UNIVERSITY OF EDUCATION WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

THE CURRENT STATE OF FIRE PROTECTION OF DOMESTIC BUILDINGS IN WA IN GHANA

JOHN ELI KOFFIE

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THE CURRENT STATE OF FIRE PROTECTION OF DOMESTIC BUILDINGS IN WA IN GHANA

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JUNE, 2014

DECLARATION

I John Eli Koffie, declare that this dissertation with the exception of quotations and references contained in the published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for any another degree elsewhere.

…….. …….

Signature Date

SUPERVISOR'S DELARATION:

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guide line for supervision of Dissertation as laid down by the University of Education, Winneba

Professor N. Kyei - Baffour **……** **……**

Signature Date

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May the Lord Almighty bless yo

DEDICATION

This work is dedicated to the Almighty God for taking me through this programme this far, Also to my beloved sister Joyce Mensah for her love, support and words of encouragement throughout this programme.

TABLE OF CONTENTS

CHAPTER THREE: METHODOLOGY

CHAPTER FOUR: RESULTS AND DISCUSSION

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Fire Safety is not given much attention in Ghana especially in domestic buildings and it is usually neglected and the consequence cannot be over emphasized.. The purpose of the study was to investigate the current state of fire protection of domestic buildings in Ghana. The study was conducted through administering of questionnaires to Domestic households, personal interviews and discussions with individuals living in domestic buildings and experts in organizations in charge of fire protection and fighting in the domestic buildings and as well as the internet. These were analyzed accordingly. The study was limited to domestic structures in the Wa Municipality. The findings revealed that most of the occupants do not know fire fighting techniques or protection methods not even the simple use of the fire extinguishers. It was also realized that over eighty percent of domestic buildings were inadequately equipped with fire fighting equipments .It was recommended that occupants should be regularly taken through sensitization training lessons on how to prevent, protect and fight fire and also the use and operating of fire extinguishers

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Every building or structure, new or old if it is designed for human occupancy, should be designed to avoid undue danger to the lives of its occupants. Thus every building shall be provided with exits and other safeguards sufficient to permit the prompt escape of its occupants or to furnish them with other means enabling a reasonable degree of safety in case of fire or other emergencies.

The phenomenon of fire is chemically classified as oxidation, and it requires specific conditions to occur. First there will have to be a source of ignition somewhere in the building. Following ignition there will have to be sufficient fuel to enable combustion and then enough oxygen to sustain combustion which in turn may generate enough heat to enable this chemical process to become continuous, (James, 1993)

However, utilisation of fire can lead to great achievements, but the other side of it can cause disasters. That is why it is said that fire is a good servant but a bad master when not controlled; therefore there is the need for the activities of use of fire by occupants within and outside of buildings to be controlled.

Fire outbreaks in Ghana recently have been one of the major disasters in the country. It is therefore important for individuals and organisations to take strict measures to curb these unfortunate incidents.

Fire in its shattering mood can to be a major contributor to economic draw-back of any nation due to the cost of damages and repair “according to the regional deputy fire officer of Upper West Region Mr Kwesi Ankra, Ghana lost GH¢10,321,963 to

fire outbreaks last year, and as at July this year, the country had recorded 3,354 fire outbreaks with a damage cost estimated at GH¢17,055,150

The Ghanaian population can largely be described as vulnerable to all sorts of hazards that are at the centre of triggering disasters. One such hazard that threatens the well-being of Ghana is fire.

1.2 Focus of Research

This study is focused on the state of fire protection in domestic buildings in Ghana. Besides that, this study is also intended to identify methods to improve fire safety in these buildings. The basic elements of the Chapter cover the background, problem of the statement, aims and objectives, and scope of the study.

The research methodology involved in conducting this study is also briefly explained. Lastly, a summary of all the chapters in this study are presented.

1.3 Problem Statement

Population explosion worldwide and scarcity of land space in big cities has resulted in the springing up of domestic buildings everywhere. This comes with its associated problems of fire outbreak. Every building must be adequately furnished with fire protection features at its design and construction. The Health and Safety Act of 1974 was enacted by government to ensure that the activities of fire by occupants of buildings are well protected against the devastating effects of fire such as loss of lives and damage to properties. Government is also responsible for the protection of legislative measures, codes of practices, codes of standards and their enforcement.

Unfortunately, the non-enforcement of laws concerning building permits, fire certificates, the lack of adequate checks to ensure that the site plans are adhered to are

some of the major cause of inadequacy of fire protection in buildings, specifically at the domestic level and therefore the high rate of fire outbreaks in these buildings. Another major cause is the unconcerned attitudes of building owners towards fire protection in their properties.

The frequency of fire outbreaks in public facilities over the past few weeks has elicited varied concerns and speculations among the Ghanaian public. At the centre of most discussions, is the attempt of unraveling the cause of what has become a major liability to the state.

Indeed, there is "Fire everywhere", as stated on the front page of the Daily Graphic of Monday, June 17 2013. Fires continue to cause considerable damage to life and property

The Ghana National Fire Service (GNFS) put the estimated cost of damage to property in the first quarter at GH¢16 million. From the total fire outbreaks recorded in the first quarter, it means that on the average, 18 fires occurred daily while 550 were reported monthly. It appears that if the trend of fire outbreaks continues this year, the number will exceed the number recorded last year. In 2012, fire outbreaks recorded nationwide were 4,577 resulting in 295 deaths. The cost of damage was put at GH¢10,321,963.

1.4 Aim of the Study

The aim of this study was to determine ways and means through which domestic buildings can be made safer during the event of a fire outbreak, through the assessment of these domestic buildings for their level of fire protection and provide adequate recommendations on fire safety measures, in order to protect life and property.

1.5 Specific Objectives

In order to achieve the stated aim, the specific objectives were:

1. To ascertain the knowledge of domestic building owners in relation to fire protection in their properties.
2. To examine the current state of fire protection in these buildings.
3. To identify the level of awareness of the occupants on the firefighting systems and facilities in the buildings.
4. To identify the extent to which the existing systems and facilities are being maintained for sustainability.
5. To determine the state of fire protection systems and facilities in domestic structures as a basis for recommending best practices for future domestic structures within the municipality.
6. To recommend appropriate measures for fire prevention and fire safety to help reduce the high incidence of fires in residential buildings.

1.6 Research Questions

1. What do domestic building owners know about fire protection in their properties?
2. What is the current state of fire protection in domestic buildings?
3. Are occupants in domestic buildings aware of fire fighting systems and facilities?
4. Are existing facilities and systems maintained in domestic buildings for sustainability?
5. What is the state of fire protection systems and facilities in domestic buildings

6. What are the appropriate measures or recommendations for fire prevention and fire safety in reducing high incidence of fire outbreaks in domestic buildings?

1.7 Significance/Justification of Study

This research gives an in-depth knowledge of the state of fire protection in domestic structures in the Wa Municipality and factors that should be considered during the design and construction of domestic buildings in case of fire outbreaks or any other emergencies in other to save the lives of the occupants and property.

1.8 Scope of Study

The research has been limited to the Wa Municipality because of recent fire outbreaks and the erection of many domestic structures in the Municipality considering its associated dangers with fire outbreaks.

1.9 Limitations of the Study

The major limitation is that the study is limited to the Wa municipality. Other challenges were that because most of the occupants were not available, interviews and interactions with the few available was very challenging and because of the language barrier, getting an interpreter was very challenging as most of the tenants were illiterates .

1.10 Research Questions

The main question was about

1. The state of fire protection of a typical domestic building in Wa?

The sub questions were:

1. Do regular users of domestic buildings know of the existence of fire protection systems and facilities of their buildings?
2. How much do they know about the fire protection systems and facilities in their buildings?

1.11 Organization of Chapters

The organization of the chapters are as follows:

The Chapter One introduces the background of the study, the scope of work, the problem statement, aim of the study and objectives. Chapter Two is the review of related literature on the problems, it discusses into detail the chemistry of fire, how it spreads and the classification of fire, it also takes into consideration definitions and potent issues relating to firefighting and escape plans. Chapter Three details precisely how the research was carried out, the various methods used and how the objective of the research was achieved and the problems encountered. Chapter Four explains how the data collected were analyzed and how findings were built logically..Chapter Five summarizes the findings, draws major conclusions and makes recommendations for further studies

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses into detail the chemistry of fire, spread of fire and the classification of fire. It also takes into consideration all the potent issues in relation to firefighting, escape plans and the perception of building professionals and the Ghana National Fire Service on firefighting and prevention

2.2 Fire

The phenomenon of fire is chemically classified as oxidation, and it requires specific conditions to occur (Patterson, 1993). First there will have to be a source of ignition somewhere in the building. Following ignition, there will have to be sufficient fuel to enable combustion and then enough oxygen to sustain combustion which in turn may generate enough heat to enable this chemical process to become continuous.

(Cox and Trait, 1991) outlined the condition that must be met if fire is to start. These are the presence of flammable material (**Fuel**), **oxygen** and a source of **heat** to cause ignition, the situation is illustrated symbolically by the fire triangle below.

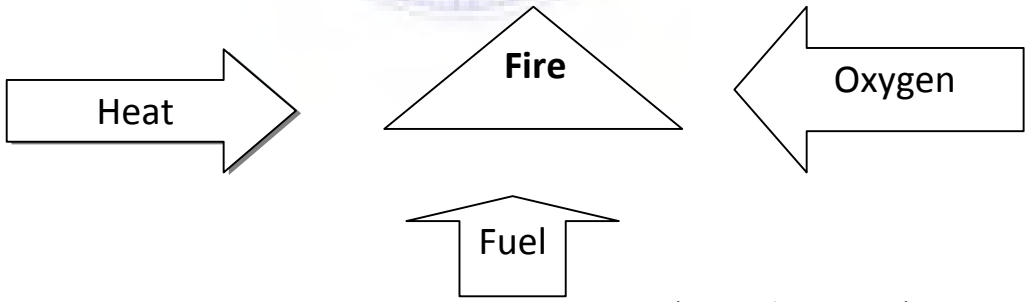


Figure 1 Source: (Cox and Trait1991)

The absence of one of the three essentials means that combustion cannot take place. This fact calls for the institution of fire prevention, fire protection and firefighting. (Cox and Trait 1991)

Fires start when a flammable or a combustible material, in combination with a sufficient quantity of an oxidizer such as oxygen gas or another oxygen-rich compound (though non-oxygen oxidizers exist), is exposed to a source of heat or ambient temperature above the flash point for the fuel/oxidizer mix, and is able to sustain a rate of rapid oxidation that produces a chain reaction. This is commonly called the fire tetrahedron. Fire cannot exist without all of these elements in place and in the right proportions. For example, a flammable liquid will start burning only if the fuel and oxygen are in the right proportions. Some fuel-oxygen mixes may require a catalyst, a substance that is not consumed, when added, in any chemical reaction during combustion, but which enables the reactants to combust more readily.

Once ignited, a chain reaction must take place whereby fires can sustain their own heat by the further release of heat energy in the process of combustion and may propagate, provided there is a continuous supply of an oxidizer and fuel.

If the oxidizer is oxygen from the surrounding air, the presence of a force of gravity, or of some similar force caused by acceleration, is necessary to produce convection, which removes combustion products and brings a supply of oxygen to the fire. Without gravity, a fire rapidly surrounds itself with its own combustion products and non-oxidizing gases from the air, which exclude oxygen and extinguish the fire. Because of this, the risk of fire in a spacecraft is small when it is coasting in inertial flight. Of course, this does not apply if oxygen is supplied to the fire by some process other than thermal convection.

