Fire Alarm System, Portable Fire Extinguisher and Hose Real System Maintenances for Safety Purpose and Requirements

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***Abstract*- Fire Fighting system or equipments are important elements in building safety measures in order to ensure people's safety when fire occurs. The Fire Alarm Systems deserves the highest level of care and maintenance achievable. However, the highly competitive environment and the expectation of unrealistically low prices by property owners often prevented maintenance contractors from delivering the expected level of service. As a result, the level of care and maintenance delivered may deteriorate to an extent that compromises the integrity of the system, thereby compromising the safety of occupants and property. In this paper, the maintenance procedure for the fire fighting systems that includes the equipments such as Fire Alarm System, Portable Fire Extinguishers and Hose Reel System will be discussed. The example the check list for maintenance purpose and needs to be record as a maintenance record keeping are shown. In the conclusion part, the safety procedures are also discussed as it is one of emergency plan. The procedure includes the Fire Drill and Fire Escapes emergency plan which important as a training plan for the building requirement. Recommendations given in this paper is the maintenance program which to be followed by the all types of building in Malaysia for safety purpose and requirement.**

Keywords: **Fire Alarm System, Portable Fire Extinguishers, Hose Reel System, Maintenance and servicing.**

I. INTRODUCTION

Fire Alarm System, Portable Fire Extinguisher and Hose Reel System are essential equipments that must be installed in every building for safety purpose and requirements. The installation should follow the guidelines and procedures highlighted by the state government which control by Malaysian Fire and Rescue Department. Many cases on fire occurred annually caused by human factors because they don't know how to prevent the fire with the equipments provided in the building.

Another factor that contributes to these cases is the lack of proper maintenance or servicing schedule for the fire fighting equipments. When the fire fighting equipments have been installed, Malaysian Fire and Rescue Department needs to do the testing and approve the systems before they can be used by customers.

In Malaysia, every building must have the Fire Fighting System in order to prevent building from fire. After approval has given by Malaysian Fire and Rescue Department, the fire fighting system needs to be maintained in order to make sure the system is in good condition in term of its functions. The building maintenance committee should have the maintenance schedule for the system and needs to follow the schedule correctly. The maintenance schedule should include of maintenance procedures, services and documentation record. This paper will discuss about the maintenance, procedure and documentation recorded in fire fighting system that implement in Malaysia.

II. FIRE ALARM SYSTEM

Fire Alarm System is designed to detect the unwanted presence of fire by monitoring environmental changes associated with combustion. In general, a fire alarm system is either classified as automatic, manually activated, or both. Automatic fire alarm systems can be used to notify people to evacuate in the event of a fire or other emergency, to summon emergency services, and to prepare the structure and associated systems to control the spread of fire and smoke. The modern fire alarm system is capable of detecting smoke and heat from a small flame, water flow in a sprinkler system or an activated pull station, and reporting this information to on-site personnel via dedicated phone line to any location in the world. Although a seemingly straightforward device from an installation standpoint, fire alarm work can be quite complex, especially when you consider the enormous moral and legal responsibilities involved. There have also been some recent updates to the technology over the last few years worth noting.

1.1 Design Consideration

Typically, a fire alarm system is made up of the following components:

1. Initiating devices, capable of placing the system in the alarm state. These can be photoelectric smoke and heat detectors, ionization smoke detectors, head detectors, in-duct smoke detectors, manually operated pull stations and sprinkler water flow sensors.

2. Indicating appliances, whose purpose is to announce building occupants or at a remote location when the system enters the alarm state, such as horns, strobe lights, chimes, bells, or combination units. They are also available in weatherproof and hazardous location versions.

3. A control panel, containing programming and operating electronics and user interface, is fed by standard branch-circuit wiring and contains replaceable circuit cards — one for each zone. This includes an alphanumeric display, showing the state of the system and providing troubleshooting information, and a touchpad so that onsite personnel can silence an alarm or trouble signal, reset the system following an event, and reprogram if necessary.

4. Sealed batteries similar to emergency light batteries, but listed for fire alarm systems. These are usually 6V batteries wired in series to make up 24VDC for a power-limited system. The batteries can be contained in the control panel or in a separate enclosure. When AC power fails, the batteries take over with no interruption in fire protection. Of course, there is also a charger.

5. Auxiliary devices, including remote annunciators with LEDs showing the state of the system, an alarm silence switch, and visual LED indication of the zone from which a fire alarm is initiated. Electromagnetic door holders (floor- or wall-mounted) are available. In case of alarm, the magnet is de-energized, allowing the door to swing shut. Later, it is reopened manually.

Initiating devices are connected to the control panel by a 2- or 4-wire initiating device circuit. In the case of a power-limited system, 24VDC is applied to two wires going to a string of initiating devices, which are wired in parallel. Both wires are grounded, and they are isolated from EMT or other raceways, which are grounded through the connector at the control panel. Polarity is also critical. This voltage is used to power the solid-state circuitry within each detector. It's also used by the control panel to monitor the state (alarm or no alarm) of the initiating devices and zone wiring.

A typical fire alarm system has numerous initiating devices divided among separate zones — each connected via an initiating device circuit to a central control panel. The control panel performs supervisory functions over the initiating devices, indicating appliances, all associated field wiring, telephone ties, and its own internal wiring and circuit cards.

