Appendices

APPENDIX I

CATALOGUE OF RESOURCE PROVIDERS

1 The Organisation of American States (OAS)

2 Caribbean Electric Utility Services Corporation (CARILEC)

3 Caribbean Disaster Emergency Response Agency (CDERA)

4 University of the West Indies (UWI) - Faculty of Engineering and the Seismic Research Unit (SRU)

5 University of Technology, Jamaica (UTEC) and the University of Guyana (UG)

6 Council of Caribbean Engineering Organisations (CCEO) and its constituent member bodies

7 Association of Commonwealth Societies of Architects in the Caribbean (ACSAC) and its constituent member bodies

8 Consulting firms specialising in natural hazards and in designing against them

9 Individual specialists in natural hazards and in designing against them

10 Building Research Establishment, UK (BRE) and other international organisations

11 Statutory bodies and government agencies involved in science and technology

12 Pan American Health Organisation (PAHO) - Emergency Preparedness & Disaster Relief Coordination Programme

13 United States Agency for International Development (USAID) - Office for Foreign Disaster Assistance (OFDA)

APPENDIX II

DECIDING ON DESIGN CRITERIA

II.1 General

Codes of practice and specifications should be used for new construction, for alterations to existing facilities, for major maintenance and for retrofitting of existing facilities to improve levels of safety.

Very commonly consultants use the minimum standards of codes, usually because of commercial pressures. Most codes are for general construction and not specific to the needs of critical infrastructure projects.

There is also the problem of building to unnecessarily high and expensive standards. Clients (in consultations with their consultants) should select, on informed and rational bases, appropriate design criteria for facilities of differing importance.

Clients should recognise the need to review, on an ongoing basis, the conditions of their facilities and their standards. Standards do change.

Codes of practice and specifications apply not only to new buildings and facilities but also to alterations and major renovations of existing buildings and facilities.

II.2 Hurricane

II.2.1 Basic wind speeds and reference pressures

Different codes and standards define and describe wind forces and speeds differently Since Caribbean Clients have to deal with different standard regimes it is important to be able to convert from one standard to another. The main parameters used in defining wind speeds are:

- averaging period
- return period
- height above ground
- upstream ground roughness and topography

Thus, in the commonly-used OAS/NCST/BAPE "Code of Practice for Wind Loads for Structural Design" the definition reads:

> *"The basic wind speed V is the 3-second gust speed estimated to be exceeded on the average only once in 50 years ..... at a height of 30 m above the ground in an open situation ....."*

II 2.2 Caribbean Uniform Building Code (CUBiC)

Figure 1 in Appendix II shows a map of the Caribbean region with isolines of reference velocity pressures taken from CUBiC for 50-year return periods.

Table 1 in Appendix II gives the CUBiC reference pressures (50-year return periods) along with corresponding wind velocities for different averaging periods.

II.2.3 Averaging periods

Figure 2 in Appendix II presents graphs which may be used to convert wind speeds of one averaging period to speeds of another averaging period

II.2.4 Return period

The Client, in consultation with (and advice from) its consultant, should make conscious decisions with respect to desired levels of safety for different facilities. These decisions are translated into return periods. The longer the return period the greater the level of safety. Figure 3 in Appendix II presents graphs from the OAS/NCST/BAPE Code addressing this parameter.

II.3 Earthquake

Much less is known about the earthquake hazard than about the wind and rainfall hazards in the Caribbean. Because of this, and because of the ongoing research in this field, there is the need for regular reviews of design criteria by the construction industry in general and consultants in particular. There may also be the justification for site-specific and project-specific studies for large or critical facilities.

For most projects, the guidance provided by existing standards and research papers would suffice. Some of these documents are listed below.

II.3.1 Caribbean Uniform Building Code (CUBiC)

Table 2 in Appendix II gives the CUBiC zone factors (Z) for different locations in the region. The table also shows the corresponding values for the Uniform Building Code (USA) and the Structural Engineers Association of California (SEAOC).

II.3 2 Dr John Shepherd's research

Figure 4 in Appendix II shows a map of the Eastern Caribbean region with isolines of accelerations due to earthquakes based on a three-year research programme which was completed in 1994 and representing some of the latest thinking on the seismicity of the region.

It should be noted that:

- BVI, Antigua & Barbuda and Montserrat would warrant a Zone 4 rating (CUBiC Z = 1.00, SEAOC 1990 Z = 0.4);
- the whole of Trinidad would warrant a Zone 3 rating;
- Dominica would warrant a Zone 3/2 rating,
- Grenada, St Lucia and St Vincent would warrant a Zone 2 rating.

Table 3 in Appendix II shows this information in comparison with the CUBiC, UBC and SEAOC factors.

II.3.4 Importance factor

Earthquakes are not amenable to statistical analysis and return periods in the same way as windstorms or rain. Nevertheless the Client, in consultation with its consultant, must still make conscious decisions with respect to desired levels of safety for different facilities. These decisions are translated into importance factors in codes and standards. These factors usually vary from 1.0 to 1.5.

II.4 Torrential Rain

II.4.1 Lirios' curves

Intensity-duration-frequency curves have been developed for several territories in the region and may be available through the Caribbean Meteorological Institute in Barbados. A sample is given at Figure 5 in Appendix II.

II.4.2 Return period

Traditionally, quite short return periods have been selected for design rain storms. It was quite common for facilities to be designed for 1-in-20-year storms. Much damage and disruption is caused with increasing frequency by torrential rains. There needs to be a reassessment of this design criterion.

