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Review of Water Supply Arrangement to Sprinkler System in Building

By

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REVIEW OF WATER SUPPLY ARRANGEMENT TO SPRINKLER SYSTEM IN BUILDING

Introduction

Past statistics have shown that life safety and property protection in buildings are greatly enhanced by the presence of sprinkler system. Therefore, we are currently reviewing the current water supply requirements for sprinkler systems, with the aim to explore the possibility of reducing sprinkler installation cost and make it more economical and easier to install, so as to encourage more buildings to go for sprinkler.

The scope of this presentation will cover the following areas:

- Present design parameters for sprinkler installation
- Design considerations
- Assumptions behind the proposal
- Application of this new proposal.
- Benefits

Present Design Parameters

SSCP 52 specifies the design parameters. Table 1 summarises the design parameters for ordinary hazard class I, II and III. Ordinary hazards refer to the commercial and industrial occupancies, which involve the handling, processing and storage of mainly ordinary combustible materials unlikely to develop intense burning fires in the initial stages. The Code also stipulates the full water tank size, which is able to supply water to the sprinkler system for 60mins. However, it allows for reduction in tank size if there is sufficient inflow of water from the PUB mains. This is reflected in the last column of the table - 25m3 for OH I, 50m3 for OH II and 75m3 for OH III. The

design densities, max area to be covered by 1 sprinkler, assumed max number of sprinklers to operate and the assumed maximum area of operation, for the 3 hazard class are shown in this table.

Hazard Class	Design density (mm/min)	Max area to be covered by one sprinkler (m^2)	Assumed max nos: sprinklers to operate	Assumed maximum area of operation (m^2)	Minimum duration of supply (min)	Reduced tank size (m^3)
OH Gp **1**	5.0	12	6	72	60	**25**
OH Gp **2**	5.0	12	12	144	60	**50**
OH Gp **3**	5.0	12	18	216	60	**75**

TABLE 1 Water requirements for Ordinary Hazard Classes

Design Consideration

The proposed water arrangement will have to take into consideration the following :

1) **Time taken for SCDF to deploy its fire appliance and effect mitigation effort.**

As mentioned earlier, SSCP 52 stipulates the size of the water tank to supply water to the sprinkler system for a period of 60mins for OH classification. However, as our fire engines are expected to arrive at the fire scene in less than 60mins, the water tank size can be reduced accordingly. In the event of a fire in a sprinklered building, the fire engine will be despatched upon receiving a call from the monitoring company. The alarm activation of the sprinkler system is connected to the fire station via DECAMS. Upon arrival of the fire engine, water will be pumped via the breeching inlet to the sprinkler system, to supplement the water demand of the sprinkler system. Therefore, the water stored in the sprinkler

system need only to be sufficient to supply the pump operation for the required duration before the arrival of the fire engine.

2) Reliability of water supply from PUB incoming mains

The second consideration is the reliability of water supply from PUB incoming mains. Presently, SSCP allows for reduction in tank size if there is sufficient inflow from PUB mains. Similarly, in designing the proposed sprinkler system, we need to consider the reliability of sufficient inflow of water from the PUB mains. What constitutes reliability and what is considered sufficient in-flow? The part on sufficient inflow will be addressed later. Meanwhile, the inflow of water from the PUB mains is considered reliable if the following conditions are met :

i) The inlet to the sprinkler tank shall be located below RL 125m. This is because the PUB mains may not be able to supply water at constant flow-rate, if it is above RL 125m.

ii) The water supply for the sprinkler system shall be drawn from the water mains laid out in ring mains and not from end feeds. This is because water can still be supplied to the tank if one side of the pipe is disrupted.

iii) The incoming replenishment from the PUB mains shall be of minimum 150 mm diameter, wherever possible, in order to ensure stable supply of water to the sprinkler pump

iv) The length of the connecting pipe between the tank and PUB mains shall not exceed 20m. This is to minimize pipe friction loss and enable faster delivery of water to the sprinkler system from the PUB mains.

The inflow of water from the PUB mains is not considered reliable if the above conditions are not met. Therefore, there will be two options in designing the proposed sprinkler system. One option is to design the system based on reliable inflow and the other based on unreliable inflow.

3) Maximum system flow-rate

The third consideration is the maximum system flow-rate. The sprinkler tank storage capacity shall be based on the maximum system flow-rate as stipulated in the SSCP 52 for the required duration. Therefore, the system demand for OH I, II and III are 540l/min, 1000l/min and 1350l/min respectively. With these flow-rates, 6 sprinklers are to operate at any one time for OH I, 12 sprinklers for OH II and 18 sprinklers for OH III. To achieve these flow-rates, orifice plates in the sprinkler distribution network shall be used to regulate the maximum water-flow so that it is identical at each floor. These devices can be installed in the system riser or at individual mains that serves each floor. The benefit of incorporating orifice plates in the system is to restrict the depletion rate of the water stored in the tank.

Assumptions behind the proposed sprinkler design

First, it is assumed that SCDF has the capability to deploy its fire appliance and effect mitigation effort within 20 minutes of activation of the fire alarm.

Second assumption is that for reliable inflow from the PUB mains to the tank, the water flow from PUB mains must be at least 1m3/min. This is considered sufficient inflow and addresses the earlier question on what is considered sufficient inflow. We have compiled a set of data on the flow-rates of public hydrants. The data shows that the water mains are capable of providing flow-rates in excess of 1.8m3/min. Adjusting for peak loads and daily fluctuations, the water flow from the PUB mains can be safely assumed to be at least 1m3/min.

Proposals

There are two options to this proposed water arrangement, one is designed based on reliable inflow and the other is based on unreliable inflow. Option 1 considers water supply arrangement to sprinkler system based on reliable inflow. In this option, only a $7m^3$ minimum effective capacity storage tank is required for ordinary hazard classification. Why $7m^3$?

Under table 16 of SSCP 52, the maximum flow-rate for OH 3 based on 18 sprinklers operating at one go - worst case scenario - is 1350l/min or 1.35m3/min. In other words, this is the water outflow rate from the pump. On the other side, the incoming water supply from the PUB mains is $1m^3$/min, based on reliable inflow. Therefore, outflow is more than inflow by 350l/min or $0.35m^3$/min. We have now assumed that SCDF will deploy its fire appliances and effect mitigation effort within 20 minutes of the activation of the fire alarm. Based on this, there will be a shortfall of $7m^3$ in that duration of 20min, that is $0.35m^3$/min multiply by 20min. To overcome this shortfall, therefore a minimum effective capacity storage tank of $7m^3$ is required. To standardize, this will be the minimum effective capacity for OH I and II as well. This reserve capacity also minimizes the possibility of the sprinkler installation being air-locked.

For option 2, it considers water arrangement to the sprinkler system based on unreliable inflow. In this instance, we assume that there is no water inflow from the PUB mains. Therefore, based on 20min deployment by SCDF, the effective tank capacity for OH III is $27m^3$, that is $1.35m^3$/min multiply by 20min. Similarly, the effective tank capacities for OH I and II are $10.8m^3$ and $20m^3$ respectively.

These are the 2 proposed options and we welcome further comments and feedback on these proposals. Let me also add at this point, that we have considered sprinkler installation, which draws water directly from the PUB mains for the operation of the pumps. We have liaised with PUB on this water arrangement. PUB is concerned

with the possibility of water flowing back from the system and into their water mains, thereby contaminating the potable water. This is possible because the non-return valve is not 100% foolproof. However, we are still discussing with PUB to see how this can be resolved.

Application

The proposed water arrangement under option 1 and 2 is only applicable for all buildings under ordinary hazard group I, II and III classification. Buildings under OH III special and extra high hazard classification are excluded from such arrangement due to the relatively higher possibility of fast spreading fires.

Once these proposals are finalised, a separate guideline will be issued as an alternative to the requirements in SSCP 52. This is because the insurance companies may insist that the design of the sprinkler requirement shall conform to that of SSCP 52. But as far as SCDF is concerned, either requirement is acceptable.

Benefits

Tables 2 and 3 compares the tank sizes under current requirement and that of the proposed arrangements. Under option 1, where effective tank capacity is based on reliable inflow, there is a drastic reduction in the tank size of about 72, 86 and 90% for OH I, II and III respectively. Under option 2, the reduction in the tank size is about 57, 60 and 64% for OH I, II and III respectively. The reduction in tank size translates to lower installation cost and space savings for the building owners. The high structural loading imposed by the weight of the water tank is also greatly reduced. This way, more buildings can be made safer with the installation of sprinklers.

Occupancy Group	System demand **	Proposed minimum effective capacity of storage tank	Minimum tank capacity in SSCP 52	Reduction in tank size
OH 1 [72m^2]	540 l/min	**7 m3**	25 m3	**72%**
OH 2 [144m^2]	1000 l/min	**7 m3**	50 m3	**86%**
OH 3 [216m^2]	1350 l/min	**7 m3**	75 m3	**90%**

** **the upper limit in column 6 of Table 19 of SSCP 52**

PUB inflow – 1 m3/min.
Test result 1.8 m3/min.

Table 2 : Effective tank capacity for systems with reliable inflow

Occupancy Group	System demand **	Proposed minimum effective capacity of storage tank for 20 min	Minimum tank capacity in SSCP 52	Reduction in tank size
OH 1 [72m^2]	540 l/min	**10.8 m3**	25 m3	**57%**
OH 2 [144m^2]	1000 l/min	**20.0 m3**	50 m3	**60%**
OH 3 [216m^2]	1350 l/min	**27.0 m3**	75 m3	**64%**

** **the upper limit in column 6 of Table 19 of SSCP 52**

Table 3 : Effective tank capacity for systems based on 20 min flow at AMAO

Conclusion

In conclusion, the proposed water arrangement to sprinkler system would result in significant reduction in the size of the water tank. In the past, many existing high-rise buildings were prevented from installing sprinkler systems due to the large space needed to accommodate the tank and the load it imposed on the building structure. However, with this proposal, these constraints can be overcome and the fire safety provisions in these buildings can be further enhanced with the provision of sprinkler protection. Of course, if space constraint is not an issue, the designer is at liberty to design the sprinkler system based on guidelines stipulated in CP52. We would also like to caution that, for purpose of insurance, the QP or the owner should liaise with the insurance company to agree to sprinkler installation based on the new set of guidelines before proceeding with the design.

An Interim Update On The Development of A Performance Based Fire Code For Singapore

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AN INTERIM UPDATE ON THE DEVELOPMENT OF A PERFORMANCE BASED FIRE CODE FOR SINGAPORE

I. Introduction

Performance based codes are touted as the next wave of the future for fire safety design. Traditionally, prescriptive codes have been the bulwark of fire safety regulations. However, in recent years, authorities in developed countries (eg. United States, Australia, UK, Canada, New Zealand) are actively advocating for reform of their fire safety regulations, in favour of performance based codes.

The Singapore Civil Defence Force has been following up with the recent developments of performance-based codes and their implementation in these countries. The performance-based approach to building design is shown to able to introduce flexibility, with possible building cost reduction, without compromising the high local standards of fire safety. SCDF is presently in the process of drawing up such a system for Singapore.

II. Why Performance-Based Codes?

" Why fix the present system if it ain't broke?"

Modern building designs have departed from traditional norms. Building practitioners find it hard to comply with all existing prescriptive code requirements for complex building designs, without sacrificing the intended aesthetic fabric of the building. Performance-based codes may help in addressing these concerns, while at the same time providing adequate fire protection to the building occupants.

Over the years, there have been tremendous improvements in building construction technology and methods. Research in the fire engineering fields have provided building practitioners with much better understanding of fire and its characteristics, material properties and also led to new and innovative fire products in the market. There are also many advanced computational tools to model the effects of fire within buildings. Performance-based regulations are be able take advantage of these

scientific advancements to provide safe and cost-effective solutions which will satisfy both the regulator and the end-user.

Performance-based codes will create the next paradigm shift in fire safety for Singapore, thus it is inevitable that we embark on this journey expediently, so as to be on the forefront of this new technological wave.

III. On the Home Front

SCDF fielded a team of officers in Nov 1999 to study the Australian experience in implementing their performance-based system. The team explored their code writing process, education, fire testing, legal infrastructure and submission procedures.

In Dec 1999, Fire Safety Bureau set up its own Performance Based Committee with representatives from SIA, IES, ACES, Ngee Ann Polytechnic, NTU, NUS, BCA, IFE to look into setting up a performance-based regime that is tailored for the local context. With the input gleaned from the Australian study trip, the committee has taken concrete steps towards the writing of our own performance-based codes.

Important areas for consideration includes:-

1. Codification of the performance-based regulations
2. Education of local fire safety engineers, building practitioners and regulators
3. Legal Infrastructure
4. Fire Testing Capabilities
5. Submission and inspection procedures

Codification of Performance-Based Regulations

The committee is presently examining the full intent covered by the prescriptive code, clause by clause, beginning with Chapter 2 of the Code of Practice for Fire Precautions in Buildings – Means of Escape. These will then be analysed to arrive at the performance-based regulations.

The performance requirements will be stated as goals or objectives to be achieved rather than specific prescribed means to achieve the objective. For example, the current prescriptive code might say "Travel distance shall not exceed 30m". The performance version of it might be "All occupants must be able to evacuate to a safe place before untenable conditions are reached." The fire safety engineer will convince the Relevant Authority, using an approved methodology, that the stated performance criteria is adequately met.

At this juncture, it must be mentioned that the current prescriptive fire code will not be phased out when SCDF introduces the performance-based code. The prescriptive code has been instrumental in enforcing high fire safety standards in Singapore, and for all intents and purposes, will continue to play an important role in the local fire safety administration. Prescriptive codes act as a necessary supplement to the performance-based codes.

Education of local fire safety engineers, building practitioners and regulators

Building up a local pool of fire safety engineers is crucial to the successful implementation of a performance-based system in Singapore. SCDF has foreseen that this aspect of training will require a substantial amount of lead time before a sizable pool of expertise is available to support the functions of the coming performance system.

SCDF introduced the Masters in Fire Safety Engineering in Nov 1999, in collaboration with University of Western Sydney, Hawksbury. The 2-year part-time programme is conducted at the Civil Defence Academy. There is a total of 52 participants, including SCDF officers, in the 1st and 2nd intakes for the programme. Within the next few years, a sizable pool of trained fire safety experts will be available to put in place the coming performance-based system.

In the area of computational fire modelling, FSB as a regulator, is taking an active approach in keeping abreast with the latest modelling tools available on the market. In this respect, FSB in a collaborative approach with Ngee Ann Polytechnic has been working on using computational fluid dynamic (CFD) modelling tools to evaluate current prescriptive requirements for air-wells used in a smoke-free approach. The results of this work will be presented in a separate seminar that is held in conjunction with this FSB Seminar.

The Civil Defence Academy has recently organised a Fire Safety Modelling Workshop for Building Professionals in Feb 2001 to educate professionals on the use of fire and evacuation modelling tools for evaluation of fire safety designs. Computational fire modelling plays an important role in the performance-based regime as it is a definitive means to prove the adequacy of a performance-based proposal in meeting the code requirements. It is expected that there will be more of such courses to be conducted in the future.

Legal Infrastructure

A legal framework is necessary to protect the interest of the community. In this respect, the Fire Safety Act 1993 will be amended accordingly, at an appropriate time, to incorporate the new performance-based system.

The apportionment of liability is an important area for consideration prior to the implementation of the performance system. The fire safety consultant, architect, engineer, building owner and management, contractor all have an active role to play in a performance submission. Each party will have to exercise his/her responsibility to ensure the functionality of the fire protection systems put in place within a building.

In the process of putting up the new legal framework , SCDF will draw its reference from performance-based legislation in countries such as Australia, New Zealand, and the United States, together with dialogues with our professional institutions.

Fire Testing Capabilities

Developing our local fire testing capabilities is critical to the success of a local performance-based system. With good fire testing facilities and expertise to evaluate proposed designs, we can build greater confidence in the workability of the proposed fire protection system. Having good testing facilities will also act as a base for promoting research on fire science, which will lead to better understanding of fire, its growth and development.

The Civil Defence Academy is in the process of setting up a burn-room to conduct actual fire testing for educational and research purposes. The burnroom is expected to be commissioned in Mar 2001.

Submission and Inspection Procedures

The submission routine for future performance-based designs will be different from that for prescriptive-compliant designs:-

a. It is envisaged that for future performance-based submissions, third party expert review of the work will be required. This will lend greater assurance to the validity of the proposed fire protection system for the building involved.

b. There will be greater need for more communication between building designer, owner and government authorities prior to the acceptance and implementation of a performance-based design.

c. Proper and thorough documentation of applied assumptions, correspondence between parties concerned is absolutely vital, as it serves as a necessary reference for future modifications to the applied performance design.

d. Regular inspections of building's active and passive fire protection system will also be in-place to check for adherence to requirements laid down as part of performance-based design criteria.

IV. Use of Computational Fire Modelling Tools

In countries where performance–based systems are in place, computational fire modelling tools are increasingly being used to support and lend credibility to performance solutions, and as a tool to convince the fire authorities to approve the designs.

SCDF, together with other government agencies, is currently working with a private entity to incorporate a portal within the proposed one-stop electronic plan submission system to facilitate computational fire modelling for performance-based designs. Users are able to use the same set of electronic plans submitted to the authorities and channel it to be used for fire modelling, without re-creating the model infrastructure from scratch. This cuts down on the cycle time for modelling process, and would also be an additional impetus to use simulation tools in the evaluation of fire safety in buildings.

V. Conclusion

We are in the threshold of an exciting new era where there are endless opportunities to explore new possibilities in the realm of fire safety. SCDF hopes to have your fullest support in making the coming performance-based system a reality.

Lessons Learnt From Construction of Household Shelters

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LESSONS LEARNT FROM CONSTRUCTION OF HOUSEHOLD SHELTERS

1 BACKGROUND

Since the CD Shelter Act came into operation on 1st May 1998, all residential developments involving new flats and houses need to incorporate household shelters (HS) or storey shelters (SS) in the developments. Household or storey shelter is to be located within a residential development so that the residents could take refuge in the shelter and would not be exposed to the threat outside during a war emergency.

Household shelter (HS) is located inside the individual dwelling unit and is to be designed as part of the dwelling unit. Storey shelter (SS), however, is a shared facility located in a common area on every storey of a residential building to serve the residents on that storey.

As at Jan 2001, there are more than 82, 700 household shelters completed and commissioned in the public and private residential projects. The private residential projects include semi-detached, terrace houses, bungalow and condominium developments.

2 INTRODUCTION

Like all reinforced concrete structures, construction of household shelters shall be carried out with good workmanship and high quality control. This is to ensure that household shelters not only meet their peacetime requirements, but also perform their intended function in a war emergency, i.e. to provide an airtight enclosure of sufficient strength and integrity to resist the effects of blast and fragmentation of weapons. Poor quality of construction works would adversely affect designed protection level of the shelter and hence endanger shelterees in the event of a war emergency. Knowing the

importance of household shelters, builders and building professionals have to give special attention to proper detailing so as to achieve high level of workmanship and quality control in the construction of HS.

Upon the completion of HS, the next stage is to commission it based on shelter technical requirements. The primary objective of commissioning household shelters is to ensure that they are built in accordance with the approved plans.

This paper highlights some salient features of the construction and commissioning phase of a household shelter. In addition, various items of non-compliance that were observed during BCA regulatory inspections and the lessons learnt in the construction of household shelters are also discussed.

3 CONSTRUCTION

3.1 Regulatory Site Inspections

The construction of household shelters poses a challenge to the QPs and the builders, as the technical requirements for HS shelters demand strict quality control, high level of workmanship and attention to details. Good workmanship and quality control are necessary to ensure that the completed shelters serve their intended function during peacetime as well as during a war emergency. BCA conducts selective regulatory site inspection as a means to ensure that shelter requirements are met during its construction stage.