1.2 Fire Alarm Control Panel (FACP)

A Fire Alarm Control Panel (FACP) is an electric panel that is the controlling component of a fire alarm system. The panel receives information from environmental sensors designed to detect changes associated with fire, monitors their operational integrity and provides for automatic control of equipment, and transmission of information necessary to prepare the facility for fire based on a predetermined sequence. The panel may also supply electrical energy to operate any associated sensor, control, transmitter, or relay. There are four basic types of panels: coded panels, conventional panels, addressable panels, and multiplex systems. A fire alarm control panel is required under the building code for a majority of new commercial building construction in most countries.

1.3 Conventional Panel

Conventional panels have been around ever since electronics became small enough to make them viable. They are no longer used frequently in large buildings, but are still used on smaller sites such as small schools, stores, restaurants, and apartments.

A conventional system employs one or more initiating circuits, connected to sensors (initiating devices) wired in parallel. These sensors are devised to decrease the circuits' resistance when the environmental influence on any sensor exceeds a predetermined threshold. In a conventional system the information density is limited to the number of such circuits used. A small map of the building is often placed near the main entrance with the defined zones drawn up, and LEDs indicating whether a particular circuit/zone has been activated. Another common method is to have the different zones listed in a column, with an LED to the left of each zone name.

1.4 Addressable panels

Addressable panels are usually much more advanced than their conventional counterparts, with a higher degree of programming flexibility and single point detection. Addressable fire alarm panels were introduced by many manufacturers during the microcontroller boom in the mid 1980s.

1.4.1 Signaling line circuit loops

Panels usually have a number of signaling line circuit loops - usually referred to as loops or SLC loops - ranging between one and thirty. Depending on the protocol used, a

loop can monitor and control several hundred devices. Some protocols permit any mix of detectors and input/output modules, while other protocols have 50% of channel capacity restricted to detectors/sensors and 1/2 restricted to input/output modules. Each SLC polls the devices connected, which can number from a few devices to several hundred, depending on the manufacturer. Large systems may have multiple SLCs, and SLCs are further divided into sub-groups through the use of fault-isolation modules. Common addressable input (initiating) devices include:

1. Smoke detectors.
2. Manual call points or manual pull stations.
3. Notification appliances.
4. Responders.
5. Fire sprinkler system inputs.
6. Switches (Flow control, Pressure, Isolate, and Standard switches)

1.5 Operational Issues

A fire alarm system operates in one of three (or more) states: normal, alarm, and trouble. The state is reported at all times on the alphanumeric display. If the system goes into alarm, the indicating appliances throughout the building go off. These could be very loud horns for some occupancies, or softer chimes in others, such as a nursing home.

The control panel monitors the initiating device circuits at all times for shorts and open wiring by means of the applied DC voltage. The initiating devices are normally open. In the event of a fire they become conductive at close to zero ohms. How, then, is it possible for the control panel to differentiate between a non-alarm state and an open wiring fault? This is accomplished by means of an end-of-line resistor.

A 4.7 kilo ohm (typically) resistor is placed across the line after the final device. When this resistance is seen by the control panel, normal status is maintained. If the resistance increases, it means that an open has developed, and the panel goes into the trouble state. A buzzer sounds to alert maintenance personnel but the much louder horns throughout the building do not go off. The alphanumeric display will read something like “Open Circuit in Zone Three.” The trouble alert can be silenced by pressing a touchpad location under the trouble alert LED.

The control panel also monitors the functionality of its own wiring and zone cards, and trouble is reported in the display.

A low-level voltage is applied to the indicating appliance circuits when the system is normal. This voltage is not sufficient to set off the horns, but it is monitored as part of the control panel's supervisory function. If current ceases to flow, the trouble alert buzzer sounds, and the display indicates the presence of an open circuit.

Several troubleshooting techniques are appropriate when the system enters the trouble state. Initially, you can unhook a zone in the control panel (after disabling the system) and place an end-of-line resistor across the output terminals. This will simulate a zone in place and the actual field wiring (including devices) can be worked on while the rest of the system is operational. Another approach is to break the zone at the middle of the run and insert an end-of-line resistor. Using the “half-splitting” troubleshooting method, as discussed in “Maintenance Facts” on page 16 of the November issue, you can easily pinpoint a fault — either short or open.[1]

Another capability of the fire alarm system is to call out in case of alarm. Two dedicated phone lines are connected, and the system performs test calls periodically in accordance with programmed instructions. If either phone line won't connect, the system goes into the trouble state, so repairs can be made.

The essence of a fire alarm system, as opposed to individual smoke detectors, even if they are wired to indicate in concert, is that it is supervised from a central location. The whole notion of supervision is critical. It does not mean that a person sits at the console and watches it at all times. What it means is that a supervisory voltage is applied to all circuitry, and current flow is monitored electronically to verify that equipment and wiring are intact.

If the system goes into alarm and won't silence due to touchpad malfunction, for example, it can be disarmed after the zone is checked for fire by cutting off the power. First, unhook one side of the battery array, and then unhook the black-white-green incoming power connector. If a fire alarm system is disabled, maintenance and security personnel should initiate fire patrols throughout the building. The telephone monitoring agency should be informed, and the insurance company contacted to verify that coverage is not voided.

1.6 Fire Alarm Maintenance

When performing periodic maintenance on the modern fire alarm system, it will be helpful to have the following bellows:

1. The manufacturer’s installation and user instructions for the system control panel, smoke or flame detectors and other specialized components.
2. The “as built” drawings of the system which should include location of all devices, wiring methods, and sequence connections between devices and control equipment.
3. Any records of tests previously performed as well as the record from test at system start up to allow a comparison of the electrical measurements being taken with those recently observed. Such comparisons

can be a valuable aid for rapid trouble shooting. Additionally, future faults may be prevented by finding the source of a difference in an initiating device circuit resistance, voltage, or current at control unit terminals and resistance to ground.