II.4.3 Changing conditions

The other factor affecting rain runoff and flooding is upstream development outside of the control of Clients. It is not unlikely that well-designed drainage systems prove to be inadequate some time after they have been implemented because of greater runoff than could reasonably have been anticipated at the time of design. This typically happens when land use upstream is changed due *eg* to urban expansion. Therefore it is appropriate to adopt a conservative approach to the selection of rainfall design criteria.

II.5 Storm Surge and Tsunami

II.5.1 Storm surge

This complex phenomenon is of interest for coastal sites. Computer models are available for developing storm-surge scenarios for coastlines. One such model is TAOS (The Arbiter of Storms) developed by Charles C Watson and tailored for the Caribbean under the USAID/OAS-CDMP programme.

II.5.2 Tsunami

Figure 6 in Appendix II shows a credible scenario from a likely eruption of the Kick 'em Jenny submarine volcano just north of Grenada.

II.5.3 Advice

The studies of both of these hazards are highly specialised subjects for which expert advice should be sought for all low-lying, coastal developments.

Reference Wind Velocity Pressures
and
Wind Speeds
(50-year return period)

Location	q_{ref} CUBiC	10 min CUBiC	1 hr	1 min (or "Fastest Mile")	3 sec
Antigua	0.82	37	35	45	56
Barbados	0.70	34	32	41	51
Belize - N Belize - S	0.78 0.55	36 30	34 29	43 37	54 45
Dominica	0.85	38	36	46	57
Grenada	0.60	32	30	38	47
Guyana	0.20	18	17	22	27
Jamaica	0.80	37	35	44	55
Montserrat	0.83	37	36	48	59
St Kitts/Nevis	0.83	37	36	48	59
St Lucia	0.76	36	34	43	57
St Vincent	0.73	35	33	42	56
Tobago	0.47	28	26	38	42
Trinidad - N Trinidad - S	0.40 0.25	26 20	25 19	31 25	39 30
Notes	q_{ref} = pressures in kilopascals (kPa)	wind speeds in metres per second (ms^{-1})			

Appendix II
Table 1

Z Values and
Seismic Zone Coefficients

Territory	Z Value CUBiC & UBC 85	Z Factor UBC 1988 & SEAOC 1990	Zone Number
Antigua	0.75	0.3	3
Barbados	0.375	0.15 - 0.2	2
Belize - areas within 100km of southern border, ie including San Antonio and Punta Gorda but excluding Middlesex, Pomona and Stann Creek	0.75	0.3	3
Belize rest of	0.50	0.15 - 0.2	2
Dominica	0.75	0.3	3
Grenada	0.50	0.15 - 0.2	2
Guyana (Essequibo)	0.25	0.1	1
Guyana (rest of)	0.00		
Jamaica	0.75	0.3	3
Montserrat	0.75	0.3	3
St Kitts/Nevis	0.75	0.3	3
St Lucia	0.75	0.3	3
St Vincent	0.50	0.15 - 0.2	2
Tobago	0.50	0.15 - 0.2	2
Trinidad (NW)	0.75	0.3	3
Trinidad (rest of)	0.50	0.15 - 0.2	2

Appendix II
Table 2

Seismic Hazard Values for Structural Design Purposes
Commonwealth Caribbean
Compiled by Tony Gibbs

Country	CUBIC Z values 1985	equivalent Zone No (SEAOC 80)	equivalent Z factor (UBC 88)	PAIGH/TG Z factors 1993/94	PAIGH/TG Zones 1993/94	equivalent Zone No (SEAOC 80)	equivalent Z factor (UBC 88)
Anguilla				0.500	2.5	2.5	0.20
Antigua & Barbuda	0.750	3	0.30	1.000	4	4	0.40
Bahamas							
Barbados	0.375	2	0.15	0.375	2	2	0.15
Belize - north	0.500	2.5	0.20				
Belize - south	0.750	3	0.30				
British Virgin Islands				1.000	4	4	0.40
Cayman Islands							
Dominica	0.750	3	0.30	0.500	2.5	2.5	0.20
Grenada	0.500	2.5	0.20	0.375	2	2	0.15
Guyana - Essequibo	0.250	1.5	0.10				
Guyana - remainder	0.000	0	0.00				
Jamaica	0.750	3	0.30				
Montserrat	0.750	3	0.30	1.000	4	4	0.40
St Kitts & Nevis	0.750	3	0.30	0.750	3	3	0.30
St Lucia	0.750	3	0.30	0.375	2	2	0.15
St Vincent & the Grenadines	0.500	2.5	0.20	0.375	2	2	0.15
Trinidad - NW	0.750	3	0.30	0.750	3	3	0.30
Trinidad - remainder	0.500	2.5	0.20	0.750	3	3	0.30
Tobago	0.500	2.5	0.20	0.500	2.5	2.5	0.20
Turks & Caicos Islands							

Notes:
In the Zone columns 1.5 means between 1 and 2
In the Zone columns 2.5 means between 2 and 3
CUBiC = Caribbean Uniform Building Code
SEAOC = Structural Engineers Association of California
UBC = Uniform Building Code (ICBO)
ICBO = International Conference of Building Officials
PAIGH = Pan American Institute of Geography and History
PAIGH's research (by Dr Shepherd) interpreted by Tony Gibbs

