An Assessment of
Turn-key Contracts
for the
Realisation of Capital Works Projects
Principally for Public Sector Healthcare Facilities

prepared by

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under contract to

The Pan American Health Organisation

with funding from

The United States Agency for International Development

November 2008

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November 2008

1 Preambles

The traditional approach to capital works building projects in Anglo-Saxon countries, including the Commonwealth Caribbean, is for the owner to have separate contracts for architects, structural & civil engineering consultants, electrical & mechanical engineering consultants, quantity surveyors (except in North America) and construction contractors. Occasionally the design team (architects, structural & civil engineering consultants, electrical & mechanical engineering consultants, quantity surveyors) are consolidated into one contract. Occasionally there is added to the team a project manager, although this coordinating role is traditionally allocated to the architect in buildings for human occupancy. The main construction contractor would usually have several sub-contractors although these sub-contractor services are sometimes contracted separately and directly by the owner.

In recent decades there has been a gradual increase in the use of various forms of package contracts. These various forms will be described in outline in the section which follows. Because of the increasing use and contemplation of use of package contracts for healthcare facilities in the Caribbean, the Pan American Health Organisation an assessment of such arrangements. In particular, this document will outline some of the reasons why package contracts are used and examine the advantages and disadvantages of such contracts. To the extent that there are disadvantages, proposals for their mitigation are presented herein.

2 Definitions

The various, more common forms of package contracts are outlined in order of greater inclusion of services.

BOLT Contracts	Build-Operate-Lease-Transfer contracts usually involve the contractor in providing the land, planning permissions, designs, finance, construction, equipment, commissioning, maintenance, and management of the facility for a medium to long period (say 25 years). The client user (eventual owner) of the facility would pay a rent to the contractor for the overall service. At the end of the period the contractor would transfer the ownership of the facility. In some cases the land would have been originally owned by the client user and conveyed to the BOLT contractor at the

commencement of the contract.

DBOT Contracts	Design-Build-Operate-Transfer contracts are similar to BOLT contracts. In these contracts finance is not always provided by the contractor. The single point of responsibility encourages the contractor to produce a facility that minimises life-cycle costs, rather than merely minimising the initial costs of the project. As in the case of a BOLT contract, the overall contractor has a direct financial interest in the medium to long term quality of the facility.
EPC Contracts	In an Engineering-Procurement-Construction contract, the EPC contractor (EPCC) agrees to deliver the keys of a commissioned plant to the owner for an agreed amount, just as a builder hands over the keys of a flat to the purchaser. FIDIC[1] Conditions of Contract for EPC, are recommended where one entity takes total responsibility for the design and execution of an engineering project. Under the usual arrangements for this type of contract, the entity carries out all the engineering, procurement and construction: providing a fully-equipped facility, ready for operation (at the "turn of the key").
DB Contracts	Design-Build contracts are not as comprehensive as BOLT or DBOT contracts. DB contracts usually exclude the land, planning permissions, finance, maintenance, and management of the facility. However, the owner contracts for both design and construction from a single entity.
PFI	Private Finance Initiative is where the public sector contracts to purchase quality services, with defined outputs, from the private sector on a long-term basis, and including maintaining or constructing the necessary infrastructure and buildings so as to take advantage of private sector management skills with the incentive of having private finance put at risk.
Turn-key Contract	The term “turn-key contract” encompasses all of the above variations, and several more – Build-Operate-Transfer (BOT); Build-Operate-Own-Transfer (BOOT); Rehabilitate-Operate-Transfer (ROT) The New Dictionary of Civil Engineering (Penguin 2005 edition)

[1]International Federation of Consulting Engineers (the acronym stands for the French version of the name) represents globally the consulting engineering industry. As such, the Federation promotes the business interest of firms supplying technology-based intellectual services for the built and natural environment.

states: "**turnkey contract** [bus.] A *design and build contract* in which a single contractor is responsible for providing all services, including finance."

Project Delivery System — The process by which a construction project is comprehensively designed and constructed for an owner, including:

- Project scope definition,
- Organisation of designers, constructors and various consultants,
- Sequencing of design and construction operations,
- Execution of design and construction,
- Close-out and start-up.

Procurement Method — The process of choosing designers, constructors and various specialist consultants, including:

- Assessment of technical qualifications;
- Assessment of price proposals;
- Definition of the "most favourable" bid;
- Selection of project participants.

Contract — The form of agreement in a construction project, including the participants':

- Requirements, obligations and responsibilities;
- Allocation of project risk;
- Payment procedures.

3 Reasons for Using Turn-key Contracts

There are a number of reasons why an owner would select a Turn-key Contract for a particular project. Many of these reasons are well-founded. Some of the reasons may be due to misconceptions.

Faster Overall Schedule — There are at least two scenarios where this is important. If the project will generate income for the owner, the earlier it could be put into use, the more favourable the situation. It is easier to "fast track" a Turn-key Contract. Construction work could commence at an earlier stage in the design process.

In the public sector there may be a question of the impending expiration of funding authority such as with the term limit of an administration. The time taken to award a design contract, to complete bid documents, to conclude the bidding process and to award a construction contract may jeopardise the project. The owner gets an earlier start to the construction of the project in exchange for losing some control over the design.

Turn-key contracts have the potential to reduce the overall period of design and construction. This comes about because of the overlapping of design and construction – fast tracking.

Single Responsibility

Turn-key contracts take many forms. There are differences in financing structures, procurement procedures, completeness of design at the time of contract start, internal arrangements between designers and builders, responsibilities for operating the facility and long-term maintenance of the facility are some of the issues. However, there is one essential characteristic of Turn-key contracts – a single point of responsibility for design and construction.

The owner may require a single entity to be responsible for both the design and the construction. This may be brought about by the remoteness of the site, by long-term considerations or by security considerations which require limited access to project documentation.

In the traditional situation with separate design and construction contracts there is an implicit warrantee by the owner to the constructor for the adequacy of the design. In other words, if the facility is constructed exactly in accordance with the design, then the constructor is freed of responsibility for its long-term performance.

With complex projects it is difficult to establish conclusively whether faults are due to inadequate design or unsatisfactory construction. By placing both function into one contract that need is avoided.

Construction Method

With complex projects it is valuable to involve the constructor at an early stage in the development of the design and indeed throughout the design phase of the project. This can be beneficial for both the cost and the schedule for construction. In the case of cost, both the quantum and the predictability could be favourably influenced.

Innovation

New and unique design and construction processes can more easily be incorporated in projects where the designer and builder are contractually joined together. Introducing construction contractor knowledge and experience early into the design fosters creativity

	and innovation.
Owner's Capability	When the project is outside of the owner's previous experience and when the owner's in-house technical resources are unable to monitor the work of designers and constructors, a Turn-key Contract may provide a degree of comfort.
Off Balance Sheet	The accounting treatment of a PFI project on a government's balance sheet may allow for the project cost not to be shown. This is so even though the accounting and reporting follows rules set by independent international organisations.

4 Questions to be Answered when Deciding whether to Utilise a Turn-key Contract

If the owner is considering utilising a Turn-key Contract for a particular project, it is highly desirable (some may say essential) that the following questions be tabled, discussed and answered before making a final decision. The questions should be answered pragmatically, objectively, avoiding over-optimism and political pressures.

Project Timing

The questions which follow deal with the project's time horizon:

- Can there be significant time savings by carrying out design and construction concurrently?
- Will constraints from the owner's human resources affect the project schedule?
- Are there deadlines for the start and end of the project?
- Can potential time savings actually be realised?

Complexity

The owner should review the technical complexity of the project. Here are some questions to be answered:

- Does the project include several distinct and different features – eg buildings, treatment plants, access roads?
- Are the different features closely related?
- Will construction scheduling be a major issue?
- Does the site have unusual conditions?
- Are specialist skills required for design and construction?
- Are specialists available in the locality of the project?