1.6.1 Control Units

1.6.1.1 Printed Circuit Board Assemblies of Modules

Most modern control units do not requires periodic adjustment or field repair other than replacement of a module, printed circuit board assembly or adjustment of battery charging voltage. When the control panel uses printed circuit boards, care should be taken to clean off excessive dust. The boards should be maintained clean and dry to ensure proper operation.

1.6.1.2 Relay Maintenance

The maintenance and adjustment of relays should be performed only at the manufacturer's plant or authorized service facility, or by an organization having the necessary technical experience, component and equipment.

1.6.1.3 Battery Charger Maintenance

Low battery voltage is generally an indication that the battery charger or battery needs maintenance. Flot-charged and trickle-charged batteries are normally kept in a fully charged condition at all times except when the battery provides power for the fire alarm system during alternating current power failures.

1.6.2 Incandescent Lamp Maintenance

1.6.2.1 Trouble Lamps or Lamps in Annunciators

The life of lamps will be extended when they are illuminated only occasionally and then only for a brief period of time. Lamp life can be shortened if subjected to vibration from nearby equipment. When lamps are used to illuminate a colored bulls-eye lens or a translucent back-lighted panel, the life of the lamp can be extended by using one with a voltage rating higher than the purpose, e.g. 28v or 32v lamps used on 24v circuits.

1.6.2.2 Fuses

Fuse maintenance consists of checking the fuse holders to make sure that good contact is made with the connectors on each end of the fuse and that they are not corroded. Hot fuse usually indicate either poor contact or over-loaded fuses, or both. A supply of fuses of each ampere size and type should be on hand so that the equipment will not remain out of service due to blown fuse.

1.6.2.3 Circuit Breakers

Magnetic and thermal circuit breakers require very little maintenance. However, they should be kept free of dust.

1.6.3 Battery Maintenance

Batteries should be located in vented clean dry place, preferably on shelves or racks above the floor level, or in cabinets. The electrolyte level of unsealed storage batteries should be checked regularly. If the electrolyte level is low, distilled water should be added to bring the level up to normal position. Most tap water has sufficient metal salts or chemical to appreciably reduce battery life. Therefore, tap water should not be used instead of distilled water in the regular maintenance of the electrolyte level. The terminals between cells should be free from corrosion which covered with an inert acid lubricant such as white petroleum jelly, to retard future corrosion. The instruction booklet furnished with the battery should be followed carefully, and, where recommended, an equalizing charger should be given at the periods recommended.

1.6.4 Manual Break Glass Boxes

Maintenance on manual fire alarm break glass boxes, with or without the presignal feature, should include periodic operation tests, replacement of broken "break glass" windows or breakable elements, and checking terminal connections for loose or corroded connections. In supervised fire alarm systems, a broken connection should sound a trouble signal.

1.6.5 Automatic Heat Detectors

1.6.5.1 Fixed Temperature Detectors

Fixed temperature type automatic heat detectors which use fusible elements require little maintenance. This is true for most types of spot head detectors. Loose or corroded terminal connections are, however, possible. Automatic heat detectors should not be painted. After 15^{th} years, each 5^{th} year remove at least two non-restorable detectors out of every hundred and

return them to a testing. After low melting-temperature detectors are tested, they should be discarded and replaced with new detectors. Since the test occurs after an initial 15th year not test period and only 2% of the installed detectors are tested every 5th year after that, this is an economical way to establish the reliability of installed detectors. Fixed temperature detectors of the restorable bimetallic type (slow make or snap action) can be tested while installed on the ceiling and connected to the control unit. A heat lamp (or hair dryer) held within an inch of the detector should cause it to operate. When the lamp is moved away from the detector, the bimetal will cool and the detector contacts will reopen and again be ready for use in detecting the heat of fire.

1.6.5.2 Rate of Rise Detectors

Spot-type, combination rate-of-rise and fixed-temperature detector are in common use. Rate-of-rise detectors can be tested with a heat lamp or hair dryer. When testing combination fixed temperature and rate-of-rise detector with a fusible-element, fixed-temperature feature, the lamp or hair dryer should be removed quickly after operation of the detector to prevent melting of the fusible element.

1.6.6 Smoke Detectors

Smoke detectors require periodic maintenance. All smoke detectors should be physically tested functionally at least semi-annually. Calibration test should be conducted after one year and then on alternate years there after in sensitivity is not changing. Smoke detectors are sensitive electronic devices. The specific detector manufacturer's literature should be followed in performing any lest or maintenance procedure. Failure to follow the manufacturer's instructions could damage the detector permanently.

1.6.7 Alarm Bells

Director current vibrating bells have contacts which alternately energize and de-energize their coils thereby causing a striker to contact a steel gong shell and produce vibrating bell sounds. Maintenance of contacts and gap spacing should be adjusted to the specification of the bell manufacturer. The distance between the gong striker and the steel gong shell require infrequent attention. Normally the bell movement is fastened to the base by two or four screws in elongated holes thereby permitting the striker to be adjusted closer or further away from the gong shell.

Altering current vibrating bells usually have on contacts. They are, however, designed to operate at 60 instead of 120 beats a second by using a permanent magnet or rectifier to cut off one side of the sine wave. This reduced rate provides a cleaner bell sound.

