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Foreword

Australia's most expensive disaster was the Sydney hailstorm of 1999, where the damage bill was about $1.7 billion. In the past eighteen months, Australia has experienced the devastation wrought by several severe storms and cyclones. In March 2006 Queensland was hit by category 5 Tropical Cyclone Larry, resulting in huge social disruption and millions of dollars of physical and economic costs that continue today. Tropical Cyclone Monica followed one month later causing further damage to north Australia and disrupting recovery efforts from Tropical Cyclone Larry. Western Australia was also impacted by serious cyclones – Clare, Glenda and Floyd.

Canberra was hit by a severe storm on 2 December 2005, which caused an estimated $15 million in damage. A severe hailstorm on the Queensland Gold Coast in October 2005 resulted in more than $60 million in damage to homes, businesses, cars and boats. This storm was followed two weeks later by another storm in the same region, which resulted in $25 million in crop damage. Earlier, severe storms caused more than $50 million in damage between Geraldton and Bunbury in Western Australia.

This third edition of the manual *Storm and Water Damage Operations* (previously titled *Storm Damage Operations*) in the *Skills for Emergency Services Personnel* section of the *Australian Emergency Manual (AEM)* series provides a basic reference for storm and water damage operations. The techniques and principles in this manual are designed for immediate and temporary storm and water damage repairs. Permanent repair measures are not the responsibility of emergency service personnel.

Storm and water damage operations are inherently hazardous and should only be undertaken by trained personnel. This manual is intended for use in the planning, training and operations of emergency service personnel and organisations.

The use of trade names in this manual is not intended to be restrictive, preferential or promotional; rather, trade names are used where descriptive clarity is required. Where trade names are utilised it should be understood that these products are neither officially endorsed nor recommended by Emergency Management Australia or individual emergency service organisations.

I would like to thank the State Emergency Service National Education and Training Committee (SES NETC) for coordinating this review and for ensuring current national best practice in storm and water damage operation skills. As situations change and improved techniques are developed, the *Storm and Water Damage Operations* manual will be updated and amended under the auspices of the SES NETC. Suggestions for changes should be forwarded to EMA at the address shown below.



Tony Pearce
Director General
Emergency Management Australia
January 2007

Emergency Management Australia, PO Box 1020, Dickson ACT 2602

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Introduction

Policy statement

Storm and water damage operations can involve hazardous situations, due either to weather conditions or working environments, or a combination of both. Personnel involved in storm and water damage operations will not be put at any undue risk to effect temporary repairs to damaged buildings. If a potentially dangerous situation arises that cannot be overcome, then other methods of assistance should be sought.

It is important that people involved in storm and water damage operations are competent, familiar with and practised in:

- safety and correct use of equipment
- characteristics of building construction
- on-site hazard identification, risk assessment and control, and
- methods of effecting temporary repairs.

This publication contains a number of methods for the provision of temporary relief for occupants of wind, storm and water damaged dwellings. The methods have been developed over a number of years of experience in storm/cyclone operations.

Other techniques will, no doubt, be developed in the future, and suggestions for amendments and the inclusion of further information are encouraged.

This manual is not to be regarded as a self-teaching medium and is provided as a reference work only. Any training in, or practical adaptation of, the methods or techniques covered in this publication should be conducted with regard to agency policy and procedures.

Scope

This publication details recommended methods, management considerations and options available to effect temporary repairs in the conduct of storm and water damage-related operations.

Aim

The aim of this publication is to detail the steps necessary to prepare personnel to control storm and water damage operations and provide timely, temporary storm and water damage assistance.

Objectives

The information in this manual will assist emergency services personnel, when undertaking storm and water damage operations, to:

- employ effective resource management
- identify common types of building construction and related problems
- identify specific hazards and risks and employ appropriate control measures
- employ safe working practices with regard to human and physical resources, and
- select and apply appropriate techniques and methods for temporary emergency repairs that suit the situation.

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CHAPTER 1

Introduction to Storm and Water Damage Operations

1.1 Introduction

Storms can range in intensity and effect from localised thunderstorms and windstorms to tropical cyclones. Damage from these events can affect both rural and urban environments.

Water damage can result from flooding caused by slow river rise, storm waters or flash-flooding.

These events can occur almost anywhere in Australia and at almost any time of the year. They can cause damage to dwellings and other structures, ranging from isolated, relatively minor cases to severe, widespread damage and, in some cases, even severe damage or total collapse.

As a result of the frequency, unpredictability and the widespread geographical likelihood of storms and local flooding, it is necessary for emergency services to be fully prepared operationally to cope with all aspects of these events.

Storm damage operations may be necessary following wind and/or hail damage to trees and structures. Water damage operations aim at reducing the impact of the water and minimising the effects of water entry. The techniques used are common to storm, flood and other water damage events.



Figure 1:1
Building damage caused by Tropical Cyclone Larry – March 2006

1.2 Principles of storm and water damage operations

The basic concept of an emergency service should be the fostering of community self-help and mutual assistance during emergency and/or disaster situations. Storm and water damage operations fall into this category, and emergency services personnel provide community support mainly by assisting residents to make temporary repairs to damaged buildings. This assistance should be based on the following seven principles.

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1.2.1 Prevention

Prevention of damage resulting from storms is preferable to carrying out repairs. Responsible agencies should embark on regular education, information and pre-storm assistance programs. These programs should aim to advise members of the public, and assist them to take steps that could reduce the effects of future storms. Emergency Management Australia (EMA) publishes free material on severe storm and cyclone awareness and preparedness for dissemination to the public by State and Territory Emergency Services.

1.2.2 Community to make its own repairs

Where possible, encourage members of the community suffering storm and/or water damage to make their own repairs. Assistance in terms of advice and supply of resources such as tarpaulins should be provided by relevant emergency service agencies.

1.2.3 Priority of assistance

Where residents have a genuine requirement for further assistance, provide assistance on a priority basis, with preference given to those most in need. These cases can broadly be categorised as follows:

High (Priority 1): Examples may include hospitals, aged-care facilities, where relocation of occupants may not be possible (for example, an elderly person on a dialysis machine), and emergency communications centres (for example, Triple 000 Communication Centres).

Medium (Priority 2): An example may include private residential buildings where living areas are affected.

Low (Priority 3): An example may include private residential facilities where damage is to areas other than the main living areas.

These are generic examples only. Tasks should be allocated a priority based upon individual circumstances.

1.2.4 Repairs should be of a temporary nature

Any repairs carried out are designed to be of a temporary nature only, and are to provide the affected people with protection until permanent repairs can be completed. Temporary repairs are not designed to provide full weather-proofing of damaged buildings under all conditions. However, the protection is usually sufficient to maintain the main part of a building in a liveable condition. Advise householders that even where sheeting or tiles are replaced with new materials, these repairs are still temporary and need to be checked by a suitably qualified roofer or builder.

1.2.5 Assistance is on a once-only basis

Any assistance provided to residents should normally be on a once-only basis. Any adjustments required to coverings should preferably be carried out by the residents if they are capable. When permanent repairs have been completed, any temporary repair materials that were issued by the emergency services should be returned to pre-arranged collection centres.

1.2.6 Safety of personnel

The safety of personnel must take precedence over the provision of assistance. Subjecting personnel to unsafe or hazardous situations to prevent further damage to property is not warranted under any circumstance.

1.2.7 Permission to make repairs

To protect the interests of the building owner, the occupants and emergency services personnel, repairs to a damaged building should not be undertaken unless the building owner, a representative or a person in authority authorises repairs to be carried out. Agencies should consider the use of an ‘Authority to conduct repairs’ form.

These principles form the basis of all storm and water damage operations and, if taken into account, will have a direct bearing on the success of subsequent operations.

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1.3 Emergency planning

In Australia, the comprehensive approach to emergency/disaster management is widely used. This approach has four elements—prevention, preparedness, response and recovery. This approach is also used in the management of storm and water damage. (Further information may be found in the Australian Emergency Manual *Emergency Planning*).

1.4 Prevention

Each local authority is responsible for the production of a counter-disaster or emergency management plan for its area. As planning for disasters is not something that can be done in isolation, the local authority forms a counter-disaster planning or emergency management planning committee, which is made up of representatives from various organisations that could have some role or responsibility in disaster situations.

A number of stages and factors must be considered in the process of producing a counter-disaster or emergency management plan, and it is not intended to cover this process in any detail in this manual.

The local counter-disaster or emergency management plan is an important part of emergency/disaster management. As well as providing a coordinated approach to the control of disaster situations, it also enables involved organisations to determine their own priorities and arrangements with regard to training, equipment and so forth.

1.5 Preparedness

The preparation for potential storm damage can be divided into five areas: individual householders, local governments, emergency services organisations, emergency service units and individual personnel preparation.

1.5.1 Individual householders

Individual householders may prepare for storms by:

- cleaning gutters and downpipes of any debris
- trimming overhanging branches
- keeping the yard and balcony free of loose items
- making sure the roof is in good repair
- keeping a list of emergency numbers handy
- protecting skylights
- preparing an emergency kit
- checking home and contents insurance, and
- securing boats on moorings or protecting on land.

This list is not exhaustive.

1.5.2 Local governments

Local governments can prepare during the planning stage of the process by dealing with the identification of possible disasters and determining measures to deal with their affects.

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1.5.3 Emergency services organisations

Preparedness involves the arrangements made or actions taken by emergency services organisations to prepare local emergency service units to be able to carry out their roles and responsibilities efficiently and effectively. The following points should be addressed:

- identification, availability and condition of resources, and
- formulation and production of standard operating procedures.

The preparation phase of storm damage operations is a critical part of the efficient conduct of the operation and the effective provision of assistance to the community. The preparation phase is now attracting more consideration.

Remember the six p's:

Prior

planning and

preparation

prevents

poor

performance.

1.5.4 Emergency service units

The aim of an emergency service at local level is to be capable of carrying out the roles and responsibilities as laid down by the control agency.

The preparation for storm damage operations involves the consideration of resources and procedures.

a. **Resources**—It is necessary for units to identify available resources and determine policies for procurement, storage, maintenance and training.

   Resources can be classified as either human or physical.

   i. **Human resources.** The most important resource is people. Without adequate or competent personnel, it can be difficult or impossible to complete the task at hand effectively and efficiently. It is therefore important to predict the number of personnel that may be required to deal with the effects of storm damage. By comparing this figure with the number of personnel currently available, possible shortfalls will become evident. It may then be necessary to eliminate or reduce this shortfall by recruiting further personnel and training personnel from other organisations, and through public education and awareness programs.

      While it is important to have personnel, it is also important that these personnel are capable of performing the tasks required with minimal supervision. To ensure this, a training program should be formulated and should include all storm damage-related subjects. It is also necessary to evaluate the level of training of personnel by undertaking exercises in all facets of storm and water damage operations.

   ii. **Physical resources.** To deal effectively with the common tasks involved in storm damage operations, emergency service units will need to have available, accessible and sufficient stocks of:

      - tarpaulins
      - rope
      - sandbags
      - plastic
      - ladders

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- hand tools
- portable and hand-held lighting
- chainsaws
- fall-prevention systems
- Acrow props and shoring materials
- personal protective equipment
- barricades
- consumable stores items such as tape, plastic bags/sheet etc., and
- communications equipment.

To ensure the efficient and effective use of these resources, it is important that all stores and equipment are in a serviceable condition and that personnel are familiar with their use and operation. It is therefore necessary to arrange regular maintenance and servicing of all physical resources. For example:

- inspection and repair of tarpaulins
- inspection of ropes and harnesses and associated equipment
- checking of lighting equipment including torches
- inspection and maintenance of ladders and Acrow props
- maintenance of pumps, generators and chainsaws, and
- maintenance of hand tools.

One useful way of maintaining physical resources is to combine maintenance and training, where personnel are trained in the operation and maintenance of particular items of equipment. This method allows personnel to gain a greater appreciation of the use and care of equipment by carrying out basic maintenance themselves. Note that this method is only for the normal day-to-day maintenance and is not intended to replace specific servicing requirements.

Return of physical resources. The method to be used to recover non-consumable physical resources issued to householders will differ depending on the circumstances of the situation. Ideally, inform householders that at the completion of permanent repairs, agency resources left must be returned to a pre-arranged drop-off point. It is also recommended that a copy of a 'Record of equipment issue' form be left at the premises. This form includes contact details of the occupier, agency and date that the stores were left. This form should be signed by both the householder and the team leader.

b. **Procedures**—To allow for the smooth operation of the unit during storm and water damage activations, formulate and document normal, routine procedures to form standard operating procedures (SOPs).

The stages of an operation normally covered by SOPs are activation/standby, operations, close down/stand down, and debrief or after-action review (AAR).

i. **Activation/standby.** This stage details how the unit will be activated and by whom and the initial steps to be taken upon activation to place the unit on standby. It also details the callout method and the actions to be taken.

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ii. **Operations**. The normal operating procedures are stated in this phase. These could involve:

- headquarters establishment and staff rosters
- headquarters duties and operation
- tasking procedures
- communications
- stores control
- safety procedures, and
- prolonged operations.

iii. **Close down/stand down.** These are the actions to be taken and the procedures to be followed at the conclusion of activities. This stage could detail:

- return of stores and equipment
- maintenance, and
- administration.

iv. **Debrief or after-action review (AAR).** The debrief procedure should use the 'www' format:

- **W**hat did we do?
- **W**hat did we do well?
- **W**hat could we do differently next time?