For development projects involving more than three household shelters, QPs are advised to complete one sample shelter unit early to serve as a reference for the construction of other or subsequent shelters within the same development. This sample shelter unit would have to be ready for commissioning within 6 to 9 months from the commencement of structural works.

3.2 Reinforcements

The fabrication and fixing of reinforcements for walls and slabs of HS are similar to that of the peacetime reinforced concrete structures. The main items of non-compliance observed during the site inspections are the provision of steel reinforcement bars and links for the shelter walls and slabs. The common mistakes observed are:

a) Incorrect spacing of main reinforcements on the inner face of HS walls,
b) Missing reinforcement links (R6-600mm c/c),
c) Inadequate reinforcement anchorage length, and
d) Missing reinforcements around HS door opening and missing starter-bars from slab/ foundation.

Any rectification works can tedious and laborious. QPs should ensure that their site staff pays extreme attention and supervise the works in accordance with the approved shelter structural plans so as to avoid re-work. The QPs are also advised to pay attention to the spacing of the reinforcement bars and reinforcement links.

3.3 Concrete Cover

Concrete cover to reinforcement is one important area often overlooked by the builders. The nominal cover of reinforcements for household shelter walls/ floors shall comply with the technical requirements and subject to a maximum of 40 mm. In some HS projects, builders have concrete cover of more than 40mm for the shelter walls/slabs, with the assumption that a thicker concrete cover would enhance the protection level. This is an incorrect assumption. On the contrary, any excessive cover would increase the risk of secondary fragments (such as scabbed concrete fragments) ejecting at high velocity from the internal face of household shelter walls and slabs into the HS due to fragmentation effects.

3.4 Formwork

Like all concreting of peacetime reinforced concrete structures, formwork is an important component in forming the shape of the structure. In the fabrication and assembly of formwork, good workmanship is essential and cannot be over-emphasized. In securing the formwork prior to the casting of HS wall, only the non-removable type of form-tie (form-tie without through opening) is allowed. Upon the removal of the recessible type of plastic cones from the form-tie after casting, the void shall be sealed with non-shrink cementitious grout. The use of form tie system, which leaves through hole in the wall and subsequently fills with non-shrink cement grout/epoxy, is not allowed. This is attributed to the reason that any dislodgment of the insufficiently bonded material due to blast and fragmentation effects will endanger the shelterees.

3.5 CD Blast Door

The door kerb is an important component of the household shelter. When the door is closed during CD mode, the door leaf, door kerb and the door frame shall provide an airtight enclosure. In our past regulatory site inspections in some household shelters, it was commonly discovered that the concrete door kerb was missing. Many builders are still unfamiliar with the need to provide a 100-mm reinforced concrete kerb as stipulated in the technical requirements for household shelters. This RC kerb is difficult to cast once the floor slab and door openings are completed. Hence, QPs and builders shall ensure that RC kerb is provided as part of shelter works.

3.6 Ventilation Sleeves

The location of the 2 ventilation openings is a critical requirement for the proper functioning of HS during a war emergency. The technical requirement stipulates that two ventilation sleeves are to be provided and positioned on opposite side of HS walls or in adjacent walls, provided that they are separated by at least 1.0 m apart. In non-

compliance cases, rectification work is difficult as it involves 'coring' through 250mm thick RC wall.

3.7 Shelter Services

The design of HS stipulates necessary service outlets such as power sockets, TV, radio and telephone points to be provided within the household shelters. This is to facilitate communication with outside during a war emergency. Other service cables, which do not serve the HS, are not allowed to be penetrated through the walls and slab of the HS or to be embedded in the HS walls and slab. During BCA regulatory site inspections, the main items of non-compliance observed are:

a) Service cables for rooms other than household shelter were found embedded into the shelter wall.

b) Incorrect method used to secure the electrical sockets/ switches encasement for the household shelter.

3.8 Construction Statistics on Defects Observed

As HS is designed to resist destructive weapon effects, good workmanship is essential to achieve the desired protection level. As such, special precaution shall be taken to ensure that technical requirements for HS are met during its construction stage. The major items of non-compliance observed from Jun 1999 to Dec 2000 are tabulated as shown below:

Table 1: Defects Observed during Regulatory Inspections of HS in Private Projects

Period	Household Shelter Component								
	Form -work	Concrete work	Reinft	Services	CD Door	Vent-Sleeve	Total Defects Found	No of Sites with non-compliance	Total Sites inspected
Jun to Dec 1999	3	19	203	79	21	8	333	153 (60%)	255
In %	1	6	61	24	6	2			
Jan to Jun 2000	2	24	261	119	37	25	468	199 (48%)	412
In %	1	5	56	25	8	5			
Jul to Dec 2000	0	19	500	134	60	40	753	351 (56%)	631
In %	0	3	66	18	8	5			

Table 2: Summary of Defects (Jan to Dec 2000)

Type of non-compliance	Rank in term of frequency of occurrence in descending order
Reinforcement	1
Services	2
Door	3
Concrete Work	4
Ventilation Sleeve	5
Form-Work	6

Repairs and maintenance of household shelters with many defects are expensive and in some cases even impossible. Thus, the shelter may not fulfil its intended use. In all cases, repairs to the household shelters shall be carefully planned, coordinated and carried out in full compliance.

4 COMMISSIONING

4.1 Commissioning Requirements

All fixtures such as TV, radio, telephone points and electrical outlets shall be provided in the completed HS. The service conduits with electrical cables serving the HS shall be provided prior to commissioning.

The HS is commissioned only if HS passed all the following tests in one single inspection:

a) Light penetration test of HS door – torchlight is used on the exterior of HS door to check on light penetration into the HS. The test is considered passed only if no light could be seen from the inside of HS.

b) Chalk mark test on the HS door – Chalk is applied to the door frame where the door seal will come into contact with when the door is closed. The test is considered passed only if all the chalk marks is transferred to the door seal when the door is closed.

c) Air-tightness test of the HS - The household shelter is tested for air-tightness by pumping air into the HS until the pressure reached a certain level of water pressure indicated on the manometer. Thereafter, the pressure is allowed to drop and maintained within a specified timeframe.

Some of the items of non-compliance observed during the commissioning of the shelter could be rectified on site while others would require replacement of the defective parts. QPs should check door seal to ensure that they are properly placed and bonded to the seal holder. In cases when the CD door cannot be locked properly, it is necessary to carry out rectification work such as to replace the defective lockset. The seal at the ventilation opening has to be rectified to ensure it is properly bonded to the ventilation sleeve. Where the over pressure test does not meet the specified criteria, the

QPs are also advised to check the door seals and other parts of the shelter for any signs of defects that could cause air-leakage during the test.

Table 3: Summary of Private Projects Commissioned from Jan to Dec 2000

Commissioning of HS	No. of Projects	No of Projects in %
Projects which passed after **1** Commissioning of HS	93	51
Projects which passed after **2** Commissioning of HS	70	39
Projects which passed after **3** Commissioning of HS	18	10
Total Projects	181	100

5 CONCLUSION

The integrity of a household shelter cannot be solely dependent on compliance to design requirements without considering its construction and commissioning requirements. A high standard of workmanship is essential during construction. This cannot be achieved without close attention and commitment from all parties, such as QPs, site supervisors and builders.

Unlike normal peacetime structures, there is little or virtually no time to carry out rectification work when any part or component of a household shelter failed or worse, cannot perform its intended function during an attack. Besides, actual resistance of a household shelter against different weapon effects can only be assessed during a real attack, by which time it would be too late if vital shelter functional requirements are impaired due to structural failure or damage to services in the household shelters.

Update on Review of Fire Code 1997

Part I

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UPDATE ON REVIEW OF FIRE CODE 1997

1 Introduction

1.1 The first release of changes/amendments to Fire Code that were approved by the Fire Code Review Committee was issued to the professional bodies via FSB's circular dated 4/12/2000.

1.2 The changes/amendments to the Fire Code up to March 2001 were dealt with and approved by the FCRC are presented in this paper.

1.3 The following pages will describe in greater details the changes/amendments to the Fire Code 1997.

2 Fire Code review/updates

(A) Smoke free approach to exit staircase - Exception

Existing clause :

2.2.13 (c) Exception

(i) where an exit staircase of any building is either fully pressurized in compliance with the requirements in Chapter 7 or cross-ventilated through fixed unobstructed ventilation openings in at least two external walls, the size of such opening being not less than 10 per cent of the floor area per floor of the staircase on each of the walls, such exit staircase may be exempted from compliance with the requirements of Cl.2.2.13(b), provided:

- **it is not a building belonging to purpose group III and VII, or a building with habitable height exceeding 60m, and**
- **it is not a fire fighting staircase adjacent to a fire lift as required in Chapter 6, and**
- **door opening into such exit staircase are fire door of at least 1 hour fire resistance and fitted with automatic self-closing device to comply with the requirements of Cl.3.9.2, or**

(ii) when the occupied space adjacent to the exit staircase achieves a smoke free condition, the Relevant Authority may consent to exemption from requirements for smoke free approach into the exit staircase.

The Fire Code Review Committee proposed to reconcile the requirements under cl.2.3.3(g) and cl.7.2.1(a) which specifically require all internal exit staircases of building exceeding a habitable height of 24m to be pressurised and the entry shall be through smoke stop lobby or external approach.

Revised clause 2.2.13(c) to be read as follows :

2.2.13 (c) Exception

(i) The omission of smoke stop lobby required under cl.2.2.13(b) to exit staircase of any building exceeding 4 storeys is allowed under the following situations, provided the door opening into the exit staircases shall be fire door of at least 1-hour fire resistance and fitted with automatic self-closing device to comply with the requirements of cl.3.9.2:

Omission of smoke stop lobby is allowed

(a) where the internal exit staircase is provided with pressurization up to a habitable height of 24m in compliance with the requirements of Chapter 7;

(b) where an external exit staircase is constructed to comply with cl.1.2.29;

(c) where an exit staircase of a building is located along its perimeter wall and provided with uninterrupted external ventilation openings having not less than 50% of the planal area of the staircase at each storey level;

(d) in an open-sided car park floor, where the occupied space adjacent to the exit staircase achieves a smoke free condition.

(ii) The omission of smoke stop lobby to exit staircases shall not be allowed under the following situations :-

Omission of smoke stop lobby is not allowed

(a) where the building exceeds 4 storeys and belongs to Purpose Group III and VII;

(b) where the internal exit staircase, which is provided with pressurization, exceeds the habitable height of 24m;

(c) where the exit staircase is designated as fire fighting staircase adjacent to a fire lift as required in Chapter 6.

Revised clause 2.2.13(c) as given above spells out in clearer terms in which situations omission of smoke stop lobby is allowed or not allowed.

(B) Exit Staircase

Existing Clause

2.3.3 (a) Internal Exit Staircase

(ii) where an internal exit staircase is directly approached from an external exit passageway or external corridor, it shall not be necessary to provide such enclosure between the staircase and the external exit passageway or external corridor provided no unprotected openings are located within 3m from the exit staircase.

The Fire Code Review Committee was of the view that the existing part of the clause requiring the 3m separation between unprotected openings and the exit staircase could be deleted as the open-balcony approach to the exit staircase is considered acceptable.

(C) Exit Staircase

Existing Clause

2.3.3 (b) External Exit Staircase

(i) external exit staircase may be used as required exit in lieu of internal exit staircase provided it complies with the requirements of exit staircase, except for enclosure of an internal staircase, and

(ii) there shall be no unprotected openings within 3m horizontally or within 3m vertically below any part of the external exit staircases; and

The above clause does not address the situation of external exit staircase abutting or adjacent to other part of the building. As such, the Fire Code Review Committee agreed that it would be appropriate to explicitly spell out the intention of wanting to keep external exit staircase at least 3m away from the adjacent or other part of the building.

Revised clause 2.3.3(b) to be read as follows :

2.3.3 (b) External Exit Staircase

(i) external exit staircase may be used as required exit in lieu of internal exit staircase provided it complies with the requirements of exit staircase, except for enclosure of an internal staircase, and

(ii) there shall be no unprotected openings within 3m horizontally or within 3m vertically below, or adjacent or facing (unless there is adequate separation complying with Cl.3.5) any part of the external exit staircase; and

(iii) the external exit staircases shall be located so as to lead directly to a street or open space with direct access to street.

The proposed clauses (ii) & (iii) would alert the readers on the need to look into the requirements of unprotected openings facing the external staircase and its discharge at grade level. No unprotected openings should be directly facing the external exit staircase, even for small openings of any size, provided there is adequate separation complying with cl.3.5.

2.3.4 Scissor Exit Staircase

(a) Where two separate internal exit staircases are contained within the same enclosure, each exit staircase shall be separated from the other by non-combustible construction having fire resistance for a minimum period equal to that required for the enclosure, and

(b) Such scissor exit staircases shall comply with all applicable provisions for exit staircase.

Proposal :

2.3.4 Scissor Exit Staircase

(a) Where two separate internal exit staircases are contained within the same enclosure, each exit staircase shall be separated from the other by non-combustible construction having fire resistance for a minimum period equal to that required for the enclosure, and

(b) Such scissor exit staircases shall comply with all applicable provisions for exit staircase, and

(c) Door opening into scissor exit staircases shall be at least 7m travel distance from each other

Reason : The Fire Code Review Committee agreed to impose the 7m separation between exits so that a fire occurring near one staircase will not affect the escape route leading to the other exit staircase. The original requirement asking for 5m separation was spelled out in the Fire Code 1991.

(D) Doors and Exit Doors

New subclause 2.3.9(i) is to be read as follows:

2.3.9 (i) Any exit door or exit access door serving spaces of assembly/mass occupation, such as auditorium, concert hall, theatre, assembly hall, exhibition hall, cinema, etc which has to be kept shut and fastened while the building or part of the building is occupied shall be fitted with 'panic bolt' and appropriately marked 'Push Bar To Open' in letters not less than 100mm high to enable the door to be quickly opened when a pressure on the bar is applied in the direction of travel.

To address the concerns on the types of locking mechanism that can be used, the Fire Code review Committee agreed that the panic bolt locking mechanism should be used for areas of assembly, such as theatre, auditorium, cinema, exhibition hall, etc where there is mass evacuation during an emergency.

(E) Doors and Exit Doors

New subclause 2.3.9(j) is to be read as follows:

2.3.9 (j) Locking of staircase and smoke stop /fire lift lobby doors

One-way locking device is allowed to be provided to doors of exit staircase, smoke stop/fire lift lobby in the following situations, provided only one-way locking device is used, eg. panic bolt or thumb turn locking device :

(i) exit door between staircase shaft and occupancy area; and

(ii) exit access door between smoke/fire fighting lobby and occupancy area; and

(iii) exit door between staircase shaft and smoke stop lobby; and

(iv) exit door between staircase shaft and circulation area; and

(v) exit access door between smoke stop/fire fighting lobby and circulation area.

For selected floors under subclause 2.3.9(i), the doors of the fire fighting/exit staircase and smoke stop/fire fighting lobby shall not be fitted with any locking device to allow for re-entry from the staircase to the interior of the building.

The Fire Code Review Committee proposed to introduce the above-mentioned to address the concerns of acceptable locking devices to doors of exit staircases. In the past, FSB had received many enquiries and consultations pertaining to locking of door to exit staircases. Thus, the Committee has agreed to spell out the situations that permit the provision of one-way locking device. However, there are exceptions that disallow the provision of any locking devices to doors serving as designated staircase re-entry, doors to exit staircases serving multi-tenancy occupancies, etc.

(F) Doors and Exit Doors

New subclause 2.3.9(k) is to be read as follows:

2.3.9 (k) Where access-control is provided to exit door using smart card locking device, magnetic bar and electro-mechanical locking device :-

(i) The activation of the building fire alarm or sprinkler system shall automatically unlock the door. It shall remain unlocked until the building fire alarm system has been manually reset; and

(ii) The door shall be arranged to unlock from a manual release device located within the occupancy space, 1200mm above the floor and within 1.5m of the exit door jamb. The manual overide device shall be readily accessible and clearly identified by a sign that reads "Emergency Door Release". The mechanism to unlock the door shall be fail-safe type.

(iii) Where doors opening into passenger lift lobby are to be provided with access-control and would be locked after normal operation hours, the lobby shall be designed to have a direct access to at least one exit staircase to prevent any occupant from being trapped in the lobby when the lifts are recalled at 1st storey or other designated floor during fire emergency or building's power failure. Alternatively, a two-way communication system shall be available inside the lift lobby for use by trapped occupants to call for help. The two-way communication system shall be linked to the fire command centre and/or building control room which shall be manned 24 hours.

Under subclause (i) & (ii), the main concern is that the electronic locking devices installed at exit access doors leading to exit staircases would seriously affect the evacuation process if such devices failed to unlock the doors during an emergency. The Fire Code Review Committee agreed to allow the provision of electronic locking devices, provided they are fail safe and back-up by a manual over-ride device.

Under cl.(iii), the need to provide direct access from lift lobbies to an exit staircase would eliminate the chance of an occupant being trapped in the lobby area during an emergency. Alternatively, it would be acceptable to provide intercom communication between the lift lobby and the fire command centre and/or building control room, for use by trapped occupants to summon for help.

(G) Doors and Exit Doors

New subclause 2.3.9(l) is to be read as follows:

2.3.9 (l) Staircase Re-entry

(i) Every exit staircase enclosure serving more than 7 storeys of non-residential building, excluding residential buildings and buildings of detention and correctional occupancies, shall allow re-entry from the staircase enclosure to the interior of the building. There shall be at least 1 level where it is possible to re-entry the interior of the building from the staircase enclosure.

(ii) There shall be not more than 6 intervening floors between floors where it is possible to leave the staircase enclosure, either re-entry into the building or exit to the exterior space at grade level or to another building. This would ensure that an occupant need not travel more than 3 floors up or down the staircase to re-entry into or exit from the building.

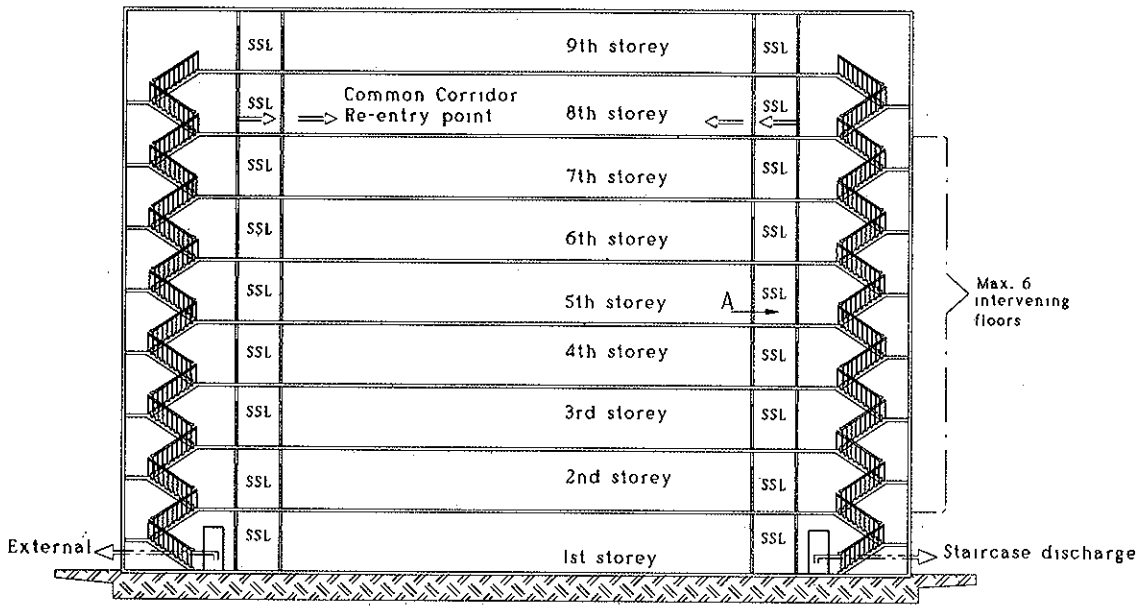
(iii) Where re-entry is provided from the staircase enclosure, it shall enter into a common corridor that is connected directly to at least one other exit staircase.