Appendix II
Table 3

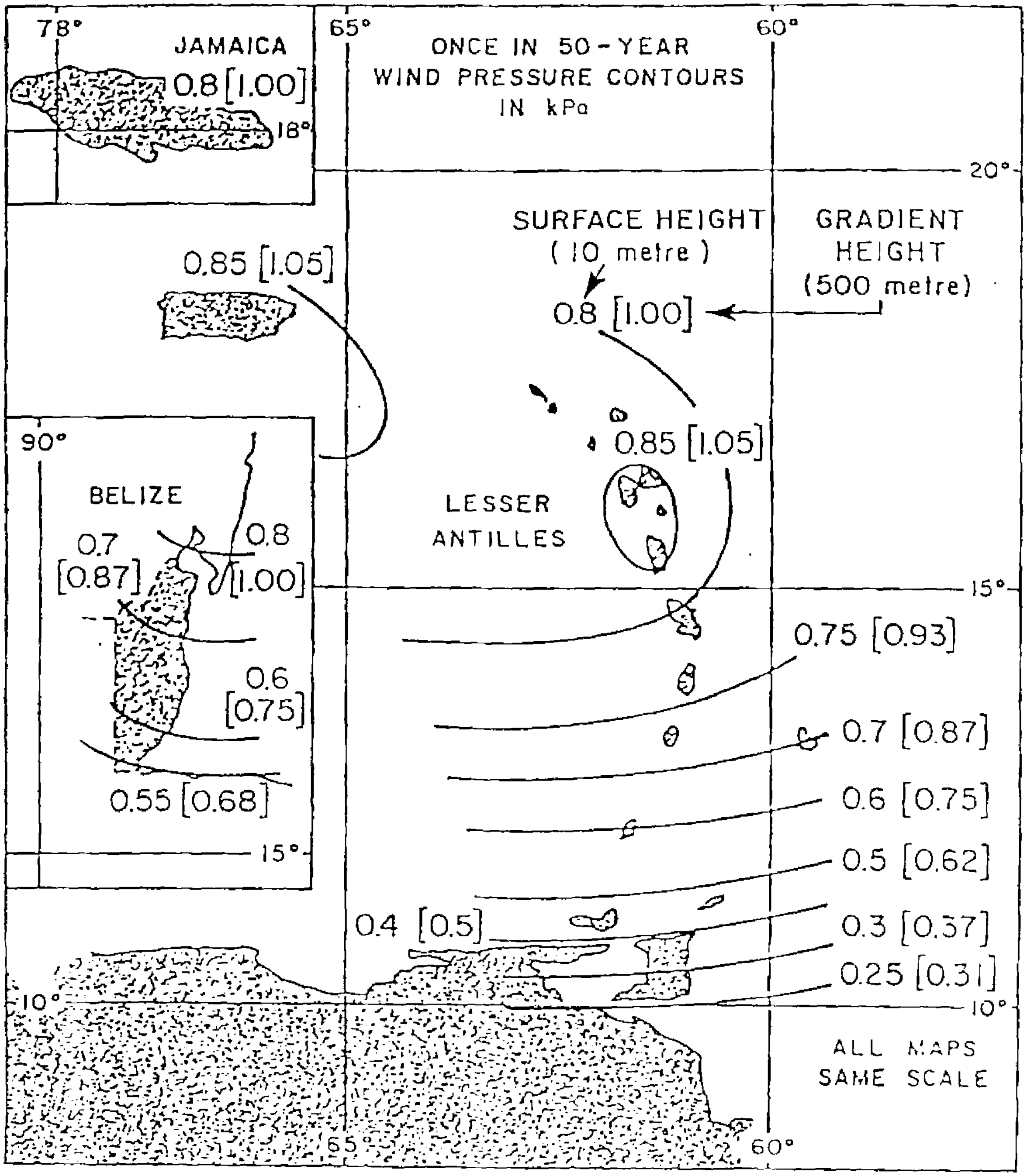


Figure A200.1 Map of Region of Application