1.6.8 Fire Alarm System Servicing and Maintenance Check List

TABLE 1.1
EXAMPLE OF FIRE ALARM CHECK LIST

Bil	Item	Good Condition	Not Good Condition	Remark
1.	AC power supply unit			
2.	DC rectification unit			
3.	AC automatic change-over to DC unit			
4.	Battery electrolyte level			
5.	Zone rotary switch for alarm, fault and isolate			
6.	Bulb Indicators			
7.	Circuitry of the alarm bell line			
8.	Lift sensing signal			
9.	Pressurization fan or smoke extract fan signal			
10.	AHU tripping mechanisms			
11.	Fire Brigade connection			
12.	Intermittent/continuous ringing mode of alarm bell			
13.	Manual break glass operation			
14.	Thermo/smoke detectors operation			
15.	Sprinkler flow switch			
16.	Emergency evacuation switch			
17.	Bell, buzzers isolate switches			
18.	Monitoring signal indicator :			
	a. Jockey pump run/trip b. Duty electrical pump run/trip c. Standby diesel/pump run/trip d. Power supply to pump starter panel phase failure e. Diesel engine low oil pressure f. Fixed halon system g. Fixed CO2 system h. Water tank low level			
19.	Others			

III. PORTABLE FIRE EXTINGUISHER

Portable Fire Extinguisher are important to fire prevention as most fire start from small and can be effectively extinguished by the used of suitable portable fire extinguisher. Fire extinguishers are designed to operate easily by any one who follows simple instructions labeled on all extinguishers. All new commercial buildings,

schools, shops, and factories, are require to be provided with fire extinguishers. The common types of fire extinguishers are:

1. Water/CO2 pressurized Fire Extinguisher
2. Chemical/Mechanical Form type
3. Dry Power, BC & ABC type
4. BCF – BromoCholorodiFluoromethane
5. CO2 – Carbon dioxide type

However, the local fire authority has in general, standardize on recommendation for the use of the use of ABC Dry Powder, BCF and CO2 types Fire Extinguishers. Fire Extinguisher is recommended based on the followings:

1. 2 units per building/floor.
2. Maximum traveling distance to fire extinguisher – 50 ft to 75 ft.
3. 1 unit to be provided for special hazard area.

Locations of Fire Extinguishers are to be based on the following guide lines:

1. Fire Extinguisher shall be conspicuously located where they will be readily accessible and immediately available in the event of fire. Preferably they shall be located along normal paths of travel, including exits from an area.

2. Fire Extinguisher shall not be obstructed or obscured from view. Exception: In large rooms, and in certain locations where visual obstruction cannot be completely avoided, means shall be provided to indicate the location.

3. Fire Extinguisher shall be installed on the hangers or in the brackets supplied, mounted in cabinets, or set on shelves unless the extinguishers are of the wheeled type.

4. Fire Extinguishers installed under conditions where they are subject to dislodgement shall be installed in brackets specifically designed to cope with this problem. Subject to physical damage, shall be protected from impact.

5. Fire Extinguisher mounted in cabinets or wall recesses or set on shelves shall be placed in a manner such that the extinguisher operating instructions face outward. The location of such extinguishers shall be marked conspicuously.

3.1 Fire Codes – N.F.P.A

Selection by Hazards

1. Fire Extinguishers shall be selected for the specific class or classes of hazard to be protected in accordance with the following subdivisions.

2. Fire Extinguishers for protecting Class A hazards shall be selected from the following: water, soda-acid, form, aqueous film forming foam (AFFF), loaded stream, multipurpose dry chemical, and bromochloridifluoromethane (Halon 1211).

3. Fire Extinguishers for protection of Class B hazards shall be selected from the following: bromochloridifluoromethane (Halon 1301), bromochloridifluoromethane (Halon 1211), carbon dioxide, dry chemical types, foam and aqueous film forming foam (AFFF).

4. Fire Extinguishers for protection of Class C hazards shall be selected from the following: bromochloridifluoromethane (Halon 1301), bromochloridifluoromethane (Halon 1211), carbon dioxide, dry chemical types.

5. Fire extinguishers and extinguishing agents for the protection of Class D hazard shall be of types approved for use on the specific combustible metal harzard.

2.1.1 Distribution of Extinguisher

General requirements. [1]

1. The minimum number of Fire Extinguishers needed to protect a property shall be determined as outlined below. Frequently, additional extinguishers may be installed to provide more suitable protection. Extinguishers having rating less than specified in Table 3.1 may be installed

provided they are not used in fulfilling the minimum protective requirements.

2. Fire Extinguishers shall be provided for the protection of both the building structure, if combustible, and the occupancy hazards contained therein.

3. Required building protection shall be provided by fire extinguishers suitable for Class A fire.

4. Occupancy hazard protection shall be provided by fire extinguishers suitable for such as Class A, B, C or D fire potentials as may be present:

   i. Class A fire : solid matters forming glowing reside eg. Wood, paper, textile, cloth, rubber, plastic etc.

   ii. Class B fire : liquid combustible matters eg. (flammable liquid) petrol, bonze, waxes, oil-base paints, lacquer and flammable gas etc.

   iii. Class C fire : electrical plant or equipment fire and combustible gas such as hydrogen, methane, LPG, LNG, etc.

   iv. Class D fire : combustible metal eg. electron, magnesium, aluminium powder etc.

