

# Disaster Mitigation For Health Facilities

Guidelines for Vulnerability Appraisal  
and Reduction in The Caribbean



Pan American Health Organisation  
Regional Office of the  
World Health Organisation



European Community  
Humanitarian Office

2000

Many health administrators, engineers and others have contributed to this publication and it is not possible to acknowledge them all individually. However Marcel Clodion, Regional Advisor for the European Community Humanitarian Office (ECHO) and Dana Van Alphen, PAHO Regional Advisor in Disaster Preparedness in the Caribbean provided both financial and other support, and Claudio Osorio, PAHO Advisor in Disaster Mitigation in Costa Rica submitted useful comments on the draft. Tony Gibbs, Director of Consulting Engineers Partnership Ltd., Barbados applied his special expertise as the Technical Advisor and David Taylor, PAHO Advisor in Hospital Management, Office of Caribbean Programme Coordination contributed the narrative and provided overall editorial direction. Finally, special thanks go to Curtis Challenor of Genesis Graphics, Barbados who assembled the document for the printers and patiently incorporated many last minute changes.

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*Cover photograph:* Severe damage to a hospital in the Caribbean following a Hurricane (PAHO).

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## INTRODUCTION

This booklet, written primarily for the Caribbean, is based on the “Guide to Making Your Home Hurricane Resistant” published by the United Insurance Company Limited of Barbados, although its scope is wider than hurricanes in recognition of the threat of other natural hazards that exist in the Caribbean. It is fortunate that the technical author of the United Insurance Guide, Mr. Tony Gibbs, made available to PAHO his special expertise in this field and is responsible for the technical aspects of this guide.

The underlying principle of both the Insurance Guide and this one is that we all have a responsibility to protect our homes and our families and in the case of those who work in the health field our patients, visitors and staff from the dangers of natural hazards. This Guide seeks to help to do that not in the expectation that its use will create a group of technical experts, but rather, by making the technical expertise available in a form that can be used by the non-technical person.

The checklists reproduced in the Annex were first used in health facilities as part of a Workshop held in the British Virgin Islands in July 1998.

The comments and suggestions of those participants have been incorporated in this final version and have undoubtedly contributed to its value.

The Guide is being published at the end of the decade that was designated by the United Nations as the “International Decade for Natural Disaster Reduction”. This timing therefore recognizes the need to persevere with the initiatives begun in the years up to 1999, in order to continue to ensure the safety of members of the community and the staff themselves in the event of natural hazards.



Although the structure was undamaged, the widespread loss of roof sheets in a hurricane meant that the hospital was effectively unuseable. (Photo Tony Gibbs)



To reduce the losses and dangers from spilt chemicals and drugs, shelves and cupboards should be designed with adequate restraints. (Photo PAHO)



Plaster ceilings should be checked for vulnerability to falling in earthquakes. (Photo PAHO)

## 1. WHAT IS MITIGATION?

During the last 15 years, it is estimated that over 90 hospitals and over 500 health centres in Latin America and the Caribbean have been damaged by natural hazards. These have been documented in more detail in other publications (see Bibliography) but probably the most serious both in terms of loss of life and injury and impact on the health services was the 1985 earthquake in Mexico City. This event affected three of the largest hospitals in the city, resulting in the loss of 856 lives and 5,829 beds.

The impact a hazard has on inadequately designed and constructed facilities can lead to disasters.

A disaster therefore, is an event that occurs usually unexpectedly and suddenly causing severe hardship to people or things, sometimes resulting in the destruction of property, damage to the environment and possibly injury and loss of life.

Examples of natural hazards are:

- Earthquakes
- Hurricanes
- Volcanic eruptions
- Tsunamis (tidal waves/storm surges)
- Landslides (some)
- Torrential rains/loods (some)



A paediatric ward was made roofless during a hurricane because of the inadequate strength of rafters and their connections.  
*(Photo Tony Gibbs)*

In addition, there are “slow onset” disasters such as droughts and epidemics and also “Man-made” disasters such as fires, explosions, contamination etc. All have relevance and have to be taken into account as we look at our health facilities.

What has also been demonstrated, particularly in relation to hurricanes, is that relatively low cost retrofitting can protect buildings and equipment, thus allowing facilities to remain functional, and in some cases these measures can save lives.



The equipment in an intensive-care unit should be secured against toppling and sliding during earthquakes. *(Photo PAHO)*

Mitigation can be defined as the reduction or prevention of damage that a hazard may cause. It refers specifically to preventive activities pre-event, compared with response in the immediate aftermath, and rehabilitation in the medium to long term. Specifically in relation to health facilities the objectives of mitigation are:

To protect the public (patients, visitors etc.) and staff from injury or death

To enable critical departments to remain functional during and immediately after an event.

## 2. ROLE OF HEALTH STAFF

This Guide has been prepared for health staff who have an important role to play both in relation to their specific responsibilities to provide safe facilities for the public and patients and more generally as advocates of preparedness in their communities and own homes.



It is not intended that they should become technical experts but rather that they should be able to participate in an informed way in identifying the measures to be taken and in the setting of priorities. It is anticipated that the Guide will be used by the “managers” i.e. the nurses in charge of polyclinics and health centres, hospital administrators and heads of departments.

The final responsibility for correcting any problems identified through the use of this Guide will probably fall to the Public Works Department or the Maintenance Department and if possible they should be involved in any inspection tours of the facility. However, one of the purposes of this Guide is to reduce dependency on these Departments and enable the health staff to make reasonably informed decisions about the vulnerability of their facilities.

The Guide does not replace any existing Building Codes that should always be followed during both the construction of new, and the retrofitting of existing buildings.

The strengthening of unreinforced masonry walls by applying a reinforced-concrete skin during the retrofitting of a hospital after hurricane damage. (Photo Tony Gibbs)



This rural clinic, although built of lightweight materials, survived a severe hurricane because of adequate connections at the bases and the roof. (Photo Tony Gibbs)

### 3. USING THE GUIDE

Ideally all physical inspections of buildings and equipment should be accompanied by technical personnel who can advise on the feasibility and cost of any proposals.

Unfortunately, this kind of assistance usually provided by maintenance engineers or the Public Works Department, is not always readily available.

The Guide and accompanying checklists are instruments to enable an assessment of the vulnerability of buildings in relation in particular to earthquakes and hurricanes (wind). The Guide has been designed to be as “user friendly” as possible, avoiding the use of technical terms. This is to enable health staff to carry out independent inspections of their facilities. However, any technical help available should be utilised.

Following are some general points in relation to using the Guide:

**Siting of Hospital and Departments:** as this Guide deals with existing buildings, the location of facilities, which relates in particular to new building, is not dealt with in any detail. However, from time to time, decisions have to be made on the location of critical facilities for example the emergency generator or a new clinical unit. Local hazards, such as propensity of the proposed sites to flooding, should always be taken into account as far as possible

**“CEN” Services and Equipment:** a useful way of categorising services and equipment in order to guide decision making and prioritising is to use the classification of Critical, Essential or Non-essential (CEN). This is based on the approach used for drug management which classifies drugs as Vital, Essential or Non-essential (VEN).

Definitions of these are:

**Critical:** services and equipment that are life saving and without which the patient’s life is at risk.

**Services:** Accident and Emergency  
Operating Theatres  
Pharmacy  
Minimum number of beds

**Equipment:** Ventilators  
Defibrillators  
Incubators



**Essential:** services and equipment which are needed to make a diagnosis or provide a unique form of therapy.

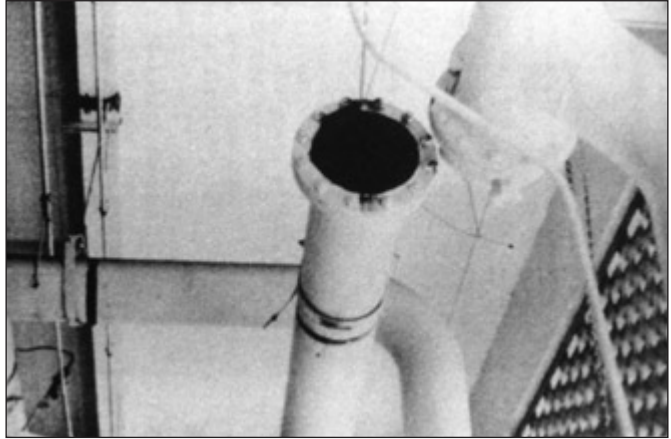
Services: Radiodiagnosis  
Laboratory

Equipment: X ray Units  
Patient Monitors  
Blood Gas Analyzers

**Non-essential:** services and equipment which support diagnosis and therapy but for which there may be reasonable alternative equipment or methods available.

Services: Physiotherapy  
Laundry  
Central Sterile Supplies  
Dietary

Equipment: Diathermy equipment  
Washing machines  
Autoclaves



Where pipes cross a movement joint in a hospital they should be provided with flexible links in the vicinity of the joint. (Photo PAHO)

This classification can be used to agree a list of priority equipment and services locally, as part of the facility's disaster/contingency plan.



The absence of anchorage led to the removal and overturning of the entire building of this clinic in a hurricane. (Photo Tony Gibbs)



### Importance of Maintenance

Checklists have been included (Annex V) which deal with maintenance of the property. This should in most cases be the responsibility of a Maintenance Department but the checklist is included as an emphasis of the importance of this in particular in relation to disaster planning and mitigation.

Regular checks of doors and windows to ensure that they close securely and clearing of drains etc. can prevent damage at very little cost. These are essentially good housekeeping measures but nevertheless are extremely important.



## Annex I

# Checklist for Vulnerability Surveys (Wind)

The sketch reference numbers refer to the illustrations in Annex II.