(iv) Staircase doors permitting re-entry into the building, shall be identified with a signage "Re-entry door" of min. 50mm lettering height on the staircase side of the staircase door.

The Fire Code Review Committee deliberated the importance and need of "re-entry" and proposed the above-mentioned to permit re-entry from the exit staircase shaft into the common area to allow cross over to another exit staircase. The clause would eliminate the scenario where occupants could be trapped in the exit staircase shafts where they are unable to re-enter into the building because of locked exit doors and move downwards the staircase because of blocked exit at the 1st storey level.

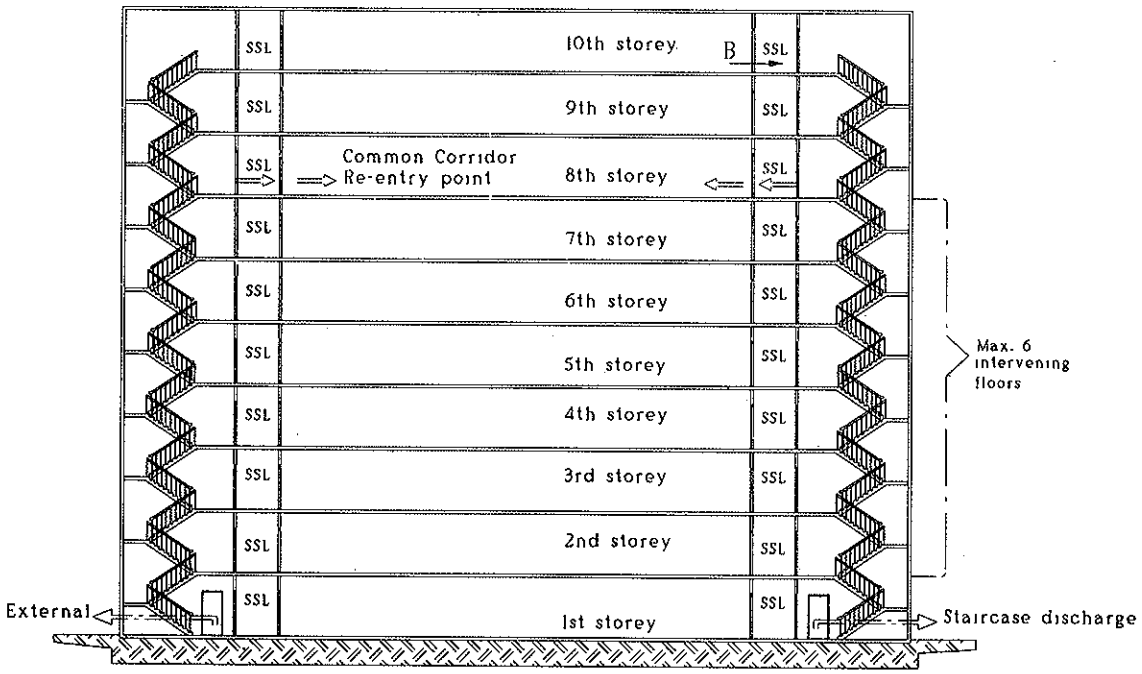
The re-entry concept also allows flexibility to the fire fighters in carrying out fire fighting from any of the staircases with ease.

Example of a 9-storey building requiring 1 re-entry point to the exit staircase



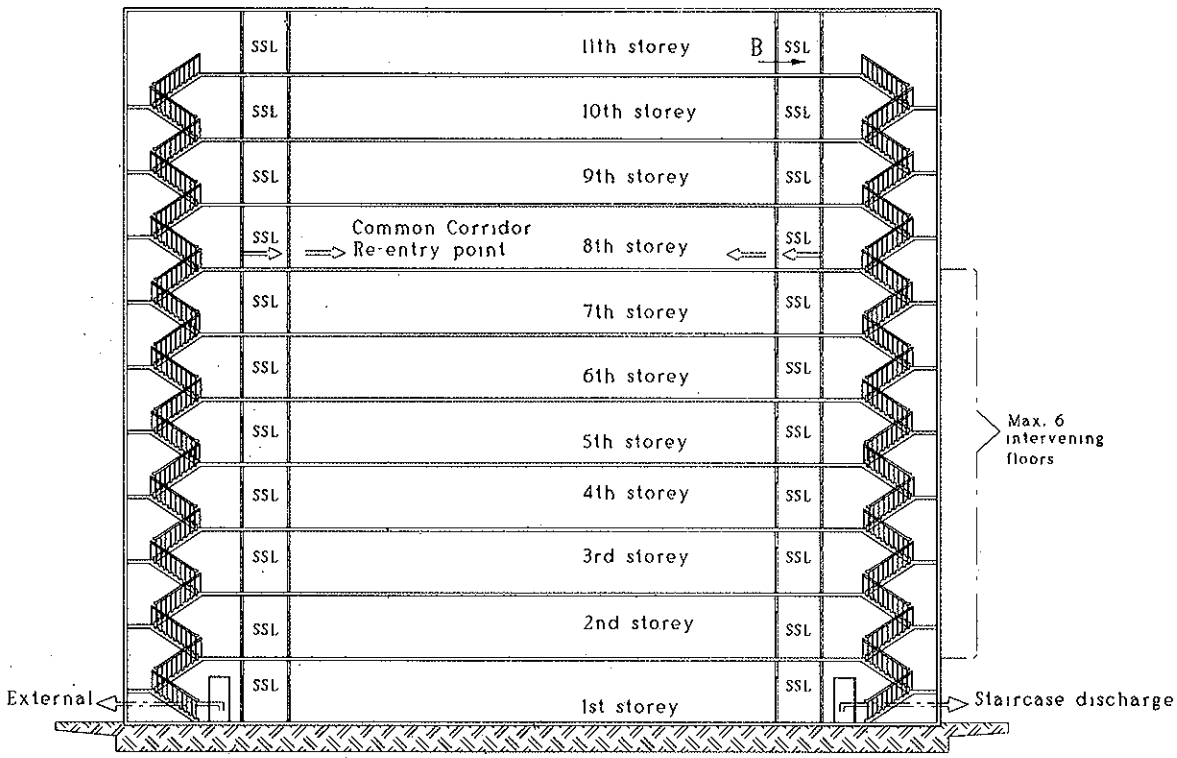
Note : Occupant A needs not travel more than 3 floors up to gain re-entry at 8th storey

Example of a 10-storey building requiring 1 re-entry point to the exit staircase



Note : Occupant B needs to travel 2 floors down to gain re-entry at 8th storey

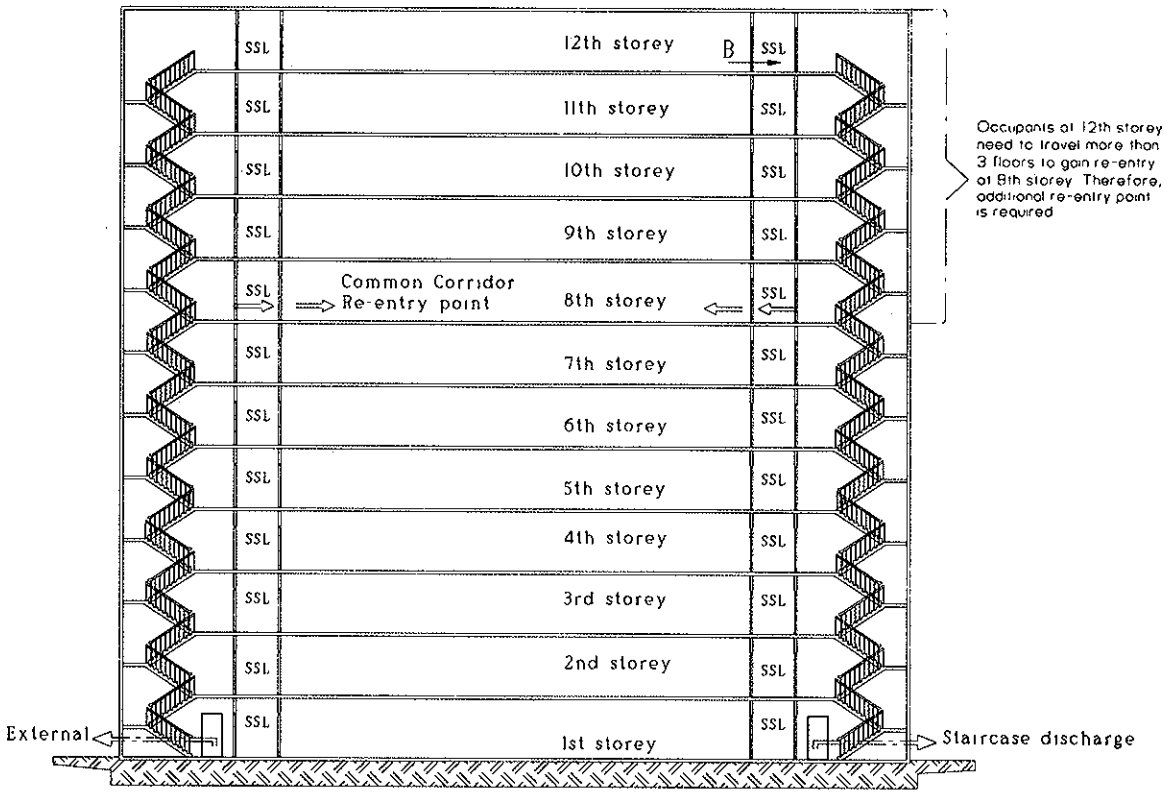
One re-entry point is required for 11th storey and below



Note : Occupant B needs to travel not more than 3 floors down to gain re-entry at 8th storey

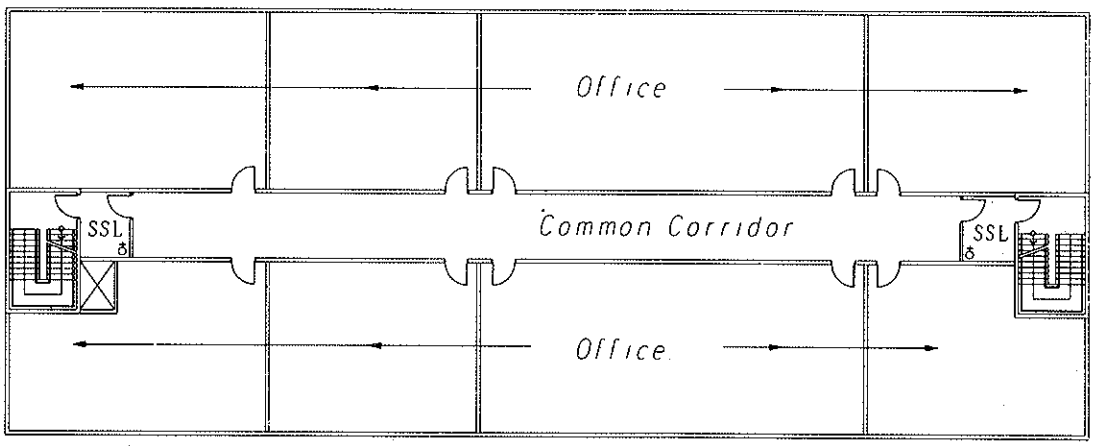
Two re-entry points are required for 12th storey and above

Not Acceptable



Note : Occupant B needs to travel more than 3 floors down to gain re-entry at 8th storey

Staircase Re-entry Floor



Typical office floor plan – Staircase doors that provide re-entry to the floor space shall be linked to at least one other exit staircase via common corridor

(H) Openings in protected shaft

Existing clause:

3.8.3 Openings in protected shaft

A protected shaft shall have no openings in its enclosure, except -

(a) In the case of any part of the enclosure which is formed by a separating wall, any opening which complies with the requirements of Cl.3.6for separating walls, or

(b) In the case of any part of the enclosure which is formed by a compartment wall or a compartment floor, any opening which complies with the requirements of Cl.3.7 for compartment wall or compartment floor, or

(c) In the case of any part of the enclosure which is formed by the protecting structure-

(i) a door which has the appropriate fire resistance to comply with the requirements of Cl.3.4 for test of fire resistance, or otherwise permitted by provision of Cl.3.8.6, or

(ii) the passage of a pipe, or

(iii) inlets to and outlets from and opening for the duct, if the shaft contains or serves as a ventilation ducts,

Such openings in the protected shaft shall be protected to comply with the relevant provisions of Cl.3.9 for protection of openings.

The "passage of a pipe" under clause (c)(ii) conveys the impression that pipes can penetrate protecting structure to protected staircase and exit passageway. Amendment to clause (c)(ii) is therefore necessary to preclude the penetration of pipe to exit staircase and exit passageway.

Revised clause to be read as follows :

3.8.3 Openings in protected shaft

A protected shaft shall have no openings in its enclosure, except -

(a) In the case of any part of the enclosure which is formed by a separating wall, any opening which complies with the requirements of Cl.3.6for separating walls, or

(b) In the case of any part of the enclosure which is formed by a compartment wall or a compartment floor, any opening which complies with the requirements of Cl.3.7 for compartment wall or compartment floor, or

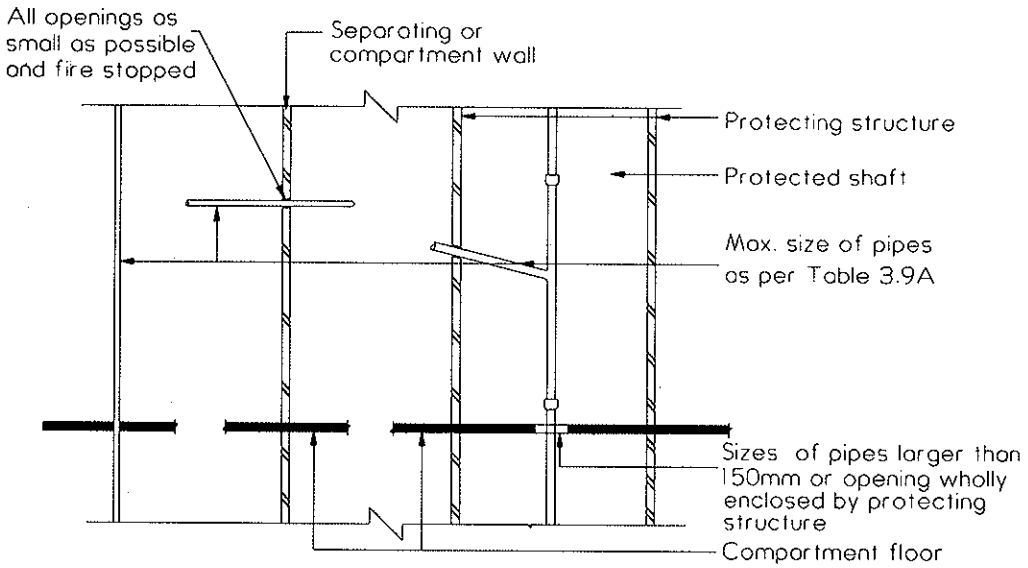
(c) In the case of any part of the enclosure which is formed by the protecting structure-

(i) a door which has the appropriate fire resistance to comply with the requirements of Cl.3.4 for test of fire resistance, or otherwise permitted by provision of Cl.3.8.6, or

(ii) the passage of a pipe, excluding protecting structure to exit staircase and exit passageway, or

(iii) inlets to and outlets from and opening for the duct, if the shaft contains or serves as a ventilation ducts,

Such openings in the protected shaft shall be protected to comply with the relevant provisions of Cl.3.9 for protection of openings.



Section

(I) Use of Sliding Doors and Roller Shutters across the Escape Paths in Building

Presently, the Fire Code does not allow sliding doors or roller shutters to be located across the paths of escape. However, owing to the popularity of such installations among Qualified Persons (QPs) for various reasons like: aesthetic appearances, functional needs or security of the spaces concerned, FSB had decided to review the relevant clauses in the Fire Code to facilitate the use of sliding doors and roller shutters in buildings.

On 4 Dec 2000, FSB has agreed to allow the use of sliding doors and roller shutters to be located across the paths of escape leading to exits in buildings, for example, across the shopfront, main entrance of office unit, exterior door opening to factory/warehouse. However, FSB has stipulated some of the conditions for compliance if such sliding doors or roller shutters are to be used in the revised clauses.

New subclause 2.3.9(h)

Any door located in a path of travel shall be of the side-hinged or pivoted swing type. The door shall be designed and installed so that when swung open, it does not prevent full use of the opening. The minimum clear width of the door opening shall not be less than the required door clear width.

Exception 1: Requirement on door swing shall not apply to buildings under Purpose Group I and residential units under Purpose Group II.

Exception 2: With prior consent from the Relevant Authority, locking of exit doors is permissible at certain rooms or spaces of health care occupancies and detention and correctional occupancies.

Exception 3: Sliding door and roller shutter as listed in (i) to (iv) are permitted to be installed across the exit access or escape paths leading to exits, including the exterior door openings except in areas stipulated under cl.2.3.9(c)(i) and (iii). These doors shall not form part of the fire compartment integrity.

Manually operable sliding doors or roller shutters shall be capable of being opened and closed manually from either side of the door. The manual force required to operate the door in the direction of door travel shall not be more than 130N to set the door in motion, and 70N to close the door or open it to the minimum required width when applied at the door handle or catch/knob which is located at the opening edge of the door under still air conditions.

(i) **Manually operable sliding door or roller shutter that can remain in closed position during the period of occupation is permitted at rooms or spaces with occupant load not exceeding 50 persons. When opened, it shall not reduce the effective width/height of the doorway leading to the escape route. Sliding door or roller shutter is allowed within rooms or spaces that serve more than 50 persons provided it shall remain in the full open position during the period of occupation. A readily discernible sign with the lettering "THIS DOOR TO REMAIN OPEN WHEN THE BUILDING IS OCCUPIED" shall be permanently pasted on both sides of such sliding door or roller shutter at a height of 1.4 m from the finished floor level. The lettering shall be 25mm height and painted in white on a red background with reflective surface, or**

(ii) **Wicket door shall be permitted to be incorporated within a roller shutter or sliding door. The wicket door shall be of the swing type having a minimum head height of 2.1m and a clear width of not less than the required door clear width. The wicket door shall comply with all the requirements of exit access door, and be clearly marked and readily visible so that the occupant can readily see where the door is. It should be fitted only with simple fastenings that can be manually operated for easy escape, or**

(iii) **A sliding door which can be swung open as well, shall swing in the direction of escape travel when a certain horizontal force is applied to the door. When the sliding door is converted to a swing door, it shall comply with all the requirements of an exit access door. The manual perpendicular force required to open the door shall not be more than 70N when applied at the door handle or catch/knob located at the opening edge of the door under still air conditions. A readily visible sign with the letterings "IN EMERGENCY, PUSH TO OPEN" shall be affixed onto the door, or**

(iv) **Power operated automatic sliding doors/ roller shutters, shall be linked to the building fire alarm system. The sliding door/ roller shutter shall automatically open to the required width/height (of door opening) upon the activation of the fire alarm. The automatic sliding door/ roller shutter shall also comply with the following:**

- **The automatic sliding doors/ roller shutters shall be of the fail safe type. Should there be any fault in electrical or sensor device, or any power failure (either mains or battery powered), these doors shall automatically open and remain in an open position until power is restored.**

- **A manual override mechanism (a device to trigger the immediate opening of sliding doors/ roller shutters) shall be provided. The doors shall open and remain open upon activation of this device. This device shall be housed in a break glass box located beside the sliding doors or roller shutters and fixed at a height of 1.4m above the finished floor level. It shall be easily accessible, conspicuous and be free from obstructions. A readily discernible sign with the lettering "EMERGENCY DOOR RELEASE" shall be permanently pasted beside the switch. The letterings shall be of at least 15mm height.**

(J) Occupancy Load Table – Schedule 6 & 8

The Fire Code Review Committee agreed to adopt 10m² across the board for all production area in factories, whether automated or not. The review was in line with the change in production methods in present factories which are less labour intensive. With this proposed revision of the occupant load factor, there is no need to retain the description such as "light, Medium or Heavy industries".