5. Combustible building having occupancy hazard subject to Class B, and/or Class C fires shall have a standard complement of Class A fire extinguishers for building protection, plus additional Class B and/or Class C extinguishers. Where fire extinguishers having more than one letter classification (such as 2-A : 20-B-C), they may be considered to satisfy the requirements of each letter class.

6. Rooms or areas shall be classified generally as light (low) hazard, ordinary (moderated) hazard, or extra (high) hazard. Limited areas of grater or lesser hazard shall be protected as required.

TABLE 3.1:
CLASSIFICATION OF FIRE EXTINGUISHER[1]

	Light (low) Hazard Occupancy	Ordinary (moderate) Hazard Occupancy	Extra (high) Hazard Occupancy
Minimum extinguisher rating.	1A	2A	2A
Maximum floor area per unit of A.	3000 sq ft	1500 sq ft	1000 sq ft
Maximum floor area per extinguisher.	11250 sq ft	11250 sq ft	11250 sq ft
Maximum travel distance to extinguisher.	75 ft	75 ft	75 ft

* 11250 sq ft is considered a practical limit.

1 ft = 0.305 m

1 sq ft = 0.0929 m^2

Note:

Certain smaller extinguishers which are charged with multipurpose dry chemical or Halon 1211 are rated on Class B and Class C fires but have insufficient effectiveness to earn the minimum 1-A rating even though they have value in extinguishing smaller Class A fires. They shall not be used to meet requirement such as table 2.1.

Where the floor area of a building is less than that specified in Table 2.1 at least one extinguisher of the minimum size recommended shall be provided.

The protection requirements may be fulfilled with extinguishers of higher rating provided the travel distance to such larger extinguishers shall not exceed 75 ft.

TABLE 3.2:
RECOMMENDED APPLICATION FOR DIFFERENCE TYPES OF FIRE EXTINGUISHERS.[1]

Bil.	Extinguisher Types	Applications
1.	Water Extinguishers	For wood, paper, textile and similar Class A fires.
2.	Form Extinguishers	For liquid fires.
3.	Powder (std) Extinguishers	For liquid, electrical equipment fires and, if no explosion risk gaseous fires.
4.	Powder (general purpose) Extinguishers	For all fires except metal fires and gaseous fires having an explosion risk.
5.	Powder (metal) Extinguishers	For metal fires.
6.	Carbon Dioxide Extinguishers	For liquid, electrical equipment fires and if no explosion risk gaseous fires.
7.	Halon Extinguishers	For liquid, electrical equipment fires and if no explosion risk gaseous fires.

TABLE 3.3
TYPES OF PORTABLE FIRE EXTINGUISHERS SHALL BE IDENTIFIED BY A BODY COLOUR.[1]

Bil	Type of Extinguishers	Malaysia	UK	Australia
1.	Water CO2	Red	Red	Red
2.	Water stored pressure	Red	Red	Red
3.	Foam, Chemical	Pale Cream	Pale Cream	Blue
4.	Form Gas container	Pale Cream	Pale Cream	Blue
5.	Foam stored pressure	Pale Cream	Pale cream	Blue
6.	Dry Powder	Blue	Blue	Red & White Band
7.	Carbon Dioxide	Blue	Blue	Black
8.	Halogenated hydro-carbon	Golden or Yellow	Green	Yellow

3.2 Portable Fire Extinguisher Maintenance

The purpose of a well-planned and well executed maintenance program is to afford maximum probability that an extinguisher:

- Will operate properly between the time intervals established for maintenance examinations in the environment to which it is exposed.

- Will not constitute a potential hazard to persons in its vicinity or to operators or recharges of extinguishers.

- Persons responsible for performing maintenance operations come from three major groups:

i. Trained industrial safety or maintenance personal.

ii. Extinguishers service agencies.

iii. Individual owners (e.g. self-employed, home owner, etc).

3.2.1 Frequency

Maintenance should be conducted at regular intervals, not more than one year apart, or after any of the following acts or conditions:

i. when found necessary by inspection.

ii. when the extinguisher is user or otherwise emptied.

iii. when there evidence of tampering.

iv. when there is mechanical injury.

v. when it has been exposed to any abnormal temperatures, corrosive atmospheres, or materials.

vi. when it otherwise impaired as evidence by leaking etc.

3.3 Portable Fire Extinguisher Maintenance Inspection

3.3.1 Frequency

The frequency of extinguisher inspections should be based on the need of the area in which the extinguishers are located. Extinguishers should be inspected on a monthly basis, or more frequently if any or all of the following exist:

i) High frequency of fires in the past.
ii) Severe hazards.
iii) Susceptibility to tampering, vandalism, or malicious mischief.
iv) Possibility of, or experience with, theft of extinguisher.
v) Location that make extinguishers susceptible to mechanical injury.
vi) Possibility of visible or physical obstruction.
vii) Exposure to abnormal temperature or corrosive atmospheres.
viii) Characteristics of extinguishers such as susceptibility to leakage.

3.3.2 Procedure

The inspection procedure should determine that:

i) The extinguisher is in its designated place.
ii) Access to or visibility of the extinguisher is not obstructed.
iii) Any seals or tamper indicators are not broken.
iv) The extinguisher has not been physically damaged.
v) The extinguisher does not have other obvious defects (clogged nozzle, corrosion, leakage, damaged hose, etc).
vi) The maintenance record tag is up-to-date.

Accessibility

The sooner a fire extinguisher can be used on a fire, the better chances for extinguishment. An inspection should include a check that the extinguisher is accessible and that it is visible or its location clearly marked.