1.5.5 Individual personnel

It is important for personnel to be prepared for storm damage activation. This preparation enables personnel to be an effective part of the operation.

Points to be considered by emergency services personnel prior to activation include physical fitness, mental preparation, training, and dress and personal equipment, including personal protective equipment (PPE).

a. **Physical fitness**—Personnel should be aware of their physical abilities and medical condition. Storm and water damage operations can involve periods of intense physical exertion under adverse conditions. It would be unwise and in some cases unsafe to undertake this type of activity if suffering from some form of physical or medical disability. Bring any doubts about physical condition to the attention of the appropriate team leader. This will allow for the allocation of suitable tasks.

b. **Mental preparation**—All personnel should be mentally prepared for all possible tasks involved in storm operations. Personal attitude plays an important part, as personnel are sometimes required to deal with distraught and/or confused members of the public who need to be approached and dealt with in a considerate manner. It is also important for all personnel to be aware of their fears or phobias. Fear of heights, enclosed spaces and sight of blood might cause problems. Team leaders must avoid placing personnel in situations that could aggravate fears.

c. **Training**—Members should recognise their level of knowledge in relation to storm damage tasks. They should bring any doubt about lack of knowledge and/or experience or personal abilities to the attention of a team leader to allow for further training. Team leaders must constantly monitor the performance of personnel and provide for ongoing skills maintenance and review on a regular basis. Ongoing training should include the use of expert advisors such as builders, architects and so forth.

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d. **Dress and personal equipment (including PPE)**—When personnel are activated for a storm damage operation, a little thought can save certain inconvenience and can provide personal safety and comfort.

Dress and equipment required to be worn by emergency services personnel under various operational conditions is laid down by State and Territory occupational health and safety legislation and by each service's requirements.

Overalls and boots are not always the most appropriate or comfortable clothing during storm damage operations. In some cases overalls can become a hazard because of their restrictive nature and boots can actually be dangerous on slippery, uneven roofing materials, where joggers or sandshoes would be safer. Give consideration to other more suitable dress with regard to current weather conditions. However, wear some form of protective foot wear and clothing at all times to guard against the possibility of injury from jagged edges, nails and other projections. Also, wear protective headgear at all times. Consult your State or Territory policy and procedures for further information.

Some items of personal comfort and safety are the responsibility of the individual to arrange. Consider items such as:

- small notebook and pencil
- easily carried high energy food such as small packet of sultanas, pieces of fruit, muesli bars
- full water bottle/s
- inclement weather gear
- sunscreen and insect repellent
- headache tablets
- a good, sharp pocket-knife or a pair of side-cutting pliers
- work gloves or similar
- goggles, helmets, ear protection
- change of clothes, and
- bag or pack to carry the above.

1.6 Response and recovery

The **response** element of the comprehensive approach to emergency/disaster management is covered in later chapters of this manual. Recovery aspects are not included under the scope of this document.

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CHAPTER 2

Building Construction

2.1 Introduction

Storms can cause structural damage to residential buildings. For safety reasons, and particularly if shoring of damaged buildings is required, it is desirable for personnel involved in storm operations to have a basic knowledge of the common styles of residential buildings.

The roof is normally the area of the building that receives the most damage, so it is important for personnel to have an understanding of common roof styles, basic roof construction methods and roofing materials. This knowledge can be of great use for the effective application of suitable temporary repair methods and for the assessment of possible hazardous situations.

2.2 Types of construction

Varying types of construction are commonly used in Australia. These all behave differently when subjected to forces from storms and water. An understanding of the various types of construction helps personnel appreciate how these structures may perform during a storm damage incident.

The most common types of construction are:

- timber (weatherboard)
- light frame (brick veneer)
- reinforced masonry
- un-reinforced masonry
- concrete tilt-up, and
- reinforced concrete and steel construction.

Details of each of these construction types can be found in the Australian Emergency Manual *General and Disaster Rescue*.

In Australia, structures have to conform to the Building Code of Australia, which is a set of regulations that ensures acceptable standards of design and construction. The Building Code of Australia also makes sure that standards of structural integrity and stability, fire safety, and health and amenities are maintained.

Buildings of all construction types may suffer similar types of damage, to a greater or lesser degree, depending on their structural integrity. However, under extreme conditions severe damage can be caused to all buildings, which could involve the partial or even total collapse of walls. The majority of structural damage caused during storm conditions is from the impact of debris, trees and branches.

No matter what the cause of the damage, to avoid further damage and for safety reasons, make a careful investigation and assessment of the situation prior to attempting any temporary repair.

2.3 Roof styles and construction

Several common styles of roof construction are used in the building industry. Although these styles can be separately identified, many roof construction methods commonly incorporate several styles to form individually designed roofs. These combined designs incorporate the attributes of each style. It would be impossible to give examples of all possible combinations of roof styles. Therefore, only the main designs are described in this manual.

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Team leaders must choose the most effective temporary repair method after identifying potential hazards and risks and determining control measures. To assist in this process, it is important that personnel understand the basic parts, terms and methods used in roof construction. The basic methods of roof construction are covered in this section without detailed technical information or involved techniques. For further information on this subject, consult the local authority building inspector or a registered builder, or refer to a detailed building construction manual.

2.3.1 Gable roof

This is one of the most common roof styles used. Pitch can vary from almost flat to 'A'-frame. The steeper the pitch, the harder it is to effect temporary repairs.

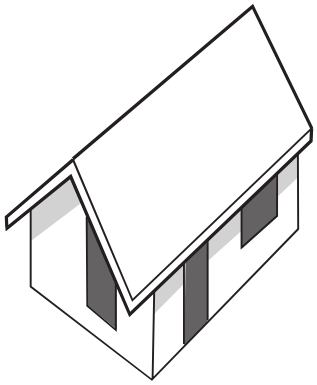


Figure 2:1
Gable roof

2.3.2 Hip roof

The hip roof is a very common roof style. It can cause some problems if tarping is required at or near hip joints.

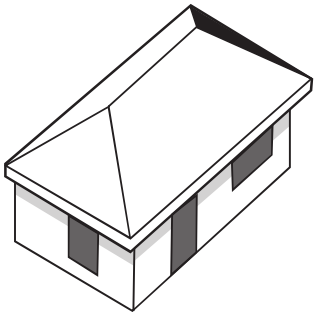


Figure 2:2
Hip roof

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2.3.3 Composite roof

A composite roof can be a combination of different styles of roofs.

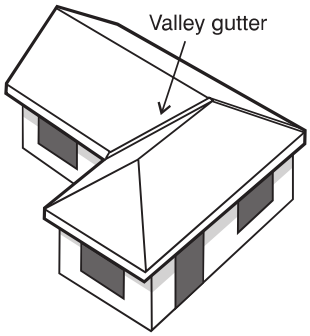


Figure 2:3
Composite roof

2.3.4 Skillion roof

A skillion roof is simply one-half of a gable roof.

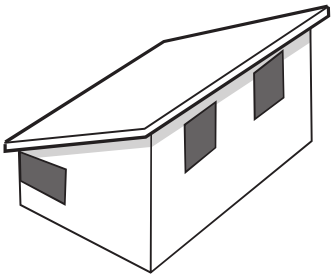


Figure 2:4
Skillion roof

2.3.5 Flat roof

A flat roof offers the least resistance to wind and usually experiences least damage. In extreme weather conditions, the complete roof may be lifted from the building. Repair methods will have to take into account an allowance for water run-off.

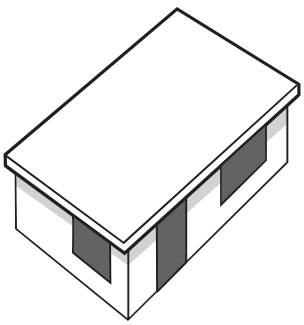


Figure 2:5
Flat roof

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2.3.6 Gambrel roof

The centre section of a gambrel roof can be quite steep and requires special safety considerations.

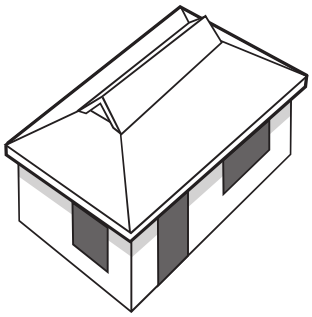


Figure 2:6
Gambrel roof

2.3.7 Jerkin head roof

The edge of a Jerkin head roof can have quite a steep pitch.

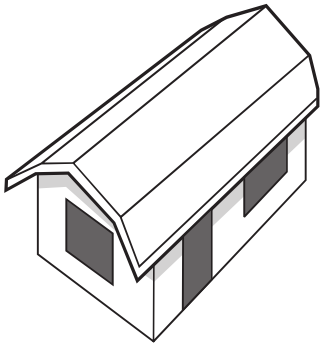


Figure 2:7
Jerkin head roof

2.3.8 'A'-frame roof

Although this is really a gable-style roof with the roof edges extending to the ground, it requires separate consideration because of its pitch or steepness. This type of roof can be subject to considerable damage, as the entire roof surface can be affected by wind gusts and debris impact. Temporary repairs may require the use of several ladders or elevated work platforms (EWPs).

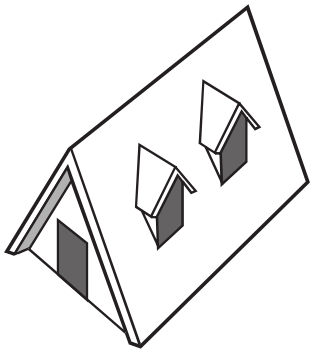


Figure 2:8
'A'-frame roof

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Figure 2:9
'A'-frame roof damage caused by Tropical Cyclone Larry – March 2006

2.4 Roof construction terminology

The following terms are used to describe specific structural components used in the construction of roofs.

Rafters Rafters run in the same direction as the roof pitch and form the main structural support onto which the roof structure is built.

Purlins Purlins form a part of the roof frame and are attached to the rafters across the roof pitch, normally at 90 degrees to the rafters. They act as supports and braces for the roof frame. Where purlins are attached to the underside of the rafters, battens must be fixed.

Battens Battens are fixed to the top side of the rafters across the roof pitch. They are the components onto which the roofing material is laid. Spacing of battens varies according to the type of roofing material being used. Close spacing is used to lay tiles.

Fascia The fascia is the piece of timber or metal attached to the lower edge of the roof onto which the edge gutter is fixed.

Barge board The barge board is similar to the fascia but is attached to the gable edge of the roof and has no guttering.

Eaves The eaves form the sealed area under the roof overhang.

Ceiling joists Ceiling joists are the structural framework onto which the interior ceiling is fixed.

Sarking Sarking is normally a bitumen-impregnated material, sometimes with a reflective coating, placed directly under the roofing material.

Trusses Trusses form the prefabricated structural roof framework and are constructed to the shape of the roof cross-section. The trusses are lifted into position and fixed to the building frame. Additional bracing and framework are added as necessary.

Noggins Noggins are timbers that are positioned between rafters and wall frame timbers to provide a point for securing purlins, sarking battens and wall panel material.

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2.4.1 Main components of a typical roof structure

Figure 2.10 shows the position of the main components in a typical roof construction.

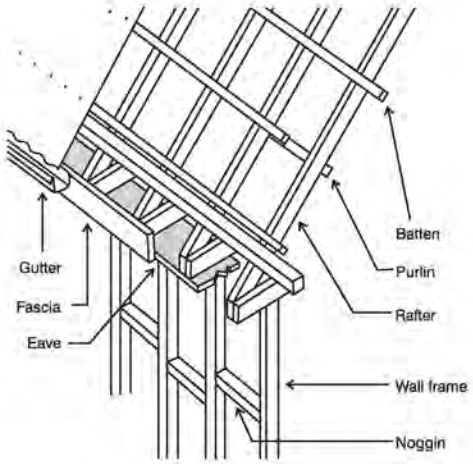


Figure 2:10
Main components of a typical roof structure

2.4.2 Trusses

Figure 2.11 shows the use of prefabricated trusses to construct the roof.

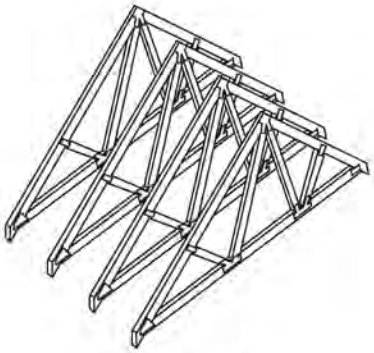


Figure 2:11
Trusses

2.4.3 Roof fixings

The framework is built using a number of different fixing methods including nails, bolts and nuts, and triple-grip fastenings. Some older-style houses used mortice and tenon joints and dovetailing methods.

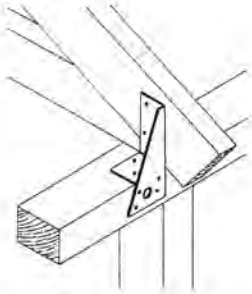


Figure 2:12
Triple-grip fastener

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2.5 Roof cladding material and damage characteristics

In choosing the most effective temporary repair methods and to enable identification of potential hazards and associated risks, it is important to recognise the various types of roof materials and their characteristics. Due to the numerous types of materials that may be used in roof construction, only the more commonly found ones are examined in this section.