Value

The owner needs to review whether relinquishing total control of the design would be compensated for by some other value added as a result of the Turn-key arrangement. The following questions may be useful in this respect:

- Will a higher quality product result from designs tailored to the builder's capabilities?
- Will there be less negative impact on the public with the

use of accelerated construction schedules?

Scope

At the end of the deliberations over the previous questions, should the decision be taken to proceed with a Turn-key Contract, the owner's team should conclude this exercise by preparing a formal project scope. The steps to be taken and documented could be those listed below:

- Agree on the single most important for the project – cost, schedule or quality.
- List the reasons for deciding on a Turn-key approach.
- List the potential benefits of using the Turn-key approach as well as the owner's actions required to realise those benefits.
- List the major components of the project.
- List the essential functions associated with each component.
- List the design constraints associated with each component.
- For each essential function list the performance requirements that define that function.
- For each performance requirement, list the performance criteria necessary to satisfy the requirement.

PFI

The PFI model for public projects is only likely to be applicable where:

- The private sector has the expertise to deliver and there is good reason to think it will offer value for money;
- The structure of the project is appropriate, allowing the public sector to define its needs as service outputs that can be adequately contracted for in a way that ensures effective, equitable and accountable delivery of public services in the long term;
- It can be demonstrated that PFI offers greater value for money for the public sector compared with other forms of procurement;
- The nature of the assets and services which form part of the PFI scheme are capable of being costed on a whole-of-life, long-term basis.

The use of PFI is unlikely to be appropriate where:

- The pre-conditions of equity and accountability in public service delivery could not be met;
- The transaction costs of pursuing PFI were disproportionate compared to the value of the investment;
- The fast pace of technological change in a particular sector

made it too difficult to establish long-term requirements.

5 Potential Advantages

It must be recognised that the advantages to be gained (potentially) from utilising various forms of Turn-key contracts usually require complementary actions on the part of the owner.

Some of the advantages of Turn-key contracts are already described in Section 3 – Reasons for Using Turn-key Contracts. They include Faster Overall Schedule, Single point of Responsibility, constructability and innovation.

Other advantages are outlined below:

Cost Considerations	The project cost could be fixed before detailed design is well advanced. By giving one entity total control over scope, design and budget reduces the likelihood of scope-related price changes. There is the potential for lower overall costs due to: ● the shortening of the project duration; ● the introduction of the construction contractor's knowledge and experience in the early stages of design. There is a reduction in claims for extras.
Disputes	The owner should be relatively sheltered from liability arising rom design errors or omissions. No longer is the designer an agent of the owner. Turn-key contract reduce the possibility of adversarial relationships between the designer and builder.
Schedule	In addition to establishing the project cost at an early stage, Turn-key contracts make it easier to fix the overall project schedule early on. A majority of project time overruns stems from communication problems between designers and builders – requests for information, design errors, design omissions – which can be minimised with Turn-key arrangements.
Size and Complexity	Many owners do not have the in-house knowledge and experience to manage large or complex projects involving separate contracts for several design entities and construction contractors. Dealing with one entity would reduce the administrative burden.
Sharing Risk	Where the sharing of risk is done appropriately and effectively, it is the key to ensuring that the value-for-money benefits in PFI projects are realised. There are certain risks that are best managed

by government in a public sector project. To seek to transfer these risks would be counterproductive in terms of costs.

The benefits PFI can offer, in terms of on-time and within-budget delivery and whole-of-life costing, flow from ensuring that the various types of risks inherent in a major project – eg building design risk or construction risk – are borne by the party best placed to manage them. This approach to risk sharing provides powerful incentives for the private sector to perform and ensures value for money for the public sector.

In the right circumstances, and where effectively used, PFI can help ensure desired service standards are maintained. Since under PFI the private sector's capital, not just its profit, is at risk depending on private sector performance, there is a very strong incentive for the private sector to maintain high and reliable service standards throughout the life of the contract.

The key risks that the public sector should not seek to transfer are usually:

- the need for the facility on the date given and the adequacy of its overall size to meet the public service needs
- the possibility of a change in public sector requirements in the future
- whether the standards of delivery set by the public sector sufficiently meet public needs
- in most cases the extent to which the facility is used or not over the contract's life
- general inflation risk

The key risks that the public sector usually seeks to transfer by contract to the private sector over the term of the contract should be specifically identified and limited. This could be the following:

- meeting required standards of delivery
- cost overrun risk during construction
- timely completion of the facility
- underlying cost to the operator of the service delivery, and the future costs associated with the asset
- risk of industrial action or physical damage
- in limited cases, certain market risks

Private-sector Skills

With Private Finance Initiative the public sector can harness the private sector to deliver investment in better quality public services while maintaining frontline services in the public sector. The public sector defines what is required to meet public needs and remains the client throughout the life of the contract.

Long-term Maintenance	PFI ensures that contractors are bound into long-term maintenance contracts and shoulder the responsibility for the quality of the work they do.
Under-investment	PFI provides government with a vehicle for reversing the legacy of under-investment in public-service infrastructure. This legacy has resulted in falling standards in hospitals, schools and other public-service assets.

PFI Potential

In the right circumstances, and where effectively used, PFI can help ensure:

- new services are more likely to start on time, since the private-sector contractor does not get paid until it delivers;
- more efficient use of public money. Under PFI the public sector only pays for the service for which it has contracted, at the stipulated price, and only when the service is available;
- contractors have the incentive to deliver the required service over a long-term life of the asset. The private sector contractor only gets paid if it maintains standards throughout the length of the contract (eg 25 years in the case of a new PFI hospital). This means that in designing, building and maintaining aq PFI hospital the private sector has a strong incentive to high standards are built in and maintained across the building's long life. (If an operating theatre in a PFI hospital is unavailable, a deduction would be made from the unitary charge paid to the contractor until the theatre is again in full working order.)

PFI helps the public sector by providing:

- a better understanding of the total costs of providing the required facility and service;
- new ways of working, and new approaches to the delivery of the service. The public sector defines the service to be delivered, it is for the private contractor to decide how to deliver it, drawing on his own innovation and experience.

6 Disadvantages

Different Cultures

Users and owners occupy a different world from contractors (providers). Providers think that what they do is right, and users tend to accept it because they are led to believe in the expertise of the providers. Users who discover problems when using facilities tend to suffer in silence rather than blame openly the providers. Providers tend to blame owners for not correctly using and maintaining the facilities. Providers often win the silent battle between themselves and the owners. In Appendix I is reproduced a table prepared by architects Kernohan, Gray, Daish and Joiner illustrating cultural differences between owners (users) and Turn-key contractors (Providers). These can pose problems, especially when the control over design is handed to another party, as in the case of Turn-key contracts.

Restricted Pool of Bidders

Turn-key contracts can require the provision of many items and services, including the provision of land, obtaining planning permissions, designs, long-term finance, construction, equipment, commissioning services, long-term maintenance, and long-term management of the facility for up to (say) 25 years. At a minimum, the Turn-key contractor must supply design and construction services. The availability of suitable and willing contractors to bid on a project is inversely proportional to the number of distinct services they are required to provide. Therefore, one of the important disadvantages of Turn-key contracts is the narrowing of the field on candidates. There are cases where this narrowing actually causes the project to be cancelled in its Turn-key form.

Bid Costs and Times

High bid costs and long procurement times represent concerns for both the public and private sectors. These costs are eventually passed on to clients. Thus they impair value for money for the public sector and limit contractors' capacity to bid for projects. Bid costs are higher and procurement time scales are longer than for conventional procurement.