Fire can be extinguished by removing any one of the elements of the fire tetrahedron. Consider a natural gas flame, such as from a stovetop burner. The fire can be extinguished by any of the following:

- turning off the gas supply, which removes the fuel source;

- covering the flame completely, which smothers the flame as the combustion both uses the available oxidizer (the oxygen in the air) and displaces it from the area around the flame with CO_2;
- application of water, which removes heat from the fire faster than the fire can produce it (similarly, blowing hard on a flame will displace the heat of the currently burning gas from its fuel source, to the same end), or
- application of a retardant chemical such as Halon to the flame, which retards the chemical reaction itself until the rate of combustion is too slow to maintain the chain reaction.

In contrast, fire is intensified by increasing the overall rate of combustion. Methods to do this include balancing the input of fuel and oxidizer to stoichiometric proportions, increasing fuel and oxidizer input in this balanced mix, increasing the ambient temperature so the fire's own heat is better able to sustain combustion, or providing a catalyst; a non-reactant medium in which the fuel and oxidizer can more readily react.

Source: Wikimedia foundation, Inc (2016) fire. Retrieved from http://Wikipedia.org/wiki/fire

2.2.1 Causes of Fire in Domestic Structure

The origin of a fire usually the result of negligence, ranges from:

(1) Direct act such as poor installation and maintenance of electrical wiring.

(2) The disposition of combustible materials within the building, either in the form of unfixed materials or part of the fabric such as wall and ceiling linings.

(3) Overloading of sockets.

(4) Leaving appliances on when not in use.

(5) Sleeping with naked light candles, mosquito coils, etc.

(6) Storage of petrol in bathroom.

(7) Other discharge of static electricity.

(Foster, 1994)

Appliances & equipment Cooking; heating; washing machines & dryers; air conditioners and fans; and more.

Arson and juvenile firesetting Children playing with fire and intentional fires.

Candles Causes and trends in home fires involving candles, candle fire frequency in other occupancies, and selected published incident descriptions

Chemical and gases Natural gas and LP-gas home and non-home fires; spontaneous combustion. Electrical Includes home structure fires involving electrical distribution or lighting equipment Fireworks Includes injury patterns and trends, including shares by type of fireworks, based on reports to hospital emergency rooms

Holiday Christmas trees, holiday lights and decorations.

Household products Mattresses, bedding and upholstered furniture

Lightning Fires and Lightning Strikes Information on incident type, and when and where the incidents occurred.

Smoking materials Fires involving smoking materials (i.e., tobacco products).

Source: National Fire Protection Association (2016) Fire causes, Retrieved from http://www.nfpa.org/research/report-and-ststistics/fire-causes

2.3 Structural fire protection

The purpose of structural fire protection is to ensure that during fire, the temperature of structural members or elements does not increase to a figure at which their strength would be adversely affected. It is not practicable or possible to give an element complete protection in terms of time, therefore elements are given a fire resistance for a certain period of time which it is anticipated will give sufficient delay to the spread

of fire, ultimate collapse of the structure, time of persons in danger to escapes and to enable fire fighting to be commenced. (Chudley, 1983)

Structural fire protection includes the insulation materials, coatings, and systems used to prevent or delay fire-induced temperature rise in structural members in buildings. It falls into the general class of passive fire protection that typically supplements active fire protection (fire alarms, fire suppression systems, human interventions, etc.), as required by the building codes. Structural fire protection for walls, columns, and floors can be provided in varied forms, different materials and products, such as lightweight or higher density spray-applied fire resistive materials, gypsum board, intumescent/mastic coatings, concrete and masonry.

Source: Hughes, (2016) Structural fire protection .Retrieved from http://www.jensenhughes.com/services/fire-protection-systems-design/structural-fire-protection

2.3.1 Factors that determine fire resistance period

Before a fire resistance period can be determined it is necessary to consider the following factors

i. The fire load of the building
ii. Behaviour of materials under fire conditions
iii. Behaviour of combinations of materials under fire condition and
iv. Building Regulation Requirements (Cot,1991).

2.3.2 Requirement of Building In Terms Of Fire

The following are fire safety requirements in terms of buildings:

1. Every flat should have a protected enhanced hall of half-hour fire resistance.
2. Every living room should have an exit into the protected enhanced hall.
3. Bedrooms should be nearer to the enhanced door than the living rooms or kitchens.
4. Doors opening on to a protected enhanced hall to be a ½ hour fire resistance.
5. Maximum travel distance from any bedroom exit to enhanced door to be 7.500m. If exceeded, an alternative route is to be provided. (Dawnson,1988)

2.3.3 Approach to Fire Safety

A systematical approach to fire safely design strategies can be developed based on the following principal types of activities

1. Prevention
2. Slowing of initial growth and spread
3. detection
4. suppression
5. compartmentation
6. evacuation and
7. design facility for firefighting operations (James,1993)

2.3.4 Heat Sources

The following are possible sources of heat in buildings

a. Fixed equipments
b. Portable equipments
c. Torches and other tools
d. Smoking materials and associated lighting implement
e. Exposure
f. Natural causes
g. Exposure to other fires (Cot , 1991)

Examples of fuels and heat sources include:

- Solid fuel – timber, coal, peat, biomass.
- Liquid – oil, liquid petroleum gas (LPG).
- Gas - natural gas, biogas.

- Electricity - grid, wind turbines, hydroelectricity, photovoltaic.
- Water – solar thermal, geothermal, ground source, water source.
- Air source.
- Heat recovery.
- Passive – solar gain, thermal mass.
- Internal heat loads - heat generated by people and equipment.

Source: www.designing buildings.co.uk/wiki/Building-heating-systems#heat_sources. Designing Buildings (2016) Building heating systems heat sources.

For a flammable or combustible liquid fire to start, a mixture of vapour and air must be ignited. There are many possible ignition sources:

- Sparks from electrical tools and equipment.
- Sparks, arcs and hot metal surfaces from welding and cutting.
- Tobacco smoking.
- Open flames from portable torches and heating units, boilers, pilot lights, ovens, and driers.
- Hot surfaces such as boilers, furnaces, steam pipes, electric lamps, hot plates, irons, hot ducts and flues, electric coils and hot bearings.
- Embers and sparks from incinerators, foundry cupolas, fireboxes and furnaces.
- Sparks from grinding and crushing operations.
- Sparks caused by static electricity from rotating belts, mixing operations or improper transfer of flammable or hot combustible liquids.

Sources: Canadian Centre for Occupational Health & Safety (1997-2016) ignition retrieved from https://www.ccohs.ca/oshanswers/prevention/flammable_general.html

2.4 Smoke

Smoke is defined as a visible airborne cloud of fire particles, the products of incomplete combustion. Whilst the above statement is indeed true, smoke can also be caused by the release into the air of a variety of chemical compounds. (Dawnson,1988) According to (Chudley,1983) more deaths are caused by smoke and heated gases than by burns. Statistics show that on average approximately 54% of deaths in fires are caused by smoke, 40% by burns and scalds and 6% by other causes. Smoke is the first evidence of fire, and indeed the only evidence which may appear in remote areas of the building following the actual combustion is smoke.

Its effects may be lethal or at least as potentially dangerous to human life as the fire itself. All smoke for fires, regardless of the material under combustion, contains gases which are toxic. Exposure times are extremely short before fatal result are reached, carbon monoxide is always present, Example: Research has shown that exposure to an atmosphere containing 1% of carbon monoxide (CO) will cause loss of consciousness in under 5 minutes and can cause death soon thereafter and experimental times typically produce CO Concentrations of up to 10% (Patterson,1993)

2.4.1 Smoke Detection Types

Three types of smoke detection equipment is in general use today and they are.

1. Sport-type ionization detectors
2. Spot-type light-scattering photoelectric detector.
3. Line-type projected-beam light obscuration detectors. **(**forster,1994**)**

Smoke detectors are housed in plastic enclosures, typically shaped like a disk about 150 millimetres (6 in) in diameter and 25 millimetres (1 in) thick, but shape and size vary. Smoke can be detected either optically (photoelectric) or by physical process (ionization), detectors may use either, or both, methods. Sensitive alarms can be used to detect, and thus deter, smoking in areas where it is banned. Smoke detectors in large commercial, industrial, and residential buildings are usually powered by a central fire alarm system, which is powered by the building power with a battery backup. Domestic smoke detectors range from individual battery-powered units, to several interlinked mains-powered units with battery backup; if any unit detects smoke, all trigger even in the absence of electricity.

Smoke alarms are designed to detect fires quickly. Like flame detectors, this fire detection equipment is divided into three subcategories.

- Photoelectric alarms: These operate with the use of a light source, photoelectric sensor, and beam collimating system. When smoke begins to enter the optical chamber, it crosses the light beam path. This results in light being scattered by the particles in the smoke. The scattered light is then directed to the sensor, after which the alarm is activated and sounded.

- Ionization alarms: A small amount of radioactive material, which passes through the ionization chamber, is contained inside of these alarms. There are two electrodes inside the chamber, with empty space in between. The radiation permits a small current between the two electrodes. If smoke enters the chamber, it absorbs the alpha particles, which results in an interrupted current and ionization reduction. When this occurs, the alarm is set off.

- Combination alarms: These have the features of both ionization and photoelectric alarm technologies. The photoelectric function responds to low energy smoldering fires, and the ionization function responds to rapid, high-energy fires.

Source: Wikimedia foundation(2016)smoke detectors retrieved fromhttps://en.wikipedia.org/wiki/Smoke_detector

2.4.2 Type of Sprinklers

Wet Pipe: Since water is always present in the pipes supplying the sprinkler heads, these types of sprinkler system are quick to react upon the operation of a sprinkler head in a fire scenario. These are the most common systems and are used in buildings where there is no risk of freezing. Wet systems are required for multi-storey or high-rise buildings and for life safety systems for UK standards.

Dry pipe: The pipes are filled with air under pressure at all times and the water is held back by the control valve outside of the protected area. Should a sprinkler head open in a fire scenario, the drop in air pressure opens the valve and water flows into the pipework and onto the fire. Dry pipe systems are used where wet or alternate systems cannot be used.

Alternate: Alternate systems have the pipes full of water for the summer period, then subsequently drained down and filled with air for the winter. This is typically for buildings that are not heated, e.g. underground car parks.

Pre-action: Like dry pipe systems the pipes are filled with air but water is only let into the pipes when the detector operates (e.g. smoke detectors). Pre-action systems are used where it is not acceptable to have a sprinkler activate unless there is a real

threat of fire, i.e. for high value stock or irreplaceable items, for example, archive material, libraries and computer backup systems.

Deluge and recycling: These are sprinkler systems only used in special cases for industrial risks. They are most commonly used for protecting tank farms where all the sprinkler heads/nozzles operate simultaneously. Foam is often introduced into the system.

Source: international fire consultants (2016)types of sprinkler systems retrieved from http://www.firesafetysearch.com/products/fire-suppression-systems/sprinkler-systems/

2.4.3 Heat Detectors

Unlike other types of alarm systems, heat detectors are not early warning devices. These devices are typically found in spots with fixed temperature, including heater closets, small rooms, and kitchen facilities. They should not be installed in areas with fluctuating ambient temperature. This is because the alarm on heat detectors is set to go off if there is a rise in the temperature. Source:Wikimedia foundation(2016)smoke detectors retrieved from https://en.wikipedia.org/wiki/Smoke_detector

2.4.4 Flame Detectors

Like their name suggests, these detectors are used to detect flames. When working properly, they detect fire nearly at the point of ignition. They are very useful for

buildings involving with hazardous processes, as well as gas and oil refineries and manufacturing industries.

There are three subcategories of flame detectors: optical, UV, and IR.

- Optical detectors: The most commonly used, these feature optical sensors for detecting flames.
- UV detectors: These work very quickly. They can detect open flames, explosions, and fires within four milliseconds, due to the UV radiation emitted at the instant of ignition. However, to prevent accidental triggers, some UV detectors are designed to integrate a three second time delay.
- IR detectors: Infrared detectors monitor the head radiation that is generated by open flames and fire. They have a response time of three to five seconds. Accidental triggers can be caused by nearby hot surfaces and background thermal radiation. False alarms can be decreased with the use of special programming algorithms, which are designed to recognize the frequency of flame flickering.