2.5.1 Corrugated sheeting

Corrugated sheeting is one of the most commonly used roofing materials. This style of sheeting comes in various profiles and compositions. Some of the more common compositions include:

- iron—either galvanised, zinc-annealed or colour-coated
- aluminium
- fibrous sheeting, and
- fibre-resin and polycarbonate.

Corrugated sheeting is laid by overlapping the sheets to prevent water penetration. Older manufacturing techniques required numerous short sheets to cover the roof, which resulted in many overlapped joins. The current method is to manufacture sheets in continuous lengths, which requires less overlapping.

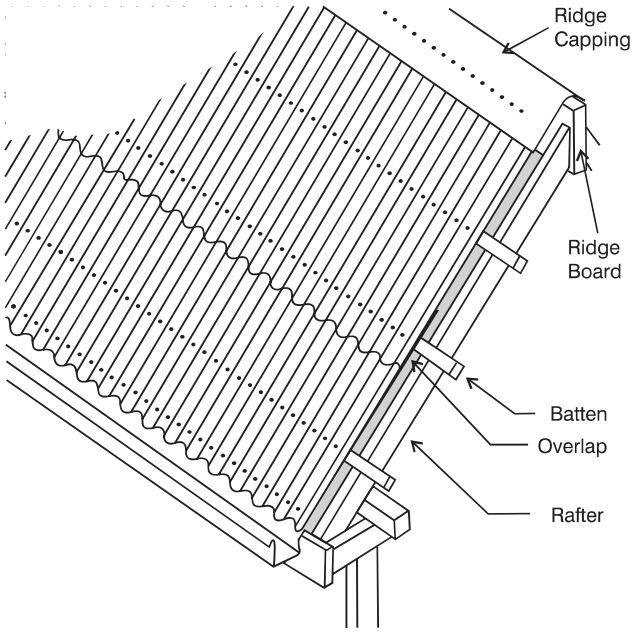


Figure 2:13
Corrugated sheeting

Fixing methods include self-sealing lead head, or cup head, galvanised nails and zinc-plated, cadmium-plated or self-tapping screws with a sealing compound or gasket.

Take care when walking on this type of roof, as further damage may be caused. Walk only along the line of roof-fixing screws on purlins or battens.

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a. **Corrugated iron—**Corrugated iron has been widely used in Australia for construction purposes for many years. It has been used in the construction of fences, walls and roof coverings.

Damage characteristics of corrugated iron

- Older roofing is prone to wind damage, causing the sheets to lift or completely blow off.
- Corrugated iron is prone to corrosion with age, resulting in water leaks and causing sheets to lift in windy conditions.
- Hail can cause denting or bending of sheets, normally without causing water leaks.
- If roof structure is weak or not fixed properly, wind pressure can cause sheeting and the roof frame to be dislodged.
- Large objects can cause severe puncturing of the roof in strong wind conditions.

b. **Corrugated aluminium—**Sheets of corrugated aluminium are normally colour-coated and manufactured in continuous lengths. These are laid as for corrugated iron and fixed with self-tapping screws.

Damage characteristics of corrugated aluminium

- This roofing is prone to wind damage, causing sheets to lift, bend or blow off.
- Sheets are able to be torn/punctured by flying debris or hail.
- This roofing is not prone to serious corrosion, but is subject to electrolysis.

c. **Corrugated fibrous sheet—**Sheets of corrugated fibrous cement are manufactured in standard lengths and come in two forms:

- standard, which has corrugations similar to corrugated iron, and
- 'Super six', which is a thicker material with larger corrugations.

Risk situations with fibrous sheet that contain asbestos occur when:

- it is turned into dust, through handling, sawing, grinding, drilling, turning, general maintenance or renovations, and/or
- it is in poor or deteriorating condition.

Damage characteristics for corrugated fibrous sheet

- Serious damage can be caused by debris and hail, resulting in extensive areas being holed or broken.
- Prolonged heavy rain can cause water penetration through the material.
- This roofing is prone to wind damage, causing sheets to lift, break or completely blow off.

Note: Take extreme care when walking on this type of roof, as further damage can be caused. Walk only on the line of roof-fixing screws on the purlins or battens.

WARNING

Fibrous sheet roofs becomes very brittle with age and a build-up of moss or mould makes it very slippery when wet. Extreme caution should be taken when operating on this type of roof.

Roof or wall sheets containing fibrous asbestos materials pose a significant health hazard. Appropriate protective measures must be employed. Never refasten or replace any fibrous sheeting.

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d. **Fibre-resin and polycarbonate**—This is corrugated clear or coloured translucent material, such as Alsynite, that is commonly used on patios, carports and skylights.

Damage characteristics of fibre-resin sheeting

- This material deteriorates with age because exposure to ultra-violet rays causes brittleness which can result in cracking or breaking when subjected to wind and/or heavy rain.
- This material is extremely susceptible to damage from hail and flying debris—sheets can disintegrate on impact.

WARNING

Never walk on this type of sheeting!

This material is not very strong and weakens with age. Extreme caution should be taken when confronted with this type of sheeting, and ladders or boards must be laid to span such sections.

2.5.2 Metal roof decking

This type of material is constructed of narrow sheets of galvanised, zinc-annealed or colour-coated steel laid by overlapping the sheets to prevent water penetration. It is normally fixed by metal clips that are nailed or screwed to the roof battens onto which the sheets clip. Generally this is found on flat roofs.

Damage characteristics of metal roof decking

- Hail can cause denting of sheets, normally without causing water leaks.
- This roofing is prone to corrosion with age, resulting in water leaks and wind damage.
- Large objects can cause severe damage in strong wind conditions.
- Wind can have a peeling effect, which can result in large expanses of the roof peeling off.

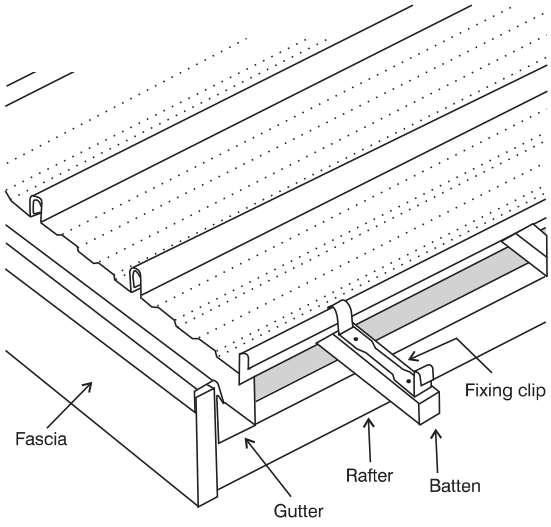


Figure 2:14
Metal roof decking

2.5.3 Concrete or terracotta tiles

Concrete or terracotta tiles are single tiles manufactured from either cement or baked clay and are glazed or colour-coated.

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Tiles are laid in horizontal rows, starting from the roof edge and working up. Each tile overlaps the tile on one side and each row overlaps the lower row. Fixing methods include wire ties, which pass through a hole on the underside of the tile and around the batten, or by nailing through a hole in the tile under the overlap. Ridge cap tiles are laid along the apex of the roof, with the end tiles fixed with nails and all tiles mortared into position.

Damage characteristics of concrete or terracotta tiles

- This roofing is susceptible to damage from hail and flying debris, causing tiles to crack or break.
- This roofing is prone to wind damage, resulting in tiles being blown off if not secured and/or tiles lifting and causing water leaks.
- Ridge tiles are commonly displaced by wind, causing loss of mortar, which may cause water leaks and further damage to other surrounding tiles.
- Tiles are brittle and can crack when walked on; therefore, take care when walking on this type of roof.

WARNING

Displaced tiles can be easily dislodged if disturbed, causing them to slide down the roof or fall through the internal ceiling, resulting in serious injury to people below.

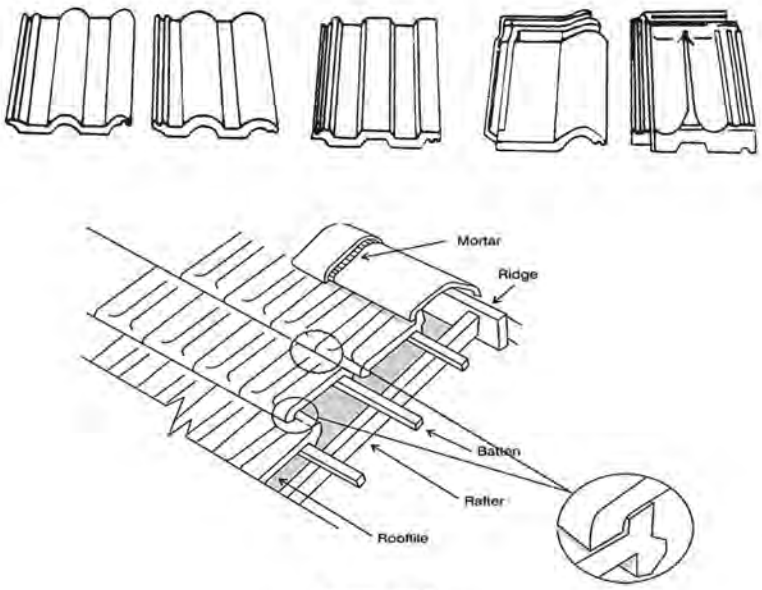


Figure 2:15
Roof tiles

2.5.4 Metal tiles

Metal tiles are tile-shaped metal strips manufactured from various metals, including aluminium and steel, and coated with a number of different materials (vinyl, plastic, tar and pebbles).

Metal tiles can be laid over existing roofs or as the original roof. They are normally laid horizontally, with each strip overlapping the lower strip, and are fixed with galvanised nails hammered under the overlap and on the batten edge.

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Damage characteristics of metal tiles

- Metal tiles are not prone to serious wind damage, but strips can lift, bend or blow off in strong wind conditions.
- Strips can be torn or punctured by flying debris or hail.
- Metal tiles are not prone to serious corrosion.

Note: Take care when walking on this type of roof, as further damage can be caused. Walk only along the lines of the purlins or battens.

2.5.5 Slate tiles

Slate tiles are usually used on steep-pitched roofs and are often rectangular in shape. Slate tiles can be fixed by tying or nailing. These tiles are more common on large, older buildings, such as schools, but are also found on some more modern, expensive homes.

Damage characteristics of slate tiles

- Slate tiles are susceptible to damage from hail and flying debris, causing tiles to crack or break.
- They are prone to wind damage, resulting in tiles being blown off and/or tiles lifting and causing water leaks.

Note: Take care when walking on this type of roof, as further damage can be caused. These tiles become brittle with age and can easily crack when walked on.

Also note that slate tiles are very difficult to replace and this task should be left to professional tilers.

WARNING

This material becomes very brittle with age and very slippery when wet. Extreme caution should be taken when working on this type of roof.

2.5.6 Shingles

Shingles can be made of flat, rectangular pieces of timber or fibro and are individually nailed and laid in an overlapped fashion. They are not widely used.

Damage characteristics of shingles

- Shingles deteriorate with age and may be seriously affected by wind and rain.
- They are prone to wind damage, resulting in tiles being blown off and/or tiles lifting and causing water leaks.
- They are prone to debris and hail damage, causing severe splitting or shattering.

2.5.7 Bituminous felt

Bituminous felt is a covering of felt material impregnated with a hot bitumen compound and is normally placed over a flat timber deck.

Damage characteristics for bituminous felt

- Bituminous felt is not normally severely damaged by wind or rain but can leak under heavy rain conditions if felt covering is worn or if bitumen compound is old and cracked.
- The surface can be damaged by heavy hail or flying debris, which may cause punctures in the felt material.

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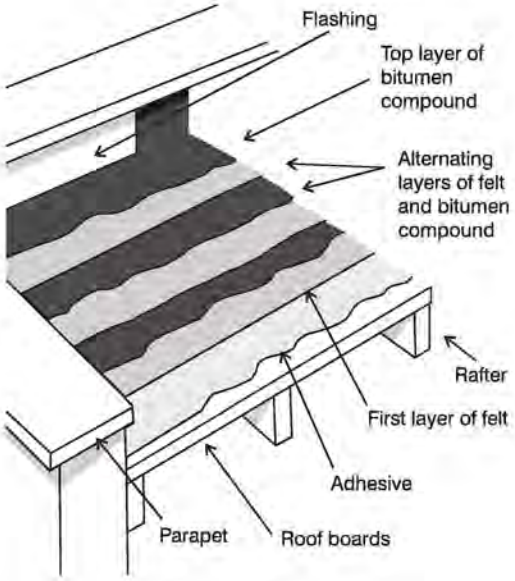


Figure 2:16
Bituminous felt roofing

2.6 Gutters

Most houses have a guttering system to collect the run-off water and channel it away from the building. These gutters are manufactured from various materials such as:

- galvanised iron
- aluminium
- polyvinyl carbonate (PVC), and
- copper.

2.6.1 Gutter types

Two main types of guttering systems are used:

- **edge gutters**—moulded gutters manufactured from any of the above materials and normally fixed to the fascia board along the lower edge of the roof, and
- **box gutters**—pressed gutters fabricated from galvanised iron and normally fitted to large roofs between two roof surfaces or along the edge of a roof where a parapet wall extends above the roof.