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ITEM	YES	NO	SKETCH REF#
<b>Walls</b>			
Precast concrete interconnected and fixed to floors and roofs			
Coral stone block masonry a 12 inches (or greater) in thickness and with a maximum height-to-thickness ratio of 12, or b 6 inches (or greater) in thickness and reinforced and fixed to floors and roofs			
Concrete block masonry reinforced and fixed to floors and roofs			
Timber construction complying with all of the following: a 3/4-inch marine plywood or 5/8-inch tongue-and-groove lumber b 2-inch by 4-inch vertical studs at (maximum) 2-foot spacing to which the plywood or lumber is nailed or screwed c two 2-inch by 4-inch horizontal base plates and two 2-inch by 4-inch horizontal eaves beams to which the studs are fastened with galvanised metal plates in accordance with manufacturers' specifications d all openings framed with 2-inch by 4-inch vertical and horizontal studs, cills and lintols all fastened with galvanised metal plates in accordance with manufacturers' specifications e the entire perimeter secured to reinforced concrete foundations with galvanised metal straps at (maximum) 4-foot spacing f minimum depth of foundation to be 3 feet below adjacent ground level unless some other means is used to achieve adequate anchorage			#W1  #W2  #W2
<b>Roofs</b>			
Concrete			
Light-weight coverings a 26-gauge steel sheeting with valley fasteners or with ridge fasteners supplemented by spacer blocks under the ridges. Fastener spacings must be not greater than 6 inches along the purlins and purlins must not be further apart than 4 feet for 15% of the roof dimension along eaves, gables and ridges.			#W3, #W4

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ITEM	YES	NO	SKETCH REF#
<p>b 22-gauge aluminium sheeting with valley fasteners or with ridge fasteners supplemented by spacer blocks under the ridges. Fastener spacings must be not greater than 6 inches along the purlins and purlins must not be further apart than 4 feet for 15% of the roof dimension along eaves, gables and ridges.</p> <p>c Asphalt shingles fixed in accordance with manufacturer's recommendations for hurricane areas and laid on waterproofing felt on top of 3/4-inch (or greater) plywood sheets which in turn are fastened by screws or annular nails to supporting timber rafters</p> <p>d shingles individually fixed to close boarding which in turn is fastened by screws or annular nails to supporting timber rafters</p> <p>NB i In all cases the methods of fixing must, at least, comply with the manufacturers' recommendations for severe hurricane locations</p> <p>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</p>			<p>#W3, #W4</p> <p>#W5</p> <p>#W5</p>
<p>Other coverings</p> <p>a slates individually fixed to close boarding</p> <p>b concrete or clay tiles individually fixed to close boarding</p> <p>NB i In all cases the methods of fixing must, at least, comply with the manufacturers' recommendations for severe hurricane locations</p> <p>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</p>			<p>#W5 #W5</p>

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ITEM	YES	NO	SKETCH REF#
<p>Frame supports for light-weight roof coverings</p> <ul style="list-style-type: none"> <li>a Steel rafters fixed to walls</li> <li>b Bolted steel trusses fixed to walls</li> <li>c Timber rafters fixed at the ridges and to the walls with bolts or proprietary fasteners</li> <li>d Bolted timber trusses fixed to the walls with bolts or proprietary fasteners</li> <li>d Timber trusses fabricated using proprietary fasteners and fixed to the walls with bolts or proprietary fasteners</li> </ul> <p>NB In all cases the methods of connecting and fixing must, at least, comply with the manufacturers' recommendations for severe hurricane locations</p>			<p>#W6 #W6 #W6, #W7</p>
<b>Windows</b>			
<p>Made of laminated glass fixed to frames with structural silicon and able to resist, without breaching, the impact of flying objects such a 2-inch by 4-inch piece of timber weighing 9 pounds moving at 35 miles per hour (similar to the requirements of Dade, Broward and Palm Beach Counties of Florida), or</p>			
<p>Protected by pre-installed or pre-fabricated shutters which are made of at least 3/4-inch timber or otherwise able to resist without breaching the impact of flying objects such as a 2-inch by 4-inch piece of timber weighing 9 pounds moving at 35 miles per hour.</p>			<p>#W8, #W9, #W10</p>
<p>Made of timber or aluminium louvres with provisions for excluding the rain during storm conditions</p>			
<p>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 severe hurricane locations</p>			
<b>Doors</b>			
<p>Glass Sliding Doors</p> <ul style="list-style-type: none"> <li>a 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</li> </ul>			

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ITEM	YES	NO	SKETCH REF#
<ul style="list-style-type: none"> <li>b Protected by pre-installed or pre-fabricated shutters which are made of at least 3/4-inch timber or otherwise 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.</li> <li>c The moving frames must have a certificate from the supplier indicating compliance with the requirements for Category 3 hurricanes, including both strength and deflexions.</li> <li>d The fixed perimeter frames must be secured to the walls, slabs, beams or columns by bolting or in accordance with the manufacturers' recommendations for severe hurricane locations.</li> <li>e The tracks of the top and bottom rails must be deep enough to prevent the moving doors from being dislodged in severe hurricanes. (The manufacturer's advice should be sought.)</li> </ul>			
<p>Roller Shutter (or Overhead) Doors</p> <ul style="list-style-type: none"> <li>a These must have certificates from the suppliers indicating compliance with the requirements for Category 3 hurricanes, including both strength and deflexions</li> <li>b The fixed perimeter frames must be secured to the walls, slabs, beams or columns by bolting or in accordance with the manufacturers' recommendations for severe hurricane locations</li> <li>c The side tracks must be deep enough to prevent the moving doors from being dislodged in severe hurricanes unless some other mechanism is employed to prevent such an occurrence (The manufacturer's advice should be sought.)</li> </ul>			
<p>Other Doors</p> <ul style="list-style-type: none"> <li>a Timber doors must be solid core or made up from solid timber members</li> <li>b Each door leaf must be fixed by hinges or bolts in at least four locations adjacent to all corners</li> </ul>			
<p>Other Apertures</p> <ul style="list-style-type: none"> <li>a Protection from wind and rain must be provided by pre-installed or pre-fabricated shutters which are made of at least 3/4-inch timber or otherwise 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.</li> </ul>			<p>#W8, #W9</p>

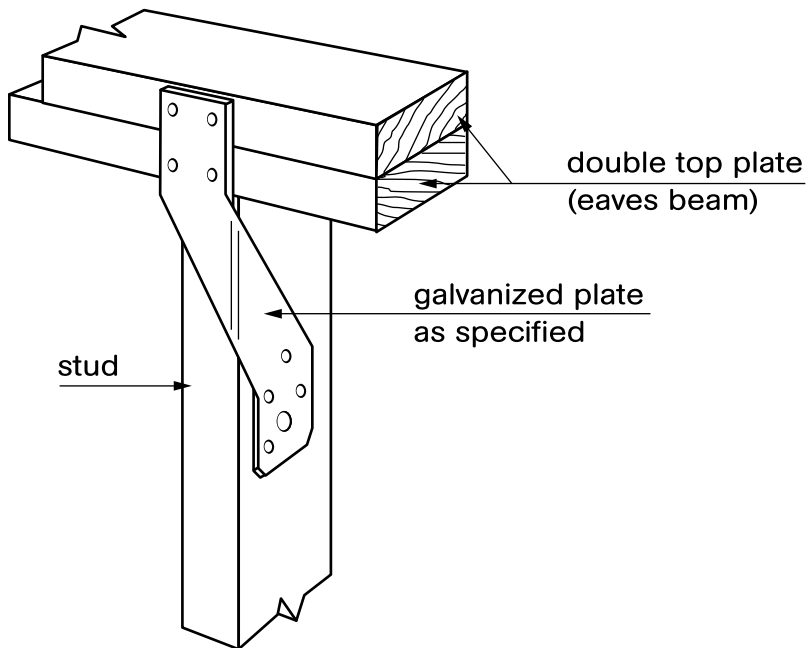
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ITEM	YES	NO	SKETCH REF#
b The shutters must be secured to the walls, slabs, beams or columns near all corners of each panel or in accordance with the manufacturers' recommendations for severe hurricane locations.			#W10
<b>Solar Water Heaters and Air-conditioners</b>			
These must have certificates from the suppliers indicating compliance with the requirements for Category 3 hurricanes for both manufacture and installation			
<b>Roof Shapes</b>			
a hip-roofs without parapets but with no overhangs and with minimum slope of 20°, or gable roofs without parapets but with no overhangs and with minimum slope of 25° b hip-roofs with parapets and with minimum slope of 15°, or gable roofs with parapets and with minimum slope of 20°			#W11  #W12

## Annex II

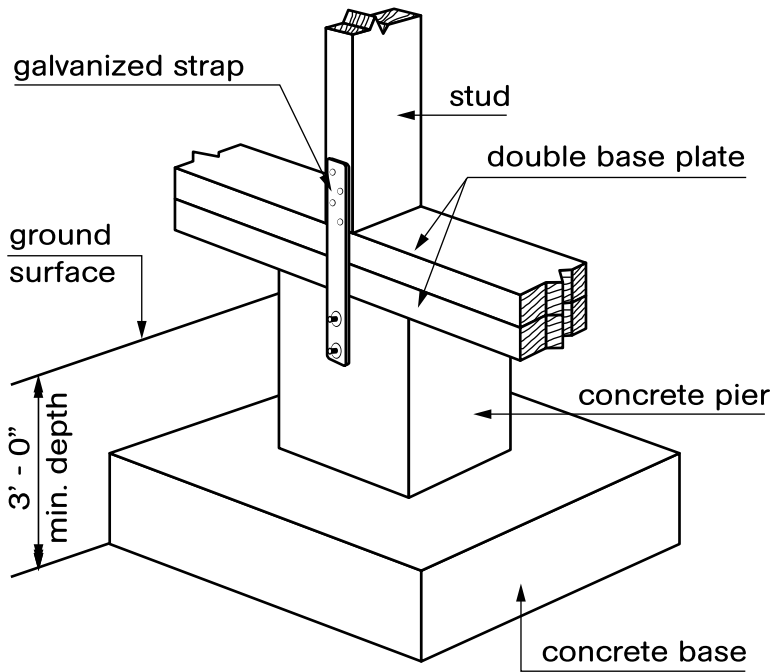
# Illustrations (Wind)

These illustrations were taken from  
“Guide to Making Your Home Hurricane Resistant”  
prepared by Tony Gibbs and Philip Jordan of Consulting Engineers Partnership Ltd  
for United Insurance Company Ltd  
1997