Source:Wikimedia foundation(2016)smoke detectors retrieved from https://en.wikipedia.org/wiki/Smoke_detector

2.5 Planning Escape Routes

When escape routes are being planned, the type of persons likely to be involved must be considered. Occupants of flats may be familiar with the layout of the premises whereas customers in a shop may be completed unfamiliar with the surroundings. In schools, the fundamental principle is the provision of an alternative means of escape

and in hospitals, the main concern is with the adequacy of the means of escape from all parts of the building.

In case of fire the building and its contents are of secondary importance the provision of a safe escape route should, however, allow at the same time an easy access for the fire brigade using the same routes. (Chudley, 1983)

Sketch a floor plan of your house. Use a separate piece of paper for every floor. Identify 2 escape routes from every room. Make sure drawings can be understood by young children. Place a copy of the escape routes within eye level in your children's rooms.

If you reside in a multi-story house, develop escape plans with ladders. Ensure that everyone living in the house understands how to use escape ladders.

Determine a central meeting location and document it, so all family members understand where to reunite during an emergency. You may also want to designate different meetings location depending on where you're at. For example, if a disaster strikes while the family is in or near your place of residence then you might all want to meet at your house or a neighbour's house. However, if a disaster occurs when everyone is outside the immediate area you may wan to set up a easily accessible location such as parking lot where you all should meet.

Source: http://www.emergencypreparednessessentials.org/plan-escape-routes.html

2.5.1 Means of Escape

The object in providing means of escape is to permit unobstructed escape routes to exit way corridor and emergency exit to a section or an open space or to an adjoining building, a roof form which access to the section may be obtained, fire resisting doors planned in strategic positions to prevent the spread of smoke and fire from

compartment to compartment and emergency exit to keep the latter free when used as an escape route. (Cot, 1991)

Providing a clear and unambiguous means of escape from buildings in the event of fire is fundamental to life safety and must be incorporated at an early stage in the design of a building.

The Regulatory Reform (Fire Safety) Order 2005 requires a means of escape that will ensure the safety of employees so far as reasonably practicable, and that may reasonably be required in the circumstances relating to the use of the building to ensure that the premises are also safe for people who are not employees.

Exit routes and exit doors themselves are kept clear (of obstruction) at all times.

Emergency routes and Fire Exits must lead as directly as possible to a place of safety.

In the event of danger, it must be possible for persons to evacuate the premises as quickly and safety as possible.

The number and dimensions of emergency routes and exits must be adequate for safe egress of all persons in the building as quickly as possible .

Sliding or revolving doors must be not be used for exits specifically designated as emergency exits.

Emergency doors must not be so locked or fastened in a way that prevents them being easily and immediately opened by any person who may require to use them in emergency

(for example a padlock).

A number of points should be noted in respect of these requirements. Firstly and most importantly, the requirements are not absolute: they need to be implemented “where necessary”.

The "necessity "is determined by a fire risk assessment. Thus, for example, it is not the case that all fire exits in all premises need to open in the direction of escape. While this might be essential for doors used by the public in a theatre, in many workplaces it might only be necessary if the door is likely to be used by more than around 60 people. Similarly, a sliding door may be acceptable on an escape route that will only ever be used by a few trained employees.

In addition it is advisable to clearly mark designated escape routes and escape exits with appropriate signs. Signs are available to cover every type of escape route. For more details visit the Signs product category on www.fireandsafetycentre.co.uk

Source: Fire and Safety Centre (2016) Providing Means for Escape retrieved from http://www.fireandsafetycentre.co.uk/bulletin.php?id=72016

This is an essential part of the fire safety system. A safe, illuminated, well identified way out of the building is required in order that the building occupants can escape a fire (or other) emergency. Often more than one escape route is required so that occupants have an alternative exit if one cannot be reached because of smoke or fire. These exits must be kept clear at all times. Storage of materials in exits is a common hazard and security problems are often overcome by illegally locking fire escape doors which place the lives of the building occupants at risk if a fire occurs.

Source: South Australian Metropolitan Fire Service (2012) Building Fire Safety Means of Escape from the Building retrieved from http://www.mfs.sa.gov.au/site/community_safety/commercial/building_fire_safety.jsp

Emergency exits are required in buildings so that occupants can quickly escape from the building at time of fire or other emergency.

Emergency exits must be available at all times. This is a requirement of Building and Work Health and Safety Legislation. The legislation generally requires that the

emergency exits can be opened by escaping building occupants without a key. Generally, the locking of an emergency exit is an offence. Should building security pose problems (eg in a prison), it is essential that fire and building approval authorities are aware of any management system in place to deal with these issues. Documented approval of such arrangements is paramount. Discussion with the Community Safety and Resilience Department is recommended.

It is an offence to store materials in an emergency exit, these can obstruct occupants' access to a safe place and may, by nature of the materials stored, pose a fire threat.

Any signs or notices which provide advice about exits (location maps, signs on doors) must be maintained so that they are legible to the occupants of the building at all times. These need to be checked periodically for compliance and currency.

It is recommended that, in hotels, boarding houses and the like, a "you are here" map be fixed to the back of each sole occupancy room door, showing the location of emergency exits and giving basic advice to the occupants of emergency and fire procedures applicable to that building.

Emergency lighting and exit signs are provided where necessary so that occupants of the building can identify the location of exits in an emergency, even in the event of a power failure.

It is important that these facilities are maintained in good working order at all times. Regular checking of these systems is essential. All checks should be recorded and immediate steps taken to rectify any faults found.

Source: South Australian Metropolitan Fire Service(2012) Fire Exits Accessibility of Emergency Exits retrieved from http://www.mfs.sa.gov.au/site/community_safety/commercial/building_fire_safety/fire_exits.jsp

2.5.2 Fire Fighting Access

The most basic fire fighting method is the application of water from fire department pump trucks and from municipal fire hydrants near the building. Most simple of domestic building do not have built in installations used to extinguish fire. There is the need for the structure to be designed and accessibility for the fire service team, this accessibility tends to be focused at the exterior for the proximity of equipment, and the interior for fire personnel accessibility to all the building space. (Chudley and Greeno1988)

2.5.3 Factors Considered When Designing Means of Escape

The objective is to provide a protected route by which the occupants can leave the premises, secondary means of escape should be provided where possible so occupant should be able to turn away from the fire (i) once a person has entered a protected area, they should not have to leave it until. They are out of the premises or the final exit.

(ii) There should be a vision panel in the connecting door of all rooms in an area with only one exit

(iii) All rooms opening on to a protected route should have a fire door providing the fire resistance required (usually 30 minutes). The only exception to this rule is the bathrooms and toilets which are considered to be low risk areas (Architectural Engineering and Structural Limited).

2.5.4 Evacuation Systems for domestic Buildings

The protection of occupants of multi-storey buildings must be made a part of every full service total fire safety programme. Regardless of building construction, sophisticated fire detection system, fire protection and fire-fighting apparatus used, a building is only as “people safe” as the building owners, managers and tenant

spokesmen want it to be. People cause fires by their acts of commission and omission; furnishings feed fires, and panic results in needless loss of live and injuries. Fire prevention, fire protection, adequate evacuation programming and planning, and complete "rehearsal for survival" are needed to make sure losses will be minimal in the event of fire.

Panic of occupants of multi-storey buildings during the early stages of a fire is a danger that can contribute to high casualty losses. Smoke, gases, and super-heated air make it imperative that an emergency evacuation programme be established for all multi-storey buildings (a high-rise building, by popular definition, is a completed, occupied structure for which the roof access level exceeds the maximum height of rescue capability from street level by the fire department).

In all cases of life safety design, consideration must be given to the special capabilities of occupants. Physical abilities must be accommodated, obviously, but an equally important factor is the communication method informing occupants of the fire and what they should do. Confusion and panic is normal following the initiation and fire. The building's systems need to reduce panic, restore order so that an effective base for life safety operations can be initiated. This is perhaps one of the leading edge problems in building fire safety design today. It has been determined that occupants who are familiar with their surroundings often have difficulty locating exits. Sometimes familiarity becomes a liability and causes more difficulty for long-term occupants than transients in a building at the outset of a fire. The building's alarm system, marking of egress paths, communication of instructions, the circulation system, and special areas of refuge, if any. **(**Cox, and Trait 1991).

2.5.5. **Some Terms Used in Firefighting**

- **Arson:** the crime of maliciously (or perhaps recklessly) setting fire to property, especially a dwelling. Punishable in various degrees, depending upon the circumstance
- **Auto extended fire**: structure fire that has gone out a window or other opening on one floor and ignited materials above, on another floor or other space (attic, cockloft).
- **Collapse zone**: a relatively poor place to park the engine near a burning structure. Estimated as an area one and a half times the height of the fire building.
- **Deflagration**: An explosion with a propagation front traveling at subsonic speeds, as compared to supersonic detonation.
- **Direct attack**: "Putting the wet stuff on the red stuff." A form of fire attack in which hoses are advanced to the fire inside a structure and hose streams directed at the burning materials.
- **Discharge flow**: The amount of water flowing from a fire hydrant when it is opened; compare to static flow and residual flow.
- **Dispatch**: Refers to person or place designated for handling a call for help by alerting the specific resources necessary.
- **Drills**: training during which an emergency is simulated and the trainees go through the steps of responding as if it were a real emergency.

- **Electrical fire**: A fire in which the primary source of heat is electricity, resulting in combustion of adjacent insulation and other materials; may be hazardous to attempt to extinguish using water
- **EMS**: Emergency Medical Service.
- **Engine pressure**: The pressure in a fire hose measured at the outlet of the pump.
- **Evacuation**: Removal of personnel from a dangerous area, in particular, a HAZMAT incident, burning building, or other emergency. Also refers to act of removing firefighters from a structure in danger of collapsing.
- **Evolution**: Uniform sequence of practiced steps by squad carrying out common tasks such as selection and placement of ladders, stowing hoses in *hose bed*, putting hoses and tools into service in particular patterns; intended to result in predictability during emergencies.
- **Extrication**: removal of a trapped victim such as a vehicle extrication, confined space rescue, or trench rescue; sometimes using hydraulic spreader, Jaws of Life, or other technical equipment
- **Fire escape**: A building structure arranged outside to assist in safe evacuation of occupants during an emergency; may connect horizontally beyond a fire wall or vertically to a roof or (preferably) to the ground, perhaps with a counter-weighted span to deny access to intruders.
- **Firefighter**: People who respond to fire alarms and other emergencies for fire suppression, rescue, and related duties. Formerly called "firemen", but modern term includes women as well.

- **Fire flow**: The amount of water being pumped onto a fire. A critical calculation in light of the axiom that an ordinary fire will not go out unless there is enough heat being removed by enough water.

- **Fire ground**: The operational area at the scene of a fire; area in which *incident commander* is in control. Also used as name of radio frequency to be used by units operating in the fire ground, as in "Responding units switch to fire ground."

- **Firehouse**: Another term for Fire station. Where fire apparatus is stored and where full-time firefighters work.

- **Fire inspector**: A person responsible for issuing permits and enforcing the *fire code*, including any necessary premises inspection, as before allowing (or during) a large indoor gathering.

- **Fire line**: A boundary of a fire scene established for public safety and to identify the area in which firefighters may be working.

- **Fire load** (Btu/sq ft): An estimate of the amount of heat that will be given off during ordinary combustion of all the fuel in a given space; e.g., a bedroom or a lumberyard.

- **Fire Marshal**: Administrative and investigative office for fire prevention and arson investigation.

- **Fire point**: temperature at which materials give off flammable gases that will sustain fire, typically higher than flash point. Temperature at flashover.

- **Fire wall**: Building structure designed to delay horizontal spread of a fire from one area of a building to another; often regulated by fire code and required to have self-closing doors, and fireproof construction.