Regional Map of Wind-pressure Contours
(from CUBiC)
Figure 1

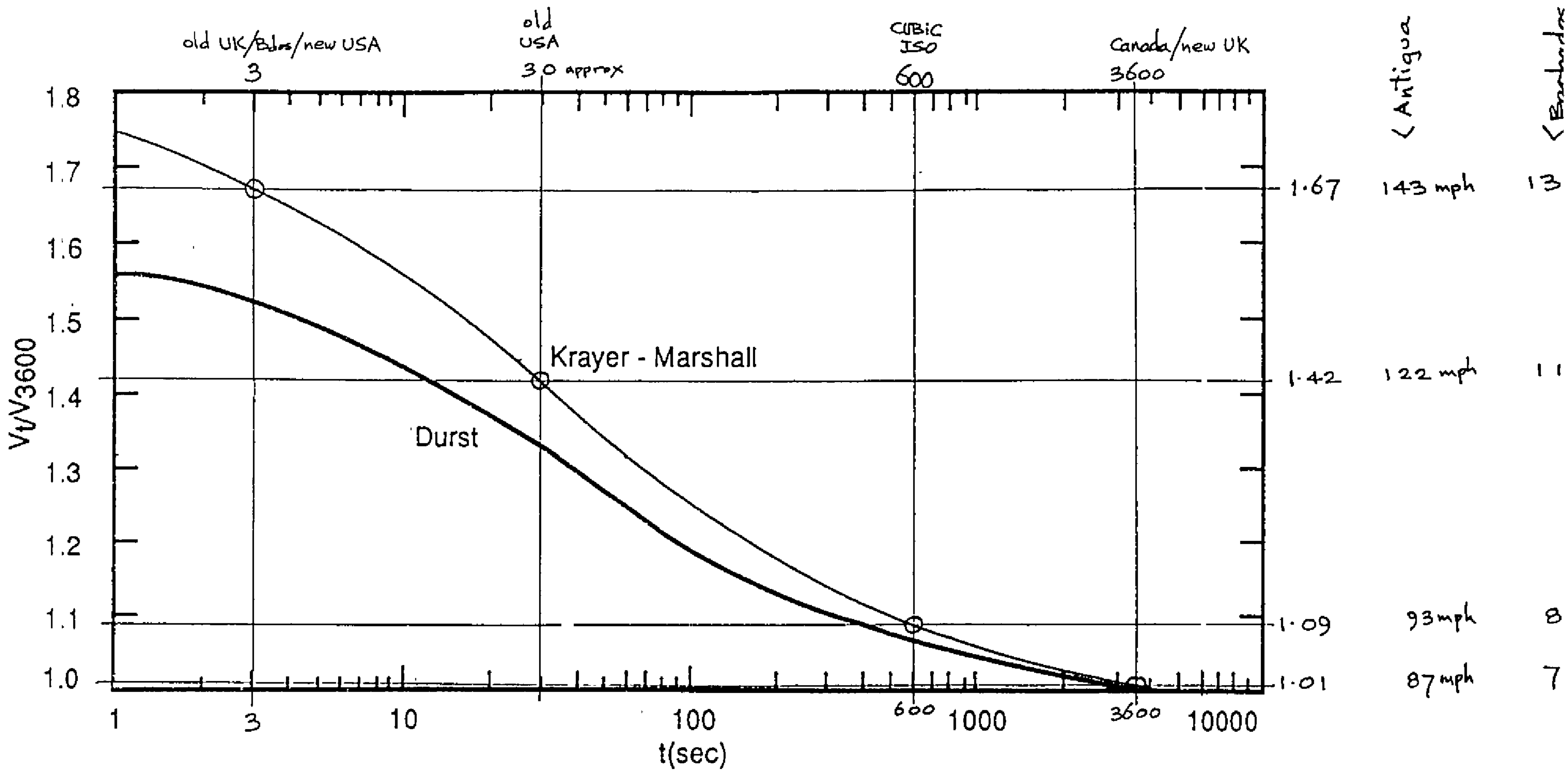
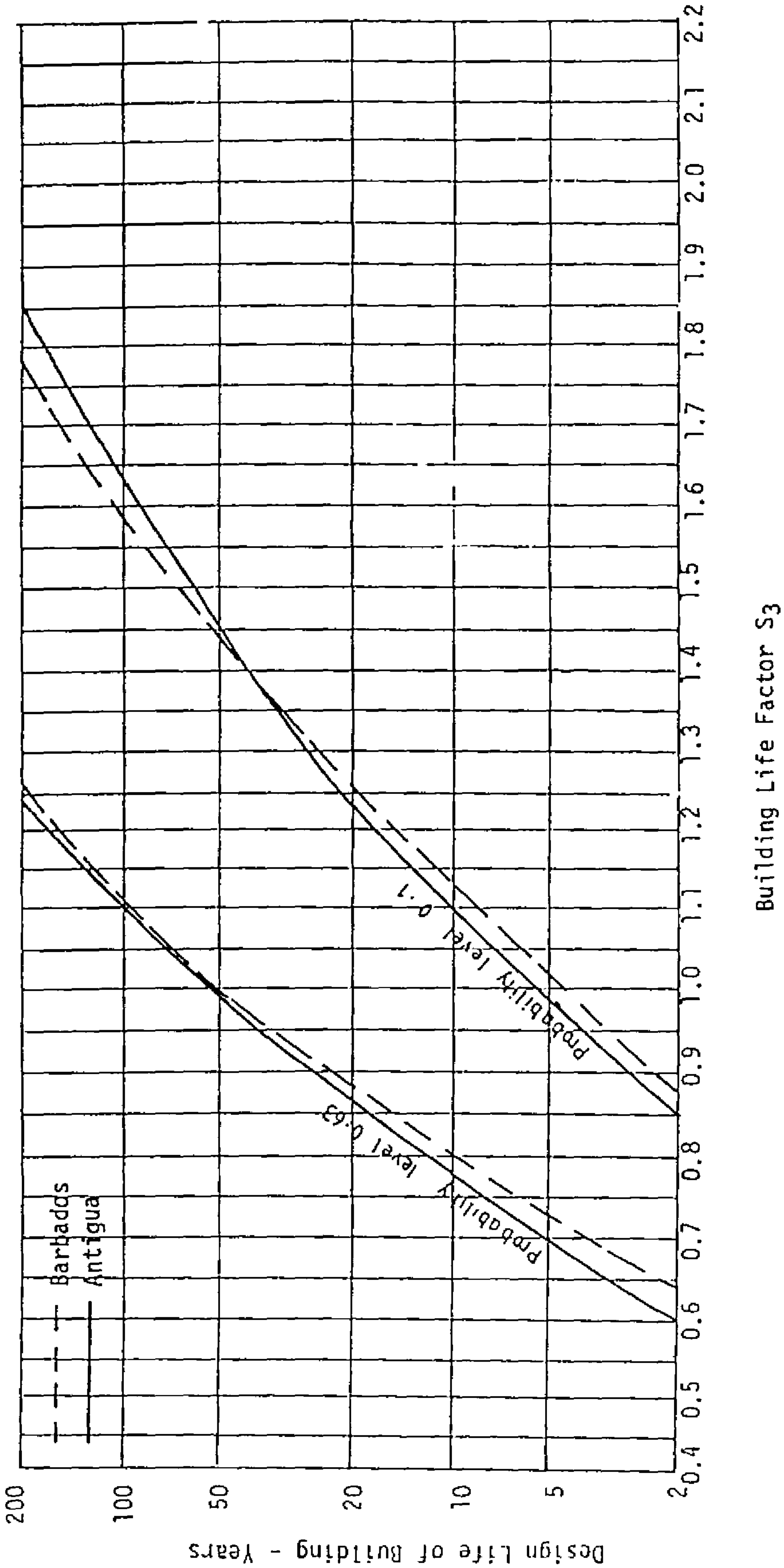