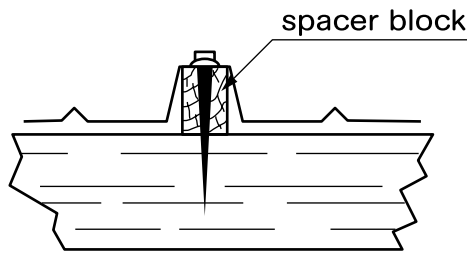


**Stud & top plate connection**

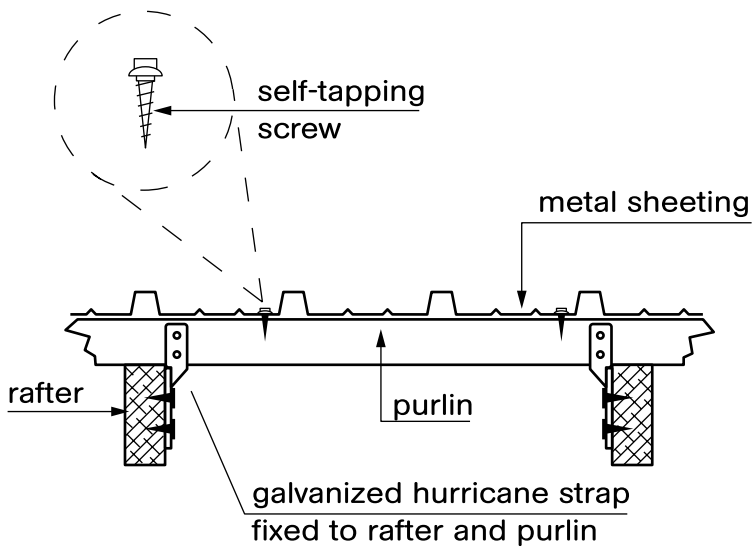




Stud to concrete connection  
Foundation anchorage

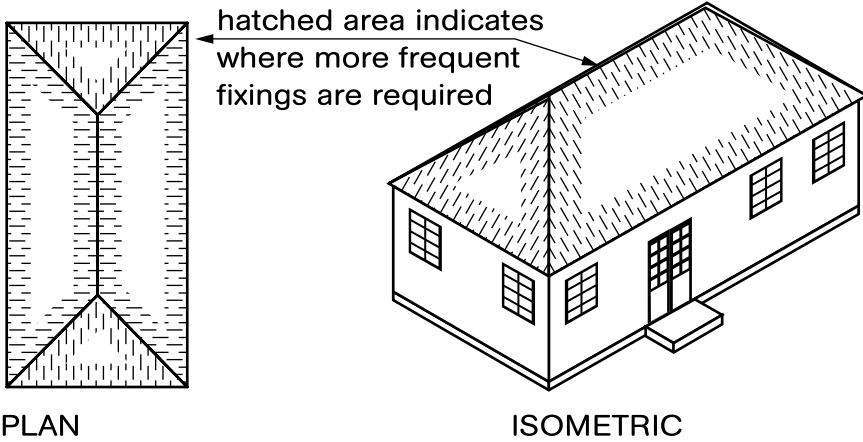


ridge connection

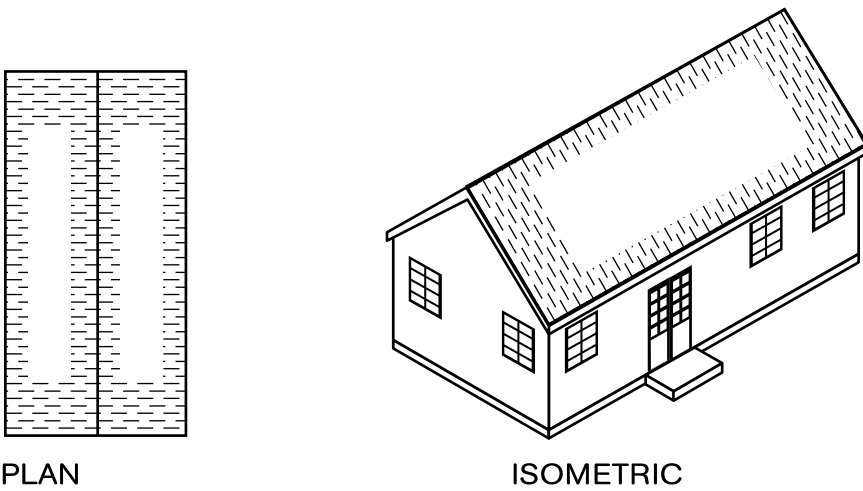


valley connection

### Metal sheet fixings and purlin-to-rafter connection

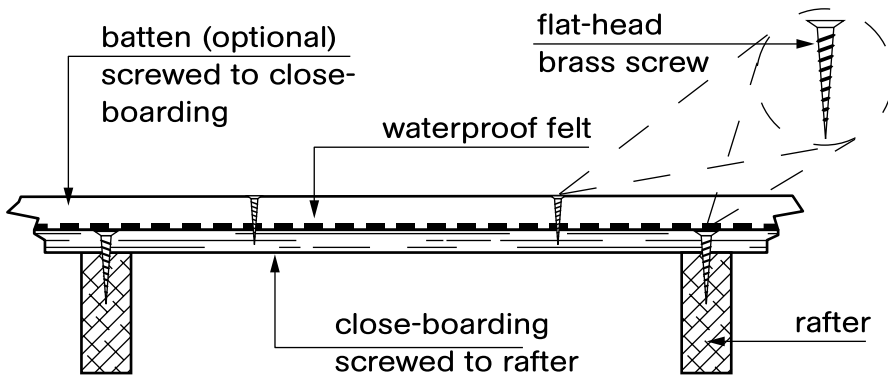


hip-roof

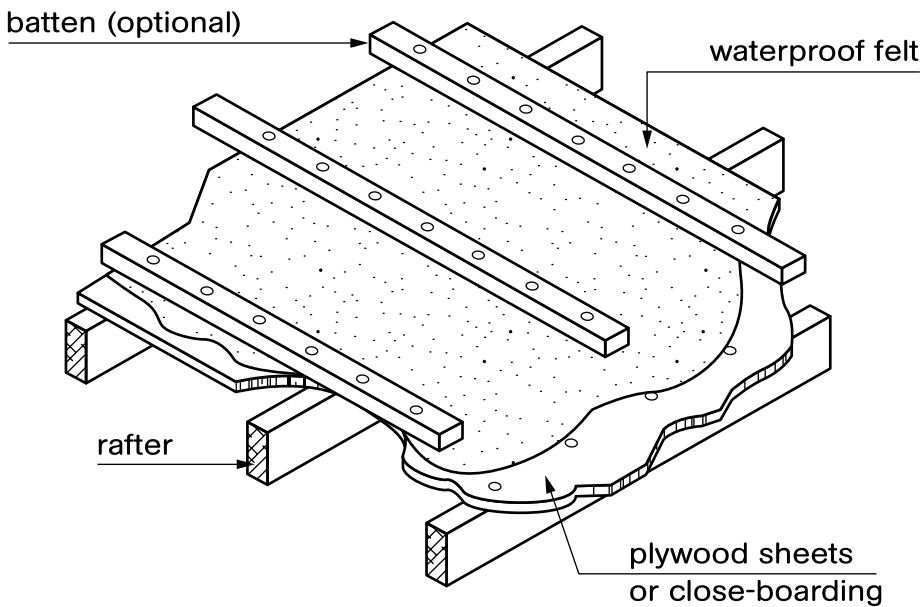


gable roof

The more vulnerable areas of roofs

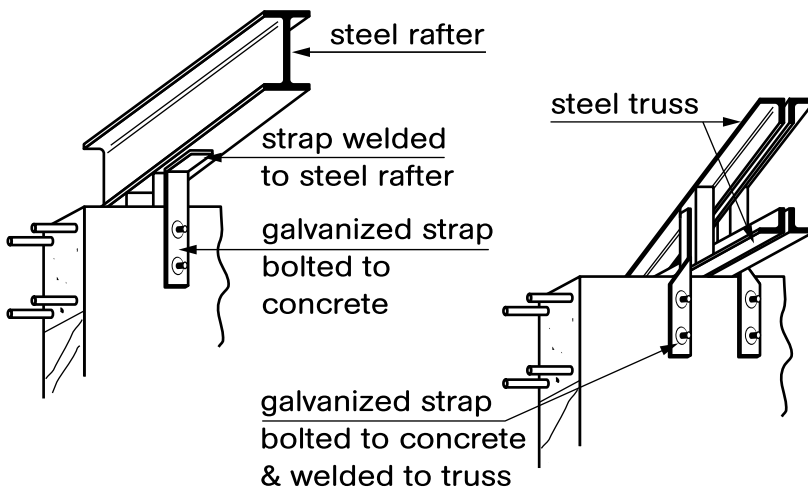


CROSS SECTION



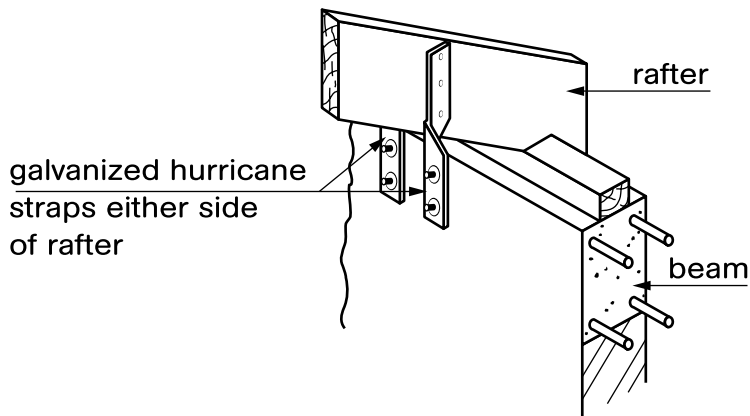
ISOMETRIC

## Fixing of close-boarding and battens for tile and shingle roofing

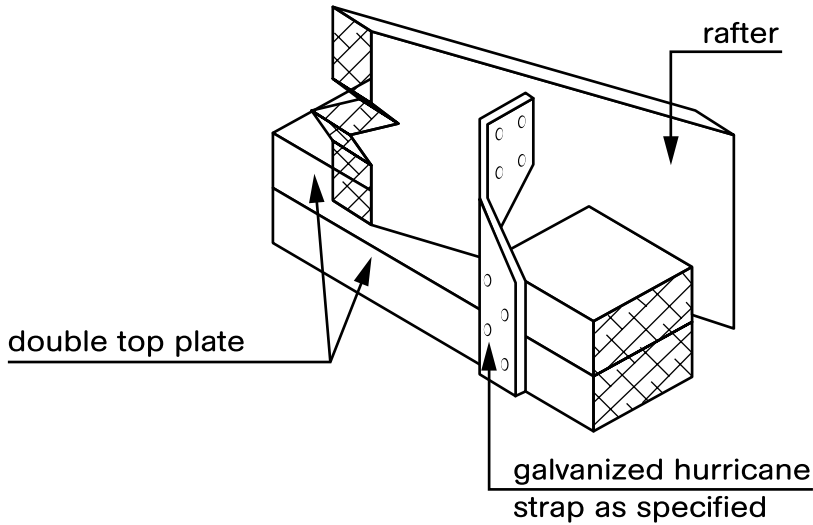


(after welding, apply rust-proofing coating)

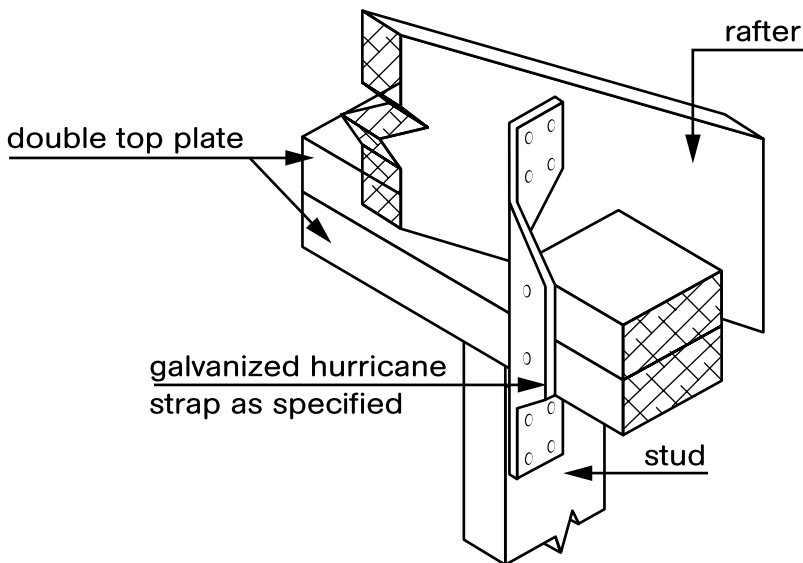
## Steel truss and rafter connection to concrete