3.3.4 Seals and Tamper Indicators

Tampering or extinguisher operation is usually indicated by broken seals or tamper indicators. These may consist of wire and lead seals, plastic indicators, paper strips, and the like, that indicate operation of the extinguisher or its movement from its hanger, bracket, or wall cabinet.

Foam, soda acid, water pump tanks, and some cartridge operated water extinguishers do not have seals or tamper indicators. They should be 'hefted' (lifted slightly) to determine if they are full.

3.3.5 Damage

Extinguishers may be damaged in many ways. Common causes of damage are vehicles or materials striking the extinguisher or dropping of the extinguisher. Any physical damage to the extinguisher shell, hose, valve, cap, gauge, or other external parts should be noted while inspecting.

3.3.6 Impairment

It is advisable to check nozzle for obstructions. Corrosion and insects are common causes of nozzle clogging. Extinguisher should be checked for obvious signs of corrosion. Gauges exposed to view should be observed to see that the pointer indicates pressure in the operable range. It is advisable to tap the gauge gently to secure a movement of the gauge pointer as a check that the pointer is not stuck.

Records

Personal charged with the inspection of extinguishers should keep records. It is desirable to provide a durable inspection tag, attached to the extinguisher, to record that an inspection has been made.

Portable Fire Extinguisher Maintenance Procedure

The first step in maintenance is a thorough examination to determine the condition of the three basic elements of a fire extinguisher. These three basic elements are:

i) Mechanical parts (containers or pressure vessels and other components).
ii) Extinguisher material (amount and condition)
iii) Expelling means (amount and any leakage of gas, or condition of pump)

This examination will reveal the need for any necessary repair, recharging, or replacement. It is recommended that extinguishers which have expellant gases, under pressure be tested for leakage following any recharge or when there is indication that the extinguisher has been used.

3.4.1 Check List for Maintenance Examination

This section is organized into two parts. First is arranged by mechanical parts (components and containers) common to most extinguishers. The second part is arranged by extinguishing material and expelling means and involves a description of the problems peculiar to each.

TABLE 3.4
EXAMPLE OF CHECK LIST FOR MECHANICAL PARTS.

EXTINGUISHER PART, CHECK POINTS AND CORRECTIVE ACTION						
Bil.	**Item**	**Corrective Action**	**Remarks**			
			Date	**G**	**NG**	**Comment**
1.	**Shell**					
a.	Hydrostatic test data or date of manufacture	Retest if needed				
b.	Corrosion	Hydrotest and refinish or discard				
c.	Mechanical damage (denting/abrasion)	Hydrotest and refinish or discard				
d.	Paint condition	Refinish				
e.	Presence of repairs (welding, soldering, brazing, etc)	Discard or consult manufacturer				
f.	Damaged threads (corroded, cross threaded, or worn)	Discard or consult manufacturer				
g.	Broken hanger attachment, carrying handle lug	Discard or consult manufacturer				
h.	Sealing surface damage (nicks or corrosion)	Clean, repair and leak test or discard				
2.	**Nozzle or Horn**					
a.	Deformed, damaged or cracked	To Replace				
b.	Blocked openings	To Clean				
c.	Damaged threads (corroded, cross threaded or worn)	To Replace				
d.	Aged (brittle)	To Replace				
3.	**Hose Assembly**					
a.	Damaged (cut, cracked or worn)	To Replace				
b.	Damaged couplings or swivel joint (cracked or corroded)	To Replace				
c.	Damaged threads (corroded, cross threaded, or worn)	To Replace				
4.	**Restraining or Locking Device**					
a.	Damaged (bent, corroded, or binding)	To repair and lubricate or replace				
b.	Missing	To replace				
5.	**Gauge or Pressure-Indicating Device**					
a.	Immovable, jammed, or missing pointer (tap to check)	To depressurize and replace gauge				
b.	Missing, deformed, or broken crystal	Depressurize and replace gauge				
c.	Corrosion	Depressurize and check calibration, clean and refinish or replace gauge				
d.	Dented case or crystal retainer	Depressurize and check calibration or replace gauge				
Check by :		Approve by :				
Date :		Date :				
Signature:		Signature :				

IV. HOSE REEL SYSTEM

A Hose reel System consists of Hose reels (30m) fixed on specific locations of all floors connected to a Fire Pump Set. This System is a pressurized one with a sole purpose of fighting any fire that might occur until the Fire & Rescue Services arrive. A Fire pump set, complete with In and Out galvanized steel pipe work and expansion vessel will be provided for the Hose reel System.[1]

Two automatic electric driven pumps and diesel driven pump shall be provided to feed the hose reel system, one of the electric driven pump shall be as duty pump, and the second electric driven pump shall act as a booster pump where the water pressure in hose reel mains needs to be boosted. The diesel driven pump (standby pump) shall be so arranged that it will operate automatically on a failure for any reason of the electric driven pumps. All pumps shall be capable of being started and stopped manually. An audible and visual alarm shall be provided. Voltage supply shall be 415-480v / Three Phase/50Hz.[1]

Both electric and diesel driven pumps shall be sited in fire-protected positions and the electrical supply to them shall be an exclusive circuit with the cables following a route of negligible fire risk or will be provided with adequate protection.

The electric driven pumps shall come into operation automatically on a drop in pressure or a flow of water. Both pumps shall be automatically primed at all times.