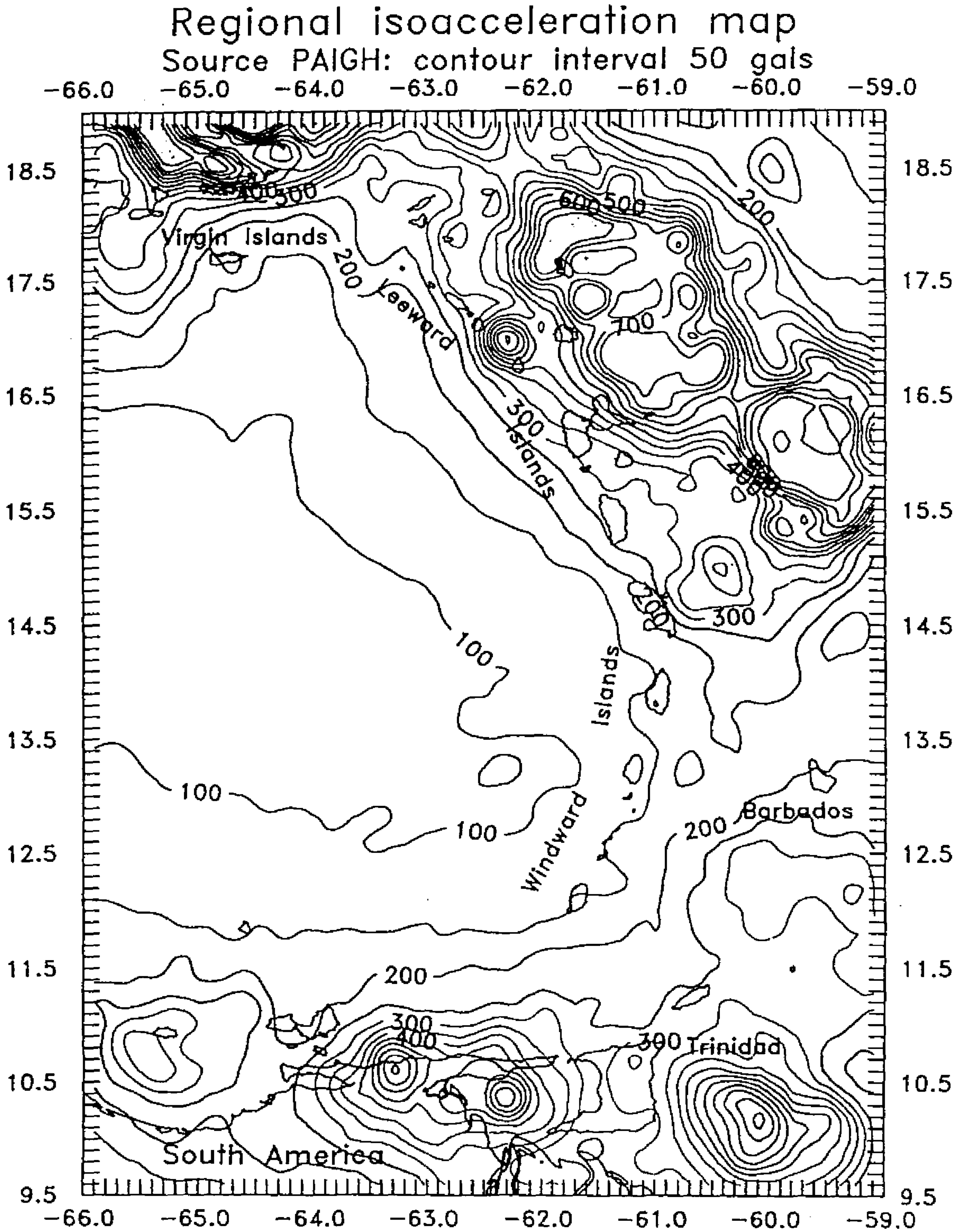
Fig. 2 Ratio of Probable Maximum Speed Averaged over *t* Seconds to Hourly Mean Speed