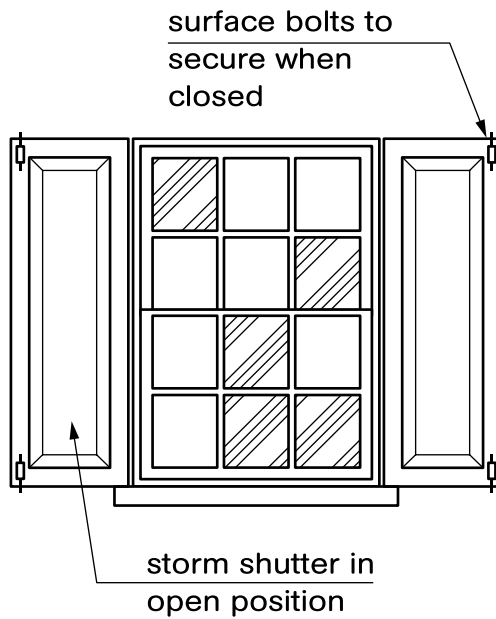
## Timber rafter connection to concrete



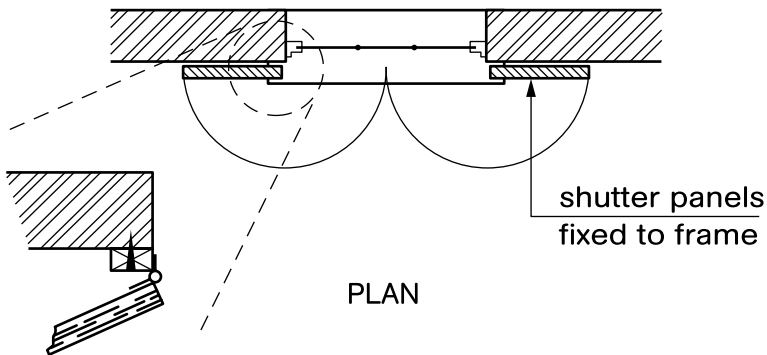
Rafter & top plate connection



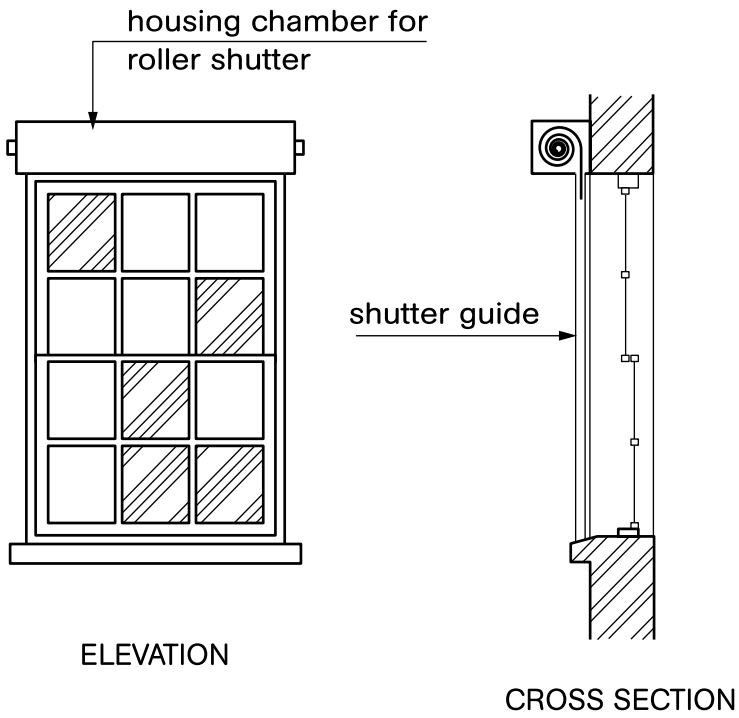
Stud, top plate & rafter connection



ELEVATION

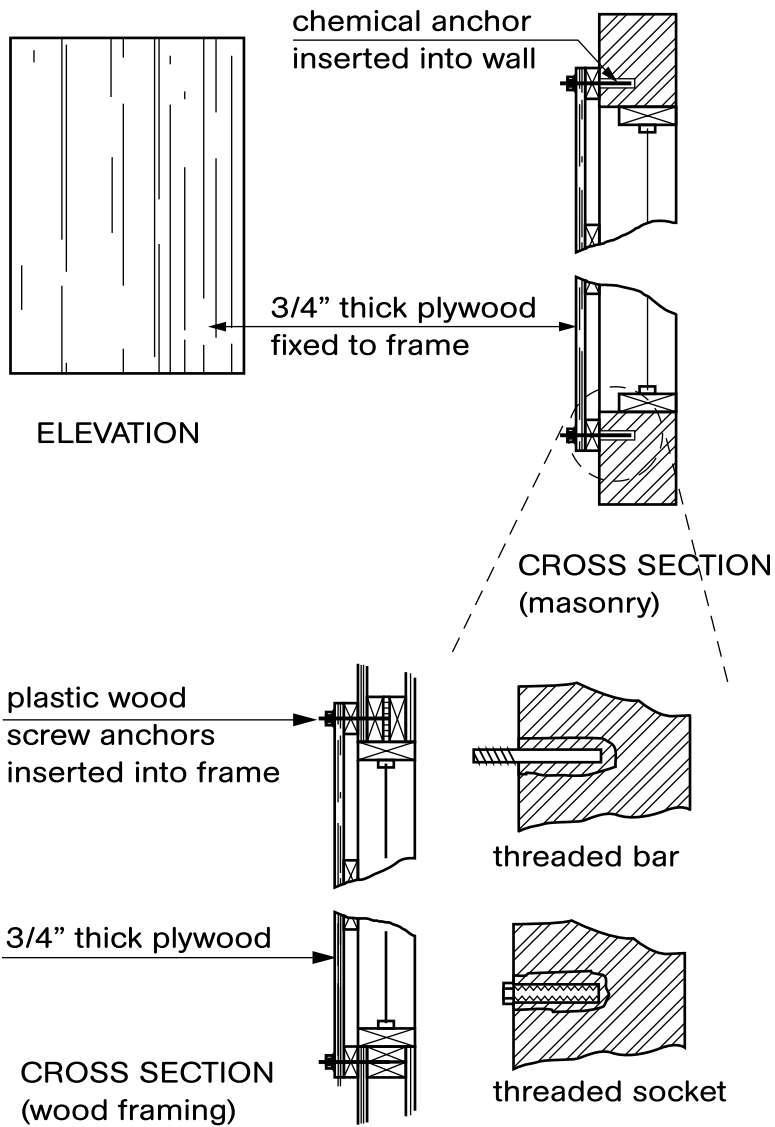


## Permanently installed shutters

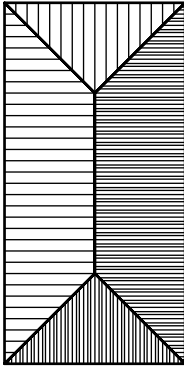


## Roller shutter

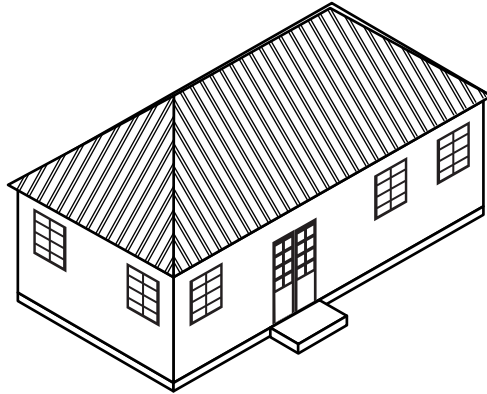




### Pre-fabricated removable shutter

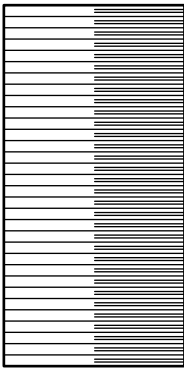


PLAN

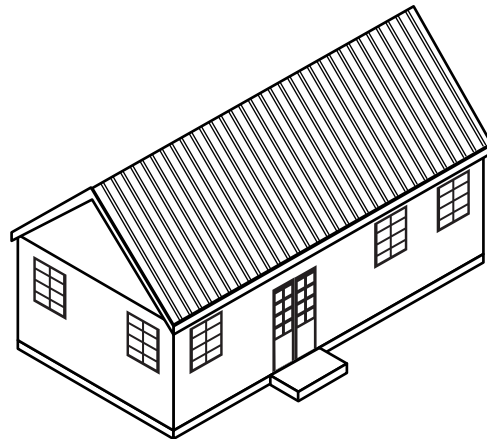


ISOMETRIC

hip: 20° or greater



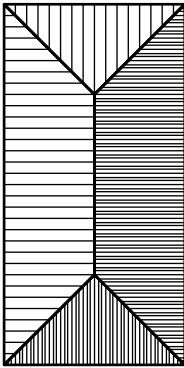
PLAN



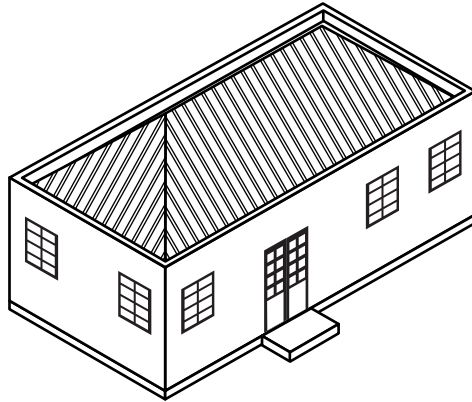
ISOMETRIC

high gable: 25° or greater

Favourable roof shapes

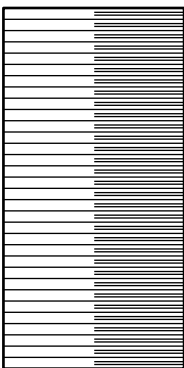


PLAN

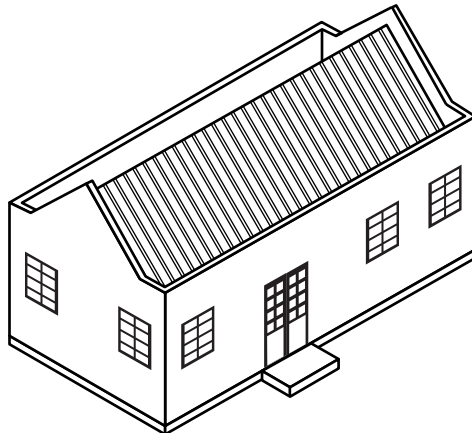


ISOMETRIC

hip with parapet:  $15^\circ$  or greater



PLAN



ISOMETRIC

high gable with parapet:  $20^\circ$  or greater

Favourable roof shapes

## Annex III

# Checklist for Vulnerability Surveys (Earthquakes)

The sketch reference numbers refer to the illustrations in Annex IV.  
Examples of structural and non-structural components are provided in illustration E1.

