8	FOILER ON STRIP DOWN.			<i>[Signature]</i>	M 25-6-80
2-8	OK			<i>[Signature]</i>	
4-1	Strip into wires using pliers			<i>[Signature]</i>	M 23/3/21

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
WKP BLDGS LTG (1)	✓						✓						✓				✓			
WKP BLDGS LTG (2)	✓						✓						✓				✓			
L/Rd BLDGS LTG	✓						✓						✓				✓			
HALLS BLR CLNG (1)					✓										✓					
HALLS BLR CLNG (2)					✓										✓					
WKP PLT RM CLNG (1)			✓								✓									✓
WKP PLT RM CLNG (2)			✓								✓									✓
SUB/ST-F/O SPACES CLNG					✓															
F/O SPACES CLNG															✓					
GENERATOR MAINT:						✓										✓				
ST: LTG(WKP/L-Rd ETC)		✓				✓				✓									✓	
ST: LTG(WKP ONLY)																				✓
WKP BLDGS PLT MAINT:(1)											✓								✓	
WKP BLDGS PLT MAINT:(2)											✓								✓	
WKP BLDGS PLT MAINT:(3)											✓								✓	
WKP BLDGS PLT ROUND		✓		✓		✓		✓				✓	✓	✓	✓					✓
WKP BLDGS TEMP: ROUND																				✓
WKP BLDGS W/SOFTNERS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
WKP S/LINE TRAPS (1)																				✓
WKP S/LINE TRAPS (2)																				✓
WKP S/LINE TRAPS (3)	✓																			✓
TOB MAIN BLRS MAINT:																				
TOB SM/BLRS-CCMP:-ETC						✓										✓				
MIS: BLDGS F/OIL QTY			✓		✓	✓	✓		✓		✓		✓		✓		✓		✓	
MIS: BLDGS PLT MAINT:						✓										✓				
HORTI/GRDS/UT-FARM Hs						✓										✓				
LONDON RD PLT MAINT:										✓									✓	
L/Rd BLDGS W/SOFTNERS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
L/Rd BLDGS STILLS							✓													✓
HALLS BLR Hs ROUND	✓	✓		✓				✓		✓		✓		✓		✓		✓		✓
HALLS PLT MAINT: (1)						✓														
HALLS PLT MAINT: (2)						✓														
HALLS PLT MAINT: (3)						✓														
HALLS PLT MAINT: (4)						✓														
HALLS K/FANS-D/WASH (1)							✓													
HALLS K/FANS-D/WASH (2)							✓													
SPINNEY MAINT:	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓	
BATTERY K/FILTERS								✓												
PALMER BLDG LTG	✓						✓						✓				✓			
PALMER BLDG E/LTG	✓												✓							
SO-CTS/PLAY AREA LTG		✓				✓				✓										✓
WAG: BATT: VAN MAINT:		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓
VAN LOG SHEETS	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓	
WAG: BATT: (LIST BELOW)	4		3		1		4		3		1		4		2		3		1	

	41	42	43	44	45	46	47	48	49	50	52
WKP BLDGS LTC (1)	✓				✓				✓		
WKP BLDGS LTC (2)	✓				✓				✓		
L/Rd BLDGS LTC	✓				✓				✓		
HALLS BLR CLNG (1)			✓							✓	
HALLS BLR CLNG (2)			✓							✓	
WKP PLT RM CLNG (1)							✓				
WKP PLT RM CLNG (2)							✓				
SUB/ST-F/O SPACES CLNG			✓								
F/O SPACES CLNG										✓	
GENERATOR MAINT:				✓							✓
ST: LTC(WKP/L-Rd ETC)		✓				✓				✓	
ST: LTC(WKP ONLY)				✓				✓			
/1 WKP BLDGS PLT MAINT:(1)						✓					
/2 WKP BLDGS PLT MAINT:(2)						✓					
/3 WKP BLDGS PLT MAINT:(3)						✓					
/4 WKP BLDGS FLT ROUND	✓	✓	✓	✓	✓			✓	✓	✓	✓
/5 WKP BLDGS TEMP: ROUND	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
/6 WKP BLDGS W/SOFTNERS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
/7 WKP S/LINE TRAPS (1)			✓							✓	
/8 WKP S/LINE TRAPS (2)					✓						
/9 WKP S/LINE TRAPS (3)								✓			
/1 TOB MAIN BLRS MAINT:				✓							✓
/2 TOB SM/BLRS-COMP:-ETC				✓							✓
1 MIS: BLDGS F/OIL QTY				✓	✓					✓	✓
2 MIS: BLDGS FLT MAINT:				✓							✓
1 HORTI/GRDS				✓							✓
1 LONDON Rd FLT MAINT:						✓					
2 L/Rd BLDGS W/SOFTNERS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 L/Rd BLDGS STILLS							✓				
4 HALLS BLR Hs ROUND	✓	✓	✓			✓	✓	✓	✓	✓	✓
2 HALLS FLT MAINT: (1)				✓							✓
3 HALLS FLT MAINT: (2)				✓							✓
4 HALLS FLT MAINT: (3)				✓							✓
5 HALLS FLT MAINT: (4)				✓							✓
6A HALLS K/FANS-D/WASH (1)					✓						
6B HALLS K/FANS-D/WASH (2)					✓						
SPINNEY MAINT:	✓		✓		✓		✓		✓		✓
BATTERY K/FILTERS				✓							
PALMER BLDG LTC	✓				✓				✓		
PALMER BLDG W/LTG	✓								✓		
SO-CRE/PLAY AREA LTC				✓				✓			
ENG: ENGT: VAN MAINT:		✓		3/		✓		✓		✓	
VAN LOG SHEETS	✓		✓		✓		✓		✓		✓
ENG: ENGT: (LTD)	✓		✓	1	4		3	1			

PLANNED MAINTENANCE JOB SHEET

Details in the boxes below are to be recorded on Time Sheet

Job Location	Job Description	Job Number
LONDON Rd SITE	Replacement of burnt out lamps	502

Details of work:- Replace burnt out lamps in the following buildings, Gt/Hall, Toilets outside the Gt/Hall, Library, Buttery, O.R.Bldg, St Davids, and Gymnasium. The above inspections also includes the Main L/Rd entrance and the outside lights around the above buildings.

NOTE:-BEFORE WORKING ON ANY LIGHT, FIRST ENSURE THE SUPPLY IS OFF.

ALWAYS USE 250/260 VOLT LAMPS, AND REPORT ANY FAULTS FOUND TO SUPERVISOR.

Job issued to:-

Issued week no:-

Report upon work carried out (TO BE FILLED IN BY THE PERSON WHO CARRIED OUT THE JO

Date job completed:-

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