Complete Design

There are projects where there the final design must be completed before an accurate estimate of cost can sensibly be made. If the bidders are encouraged to submit tenders which allow for a high degree on uncertainty, the owner would end up probably paying too much for the facility. This is so because the design-builder would have to include a large contingency sum to cover those uncertainties. The other, equally unsatisfactory, scenario is that one of the competing bidders underbids the project. In both cases the owner would be faced with difficult decisions.

Owner Input	The owner may want significant input in the design. Successful Turn-key projects necessitates the design-builder to "own" the details of design. There is an assumption of trust between the owner and the contractor. If the owner attempts (or needs) to influence the details of design after the award of the contract, there could be negative cost implications and a breakdown in relationships. An owner who demands to control the design details may see every deviation from its mandate as an attempt to cut corners on quality. This could bring about an adversarial relationship to the detriment of the project.
Small Projects	Projects that are too small to attract competent Turn-key contractors should utilise the tradition procurement processes. The design-builder is taking on more risk than usual. The project must be large enough to a commensurate reward. Small Turn-key projects properly run have disproportionately high development, procurement and management costs. This is particularly evident with PFI projects. Some reasons are that: ● small projects face the same costs of using third-party finance, employing legal and technical advisers, and doing due diligence financial modelling as for much larger schemes; ● bidders in small PFI schemes must typically meet the costs of technical, financial, design and legal advisors; ● the procurement process for small projects is of comparable length to that of major capital schemes.
Equipment	Where specialised equipment is of a class with rapid development and improvement, there may be the need for greater flexibility in the contract terms. This is not what is envisaged in Turn-key contracts. Many aspects of high technology equipment procurement do not fit well with the central requirements of PFI, particularly: ● the fast pace of change in the sector make it difficult for the public sector to define effectively the outputs it requires in a long-term contract; ● the high level of integration of IT and other high technology infrastructure into the other systems of the owner makes it difficult to delineate clearly the areas of responsibility to the owner and the contractor;

- the duration and phasing of investment, where high technology projects have a short life, and include significant asset refresh, makes defining and enforcing long-term service needs problematic.

Procurement Periods

Long lead times for procurement can be associated with PFI contracts. Extended procurement periods can be the result of:

- the increased complexity of procuring a PFI project, including securing the necessary technical, legal and financial advice and conducting contract negotiations;
- the need for the public sector to specify carefully its actual service requirements, rather than provide a prescriptive design specification.

7 Strategies for Mitigating the Disadvantages

With the gradually increasing use of Turn-key contracts for hospitals and other large capital projects in the Caribbean and elsewhere, it is appropriate to provide some guidance towards improving the success of such projects.

Procurement Skills

Strong procurement skills are required from owners for delivering quality investment on time and in a way that secures value for money for the public sector. It is important that the owner has the capacity and the support needed for effective PFI procurement. PFI requires relevant expertise – long-term options appraisal, significant use of specialist advisers and probably complex contract negotiations reflecting the owner's approach to risk sharing.

User Participation

User participation in the design of projects is an important ingredient for success. This becomes more difficult in Turn-key projects where the owner hands over the responsibility for design to an entity which is not focussed solely, or even principally, on design. To counteract this disadvantage it is necessary to prepare more-detailed performance specifications (not prescriptions) than would be required in a conventional project.

Part of the procurement process for Turn-key projects involves negotiations. This is an opportunity to supplement the bid brief with the selected bidder. These negotiations take place in advance of the contract award so that the results of the negotiations can be incorporated in the contract from its start. All essential matters should be settled at this time.

There is great value in user knowledge. This must be gathered initially and incorporated in the performance specifications in the bid documents. They could then be reviewed with the selected bidder during the negotiation phase.

There are different kinds of users – occupants, visitors, owners and tenants. Their views must all be accommodated and this is the role of the owner and advisers. The providers (Turn-key contractor) include makers, traders, landlords and lessees, maintainers.

Performance Criteria

A "performance criterion" may be defined as "a rule by which the effectiveness of operation or function is judged and its value measured".

The project scope must be described by definitive, project-based performance criteria rather than by comprehensive construction plans and specifications. All parties must embrace performance criteria as the definitive project scope due to the risk of costly scope creep as the project proceeds to completion.

These performance criteria serve to articulate the scope, quality, cost, schedule and other requirements for a given project and become the foundation for the Turn-key contract.

Objectives

The owner has four main objectives when establishing the performance scope of work in a Turn-key contract:

- Develop a clear project description in functional terms.
- Define operational and quality requirements in performance terms.
- Define all the project's requirements without relying on the post-award process.
- Outline the performance/acceptance tests required that will demonstrate the requisite level of quality for each item of work.

Performance Categories

There are essentially four types of performance criteria that must be developed for every Turn-key project:

- Management
- Schedule
- Technical
- Cost

Management Criteria

This category can be broken down into six major areas:

- Applicable technical design experience
- Applicable technical construction experience
- Turn-key experience
- Experience working with current Turn-key partners as a team
- Experience working for the owner
- Experience in the project's geographic location

Quality

"Quality" may be defined as "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs".

The design-builder is in a position where the details of design and therefore the resulting level of quality are constrained by the budget and the schedule. It is very important to both the owner and the contractor that the requirements for quality be clearly communicated in the bid documents so that the resulting proposals will be responsive to the owner's needs.

There are six general approaches to articulating the owner's Turn-key quality requirements in the bid documents:

- Quality by qualifications
- Quality by evaluated programme
- Quality by specified programme
- Quality by performance criteria
- Quality by specification
- Quality by warranty

Schedule Criteria

Schedule criteria come in four general forms:

- Completion criteria
- Intermediate milestone criteria
- Restrictive criteria
- Descriptive criteria

Technical Criteria

It is necessary to understand the functional requirements of the project and its components thoroughly. To do this the persons preparing the technical criteria for the bid documents should answer the following questions:

- Which requirements are minimum or threshold requirements?
- What is each threshold?
- Are there maximum requirements?
- What design constraints will apply?

Cost Criteria

Generally there are three types of cost criteria:

- Cost limitation criteria
- Cost breakdown criteria
- Life cycle cost criteria

Independent Review

As in other aspects of the design and construction processes, an independent review of the bid documents is recommended. That review should accomplish the following tasks:

- Check that the bid documents are fully responsive to the project's programme:–
  - all major features of work included
  - all owner's requirements included
  - all master planning documents considered and complied with
  - all outside agency requirements for permits, coordination or notification identified
- Consistent format, order and descriptors to facilitate interpretation
- Identify ambiguities and conflicts between bid document sections
- Look for ways to strengthen the clarity of the words, numbers and approach to defining product quality
- Verify design risk allocation between the bid documents and the owner's ability to manage that risk
- Verify construction risk allocation between the bid documents and the owner's ability to manage that risk

Value for Money

The public sector should aim at achieving the optimum combination of whole-life cost and quality (fitness for purpose) to meet the user requirements. It should seek to ensure that:

- the evaluation of which procurement option to

adopt is undertaken with no inherent preference for one over another;
- value is not taken to be the least cost;
- a full evaluation of costs and benefits on a whole-life basis is undertaken, including an assessment of risk.

Employee Protection

PFI projects sometimes have the potential of affecting the terms and conditions of current employees in the system. The following guidelines are provided to address this potential problem:
- Be open with staff by providing greater transparency about workers' rights.
- Protect the terms and conditions for both transferees and new joiners to PFI workforces.
- Protect staff pensions.
- Retain flexibility in public service delivery, including through PFI, to ensure efficient workforce management and encourage innovation in service delivery.