- **Fire watch**: Fixed or mobile patrols that watch for signs of fire or fire hazards so that any necessary alarm can be quickly raised or preventive steps taken.

- **Flash point**: Lowest temperature at which a material will emit vapor combustible in air mixture. Lower than fire point of same material.

- **Flashover**: simultaneous ignition of combustible materials in a closed space, as when materials simultaneously reach their fire point; may also result in rollover.

- **Forcible entry**: gaining entry to an area using force to disable or bypass security devices, typically using force tools, sometimes using tools specialized for entry (e.g., Halligan, K-tool).

- **Freelancing**: dangerous situation at an incident where an individual carries out tasks alone or without being assigned; violation of personnel accountability procedures.

- **Frontage**: The size of a building facing a street. .

- **HAZMAT**: Hazardous materials, including solids, liquids, or gasses that may cause injury, death, or damage if released or triggered.

- **High-rise building**: Any building taller than three or four stories, depending upon local usage, requiring firefighters to climb stairs or aerial ladders for access to upper floors.

- **Incident Commander**: The officer in charge of all activities at an incident. See Incident Command System.

- **Incident Safety Officer**: The officer in charge of scene safety at an incident. See Incident Command System.

- **Indirect attack**: Method of firefighting in which water is pumped onto materials above or near the fire so that the splash rains onto the fire, often used where a structure is unsafe to enter.

- **Initial attack**: First point of attack on a fire where hose lines or fuel separation are used to prevent further extension of the fire. .

- **Mass casualty**: Any incident that produces a large number of injured persons requiring emergency medical treatment and transportation to a medical facility. The exact number of patients that makes an incident "mass casualty" is defined by departmental procedures and may vary from area to area.

- **Means of egress**: The way out of a building during an emergency; may be by door, window, hallway, or exterior fire escape; local fire codes will often dictate the size. location and type according to the number of occupants and the type of occupancy.

- **Nozzle pressure**: Pressure in a fire hose measured at the nozzle. .

- **Pre-fire, pre-incident planning**: Information collected by fire prevention officers to assist in identifying hazards and the equipment, supplies, personnel, skills, and procedures needed to deal with a potential incident.

- **Pre-planning**: Fire protection strategy involving visits to potentially hazardous occupancies for inspection, follow up analysis and recommendations for actions to be taken in case of specific incidents.

- **"Probie"**: (also rookie) new firefighter on employment probation (a period of time during which his or her skills are improved, honed, tested, and evaluated).

- **Public alarm**: Means for public to report a fire, includes telephone, street-corner pull-boxes, building pull-stations, and manual bells or sirens in rural areas.

- **Pumper company**: Squad or company that mans a *fire engine* (pumper) and carries out duties involving getting water to the fire.

- **Radiant extension**: fire that has transferred ignition heat to adjacent materials across open space. One reason some city fire codes prohibit windows facing each other in adjacent warehouses.

- **Recovery**: Location and removal of deceased victims. Also, the time needed for a firefighter to spend in *rehab* before being considered ready to continue working the incident.

- **Residential sprinkler system**: A sprinkler system arranged for fire suppression in a dwelling.

- **Structural fire**: Fire involving houses, buildings, or other structures. Urban fire departments are primarily geared toward structural firefighting. The terms structural fire and structural firefighting are often used to distinguish them from wildland fire.

- **Salvage, salvage cover**: Heavy-duty tarpaulins folded or rolled for quick deployment to cover personal property subjected to possible water or other damage during firefighting. .

- **Search and rescue (or SAR)**: Entering a fire building or collapse zone for an orderly search for victims and removal of live victims. Becomes "recovery" if victims are not likely to be found alive.

- **Shoulder load**: The amount of hose a single firefighter can pull off a hose wagon or pumper truck and carry toward the fire. .

- **Tailboard**: Portion at rear of fire engine where firefighters could stand and ride (now considered overly dangerous), or step up to access hoses in the hose bed.

- **Universal precautions**: The use of safety barriers (gloves, mask, goggles) to limit an emergency responder's contact with contaminants, especially fluids of injured patients.

- **Working fire**: A fire that is in the process of being suppressed; often a cue for dispatch of additional resources.

Source: East Glenville fire department (2009) glossary of fire fighting terms retrieved from http://www.eastglenvillefd.com/_mgxroot/page_10845.html

2.6 Forms and Types of Ignitable Material

Building materials**:**

1. Interior and exterior finishes
2. Contents and furnishings
3. Stored materials
4. Trash, limit and dust
5. Combustible or flammable gases or liquid and
6. Volatile solids

2.6.1 Factors That Bring Heat and Ignitable Materials Together

1. Misuse of the heat source
2. Mechanical or electrical failure
3. Design, construction, or installation deficiency
4. Error in operating equipment
5. Natural causes
6. Exposure **(**Barry, 1972**)**

2.6.2. Combustible Materials

Combustible materials are materials which catch fire easily. Examples of such materials are

- Timber and
- Plastics

Combustibility is a measure of how easily a substance will set on fire, through fire or combustion. This is an important property to consider when a substance is used for construction or is being stored. It is also important in processes that produce

combustible substances as a by-product. Special precautions are usually required for substances that are easily combustible. These measures may include installation of fire sprinklers or storage remote from possible sources of ignition.

Substances with low combustibility may be selected for construction where the fire risk needs to be reduced. Like apartment buildings, houses, offices and so on. If combustible resources are used there is greater chance of fire accidents and deaths. Fire resistant substances are preferred for building materials and furnishings.

Source: Wikipedia, the free encyclopedia (May 2012) Combustibility retrieved From https://en.wikipedia.org/wiki/

2.6.3 Non Combustible Materials

Non Combustible materials are materials which do not catch fire easily. Examples of such materials are:

- Steel
- Aluminum
- Concrete
- Stone
- Cast Iron and
- Bricks

Non combustible material: A non combustible material is a substance that will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat, in the form in which it is used and under conditions anticipated.

Examples of non-combustible materials include: a. Portland cement concrete, gypsum concrete (normally used in drywall or poured gypsum floor toppings), or magnesite (magnesium oxide)

Concrete having aggregates of sand, gravel, expanded vermiculite, expanded or vesicular slags, diatomaceous silica, perlite, or pumice

2.7 Passive Construction Components

In this Chapter, passive construction components are considered. Identified here are fire barriers, which must positively limit the spread of fire for a stipulated time; and smoke barriers, which must positively prohibit the passage of smoke. Smoke control devices are also identified, such as natural ventilation, pressurization, curtains and reservoir. Fire blocking and draft stops in combustible construction are included. Interior finishes and their effect upon flame spread and smoke generation are discussed and the method by which the designer can choose interior finishes for optimum fire safety of spaces are covered. (Foster,J. S. 1994)A passive component is a module that does not require energy to operate, except for the available alternating current (AC) circuit that it is connected to. A passive module is not capable of power gain and is not a source of energy. A typical passive component would be a chassis, inductor, resistor, transformer, or capacitor.

Source: Techopedia Inc (2016) passive component retrieved from https://www.techopedia.com/definition/735/passive-component

2.7.1 Active Construction Components

Active components for building fire safety are those origins of performance in mechanical, electrical, communications, hydraulic, chemical, or other applied

science processes (Foster, 1994). For our purposes, we have grouped these into two major functional categories:

- Detection, alarm and communications components
- Single initiation and notifications
- Control over protective devices
- Fire and smoke detectors
- Extinguishing Equipment
- Standpoint and hose systems
- Automatic sprinklers and
- Portable extinguishers and other chemical extinguishers.(Foster,1994)

2.8 Fire Detection and Alarm System

Fire detection is necessary for three main purposes:

- To cause the activation of automatic or manual suppression system
- To cause the activation of other active suppression systems such as automatic smoke damper fire doors and escape protection.
- To provide time for occupants to safely evacuate.

A fire detection and alarm system comprises:

- Control panel
- Smoke detectors

- Heat detectors
- Beam detectors
- Flame detectors
- Combustion gas detectors and
- Call points & sounders.

Since time is of essence, fire outbreak detection based on smoke sensing are frequently the most effective since smoke is usually the first detectable indication of a fire in progress **(**James, 1993**).**

A key aspect of fire protection is to identify a developing fire emergency in a timely manner, and to alert the building's occupants and fire emergency organizations. This is the role of fire detection and alarm systems. Depending on the anticipated fire scenario, building and use type, number and type of occupants and criticality of contents and mission, these systems can provide several main functions. First they provide a means to identify a developing fire through either manual or automatic methods and second, they alert building occupants to a fire condition and the need to evacuate. Another common function is the transmission of an alarm notification signal to the fire department or other emergency response organization. They may also shut down electrical, air handling equipment or special process operations, and they may be used to initiate automatic suppression systems

Source: Northeast document conservation center (2016) retrieved from https://www.nedcc.org/free-resources/preservation-leaflets/3.-emergency-management/3.2-an-introduction-to-fire-detection,-alarm,-and-automatic-fire-sprinklers.

Fire detection systems are designed to discover fires early in their development when time will still be available for the safe evacuation of occupants. Early detection also plays a significant role in protecting the safety of emergency response personnel. Property loss can be reduced and downtime for the operation minimized through early detection because control efforts are started while the fire is still small. Most alarm systems provide information to emergency responders on the location of the fire, speeding the process of fire control

Source: occupational health and safety (2016) fire Detection and Alarm retrieved from https://ohsonline.com/Articles/2007/12/Fire-Detection-and-Alarm-Systems-A-Brief-Guide.aspx

2.8.1 Problems Associated With Detectors

Fire detector is not solely to detect on fire but to discriminate reliably that absence and the presence of a time, if a detector is too sensitive it gives a false alarm for a non fire condition. While a less sensitive device will not raise alarm to time. Thus from a practical view point the sensitivity of a detector must be optimized so that it will give an alarm for a reasonably large and potentially dangerous fire (James, 1993).

- Improper placement of detectors or improper selection of detectors (e.g. Putting smoke detectors by locker rooms when heat detectors would be more appropriate)
- Not enough detectors installed (sometimes missing in air handlers)
- Improper programming of panels (the panel might have been properly programmed when first installed, but when the building layout changed, the panel wasn't reprogrammed to adjust to the changes)
- Audibility and intelligibility of voice evacuation system
- Incorrect placement of audible and visual notification devices

- Lack of system maintenance (e.g. dirty detectors, dead batteries)
- Lack of zoning or incorrect zoning
- Lack of electromagnetic door holders (this leads to building occupants propping doors open)

Source:

Gray.R·(January18,2011)http://www.campussafetymagazine.com/article/Most-Common-Fire-Alarm-System-Problems

2.8.2 Inspection of Electrical Systems

When inspecting electrical systems things to look for are:

- Old round-pin power points and round light switches
- Rubble insulated cable
- Fuses which blow repeatedly
- Power points and other outlets which do not work, in a house still has round rim power or round light switches, than it is likely the house needs to be rewired. But new wiring does not guarantee that all is well (Barry,1972)

Common issues inspectors find during testing include non-operational equipment or equipment that does not operate as originally installed, according to such parameters as sound-pressure levels and detector sensitivity.

Other issues commonly encountered include: systems that have not been maintained properly, such as not cleaning detectors in harsh environments; system modifications that are not code-compliant and, as a result, hinder system performance and integrity; and poor system installations and modifications.

A lack of knowledge about the system, improper documentation, and improper component and circuit labeling also can pose problems during testing. Also, accidental discharges of fire-suppression systems, such as clean agents and deluge sprinklers, can occur if the service company is not aware of specific system functions or does not follow proper testing protocol.

The age of a fire-alarm and detection system also can pose problems during testing. Systems that are 15 years old and older might have lived out their performance lives. Testing systems of this age typically uncovers problems that include equipment that no longer functions properly, defective components requiring replacement, and poorly maintained equipment.