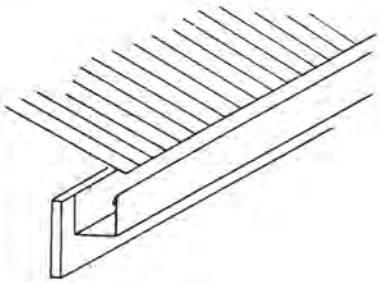


Figure 2:17
Edge gutter

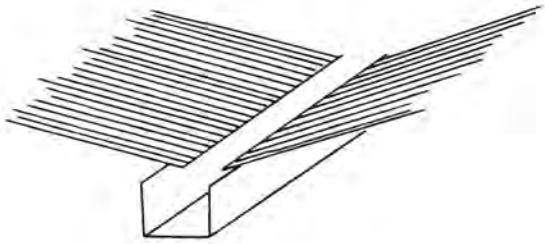


Figure 2:18
Box gutter

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2.6.2 Blockages

Although guttering can be damaged or dislodged during storms, there is generally no need for emergency services personnel to make any repairs. The only problem commonly encountered is the blockage of the gutter and/or downpipe with hail, debris or leaves, which may cause water to overflow back into the eaves and eventually into ceilings and internal walls.

2.6.3 Fragility

Take care when working around edge gutters, as they can bend or break under pressure. This is a particular problem when a ladder is placed for access to a roof. To reduce the risk of damage to the guttering, place a suitable sized item, such as a timber block or sandbag, in the gutter space at the point where the ladder is rested.

2.7 Roof protrusions

Most buildings have one or more protrusion hazards projecting past the roofline. These can include:

- chimneys
- skylights
- extraction fans
- ventilation pipes
- satellite dishes and television antennas
- evaporative cooler and air-conditioning units, and
- solar heating systems.

2.7.1 Damage problems

These protrusions can be damaged during storms, resulting in more extensive damage to the roof surface itself. They also present problems when temporary repairs, such as tarping, need to be effected around the protrusion. For safety reasons and to prevent further damage, it is important to check the condition of these objects before commencing operations.

2.7.2 Flashing

The joint where protrusions pass through the roof is normally sealed with a strip of metal or rubber collar, which is known as flashing. This flashing can be corroded or loosened with age, causing water leaks during heavy rain.

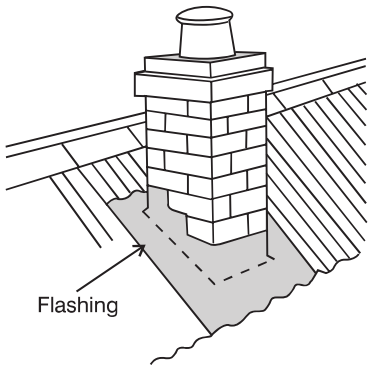


Figure 2:19
Flashing

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CHAPTER 3

Safety in Storm and Water Damage Operations

3.1 Risk management process

Storm damage operations often involve personnel operating in potentially hazardous situations. There have been instances recorded of severe injuries and even death directly caused by people working in hazardous conditions during or following storms.

A risk management approach to storm and water damage operations is necessary to ensure hazards are identified, associated risks are assessed and appropriate strategies are put in place to eliminate or control the risks.

The Australian Standard 4360 for risk management also emphasises the need for constant monitoring, reviewing, communicating and consulting with respect to the hazards and risks identified.

3.2 Hazard identification

A hazard is anything with the potential to cause harm.

The identification of hazards will often take place during a reconnaissance of the work site.

Storm damage operations require as much care and assessment as any other potentially dangerous rescue operation. Although the types of hazards may differ from operation to operation, the assessment method remains the same. Some hazards may not be readily recognised by simply looking around, so make full use of your senses and employ proper questioning techniques.

Sight—Look at the entire site and its surrounds for visual signs of danger.

Sound—Listen for any signs of danger (gas leaking, electric wires shorting out and so forth).

Smell—Be aware of any odours that may indicate a source of danger (smoke, gas, fuel and so forth).

Touch—Feel surfaces for signs of danger (heat, unstable structure, slippery surface and so forth).

Potential hazards are not usually confined to one particular area. They are normally spread out over the damage site and its surrounds. Therefore, to ensure that all hazards are identified, undertake a logical, progressive survey covering the whole site.

3.3 Common hazards

Many hazards are associated with storm and water damage. These may include working conditions, structural style and damage, public utilities, fibrous products, surface conditions, ignition sources and fuel, trees and branches, debris, working at heights, confined or enclosed spaces, equipment and vehicles, fauna, and contamination and disease.

3.3.1 Working conditions

a. **Personnel**—Team personnel have a responsibility to ensure that safety precautions are taken to prevent any injury to themselves or others. This is achieved by:

- personnel knowing their own competencies and limitations
- ensuring the team leader is informed of any problems that may exist with respect to individuals' health, competence and known limitations
- obeying all organisational operation procedures

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- understanding and using safe work practices
- being physically and mentally prepared
- being aware of time pressures to complete operational requirements
- being aware of the consequences of being fatigued, and
- ensuring compliance with organisational standards with respect to blood alcohol levels and drug usage.

b. **Weather conditions**—Wind, rain, hail and lightning are obvious weather conditions that pose a hazard to personnel when making temporary roof repairs. Each hazard needs to be considered individually and a risk assessment undertaken prior to determining if it is safe to proceed. Any risk assessment should drive the operation.

   Other weather conditions that should be considered include extremes of temperature and the effects of the sun, which may result in dehydration and sunburn. These can have a direct bearing on personnel safety.

   To overcome the effects of adverse weather conditions, the enforcement of safety precautions and appropriate dress standards, along with the provision of adequate rest breaks, food and drinks, is important.

c. **Working at night**—Care should be taken with the use of lights at night, especially when working at height. The incorrect positioning or use of lights, even a torch, could destroy night vision and cause a person to step off the edge of a roof or walk into an unsafe area. Also take care when moving from a lighted area into a darker, unlit area. Allow time for the eyes to adjust to the darker conditions before continuing with the task.

d. **Falling objects**—Falling objects can injure or kill. In developing a risk assessment for particular tasks, all team personnel should consider potential falling objects as hazards.

   Establish ‘no access’ areas below overhead work. Cordon off these ‘no access’ areas and put adequate measures in place to prevent access into the areas. Make all people on the site aware of any ‘no access’ area.

   At all times when in the work area:

   - wear a safety helmet
   - prevent entry to ‘no access’ areas
   - be aware of activities that are occurring around, above and below you, and
   - communicate as necessary to other people in the area.

e. **Site access and egress—**When approaching or leaving a site, whether on foot or by vehicle, a number of hazards may be present. These may include, but are not limited to, debris from structures and trees, downed powerlines and potential surface cave-ins. Accordingly, an appropriate safety management system needs to be put in place during access and egress to the site.

3.3.2 Structural style and damage

The structural style of the damaged building can be a hazard. Buildings with steeply pitched roofs, multi-storey buildings, and the type and age of roofing materials can pose a risk to personnel.

The extent, type and location of damage caused to the building can also be a hazard. Buildings that have suffered structural damage may be unstable because of movement on their foundations. They may have serious damage to roof frame supports, causing it to be unsafe to work on the roof area. Buildings that have been struck by lightning can have serious damage to the roof frame without obvious external signs. Check the framework of these buildings for damage by carrying out an inspection from the underside of the roof before commencing any repairs. The extent, type and location of the damage will impact upon the approach that is taken to making temporary repairs.

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Debris from a damaged roof can build up on the roof and within the ceiling cavity, and can put excessive strain on the ceiling material, which also may have been weakened by water penetration. Any water built up within the roof can cause similar problems. Unless the strain on the ceiling can be released, the ceiling could collapse and injure the occupants of the house. If possible, remove the debris or release the water and advise the occupants to keep well clear of the area until it has been made safe.

3.3.3 Public utilities

a. **Electricity—**One of the most common hazards associated with storm damage results from the downing of electrical powerlines. When these lines contact the ground or a structure (for example, fences, roofs, trees) they transmit electrical energy into and through the structure or ground. This means that an area around or connected to this electrical energy could cause severe injury or death to anyone who enters the area or comes in contact with the object or structure. This effect can be magnified by the presence of water or in wet/damp conditions.

   Undamaged overhead powerlines can also be a potential hazard, especially where the lines are close to or over the damaged building. Take care with the movement and positioning of ladders, equipment and vehicles when operating under or around these lines. Take care with the movement and positioning of ropes and metal ladders by keeping them away from powerlines.

   The internal power supply of a building could also become a hazard if the wiring has been damaged or the circuit has suffered water penetration or been damaged by lightning strike. If in doubt, disconnect the power supply at the main switchboard or, if this is not possible, advise the electricity authority.

   At times, electrical fittings may suffer from water penetration. In these situations it is important to first isolate the mains power before switching off the appliance. The owner of the premises should be advised to contact an electrical contractor.

   Communication cables carry vision and telephone networks. Some cable television lines can carry up to 90 volts. Optic fibres may cause damage to eye sight, so always avoid looking into the end of these cables. Television antennas and satellite dishes can carry 24 volts, but if they are badly damaged they can become active to 240 volts (dampness on cables).

   The internal power supply of a building could also become a hazard if the wiring has been damaged or the circuit has suffered water penetration or been damaged by lightning strike.

   Electrical Hot Sticks are available commercially. Refer to and comply with manufacturers' instructions, safety warnings and organisational policies and procedures at all times.

   If the property has been fitted with a Remote Area Power Supply (RAPS) (for example solar, generator, wind and so forth), take appropriate actions to ensure that it is properly isolated. The directions for isolation will normally be located in the premise's power distribution box.

WARNING

The building will still be 'live' to the street source even when internal fuses are removed. Always treat powerlines as being live. Bring the presence of any downed powerline to the attention of the electricity authorities and obtain confirmation of the disconnection of the power supply before proceeding with any work in that area.

b. **Gas—**Gas comes in two types, natural and liquefied petroleum gas (LPG). Natural gas is supplied through a mains system, whereas LPG is stored in a cylinder or bottle. LPG can be used to supply gas from a single point to one appliance or may be piped to numerous locations within a building or residential complex.

   If a gas leak from a bottle or cylinder is suspected, turn off the gas. If the gas is supplied through the mains, shut it off and immediately contact the relevant supply authority. Consider evacuation of the immediate area.

c. **Water and sewerage—**Water and sewerage utilities may be damaged, causing risk to health. Where possible, turn off water mains. Contact relevant authorities where there is damage to sewerage systems.

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3.3.4 Fibrous products

When working with fibrous products during storm damage operations, personnel may be at risk due to the existence of dangerous airborne particles. A large number of products made from asbestos cement may be found in damaged buildings, houses and structures. These products include flat, corrugated or compressed fibro sheeting, pipes, roofing shingles and guttering. Fibrous products are also used for insulation in the form of lagging of pipes, batts and as loose fill. The relevant State or Territory workplace health and safety organisations and emergency services have codes of practice/advisory standards, which deal specifically with working with fibrous products.

WARNING

It is imperative, when dealing with fibrous products such as asbestos, that relevant Australian standards and State/Territory legislation are complied with at ALL times. Relevant organisational policy and procedures must also be complied with at ALL times.

3.3.5 Surface conditions

Varying conditions of the surface of roofing material can pose a hazard, such as:

- wet, painted, glazed, moss-covered surfaces, which cause the roofing material to become slippery
- deterioration of the surface with age or under a person's weight, and
- roofs with loose or protruding sheets or tiles, which may cause serious lacerations.

3.3.6 Ignition sources and fuel

Hazards from ignition sources and fuel can be present in the form of:

- arcing electricity circuits
- low power supply, causing electrical appliances to overheat
- leaking gas mains or LPG cylinders, and
- leaking or exposed containers of hazardous materials (for example, petrol, cleaning liquids, solvents).

3.3.7 Trees and branches

Trees, especially shallow-rooted trees, can be a hazard. Occasionally, trees or branches are weakened by storm and water damage and may only require minimal disturbance to fall.

Fallen trees can also pose a problem, especially if they are precariously supported against a building or other structure. Removal of these trees should be attempted only by experienced personnel after they have carefully assessed the situation to eliminate the possibility of causing injuries to persons in the area or further damage to the building.

3.3.8 Debris

The presence of storm-scattered debris is a potential hazard. Working amongst debris can be unsafe. Implement appropriate control measures to minimise the risk. Ideally, debris should be removed from the immediate work area.

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Figure 3:1
Debris caused by Tropical Cyclone Larry – March 2006

3.3.9 Working at heights

When working at heights, personnel may be at risk of slipping or falling. Personnel operating on roofs must be protected with some form of safety line system that prevents the person from falling from the roof. These systems generally consist of a main line secured to appropriate anchors, with safety lines attached to this main line. The person is appropriately attached to the safety line. It must be stressed that such systems are not 'fall arrest' systems, but rather 'fall prevention' systems designed to maintain the safety of the person at all times. The relevant State or Territory workplace health and safety organisations have codes of practice/advisory standards that deal specifically with working at height.

WARNING

It is imperative, when working at heights, that the relevant Australian standards and State/Territory legislation are complied with at ALL times. Relevant organisational policy and procedures must also be complied with at ALL times.

3.3.10 Confined or enclosed spaces

Storm and water damage operations may involve working in a confined space. Confined spaces are fully or partially enclosed areas that are not designed to be normal places of work, and where entry and exit are restricted. They include areas like roof voids and spaces under buildings.