Guidelines for Vulnerability Appraisal and Reduction in The Caribbean

ITEM	YES	NO	SKETCH REF#
<b>Electricity</b>			
Generator a Is the emergency generator adequately secured?			
Batteries a Are the batteries securely attached to the battery rack? b Is the rack cross-braced in both directions? c Does the battery rack have bolts secured to a concrete pad?			
Diesel Fuel Tank a Is the tank securely attached to the supports? b Are the tank supports cross-braced in both directions? c Is the bracing attached with anchor bolts secured to a concrete pad?			#E2
Fuel Lines and Other Pipes a Are these lines and pipes attached with flexible connections? b Are they able to accommodate relative movement across joints?			#E2
Transformers, Controls, Switchgear a Are these items properly attached to the floor or wall?			
Bus Ducts and Cables a Are these able to distort at their connections to equipment without rupture? b Are they able to accommodate relative movement across joints? c Are they laterally braced?			
<b>Fire Fighting</b>			
Smoke Detectors and Alarms a Are they properly mounted? b Are the control system and fire doors securely anchored?			
Fire Extinguishers and Hose-reel Cabinets a Are the cabinets securely mounted? b Are the extinguishers secured with quick-release straps?			#E3

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ITEM	YES	NO	SKETCH REF#
Emergency Water Tank a Is it securely anchored to its supports? b Are the supports braced in both directions? c Are the supports or braces anchored to a concrete foundation?			#E2
<b>Propane Tanks</b>			
The Tank a Is it securely anchored to its supports? b Are the supports braced in both directions? c Are the supports or braces anchored to a concrete foundation?			#E2
Shut-off Valve a Does the system have an automatic, earthquake-triggered shut-off valve? b If manual, is a wrench stored close by?			
Supply Pipes a Are they able to accommodate relative movement across joints and at the tank? c Are they laterally braced?			#E2
<b>Plumbing</b>			
Water Heaters and Boilers a Are they securely anchored to the floor or wall? b Does the gas line have a flexible connection to the heater or boiler to accommodate movement?			#E4
Pumps a Are they anchored or are they mounted on vibration isolation springs with seismic lateral restraints?			
Hot and Cold-water Pipes and Wastewater Pipes a Are the pipes laterally braced at reasonable intervals? b Do they have flexible connections to boilers and tanks? c Can they accommodate movement across joints? d Are “free” pipe penetrations through walls large enough to for seismic movement? e Are they free of asbestos insulation (which can be broken in an earthquake)?			
Solar Panels a Are they securely anchored to the roof?			

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ITEM	YES	NO	SKETCH REF#
<b>Elevators</b>			
Cab a Is it properly attached to the guide rails?			
Cables, Counterweights, Rails a Are cables protected against misalignment during an earthquake? b Are counterweights properly attached to guide rails? c Are guide rails properly attached to the building structure?			
Motors and Control Cabinets a Are these anchored?			
<b>Air Conditioning</b>			
Chillers, Fans, Blowers, Filters, Air Compressors a Are they anchored or are they mounted on vibration isolation springs with seismic lateral restraints?			
Wall-mounted Units a Are they securely mounted?			
Ducts a Are they laterally braced? b Can they accommodate movement at locations where they cross separation joints?			
Diffusers a Are the grills anchored to the ducts or to the ceiling grid or to the wall? b Are hanging diffusers adequately supported?			
<b>Non-structural Walls and Partitions</b>			
Concrete Block, Brick, Clay Block a Are they reinforced vertically and/or horizontally? b Are they detailed to allow sliding at the top and movement at the sides? c Are they restrained at the top and the sides against falling?			#E6
Stud-wall and Other Lightweight a Are partial-height partitions braced at their top edges? b If they support shelving or cabinets, are they securely attached to the structure of the building?			#E5

ITEM	YES	NO	SKETCH REF#
<b>Ceilings and Lights</b>			
Ceilings a Do the suspended ceilings have diagonal bracing wires? b For plaster ceilings is the wire mesh or wood lath securely attached to the structure above?			#E7
Lighting a Do light fixtures (eg lay-in fluorescent fixtures) have supports independent of the ceiling grid? b Do pendant fixtures have safety restraints (eg cables) to limit sway? c Are emergency lights mounted to prevent them falling off shelf supports?			
<b>Doors and Windows</b>			
Doors a If exit doors are heavy metal fire doors that might jam in an earthquake, is there a crowbar or sledge hammer readily available to facilitate emergency opening? b Do automatic doors have manual overrides?			
Windows a Is it known whether the glazing has been designed to accommodate lateral movement? b Do large windows, door transoms and skylights have safety glass?			
<b>Appendages and Sundries</b>			
Parapets, Veneer and Decoration a Are parapets reinforced and braced? b Do veneers and decorative elements have positive anchorage to the building?			
Fences and Garden Walls a Is it known whether these were designed by the architect or engineer to resist lateral forces? b Are masonry walls reinforced vertically and rigidly fixed to their bases?			
Signs and Sculptures a Are signs adequately anchored? b Are heavy and/or tall sculptures anchored to prevent overturning? Clay and Concrete Roof Tiles			



Guidelines for Vulnerability Appraisal and Reduction in The Caribbean

ITEM	YES	NO	SKETCH REF#
a Are such tiles secured to the roof with individual fixings for each tile?			
<b>Movable Equipment</b>			
Communications a Is radio equipment restrained from sliding off shelves? b Are telephones placed away from edges of desks and counters? c Are elevated loud speakers and CCTV anchored to the structure?			
Computers a Is vital computer information backed up regularly and stored off site? b Is heavy computer equipment with a height-to-width ratio greater than 2 anchored or braced? c Are desktop items prevented from sliding off tables? d Are access floors braced diagonally or do they have seismically-certified pedestals?			#E8 #E9
Storage of Records and Supplies a Are shelving units anchored to walls? b Are shelves fitted with edge restraints or cords to prevent items from falling? c Are heavier items located on the lower shelves? d Do filing cabinet drawers latch securely? e Are heavily-loaded racks braced in both directions? f Are fragile or valuable items restrained from tipping over? g Are chemical supplies secured or stored in "egg crate" containers?			#E13  #E13 #E13 #E11 #E10  #E13  #E13
Hazardous Items a Are gas cylinders tightly secured with chains at top and bottom (or otherwise)? b Are the chains anchored to walls? c Are chemicals stored in accordance with manufacturers recommendations? d Are cabinets for hazardous materials given special attention with respect to anchoring?			#E12   #E13

Disaster Mitigation For Health Facilities

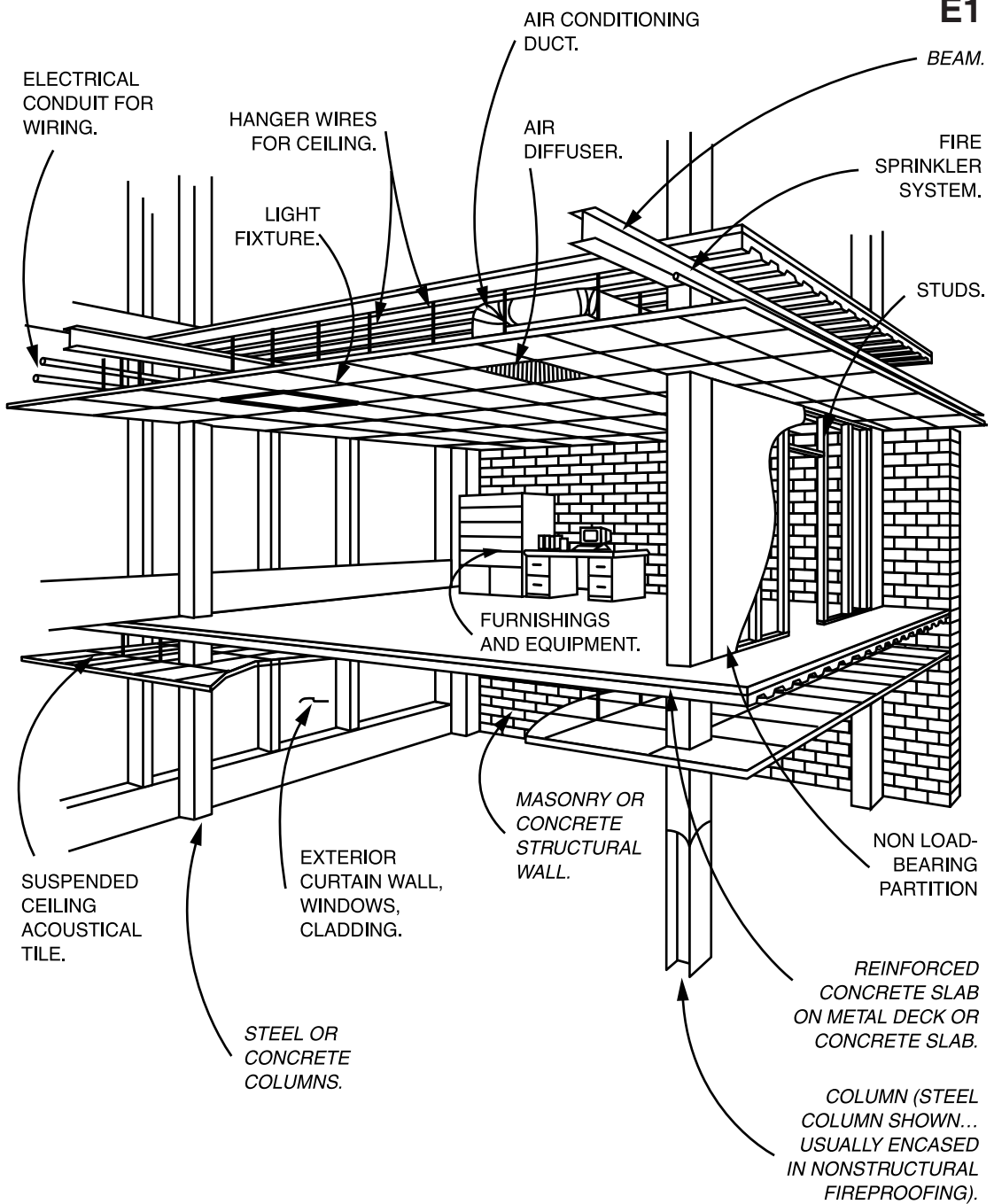
ITEM	YES	NO	SKETCH REF#
Furniture a Are heavy potted plants restrained from falling or located away from beds? b Are beds and tables and equipment with wheels provided with locks or other restraints to prevent them rolling unintentionally?			#E8

## Annex IV

# Illustrations (Earthquakes)

These illustrations are taken from  
“Reducing the Risks of Nonstructural Earthquake Damage”  
Issued by the Federal Emergency Management Agency (FEMA)  
Third Edition FEMA 74/September 1994