Key Players

The key players can be grouped as follows:
- Public owner
  - users/tenants
  - designers
  - legal council
  - contracting project management
  - construction representative
- Private owner
  - users/tenants
  - engineers/technicians
  - construction manager
- Design-builder
  - constructor
  - designer-of-record
  - design-build project manager
  - design manager
  - construction manager
  - speciality consultants
  - suppliers
- Consultant
  - design criteria consultant
  - bridging consultant
  - oversight/checking consultant

Oversight/Checking Consultant	The role of the oversight/checking consultant is essential in Turn-key contracts. This is to be emphasised in geographic locations (such as the Caribbean) where there are multiple hazards to be accommodated, with the corresponding need for significant care and attention to detail in all aspects of design, construction and maintenance of the built environment. To assist the design-builder to understand better the issues to be addressed, and to assist the checking consultant in carry out that function, the following appendices are appended to this document: • Appendix II – Check List for Designing to Counteract Natural Hazards • Appendix III – Check List for Non-structural Components for Earthquakes • Appendix IV – Check List for Non-structural Components for Hurricanes • Appendix V – Check List for Maintenance

Appendix I

Cultural Differences:
Comparison of Providers' and Users' Attitudes and Beliefs with respect to Facilities

Appendix II

Detailed Engineering:
Check List for Designing to Counteract Natural Hazards
(Earthquakes, Hurricanes and Torrential Rains)

APPENDIX II

DETAILED ENGINEERING

CHECK LIST FOR DESIGNING TO COUNTERACT NATURAL HAZARDS (Earthquakes, Hurricanes and Torrential Rains)

Appendix V constitutes a comprehensive list of issues to be addressed in designing to counteract the effects of natural hazards. This is a very complex process, if done properly and thoroughly. Thus, check lists are invaluable to the exercise. For any particular project all of the items may not be relevant, but excluding items from a comprehensive list is always easier than adding relevant items to a short list.

1 Seismic, Hurricane and Rain Hazards

1.1 History
- 1.1.1 Earthquake
- 1.1.2 Hurricane
- 1.1.3 Torrential rain

1.2 Geology

1.3 Tectonics

1.4 Design characteristics
- 1.4.1 Earthquake design characteristics
- 1.4.2 Hurricane design characteristics
- 1.4.3 Design characteristics for torrential rains

2 Site Conditions

2.1 Soils
- 2.1.1 Liquefaction
- 2.1.2 Seismic characteristics

2.2 Topography
- 2.2.1 Landslide
- 2.2.2 Building on slopes
- 2.2.3 Topographic effect on wind speeds
  - 2.2.3.1 Ridges
  - 2.2.3.2 Valleys
- 2.2.4 Flood prone areas

2.2.4.1 Torrential rains
2.2.4.2 Storm surge
2.2.4.3 Tsunami

2.3 Other Factors
2.3.1 Corrosive Environments
2.3.1.1 Coastal areas
2.3.1.2 Industrial and other chemical pollutants

3 The Client's Brief

3.1 Function

3.2 Cost

3.3 Reliability
3.3.1 Serviceability for different components of the facility
3.3.2 Safety for different components of the facility

4 Design Philosophy

4.1 Performance in moderate and frequent hazardous events
4.1.1 Protection of property
4.1.1.1 Cost of repairs should be minor

4.2 Performance in strong, rare, hazardous events
4.2.1 Saving lives
4.2.2 Repairable damage (very critical facilities in earthquake events)
4.2.3 Protection of all property in hurricanes and torrential rains
4.2.4 Protection of all property in earthquakes (base isolation)

4.3 Critical areas or components of facilities

4.4 Post-yield behaviour of structural elements
4.4.1 Ductility
4.4.2 Energy absorption
4.4.3 Deformations

4.5 Building Envelope for Hurricanes
4.5.1 Windows, external doors and roof cladding

5 Choice of Form or Configuration

Poor design concepts can be made safe but are unlikely to perform really well in strong earthquakes

5.1 Failure modes

- 5.1.1 Redundancy
- 5.1.2 Accidental strength
- 5.1.3 Column capacities (and those of other vertical load-carrying elements) - New Zealand's "capacity design"
- 5.1.4 Designing for failure
- 5.1.4.1 Avoid failure in vertical, shear and compression elements
- 5.1.4.2 Avoid brittle failure
- 5.1.4.3 Avoid buckling failure
- 5.1.5 For hurricane forces design for repeated loads without degradation

5.2 Geometric issues

- 5.2.1 Simplicity and symmetry
- 5.2.2 Long buildings to be structurally broken (separation gaps of sufficient widths to avoid hammering in earthquakes)
- 5.2.3 Elevation shape
- 5.2.3.1 Sudden steps and setbacks to be avoided
- 5.2.4 Uniformity
- 5.2.4.1 Distribution of structural elements
- 5.2.4.2 Principal members to be regular
- 5.2.4.3 Openings in principal members to be avoided
- 5.2.5 Continuity
- 5.2.5.1 Columns and walls from roof to foundation (without offsets)
- 5.2.5.2 Beams free of offsets
- 5.2.5.3 Coaxial columns and beams
- 5.2.5.4 Similar widths for columns and beams
- 5.2.5.5 Monolithic construction
- 5.2.6 Stiffness and slenderness (h>4b)
- 5.2.6.1 Stiffness versus flexibility
- 5.2.6.2 Maintaining the functioning of equipment
- 5.2.6.3 Protecting structure, cladding, partitions, services
- 5.2.6.4 Resonance
- 5.2.7 Favourable and unfavourable shapes
- 5.2.7.1 Square
- 5.2.7.2 Round and regular polygons
- 5.2.7.3 Rectangular
- 5.2.7.3.1 Aspect ratios
- 5.2.7.4 **T** and **U** shaped buildings
- 5.2.7.4.1 Aspect ratios

5.2.7.4.2 Deep re-entrant angles
5.2.7.4.3 Establish structural breaks (create rectangular plan forms - see 5.2.2)
5.2.7.5 **H** and **Y** shaped buildings
5.2.7.5.1 Aspect ratios
5.2.7.5.2 Deep re-entrant angles
5.2.7.5.3 Establish structural breaks (create rectangular plan forms - see 5.2.2)
5.2.7.6 External access stairs
5.2.7.7 False symmetry - regular perimeter masking irregular positioning of internal elements
5.2.8 Soft storey
5.2.9 Cantilevers to be designed conservatively
5.2.10 Desirable roof shapes for hurricane resistance
5.2.10.1 Steep pitched roofs (20 - 40 degrees)
5.2.10.2 Hipped roofs are preferable
5.2.10.3 Gable roofs are an acceptable compromise
5.2.10.4 Mono-pitched roofs are undesirable
5.2.10.5 Boxed eaves recommended for overhangs exceeding 450mm
5.2.10.6 Parapets reduce wind uplift
5.2.10.7 Ridge ventilators reduce internal pressures

5.3 Distribution of horizontal load-carrying functions in proportion to vertical load-carrying functions (avoid the overturning problem)

5.4 Structural system to be agreed by design team
5.4.1 Moment-resisting frames
5.4.2 Framed tubes
5.4.3 Shear walls and braced frames
5.4.4 Mixed systems

6 Choice of Materials

6.1 Local availability

6.2 Local construction skills

6.3 Costs

6.4 Politics

6.5 Ideal properties
6.5.1 High ductility

6.5.2 High strength-to-weight ratio
6.5.3 Homogeneous
6.5.4 Ease of making connections
6.5.5 Durable

6.6 Order of preference for low-rise buildings
6.6.1 In-situ reinforced concrete
6.6.2 Steel
6.6.3 Reinforced masonry
6.6.4 Timber
6.6.5 Prestressed concrete
6.6.6 Precast concrete
6.6.7 Unreinforced masonry not recommended