Revised Schedule 6 & 8 changes were highlighted in bold figures

OCCUPANCY LOAD-	SCHEDULE 6
PURPOSE GROUP VI-	FACTORY
BUILDING TYPES	FACTORIES, FLATTED FACTORIES, INDUSTRIAL PLANTS

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area/Visitors Lounge		3.0
Admin Office		10.0
Meeting/Seminar Room		1.5
Library	Stack Area	10.0
	Reading Area	5.0
Workshop		5.0
Laboratories		5.0
Exhibition		1.5
Production Area*(2)		**10.0**
Packing/Distribution Area		10.0
Material/Product/		30.0
General Storage	non-simultaneous	—
Multi-purpose Area		1.5
Staff Recreation Room	non-simultaneous	—
Staff Rest Room	non-simultaneous	—
Staff Canteen		1.5
Toilets/Changing/Locker Room	non-simultaneous	—
Sick Room	non-simultaneous	—
Mechanical Plant Room		30.0

*To refer to (1) (2) or (3) of notes at the end of Schedule 8

OCCUPANCY LOAD-	SCHEDULE 8
PURPOSE GROUP VIII-	WAREHOUSE, GODOWNS, PUBLIC CAR PARK
BUILDING TYPES-	WAREHOUSE, GODOWNS, CAR PARKS

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area/Visitors Lounge		3.0
Admin Office		10.0
Meeting/Seminar Room		1.5
Packaging Area		10.0
Goods Storage		30.0
General Storage		30.0
Loading/Unloading Area	4 per Bay	
Staff Rest Room	non-simultaneous	—
Toilets/Changing Room	non-simultaneous	—
Staff Canteen		1.5
Kitchen/Service Area		10.0
Mechanical Plant Room		30.0

Note:

a) Car Parking Areas - occupancy calculated on the basis of 30 m^2 per person.

b) For building types not included in the above tables, occupancy load calculation shall be based on the figures established for buildings within the same purpose group, or as otherwise determined by the Relevant Authority.

*(1) Laundry Areas equipped with machine operation, occupancy may be calculated at 15.0 sq m per person.

*(2) Production Area whether automated or not, shall be calculated on the basis of **10.0 m^2 per person.**

*(3) Health/Fitness Centres include areas for weight training, aerobics, massage, sauna/steam bath and whirlpools.

(K) Occupancy Load Table – Schedule 7.1, 7.8, 7.9 & 7.10

The Fire Code Review Committee proposed to standardise the occupancy load factors for discotheques and night clubs in both hotel and non-hotel premises. The Committee agreed to standardise discotheque occupant load to 1.0m²/person across the board for bar and pub gross area instead of having another occupant load figure for bar area with seating arrangement. The occupant load for night club will adopt 1.5m²/person across the board without having to differentiate between dancing or dining. The karaoke lounge occupant load will also adopt 1.5 m²/person instead of breaking them up into gross area and room area.

The Committee also agreed to standardise the occupant load factor for food outlet to 1.0m²/person instead of 1.5m²/person. The review would allow more flexibility in designing the area for either dine area and dance area for the designated spaces. It might appear more stringent by reducing the occupant load factors for the above respective premises in respect of exit provision. However, it would indirectly benefit the operators of the floor spaces as they could increase the number of occupants in their premises.

Revised Schedule of the above-mentioned changes were highlighted in bold figures

OCCUPANCY LOAD-	SCHEDULE 7.1
PURPOSE GROUP VII-	PLACES OF PUBLIC RESORT
BUILDING TYPES-	HOTELS, HOLIDAY RESORTS, BOARDING HOUSES, CONVENTION CENTRES, PRIVATE CLUBS

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area/Visitors Lounge		3.0
Atrium Floor/Concourse		3.0
Hotel Bedroom	4 to a room	
Bar/Pub	**Gross area**	**1.0**
Discotheque	**Gross area**	**1.0** (including dine & dance area)
Night Club	**Gross area**	**1.5** (including dine & dance area)
Restaurant		1.5
Exhibition/Multi-purpose Area		1.5
Function/Ball Room		1.5
Pre-function Room	non-simultaneous	—
Business Centre		10.0
Admin Office		10.0
Conference Room		1.5
Meeting/Seminar Room		1.5
Library	Stack Area	10.0
	Reading Area	5.0
Shop		5.0
Health Club/Centre*(3)		5.0
Swimming Pool Deck		10.0
Swimming Pool		—
Squash Court	2 per court	
Staff Rest Room	non-simultaneous	—
Staff Canteen		1.5
Toilets/Changing/Locker Room	non-simultaneous	—
Kitchen/Service Area		10.0
Laundry*(1)		10.0
Mechanical Plant Room		30.0

*To refer to (1) (2) or (3) of notes at the end of Schedule 8

OCCUPANCY LOAD-	SCHEDULE 7.8
PURPOSE GROUP VII-	PLACES OF PUBLIC RESORT
BUILDING TYPES-	RECREATIONAL BUILDINGS, AMUSEMENT CENTRES

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area/Visitors Lounge		3.0
Admin Office		10.0
Meeting/Seminar Room		1.5
Bowling Alley	exclude bowling lanes	1.0
Amusement Park	exclude machine areas	1.0
Billiards Room		5.0
Skating Rink	Rink Area	3.0
	Spectator Area	1.5
Discotheque	**Gross Area**	**1.0** (including dine & dance area)
Pub/Bar	**Gross Area**	**1.0**
Karaoke Lounge	**Gross Area**	**1.5** (including dine & dance area)
Night Club	**Gross Area**	**1.5** (including dine & dance area)
Health Club/Centre*(3)		5.0
Restaurant		1.5
Cafetaria/Snack Bar		1.5
Fast Food Outlet		**1.0**
Kitchen/Service Area		10.0
Toilet/Changing Room	non-simultaneous	—
General Storage		30.0
Mechanical Plant Room		30.0

*To refer to (1) (2) or (3) of notes at the end of Schedule 8

OCCUPANCY LOAD-	SCHEDULE 7.9
PURPOSE GROUP VII-	PLACES OF PUBLIC RESORT
BUILDING TYPES-	EATING HOUSES, RESTAURANTS, COFFEE SHOPS, HAWKER CENTRES, FAST FOOD OUTLETS

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area		3.0
Admin Office		10.0
Meeting/Seminar Room		1.5
Dining Area	Hawker Centres	1.5
	Fast Food Outlets	**1.0**
	Others	1.5
Bar/Pub		**1.0**
Lounge		2.5
Kitchen/Service Area		10.0
Storage Area		30.0
Toilet/Changing Room	non-simultaneous	—
Staff Rest Room	non-simultaneous	—
Mechanical Plant Room		30.0

OCCUPANCY LOAD-	SCHEDULE 7.10
PURPOSE GROUP VII-	PLACES OF PUBLIC RESORT
BUILDING TYPES-	BUS TERMINAL, TRAIN STATION, AIRPORT, FERRY TERMINAL

FUNCTIONAL SPACES	REMARKS	OCCUPANCY LOAD (m^2/person)
Reception Area		3.0
Lobby/Corridors	non-simultaneous	—
Waiting Area/Visitors Lounge		3.0
Concourse		3.0
Admin Office		10.0
Meeting/Seminar Room		1.5
Ticketing Office		10.0
Business Centre		10.0
Passenger Arrival/	Bus Terminal	1.5
Departure Areas/Foyers	Others	3.0
Restaurant		1.5
Cafeteria		1.5
Fast Food Outlet		**1.0**
Kitchen/Service Area		10.0
Shop		5.0
Staff Rest Room	non-simultaneous	—
Storage Area		30.0
Toilets/Changing Room	non-simultaneous	—
Mechanical Plant Room		30.0

(L) Private Lifts

Proposed new definition subclause 1.2.46(A)is to be read as follows:

1.2.4 6(A) Private lifts are passenger lifts which are meant for the exclusive use of occupants in the building, and are located to open its door directly into private enclosed spaces at each storey level.

Proposed new subclause 3.8.8(c) is to be read as follows:

3.8.8(c) Private lifts that are provided for the exclusive use of occupants in residential units under purpose group II buildings shall comply with the following requirements :

(i) Smoke detectors shall be provided at ceiling level over the lift landing door at each storey level. The activation of any of the smoke detectors at any storey level shall cause the lift to home to the designated floor; and

(ii) Emergency power supply from a generating plant shall be provided to home the lift to the designated floor when there is a power failure in the building; and

(iii) The lift shall not be permitted to double-up as a fire lift; and

(iv) All private lifts shall comply with SS CP 2.

Private lifts have become a common building facility in most residential developments. FSB is concerned of the spread of smoke and fire from the lift shaft into the occupancy space. The FSB Wavier Committee has received many wavier applications for the provision of private lifts in buildings. The proposed new subclause is to permit the provision of private lifts in buildings under Purpose Group II buildings.

(M) Clause 2.5 – HEALTH CARE OCCUPANCY

Existing clause:

2.5.1 (a) Hospital – A building used for medical and surgical care and shall include general hospitals, hospitals for psychiatric care, children's hospitals, with 24 hours or in-patient service.

Revised clause 2.5.1(a) to be read as follows :

2.5.1 (a) Hospital

A building used for medical and surgical care and shall include general hospitals, hospitals for psychiatric care, children's hospitals, with 24 hours or in-patient service.

(i) Basement

Patient accommodation area containing beds shall not be located in the basement storey.

(ii) Number of exits per ward

Each patient accommodation ward area shall be provided with at least 2 exits, which shall be remotely located from each other, if the occupant load exceeds 15 patients.

(iii) Provision of area of refuge

Every upper storey used for the accommodation of patients shall be provided with at least an area of refuge for horizontal evacuation purposes. The size of the area of refuge and the routes leading to it shall comply with clauses 1.2.4 and 2.5.3.

(iv) Size and compartmentation of patient accommodation area

(a) Each patient accommodation ward shall not exceed a floor area of 750m² and an occupant load of 75 persons, calculated on the basis of gross floor area of 10m² per person.

(b) Each patient accommodation ward area shall be constructed as a compartment having fire resistance rating of at least 1-hour for walls/ceilings and ½-hour fire door for protection of door openings. The internal walls between wards shall be constructed to have min. 1-hour fire resistance rating and door opening shall be protected by ½ hour fire door. For walls and doors between ward and main exit access corridor (either internal or external corridor), the requirements given in subclause 2.5.1(a)(vi) and 2.5.1(a)(vii) shall be complied with. This requirement shall not be applicable to patient accommodation floor which is sprinkler protected.

(v) Provision of Escape Bed-lifts

(a) An escape bed-lift shall be provided adjacent to a protected exit staircase to serve every storey and/or every area of refuge above the 1st storey containing Operating Theatre Department, Coronary Care Unit, Intensive Care Units, Intensive Therapy Units, Neo Natal Units and patient accommodation areas where patients could not be able to be evacuated, in the event of a fire, by any means other than a bed, patient trolley or similar conveyance.

(b) A protected shaft containing an escape bed-lift shall be constructed to comply with the relevant requirements under clause 3.8.

(c) The entry into the escape bed-lift and the protected exit staircase shall be through a common protected lobby. The protected lobby shall have a floor area of not less than 9 sq m, having a depth of min. 2.5m perpendicular to the lift landing door, and shall be large enough to hold a minimum of two beds, attendant staff and additional equipment. In the situation where the protected lobby is also acting as a smoke stop lobby or fire fighting lobby, the floor area of the lobby shall be of sufficient size to allow the evacuation of the required number of beds and the movements of other occupants into the protected staircase.

(d) **Escape bed-lift is to be used for the evacuation of patients in beds including those confined to wheel-chairs or physically disabled, in a fire emergency, although it can be used as a normal passenger lift during normal times in the day to day running of the hospital. A signage shall be posted outside the bed-lift stating "FIRE ESCAPE BED-LIFT"**

(e) **The escape route for the escape bed-lift at the 1st storey level shall be made protected from other occupancy areas by minimum 1- hour fire resistance separation and shall discharge directly into a safe exterior space.**

(f) **An escape bed-lift that opens directly into an external corridor at each level and is sited adjacent to a protected exit staircase does not require a protected lobby, provided there is no unprotected opening within 3m horizontally from the escape bed-lift door opening. The escape bed-lift provided under the above situation may be treated as common bed-lift that can serve multiple compartments located on the same floor.**

(g) **An escape bed-lift shall be provided with the following features :**

(i) **a duplicate power supply from an emergency generating plant;**

(ii) **a switch labelled "Evacuation Bed-Lift" situated next to the lift landing door at the final exit storey, which enables an authorised person nominated by the building management to take control of the lift car during an emergency. Operation of the switch should isolate the lift landing call controls and return the lift immediately to the final exit storey, where upon the lift can only operate in response to the lift car control panel. Such a switch is not needed in 2-storey buildings, and**

(iii) **a communications system (except in 2-storey building) should be installed to allow communication between occupants at each lift landing and the operator in the lift car.**

(h) **The installation of escape bed-lifts shall be in accordance with SS CP 2 Code Of Practice For Installation, Operation And Maintenance Of Electric Passenger And Good Lifts.**

(vi) Internal access corridor to wards

Patient accommodation ward with access through an internal access corridor shall comply with the requirements as follows:

(a) Each ward shall be separated from the internal access corridor by a wall having fire resistance of at least 1-hour.

(b) Doors opening into internal access corridor shall have fire resistance of at least ½-hour and fitted with automatic self-closing device to comply with the requirements of cl.3.9.2; or held open by electromagnetic or electromechanical device and

(c) Requirements on fire compartmentation under (a) and (b) will not be applicable if the patient accommodation floor is sprinkler protected.

(d) Internal access corridors shall be naturally ventilated with fixed openings in an external wall, such ventilation openings being not less than 15 percent of the floor area of the internal access corridor; and

(e) The ventilation opening in the external walls shall not be less than 3.5 sq m and shall be unobstructed from parapet wall or balustrade level upwards and be positioned on opposite sides of the internal access corridor such that they provide effective cross-ventilation throughout the entire space of the corridor; and

(f) The ventilation openings in the external walls shall not be more than 12m from any part of the internal access corridor.

(g) Internal access corridor may be provided with mechanical ventilation and pressurisation in lieu of natural ventilation.

(h) Other non-patient accommodation ward or spaces which open into or form part of the internal access corridor and which may prejudice the means of escape provision shall be required to be compartmentalised by min. 1-hour fire rated enclosures and min ½-hour fire doors.

(vii) External access corridor

Patient accommodation ward with access through an external access corridor shall comply with the requirements as follows:

(a) **Patient accommodation ward shall be separated from the external access corridor by a wall having fire resistance of at least 1-hour, except that ventilation openings of non-combustible construction may be fixed at or above 1.1m, measured from the finished floor level of the external exit access corridor to the sill height of the opening; and**

(b) **Doors opening into the external access corridor shall not be required to have fire resistance rating; and**

(c) **External access corridor shall conform to the requirements of external exit passageway for minimum width, changes in floor level, roof protection and provision of parapet wall or solid balustrade which shall not exceed 1000mm height along the outer side of the corridor.**

(viii) Smoke free approach to exit staircase

(a) **Entry into an exit staircase from any part of a building of all upper storeys above ground level shall comply with requirements of cl.2.2.13(a) & (b) – requirements of smoke free approach to an exit staircase.**
Pressurisation of staircase in lieu of the provision of smoke stop lobby is not permitted.

(b) **Any exit staircase which serves a basement storey shall comply with Cl.2.2.14 and Cl.2.3.5.**

(c) **Where a smoke stop lobby is provided to exit staircase to serve a patient accommodation floor, or any area where patients may need to be evacuated on mattresses or stretchers, the lobby shall have a minimum clear space (unobstructed by door swings) of 6 sq metres.**

(ix) Staircase landing width/depth

(a) **Exit staircases that serve patient accommodation floor and are to be used by patients in an emergency fire situation shall be designed to allow evacuation of patients on mattresses or stretchers.**

(b) **The width of stair, landing width and depth shall comply with the following table:**

Table 2.5.1 (a)(viii)(b)			
STAIR WIDTH	MIN LANDING WIDTH	MIN LANDING DEPTH	
1000	2800	1900	Allows mattress or stretcher evauation only (ie no pedestrian passing).
1250 1500	2800 3200	1900 1550	Allows mattress or stretcher evacuation and restricted ambulant passing.
1750 2000	3600 4000	* 1350 * 1250	Allows mattress or stretcher evacuation and ambulant passing.

* **For the purpose of calculating the exit capacity of the staircase, clear landing depth, instead of the clear stair width, should be taken.**

The Fire Code Review Committee agreed to adopt 750m² as the size limit for each compartment, basing on an occupant load of 75 person and an occupant load factor of 10m² per person instead of 2.8 m² per person. The review warrants the provision of area of refuge and evacuation bed-lifts applicable to all hospital premises. The evacuation bed-lifts are vital and essential for the evacuation of bedridden or immobile patients with medical support equipment. The fire safety requirements that are drafted represent the minimum fire safety level necessary for hospitals and nursing homes.

Existing subclause 2.5.1(b)

2.5.1 (b) Nursing Home – A building or part thereof, used for the housing and nursing care of persons, who because of the mental or physical incapacity, may be unable to care for their own needs and safety without the assistance of other persons. Such buildings shall include nursing and convalescent homes and homes for the aged.

Revised subclause to be read as follows :

2.5.1 (b) A building or part thereof, used for the housing and nursing care of persons, who because of mental or physical incapacity, may be unable to care for their own needs and safety without the assistance of other persons. Such buildings shall include nursing and convalescent homes, homes for the aged and hospices.

(i) Fire safety requirements under Cl.2.5.1(a) – Hospital shall be fully complied with.

"Hospice" would come under the provision of nursing home as the patients could be receiving medical care and highly dependent on nurses or equipment for movement

Existing subclause 2.5.1(c)

2.5.1 (c) Custodian Care Facility – A building or part thereof, used for the housing, on a 24 hour basis, of persons who, because of age, or physical or mental disabilities, are unable to care for their self preservation and safety. Such buildings shall include nurseries for children under 6 years of age and hospitals and institutions for the mentally retarded

Revised subclause to be read as follows :

(c) Custodian Care Facility

A building or part thereof, used for the housing, on a 24 hour basis, of persons who, because of age, or physical or mental disabilities, are unable to care for their self preservation and safety. Such buildings shall include nurseries for children under 6 years of age and hospitals and institutions for the mentally disabled.

(i) Nurseries, including Childcare Centres, Kindergarten, shall not be located in any floor higher than 2nd storey. If located within a building of mixed use, they shall be compartmentalised from other spaces and occupancies by walls and doors having at least 1-hour fire resistance rating and provided with its own means of escape.

(ii) Hospitals and institutions for the mentally disabled shall be designed with each storey having an area of refuge in accordance with Cl.1.2.4 and 2.5.3. Fire safety requirements under Cl.2.5.1(a)- Hospital, shall be fully complied with, except Cl.2.5.1(a)(v) on Provision of escape bed-lift and Cl.2.5.1(a)(ix) on Staircase landing width/depth.