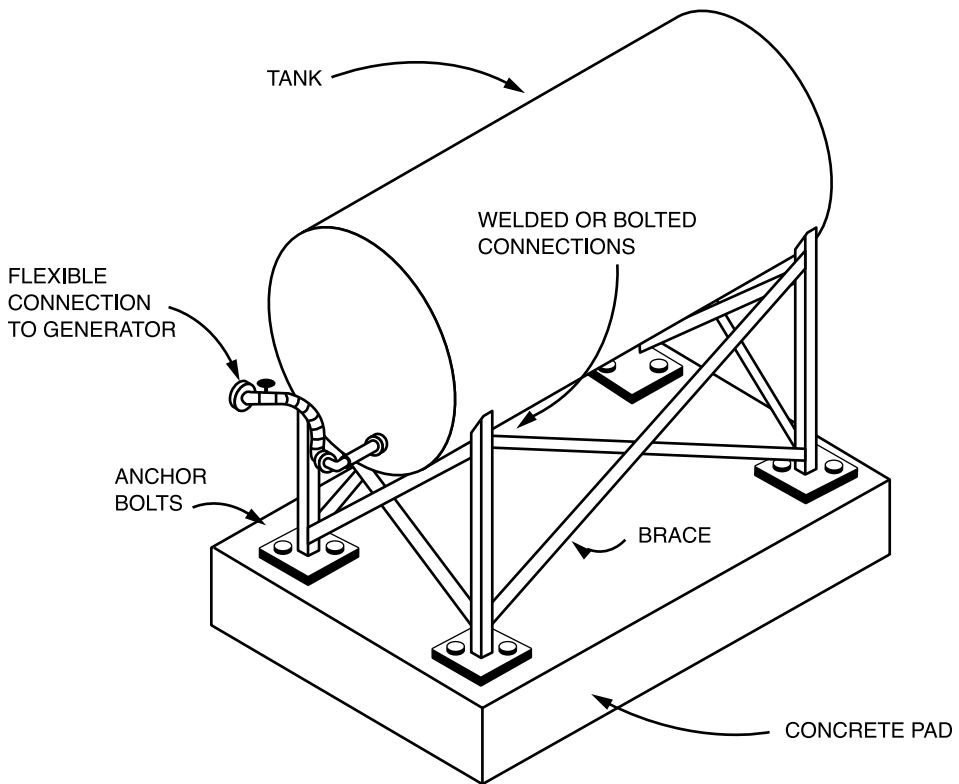
**E1**

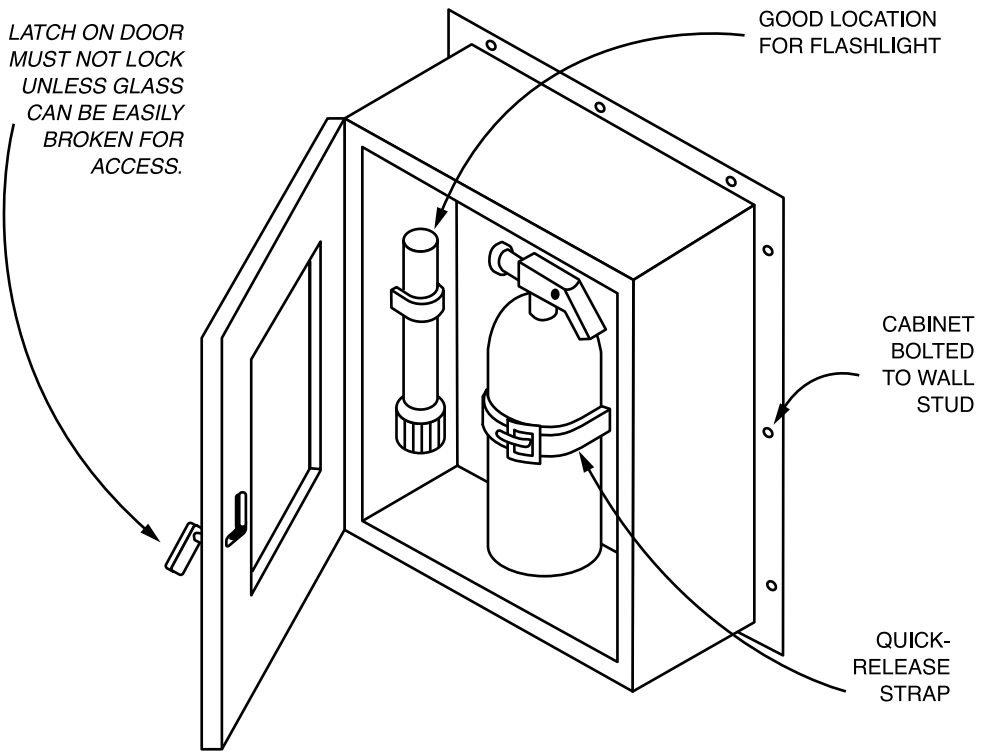


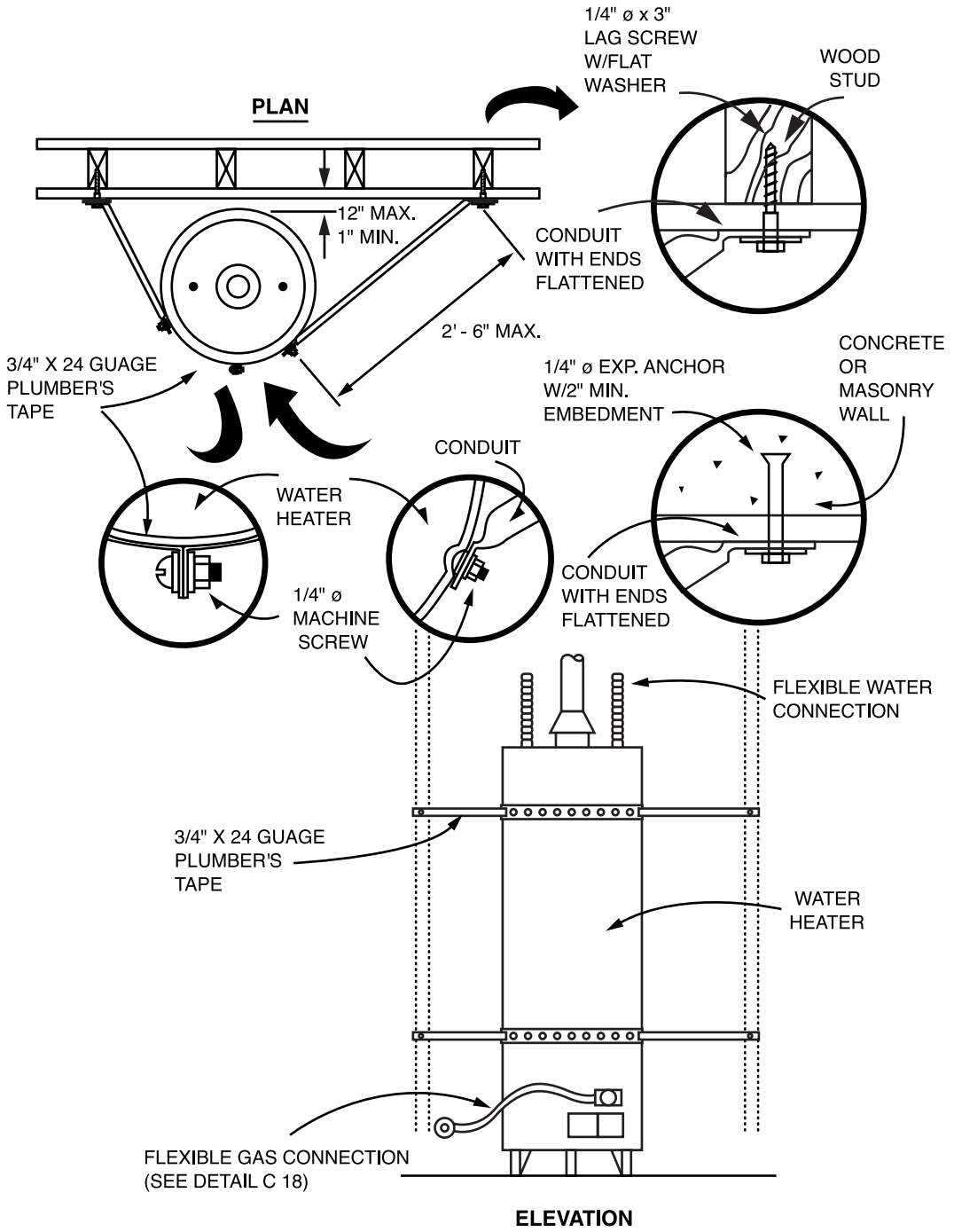
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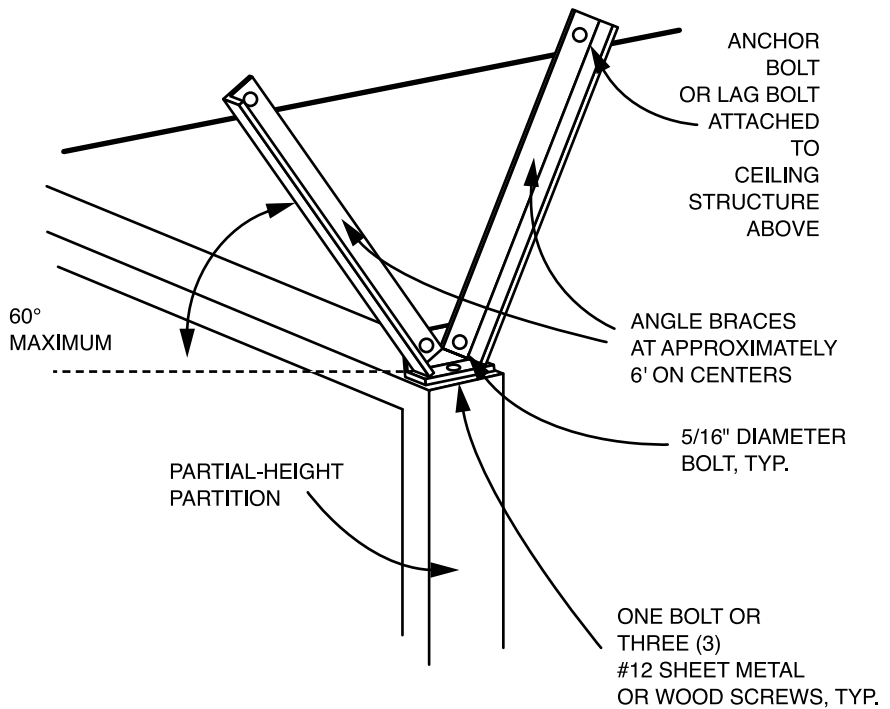
NONSTRUCTURAL ITEMS (STANDARD TEXT)

STRUCTURAL ITEMS (*ITALICS*)