4.1 Hose Reel Design Requirement [1]

1. Discharge capacity of the hose reel = 30 liters/min.

2. Adjustable jet and spray type of nozzle.

3. Water pressure from the nozzle should be able to throw 20 ft minimum.

4. Pump set to be installed in protected area. Two numbers electrical pump set are acceptable provided there is essential power supply to the pump starter panel otherwise the standby pump set must be diesel engine driven type.

5. The pump set must be able to start and stop automatically during operation and the standby unit is on 50% basis i.e. when the demand of water supply is greater than the duty pump set can cope with, the standby unit will also operate simultaneously.

6. The status of the pump sets must be monitored to the fire alarm panel. The following are the signals to be monitored.

   Duty Pump : Run and Trip

   Standby Pump : Run and Trip

   Power Failure : Common AC Fail

7. Minimum water tank capacity is 500 gallon and each additional hose reel drum requires 250 gallon extra up to maximum of 2000 gallons.

4.2 Hose Reel Maintenance

Maintenance should be carried out by persons authorized to do so by the inspecting Authority and having qualifications and experience suitable for the work on which they are engaged. There are 2 different levels of maintenance for fire hose reels. These levels and their frequencies are as follows:

1. Type 1 Six Monthly

2. Type 2 Annually

4.2.1 Type 1 Six Monthly [5]

The following works should be carried out:

- Inspect fittings and test swing arm, inspect hose for any leaks.
- Test that at least 5m of hose can be unwound and test that water can flow.
- Check for obstruction, signage and any damage.

4.2.2 Type 2 Annually [5]

The following work should be carried out:

- Carry out the checks required for the six monthly inspections.
- Check whole length of hose for damage, check that any foam branch pipes or other equipment is in good repair.
- Check hose guide and attachment to wall.
- Check bearings.
- Ensure it is installed appropriately and not altered.

4.2.3 Record Keeping

All Service Reports should be kept. A log book, showing the location and identifying marks or numbers for each hose reel must be set up and kept. The following information must be recorded:

- The date of each inspection carried out.
- Any defects found.
- On the tag attached to each hose reel, record the date of each inspection.
- If the fire hose reel system incorporates a pump it is required that a record of the date of the monthly test carried out to ensure correct start-up of the pump is kept.

4.2.4 Hose Reel System Check List

TABLE 4.1
PERIODIC CHECKING, TESTING AND SERVICING CHECK LIST

Bil	Item	Good	No Good	Remarks
1.	Pump set control starter panel for manual and automatic operation.			
2.	Condition off electrical components in the starter panel.			
3.	Condition of all indicators in the panel.			
4.	Proper functionary of all the control switches in the starter panel.			
5.	Pump set gland packing and coupling alignment.			
6.	Electrical motor carbon brush and bearings.			
7.	Isolating valve gland packing and hand wheel.			
8.	Hose reel nozzle, rubber hose and free movement of the hose reel drum			
9.	Physical condition of water storage tank and accessories.			
Check by:			Date :	
Signature :				
Approve by :			Date :	
Signature :				

V. CONCLUSION

Fire Fighting System is one important system which everyone needs to know in order to prevent or to eliminate fire. The fire fighting systems need to be maintained correctly to make sure the system is able to function at all the time. Fire fighting maintenance is important thinks for every one who are involved in building maintenance members. Each person that involved in building maintenance needs to have the skills and knowledge to use the fire fighting system equipments. For this purpose, the building owner or the security chief needs to send their peoples to seminar or training in fire fighting in order to give the knowledge and skills of handling fire. Besides, the building owner need have the strategic emergency plan to make sure the staff or peoples are ready when the fire occurs. The owner also needs to conduct a fire drill as a training to make sure that the emergency plan can be used safely. To ensure the safety of people case of fire, three things are considered as essentials:

1. Fire alarm and fire escape systems in good working order, with full knowledge by the user of how to use them.
2. A definite procedure to be followed in case of fire.
3. Adequate drill to ensure prompt and certain action when alarm is given.

(a) Procedure to be Followed In Case Of Fire [3]

1. Immediately after the discovery of a fire, the building alarm must be sounded. Fire alarms must be reported to Malaysian Fire and Rescue Department via telephone number "994".
2. All persons (except as noted under number 4 below) shall evacuate the buildings in accordance with the established fire drill procedure.
3. In the event of an actual fire the operating staff shall assist the fire department in turning off the heating plants and associated equipment if necessary. All exhaust fans are to be left operating to assist in clearing smoke from the building. The staffs shall shut off all motors, machinery and gas valves in their charge when the fire alarm bells sound.
4. Employees not engaged in directing the evacuation of the building shall use fire extinguishers if the fire is incipient or small.

(b) Fire Drills [3]

Fire drills are necessary as their purpose are to test the development of system, discipline, and control in an emergency.

1. Once fire drill procedure has been established at the beginning of each year, drills should always come unexpectedly. The fire-alarm must always be obeyed. Reasonably prompt emptying of the building is important, but running should not be permitted.
2. In building such as schools where any students or teachers remain during the noon recess, the head of department or principal must make provision for appropriate procedure in case of fire or fire alarm.
3. No person may be excused from taking part in fire-drills. This regulation applies to caretakers and workmen as well as to all people.
4. Any ring of the fire-gong is a fire-alarm and must be obeyed.
5. No person taking part in fire-drill in a building shall be permitted to take with him any article of clothing or other possession not on his person at the time of the fire alarm.
6. The maintenance person or security shall arrange that the room door is closed after the last person has made his exit.
7. On emerging from the building during fire-drill, people are to be lined up in group on the building grounds at

some distance from the building. Before the recall signal is given each head of department shall check the group of which he is at the time in charge to make sure that no people is left in the building.