6.7 Light-weight roof cladding of pitched roofs
6.7.1 Method of fixing critical to roof performance

7 Construction Considerations

7.1 Supervision

7.2 Workmanship

7.3 Ease of construction

8 Components

8.1 Base isolators and energy-absorbing devices (to be given consideration)

8.2 Foundations
8.2.1 Continuous
8.2.2 Isolated (to be avoided)
8.2.3 Piled

8.3 Movement and separation joints

8.4 Diaphragms

8.5 Precast concrete

8.6 Welded beam-column joints for moment-resisting steel frames (to be avoided)

8.7 Shear walls and cross bracing

8.8 Hurricane straps, wall plates and connections

8.9 Joint details for roof trusses

8.10 Asbestos-cement cladding (unfavourable in hurricane situations)

9 Elements

9.1 Structure

9.2 Architecture

9.3 Equipment
9.3.1 Electrical feed to be kept clear of roof structure
9.3.2 Electrical feed to be routed underground within the property

9.4 Contents

10 Cost Considerations

10.1 Capital costs ignoring natural hazards (hypothetical, academic)

10.2 Capital costs including natural hazards

10.3 Maintenance costs

11 Analysis

11.1 Understanding the structural model

11.2 Torsional effects

11.3 Geometric changes
11.3.1 The P-delta effect

11.4 3-D analysis (required only for irregular structures)

11.5 Dynamic analysis (required only for complex structures)

11.6 Stress concentrations

11.7 Complexity of earthquake effects and inadequacies of sophisticated analytical methods

11.8 Effects of non-structural elements

11.8.1 Change in the natural period of the overall structure

11.8.2 Redistribution of lateral stiffness and, therefore, forces and stresses (this could lead to premature shear or pounding failures of the main structures and also to excessive damage to the said non-structural elements due to shear or pounding)

11.9 Soil-structure interaction

11.9.1 Critical but usually ignored or played down

12 Detailing

12.1 Compression members

12.2 Beam-column joints

12.2.1 Reinforced concrete

12.2.2 Structural steel :- all-welded construction

12.3 Reinforced-concrete frames

12.4 Non-structural walls and partitions

12.5 Shelving

12.6 Mechanical and electrical plant and equipment

12.6.1 Securely fastened to the structure

12.6.2 Pipework

13 Construction Quality

14 Maintenance

14.1 Refer to Appendix V – “Maintenance as a Tool for Mitigation”

Appendix III

Earthquakes:
Check List for Non-structural Components for Earthquakes

APPENDIX III

EARTHQUAKES

CHECK LIST FOR NON-STRUCTURAL COMPONENTS FOR EARTHQUAKES

This Appendix constitutes a list of items and issues to be considered in designing the non-structural components of healthcare facilities to counteract the effects of earthquakes. Check lists are valuable as *aides-mémoire* for the exercise. For any particular project all of the items may not be relevant, but excluding items from a comprehensive list is always easier than adding relevant items to a short list.

1 Electricity

1.1 Generator
1.1.1 Anchorage of the emergency generator

1.2 Batteries
1.2.1 Attachment of the batteries to the battery rack
1.2.2 Cross-bracing the rack in both directions
1.2.3 Battery rack bolted securely to a concrete pad

1.3 Diesel Fuel Tank
1.3.1 Attachment of the tank to the supports
1.3.2 Cross-bracing the tank supports in both directions
1.3.3 Bracing attached with anchor bolts to a concrete pad

1.4 Fuel Lines and Other Pipes
1.4.1 Lines and pipes attached with flexible connections
1.4.2 Able to accommodate relative movement across joints

1.5 Transformers, Controls, Switchgear
1.5.1 Items properly attached to the floor or wall

1.6 Bus Ducts and Cables
1.6.1 Able to distort at their connections to equipment without rupture
1.6.2 Able to accommodate relative movement across joints
1.6.3 Laterally braced

2 Fire Fighting

2.1 Smoke Detectors and Alarms

2.1.1 Properly mounted
2.1.2 Control system and fire doors securely anchored

2.2 Fire Extinguishers and Hose-reel Cabinets
2.2.1 Cabinets securely mounted
2.2.2 Extinguishers secured with quick-release straps

2.3 Emergency Water Tank
2.3.1 Securely anchored to its supports
2.3.2 Supports braced in both directions
2.3.3 Supports or braces anchored to a concrete foundation

3 Propane Tanks

3.1 The Tank
3.1.1 Securely anchored to its supports
3.1.2 Supports braced in both directions
3.1.3 Supports or braces anchored to a concrete foundation

3.2 Shut-off Valve
3.2.1 System with an automatic, earthquake-triggered, shut-off valve
3.2.2 If manual, provided with a wrench stored close by

3.3 Supply Pipes
3.3.1 Able to accommodate relative movement across joints and at the tank
3.3.2 Laterally braced

4 Plumbing

4.1 Water Heaters and Boilers
4.1.1 Securely anchored to the floor or wall
4.1.2 Gas line with a flexible connection to the heater or boiler to accommodate movement

4.2 Pumps
4.2.1 Anchored or mounted on vibration isolation springs with seismic lateral restraints

4.3 Hot and Cold-water Pipes and Wastewater Pipes
4.3.1 Pipes laterally braced at reasonable intervals
4.3.2 Flexible connections to boilers and tanks
4.3.3 Able to accommodate movement across joints
4.3.4 Pipe penetrations through walls large enough for seismic movement

4.3.5 Free of asbestos insulation (which can be broken in an earthquake)

4.4 Solar Panels
4.4.1 Securely anchored to the roof

5 Elevators

5.1 Cab
5.1.1 Properly attached to the guide rails
5.1.2 Alarm system for emergencies

5.2 Cables, Counterweights, Rails
5.2.1 Cables protected against misalignment during an earthquake
5.2.2 Counterweights properly attached to guide rails
5.2.3 Guide rails properly attached to the building structure

5.3 Motors and Control Cabinets
5.3.1 Anchored

6 Air Conditioning

6.1 Chillers, Fans, Blowers, Filters, Air Compressors
6.1.1 Anchored, or mounted on vibration isolation springs with seismic lateral restraints

6.2 Wall-mounted Units
6.2.1 Securely mounted

6.3 Ducts
6.3.1 Laterally braced
6.3.2 Able to accommodate movement at locations where they cross separation joints

6.4 Diffusers
6.4.1 Grills anchored to the ducts or to the ceiling grid or to the wall
6.4.2 Hanging diffusers adequately supported

7 Non-structural Walls and Partitions

7.1 Concrete Block, Brick, Clay Block
7.1.1 Reinforced vertically and/or horizontally
7.1.2 Detailed to allow sliding at the top and movement at the sides
7.1.3 Restrained at the top and the sides against falling

7.2 Stud-wall and other Lightweight Walls
7.2.1 Partial-height partitions braced at their top edges
7.2.2 If they support shelving or cabinets, securely attached to the structure of the building

8 Ceilings and Lights

8.1 Ceilings
8.1.1 Suspended ceilings with diagonal bracing wires
8.1.2 Plaster ceilings with the wire mesh or wood lath securely attached to the structure above

8.2 Lighting
8.2.1 Light fixtures (*eg* lay-in fluorescent fixtures) with supports independent of the ceiling grid
8.2.2 Pendant fixtures with safety restraints (*eg* cables) to limit sway
8.2.3 Emergency lights mounted to prevent them falling off shelf supports

9 Doors and Windows

9.1 Doors
9.1.1 If exit doors are heavy metal fire doors that might jam in an earthquake, provision of a crowbar or sledge hammer readily available to facilitate emergency opening
9.1.2 Automatic doors with manual overrides
9.1.3 Directions in which the doors swing

9.2 Windows
9.2.1 Glazing designed to accommodate lateral movement
9.2.2 Large windows, door transoms and skylights with safety glass

10 Appendages and Sundries

10.1 Parapets, Veneer and Decoration
10.1.1 Parapets reinforced and braced
10.1.2 Veneers and decorative elements with positive anchorage to the building