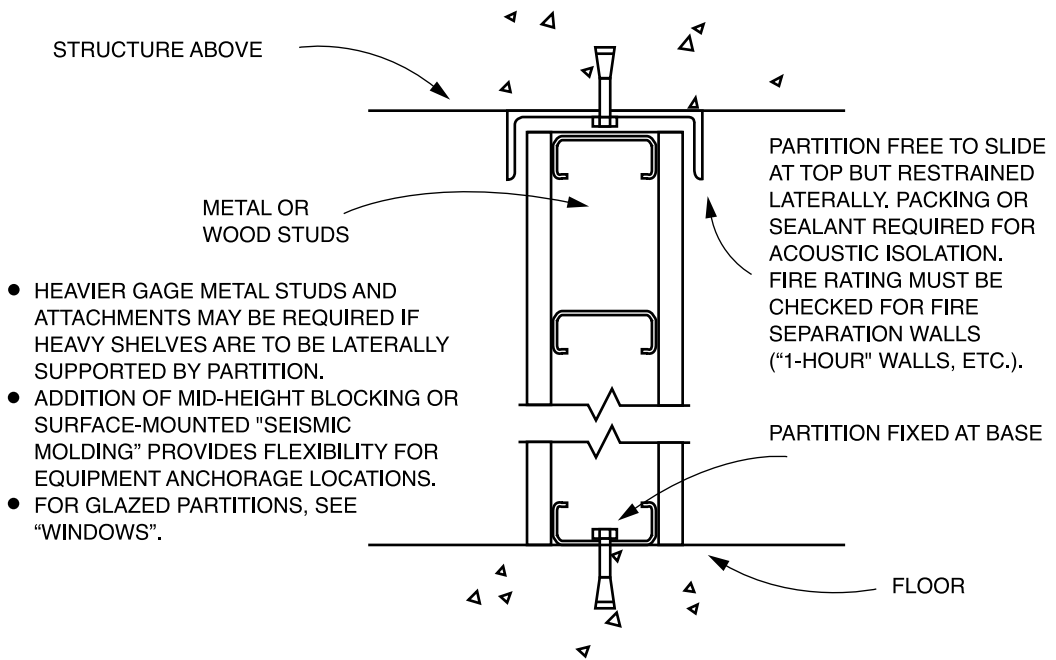


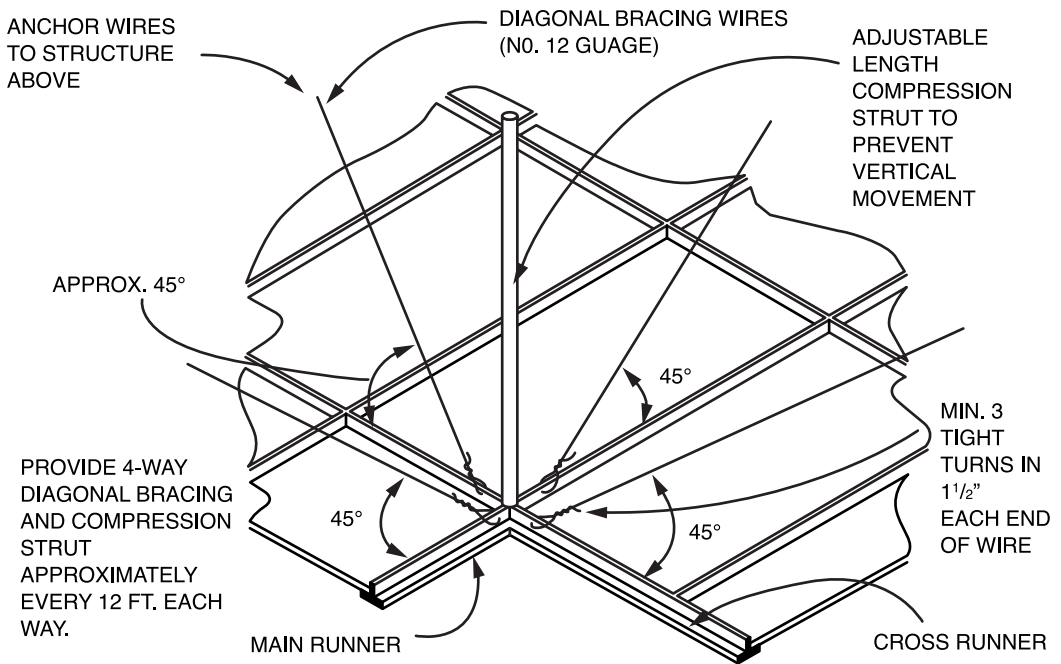


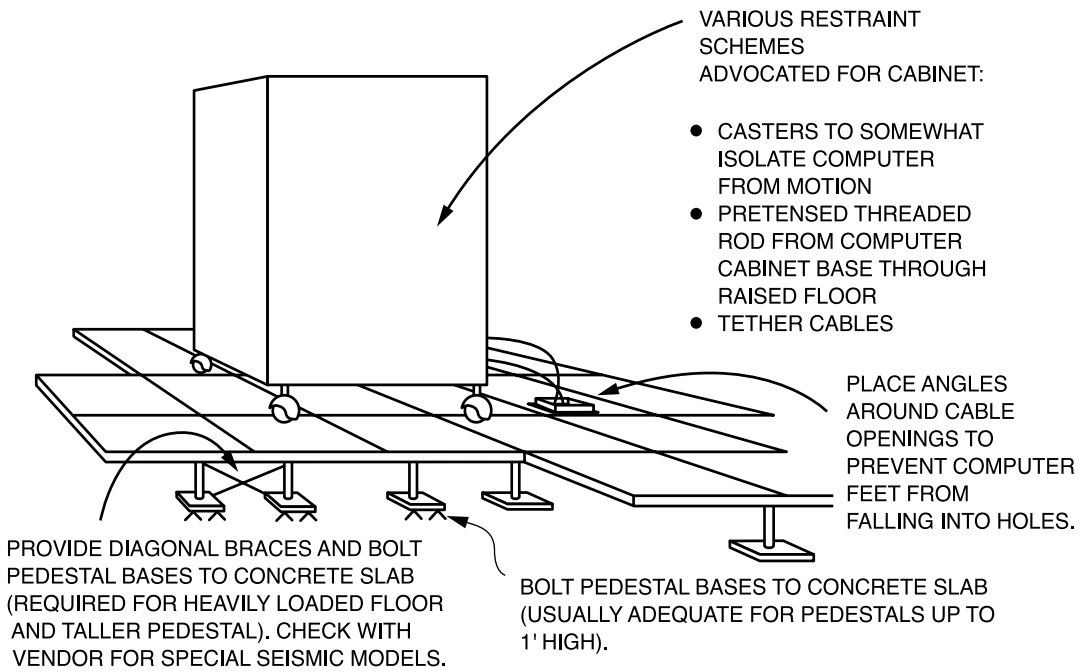


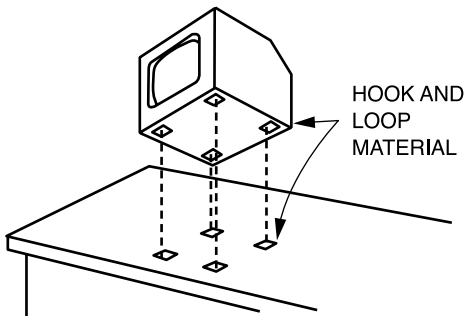
- HEAVIER BRACES OR CLOSER SPACING MAY BE REQUIRED IF PARTITION IS USED TO SUPPORT OR SEISMICALLY RESTRAIN HEAVY SHELVES OR OTHER NONSTRUCTURAL ITEMS.