8. When a fire alarm is given, any people or person who has left in room for any reason, whether he is in the room or any building area, shall go directly to meet his group on the grounds.
9. Instructions 5, 6 and 7, noted under "Fire Alarms and Fire Escapes: apply to all fire drills.

(c) Fire Alarms and Fire Escapes [3]

1. All members of the teaching and custodial staff must be familiar with the exact location of fire alarm stations in their respective schools and must know how to turn in an alarm in case of fire and how to proceed subsequently.
2. The fire alarm system must not be used for any purpose other than fire drills or alarm in case of fire. The fire alarm system must be tested by the custodian monthly.
3. The caretaker must examine fire escapes and exits each morning before school assembles and see that all doors open freely and that all platforms and stairs are cleared of ice, snow and other obstructions.
4. The principal shall, at the beginning of the school term, make provision for some other member of his staff to control fire drill in case of his or her absence and to assume all other duties of the principal in case of fire. Such person in a school should be familiar with the general regulations regarding fire and the supplementary regulations for the school in which he or she is acting.
5. Special attention should be given to beginning person, to person suffering from physical and mental handicaps, and to person enrolled in visiting building.
6. Some persons should be delegated to see that every room, including cloak-rooms, washrooms and basements, is empties.

VI. RECOMMENDED MAINTENANCE PROGRAM

TABLE 6.1
FIRE ALARM SYSTEM MAINTENANCE WORK CLASSIFICATION CATEGORY SUB-CATEGORY DESCRIPTION.[2]

Category	Sub-Category	Description
Planned Maintenance	Time-based Maintenance	Detects system deterioration and prevents failure by systematic inspection and monitoring undertaken at predetermined time intervals.
	Condition-based Maintenance	Corrective maintenance work performed, as a result of significant deterioration or failure, to restore the system to full functionality.
	Statutory Maintenance	Actions performed to provide the minimum level of maintenance to meet mandatory requirements of Bomba or Code of Practice such as BS5839 Part 1. (Often includes some of the Time-based and Condition-based maintenance tasks).
Unplanned Maintenance	Routine & Breakdown Maintenance	Unplanned and reactive maintenance actions performed to restore the system to full functionality, as a result of an unforeseen failure.
	Incident Maintenance	Unplanned maintenance actions to restore the system to full functionality as a result of damage resulting from a lightning strike, vandalism, fire or other accidents.

Generally, the more rigorously planned maintenance, and in particularly time-based preventive maintenance is implemented, the less likely is the need for costly and disruptive unplanned maintenance. The code of practice for system design, installation and servicing of a fire detection and alarm system, BS5839 Part 1, lists the recommended tasks to be performed as part of the time-based preventive maintenance program. The fire alarm system is most likely to perform its critical life-safety functions at all times if these maintenance tasks are performed dutifully. Tasks from clauses 29.2.3 – 29.2.7 of the code of practice are summarized below.[2]

TABLE 6.2
TIME-BASED PREVENTIVE MAINTENANCE ACCORDING TO BS5839 PART 1.[2]

Daily	• Check the control panel to ascertain that it shows normal operation. Otherwise log the failure. • Ensure that any fault reported the previous day has received attention.
Weekly	• Ensure that the system is capable of operating under alarm conditions by operating at least one detector or call point on one circuit (zone or loop). For systems with 13 circuits or less, each circuit should be tested in turn. For systems with more than 13 circuits, then more than one circuit must be tested each week so that the interval between tests on one circuit does not exceed 13 weeks. • Visually inspect backup batteries • Check fuel, oil and coolant levels of any standby generators, if any • Check any printers to ensure that reserves of consumables are adequate for 2 weeks normal usage
Monthly	• Simulate mains failure to automatically start standby generator to power the fire alarm system for at least 1 hour. Check for malfunctions. Restore to normal supply and check generator startup battery & charger. Fill up fuel tanks, top up oil and coolant if necessary.
Quarterly	• Check entries to log book and ensure that necessary actions are taken • Examine batteries and their connections and test them as specified by supplier to ensure that it is not likely to fail before the next quarterly inspection. • Check Alarm functions of the panel by operating a detector or call point in each zone • Check Alarm sounders and automatic link to remote centers, if any. • Check all ancillary functions of the control panel, where possible. • Check all fault indicators and circuits by simulating a fault condition. • Visually inspect the control panel for signs of moisture ingress or other deterioration. • Visually inspect whether structural or occupancy changes have affected the requirements for the siting of call points, detectors and sounders. • Visually inspect to confirm that a clear space of at least 750mm is preserved in all directions below each detector, that detectors are sited in accordance with code of practice clauses 12 &/or 13 and that all call points remain unobstructed and conspicuous. • These tests should be done by a competent person, and upon completion, a certificate of testing is issued to the responsible person.
Annually	• Check each detector for correct operation in accordance to manufacturer's recommendation. • Visually check all cable fittings and equipment are secure, undamaged and adequately protected. • Record any defects in a logbook and upon completion, a certificate of testing is issued to the responsible person.

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[3] Seven OAKS School Divison, *"Fire Alarm and Fire Drills."*

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[5] STOKES PERNA PTY LTD, 506 Hampton Street, Hampton, Victoria 3188, *"Fire Hose Reels."*