Addressing system problems can be as simple as replacing faulty components, repairing wiring and conducting routine maintenance. Using competent, experienced fire-alarm contractors for system installations can reduce future problems resulting from poor installations.

Source: Lanny.*(* January 2010)

http://www.facilitiesnet.com/firesafety/article/Trouble-Spots-for-Fire-Alarm-and-Detection-Systems-Facility-Management-Fire-Safety-Feature--11442Trouble Spots for Fire-Alarm and Detection Systems

2.8.3. When to inspect electrical home systems

- When purchasing a home.
- When a home is 40 years or older.
- When adding an appliance.
- When a home has had a major renovation.

2.8.4. Importance of inspection of Domestic electrical systems

- Ensuring the safe operation of electrical components in your home.
- Identifying common electrical mistakes made by contractors and previous homeowners.
- Recognizing outdated wiring such as aluminum or knob and tube.
- Identifying electrical wiring and components that may have degraded over time.
- Spotting oversized fuses or breakers that could lead to fire.
- Allowing for the correction of fire and safety hazards.
- Helping you save energy and reduce costs.
- Meeting insurance risk assessment inspections requirements.
- Letting you know the electrical in a new home is safe before you purchase it.

Source: international franchise association (2016) retrieved from http://mrelectric.com/electrical-safety-inspectionsWhat is an electrical home inspection?

2.9. Effect of Fire Outbreak

The occurrence of any time accident to a building brings about suffering and affection to the individual workers and the occupants, financial hardships to the families of victims of the fire, occupants building owners and the companies or management. (Ghana National Fire Service, 2013)

Wildfire is a part of nature. It plays a key role in shaping ecosystems by serving as an agent of renewal and change. But fire can be deadly, destroying homes, wildlife

habitat and timber, and polluting the air with emissions harmful to human health. Fire also releases carbon dioxide- a key greenhouse gas—into the atmosphere. Fire's effect on the landscape may be long-lasting. Fire effects are influenced by forest conditions before the fire and management action taken or not taken after the fire.

Source: PacificNorthwestResearchStation (Monday, 14September 2015) Understanding Fire Effects on the Environment, retrieved from http://www.fs.fed.us/pnw/research/fire/fire-effects.shtml

2.9.1 The Objectives of Fire Safety

Fire safety design are defined in order of priority as (Ghana National Fire Service, 2013)

- Life safety
- Property protection
- Continuity of building operations

Building fire safety comprises a "package" which incorporates construction methods, mechanical and electrical devices, management practice and organized human response tailored to reduce the impact of fire upon the occupants, the building, its contents, the attending firefighters and any neighboring property. In the context of building fire safety, fire impact is considered to be any threat to life and property caused by heat or smoke and may include adverse environmental impact from toxic products stored on the premises.

Building fire safety cannot be defined as a "single system", it relies upon a group of "sub systems" to form a complete "package". More often than not, if one of the "sub systems" is removed, the whole "package" will collapse and the occupants within the

building will face an unacceptable risk in the event of outbreak of fire. For simplicity, the "package" can be broken down into nine principle "sub systems", comprising:

- occupant training and education
- means of escape from the building
- ignition potential
- fire load
- compartmentation and structural fire resistance
- firefighting systems
- fire detection, alarm and communication systems
- smoke management systems
- fire brigade response.

Source: South Australian Metropolitan Fire Service (2012) Overview of Building Fire Safety retrievedfromhttp://www.mfs.sa.gov.au/site/community_safety/commercial/building_fire_safety.jsp

2.10 Compartmentation:

Compartmentation is a process of designing barriers into a building that will prevent the spread of a fire. To accomplish this, the barriers need to contain the fire for a sufficient time to enable evacuation of the buildings' occupants and extinguishment of the fire within the compartment. By containing the fire within the compartment, its propagation to other areas is prevented. Barriers thus are known as fire walls, and have rated values based on laboratory tests. (James, 1993)

The division of the building into discrete fire zones offers perhaps the most effective means of limiting fire damage. Designed to contain the fire to within the zone of origin, this approach provides at least some protection for the rest of the building and its occupants even if first aid fire fighting measures are used and fail. It also delays the spread of fire prior to the arrival of the fire brigade.

In the event of a fire within a building protected by compartmentation, the size of the damaged area would depend upon the layout of the fire resisting barriers within the building. Almost every building has its own natural compartment lines which, with a little attention, are capable of providing upward of 30 minutes protection against a fully developed fire, and often provide an hour or more. Fire compartmentation should therefore form an important part of any damage limitation strategy.

Ideally, halls and landings would be separated from staircases to prevent a fire from travelling vertically up the stairwell to all floors. However the creation of new lobbies can have a devastating impact on the character of a fine historic interior, and is often unacceptable. There also need to be practical limitations on the number of compartment lines because an over-compartmented building can become restrictive in its daily use. To be effective, compartmentation does need to be planned and implemented properly. There is no point in upgrading the fire resistance of a door and then not protecting the plywood duct by the side of it which runs through to the floor above, or even through to the adjacent room.

In deciding upon a compartmentation strategy it is important to have full knowledge of the voids that exist within the building: many historic properties do have hidden voids often purely as a result of the method of construction. It has been said, in respect of the Windsor Castle fire, that effective fire fighting could have been

achieved with explosives as much as with water! The fire unfortunately kept breaking out ahead of the fire fighting operation as it exploited unsealed voids.

The most important elements to be upgraded are the doors, floors and walls, penetrations through floors and walls, and cavity barriers in the roof spaces. Some simplified guidance as to how compartmentation should be implemented is given below.

Source: Thameside Fire stopping (2013) Passive Fire Protection compartation retrieved from http://www.thamesidefirestopping.com/services/compartmentation

Compartmentation in structures is the fundamental basis and aim of passive fire protection. The idea is to divide a structure into "fire compartments", which may contain single or multiple rooms, for the purpose of limiting the spread of fire, smoke and flue gasses in order to enable the three goals of fire protection.

The construction of such compartments and all their components is a matter of systems within systems, which use bounding to achieve fire-resistance ratings, all interdependent, forming part of an overall fire safety plan.

Fire compartmentation forms part of the basic fundamentals of a 'fire safe' building. Understanding where these fire compartment lines are, or where they should be located, is critical in maintaining safe escape routes and reducing the spread of hot gases and smoke in the event of a fire.

Specialist knowledge is required to understand the fire strategy of a building and how the occupants might react in an emergency. It is this knowledge, training, and experience, which allow us at Fire Quest to determine where these physical compartment walls, floors, ceilings and doors are where they should be.

Understanding the structure of a building, and how the emergency fire evacuation plan works, is of paramount importance, especially if there is a sleeping risk, or occupants are 'dependant' or 'highly dependent', such as in care homes or hospitals. In these circumstances the evacuation plan of a building will normally require 'Phased Horizontal Evacuation' (PHE) and specifically designed and intact fire compartments are necessary.

The three goals of fire protection are life safety, property protection and continuity of building operation.

Source: Firequestuk (2016) Fire Compartmentation retrieved from http://lgn1410171026.site-fusion.co.uk/fire-compartmentation

2.11 Classification of Fire

CLASS	**MATERIAL TYPE**	**EXTINGUISHER REQUIRED**
Class **A** fires	Wood,cloths,paper, rubber and some plastics, etc.	Water, dry powder extinguisher
Class **B** fires	Petrol, liquids, fats, gasoline, kerosene, paints, thinners and propane	Dry powder ,carbon, foam extinguisher
Class **C** fires	Gas fire, live electrical equipment, switches, panel boxes and power tools	Carbon 2 foam dry powder extinguisher
Class **D** fires	Combustible metals such as magnesium, titanium, potassium, sodium, lead,	Dry powder, foam extinguishers

	and copper.	
Class **K** fires	Are used in commercial kitchens and specifically designed to extinguish grease fires	Composition of carbon 2,dry powder and special agent

Source: Regional Fire Service (Wa), 2013

There are different classes of fire and different types of fire Extinguishers for each class. Using the wrong type can make the fire worse or cause serious injury to you. To select the right type of extinguisher for use with a particular class of fire, you need to understand (a) the different classes of fire (b) the different type of extinguishers and (c) the suitability of fire each type for each class of fire.

Class A: fire involving solid materials, usually of an organic nature, in which combustion normally takes place with the formation of glowing embers (eg.paper, wood, textiles)

Class B: fires involving liquids or liquefiable solids (eg. Petrol, oil, paint)

Class C: fires involving gasses (eg. Hydrogen, propane, butane)

Class D: fires involving metals (eg. Potassium, magnesium, sodium)

Class F: fires involving cooking oil and fats

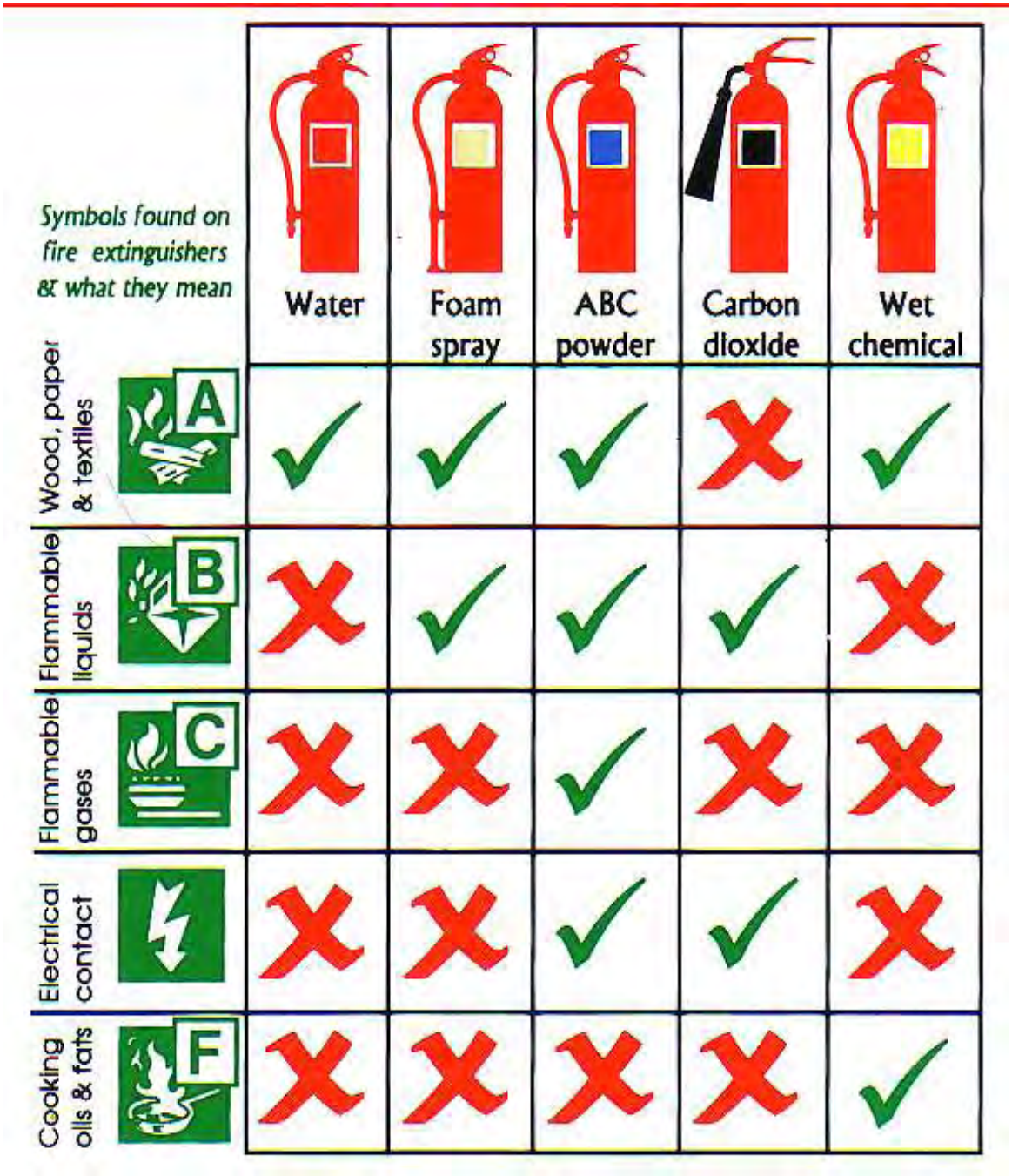
Note: electrical fires (formerly class E) are not included as fires involving electrical hazards can fall into any of the five classes.