Durst and Krayer-Marshall Graphs

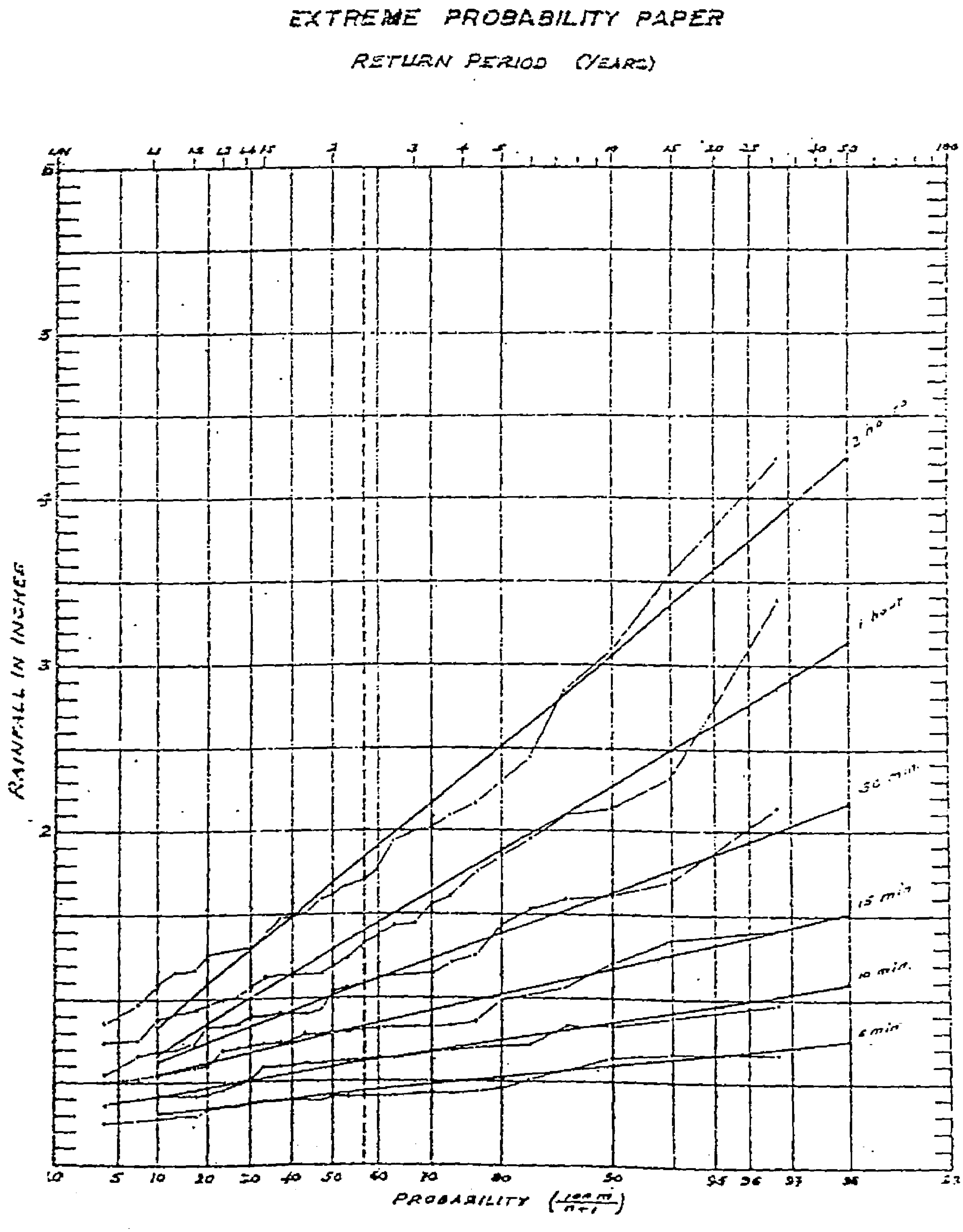
FACTOR FOR BUILDING LIFE



S_3 Factor for Return Period and Probabilities (from OAS/NCST/BAPE Code)