Severe illness and even death has been caused by people operating in confined spaces without following correct procedures and using risk controls.

Hazards associated with a confined space include:

- lack of ventilation
- unsound or insecure structures
- low visibility or lack of illumination
- size and shape that restricts movement
- difficult or obstructed entry/exit points
- noise (tasks such as hammering may become louder)

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- potential for uncontrolled introduction of steam, water or other gas or liquid
- the state of the atmosphere inside the space
- the presence of contaminants (gases, vapours, fumes, particulates), and
- higher or lower than normal temperature.

WARNING

It is imperative, when operating in a confined space, that the relevant Australian standards and State/Territory legislation are complied with at ALL times. Relevant organisational policy and procedures must also be followed.

3.3.11 Equipment and vehicles

Always use equipment for storm and water damage operations safely in accordance with organisational policy and procedures.

Observe all road rules and organisational policy when driving a vehicle in response to a storm damage incident. Excessive speed or failure to observe traffic regulations are not warranted in these situations. The road conditions are normally poor following storms, so use caution when operating vehicles in these situations.

Take care when parking the vehicle on-site to ensure the vehicle is visible to other road users. At night and in poor visibility, ensure hazard warning systems are displayed as appropriate.

Allow a sufficient safe working area around the vehicle for the unloading and loading of equipment and personnel.

Ensure that all items of equipment are secured to the vehicle before moving off. This also includes securing equipment carried inside the vehicle to prevent injuries due to unexpected movement.

3.3.12 Fauna

Animals and insects may create risks during storm and water damage operations. Again, like all other hazards, undertake a full risk assessment and put appropriate controls in place prior to commencing the task.

3.3.13 Contamination and disease

Take care when working around hazardous materials such as chemicals and waste. Other hazards such as stagnant water and sewerage have the potential to adversely affect the health and wellbeing of personnel.

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3.4 Taking appropriate action

Once the hazard identification and risk assessment has been done, it will probably be necessary to take action to ensure that the risks are eliminated or controlled, so they do not endanger emergency workers or personnel or the public. This action will normally fit into one of these categories (refer Figure 3:2):



Figure 3:2
Hierarchy of control

a. **Design**—This is the most effective treatment option and involves selecting appropriately designed equipment or work processes to eliminate the hazard.

b. **Elimination**—This is a solution that should completely remove the hazard altogether. This could involve clearing debris from the site, removal of fuel, arranging for disconnection of electricity supply, and so on.

c. **Substitution**—The process of replacing the hazard with one that represents a lower risk is called substitution. An example may be the use of a more-experienced team to replace a less-experienced one.

d. **Redesign—**Redesigning or modifying plant or work processes involves a structural change to an existing piece of equipment or process in order to place an engineered barrier between the individual and a hazard or to interrupt the transmission path of a hazard. An example might be the use of a roof-top safety system.

e. **Separation**—Separating or isolating the hazard involves enclosing the hazard or increasing the distance between the individual and the hazard, such as by roping-off or barricading unsafe areas (for example, a building, which could possibly collapse, or downed powerlines).

f. **Administration**—Administrative controls attempt to reduce or eliminate exposure to a hazard by introducing the need to follow workplace procedures or instructions. Examples are SOPs, appropriate training, hazard warning signs and safe work practices.

g. **Personal protective equipment (PPE)**—PPE is worn by individuals as a last line of defence against a risk and should only be used in conjunction with a higher option. The appropriateness and effectiveness of the PPE must be considered at all times. Some examples may include eye, ear and head protection.

The team leader is accountable for hazard identification and will make any arrangements to eliminate or reduce the risk by use of appropriate controls.

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3.5 Summary of risk management

Risk management is more than just looking around for obvious dangers. It involves using all the senses and questioning techniques to identify all potential hazards.

A properly conducted risk management process can prevent serious injury or even death and should be carried out at each individual site regardless of location or urgency.

The safety of team personnel and the public is far more important than the protection of property. Personnel should not allow property owners to pressure them into attempting to effect repairs if the hazards present warrant other action.

Risk management is for the safety of the team personnel and public on site. Notify the tasking headquarters of any delay in the completion of a task or inability to provide assistance because of unsafe conditions.

3.6 Safety responsibilities

Safety is the responsibility of all personnel at all levels. Take note of the following safety responsibilities:

- Each person has a duty to draw attention to any matter relating to any aspect of safety.
- Every individual is required to act safely at all times and not, through their actions, endanger themselves, others or their environment.
- Organisational SOPs must be followed.

REMEMBER! SAFETY IS EVERYONE'S RESPONSIBILITY

The safety of team personnel and the public is far more important than the protection of property. At no time should unacceptable risks be taken. To ensure unacceptable risks are not undertaken, implement the risk management process at all times so as to ensure the safety of all those involved in the operation.

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CHAPTER 4

Temporary Repair Methods

4.1 Introduction

Temporary repairs of damaged structures may be needed in order to make them safe and to prevent further damage. Where possible, repairs should be such that a building is returned to a habitable state. There are numerous repair options, so a determination as to the most effective and efficient method is needed. Householders should be advised that ALL repairs are temporary and need to be checked by a suitably qualified roofer or builder. This is the case, even when, for example, broken tiles are replaced by new ones.

4.2 Roof damage

4.2.1 Temporary repairs

a. **Planning for temporary repairs**—Prior to making any temporary repairs, it is important to consider the style and type of roof, the nature and location of any protrusions, and damage characteristics. Develop a plan to determine what method or methods are most effective and efficient for the nature of the job to be undertaken. Also consider:

- hazards, risk and control measures when developing a repair plan
- selection of appropriate materials prior to making any storm damage repairs, and
- how the materials to be used in repair are to be transported onto the roof.

Transporting materials onto the roof:

- As you need both hands for climbing a ladder, the safest way to get materials onto the roof is to pull them up by rope.
- Fasten the rope to the equipment using the most appropriate knot. A useful knot for hauling tarpaulins to the roof is the Portuguese Bowline (refer to the Australian Emergency Manual *General and Disaster Rescue*). This knot forms loops that can be placed around the load during lifting.

b. **Methods of temporary repair**—The main methods of effecting temporary repairs to storm damaged roofs are:

- refastening roofing materials
- replacing roofing materials, and
- temporarily covering damaged surfaces with tape (for example flashband, PVC ducting tape), sealing compounds, plastic (for example, sheeting, bags) and tarpaulins.

4.2.2 Refastening roofing materials

In some cases roofing sheets that have been dislodged are able to be refastened. If this is possible, it is probably the best way of effecting repairs. Metal sheets may require straightening before they can be repositioned and refastened. Methods of refastening include:

- using a hammer and roofing nails, and
- using roofing screws that are fixed with a spanner/socket or a battery-powered drill with socket.

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When refastening sheeting ensure that the existing overlapping position of the sheeting is followed to ensure water does not penetrate the roof.

Take care when refastening sheeting to ensure its integrity is maintained and that the sheeting is fastened, through the ridge of the corrugation, into a batten.

WARNING

Never refasten any fibrous cement sheeting.

4.2.3 Replacing roofing material

Replacing roofing sheets or tiles that have been dislodged is one of the best methods of temporary roof repair. Check with the householders to determine if they can provide spare sheets or tiles.

a. **Tiles**—In some cases tiles that have been dislodged are able to be replaced. Roofs that have several damaged tiles on the main part of the roof can sometimes be replaced with tiles from the edge of the roof over the eaves or from the roof over a less-important part of the building (for example, garage, carport, veranda). The removal of these tiles often does not result in water leakage into the living area of the building. However, be aware of covered eaves, as the removal of these tiles can have the potential to cause water to flow into the building. When replacing displaced tiles, levering up tiles is easier if you use an aid such as a wide-blade screwdriver, a wrecking bar, a wedge (wooden) or a tyre lever. At times, the wire tie or nail holding the tile in place will need to be removed. Tiles can be held up from the row below by using a piece of broken tile as a prop.

   Displaced tiles on small areas of tiled roofs can also be replaced, but large areas normally take too much time.

   Broken or cracked tiles may be sealed in a plastic bag, such as a shopping bag, or wrapped in plastic sheeting and then replaced back in position. Avoid puncturing or tearing the covering.

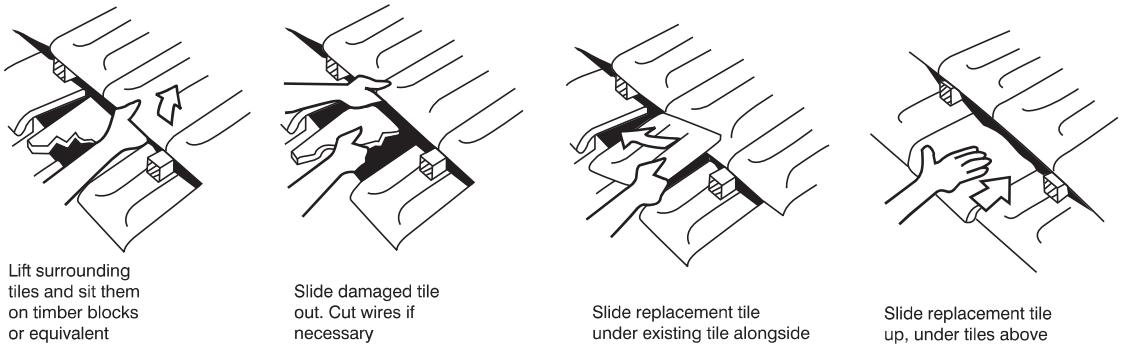


Figure 4:1
Replacing a tile

b. **Sheeting—**Where sheeting cannot be repaired, the householder may have some spare sheeting immediately available that could be used to replace the existing sheeting. This sheeting may be fastened as described above.

   When replacing sheeting, ensure that the existing overlapping lay of the sheeting is followed to ensure water does not penetrate the roof.

   Take care when fastening sheeting to ensure its integrity is maintained and that the sheeting is fastened, through the ridge of the corrugation, into a batten.

WARNING

Never replace any fibrous cement sheeting.

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4.2.4 Methods of temporarily covering damaged surfaces

a. **Tape**—Waterproof, self-adhesive tape has proved to be an effective way of sealing cracked tiles or covering small holes in roofing sheets. Even in cases where the roof has numerous holes, tape has proved to be more effective and a less resource and time-consuming method.

The types of tape that have proved successful are as follows:

- **Flashband**—A metal or plastic-backed tape coated with a black bituminous sealing compound, manufactured in various widths. This tape is excellent for sealing small holes or cracks in almost any type of roofing material, including metal sheets, tiles and guttering. Flashband works best when applied to a warm surface.

- **PVC ducting tape**—A plastic tape impregnated with a fibre reinforcing. This tape may be used to temporarily seal cracked tiles and small holes in metal sheets. It can also be used to repair minor splits or tears in tarpaulins.

No matter which material is used, it is important that the roof surface is dry and cleaned of any dirt, loose paint or scale before applying the tape. The easiest way of doing this is to buff the surface around the damaged area with a wire brush and wipe clean with a rag.

b. **Sealing compounds**—There are many different external waterproof sealing compounds available that can be successfully used to repair small holes or cracks in roofing material. Many of these are silicon-based sealants supplied in tubes of varying sizes. Other sealants can be bituminous-based or mastic compounds, which can be either putty-like in consistency or in a brushable form. These compounds can be used to make temporary repairs to damaged roofs.

Silicone sealing compounds are effective in sealing water leaks and small punctures in sheeting, around chimneys, air-conditioners, skylights and other roof protrusions that have been moved in high winds.

c. **Plastic—**Plastic in the form of sheeting or bags can be very useful to temporarily repair damaged roofs. Plastic bags, which are cheap and easily acquired (often from the householder), can be used to seal small holes by half-filling them with sand or soil and placing them over the hole. In some cases the bags may need to be held in position by tying a number of them together. Care needs to be taken to ensure the number of bags on a roof does not compromise the integrity of the roof. Plastic bags can also be used to seal larger holes by placing a flattened out bag over the hole and sealing it with waterproof tape.

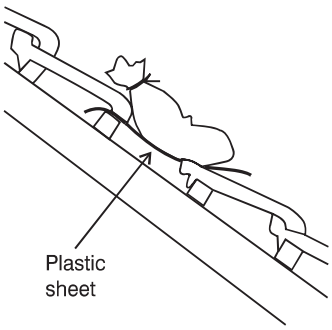


Figure 4:2
Using a bag to seal a small area

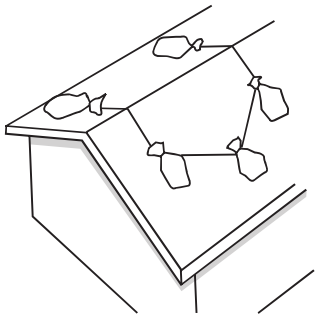


Figure 4:3
Securing multiple bags

(These methods are also applicable to the use of sandbags.)

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Plastic sheeting can be used to seal large areas by taping it over the hole or by laying it in the same manner as tarpaulins and securing it with timber battens. Seal the edges of the plastic with tape to prevent lifting and tearing in windy conditions. Plastic can also be tucked in under tiles using a long, wide-blade screwdriver or a tile-lifter.