Source: firesure (2011) the fire classification system, classes of fire retrieved from http://www.firesure.ie/fire_safety_guidance/fire_extinguishers_and_classes_of_fires.html

2.12 Types of Fire Extinguishers

According to types of fires, different types of fire extinguishers are made. The most commonly used types of fire extinguishers are:

- Soda Acid Extinguisher
- Foam Extinguisher
- Dry-powder type
- Carbon dioxide Extinguisher
- Halon type (Ghana National Fire Service, Wa .2013).



Source: firesure (2011) the fire classification system, classes of fire retrieved from http://www.firesure.ie/fire_safety_guidance/fire_extinguishers_and_classes_of_fires.ht

2.13 How to Use an Extinguisher Properly

A portable fire extinguisher should only be used in early stages of a fire and only when it is safe to do so. If the fire is too large, or it is spreading and threatening to block your path of escape, leave the area immediately. When using the fire extinguisher, use the **PASS** method. This method simply means **PULL, AIM, SQUEEZE and SWEEP.**

1. P=Pull the pin

2. A=Aim the extinguisher at the base of the flames

3. S=Squeeze the trigger while holding the extinguisher upright

4. S=Sweep the extinguisher from side to side, covering the area of the fire with the extinguishing agent

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter details precisely how the research was carried out, the methods used. The objectives of the research was achieved and the problems encountered

3.2 The Study Area

The study was conducted on some selected buildings in the Wa Municipality in Ghana.

3.3 Population of the Study

The research was conducted using domestic buildings in the Wa Municipality in the Upper West Region of Ghana.

3.4 Method of Data Collection

The methods used for collecting data were:

- Questionnaires
- Personal Observations
- Interviews and
- Journals & Internet

3.5 Questionnaire

A set of printed questionnaires were administered to occupants in hundred selected domestic structures in the Wa Municipality with one questionnaire to each household.

3.6 Personal Observation

This was done during the administration of questionnaires and through personal visitation to various occupants of selected domestic structures, and authorities in

charge of fire fighting and prevention. Personal observations were one of the most helpful methods used to gather information for the research.

3.7 Interviews

This was carried out during the distribution of the questionnaires the basic format was purely unofficial whereas a number of people were interviewed. This was done during the normal working hours and weekends in the following institutions and various homes

3.4 Problems Encountered

The researcher encountered some difficulties in obtaining information from land lords and tenants due to their tight schedule. It was very difficult for them making time for the researcher. Also most of the occupants delayed in returning the filled questionnaires and some could not even return the questionnaires at all, others were out of reach due to their tight schedule. Due to these difficulties, out of hundred (100) questionnaires distributed only sixty (60) were returned filled. Representing 60% of the questionnaires sent. Some of the occupants did not take the exercise seriously.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter explains how the data collected were analyzed and how findings were built up logically. These were done in addressing the research questions, patterns, relationships and themes described as findings and are supported by data relevant to the issues discussed.

TABLE 1: RESULTS PRESENTATION

NO	QUESTION	THOSE WHO RESPONDED 'YES'	THOSE WHO RESPONDED 'NO'	THOSE WHO HAD NO IDEA
1	Do you know the Escape Route in case of fire (Question 1)	12	48	0
2	Do you have fire extinguisher in your house (Question 2)	3	57	0
3	If the answer to Question no 2 is 'yes' how many do you have? (Question 3)	all 3 said they had only one		
4	How often do you refill your extinguishers (Question 4)		All 3 said no	

5	What type of extinguisher do you have? (Question 5)			All said they had no idea
6	Do you have smock detectors? (Question 6)		60 said no	-
7	Knowledge of the use of fire extinguishers (Question 8)	39 said yes	21 said no	-
8	Sequence of operating the fire extinguisher (Question 9)	21 had it right	39 had it wrong	-
9	Knowledge of the Regional fire Response number (Question 11)	3 said yes	57said no	-
10	When asked whether they knew the rapid response number. (Question 11)	42 said yes	18 said no	-
11	When asked to quote the rapid response number,(Question 12)	30 had it right	30 had it wrong	-
12	Provision of fire alarm system in the building. (Question 13)	12 said yes	36 said no	12said no idea
13	Accessible layout (Question 14)	33said yes	18 said no	9 had no idea

14	Availability of Fire hydrant (Question 15)	3 said yes	18 said no	39 had no idea
15	How old is your building? (Question 16)	1-10 years =3 11-20years=15 21-30years=42		-
16	Electrical re-wiring(Question 17)	42 said yes	3 said no	33 had no idea
17	maintenance	12 maintain	48 do not maintain	-
18	Socket loading (Question 21)	1-2appliances=12 2-4 appliances=36 4 or more =12		-
19	Causes of fire outbreaks (Question 24)	36 said =electrical 24 said= negligence		-
20	Training in fire prevention(question 25)	12 said yes	48 said no	-

21	Preparedness for training (Question 26)	60 said yes		-
22	Practices on Escape Route		60 said no	-

4.2 Knowledge of Escape Routes (Question 1)

The data showed that 80% of the occupants in the buildings had no knowledge about means of escape route during the onset of fire outbreak whilst 20% had fair or little knowledge. Personal observations, however, revealed that most of the occupants did not even know where to pass or what to do in case of fire outbreak

4.3 Do you have a fire extinguisher in your house? (Question 2)

It showed from the survey that 95% had no fire extinguishers in their houses and 5% proved otherwise. Personal observations, however, revealed that all the 5% that had fire extinguishers were the rich in the community.

4.4 If the answer to Question no 2 is "yes" how many do you have? (Questions 3)

It was revealed from the data that 100% of the occupants that said yes indicated they had only one fire extinguisher.

4.4 How often do you refill your extinguishers (Question 4)

In the data collected it was observed that 100% did not refill their extinguishers at all after the purchase that was the end. Personal interviews: during the research, it was realized that 90% did not know that the extinguishers expire. Whilst the remaining 10% knew about the expiry date but did not see the importance.

4.5. What type of extinguisher do you have? (Question 5)

With this question 100% said they had no idea about the type of extinguisher they had

4.6 Do you have smoke detectors? (Question 6)

The entire occupants said no to this question. None of them had smoke detectors

4.7 The Use of Fire Extinguishers (Question 8)

It was revealed that 65% of the people had knowledge on the use of fire extinguishers only 35% had no idea. Interview of some of the occupants showed that they do not know even the handle of the extinguisher.

4.8 Sequence of Operating the Fire Extinguisher (Question 9)

When asked on the sequence or steps in the operation of the fire extinguisher, only 34% had it right and the rest of the 65% had it wrong. This really indicates that most of the occupants who said they knew how to operate the fire extinguisher did not know the right thing and that only about 35% of them knew the right operating steps

4.9 Regional Fire Response Number (Question 11)

When asked if they knew the regional response number, only 5% responded 'Yes' and 95% responded 'No', According to the interview about less than 5% knew the regional fire response number.

4.10 Rapid Response Number (Question 11)

The collected data revealed that 70% said they knew the rapid response number of the national fire service while 30% said they did not know. Personal interview however revealed that only 40% really knew the real rapid response number.

4.11. Rapid Response Number (Question 12)

According to the data collected **50%** said the rapid response number was **999** while **50%** said it was **192.** Personal interview however revealed that 40**%** said it was **192** and 60% said it was **999**.

4.12 Provision of Fire Alarm System (Question 13)

From the data collected when occupants were asked if there were fire alarm systems provided in their buildings,20% responded yes,60% responded no and 20% said they did not know. From personal observations, it was revealed that no fire alarm systems were provided in all the buildings,

4.13 Accessible Layout (Question 14)

The collected data revealed that 55% of the respondents indicated that there was enough space provided in the building while 30% proved otherwise and 15% had no idea.

Personal observation, however revealed that, accessibility for fire personnel in the event of fire outbreak and traffic congestion combined with lawlessness on the

roads are big problems for the fire tenders and these cause delays in responding quickly to emergency calls in case of fire outbreaks.

4.13 Fire Hydrant (Question 15)

30% of the responses from the data obtained indicated that there is no fire hydrant in some areas but 5% said they had it while 65% also said they had no idea.

4.14 How Old is Your Building (Question 16)

The collected data revealed that 5% of the buildings were between 1-10years old 25% were between 11-20years old while 70% were between 21-30years old.

4.15 Electrical Re-Wiring (question no17)

When asked whether the electrical systems have been re-wired before, 40% said yes, 5% said no, and 55% said they had no idea. It was revealed through personal observations and interviews that about 90% of the electrical wiring are very old and has not been changed for over fifteen to twenty years.

4.16 Condition and Age of Meter

Observation show that most of the meters have not been changed for a very long time and about 20% are not in a good state and were very old. Over fifteen to twenty years old

4.17 Maintenance

The data collected revealed that 70% did not check their electrical layout or wiring, however, 20% did check

4.18 Socket Loading (Question 21)

Data revealed that 20% used 1-2 appliances per socket, 60% loaded 2-4 appliances per a socket whereas 20% loaded more than four appliances per socket. Personal interviews and observations showed that 50% usually connect 1-2 appliances per outlet while 40% connected 2-4 appliances to each socket outlet and 10% connect more than four appliances by the use of extension boards.

4.19 Causes of Fire Outbreaks (Question 24)

The causes of fire outbreak in the opinion of occupants according to the data collected revealed that, 60% felt it was due to electrical faults, and 40% said it was due to negligence. But according to personal interviews and actual data analysis from the municipal fire unit, about 81% of domestic fires are caused by negligence whereas electrical causes are about 19% in the municipality.

4.20 Training in Fire Prevention (Question 25)

According to the data collected, 20% said they have had some sort of training in fire fighting whereas 80% said they have had no training at all from the national fire service.

4.21 Preparedness for Training (Question 26)

According to the data, 100% of those who said they had not undergone any sort of training with the national fire service said they were willing to be trained.

4.21 Practices on Escape Route

When occupants were asked whether they practice on escape routes or how to escape, 100% said they did not practice at all.

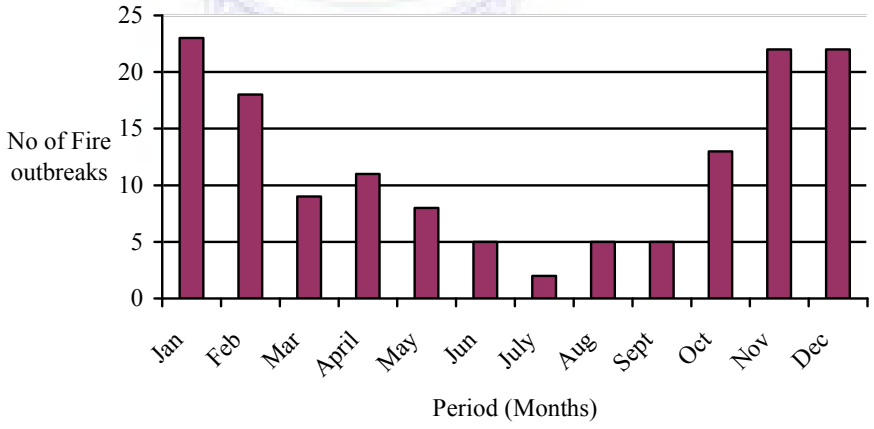


Figure 1: Bar Chart showing Fire Outbreaks in Wa Municipality in 2008

In the year 2008, the highest occurrence of fire outbreaks was in January, twenty three (23) cases occurred in that month and in November and December 22 cases were recorded in each month. February recorded 18, October recorded 13 April recorded 11 March recorded 9 May recorded 8 June, August and September recorded 5 each and July recorded the lowest of 2 cases only, in all a total of 143 cases were recorded in that year.