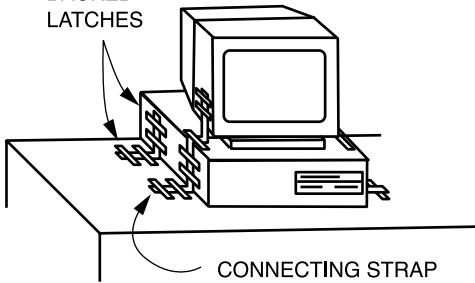




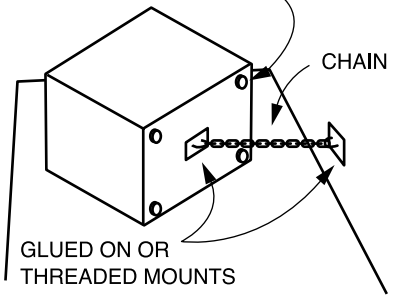




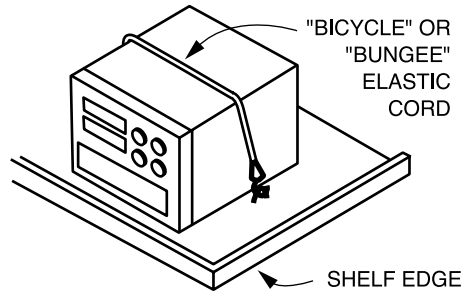
ADHESIVE BACKED LATCHES

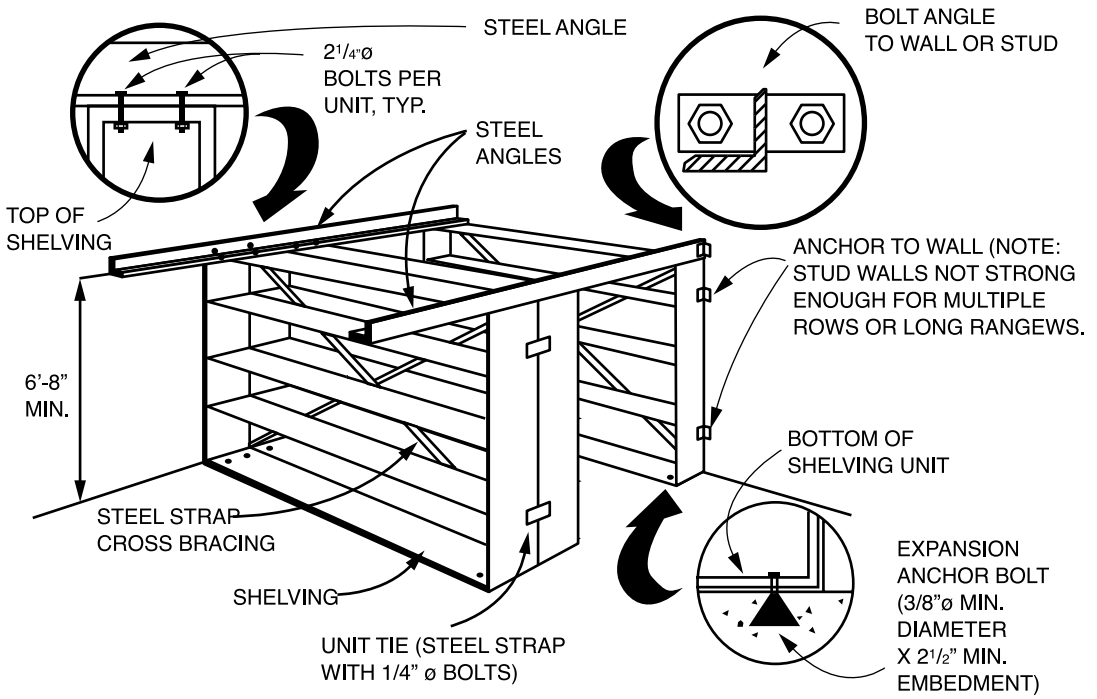


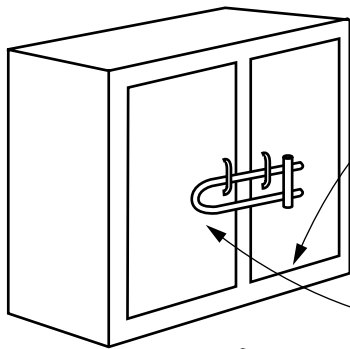
RUBBER "DOORKNOB" BUMPERS



"BICYCLE" OR "BUNGEE" ELASTIC CORD

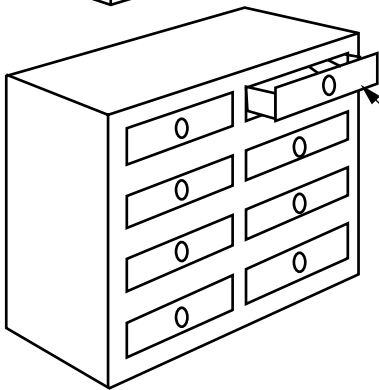




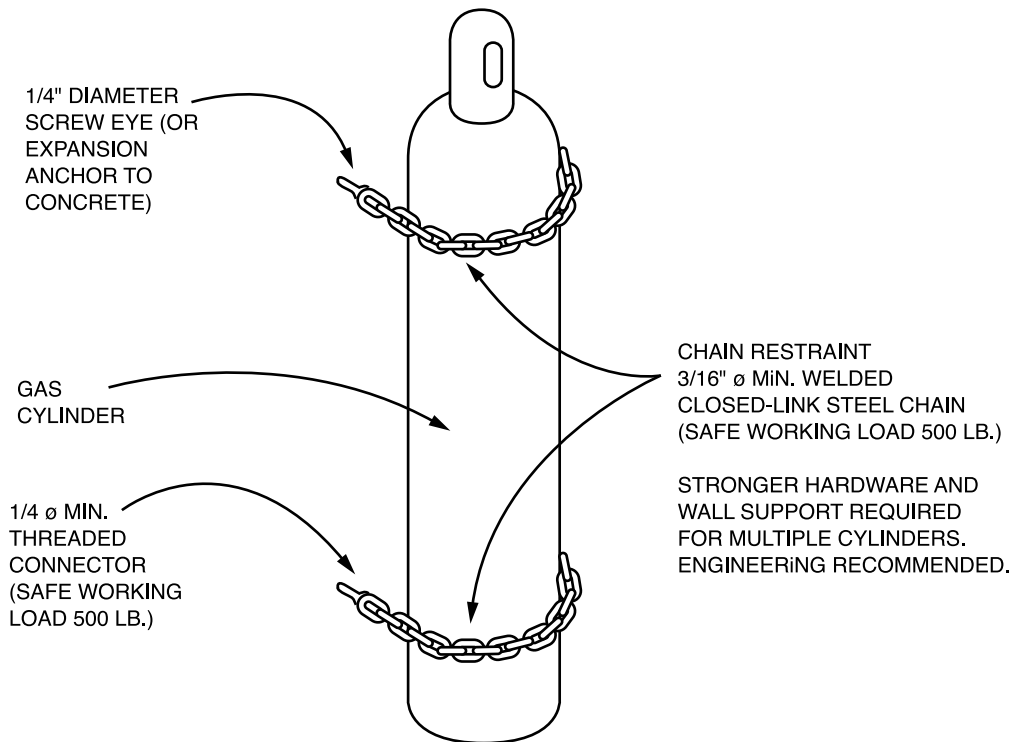


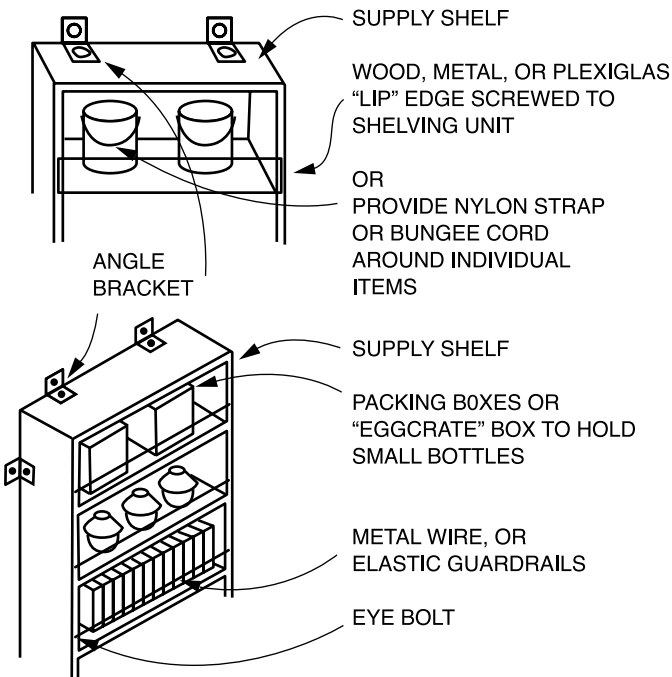
INSTALL STRONG MECHANICAL CABINET CATCHES (SAFETY HASP SLIDE BOLT, TOUCH-DOOR CABINET CATCH, CLIP-ROLLER OR SNAP-ACTION CABINET CATCH, ETC.)

ALTERNATIVE: PROVIDE BABY-PROOF CLOSURE



INSTALL MECHANICAL DRAWER CLOSURE (BABY-PROOF LATCHES, DRAWER LOCKS, OR OTHER SPECIALTY LATCHES)





- ANCHOR STORAGE SHELVES
- PROVIDE SAFETY LIP OR SHELF EDGE
- PROVIDE MECHANICAL LATCHES FOR CABINETS AND DRAWERS
- STORE SMALL OR BREAKABLE ITEMS IN ORIGINAL PACKING OR EGGCRATE BOXES, NOT LOOSE ON SHELF OR IN DRAWER
- STORE INCOMPATIBLE MATERIALS AT A SAFE DISTANCE TO AVOID MIXING IF THE CONTAINERS FALL
- ORDER HAZARDOUS LAB CHEMICALS IN UNBREAKABLE PLASTIC BOTTLES OR IN GLASS BOTTLES WITH AN EXTERIOR PLASTIC SAFETY COATING



## Annex V

# Checklists for Maintenance Operations

Four tables are presented covering:

**Building Interior**

**Building Exterior**

**Compound**

### Guidelines for Maintenance Checklists

The following abbreviations are used in the tables:

<i>Frequency</i>		<i>Operator</i>	
I	Immediately	C	General cleaners
D	Daily	MS	Maintenance staff
W	Weekly	HA	Hospital Administrator/Officer In Charge
Q	Quarterly		
A	Annually	G	Gardener

- Notes:
1. For *Frequency* the maximum period is given.
  2. For *Operator* the person named is usually responsible for seeing that the operation is carried out.

**Building Interior**

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

<b>Building Exterior</b>		
<b>SPACES/MATERIAL</b>	<b>FREQUENCY</b>	<b>OPERATOR</b>
<u>Wood</u> Inspect panels, louvres, railings and report deficiencies Replace all broken wood louvres Replace other damaged elements Clean and paint marked surfaces	A D Q A	MS MS MS MS
<u>Windows</u> Inspect and report deficiencies Remove broken glass louvres or panes (see above also) Order replacements for broken glass and other elements Replace broken elements Grease and oil louvre operators or handles Replace broken wire-mesh grills Wash windows	D I I Q A Q Q	MS MS MS MS MS MS C/MS
<u>Doors and Frames and Partitions</u> Inspect and report deficiencies Oil hinges etc. Replace defective and broken hardware Repair or replace defective doors and/or frames	Q A I I	MS MS MS MS
<u>Stairs and Balconies</u> Sweep stairs and balconies Wash stairs, walls and rails Clean metal work of rust and coat with primer and paint Sand and paint wood railings or posts	D Q A every 2 years	C C MS MS
<u>Roofs and Gutters</u> Inspect and report deficiencies Repair and replace roof sheets and gutters as required	A W	MS MS
<u>Metal Panels</u> Inspect Wash and remove graffiti Clean rust and repaint	A A every 2 years	MS MS MS

Guidelines for Vulnerability Appraisal and Reduction in The Caribbean

Compound		
SPACES/MATERIALS	FREQUENCY	OPERATOR
<u>Gardening</u>		
Clean flower beds	W	G
Watering and fertilise plants	D	G
Remake plant beds	Q	G
Prune plants, trim hedges/trees	M	G
Grass playing fields	as required	G
Cut grass	W	G
<u>Fence</u>		
Inspect and report deficiencies	Q	MS
Repair	Q	MS
Paint	every 2 years	MS
<u>Walkways and Courtyards</u>		
Sweep	D	C
Clear litter and rubbish	D	C
<u>Drainage Ditches</u>		
Clean routinely	W	C
Clear blockages caused by excessive rain	I	MS
Repair damaged drains	A (in August)	MS
<u>Water Mains</u>		
Inspect and report deficiencies	Q	MS
Maintain earth cover	Q	MS
Repair breaches/leaks	I	SS
<u>Septic Tank</u>		
Inspect and report deficiencies	A (in August)	MS
Clean and flush out	every 4 years	MS
Repair	I	MS
<u>Erosion near Structures</u>		
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	MS
<u>Rubbish bins</u>		
Empty drums and burn (or carry away) rubbish	D	C
Inspect and replace bins if necessary	A	MS

**Guidelines for Maintenance Checklists**

In reporting deficiencies, the maintenance staff or handyman should be guided by the following notes. However, the guidelines which are given here are not intended to be exhaustive. They will, however, focus inspection on the critical areas.

SPACES/MATERIALS	GOOD	BAD
<p>(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</p>	<p>-----                      -----                      -----</p>	<p>-----                      -----                      -----</p>
<p>(b) <u>Corridors and Classrooms</u>                      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                      Check to see if the walls are damaged and need repairing</p>	<p>-----                      -----</p>	<p>-----                      -----</p>
<p>(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</p>	<p>-----                      -----                      -----                      -----</p>	<p>-----                      -----                      -----                      -----</p>
<p>(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</p>	<p>-----                      -----                      -----                      -----                      -----                      -----                      -----                      -----</p>	<p>-----                      -----                      -----                      -----                      -----                      -----                      -----                      -----</p>
<p>(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</p>	<p>-----                      -----                      -----                      -----</p>	<p>-----                      -----                      -----                      -----</p>

Guidelines for Vulnerability Appraisal and Reduction in The Caribbean

SPACES/MATERIALS	GOOD	BAD
<p>(f) <u>Windows</u>            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</p>	<p>-----            -----            -----            -----            -----</p>	<p>-----            -----            -----            -----            -----</p>
<p>(g) <u>Doors and Frames and Partitions</u>            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</p>	<p>-----            -----            -----            -----            -----            -----            -----</p>	<p>-----            -----            -----            -----            -----            -----            -----</p>
<p>(h) <u>Roof and Gutters</u>            Check roofs for leaks            Check gutters for holes            Check gutter brackets to see if they are broken or rusted</p>	<p>-----            -----            -----</p>	<p>-----            -----            -----</p>
<p>(i) <u>Fence</u>            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</p>	<p>-----            -----            -----</p>	<p>-----            -----            -----</p>
<p>(j) <u>Water mains</u>            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</p>	<p>-----            -----</p>	<p>-----            -----</p>
<p>(k) <u>Septic tank</u>            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, children 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</p>	<p>-----            -----            -----            -----            -----            -----</p>	<p>-----            -----            -----            -----            -----            -----</p>

Disaster Mitigation For Health Facilities

SPACES/MATERIALS	GOOD	BAD
<p>Where there is a soakaway check to see if the pipe to the soakaway is firmly bedded</p> <p>See if there is any odour around the tank. If there is, the tank needs cleaning or another soakaway should be dug</p> <p>Where there are tile fields, check to see if the pipes (tiles) are exposed. They should be well below ground level</p> <p>See if the tiles are working and that there is no water on the ground around the pipes</p>	<p>-----</p> <p>-----</p> <p>-----</p> <p>-----</p>	<p>-----</p> <p>-----</p> <p>-----</p> <p>-----</p>
<p>(I) <u>Erosion near Structures</u></p> <p>Examine the ground around the buildings to see if the rain water has removed any material - soil or stones</p> <p>Check around the pipes to see if the pipes that were buried are still properly buried</p> <p>Check around telephone or electricity poles on the property to see whether the rain water has removed soils around the bottom of the poles</p>	<p>-----</p> <p>-----</p> <p>-----</p>	<p>-----</p> <p>-----</p> <p>-----</p>

## **Bibliography**

“Reducing the Risks of Nonstructural Earthquake Damage” Federal Emergency Management Agency (FEMA), FEMA 74/September 1994

“Disaster Mitigation Guidelines for Hospitals and other Health Care facilities in the Caribbean” Pan American Health Organization, January, 1992

“Guide to Making Your Home Hurricane Resistant” United Insurance Company Limited, Barbados

“Mitigation of Disasters in Health Facilities” Volumes 1-4, Pan American Health Organization, 1993