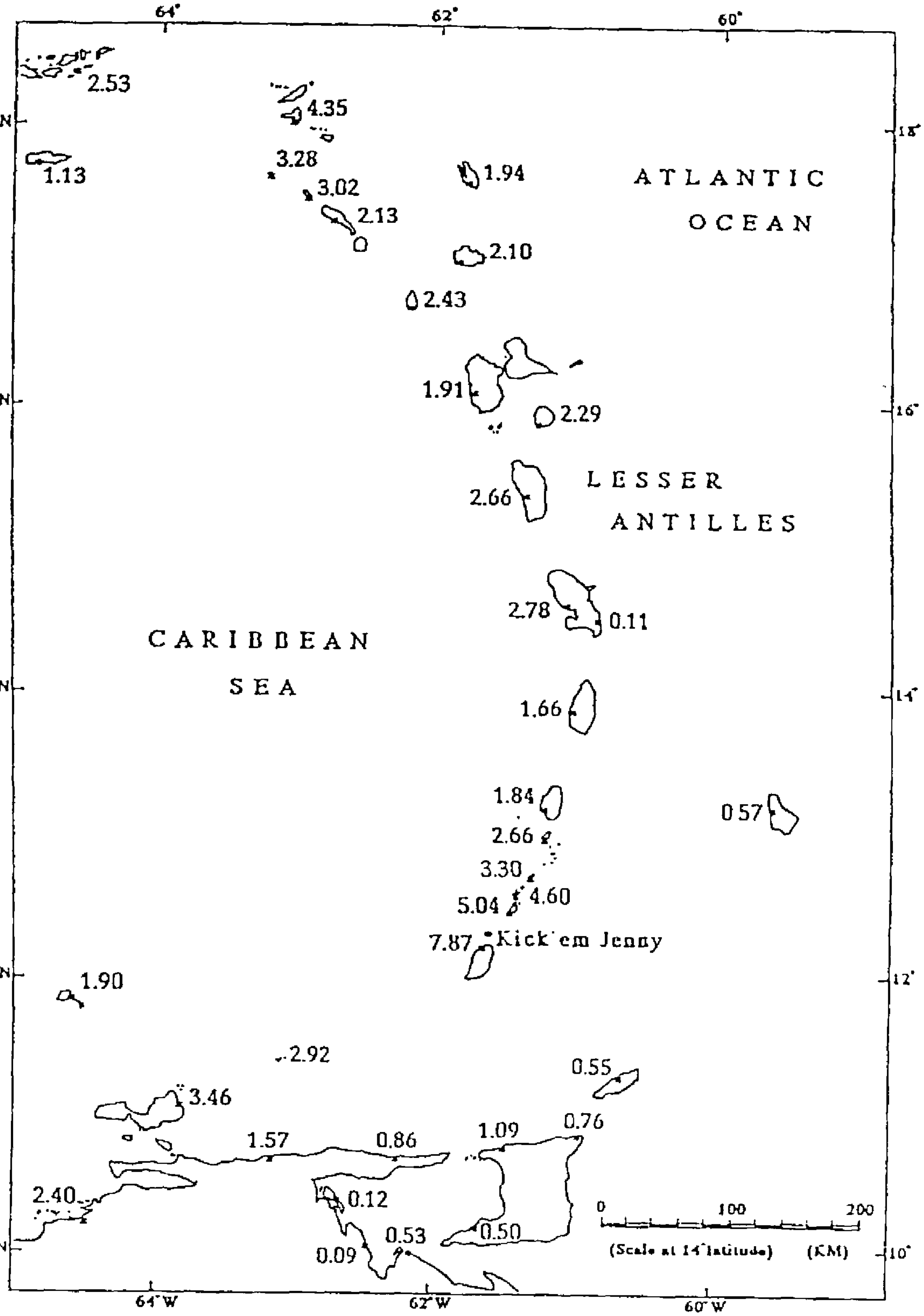


Isoacceleration Map of the Eastern Caribbean
(from John Shepherd - PAIGH)
Figure 4



Probability of Exceedance {100m/(n+1)}
m = rank of sampled value
n = number of value

Rainfall-Duration-Frequency Curves for Seawell Airport, Barbados
(Based on recording rain-gauge data for the period 1942-70. Station elevation = 183 feet above MSL)
(from Lirios)
Figure 5



Final run-up values in metres for a 'realistic' scenario event at Kick'em Jenny (VEI = 3).

Tsunami Heights for Realistic Kick 'em Jenny Eruption
(from Martin Smith & John Shepherd)
Figure 6

APPENDIX III

DETAILED ENGINEERING

Check List for Designing to Counteract Earthquakes, Hurricanes and Torrential Rains

Appendix III is included in this document, not for the direct use by the Client's personnel, but possibly for use by their consultants. It 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.

It is recommended that Appendix III be issued by Clients to their consultants when embarking on new projects, extensions to existing facilities and major renovations.

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 Land slide
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

4.3 Critical areas or components of facilities

4.4 Post-yield behavior 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
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 - see table of pros and cons
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 Diagrams of favourable and unfavourable shapes (see attached)
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 Ideal to establish structural breaks (create rectangular plan forms)
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 Ideal to establish structural breaks (create rectangular plan forms)
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

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

APPENDIX IV

MAINTENANCE AS A TOOL FOR MITIGATION

This was originally prepared by Alwyn T Wason on behalf of Tony Gibbs for an earlier schools manual. The information and charts given in this appendix would be similar for many of the buildings in the Commonwealth Caribbean, and is repeated in this Manual to show the administrators of buildings the detailed examinations required for adequate maintenance.

IV.1 General

The physical condition of many Caribbean schools is poor. Windows and doors 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 school, the annual maintenance budget 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 schools, it is estimated that the replacement cost is about US$150,000 per classroom. (This figure includes for common and administrative areas as well as infrastructure.) The maintenance allocation should therefore be no less than US$6,000 per classroom per year.

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

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, all telephone and off-site water supply as maintenance of these life lines are carried out by the utility organisations concerned. On the other hand, standby electricity plant and water systems (storage tanks and pumps) must be maintained by the school-maintenance organisation.

IV.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 proactive 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 education 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.

IV.3 Planning of Maintenance Activities

The planning of the maintenance activities will normally be carried out by the school 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 schools.

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 school superintendent and school 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 report but the school superintendent may wish to devise his own form which may be more responsive to the problems in the school. 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.

IV.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 school 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 school and the corrective measures to be taken are:

IV.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.

IV.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.

IV.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.

IV.5 Proposed Maintenance Organisation and Staffing

Basic assumptions:

- The school administrator is responsible to the ministry for the efficient operation of the school (including the general staff matters, buildings, equipment and grounds) and for the expenditures authorized in the annual estimates.

- The school superintendent is responsible for the maintenance of all buildings and plant and for providing advice to the school administrator on capital requirements and on the condition of the buildings and plant.

- Technical staff (as required) report to the school superintendent including:

    - carpenters
    - plumbers
    - electricians
    - painters

- The gardeners and cleaning staff report to the school administrator.

- Major repair or renovation projects must be specifically authorized by the school superintendent and the school 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 - students, teachers, administrators and other staff.

- The school superintendent must make monthly reports to the school 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.

IV.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

I: Immediately
D: Daily
W: Weekly
Q: Quarterly
A: Annual

Operator

C: General cleaners
MS: Maintenance staff
SS: School Superintendent
SA: School Administrator
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.

IV.6.1 Building Interior

Spaces	Frequency	Operator
Washrooms and Toilet		
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
Corridors and Classrooms		
Inspect and report deficiencies	D	C
Wash walls	W	C
Ceilings, Interior Roofs, Canopies		
Inspect and report deficiencies	A	MS
Repaint	every 4 years	MS
Laboratories and other Technical Areas		
Clean all counters, floors and walls	D	MS
Plumbing		
Inspect and report deficiencies	D	MS
Repair or replace defective pieces	I	SS
Internal Communication System		
Inspect all internal communications to ensure that the system is functioning properly and report defects.	Q	SS
Electricity		
Inspect electricity wiring on a room by room basis and report deficiencies.	Q	MS
Furniture		
Repair or replace broken elements	A	MS