The Fire Code Review Committee proposed to introduce "mentally disabled" instead of "mentally retarded". The Committee agreed that a mentally disabled person may not be bedridden. As such, the set of requirements for hospital should not be made fully applicable to hospitals or institutions for the disabled

Existing subclause 2.5.1(d)

2.5.1 (d) Supervisory Care Facility – A building or part thereof, used for the housing, on a 24 hour basis, of mental health patients who may be capable of self preservation but require supervision and are receiving therapy, training or other health related care and for whom there may be security measures not under their control.

Revised subclause to be read as follows :

(d) Supervisory Care Facility

A building or part thereof, used for the housing, on a 24 hour basis, of mental health patients who may be capable of self preservation but require supervision and are receiving therapy, training or other health related care and for whom there may be security measures not under their control.

(i) Fire safety requirements under Cl.2.5.1(a) – Hospital, shall be fully complied with, except Cl.2.5.1(a)(v) on Provision of escape bed-lift and Cl.2.5.1(a)(ix) on Staircase landing width/depth.

Patients could be heavily sedated at any time of the day. The provision of compartmentation to patient wards would help in the orderly evacuation of occupants, which would be closely supervised by staff for security reasons.

Existing subclause 2.5.1(e)

2.5.1 (e) Ambulatory Health Care Centre – A building or part thereof, used for providing services on an out-patient basis for :

(i) treatment for patients which would render them incapable of taking action for self preservation or safety under emergency conditions without assistance from others, such as hemodialysis units, or

(ii) surgical treatment requiring general anaesthesia

Revised subclause to be read as follows :

2.5.1 (e) Ambulatory Health Care Centre

A building or part thereof, used for providing services on an out-patient basis for:

* **treatment for patients which would render them incapable of taking action for self preservation or safety under emergency conditions without assistance from others, such as hemodialysis units, or**

* **surgical treatment requiring general anaesthesia.**

(i) Ambulatory Health Care Centre, if located within a building of mixed use, shall be compartmented from other tenants and occupancies by walls and doors having at least 1-hour fire resistance rating. The Ambulatory Health Care Centre shall be provided with its own means of escape to at least one exit staircase.

(ii) Fire Safety requirements under (a) – Hospital, shall be fully complied with except Cl.2.5.1(a)(iii) on Provision of area of refuge for horizontal evacuation, Cl.2.5.1(a)(v) on Provision of escape bed-lift and Cl.2.5.1(a)(ix) on Staircase landing/depth.

The clause was expanded to incorporate health care centre or specialists' clinics, which provide day surgery or surgical treatments that required the use of anaesthesia. The main concern is the provision of adequate means of escape for patients who are under the influence of anaesthesia.

(N) Area of refuge – occupancy load

Existing subclause 2.5.3

2.5.3 Area of refuge - Occupancy load

Where Area of Refuge serves as required exit, the calculation of area for refuge occupants shall be based on the following:

(a) Hospitals - 2.8 m²/person.
(b) Nursing Homes - 2.8 m²/person
(c) Custodian Care Facility - 1.4 m²/person.
(d) Supervisory Care Facility - 0.56 m²/person.
(e) Ambulatory Health Care Centre - 1.4 m²/person.

Revised subclause 2.5.3 to be read as follows :

2.5.3 Area of refuge - Occupancy load

Where Area of Refuge serves as required exit, the calculation of area for refuge occupants shall be based on the following:

(i) Hospitals - 2.8 m²/person.
(ii) Nursing Homes - 2.8 m²/person
(iii) Custodian Care Facility - 1.4 m²/person.
(iv) Supervisory Care Facility - 0.56 m²/person.
(v) Ambulatory Health Care Centre - 1.4 m²/person.

On storey of hospitals or nursing homes where patient accommodation is not provided, at least 0.56 m² per occupant shall be taken for the calculation of the area for refuge of occupants.

The above clause is expanded to allow the occupant load factor of 0.56m² per person to be applied to non-patient accommodation floors in hospitals or nursing homes. This would allow more occupants to be located in the area of refuge.

3 Conclusion

3.2 Regular review of the Fire Code helps to sift out clauses which are not clear or outdated or overly stringent. In areas, which are not well covered by the code, additional fire safety requirements would be introduced.

3.3 An updated code would help the readers to gain better understanding of the fire safety requirements and leads to better quality building plan submission to FSB.

3.1 The review would not be possible without the active involvement and participation of the professional bodies. FSB is positive that the regular review of Fire Code would benefit the building professionals and the building industry as a whole.

Water Mist
Fire Protection System

By

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WATER MIST FIRE PROTECTION SYSTEM

1 INTRODUCTION

1.1 The potential of fine water spray for fire protection has been recognised for many years. Initially, the water mist system was developed to protect ship's engine/equipment rooms.

1.2 The international call for phasing out of halons in view of their impact on the environment has led to an intense search for halon replacements for fire protection. When the advantages of water mist system (in terms of rate of fire extinguishing, water consumption and property protection) over the use of conventional sprinkler system were discovered and proven through numerous full-scale fire tests, it was further developed. It has now emerged as one of the most effective substitutes in place of halons for protection to a wide variety of specific installations on land, in particular in areas where water supply is limited or the use of water is restricted, e.g. turbine, generator, diesel engine, computer, electrical switch-gear, etc.

1.3 FSB has recently studied the potential of water mist system and has accepted it as a substitute for sprinkler system in sprinkler protected buildings.

1.4 However, owing to the insufficient understanding of the complex nature of the delivery of the fine water spray to combustion zone, there is difficulty in developing comprehensive design criteria for the use of water mist system for general applications. For this reason, the empirical approach with full-scale fire test has been adopted as the basis of design of water mist system.

1.5 This paper discusses the issues associated with the primary mechanisms, system design and the appropriate areas of applications of water mist systems.

2 MECHANISIMS OF WATER MIST SYSTEM

2.1 In a nutshell, water mist system is a distribution system connected to a water supply and equipped with one or more nozzles capable of delivering fine water mist intended to control, suppress, or extinguish fires and that **has been demonstrated to meet the performance requirements of its listing standard**.

2.2 A technical symbol, "D_{vf}", is used to define the term "Water Mist". By definition, D_{vf} is a droplet diameter such that the cumulative volume, from zero diameter to this respective diameter, is the fraction, f, of the corresponding sum of the total distribution. For example, $D_{v0.90}$ is the median diameter, that is, 90 per cent of the total volume of liquid are in drops of smaller diameter and 10 per cent are in drops of larger diameter.

2.3 Water mist is defined as "a water spray for which D_{vf} as measured at the coarsest part of the spray in a plane 1m from the nozzle, at its minimum design operating pressure is less than 1000 microns (1 mm)".

2.4 The various types of water mist systems are distinguished by the different methods in which the mist is formed and the characteristics (droplet size and distribution) of the mist. Water is forced under pressure through specially designed nozzles, and this action atomises the water into small droplets which are propelled at high speed to reach the combustion area and fill the whole space. The pressure is supplied to the system by high pressure accumulators (usually containing air or nitrogen) or pump, or a combination of both.

2.5 The nozzles (see illustration in **Appendix A**) of water mist system are capable of delivering water mist with droplet diameters of not more than 1,000 microns, thus allowing the system to use much smaller quantities of water than conventional sprinkler system and yet have the capability to extinguish fires effectively.

2.6 Water and compressed air/nitrogen are separately stored in pressured cylinders. Their capacities depend on the type of installations to be protected.

2.7 Basically, water mist system works on the following fire extinguishing principles:

i) By cooling: Water droplets of water mist system have a high surface area to volume ratio and are thus able to absorb more heat radiating from the fire and its surrounding. Table 1 below shows the diameter of water droplet of water mist and conventional sprinkler water. The cooling effect is a function of the number and size of water droplets and is achievable through the huge amount of fine water droplets covering the combustion zone.

ii) By oxygen depletion: The volume of water expands to over more than a thousand times of the original volume in vaporisation. The water mist locally inerts the atmosphere creating an effect in driving out the oxygen from the combustion zone and simultaneously preventing the ingress of fresh oxygen into the combustion zone.

iii) By blocking of radiant heat: The huge amount of small droplets provides an effective shield to block radiative heat from transmitting to the surrounding of the combustion zone.

iv) By smoke scrubbing: The fine water droplets have the ability to strip the atmosphere of smoke particles and absorb soluble gases.

The combined effect of these features gives the water mist rapid extinguishing capability.

Drop size comparison	Drop size diameter (average, m)	No. of droplet	Surface area	Vaporisation (sec)
	> 1000	1	1	1
	400	40	10	0.1
	<100	8000	400	0.003

Table 1 Water droplet sizes of water mist system and sprinkler system

3 FEATURES OF WATER MIST SYSTEM

3.1 Fundamentally, water mist system can be either a self-contained and pressured with or without pump powered type, or a type installed with water tank.

3.2 For the design of Self-contained water mist system, it either consists of:

i) A water cylinder pressurised with nitrogen or compressed air at 175-200 bars connected via electrical valve through tubes and fittings to a series of spray heads (see illustration in **Appendix B**). If the system consists of a bank of water cylinders, the cylinders complete with electrical valve are connected via a manifold to the tubes and fittings and a series of spray heads.

ii) A water cylinder pressurised with nitrogen gas or compressed air at 175-200 bars complete with electrical valve connected to a group release valve and through tubes and fittings to a series of sprinkler heads with pilot pot, and through this pilot pot to pilot line and to a series of spray heads (see illustration in **Appendix C**). If the system consists of a bank of water cylinders, the cylinders complete with electric valves are connected via a manifold to a group release valve, and through tubes and fittings to a series of sprinkler heads with pilot pot and through this pilot pot to pilot line and to a series of spray heads.

Actuation of the water mist system can be through automatic detectors installed with the system, or by means of sprinkler head similar to the operation of conventional sprinkler system.

3.3 The water mist sprinkler system with pump water tank consists of electrically driven and/or diesel engine driven pumps, a water tank with minimum effective capacity, section valves, group release valves, sprinkler heads, sprinkler heads with pilot pot, spray heads, stainless steel tubes, fittings and other accessories to suit the design (see illustration in **Appendix D**).

4 DESIGN PARAMETER

4.1 Although specific standards are established, such as the AS 4587-1999: Water Mist Fire Protection Systems-System Design, Installation and Commissioning, and the NFPA 750-1996: Water Mist Fire Protection Systems, they do not provide definite fire performance criteria nor specific guidance that suitable for all different types of building designs and installations. In this respect and for the purpose of FSB approval, users of water mist system will have to work closely with the manufacturer in working out the criteria, based on the listing parameters for the specific hazards and performance objectives provided in the aforesaid standards, for the designing and installation of water mist system in buildings.

4.2 In addition, any alternative design which does not comply with the specific requirements of the adopted standards, but is proven to give equivalent results to those specified would be permitted provided it is listed by a recognised testing laboratory.

4.3 The design and installation of water mist system, including submission of plans to FSB, shall be the responsibility of a professional mechanical engineer in mechanical discipline.

5 AREAS OF APPLICATION

5.1 Water mist system listed by a recognised testing laboratory is permitted for protection in the following areas:

i) As supplement to sprinkler system for specific hazards, e.g. electrical plant room, telecommunication services, computer room, spray painting room/booth, kitchen, coldroom, etc. With the provision of water mist system, the requirement of compartmentation for such rooms shall not apply.

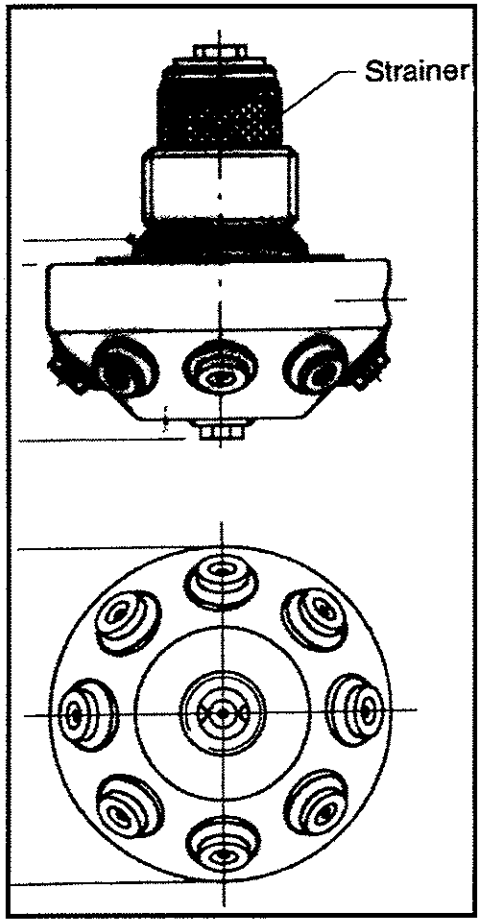
ii) As an alternative to sprinkler system in existing buildings that are required to be upgraded to sprinkler protected buildings.

iii) As an alternative to sprinkler system required for buildings, including mechanised carparks and basement carparks.

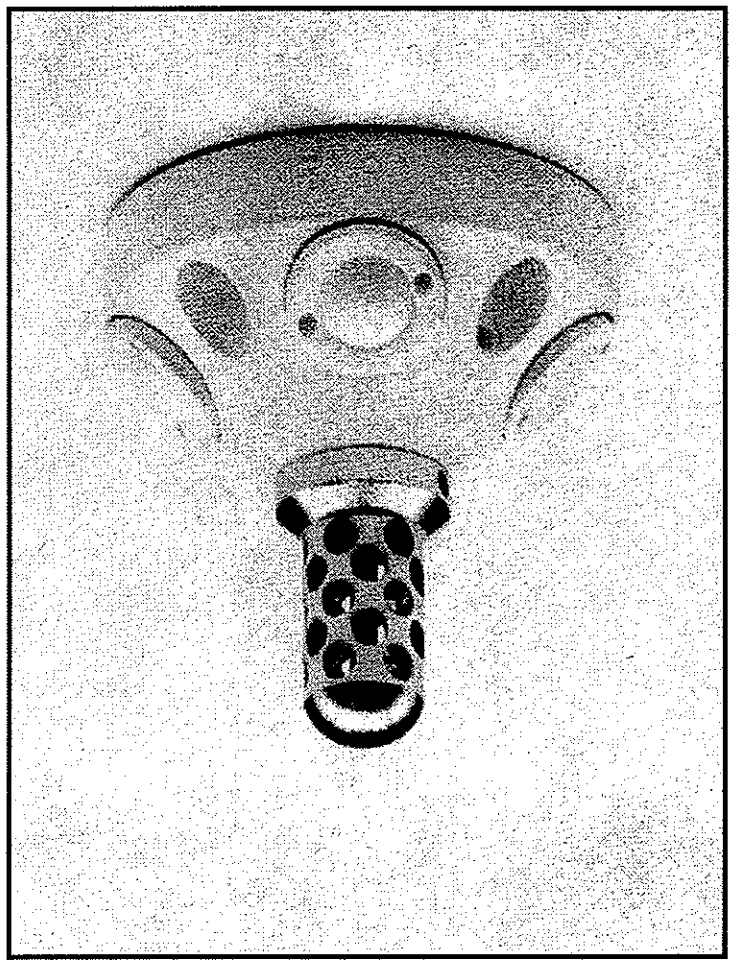
CONCLUSION

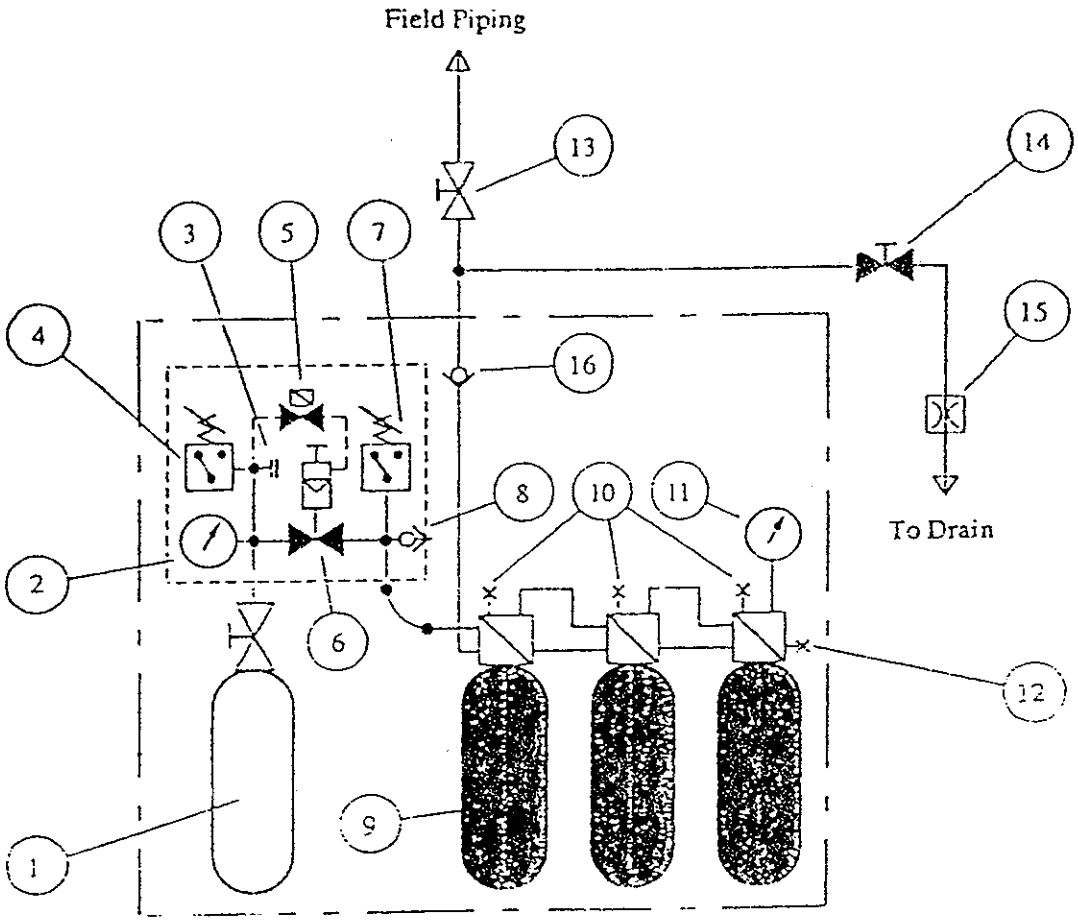
The potential of water mist system in fire extinguishing capability was scientifically established for many specified hazards/applications, particularly where available water supplies are limited or where the application of water is restricted. With proof of positive tests results achieved for its performance objectives, and the superiority over many gas flooding systems in the fields of environmental and personal health factors, there is confidence that the water mist system would emerge as one of the best alternatives of sprinkler system.