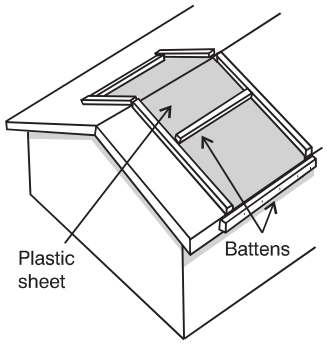


Figure 4:4
Using plastic to seal large areas

Some stronger types of plastic sheeting can be simply held in position by tying lengths of rope to the corners and edges of the sheet and anchoring as for tarpaulins. Pieces of timber or small rocks can be folded in the plastic to provide more grip for the rope. There are also many commercially available fastenings that may be used. Puncturing or tearing the plastic to make eyelets should be avoided, as this can cause the plastic to tear when under tension.

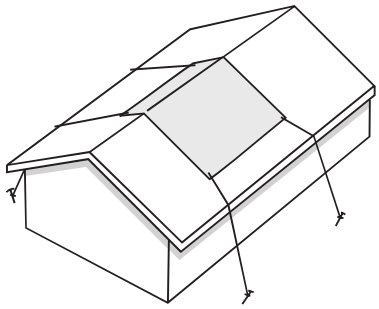


Figure 4:5
Securing plastic sheeting

Nail guns may be used to secure plastic in place, with nails placed into the battens. Nail guns can be very dangerous and must only be used by trained and authorised operators. When a nail gun is being used, keep the area surrounding the operator clear of all people for a distance of at least 6 metres in every direction from the point of operation. Wear face shields and ear protection when operating this equipment.

d. **Tarpaulins—** Undertake tarping only when all other options have been considered and rejected. Tarping is resource-expensive, time-consuming and labour-intensive, and presents the added difficulty of recovery and/or replacement of damaged tarps. The use of tarpaulins can be an expensive exercise.

Tarpaulins do not make a property totally waterproof and in some cases, when a tarping job is done poorly, even greater water damage may occur.

Tarping operations should be undertaken in four phases: planning, preparation, positioning and tying-off.

i. **Planning**. Tarpaulins come in many sizes and are made of various materials. Those used for storm damage operations are usually made of polymer compounds. The most suitable tarp will largely depend on the area to be covered and the style of roof. The use of the smallest number of tarps as possible will cut down on unnecessary labour and resources. This will also reduce the potential for leakage and wind damage.

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No matter what size tarp is being used, take extreme caution during windy conditions. Even moderate winds can cause a tarp to flap so violently that it could cause someone to be flung off a roof, resulting in serious injury.

WARNING

Do not attempt to tarp roofs in strong wind conditions.

ii. **Preparation**. Prior to tarping, it is important to remove any debris from the roof, particularly as this may cause damage to the tarp. This might involve straightening or removing bent or torn metal sheets or removing protruding nails.

To make the positioning of the tarp easier, fold and roll the tarpaulin before taking it onto the roof. There may be some instances where having ropes already attached to the tarp would be an advantage. Do this by laying out the tarp on the ground and determining how it will be positioned on the roof. You can then estimate the lengths of rope required and tie them to each eyelet. When the tarp has been positioned on the roof, the ropes can then be tied off.

iii. **Positioning**. When covering a roof with tarpaulins, take care to overlap the tarps correctly. The first tarp must be laid on the lower part of the roof. The tarp on the higher part must then overlap the lower tarp by at least 500 millimetres to allow for water run-off. The uppermost tarp must cover the ridge capping of the roof.

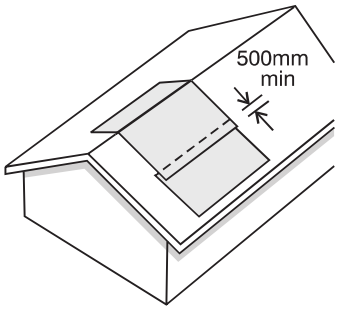


Figure 4:6
Top and bottom tarp overlap

Tarps laid side by side also should be overlapped by at least 500 millimetres to reduce water penetration. If possible, the overlap should take into account the current wind direction. Joints can be taped with ducting tape for greater protection.

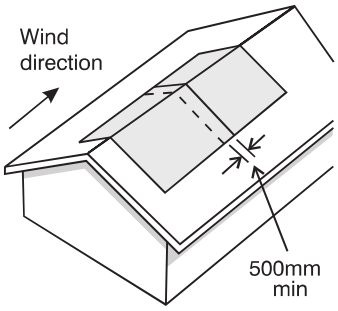


Figure 4:7
Side-by-side tarp overlap

Buildings with hip and composite roofs can pose problems during tarping activities. When tarping these roofs, it is necessary to position and fold the tarp to allow for the change in roof angles.

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iv. **Tying-off.** A tarpaulin should be tied down at every eyelet to avoid placing undue strain on any one point. Where possible, attach cordage to the tarp prior to placement on the roof. The Bowline (with a half-hitch) or Figure of Eight Follow Through (also called a Figure of Eight Loop – refer to the Australian Emergency Manual *General and Disaster Rescue*) are the recommended knots to be used for attaching the ropes to tarpaulins. For added security, ropes may be tensioned across the tarp in criss-cross pattern and tied down. Tie-down ropes can pull out of the eyelets of tarps. This problem can be overcome by threading rope along each edge of the tarp through all the eyelets using half-hitches. This rope can be used to tie down the tarp or the tie-down ropes can be attached to this threaded rope.

Sandbags may be used to hold tarpaulins down. However, take extreme care when adopting this method. Limit the number of sandbags used so as to not overload the roof. It is also necessary to secure all sandbags to a suitable tie-off point so the sandbags do not slide or become airborne and create further risk to property or people.

Tension and tie-off the ropes to anchor points so as to allow for easy adjustment. Knots such as the 'truckie's hitch' should not be used, as they can slip or easily place excessive stress on the rope and tarp. The most suitable anchoring method is to use a round turn and two half-hitches (refer to the manual *General and Disaster Rescue*), as this allows for easy adjustment.

Fences, house stumps, pergolas and so forth may make ideal anchor points. However, assess every anchor point prior to use to ensure that it is structurally sound and able to support the force that may be applied. Never tie-off to structures such as gas pipes or water meters. Often there will be no readily available tie-off point. In these cases there are several alternatives.

- Drive roofing nails or roofing screws into the fascia or barge boards (check with the householder before using this method).
- Use edge and gutter hooks. These can be made up locally from pieces of scrap metal.

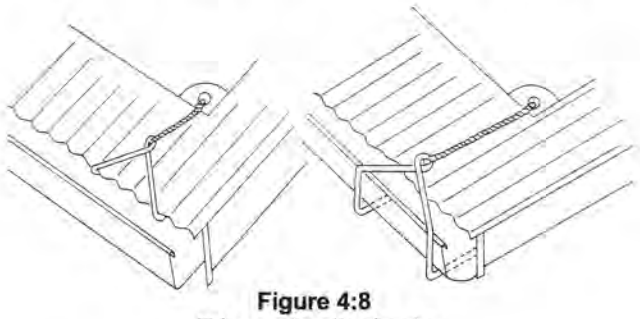


Figure 4:8
Edge and gutter hooks

- Use suspended ties. Where no tie-off points are available, weights can be suspended from the edge of the tarp to provide the required tension. Sandbags, garbage bags or similar weights can be used for this purpose. For safety reasons and to prevent any damage to the house, ensure the weights are just in contact with the ground.

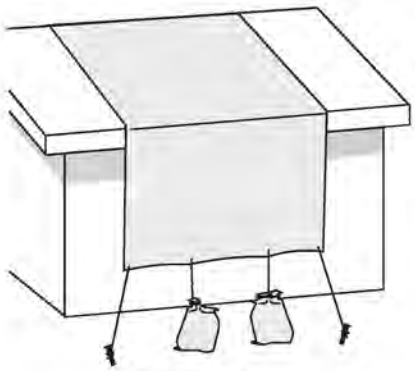


Figure 4:9
Suspended ties

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- Create an anchor using pickets or roofing screws.
- Wrap a tarp around a piece of board and secure the board to the roof structure or prop it up with secure timber.
- Lift tiles and use battens as tie-off points.
- Use the rope-around method when no other tie-off points are available. Run a large diameter rope completely around the building and tie-off securely. The tarpaulin tie-down ropes can then be tied off to this rope. Take care in the placement of the larger rope to avoid obstructing doors and windows and damaging parts of the building (such as the downpipes).

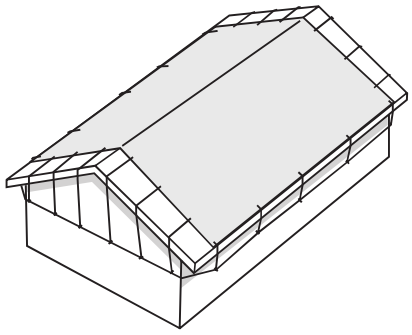


Figure 4:10
Rope-around method

4.2.5 Internal tarping

In some instances, it is not possible to tarp the roof of a damaged building effectively. This may be due to excessive damage to the building, limited access to the roof or when the risk of being on the roof is unacceptably high. An alternative method of providing assistance is to cover the furnishings in the building with tarpaulins. Depending on the extent of damage, this could range from covering the entire contents of the house to covering the contents of one room. Place the items to be covered together to allow one tarp to cover them. This saves resources and is less time-consuming. In some cases the occupants will be able to cover their own contents if supplied with tarps or waterproof covers.

4.3 Window damage

It is quite common for windows to sustain damage from hail or flying debris during storms.

4.3.1 Temporary covering

Depending on the size and style of window, it is normally a fairly simple matter to provide a temporary covering. Timber-framed windows can normally be covered by nailing a sheet of hardboard or ply to the outside of the window frame. Other methods are used for varying window styles such as casement and hopper windows, double-hung sash windows, sliding aluminium windows, louvres, fixed windows and large glass areas.

4.3.2 Casement and hopper windows

Casement and hopper windows usually can be waterproofed by placing a sheet of plastic over the outside of the window, folding the sheet around the edges of the window frame, and then closing the window onto the plastic. The plastic can then be taped into position on the inside of the window frame.

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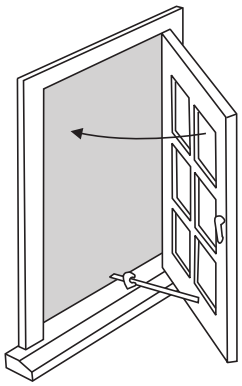


Figure 4:11
Casement window

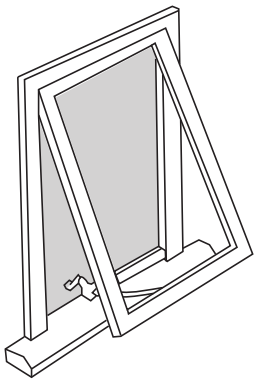


Figure 4:12
Hopper window

4.3.3 Double-hung sash windows

Seal double-hung sash windows by either taping a piece of plastic over the outside of the window or by sliding a plastic sheet up the outside of the lower window until it can be folded over the top of the frame and taped into position. The plastic is then folded under the bottom of the frame and the window closed onto the plastic. The plastic is then taped along the inside edge and the external sides of the plastic sheet.

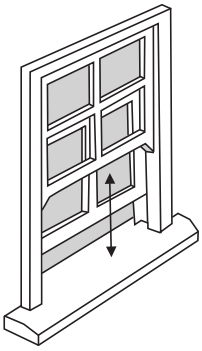


Figure 4:13
Double-hung sash window

4.3.4 Sliding aluminium windows

The sliding portion of an aluminium window can be easily covered with plastic by first removing it from its sliding track. Do this from inside the house by unlatching the window and lifting the sliding aluminium frame up until the bottom edge is free of the fixed track, then move the bottom of the window towards you and lower it until the top of the frame is clear. A plastic sheet can then be placed over the external side of the frame and taped into position. To allow the window to be opened, the bottom edge of the frame should not be covered with plastic. Replacing the window is the reverse of removing it.

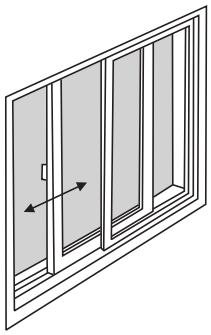


Figure 4:14
Sliding aluminium window

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4.3.5 Louvres

Broken timber of glass louvre windows usually require a covering of either timber or plastic, tacked or taped over the external window opening. In some cases, if the sizes are the same, it may be possible to replace broken blades with unbroken ones from another part of the house. If this can be done, it might mean that only one or two windows require covering, instead of four or five.

It is possible to replace broken louvre blades with pieces of hardboard or ply, cut to size. Although this method is effective, it is not recommended, as cutting and preparing the boards can be a time-consuming process.

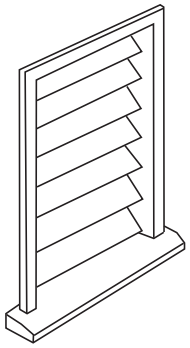


Figure 4:15
Louvres

4.3.6 Fixed windows

Immovable fixed windows normally require covering with boards or plastic from the outside. In some buildings, the outside of these windows may not be easily accessible and the windows will need to be covered from the inside. Whatever the case, the edges of the covering should be well sealed with waterproof tape.

4.3.7 Large glass areas

In situations where there are large expanses of damaged windows or large picture windows, it may be possible and more beneficial to cover the entire area with a larger cover (for example, a tarpaulin, large sheet of plastic). In these cases the cover is usually fixed in position by tacking timber battens to the external walls of the house across the top, sides and bottom of the covering.