IV.6.2 Building Exterior

Spaces/Materials	Frequency	Operator
Wood		
Inspect panels, louvres, railings and report deficiencies		
Replace all broken wood louvres	A	MS
Replace other damaged elements	D	SS
Clean and paint marked surfaces	Q	SS
	A	MS
Windows		
Inspect and report deficiencies	D	MS
Remove broken glass louvres or panes (see above also)		
Order replacements for broken glass and other elements	I	MS
Replace broken elements		
Grease and oil louvre operators or handles	I	SS
Replace broken wire-mesh grills	Q	MS
Wash windows	A	MS
	Q	SS/MS
	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		
Sand and paint wood railings or posts	A	MS
	every 2 years	MS
Roofs and Gutters		
Inspect and report deficiencies	A	MS
Repair and replace roof sheets and gutters as required		
	W	SS
Metal Panels		
Inspect	A	MS
Wash and remove graffiti	A	MS
Clean rust and repaint	every 2 years	MS

IV.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	Q and as required	MS
Return soil, grass area, re-direct water source	Q and as required	MS
Repair eroded area	I	SS
Rubbish bins		
Empty drums and burn (or carry away) rubbish	D	C
Inspect and replace bins if necessary	A	MS

IV.7 Proposed Monthly Report Form

To: School Administrator

Report of the Maintenance Division

For the month of: ______________

Submitted by: ________________

Date: ________________________

Trade	Area or Class	Work done	Material cost	Labour cost	Remarks
Carpentry Doors Windows Roof Floors					
Masonry					
Electricity					
Plumbing					
Painting					
Other trades					

IV.8 Guidelines for Maintenance Checklists

In reporting deficiencies, the maintenance staff or handyman should be guided by the following aide memoirs. 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)	Washrooms and Toilets		
o	Check to see if the walls are cracked	------	-------
o	Where the walls are made of rubble stone see if the mortar is in good condition	-------	-------
o	Check to see if items such as soap holders and toilet paper holders are in place and are in working order	-------	-------
(b)	Corridors and Classrooms		
o	Examine the floors to see if the concrete has been damaged in any way so that persons walking in the corridors or classrooms may trip	-------	-------
o	Check to see if the walls are damaged and need repairing	-------	-------
(c)	Ceilings, Interior Roofs, and Canopies		
o	See if the ceilings and the undersides of the roofs and canopies have any watermarks which indicate leaks in the roof	--------	-------
o	See if any timber supports are rotten	--------	-------
o	Where the roof supports are of steel, check to see if there is any rust	--------	-------
o	See if any ceiling tiles need replacing	--------	-------

Spaces/Materials		Good	Bad
(d)	Plumbing		
o	Check to see if there is any water on the floor	--------	--------
o	If there is, examine the wash basin to see if it is plugged	--------	--------
o	Examine the WC to see if the bowl is cracked	--------	--------
o	See if the flush tank is cracked	--------	--------
o	Check to see if the toilet seat cover is broken	--------	--------
o	See if the flush handle or pull chain is broken	--------	--------
o	See if the toilet bowl is fixed properly to the floor so that it does not rock when being used	--------	--------
o	See if the sewer pipe is properly fixed to the toilet and that there is no leaking at the joint	--------	--------
(e)	Electricity		
o	See if all light bulbs are working and that all are in place	--------	--------
o	See if the wall plates are in good condition	--------	--------
o	See if the wall switches or pull switches are working	--------	--------
o	See if wall outlets are working	--------	--------
(f)	Windows		
o	See if the windows can close securely	--------	--------
o	See if the window operators are in good condition and are working	--------	--------
o	See if the bolts and locks are in working condition	--------	--------
o	See if the timber surrounding the windows is rotten and should be replaced	--------	--------
o	See if the windows leak even when closed	--------	--------

Spaces/Materials		Good	Bad
(g)	Doors and Frames and Partitions		
o	See if the doors can close properly	--------	--------
o	See if the bolts and locks are in place and are working	--------	--------
o	See if the door frame is in good condition and that the timber is not rotten	--------	--------
o	Where the door is a wood door (brace and batten) see that the door has not warped	--------	--------
o	Check the partitions to see if the walls are in good condition	--------	--------
o	Report any loose mortar in a rubble wall	--------	--------
o	Report any cracked wall	--------	--------
(h)	Roof and Gutters		
o	Check roofs for leaks	--------	--------
o	Check gutters for holes	--------	--------
o	Check gutter brackets to see if they are broken or rusted	--------	--------
(i)	Fence		
o	With a chain link fence, check to see if the fence is broken	--------	--------
o	See if the fence posts are firmly in the ground	--------	--------
o	With a timber fence, check for rotten timber	--------	--------
(j)	Water mains		
o	Check ground to see if there are any wet spots which would indicate a leaking water main	--------	--------
o	See if the water main is properly buried beneath the ground, or is well protected by concrete	--------	--------

Spaces/Materials		Good	Bad
(k)	Septic tank		
o	Check to see if the tank has been cleaned in the last three years	--------	--------
o	See if the access covers fit properly, are in good condition and can be removed for cleaning	--------	--------
o	If the access covers can be opened too easily, children may remove the covers wilfully	--------	--------
o	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.	--------	--------
o	See if the inlet pipe is firmly fixed to the tank and that there is no leak	--------	--------
o	Where there is a soakaway check to see if the pipe to the soakaway is firmly bedded	--------	--------
o	See if there is any odour around the tank. If there is, the tank needs cleaning or another soakaway should be dug	--------	--------
o	Where there are tile fields, check to see if the pipes (tiles) are exposed. They should be well below ground level	--------	--------
o	See if the tiles are working and that there is no water on the ground around the pipes	--------	-------
(l)	Erosion near Structures		
o	Examine the ground around the buildings to see if the rain water has removed any material - soil or stones	--------	--------
o	Check around the pipes to see if the pipes that were buried are still properly buried	--------	--------
o	Check around telephone or electricity poles on the property to see whether the rain water has removed soils around the bottom of the poles	--------	--------