Spray Head



Sprinkler Spray Head



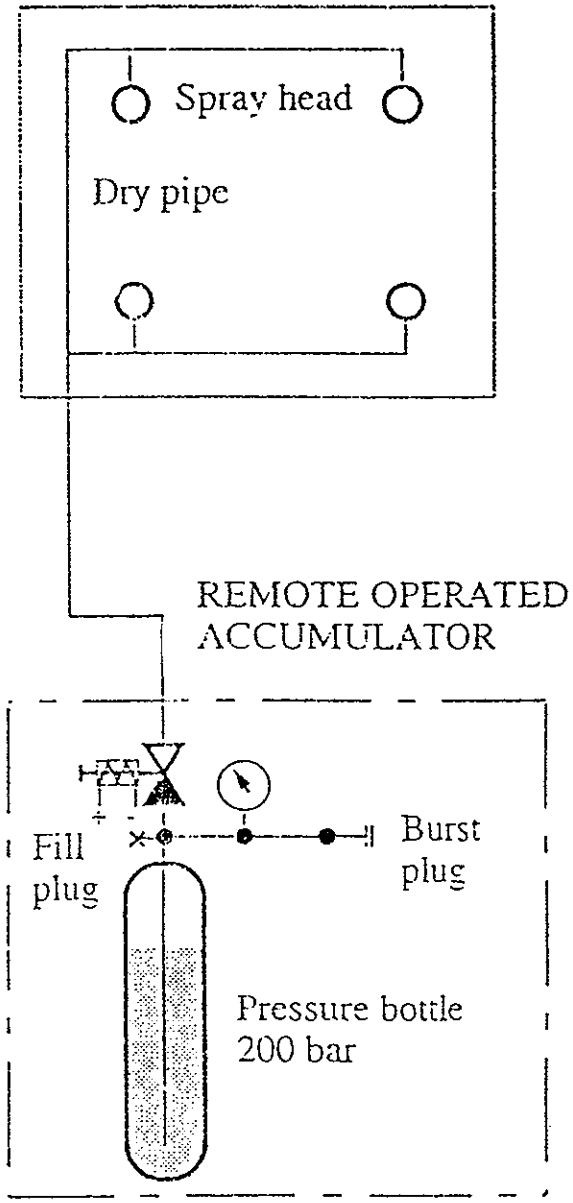


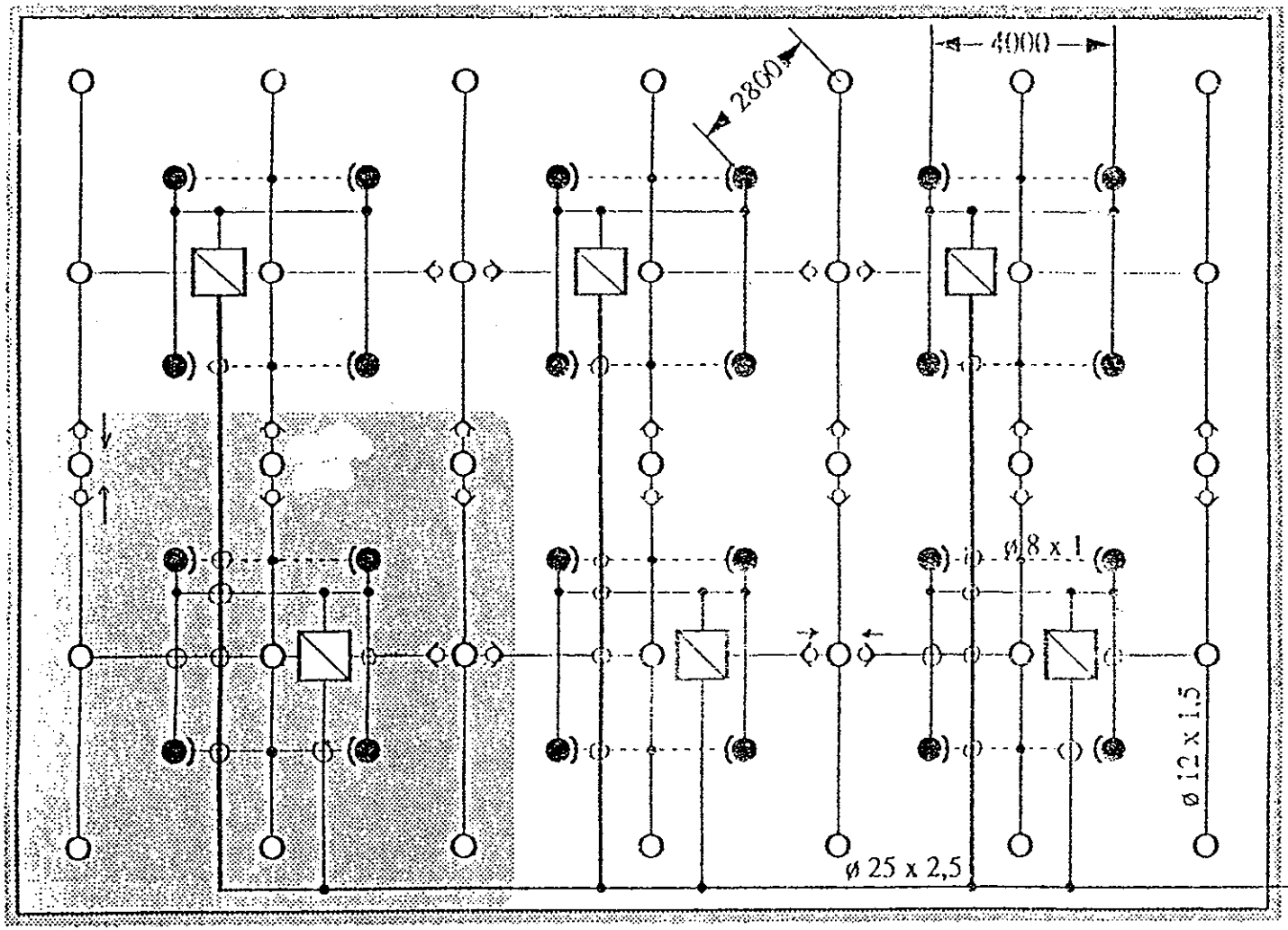
1. Nitrogen Cylinder (10 to 50 L)
2. Pressure Gauge
3. Burst Plug
4. Pressure Switch
5. Electric Solenoid Valve
6. Pneumatic Activation Valve
7. Pressure Switch
8. Micro leakage valve
9. Water Cylinders (20 to 50L)
10. Venting Plugs
11. Pressure Gauge
12. Water Filling Port (Plugged)
13. Isolating Valve *
14. Drain Valve (Test Valve)*
15. Test Orifice
16. Check Valve

Options

* Isolating and drain valve must be monitored

Self-contained system





sprayhead

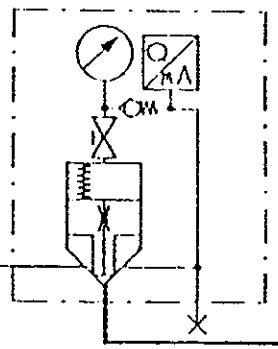
sprinkler

Check valve

Group release valve

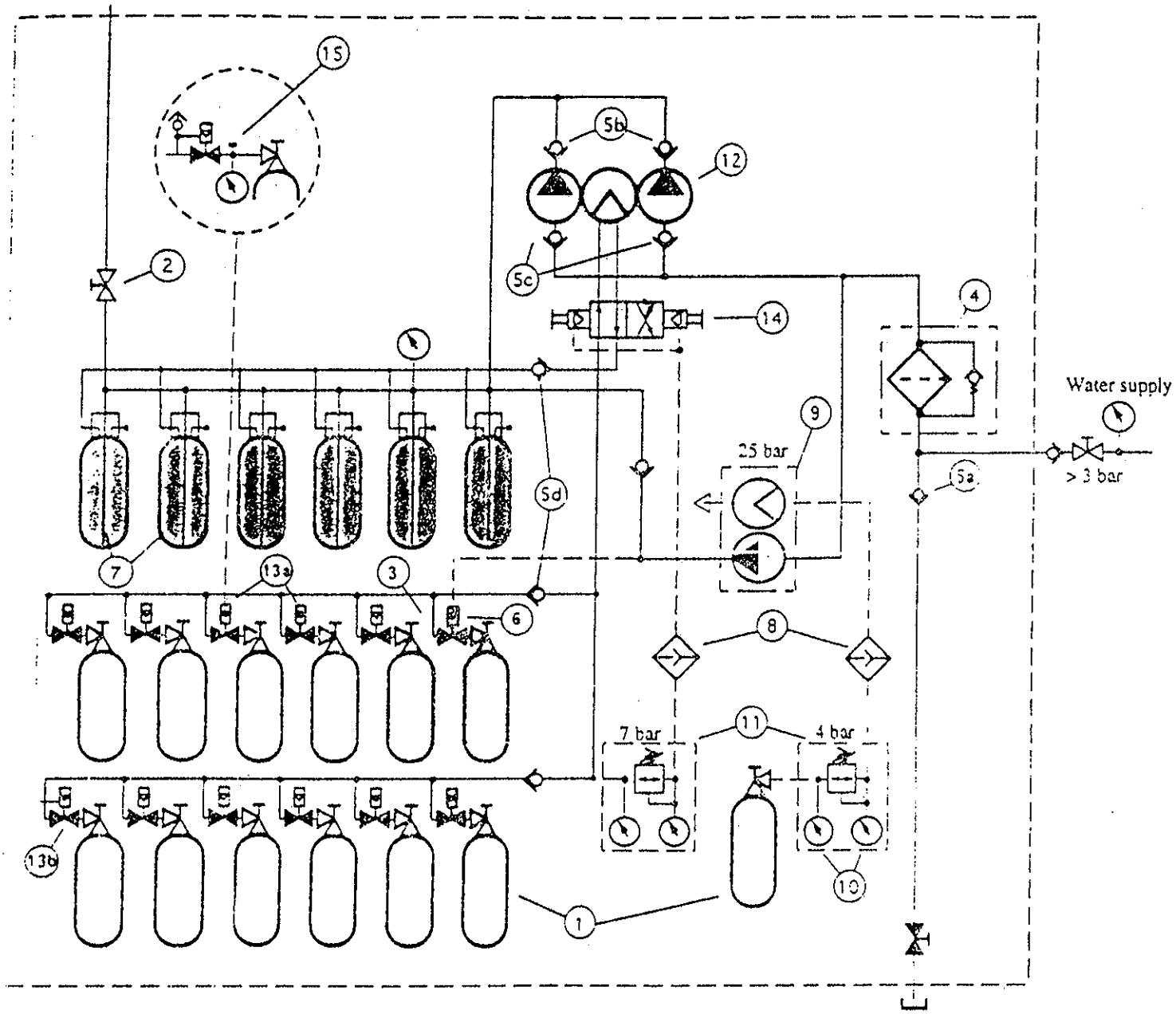
100 m 2 coverage

Section valve



Typical layout including
both spray head and sprinkler head

Appendix C



1. Gas Cylinder (50 L)
2. Shut-off Valve
3. Flexible Hose
4. Filter ≤ 100 µm
5. Check Valve
6. Hydraulic Valve
7. Water Cylinder (50 L)
8. Lubrication Unit
9. Standby Pump
10. Pressure Gauge
11. Pressure Regulator
12. Gas-driven Pump
13. Pneumatic Valve
14. Directional Control Valve
15. Burst Plug

Improvement
In
Fire Safety Inspection Methods

⇒ **Improved LPG Manifold System At Eating Places**

⇒ **Proposed New Feature For Incorporation Into Fire Hose Reel System**

By

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IMPROVED LPG MANIFOLD SYSTEM AT EATING PLACES

CURRENT SYSTEM DESIGN

A typical LPG installation at HDB coffee shops consists of two banks of 6 x 50 kg LPG cylinders (housed in two separate steel cabinets) connected by a manifold pipe work that distributes the gas supply to various stalls in the coffee shops (see Annex A). At any one time only one bank is feeding liquid LPG to a vaporizer which converts liquid LPG into vapour LPG. The other bank acts as standby. A regulator which limits the transmission vapour pressure to 20 psi , a knock out pot (purpose is to collect heavy ends, residues & impurities) and a remote emergency shut-off lever are also installed after the vaporizer.

FACTS ABOUT LPG

2 Liquefied petroleum gas (LPG) vapour mixed with air can be controlled to burn harmlessly to use as a fuel for cooking purposes in eating places. However, if liquid LPG is introduced into the LPG installation system, burning cannot be controlled. This could likely lead to a flash fire.

3 LPG can either consist of pure propane alone, pure butane alone or a mixture of both propane and butane. For pure propane or butane, the boiling point in the liquid state is the same as that of the dew point (temperature at which the vapour LPG condenses into liquid phase) in its gaseous state. As such, pure propane or butane exists in two physical states, i.e vapour or liquid.

THE PROBLEMS

4 The LPG used in Singapore consists of 30% propane and 70% butane. Our local temperature varies from 33^0C to 25^0C. At an ambient temperature of 32^0C, the vapour pressure of the LPG inside the cylinders as well as after passing out from the vaporizer is 66 psi (see Annex B). At this vapour pressure, the dew point (temperature at which the vapour LPG condenses into the liquid phase) is at 35^0C (see Annex C). The vapour LPG on the outlet of the vaporizer is between 50^0C and 70^0C(above the dew point of 35^0C). As vapour LPG travels along the pipeline, the vapour temperature will drop. When this temperature falls below 35^0C, some vapour LPG will be converted to liquid. This means the liquid LPG mixed with vapour will surface at the points of consumption.

5 At night, when the temperature of the surroundings drops to 25°C, vapour LPG in the knock-out pot condenses into liquid and is trapped inside. As the level of the liquid builds up over a period of time, it spills over from the knock-out pot into the pipelines and surfaces at the points of consumption. The danger of liquid in the vapour phase is a likely uncontrolled small flash fire at the points of consumption.

6 If not controlled or prevented, the flash fire will endanger the lives of the general public and especially the end users of the piped gas system from the LPG cylinders.

SMALL FLASH FIRE AT POINT OF CONSUMPTION

7 Recently, there has been a spate of fire incidents involving LPG cylinders installed at eating places where liquid LPG is detected in the vapour line. Fortunately, these are minor incidents and there were no reports of fatalities in these few incidents. Upon investigation, it was found that these incidents arose because of the problem of vapour LPG condensing to liquid LPG downstream of the vaporizer.

8 Arising from the above incidents, checks were carried out to detect the presence of liquid LPG at the knock-out pot at one of the HDB coffee shops from 15/01/2001 to 07/02/2001. The results of the findings were tabulated as shown in Annex D.

9 From the tabulated results, it is noted that liquid was detected in the vapour line when the ambient temperature falls below the dew point of the LPG mixture of 70% butane and 30% propane.

IMPROVEMENT TO CURRENT SYSTEM DESIGN

10 To prevent such incidents of flash fire from occurring at the point of consumption, the following two measures are recommended :

a) Use a **vaporizer** that has a special device to prevent liquid LPG from passing into the vapour line.

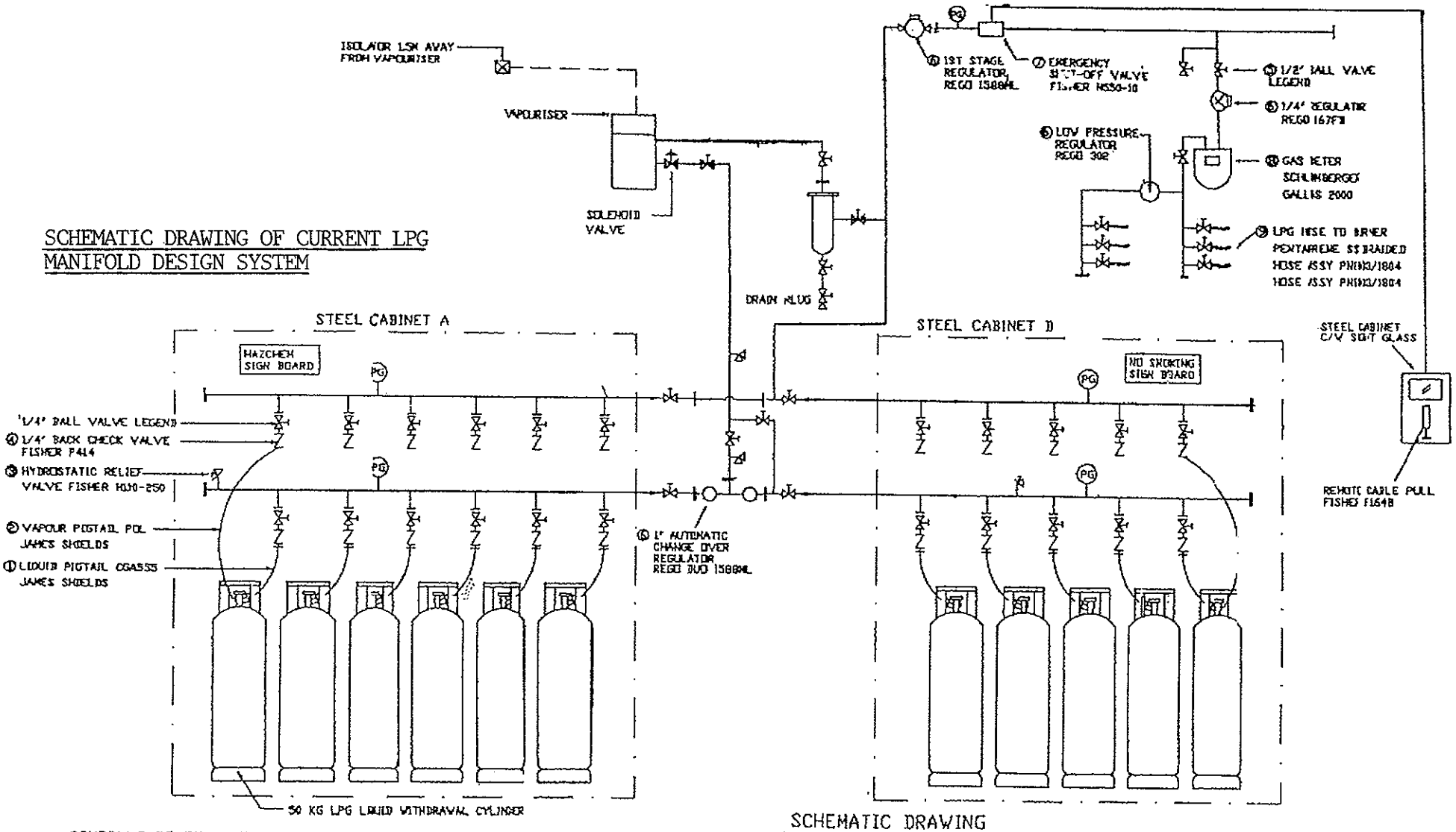
b) Install an **overpressure protection device** before the knock out pot but after the first stage regulator that will automatically shut off the gas supply to the LPG manifold system when the vapour pressure exceeds 25 psi. (see Annex E).

CONCLUSION

11 The systems which have since been installed with special devices in the vaporizers and overpressure protection devices after the first stage regulator are working well. No liquid LPG has since been detected in the knock out pots.

12 Most LPG systems in HDB eating places and factories are already equipped with vaporizers to convert liquid LPG to vapour to meet high demand. PE/QP when designing LPG system using vaporizer is advised to incorporate **a special device (in the vaporizer) and an overpressure protection device** so as to prevent and eliminate the problem of liquid LPG passing into the vapour line, and thereby averting the incidence of flash fires.

SCHEMATIC DRAWING OF CURRENT LPG MANIFOLD DESIGN SYSTEM



SCHEDULE OF FITTINGS	STANDARDS/CODES/UL LISTING
1 LIQUIT PIGTAIL CGA555	: AS/NZ 1869
2 VAPOUT PIGTAIL POL	: AS/NZ 1869
3 HYDRO RELIEF VALVE	: UL 132
4 BACK CHECK VALVE	: UL 407
5 BALL VALVE	: UL 44RR
6 REGULATOR	: UL 144
7 EMERGENCY VALVE	: UL MH 6294
8 GAS METER	: AG 702
9 BURNER HOSE ASSEMBLY	: AS/NZ 1869
10 VAPOURISER	: DIN 2391 CLASS 1 ZONE 2

SCHEMATIC DRAWING PIPED LP GAS SYSTEM

NOTE:

(1) PIPE CONNECTIONS SHALL BE WELDED EXCEPT FOR ENTRY TO EQUIPMENT
(2) STEEL PIPES & FITTINGS TO ASTM A53
(3) COPPER TUBINGS & FITTINGS TO ASTM B88
(4) ALL PIPE THREADS TO BE TAPER THREADS

Annex A

PRESSURE FACTS

In LP-gas work, we take advantage of the fact that pressure attempts to escape", and use it to move gas along the pipe or tubing to the appliance burner. Outside temperature greatly affects container pressure. Too low a container pressure means that not enough gas is able to get to the appliance. The table below shows vapour pressures for different gas mixtures at various outside temperatures.