10.2 Fences and Garden Walls
10.2.1 Designed to resist lateral forces
10.2.2 Masonry walls reinforced vertically and rigidly fixed to their bases

10.3 Signs and Sculptures

10.3.1 Signs adequately anchored
10.3.2 Heavy and/or tall sculptures anchored to prevent overturning

10.4 Clay and Concrete Roof Tiles
10.4.1 Tiles secured to the roof with individual fixings for each tile

11 Movable Equipment

11.1 Communications
11.1.1 Radio equipment restrained from sliding off shelves
11.1.2 Telephones placed away from edges of desks and counters
11.1.3 Elevated loud speakers and CCTV anchored to the structure

11.2 Computers
11.2.1 Vital computer information backed up regularly and stored off site
11.2.2 Heavy computer equipment of significant height relative to width anchored or braced
11.2.3 Desktop items prevented from sliding off tables
11.2.4 Access floors braced diagonally or with seismically-certified pedestals

11.3 Storage of Records and Supplies
11.3.1 Shelving units anchored to walls
11.3.2 Shelves fitted with edge restraints or cords to prevent items from falling
11.3.3 Heavier items located on the lower shelves
11.3.4 Filing cabinet drawers latched securely
11.3.5 Heavily-loaded racks braced in both directions
11.3.6 Fragile or valuable items restrained from tipping over
11.3.7 Chemical supplies secured or stored in "egg crate" containers

11.4 Hazardous Items
11.4.1 Gas cylinders tightly secured with chains at top and bottom (or otherwise) and with chains anchored to walls
11.4.2 Chemicals stored in accordance with manufacturers recommendations
11.4.3 Cabinets for hazardous materials given special attention with respect to anchoring

11.5 Furniture
11.5.1 Heavy potted plants restrained from falling or located away from beds
11.5.2 Beds and tables and equipment with wheels provided with locks or other restraints to prevent them rolling unintentionally

Appendix IV

Hurricanes:
Check List for Non-structural Components for Hurricanes

APPENDIX IV

HURRICANES

CHECK LIST FOR NON-STRUCTURAL COMPONENTS FOR HURRICANES

This Appendix constitutes a list of items and issues to be considered in designing the non-structural components of healthcare facilities to counteract the effects of hurricanes. Check lists are valuable as *aides-mémoire* for the exercise. For any particular project all of the items may not be relevant, but excluding items from a comprehensive list is always easier than adding relevant items to a short list.

1 Roofs

1.1 Light-weight Coverings

1.1.1 Gauge of corrugated sheeting

1.1.2 Type and quality of corrugated sheeting

1.1.3 Valley fasteners for trapezoidal profiles

1.1.4 Ridge fasteners supplemented by spacer blocks under the ridges or by hurricane washers

1.1.5 Fastener spacings specified for interior areas and for perimeter areas (for approximately 15% of the roof dimension along eaves, gables and ridges)

1.1.6 Asphalt shingles (vulnerable in high winds) laid on waterproofing felt on top of plywood sheets which in turn are fastened by screws or annular nails to supporting timber rafters

1.1.7 Wooden shingles individually fixed to close boarding which in turn is fastened by screws or annular nails to supporting timber rafters

NB
- i In all cases the methods of fixing must, at least, comply with the manufacturers' recommendations for specified hurricane locations
- ii If battens are used, the fastening of the battens to the close boarding must be at least as strong as the fastening of the covering to the battens

1.2 Other coverings

1.2.1 Slates individually fixed to close boarding

1.2.2 Concrete or clay tiles individually fixed to close boarding

NB
- i In all cases the methods of fixing must, at least, comply with the manufacturers' recommendations for specified hurricane locations
- ii If battens are used, the fastening of the battens to the close boarding must be at least as strong as the fastening of the covering to the battens

2 Windows

2.1 Made of laminated glass fixed to frames with structural silicon and able to resist, without breaching, the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour (similar to the requirements of Dade, Broward and Palm Beach Counties of Florida)

or

2.2 Protected by pre-installed or pre-fabricated shutters which are able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

or

2.3 Made of timber or aluminium louvres with provisions for excluding the rain during storm conditions and which are able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

NB The windows or shutters must be secured to the walls, slabs, beams or columns near all corners of each panel or in accordance with the manufacturers' recommendations for specified hurricane locations.

3 External Doors

3.1 Glass Sliding Doors

3.1.1 Made of laminated glass fixed to frames with structural silicon and able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

or

3.1.2 Protected by pre-installed or pre-fabricated shutters which are able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

3.1.3 Moving frames with a certificate from the supplier indicating compliance with the requirements for the appropriate intensity of hurricanes, including both strength and deflexions

3.1.4 Fixed perimeter frames secured to the walls, slabs, beams or columns by bolting or in accordance with the manufacturers' recommendations for specified hurricane locations

3.1.5 Tracks of the top and bottom rails deep enough to prevent the moving doors from being dislodged in specified hurricanes

3.2 Roller Shutter (or Overhead) Doors

3.2.1 Certificates from the suppliers indicating compliance with the requirements for the appropriate level of hurricanes, including both strength and deflexions

3.2.2 Fixed perimeter frames secured to the walls, slabs, beams or columns by bolting or in accordance with the manufacturers' recommendations for specified hurricane locations

3.2.3 Side tracks deep enough to prevent the moving doors from being dislodged in specified hurricanes unless some other mechanism is employed to prevent such an occurrence

3.3 Other Doors

3.3.1 Timber doors with solid cores or made up from solid timber members and able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

3.3.2 Each door leaf fixed by hinges or bolts in at least four locations adjacent to all corners

4 Other Apertures

4.1 Protection from wind and rain provided by pre-installed or pre-fabricated shutters which are able to resist without breaching the impact of flying objects such as an 8-foot long 2-inch by 4-inch piece of timber moving at 35 miles per hour

4.2 Shutters secured to the walls, slabs, beams or columns near all corners of each panel or in accordance with the manufacturers' recommendations for specified hurricane locations

5 Solar Water Heaters and Air-conditioners

5.1 Certificates from the suppliers indicating compliance with the requirements for the appropriate intensity of hurricanes for both manufacture and installation

Appendix V

Maintenance as a Tool for Mitigation of Damage

APPENDIX V

MAINTENANCE AS A TOOL FOR MITIGATION OF DAMAGE

This Appendix is based on the work of Alwyn T Wason.

1 General

The physical condition of many Caribbean hospitals is poor. Most components show lack of maintenance and repair. It is considered that a major effort should be taken to bring the condition of the buildings to the standard where a normal maintenance crew can be expected to deal with the routine maintenance requirements of the facility. It is considered, also, that the existing staff and maintenance budget is generally insufficient to provide for proper maintenance.

It is normal that for public buildings with the heavy usage of a hospital, the annual maintenance budget should amount to about 4% of the contemporary capital cost of the building and equipment, assuming that the facilities are in good condition to start with. For hospitals, it is estimated that the replacement cost is about US$130,000 per bed. (This figure includes for common and administrative areas as well as infrastructure.) The maintenance allocation should therefore be no less than US$5,000 per bed per year.

The maintenance of a hospital, rather than being a one-off activity as is the construction of the hospital, is a continuous daily operation of the institution and is an important ingredient in the delivery of healthcare.

A good maintenance system is also a good disaster mitigation system, as the review of damage caused by recent hurricanes and floods has shown. To some extent the damage to buildings was due to lack of sustained maintenance of critical items. Also, a well-operated system of maintenance for buildings and equipment has the effect of being a very effective disaster mitigation measure in terms of cost and facility usage. It ensures the most economic way to keep the building and equipment in the best of form for normal use, given the original design and materials. It is essential that a maintenance plan be included in disaster mitigation plans.

This Manual therefore stresses the need for continuous attention to all parts of the building and equipment from sweeping of the floors to care of the grounds.