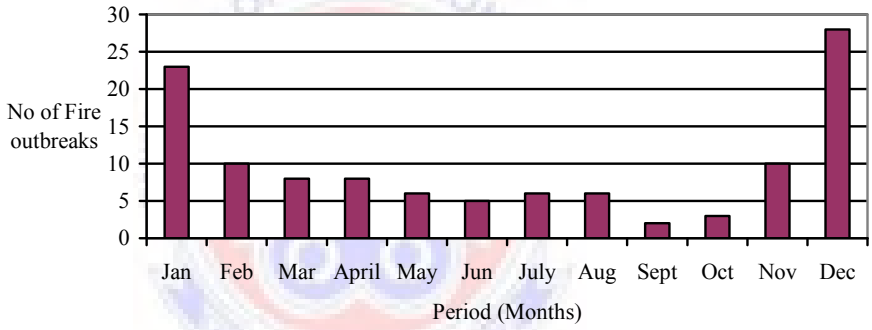


Figure 2: **Bar Chart Showing Fire Outbreaks in the WA Municipality in 2009**

In the year 2009, December recorded the highest of 28 cases followed by January 23 February and November recorded 10 each April and March recorded 8 each, whilst May, July and August recorded 6 each, June recorded 5 October recorded 3 and September recorded the lowest of 2 cases only in 2009.

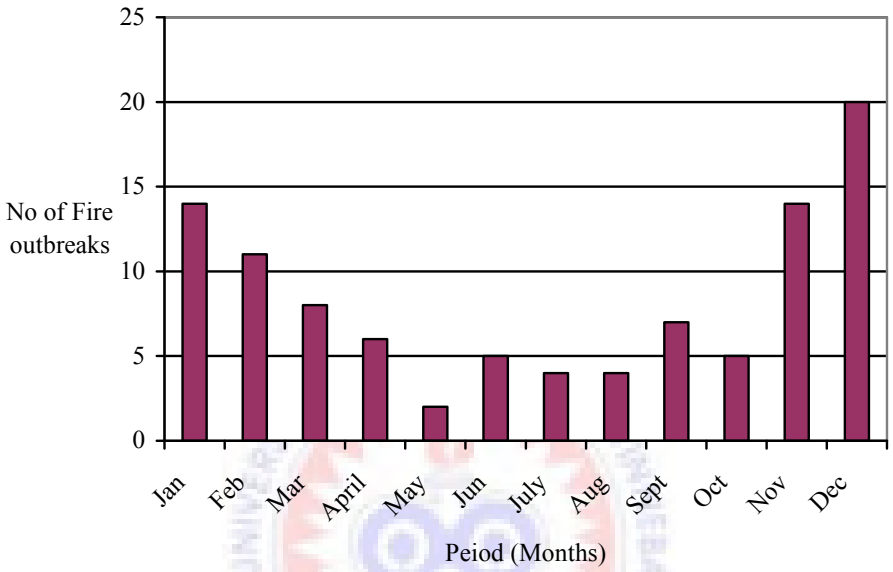


Figure 3: Bar Chart Showing Fire Outbreaks in Wa Municipality in 2010

In 2009, the highest case recorded was 20 which was in December, January and November recorded 14 cases each, February recorded 11 cases, March recorded 8 ,September recorded 7 April recorded 6 , June and October recorded 5 each , July and August also recorded 4 each and the lowest was in May only 2 cases were recorded. the total number recorded for 2010 was 100

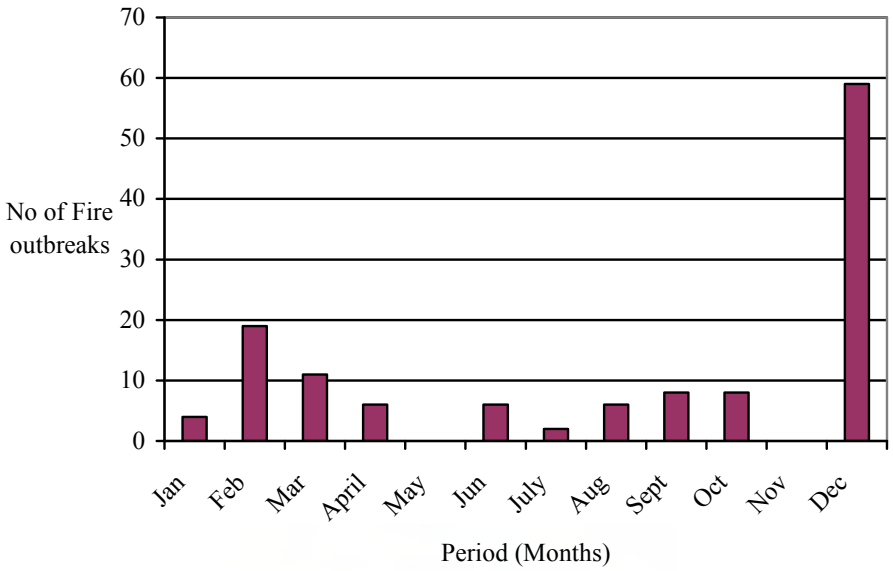


Figure 4: **Bar Chart Showing Fire Outbreaks in the Wa Municipality in 2011**

December recorded the highest of 59 cases, February recorded 19 cases, March recorded 11 cases, September and October recorded 80 each, April, June and August recorded 6 each, followed by June with 2 cases. Interestingly, May and December recorded zero and that gives a total number of 129 cases in 2011.

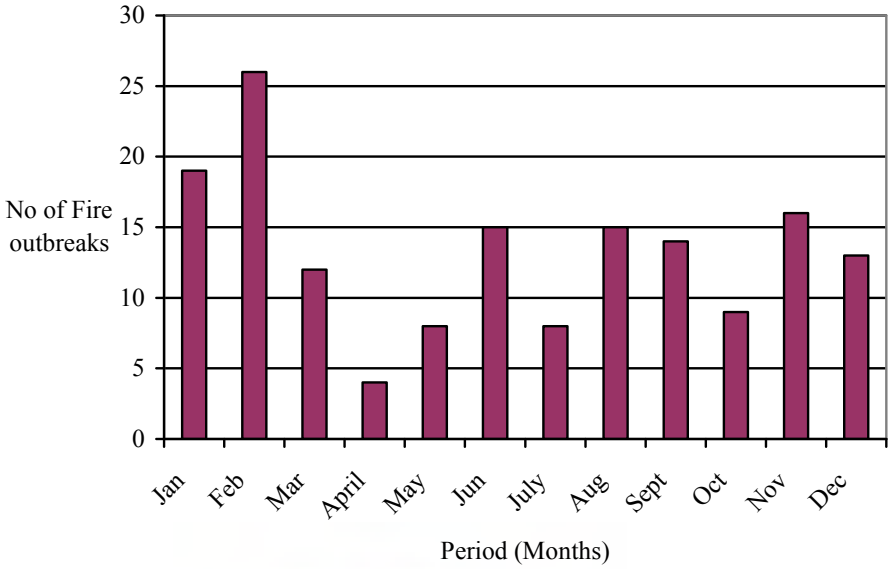


Figure 5: **Bar Chart Showing Fire Outbreaks in the Wa Municipality In 2012**

In the year 2012, February recorded the highest of 26 cases followed by January with 19 cases, November recorded 16, June and August recorded 15 cases each, September recorded 14 cases, December recorded 13cases, March recorded 12 cases, October recorded 9 cases, May and July recorded 8 cases each, and April recorded the lowest of 4 cases.

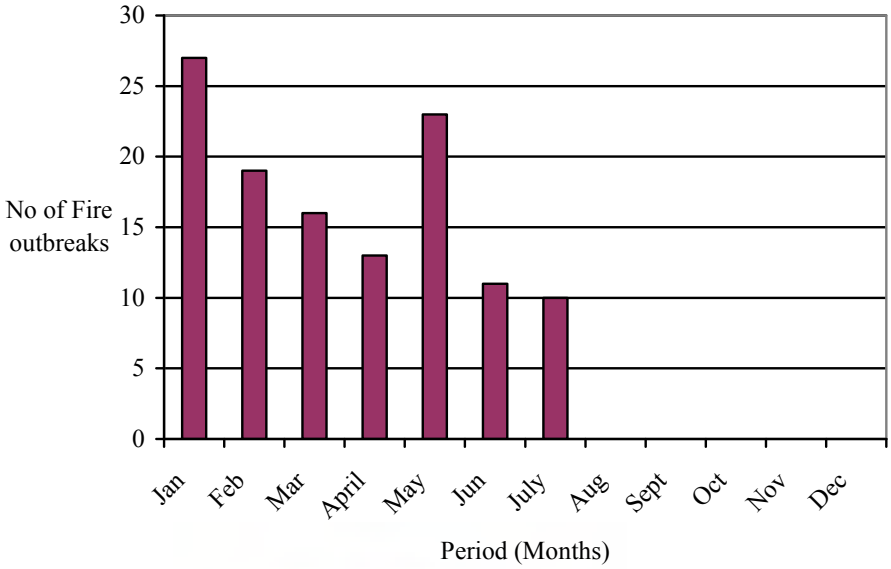


Figure 6: **Bar Chart Showing Fire Outbreaks in the Wa Municipality in 2013**

In 2013 records were taken from January to July. May recorded the highest of 23 cases, followed by January with 22 cases, February followed with 19 cases, March recorded 16 cases, April 13 cases, June recorded 11 cases, and July recorded the lowest of 10 cases.

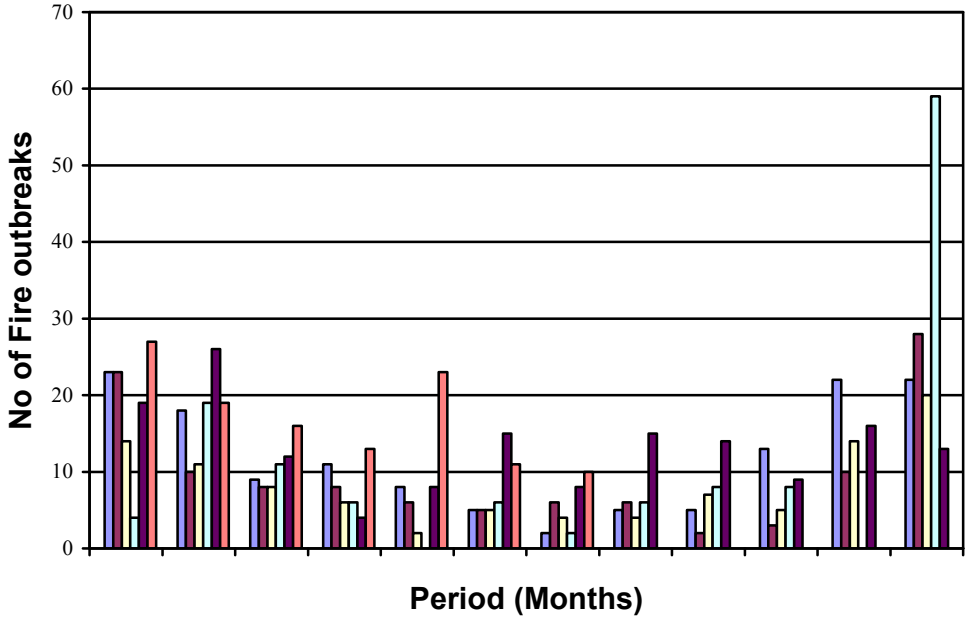


Figure 7 Bar Chart Showing Fire Outbreaks in the Wa Municipality in from 2008 to middle part of 2013

Analyzing the data collected from 2008 to the middle part of 2013, January, February, November and December are the months that recorded the most fire outbreaks. This is due to the fact that these are the months that have less rainfall in the Upper West Region during the harmattan. Therefore the weather conditions are very dry during these months making substances catch fire easily

TABLE 2: RECORD OF FIRE OUTBREAKS IN THE WA MUNICIPALITY WITH REGARDS TO LIVES AND COST OF DAMAGE

YEAR	NUMBER OF FIRE OUTBREAKS	NUMBER OF INJURIES	NUMBER OF DEATHS	COST OF DAMAGE (GH₵)
2008	143	0	0	-
2009	115	0	0	68,038.17
2010	100	0	0	-
2011	129	0	0	-
2012	159	10	2	4,955.00
2013 (From January to July)	119	0	3	-
TOTAL	**765**	**10**	**5**	**72,993.17**

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the findings and draws major conclusions and makes recommendations for further studies

5.2 Summary of Findings

The study investigated the state of fire protection systems within domestic buildings in Wa Municipality of the Upper West Region. Out of one hundred questionnaires distributed, only sixty were returned filled this represents sixty percent of the total questionnaire.