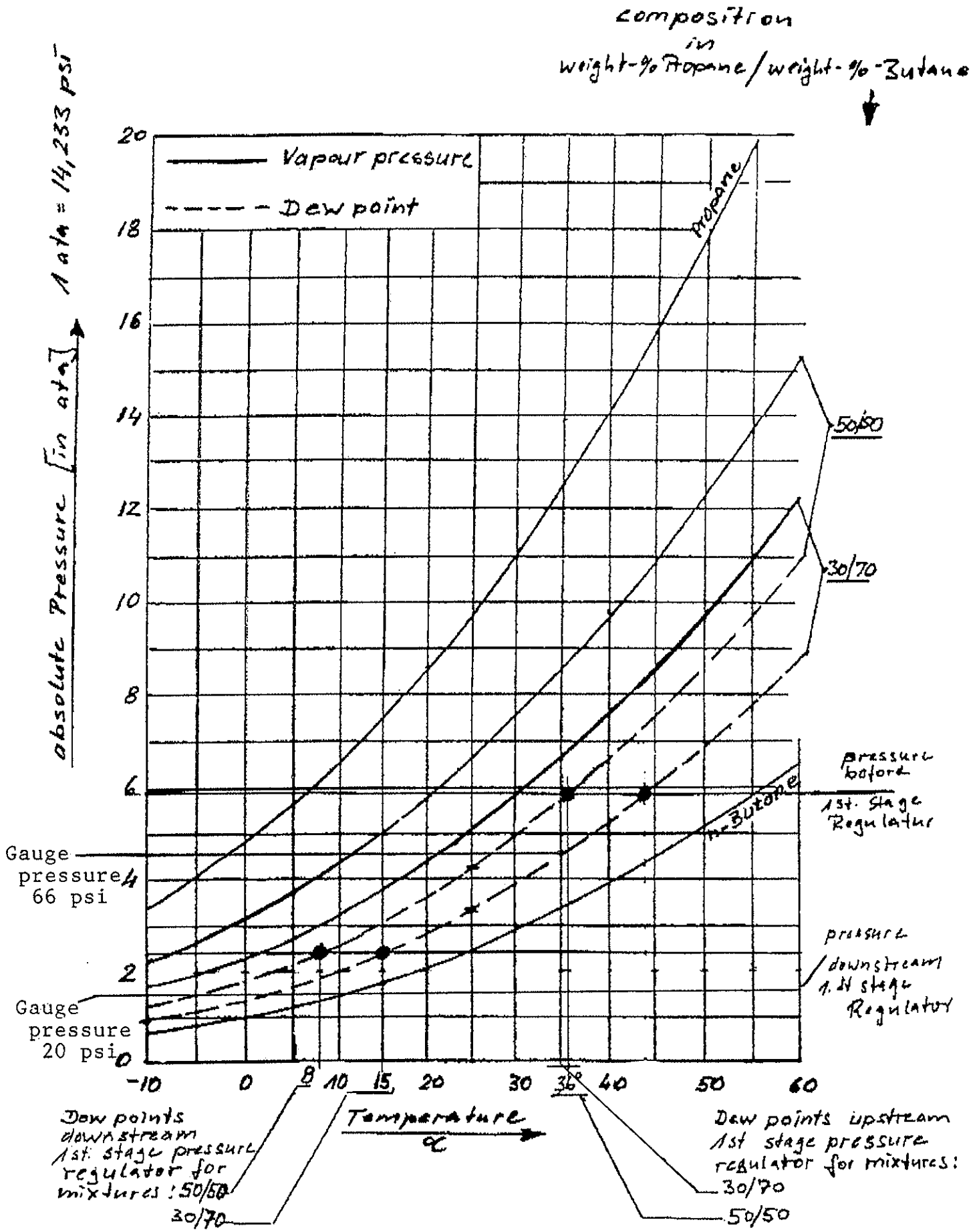
	VAPOUR PRESSURE, PSIG ***OUTSIDE TEMPERATURE, DEGREE FAHRENHEIT***														
	-30	**-20**	**-10**	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**
100% Propane	6.8	11.5	17.5	24.5	34	42	53	65	78	93	110	128	150	177	204
70% Propane 30% Butane	-	4.7	9	15	20.5	28	36.5	46	56	68	82	96	114	134	158
50% Propane 50% Butane	-	-	3.5	7.6	12.3	17.8	24.5	32.4	41	50	61	74	88	104	122
70% Butane 30% Propane	-	-	-	2.3	5.9	10.2	15.4	21.5	28.5	36.5	45	54	66	79	93
100% Propane	-	-	-	-	-	-	-	3.1	6.9	11.5	17	23	30	38	47

Local Use

For a 70% Butane & 30% Propane gas mixture, the vapour pressure is 66 psig when the outside temperature is 32 degree celsius

Annex B

DIAGRAM OF VAPOUR PRESSURE AND DEW POINT FOR MIXED LPG



Annex D

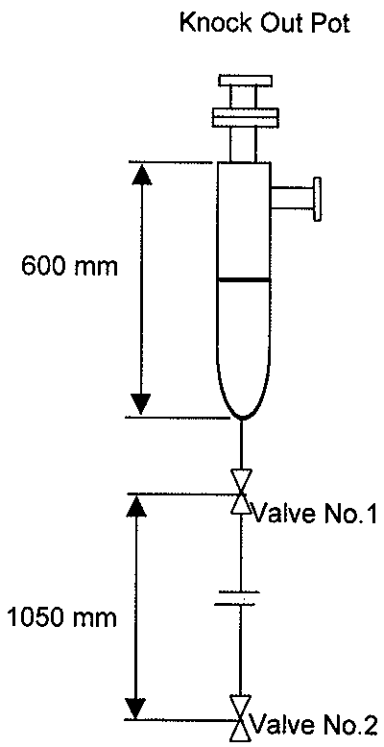
OBSERVATIONS OF VAPOUR LPG CONDENSING TO LIQUID LPG AT KNOCK OUT POT OF A CURRENT SYSTEM DESIGN

DATE	*TIME*	*PRESSURE (psi)*	*TEMPERATURE (Deg C)*	*DEW POINT (Deg C)*	*NUMBER OF PURGES*
15.01.2001	7.45pm	50	28	36	2
16.01.2001	8.45am	30	24	25	1
	6.00pm	50	27	36	6
17.01.2001	8.45am	45	24	33	6
	5.20pm	50	29	36	1
18.01.2001	8.45am	45	29	33	4
	6.30pm	50	30	36	3
19.01.2001	8.45am	47	29	34	2
	5.00pm	45	34	33	0
BREAK					
31.01.2001	8.30am	30	27	25	0
01.02.2001	8.30am	28	27	24	0
02.02.2001	8.30am	50	30	36	6
05.02.2001	8.30am	30	27	25	0
06.02.2001	8.30am	25	27	20	0
07.02.2001	8.30am	50	28	36	6

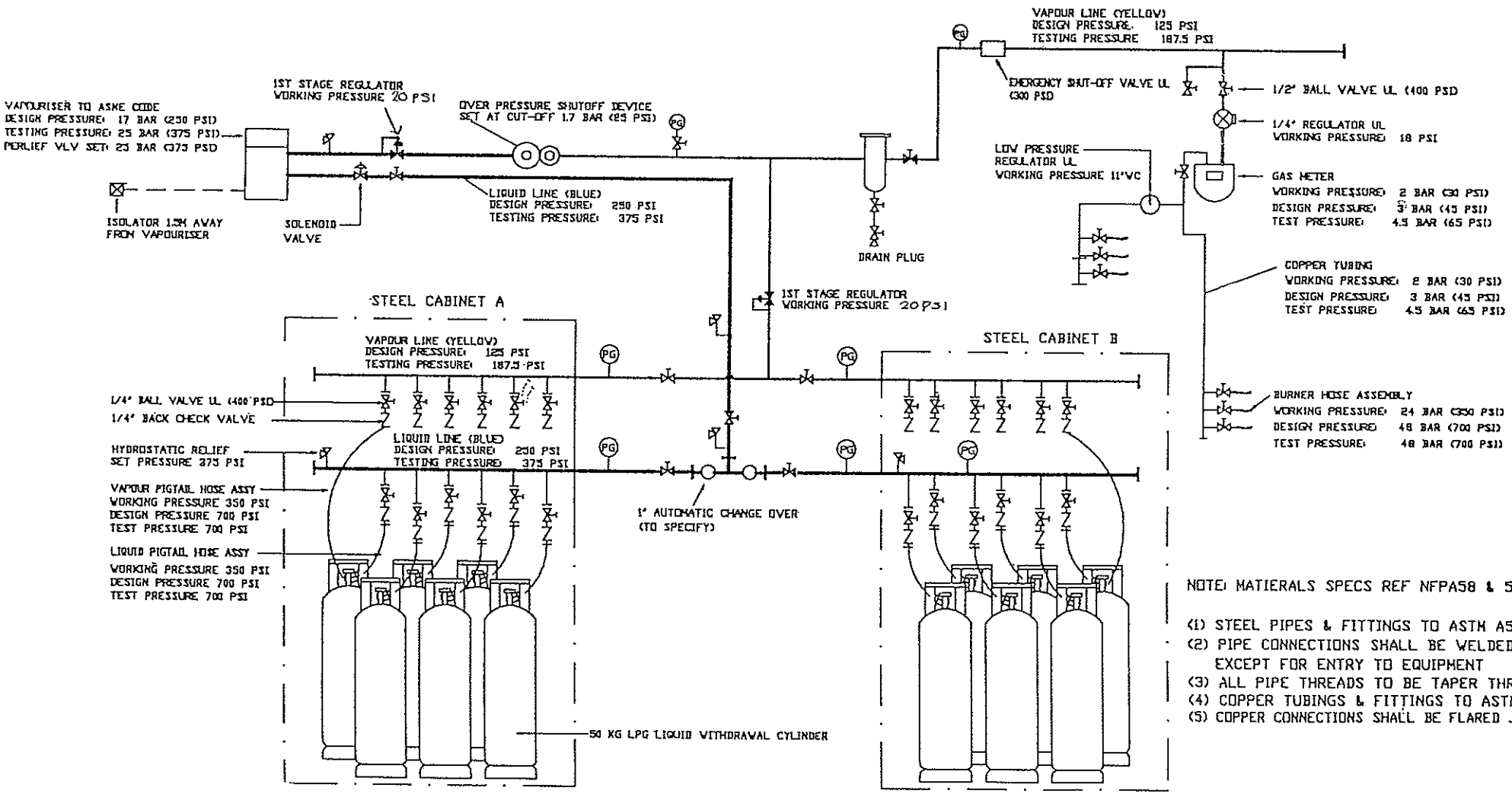
Purging Procedures

1.Open valve No.1 to fill the space between valve No.1 & 2
2.Close valve No.1.
3.Open valve No.1 to purge.
4. Close valve No.2.
5. Repeat step 1 to step 4 until all liquid LPG are drawn off.

Rmks: Normally, valve No. 1 and 2 are closed.



SCHEMATIC DRAWING OF IMPROVED LPG MANIFOLD DESIGN SYSTEM



NOTE: MATIERALS SPECS REF NFPA58 & 54

(1) STEEL PIPES & FITTINGS TO ASTM A53
(2) PIPE CONNECTIONS SHALL BE WELDED EXCEPT FOR ENTRY TO EQUIPMENT
(3) ALL PIPE THREADS TO BE TAPER THREADS
(4) COPPER TUBINGS & FITTINGS TO ASTM B88
(5) COPPER CONNECTIONS SHALL BE FLARED JOINTS

Annex [illegible]

PROPOSED NEW FEATURE FOR INCORPORATION INTO FIRE HOSE REEL SYSTEM

INTRODUCTION

1. Fire Safety Bureau (FSB) has very often over many years, received complaints from the public about misuse / abuse of fire hose reels and requests for enforcement action to be taken against the offenders. It is also common for the public to ask FSB to provide solutions to overcome this problem. Many members of public are of the opinion that since hose reels are required under FSB's guidelines it is then FSB's responsibility to also help control this vandalism problem. FSB has been conducting the normal enforcement action and public education activities to overcome this problem. However, it has also considered that some form of technical solution to the problem be looked into as well. The technical solution should either inhibit or discourage a person from misusing / abusing the hose reel. FSB has recently come up with one such solution and would like to propose its device for this purpose.

AIM

2. The aim of this paper is to present a new feature that can be incorporated into the hose reel system to discourage people from using it other than the purpose it is intended for.

DISCUSSION

3. The concept of preventing the misuse is one based on shocking the culprit and alerting the others in the vicinity. To do this, the use of a high pitched sounder is adopted as the principle design of this feature. The hose reel system shall work in the following manner once this new feature is incorporated:

   " The sounder will emit a high pitch sound whenever the inlet valve is turned on and the sounder will be silenced whenever the inlet valve is turned off ".

4. The use of the high-pitch sounder serves 2 functions. Currently, when a hose reel is used in an actual fire-fighting scenario, there is no alarm activation. As a result, the building occupants will not be alerted to the occurrence of a fire. The hose reel is not linked to the fire alarm system like the other fire systems such as the sprinklers and detectors. Therefore, the installation of a sounder for the hose reel system provides similar benefits to that of the automatic fire alarm system. The sounding of the sounder will automatically alert the people in the vicinity of that particular hose reel and give them time to take evasive action even if the general sounding of the alarm is not present.

5. The 2nd function which was primarily the reason for this new feature to be developed, is to shock and discourage people in their attempt to misuse the hose reel and at the same time alert others in the vicinity about the possible misuse of the hose reel. In such instances, the person committing the offence is likely to turn off the inlet valve immediately and leave the scene to avoid being caught. The new feature also creates the opportunity for an offender to be apprehended. Building owners facing such problems of misuse can exploit the benefits of this new feature by further developing it into a monitored system. This enhances the security, enabling such offenders to be easily located and identified either through physical checks or by a closed-circuit camera system.

DESIGN DETAILS

6. In putting up this proposal, we took into consideration that the new feature must:

   a. Not be too costly such as to outweigh its benefits.
   b. Be of a simple design such that it can be incorporated easily into the design of a hose reel system.
   c. Work effectively to serve the purpose it is designed for.
   d. Be reasonably tampered proof and maintenance free.
   e. Not hinder or affect or change the operation of the hose reel and its efficiency.
   f. Work automatically and does not require re-setting after activation.
   g. Be such that normal servicing is minimal and its cost low.

7. The feature basically comprises 2 components. They are:

   a. The high-pitched sounder.
   b. A flow- switch.

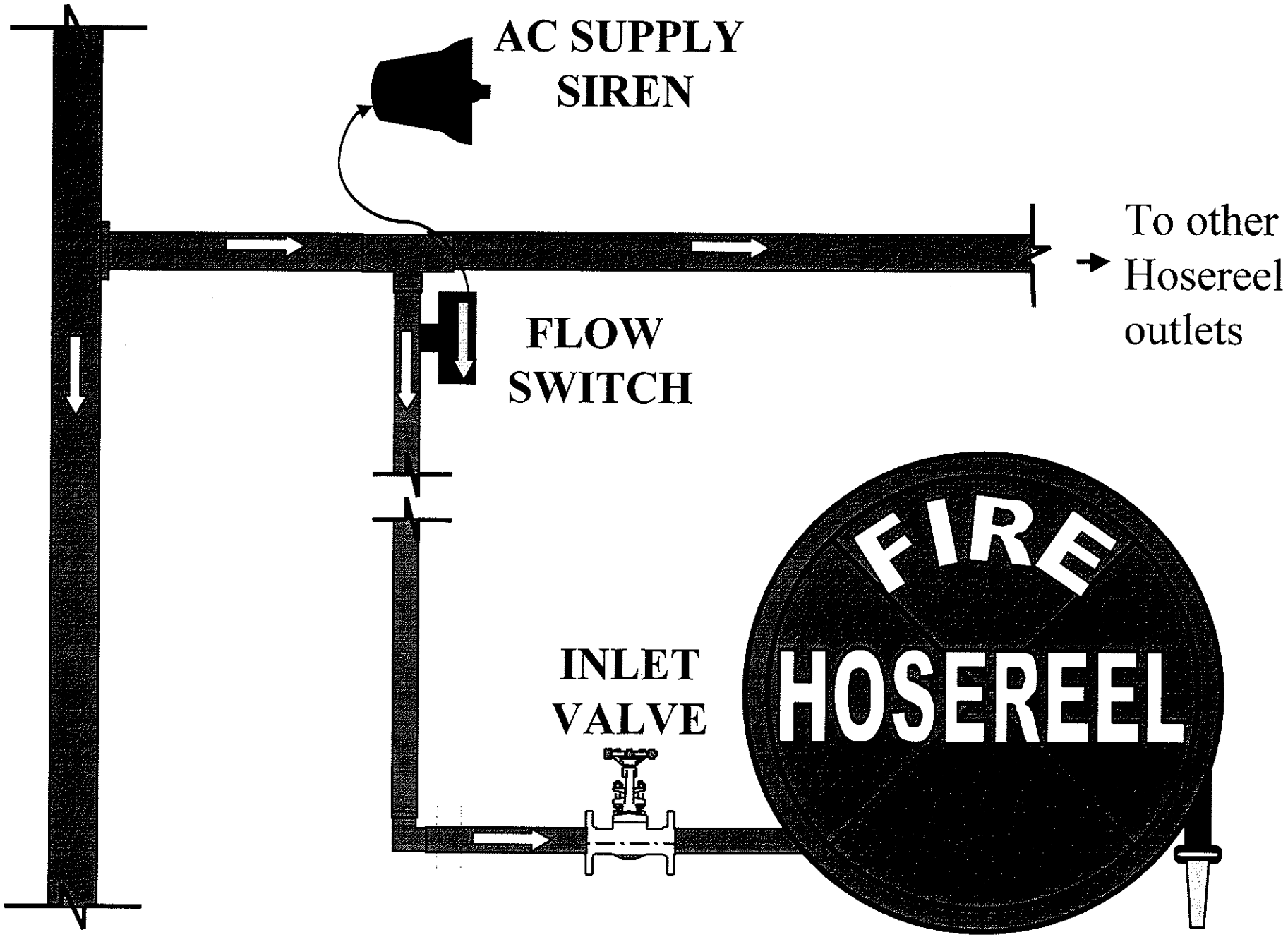
8. The flow- switch is to be installed at the upstream pipe of the hose reel inlet valve. The flow switch is designed to detect a flow of water and when it does so it will send a signal to a receiving device which will be activated. In this case, the receiving device is the high-pitched sounder. Therefore, when the inlet valve is turned on, water will flow through the upstream pipe and the flow switch will detect the movement of water. When the water movement is detected, the flow switch will send a electrical signal to activate the sounder. And the sounder shall emit a high pitched sound. When the inlet valve is turned off, the flow switch shall return to normal and the electrical signal to the sounder shall be cut off and the sounder shall be silenced.