This Manual does not deal with the maintenance needs of off-site electricity, telephone communications and off-site water supply as maintenance of these lifelines are carried out by the relevant utility organisations. On the other hand, standby electricity plant and water systems (storage tanks and pumps) must be maintained by the hospital-maintenance organisation.

2 Proposed Maintenance System

The purposes for maintaining a building and its associated plant are to ensure that the facility can:

- function at its designed level at all times;
- function for the normal life spans of the building and of the plant;
- resist the effects of extreme natural events such as hurricanes, floods, and earthquakes without damage to its occupants and with minimal repair or rehabilitation necessary after the passing of the event (provided that the original design and construction were satisfactory for this purpose).

All maintenance activities should be systematised and pro-active and not merely reactive. It is important to recognise that maintenance is not necessarily repair. Too often repair is considered to be the main purpose of the maintenance system rather than the prevention of the need for repair. The scheduled oiling of door hinges and window operators or the painting of exterior wooden members is necessary to prevent failure of the equipment or rotting of the wooden members.

It is recommended therefore that comprehensive maintenance systems be instituted by health ministries. These systems should comprise:

- an organisational structure with clearly defined duties and responsibilities;
- an operation maintenance manual and procedures reference for the buildings and equipment;
- a management information system which will produce reports on budget, stocks, inventories of equipment, staffing requirements, *etc*;
- a preventative maintenance plan for equipment;
- a building maintenance plan - including roofs, walls, electricity, water lines;
- a continuous maintenance training plan for selected maintenance personnel.

3 Planning of Maintenance Activities

The planning of the maintenance activities will normally be carried out by the hospital superintendent but this planning, which should include the development of a detailed annual maintenance budget, can only be effective if there is a detailed list of areas, spaces, materials and equipment to be maintained and a list of defects to be corrected. The maintenance staff must therefore be trained to examine all parts of the buildings and plant in their care and to record deficiencies. Such lists must be prepared on an annual basis, but this does not preclude the immediate attention to problems which are endemic in many hospitals.

It must be emphasised that a careful record of all maintenance activities is essential, and every effort must be taken to avoid returning to the situation where *ad hoc* repair is the norm. The check list given in this Manual is a guide for the detailed examination of all parts of the facility and should be reviewed by the hospital superintendent and hospital administrator to ensure that maintenance is indeed being carried out efficiently.

Reporting of work done is also an essential part of the maintenance system. A simple reporting form is included in this Manual but the hospital superintendent may wish to devise his own form which may be more responsive to the problems in the particular hospital. It is considered, however, that the simpler the form the better will be the chances of having the form properly filled out and submitted monthly.

4 Maintenance as a Part of Disaster Mitigation

If a good system for maintenance is not properly organised, funded, staffed and carried out, then all other disaster mitigation methods could prove insufficient. Experience indicates that roofs, walls, and equipment in general are more vulnerable to failure if normally operated at near breakdown or at any level of technical deficiency.

While a properly designed and maintained building would be resistant to natural hazards yet experience shows that some additional precautions may have to be taken to secure the hospital and allow it to function during and immediately after such events. The principal areas to be examined for maintaining hurricane resistance (in particular) of the hospital and the corrective measures to be taken are:

4.1 Roofs

- All corroded roof sheets should be replaced.
- Examine the purlins and rafters and replace the rotten ones. Make sure that the drive screws are driven into solid material and cannot be pulled out easily.
- Make sure that the ridge cap is solidly fixed to the roof sheet and that the wind cannot peel the ridge cap off.
- Check the wall plate to be sure that it is not rotten. If so, replace it and secure the plate to the wall by bolts.

4.2 Doors and Windows

- Examine the doors and windows. They must close tightly.
- Ensure that the operators on louvred windows are all working.
- Replace all broken glass in windows.

4.3 External Areas

Flooding often follows a hurricane. Check to see how high the water reached in previous heavy rain storms and ensure that drains are cleared to carry the rain water away from the building and that no storm water can get into the building.

5 Proposed Maintenance Organisation and Staffing

Basic assumptions:

- The hospital administrator is responsible to the ministry for the efficient operation of the hospital (including the general staff matters, buildings, equipment and grounds) and for the expenditures authorized in the annual estimates.
- The hospital superintendent is responsible for the maintenance of all buildings and plant and for providing advice to the hospital administrator on capital requirements and on the condition of the buildings and plant.
- Technical staff (as required) report to the hospital superintendent including:
  - carpenters
  - plumbers
  - electricians
  - painters
- The gardeners and cleaning staff report to the hospital administrator.
- Major repair or renovation projects must be specifically authorized by the hospital superintendent and the hospital administrator depending on the budget requirements, but normal maintenance and minor repair can be carried out by in-house staff without specific authorization.

The following comments are appropriate at this point:

- Annual inspections of the buildings and plant must be carried out. (The recommended time for such inspections is August so the annual estimates can be prepared.)
- Inspections of the windows, doors, roofs and drainage ditches must be carried out in April and repairs effected before the hurricane season.
- The budget estimates for effective maintenance must be based on detailed examination of the buildings and plant supplemented by reports from the users of the buildings and plant - patients, nurses, doctors, administrators and other staff.
- The hospital superintendent must make monthly reports to the hospital administrator detailing the work carried out, the cost of the work, the staff available and the problems to be dealt with during the financial year and those requiring further examination and/or funding.

It is expected that major renovation work which may be necessary will be contracted out and not carried out by the regular maintenance staff.

6 Checklists and Frequencies for Maintenance Operations

Three tables are presented covering:

- the building interior;
- the building exterior;
- the compound.

The following abbreviations are used in the tables:

Frequency		*Operator*	
I:	Immediately	**C**:	General cleaners
D:	Daily	**MS**:	Maintenance staff
W:	Weekly	**SS**:	Hospital Superintendent
Q:	Quarterly	**SA**:	Hospital Administrator
A:	Annual	**G**:	Gardener

Notes: 1 For *frequency* the maximum period is given.
2 For *operator* the person named is the one responsible for seeing that the operation is carried out.

6.1 Building Interior

Spaces	Frequency	Operator
<u>Washrooms and Toilet</u>		
Inspect and report deficiencies	**D**	**C/MS**
Wash floors, toilet bowls, urinals, wash basins with disinfectant and deodorant	**D**	**C**
Order replacements	**I**	**SS/SA**
Replace broken elements	**Q**	**MS**
Repair	**I**	**SS**
Paint	**A**	**MS**
<u>Corridors and Wards</u>		
Inspect and report deficiencies	**D**	**C**
Wash walls	**W**	**C**
<u>Ceilings, Interior Roofs, Canopies</u>		
Inspect and report deficiencies	**A**	**MS**
Repaint	every 4 years	**MS**
<u>Laboratories and other Technical Areas</u>		
Clean all counters, floors and walls	**D**	**MS**
<u>Plumbing</u>		
Inspect and report deficiencies	**D**	**MS**
Repair or replace defective pieces	**I**	**SS**
<u>Internal Communication System</u>		
Inspect all internal communications to ensure that the system is functioning properly and report defects.	**Q**	**SS**
<u>Electricity</u>		
Inspect electricity wiring on a room by room basis and report deficiencies.	**Q**	**MS**