5.3 Conclusions

The study after investigating the state of fire protection systems in multi-storey buildings and after the analysis of the results concludes that:

- Fifty percent of building owners have little or no knowledge in fire protection.
- Ninety percent of Domestic buildings in the municipality have no fire protection sytems.
- Ninety five percent of occupants in domestic buildings in the Municipality have little knowledge in firefighting systems and facilities.
- Existing firefighting systems are not maintained for sustainability.
- The state of fire protection systems and facilities in domestic structures in the Municipality is bad and nothing to write home about.

- Development in the techniques for individuals to protect themselves from exposure to smoke in fire incidents was not known by most of the occupants.

- Some building occupants overload their sockets, or use faulty electrical appliances, which result in fire outbreaks.
- Spaces around buildings are not enough to facilitate firefighting as some buildings are just too close to each other.
- Enough fire hydrants are not in the area.
- Some Buildings do not have fire detection systems.

5.4 Recommendations

Having gone through the research, the following recommendations are made:

- Smoke detector systems should be provided in all rooms by arrows to detect smoke at early stages of fire outbreaks
- Road accessibility in the area should be upgraded to standard by the Municipality.
- Adjoining properties should at least allow 3m spacing around their buildings to allow for enough space around the building to provide good accessibility for fire service personnel to fight fire.
- Faulty electrical appliances should not be used and also building occupants should not overload their sockets
- The width of the exit route should be adequate for evacuation.
- Fire resisting doors should be provided across the protected routes at compartment walls and at predetermined and approved distances and these doors must open in the direction of exit using automatic closing systems
- Building occupants must be trained regularly by the Ghana National Fire Service (GNFS) on firefighting techniques and operating systems
- The fire service must be given adequate logistics to train occupants in buildings regularly on how to prevent and fight fire most especially on the use of fire extinguishers

- Other management institutions of state and telephone companies should make sure that emergency fire numbers are clearly displayed beside their office telephones
- Government should make it a policy that proposed building plans should not be granted approvals without the stamp of the fire officer in charge of the area
- Fire Service Departments peopled with competent, passionate, routinely trained and well-remunerated, motivated personnel. The capabilities of the Fire Service must be stepped up by providing them with requisite state-of-the-art firefighting equipment so they can respond more efficiently during fire outbreaks. Not just the government, corporate bodies and individuals must also invest in safety equipment, measures to forestall fire outbreaks
- Ghanaians must embrace the culture of subscribing to insurance, indemnities that cover their homes, properties, personal effects, businesses etc. This will minimize losses in the event of a fire outbreak or other natural disasters.
- Ghanaians must have the emergency telephone numbers of the fire service and the security agencies on their phones as the numbers will come in handy if and when there is an emergency.
- The relevant Ghanaian authorities must guard against indiscriminately situating petrol stations too close to residential apartments. Stringent safety measures must be put in place if petrol stations are to be sited close to residential apartments.
- Organizations must carry out periodic risk assessment of their premises/facilities, put in place and routinely train staff on comprehensive fire emergency evacuation plans, drills and procedures which must encompass actions to be taken on discovering fire or hearing a fire alarm, identification of key escape routes, places of assembly and roll call amongst others.
- Always ensure you switch off or unplug electrical appliances (at home and in the office) when not in use from the socket because a voltage surge could destroy your gadgets and worse still, an inferno may ensue. If you can, please invest in a good surge protector; they

are not quite expensive these days. Don't patronize low quality, used (second hand) electrical extensions, sockets and wire

- . Guard against overloading electrical sockets/outlets with a lot of appliances at the same time to prevent sparks that may lead to fire.
- Consult an expert (an electrical engineer/electrician) if your electrical appliance(s) malfunctions; fixing it by yourself may be dangerous if it is not well done.
- Never store petrol or pyrotechnics (knockouts) inside your apartments. Given our generator-driven economy/society, there is a tendency for people to store petrol within reach thereby endangering their lives should a fire outbreak occur.
- Ensure you put candles out before going to bed or leaving your abode, better to use a good candle stand. Also desist from throwing matchstick indiscriminately without ensuring the light is completely quenched.
- For smokers, don't dispose spent cigarette butts indiscriminately and avoid smoking while lying on your bed so as not to sleep off while still having a half-lit cigarette on your hand which can easily cause an inferno if it drops on the rug carpet or a mattress.
- Gas cookers and cylinders must be kept in good conditions at all times to avoid sludge or grease from building up and must be routinely checked for leakage.
- Fire retardants, extinguishers must be kept within reach in our homes, offices, cars and everybody, children inclusive should be thought how to operate a fire extinguisher.
- Desist from refueling your generator while it is still running. Better to have enough petrol that will last an estimated duration. It is advisable to stop the generator, refuel it and start it again especially if it is the poorly serviced type that smokes. Similarly, generators should be kept in a place that allows cross-ventilation because of the carbon monoxide fumes. Entire families have been wiped out by carbon monoxide fumes.

- If you reside in an environment with proximity to bushes, make out time to clear or cut down the shrubs, trees within your fence or house. Similarly, folks must desist from indiscriminate bush burning especially during the harmattan season.
- Fire alarms, smoke detectors are affordable these days; ensure you install them in your homes/offices. It is also advisable to have a thunder arrestor on your building; it dispels electrical charges or current away from the building to the earth in the event of a thunder storm.
- In the event of a fire outbreak, road users and residents will do well to give fire fighters easy access to the scene of a fire outbreak. Folks, hoodlums must desist from vandalizing and looting properties during a fire incident.

5.5 Suggestions for Further Research

Based on the analysis and findings, research should be conducted into

- The type and quality of electrical materials used for wiring domestic buildings.
- Building plans and permits from Ghana National Fire Service (G.N.F.S) and Environmental Protection Agency (E.P.A).

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APPENDIX

UEW, COLTEK, DEPARTMENT OF CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, KUMASI CAMPUS

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THE STATE OF FIRE PROTECTION SYSTEMS IN DOMESTIC BUILDINGS IN WA IN GHANA

I am a student of the University of Education doing my post graduate programme, and I am conducting a survey to obtain data that are relevant to the above research topic. Hence, I will greatly appreciate your participation by responding to this questionnaire. I can assure you that any critical information you give will be strictly confidential and academic. Thanks so much for your assistance and using your invaluable time to fill this questionnaire.

==========

Please tick the most relevant to your situation or provide short notes if possible for the following questions.

1) Do you know the escape route in case of a fire outbreak?
   (a)Yes [ ] (b) No [ ]

2) Do you have a fire extinguisher in your house?
   (a)Yes [ ] (b) No [ ]

3) If the answer to Question 2 is 'yes,' how many fire extinguishers do you have?
   (a) 1 [ ] (b) 2 [ ] (c) 3 [ ] (d) other [ ]

4) If the answer is 'yes' to Question 2 how often do you refill it?
   (a) every 6-months [ ] (b) every 1-year [ ] (c)on expiry[ ] (d) never[ ]

5) What type of extinguisher do you have?
   (a) Foam [ ] (b) water [ ] (c) carbon dioxide [ ] (d) dry powder (e) wet chemical (f) no idea [ ]

6) Do you have smoke detectors?
   (a) Yes [ ] (b) No [ ]

7) If you answer to Question 6 is 'Yes', how many do you have.
(a) 1 [ ] (b) 2[ ] (c) 3[ ] (d) other [ ]

8) Do you have any knowledge of the use of the fire extinguishers?
(a)Yes [ ] (b) No [ ]

9) Which of the following sequential order in operating the fire extinguisher is correct? (1)
Aim the extinguisher at the base of the flames
(2) Sweep the extinguisher from side to side covering the area of the fire with extinguishing agent
(3)Squeeze the trigger while holding the extinguisher upright
(4) Pull the pin
(5) Lift the extinguisher
(a) 1,2,3,4,5[ ] (b) 5,4,3,2,1[ ] (c)2,4,5,3,1[ ] (d)5,4,1,3,2[ ]

10) When there is fire outbreak, what will you do?
(a) Raise alarm[ ] (b)Run Away [ ] (c) Call fire Service[ ]

11) Do you know the rapid response number of the Ghana National Fire Service?
(a)Yes [ ] (b)No [ ]

12) If your answer to Question 11 was 'Yes', what is the number?
(a) 999 [ ] (b) 091 [ ] (c) 092 [ ]

13) Is there any fire alarm system provided in your building?
(a) Yes [ ] (b) No [ ]

14) Do you have good road accessibility in this area in case of fire outbreak?
(a)Yes [ ] (b) No[ ]

15) Do you have a fire hydrant in this area?
(a) Yes[ ] (b) No [ ] (c) No idea[ ]

16) How old is your building?
(a) 1-10 years [ ] (b) 11-20 years [ ] (c) 21-30 years [ ]

17) Has the electrical systems been rewired before?
(a) Yes [ ] (b) No [ ] (c) No idea [ ]

18) Do you normally have problems with your electrical systems?
(a)Yes [ ] (b)No [ ]

19) Do you often inspect or check your electrical layout and fittings?
(a)Yes [ ] (b)No [ ]

20) If your answer to Question 19, was "Yes" how often do you check?

(a) 1-2 years [ ] (b) 2-3 years [ ] (c) 3-5years [ ]

21) How many electrical appliances does a socket take in your house?
(a) 1-2[ ] (b) 2-3 [ ] (c)3-4 [ ] (d) more than four[ ]

22) Do you often experience unexpected daily power outages without warnings?
(a)Yes [ ] (b)No [ ]

23) If your answer was 'Yes' to Question 22, state how often?
(a) 1-2 times[ ] (b) 2-3 times[ ] (c)3-4times [ ] (d) more than four[ ]

24) In your own opinion, what do you think is the major cause of fire outbreaks in Ghana? (a) cigarette smoking [ ] (b) gas cooker leakage [ ] (c) negligence[ ] (d) electrical power fluctuation [ ]

25) Has the National Fire Service taken you through any form of firefighting or prevention training?
(a)Yes [ ] (b)No [ ]

26) If you answered 'No' to Question 25, are you prepared to receive training in firefighting and prevention? (a)Yes [ ] (b) No [ ]

27) Do you know how to switch off power in your house?
(a) Yes [ ] (b) No [ ]

28) Do you employ qualified electricians for services?
(a) Yes [ ] (b) No [ ]

29) How do you know?
(a) Request for their certificate [ ]
(b) Pick then from registered companies [ ]
(c) Pick them from the road side [ ]
(d) Do it myself [ ]

30) Do your dependents know how to switch off power in the house?
(a) Yes [ ] (b) No [ ]

Thank you.