Before attempting to cover any damaged windows, remove all broken glass from the window frame. This prevents injuries to people and prevents damaging the covering.

4.4 Roller shutters/doors/security shutters

Roller shutters/doors/security shutters are an external feature fitted to many homes, old or new. These features are largely fitted as security features. Generally, security screens are not subject to damage from wind; however, roller shutters have the potential to be blown out because of their large, impermeable surface area. These should, if possible, be treated as per large glassed areas. If required, you may need to remove the screen or shutter.

4.5 Wall damage

4.5.1 Causes

Walls of premises are at risk of damage in a number of ways. These include the impact from flying debris, fallen trees or branches, or force of the wind and/or water.

4.5.2 Construction type

Lightly-constructed walls are more prone to damage than those of double brick, block or stone, but this tends to be offset by the fact that lightly-built walls are generally easier to repair. The following guidelines for temporary repair are appropriate.

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a. All structures must be made safe prior to any work being carried out in or around the structure. If in doubt, isolate the structure and seek professional advice. Where a wall of any type is damaged to the extent that it may affect the integrity of the structure, secure a safety area with cordons or barriers.

b. It may be necessary to shore up the structure to prevent collapse.

WARNING

Only suitably trained and qualified persons should undertake structural shoring, as this is a specialist skill (refer to the Australian Emergency Manual *General and Disaster Rescue)*.

c. Once the structure has been stabilised, weatherproof the premises to prevent further damage. This can be done using plastic sheeting and battens or tarpaulins in the same manner as roof damage tasks.

4.6 Elevated work platforms (EWPs)

At times, access to structures may require the use of an elevated work platform (EWP, commonly known as a cherry picker).

When requesting and using an EWP, consider:

- the load
- the reach
- access to the area
- road conditions and width
- safety of your team, the public and vehicles
- overhead clearance, including powerlines
- ability to manoeuvre around the site
- slope
- what clearing activities may be needed prior to setting up the EWP, and
- communication with the EWP operator.

EWPs should only be used by trained and, where necessary, licensed operators.

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CHAPTER 5

Tree Operations

5.1 Introduction

During storms, trees or branches can cause severe damage to buildings.

5.1.1 Tree damage problems

Crews responding to tree damage may be faced with:

- damaged trees, which threaten to fall or drop branches
- trees or branches that are leaning against buildings
- fallen trees or branches on or through building roofs, and
- trees or branches across roads or other property.

5.1.2 Skills reference

In any situation requiring the use of a chainsaw, refer the matter to a qualified chainsaw operator or consult your organisation's chainsaw guidelines.

5.2 Assessment of tree operations

Make a careful risk assessment of each situation before any action is commenced. A decision to stabilise a damaged tree or remove a tree from a building **must be made in accordance with organisational policy and procedure, with safety as the primary concern.** Commence work only after a thorough assessment.

5.2.1 Hazards

The following points must be considered in the identification of hazards.

a. **Electricity**—Contact the supply authority where there is any concern.

b. **Water or gas supplies**—It may be necessary to shut off supply at the main or meter.

c. **Further collapse**—Consider all possibilities.

d. **Weather**—Consider possible effects of the weather, such as wind, rain, hail and the sun. Also consider changes in the weather.

e. **Communication cables**—Consider communication cables, which may be over or under the ground.

f. **Loose materials or debris**

g. **Associated hazards**—Be aware of associated hazards, such as a garage storing hazardous materials.

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h. **The tree**—Considerations specifically relating to the tree include:

- tension or compression forces in the tree
- the results of a change of balance and any subsequent leverage effect at any time
- the potential for movement if the tree is cut
- hanging branches (including bark)
- cavities
- cracks or splits
- termite damage
- root damage
- burnt-out areas
- lightning damage, and
- insects.

i. **The structure**—Considerations relating to the structure include:

- the security of the structure and the need for shoring
- the reaction of the structure if the tree is removed, and
- the potential to cause further damage.

j. **The site**—Considerations relating to the site include:

- powerlines (overhead and underground)
- other underground services
- traffic and pedestrian movement
- adjacent buildings and trees
- terrain and access, and
- working from height (personnel may need to be protected with a fall-prevention system or a belayed rope).

Once hazards are identified, the associated risks need to be determined. Eliminate the risks or put controls in place to lower the risks to as low as reasonably practicable.

5.2.2 Resources

Give consideration to:

- team competence and experience
- team alertness (fatigue)
- equipment required and available (this includes safety equipment and the need for cranes and elevated work platforms), and
- the need and availability of other trained teams and/or private contractors.

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5.3 Guidelines for tree operations

A plan will need to be developed to deal with the tree once the assessment has been carried out, the hazards identified, risks assessed and controlled, and the resources available considered.

The plan may identify the need for a tree or branch to be secured to prevent further movement, which could result in property damage and danger to:

- personnel
- householders, and
- the public.

Once the tree is secure, work can be carried out in a safe, controlled and systematic manner.

5.3.1 Threatening trees and branches

In cases where a tree has been damaged or partially uprooted, or a branch has been broken, the tree or branch may threaten to fall.

a. **Appropriate actions**—Following the assessment, a team may use one, or a combination of, the following options:

   - secure the tree to prevent further collapse
   - cordon off the area and leave the task to a private contractor or more experience team, or
   - remove the tree or branch.

b. **Suitable methods**—Either secure or remove the threatening tree or branch.

   Secure the threatening tree or branch by:

   - the use of guy ropes to stabilise the tree/branch, with due regard to the safe working load of ropes, anchorages and the condition of the tree/branch, or
   - using timber shoring or Acrow props to support a damaged tree.

   Remove the threatening tree or branch:

   - Undertake removal only where a clear working area is available and a safe course of action can be clearly set out.
   - A tree may then be felled or winched clear of the building, while a branch can be lowered or winched to the ground.

5.3.2 Trees/branches leaning against buildings or on a roof

In cases where a tree or branch is leaning against a building or on a roof, there could be some structural damage to the building.

a. **Appropriate actions**—Following the assessment, a team may use one, or a combination of, the following options:

   - trim the tree and then remove it
   - trim the tree and leave part of it in place
   - secure the tree (before or after trimming) to prevent further movement and damage
   - leave the tree, with due regard to the force that the tree is exerting on the building and the possibility of structural damage/collapse

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- isolate the area and leave the task to a private contractor or more experienced team, or
- remove the tree or branch.

b. **Suitable methods**—Either secure or remove the threatening tree or branch.

Secure the threatening tree or branch by:

- the use of guy ropes to stabilise the tree/branch, with due regard to the safe working load of ropes, anchorages and the condition of the tree/branch, or
- using timber shoring or Acrow props to support a damaged tree.

Remove the threatening tree or branch:

- Undertake removal only where a clear working area is available and a safe course of action can be clearly set out.
- A tree or branch may be removed a piece at a time. Ensure that the remainder of the tree or branch and the structure are secure.
- A crane may be used to remove the tree or branch. Care needs to be taken, as the use of a crane is a specialist job and emergency teams will need to work closely with the crane operator.

If the task exceeds the capacity of the team, leave the tree for a professional contractor or more experienced team.

5.3.3 Trees/branches through structures or roofs

This scenario is similar to a tree or branch leaning against a structure, with the added hazard of penetration causing structural damage.

a. **Appropriate actions**—As an initial measure, a fallen tree or branch must be secured to prevent movement, which may cause danger to personnel or further damage to the building.

Once secured, the tree can be worked on more safely, and personnel may cut and remove all or part of the material in a controlled and systematic manner.

b. **Suitable methods**—Suitable methods may include the following.

Secure the threatening tree or branch by:

- the use of guy ropes to stabilise the tree/branch, with due regard to the safe working load of ropes, anchorages and the condition of the tree or branch and the structure, or
- the use of timber shoring or Acrow props to support a damaged tree.

Remove the threatening tree or branch. Ensure the removal process follows a series of logical steps, such as:

- safe access for rescuers to the work area
- a sequence of cutting operations that causes least movement of the tree or damage to the roof
- provision of a safe working area for personnel, and
- use of cranes or roping systems to remove cut sections, and the possible use of elevated platform vehicles as work platforms for chainsaw operators.

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5.3.4 Tree/branch across road or property

A number of options exist when managing a tree or branch across a road or property. These include:

- leave the tree or branch and cordon off the area
- cut up and remove the tree or branch, or
- winch or tow the tree or branch.

Note: Conduct all tree operations in accordance with organisational policies and procedures, and with local and State legislative arrangements. Chainsaw operations should involve continual re-assessment of the situation and there should be minimal disposal of cut timber and clean-up of the area.



Figure 5:1
Chainsaw operations following the impact of Tropical Cyclone Larry – March 2006

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CHAPTER 6

Local Flooding

6.1 Introduction

The development of residential areas, which include vast masses of concrete and bitumen, inevitably leads to local flooding during periods of heavy rain. The rainfall run-off that results can very rapidly cause local flooding of residential, shopping or business areas.

Apart from the effect of run-off, drains blocked by plastic bags, leaves and other debris, together with overflowing gutters and stormwater channels, will worsen the flooding.

6.2 Types of problems

The major problem is low-level flooding of houses and businesses, with severe damage to furnishings, fixtures and stock. Additional problems may be created by the pooling of large quantities of water in basements, underground car parks and garages.

6.3 Solutions

There is a range of possible solutions to the problem of local flooding. Solutions incorporate prevention, diversion or removal measures.

6.3.1 Prevention

Water can be prevented from flowing into unaffected areas by damming the openings into them with tarpaulins or material on hand, such as towels, old carpet and so forth. These can be covered by plastic sheeting. Sandbag walls can also be used.

It is important to locate drains and keep them clear of debris. A wire mesh guard is the most suitable means of achieving this, but it is often possible to find suitable material and improvise a barrier. Where there is a lot of debris, it may be desirable to assign people to keep the guards clear.



Figure 6:1
Wire mesh drain

Where water is entering premises, considerable damage can be prevented by moving furniture and fittings to the safest place in a room, such as lifting stock from the floors onto tables, counters, benches, shelves or other support and covering them with sheeting. Put any rugs and carpets over furniture to protect these items before covering. Collect together fragile items, such as glass, china and pictures, and put them somewhere where they will be safe from breakage before covering them. It is often better to use transparent polythene sheeting rather than tarpaulins when covering fragile items, so that it is possible to see what is underneath the covering.

Ensure that all items are thoroughly covered at top and sides, with the bottom of the sheet reaching, but not dragging on, the floor. When one sheet is not sufficient, place successive sheets around the side so that they are overlapped by the upper sheets and water can drain off.

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6.3.2 Diversion

Where possible, water should be diverted out of or away from a building, or into suitable drains. A trough can be improvised by opening a tarpaulin to its full length but only half its width, then folding in the edges lengthways to give the depth required. Several tarpaulins appropriately arranged can be placed end to end with an overlap in the direction of the flow.

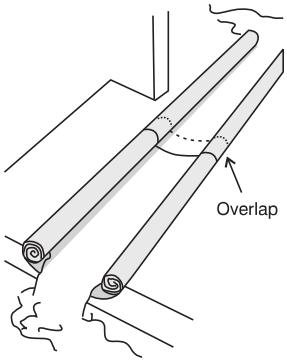


Figure 6:2
Tarpaulin trough

6.3.3 Sandbagging

Sandbagging is a useful means of diverting water or strengthening levees. Sandbags can also be used during flood response operations to construct temporary levees and to protect physical assets.

The decision to use sandbags should only be taken after alternative methods of flood protection have been examined. Take the following points into consideration:

- for sandbagging to be effective and safe, the bags must be laid correctly
- sandbagging is extremely slow and labour-intensive
- sandbags should not be used to increase the height of existing levee structures, and
- mechanical assistance such as earthmoving equipment can prove very effective for speed, as often flooding can occur and increase quite rapidly.

Note: Particular care is necessary when sandbagging, as diverting the flow of water may cause unintended damage to other areas.

a. **Types of sandbags**—There are many types and sizes of sandbags available. Generally, they come in either hessian or plastic. The preferred size is 825 millimetres long by 350 millimetres wide. Larger sizes are not recommended, as they can be too heavy to handle. A standard sandbag, properly filled, weighs around 18 kilograms. This weight will be greater if the contents of the sandbag are wet.

   Unfilled sandbags are normally packed in bales of 1000, which contain 20 bundles each of 50 bags. A bale of sandbags weighs 210 kilograms, so mechanical handling equipment may be required to unload and perhaps to move them to the filling area.

b. **Filling sandbags**—Filling sandbags by hand is arduous and time-consuming, so mechanical filling machines are desirable. Some emergency services use purpose-built sandbag-filling machines. Cement trucks can also be used as an improvised mechanical filler.

   If mechanical devices are not available, it is wise to construct hand-filling devices. A simple aid can be made from a length of 200 millimetre pipe or a bucket.

c. **Laying sandbags**— Stack sandbags to form a barrier against flood waters. Take care to ensure that they are stacked in a way that is efficient and safe. Water exerts pressure against the sandbags, so dig a trench, if possible, to prevent the levee from moving. Other methods of anchoring the levee include placing the levee base against features such as a ditch, raised roadbed or a foundation wall.