Furniture Repair or replace broken elements	**A**	**MS**

6.2 Building Exterior

Spaces/Materials	**Frequency**	**Operator**
Wood		
Inspect panels, louvres, railings and report deficiencies	**A**	**MS**
Replace all broken wood louvres	**D**	**SS**
Replace other damaged elements	**Q**	**SS**
Clean and paint marked surfaces	**A**	**MS**
Windows		
Inspect and report deficiencies	**D**	**MS**
Remove broken glass louvres or panes (see above also)	**I**	**MS**
Order replacements for broken glass and other elements	**I**	**SS**
Replace broken elements	**Q**	**MS**
Grease and oil louvre operators or handles	**A**	**MS**
Replace broken wire-mesh grills	**Q**	**SS/MS**
Wash windows	**Q**	**C/MS**
Doors and Frames and Partitions		
Inspect and report deficiencies	**Q**	**MS**
Oil hinges etc.	**A**	**MS**
Replace defective and broken hardware	**I**	**SS**
Repair or replace defective doors and/or frames	**I**	**SS**
Stairs and Balconies		
Sweep stairs and balconies	**D**	**C**
Wash stairs, walls and rails	**Q**	**C**
Clean metal work of rust and coat with primer and paint	**A**	**MS**
Sand and paint wood railings or posts	every 2 years	**MS**
Roofs and Gutters		
Inspect and report deficiencies	**A**	**MS**
Repair and replace roof sheets and gutters as		

<u>Metal Panels</u> Inspect Wash and remove graffiti	 **A** **A**	 **MS** **MS**

6.3 Compound

Spaces/Materials	**Frequency**	**Operator**
Gardening		
Clean flower beds	**W**	**G**
Watering and fertilise plants	**D**	**G**
Remake plant beds	**Q**	**G**
Prune plants, trim hedges	**M**	**G**
Grass playing fields	As required	**G**
Cut grass	**W**	**G**
Fence		
Inspect and report deficiencies	**Q**	**MS**
Repair	**Q**	**MS**
Paint	every 2 years	**MS**
Walkways and Courtyards		
Sweep	**D**	**C**
Clear litter and rubbish	**D**	**C**
Drainage Ditches		
Clean routinely	**W**	**C**
Clear blockages caused by excessive rain	**I**	**MS**
Repair damaged drains	**A** (in August)	**MS**
Water Mains		
Inspect and report deficiencies	**Q**	**MS**
Maintain earth cover	**Q**	**MS**
Repair breaches/leaks	**I**	**SS**
Septic Tank		
Inspect and report deficiencies	**A** (In August)	**MS**
Clean and flush out	Every 4 years	**MS**
Repair	**I**	**SS**

Erosion near Structures Inspect and report deficiencies after heavy rainfall Return soil, grass area, re-direct water source Repair eroded area	 **Q** and as required **Q** and as required **I**	 **MS** **MS** **SS**
Rubbish bins Empty drums and burn (or carry away) rub-	 **D**	 **C**

7 Proposed Monthly Report Form

To: Hospital Administrator

Report of the Maintenance Division

For the month of: _______________

Submitted by: __________________

Date: _________________________

Trade	**Area or Class**	**Work done**	**Material cost**	**Labour cost**	**Remarks**
<u>Carpentry</u> Doors Windows Roof Floors					
<u>Masonry</u>					
<u>Electricity</u>					
<u>Plumbing</u>					

<u>Painting</u>					
<u>Other trades</u>					

8 Guidelines for Maintenance Checklists

In reporting deficiencies, the maintenance staff or handyman should be guided by the following *aides-memoire*. It should be noted that the guides which are given here are not intended to be exhaustive. They will, however, focus inspection on the critical areas.

Spaces/Materials	Good	Bad
(a) <u>Washrooms and Toilets</u>		
○ Check to see if the walls are cracked	-------	-------
○ Where the walls are made of rubble stone see if the mortar is in good condition	-------	-------
○ Check to see if items such as soap holders and toilet paper holders are in place and are in working order	-------	-------
(b) <u>Corridors and Wards</u>		
○ Examine the floors to see if the concrete has been damaged in any way so that persons walking in the corridors or wards may trip	-------	-------
○ Check to see if the walls are damaged and need repairing	-------	-------
(c) <u>Ceilings, Interior Roofs, and Canopies</u>		
○ See if the ceilings and the undersides of the roofs and canopies have any watermarks which indicate leaks in the roof	--------	-------
○ See if any timber supports are rotten	--------	-------
○ Where the roof supports are of steel, check to see if there is any rust	--------	-------
○ See if any ceiling tiles need replacing	--------	-------

Spaces/Materials		**Good**	**Bad**
(d)	<u>Plumbing</u>		
○	Check to see if there is any water on the floor	--------	--------
○	If there is, examine the wash basin to see if it is plugged	--------	--------
○	Examine the WC to see if the bowl is cracked	--------	--------
○	See if the flush tank is cracked	--------	--------
○	Check to see if the toilet seat cover is broken	--------	--------
○	See if the flush handle or pull chain is broken	--------	--------
○	See if the toilet bowl is fixed properly to the floor so that it does not rock when being used	--------	--------
○	See if the sewer pipe is properly fixed to the toilet and that there is no leaking at the joint	--------	--------
(e)	<u>Electricity</u>		
○	See if all light bulbs are working and that all are in place	--------	--------
○	See if the wall plates are in good condition	--------	--------
○	See if the wall switches or pull switches are working	--------	--------
○	See if wall outlets are working	--------	--------

Spaces/Materials		**Good**	**Bad**
(f)	Windows		
○	See if the windows can close securely	--------	--------
○	See if the window operators are in good condition and are working	--------	--------
○	See if the bolts and locks are in working condition	--------	--------
○	See if the timber surrounding the windows is rotten and should be replaced	--------	--------
○	See if the windows leak even when closed	--------	--------
(g)	Doors and Frames and Partitions		
○	See if the doors can close properly	--------	--------
○	See if the bolts and locks are in place and are working	--------	--------
○	See if the door frame is in good condition and that the timber is not rotten	--------	--------
○	Where the door is a wood door (brace and batten) see that the door has not warped	--------	--------
○	Check the partitions to see if the walls are in good condition	--------	--------
○	Report any loose mortar in a rubble wall	--------	--------
○	Report any cracked wall	--------	--------

Spaces/Materials	**Good**	**Bad**
(h) Roof and Gutters		
○ Check roofs for leaks	--------	--------
○ Check gutters for holes	--------	--------
○ Check gutter brackets to see if they are broken or rusted	--------	--------
(i) Fence		
○ With a chain link fence, check to see if the fence is broken	--------	--------
○ See if the fence posts are firmly in the ground	--------	--------
○ With a timber fence, check for rotten timber	--------	--------
(j) Water mains		
○ Check ground to see if there are any wet spots which would indicate a leaking water main	--------	--------
○ See if the water main is properly buried beneath the ground, or is well protected by concrete	--------	--------

Spaces/Materials		Good	Bad
(k)	Septic tank		
○	Check to see if the tank has been cleaned in the last three years	--------	--------
○	See if the access covers fit properly, are in good condition and can be removed for cleaning	--------	--------
○	If the access covers can be opened too easily, members of the public may remove the covers wilfully	--------	--------
○	See if the holders for the covers will cause people to trip. The holder should be recessed with just enough room for a pickaxe blade to get under the holder.	--------	--------
○	See if the inlet pipe is firmly fixed to the tank and that there is no leak	--------	--------
○	Where there is a soak-away check to see if the pipe to the soak-away is firmly bedded	--------	--------
○	See if there is any odour around the tank. If there is, the tank needs cleaning or another soak-away should be dug	--------	--------
○	Where there are tile fields, check to see if the pipes (tiles) are exposed. They should be well below ground level	--------	--------
○	See if the tiles are working and that there is no water on the ground around the pipes	--------	-------

Spaces/Materials		**Good**	**Bad**
(l)	<u>Erosion near Structures</u>		
○	Examine the ground around the buildings to see if the rain water has removed any material - soil or stones	--------	--------
○	Check around the pipes to see if the pipes that were buried are still properly buried	--------	--------
○	Check around telephone or electricity poles on the property to see whether the rain water has removed soils around the bottom of the poles	--------	--------