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Only fill sandbags to two-thirds of their capacity—never overfill them. This allows overlap, which 'locks' bags together.

Construct sandbag walls using alternate rows of 'headers' and 'stretchers'. Headers are sandbags placed end-on to the direction of the water, with the neck facing away from the water; stretchers are placed side-on, with the seam opposite the direction of the water. Always lay the bottom row of sandbags using headers, with the necks folded over and facing away from the direction of the water.

Never construct sandbag walls with a vertical face, because a wall so laid will possess little strength. Lay them in a pyramid shape, never less than two rows at the top of the pyramid.

The maximum recommended height for a sandbag wall is 1.5 metres. If there is a requirement for protection greater than the recommended height, a mixture of earth and sandbags is preferable. The diagrams below illustrate methods of construction.

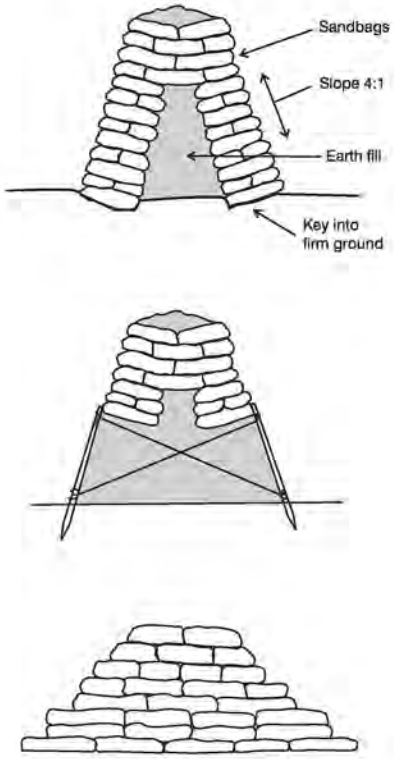


Figure 6:3
Example of sandbag wall construction

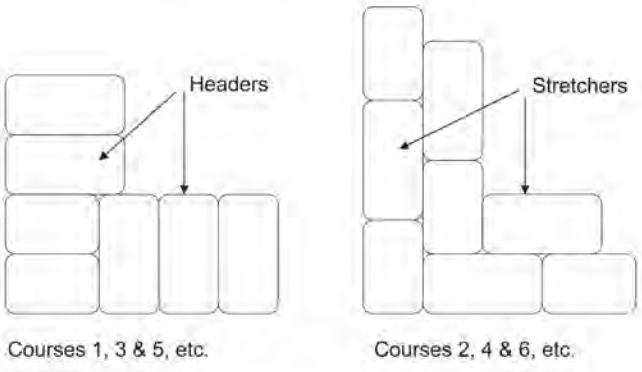


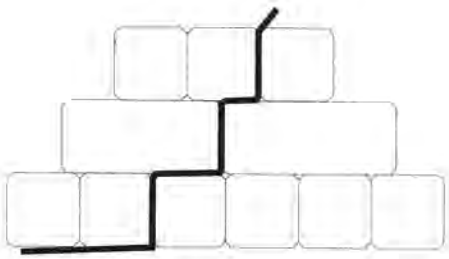
Figure 6:4
Turning a corner

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d. **Waterproofing**—Sandbag walls are not waterproof, but waterproofing can be achieved using plastic sheeting threaded through the layers. Avoid placing any on the outside wall in the direction of the water.



Location of Plastic Waterproofing Sheet

Figure 6:5
Waterproofing sandbag walls

e. **Dimensions of filled sandbags**—The number of sandbags required to erect a wall will vary depending on the size of the sandbag. However, as a guide, consider:

- a tamped sandbag will be approximately 150 millimetres high, requiring about six rows above ground and one below for a height of one metre, and
- the width of a header will be about 250 millimetres and the width of a stretcher will be about 600 millimetres.

Height of wall	Sandbags required
300 mm	600
600 mm	2000
900 mm	3400

Table 6:1
Bags required for 30 metres of wall

6.3.4 Removal

Methods for removing flood water from buildings include:

- pushing out the water, by keeping it on the move with brooms and squeegees, so that it does not collect or increase in depth
- boring small holes in the floor with an auger, or by using a crowbar to prise up a floorboard where it joins another and using a wedge to keep the joint open
- baling the water out of the building
- syphoning the water to a lower point
- pumping the water into drains or tankers, and
- wet and dry vacuum cleaners.

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6.4 Pumping operations

6.4.1 Calculating water volume and weight

When a large quantity of fluid is required to be removed from an area, it may be necessary to employ pumping equipment. To determine which pump is appropriate to the task, estimate the volume and type of liquid to be displaced. The weight of fluid may also need to be taken into consideration.

These formulas are approximate and have been developed for ease of calculation.

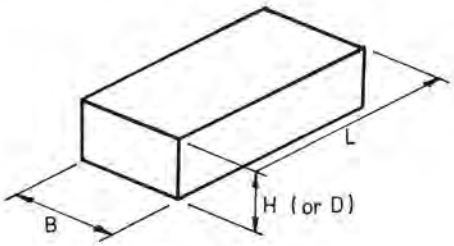


Figure 6:6
Water volume

a. **Volume**
Volume = length x breadth x height (or depth)
Vol (m^3) = L x B x H (or D)

b. **Capacity**
1 $metre^3$ = 1000 litres of water

c. **Weight**
1000 litres of water = 1000 kilograms (I tonne)

Example:

Where L = 6 m, B = 3 m and C = 2 m

The volume of water = 6 x 3 x 2 = 36 m^3

This is equal to a capacity of 36,000 litres and weighs 36,000 kilograms or 36 tonnes.

6.4.2 Pump categories

Pumps for moving fluids fall broadly into three categories: positive displacement pumps, centrifugal pumps and ejector pumps.

a. **Positive displacement pumps**—Positive displacement (PD) pumps, as a general rule, are not as efficient as centrifugal pumps. Portability is a major requirement in storm operations, so the only type of submersible PD pump worthy of consideration is an air-operated diaphragm (force) pump. Various types of PD pumps for surface usage are readily available, including the hand-operated stirrup pump, motorised portable pumps and trailer-mounted pumps. Where the water contains debris and suitable strainers are not affixed to inlets, the use of a surface diaphragm-style pump is recommended.

There are four main types of pump in this category.

i. **Force pumps**. Fluid is forced out by a solid piston, a diaphragm (for example, a petrol pump) or compressed air.

ii. **Lift pumps**. Fluid can pass freely in one direction through a hollow piston with a one-way valve (for example, a well pump).

iii. **Bucket and plunger pumps (sludge pump)**. A combination of a force and lift pump, with a column mounted above the hollow piston to displace fluid during the downstroke.

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iv. **Rotary and semi-rotary pumps**. Fluid is moved from one part of a partially cylindrical chamber to another part, for discharge, by projections located around an axis (for example, the gear pump circulating oil in an internal combustion motor).

b. **Centrifugal pumps**—Centrifugal pumps are the most efficient and versatile pumps and are therefore more common in both the submersible and surface groups. Because there are fewer moving parts, they are smaller in size in relation to the volume of water and pressure that they can discharge. The majority of submersible pumps fall into this category and are well suited to discharging water from inside buildings. Surface-operated centrifugal pumps are certainly the most effective, under the right conditions, when a large volume of water is to be moved in a short time. The disadvantage is that the suction hose must be primed prior to commencement of pumping.

   Note: Both the positive displacement and centrifugal pumps are fed with fluid, either by gravity, under pressure from a main supply, or other sources (for example, compressed air or by atmospheric pressure).

c. **Ejector pumps**—These are special pumps with no moving parts, in which a jet of water is injected into a larger orifice, causing reduction in atmospheric pressure. Special filters are required at the inlet to the supply of the jet. This type of pump is particularly suitable for use where it would not be possible to use a normal pump (in the categories mentioned above), such as a confined space.

6.4.3 Pump considerations

The common pumps used during storm operations are those in the positive displacement and centrifugal pump categories. In each category, pumps can be grouped as follows:

a. **Surface**—The pump is isolated from the fluid to be moved and reliant on a suction hose through which the fluid is drawn to the pump, then pushed to the discharge point. Limitations to this group can include mobility/portability, toxic fumes produced by motors and the required close proximity to the fluid.

b. **Submersible**—The pump is located within the fluid and immediately draws fluid in to the discharge point. Such a pump can push the fluid further than a similar surface pump can lift or draw the same fluid. Limitations to this group include their restricted size and power sources (for example, only electricity, compressed air or a shaft driven by a surface-mounted motor).

6.4.4 Using pumps

The following general rules apply when using most pumps:

- Refer to the manufacturer’s handbook for specific operating, safety and maintenance procedures.
- Determine an appropriate discharge point with relation to the suction hose access to the flood water.
- Install strainers on the suction hose to protect the pump.
- Position the hoses, avoiding sharp bends and protecting against sharp edges. Before lowering the inlet into deep water, secure it with a line. This will also assist during retrieval.
- Ensure the inlet remains submerged. With surface pumps this is particularly important, as air in the suction hose will cause the vacuum to break and the pump will then need to be primed again.
- Place the strainer upstream against the flow of the water to prevent a vortex forming around the strainer and limiting suction.
- Constantly monitor the pumping operation, including the strainers, which may need regular cleaning.
- When using surface pumps, locate the pump as close as possible to the flood water so that no more suction hose than necessary is used. Each additional length of hose increases friction loss. The suction hose must be specifically designed to withstand external pressure when the vacuum is created.

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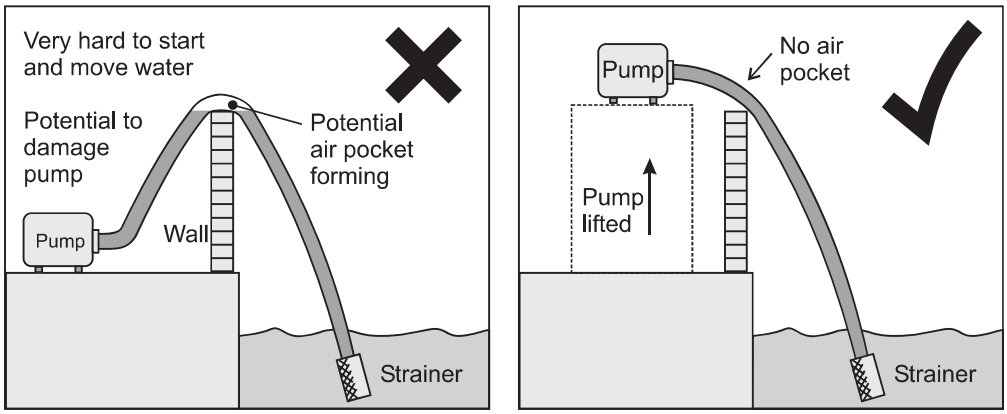


Figure 6:7
Using pumps

WARNING

Ensure adequate ventilation is provided at all times where combustion motor-powered pumps are used, as carbon monoxide build-up may be rapid and fatal. This is especially relevant in basements of houses or in pits and submerged garages.

6.4.5 Sourcing pumps

Pumps of various types and for various purposes are available from a number of sources for hire or loan. The major sources are:

- government authorities (for example, councils and firefighting services)
- state government water and drainage authorities
- local government authorities
- commercial suppliers and hire companies, and
- private businesses such as mining companies, agricultural suppliers and liquid waste disposal experts.

6.4.6 Hazards associated with pumping operations

Be aware of hazards associated with pumping operations:

- health problems, which can be caused by effluent in floodwaters—refer to local health authorities for planning and response advice
- electrical, fire and chemical hazards
- deep water—consider wearing personal flotation devices (PFD) when working around deep water
- be careful of burns—exhaust manifolds can get very hot, and
- exhaust gases—provide adequate ventilation to disperse the exhaust gases produced by combustion engine-driven pumps. Carbon monoxide poisoning can be fatal.

Note: When choosing a pump, always ensure that you consult the supplier regarding its operational capacity and task suitability.

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Chapter 2	2:1 – 2:8, 2.10 – 2:11, 2:13 – 2:14, 2:16, 2:19	New South Wales State Emergency Service	*Storm and Water Damage Operations* Training Resource Kit, 2003/04
	2:9	Emergency Management Queensland, Queensland Department of Emergency Services	
	2:15	Fire and Emergency Services Authority of Western Australia	FESA *Undertake Storm and Water Damage Operations* Training Resource Kit, 2007
Chapter 3	3:1	Emergency Management Queensland, Queensland Department of Emergency Services	
Chapter 4	4:1 – 4:4, 4:6 – 4:7, 4:11 – 4:15	New South Wales State Emergency Service	*Storm and Water Damage Operations* Training Resource Kit, 2003/04
Chapter 5	5:1	Emergency Management Queensland, Queensland Department of Emergency Services	
Chapter 6	6:2 – 6:3	New South Wales State Emergency Service	*Storm and Water Damage Operations* Training Resource Kit, 2003/04

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Emergency Management Australia

STORM AND WATER DAMAGE OPERATIONS MANUAL 30

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JURAT ATTACHMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

STATE OF Texas }

COUNTY OF Tarrant }

The foregoing instrument was subscribed and sworn before me this date of 09/09/2023, by Nathaniel Frank-White

This notarial act was an online notarization.



(Notary Seal)

Notary's Signature _____

Registration No.: 133645929

Commission Expiration Date: March 15, 2026

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