9. The entire feature should be installed at a location that is out of reach to prevent tampering, preferably near ceiling height. The sounder shall be connected directly to a continuous normal power supply source. CP 10 specifies a minimum sound level of 65 dB(A) for fire alarm system and this standard can be adopted for the sounder. The sounder need not necessarily be of the bell or gong type. Other suitable tones may be used but it is preferable that the same type of tone is used throughout the building for this particular purpose. All electrical wiring for this feature shall be installed in accordance to CP 5 – Wiring of Electrical Equipment in Buildings.

10. In selecting the flow switch, the minimum flowrate requirement 0.4 litres per second for a hose reel should be taken into consideration. To avoid false alarms due to minor water leakage and water surges, a value of 0.05 litre per second can be adopted for the flow switch to transmit the electrical signal to activate the sounder. A simple schematic diagram of the feature is shown in the Annex. The feature can be extended such as to become a monitored system for fire hose reels. This can be done simply by linking the flow switches to sub alarm panels and to the main alarm panel. Therefore, whenever a flow switch is activated, it will in turn activate the corresponding audible and visual indicator for hose reels on the main alarm panel.

CONCLUSION

11. The proposal will not be made mandatory and it is up to building owners to consider whether they would like to incorporate the feature. A short clause on this matter will be included in CP 29 – Fire Hydrant Systems and Hose Reels. We hope building owners will find this proposal practical and worthwhile. Building owners may also consider developing or introducing their own systems using the same principles. Building owners may also like to further develop on this proposal and extend it such that it becomes a monitored system. This may be advantageous in large buildings where very likely a security system is already in place to complement it. The feature need only be installed for those hose reels that are sited at locations where they are likely to be misused. We believe that the incorporation of this feature will discourage / prevent the misuse of hose reel and solve a perennial problem.


AC SUPPLY
SIREN
To other
Hosereel
outlets
FLOW
SWITCH
INLET
VALVE
FIRE
HOSEREEL

FSB Plan Fee Computation Guidelines

By

Ms Nancy Ang Ai Hua

Plan Processing Officer, Industrial Section

Plans Approval & Consultation Branch

Fire Safety Bureau

FSB PLAN FEE COMPUTATION GUIDELINES

1. Introduction

1.1 FSB has received feedback that there is some confusion relating to the methods of plan fee computation. In the light of this, FSB recently studied the various types of fire safety works commonly submitted for approval by Qualified Persons (QPs) and provided guidelines on how the plan fee for approval should be computed for each of these types of fire safety works.

2. Objective

2.1 The main objective of these guidelines is to streamline the various methods of plan fee computation so as to assist the QPs in their plan submission.

2.2 With these proposed guidelines, we hope to achieve consistency in computing the plan fee chargeable for fire safety works.

3. Points to Note

3.1 FSB would like to highlight that there is no change made to the plan fee structure provided in the Fire Safety Act.

3.2 Please bear in mind that the list is not exhaustive and serves only as a guide to improve clarity on plan fee computation. We would like to take this opportunity to advise QPs to seek consultation at our counters if they need any clarification..

FSB PLAN FEE

COMPUTATION GUIDELINES

OBJECTIVE

- To streamline the various methods of plan fee computation so as to assist the QPs in their plan submission.
- To achieve consistency in computing the plan fee chargeable for fire safety works.

POINTS TO NOTE

- There is no change to the Plan Fee Fee Structure provided in the FSA.
- The list is not exhaustive and serves only as a guide to improve clarity on fee computation.

New Fire Safety Works
Plan Fee Charged at $150 / 100 m^2

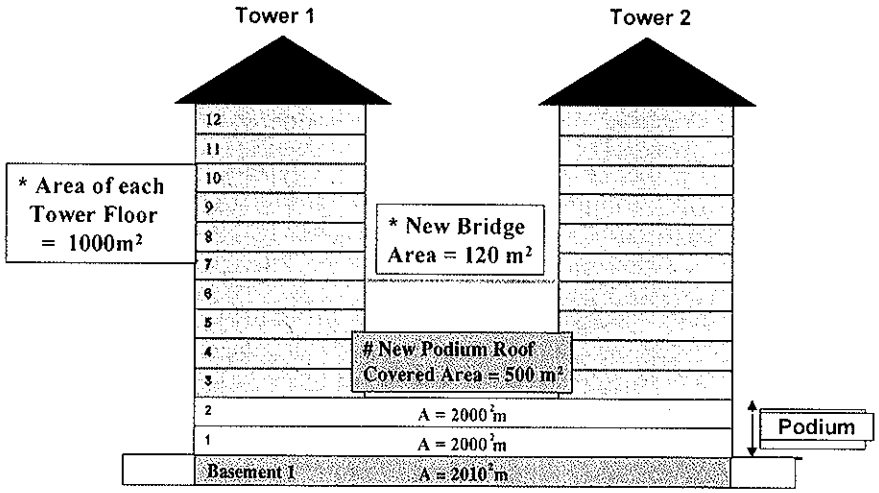
- New Building Works *
- New Extension
- New Covered Walkway
- New Shed
- New Structure for Proprietary Equipment erected outside the Building [eg tanks, generator set, processing plant, etc]
- New Mezzanine Floor * / Attic
- New Covered Roof Area which is Accessible from the Building
- New Covered & Uncovered Platform [including perforated type]

New Fire Safety Works
Plan Fee Charged at $150 / 100 m^2

- Reconstruction of Building
- New Underground * / Aboveground Tank
- New Covered Swimming Pool
- New Covered & Uncovered Bridges
- New Tunnels
- New Awnings having a horizontal projection equal to & exceeding 1.4m *
- New Containers *
- New Wharves / Jetties / Slipways

Example 1

Proposed 12-Storey Building comprising of Two 10-Storey Tower Blocks and a 2-Storey Podium Block with a Basement



Example 1

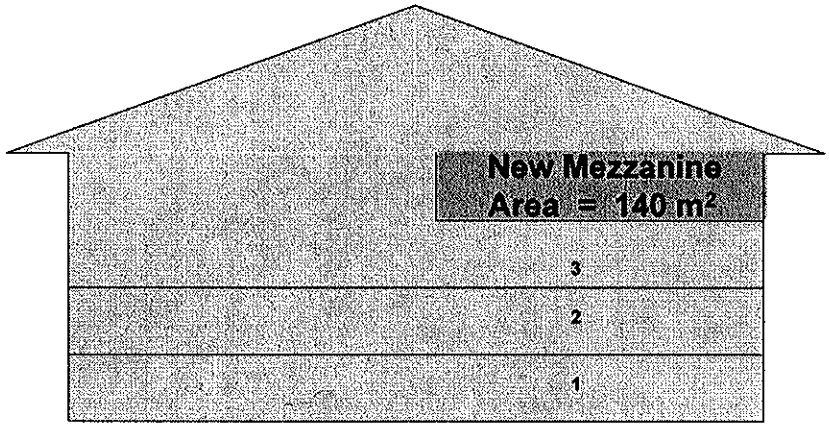
The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the installation of Fire Safety measures shall be $150 for every 100 m² of floor area or part thereof.

The computation shall include the Bridge and the Podium Roof which is covered and accessible from the Building.

Type of Works	Floor Area	Total Floor Area	Plan Fee Rate	Plan Fee Payable
Fire Safety Works	1 basement floor = 2010m² 2 podium floor = 4000m² 20 tower floors = 20000m² *podium roof = 500m² *bridge = 120m²	26630m²	267 x $150/100m²	$40050
Total Fee Payable : $40050				

Example 2

Proposed Mezzanine Floor to Existing Building



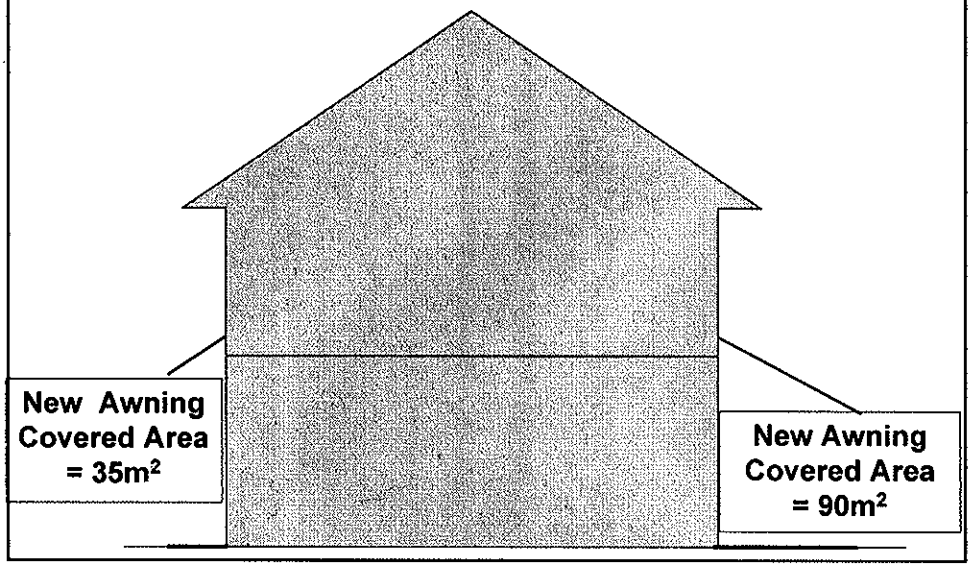
Example 2

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the installation of Fire Safety measures shall be $150 for every 100 m² of floor area or part thereof.

Type of Works	Floor Area	Plan Fee Rate	Plan Fee Payable
Proposed Mezzanine Floor	140m²	2 x $150/ 100m²	$300
Total Fee Payable : $300			

Example 3

Proposed Awning to Existing Building



Example 3

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the installation of Fire Safety measures shall be $150 for every 100 m² of floor area or part thereof.

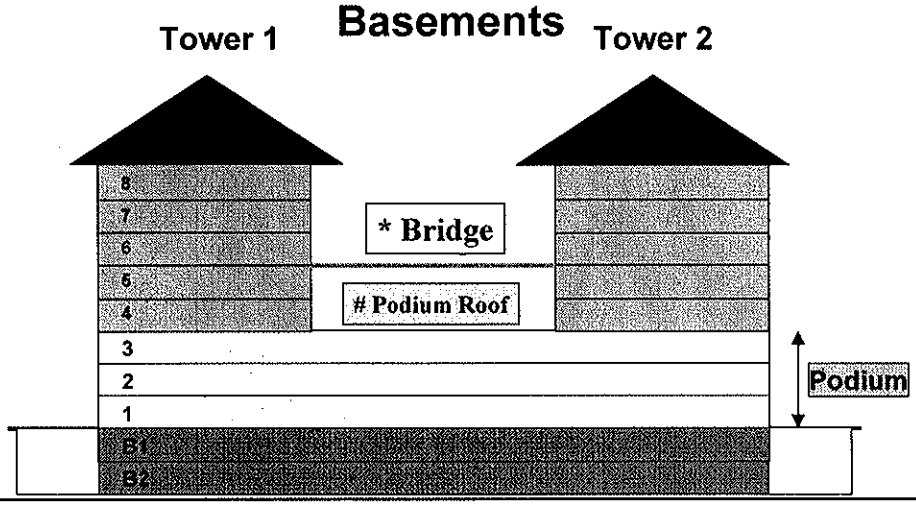
Type of Works	Floor Area	Plan fee Rate	Plan Fee Payable
Awning	125m²	2 x $150/100m²	$300
Total Fee payable : $300			

Other Fire Safety Works
Plan Fee Charged at $75 / Floor

- M & E Works *
- Additions / Alterations to Existing Building
- Change of Use
- Amendment to Existing Building *
- Change of Roof Materials *
- Replacement of Existing Covered Walkway * & Bridges
- Claddings

Example 4

Proposed Amendment Works to a 8-Storey Building comprising of Two 5-Storey Tower Blocks and a 3-Storey Podium Block with 2 Basements



Example 4

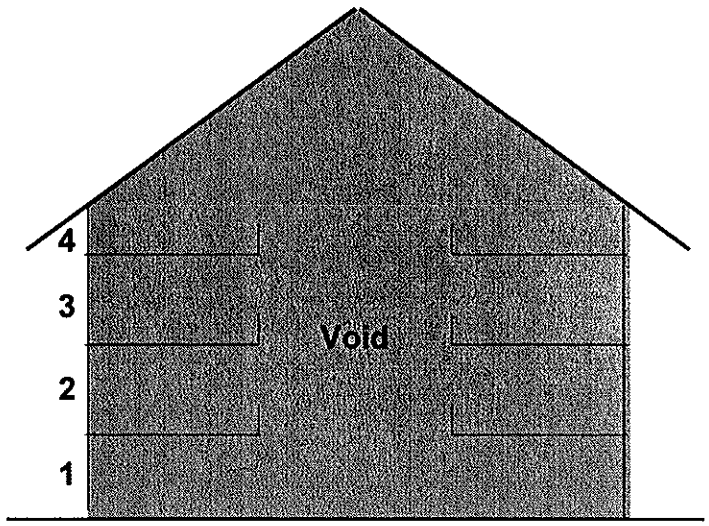
The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the provision of New Fire Protection Works or Minor Works shall be $75 for each storey.

The Bridge and the Podium Roof shall be computed separately at $75 / Storey.

Type of Works	Storeys Affected	No. of Storeys Affected	Plan Fee Rate	Plan Fee Payable
Amendment Works	B1 & B2	2 basement floors	2 x $75/storey	$150
	1st to 3rd sty	3 podium floors	3 x $75/storey	$225
	4th to 8th sty	2 x 5 tower floors	10 x $75/storey	$750
	bridge	*bridge	1 x $75/storey	$75
	podium roof	#podium roof	1 x $75/storey	$75
Total Fee Payable : $1275				

Example 5

Proposed Amendments to 1st to 4th Storey of Existing Building



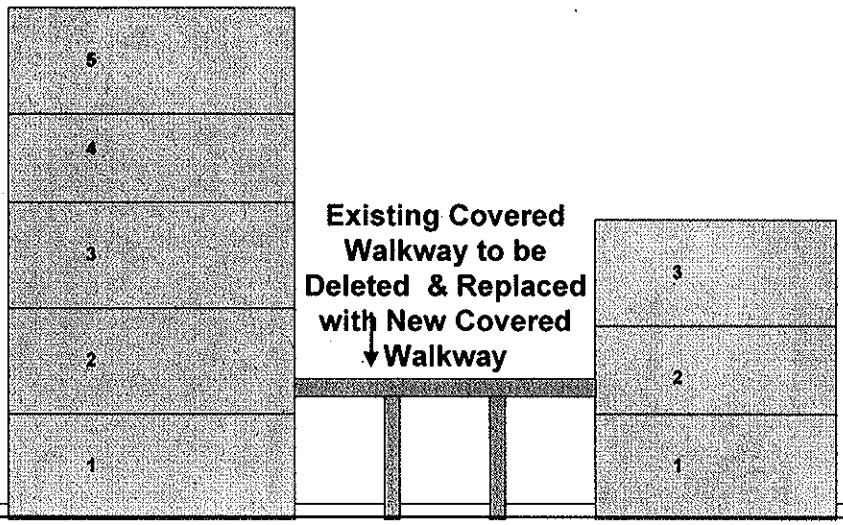
Example 5

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the provision of New Fire Protection Works or Minor Works shall be $75 for each Storey

Type of Works	No. of Storeys Affected	Plan Fee Rate	Plan Fee Payable
Amendments to approved fire safety works	4	4 x $75/storey	$300
Total Fee Payable : $300			

Example 6

Proposed Replacement of Existing Covered Walkway



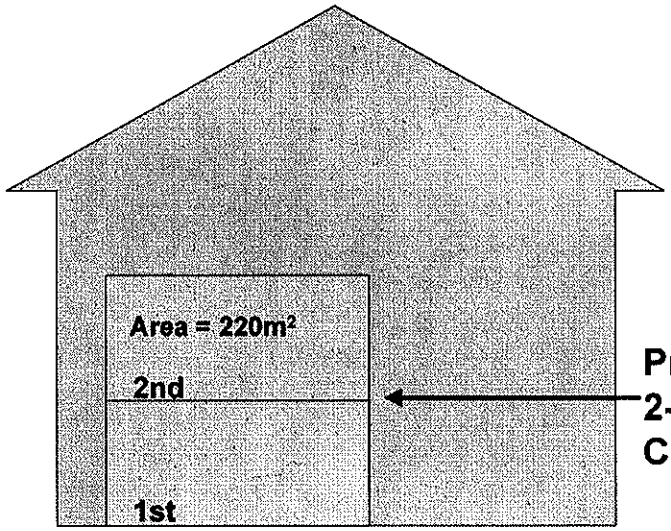
Example 6

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the Provision of New Fire Protection Works or Minor Works shall be $75 for each Storey.

Type of Works	No. of Storey Affected	Plan Fee Rate	Plan Fee Payable	
Walkway	1	1 x $75 / Storey	$75	
Total Fee Payable : $75				

Example 7

Proposed 2-Storey Container to Existing Building



Example 7

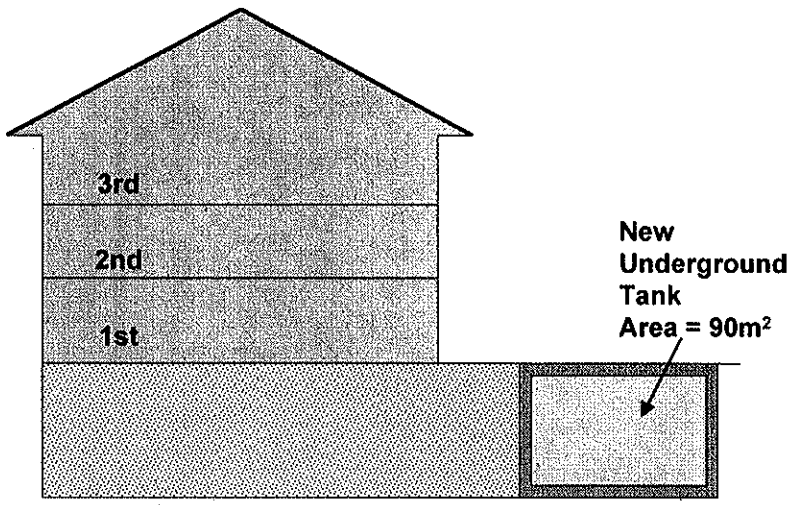
The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the installation of Fire Safety measures shall be $150 for every 100 m² of floor area or part thereof.

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the provision of new Fire Protection Works or Minor Works shall be $75 for each Storey.

Type of Works	Floor Area/ No. of Storey Affected	Plan Fee Rate	Plan Fee Payable
1st Storey	1	1 x $75/storey	$75
2nd Storey	220m²	3 x $150 /100m²	$450
Total Fee Payable : $525			

Example 8

Proposed Change of Roof Materials & Proposed Underground Tank



Example 8

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the installation of Fire Safety measures shall be $150 for every 100 m² of floor area or part thereof.

The Fee payable for any Application for Approval of Plans of Fire Safety Works under Part IV of the Act which involves the provision of New Fire Protection Works or Minor Works shall be $75 for each Storey.

Type of Works	Floor Area/ No. of Storey Affected	Plan Fee Rate	Plan Fee Payable
Change of Roof Materials	1	1 x $75/storey	$75
Underground Tank	90m²	1 x $150 / 100m²	$150
Total Fee Payable : $225			

Plan Fee Charged at $75 / Submission

- Minor A / A Plans [MAA Plans]
- Installation of Piping System for Flammable Liquid / Gas
- New Open rooftop Carpark
- New Open Swimming Pool located Within the Building

MISCELLANEOUS

- Waiver shall be Charged at $100 per Waiver Item
- No Payment is Required for Consultation Service
- The Fee for an Application for Approval of Building Materials used for Construction or Structural Assemblies, Installations, Equipment & Components shall be $100

Typical Plan Submissions
[Which are Not Mandatory]

- Open Walkway
- Open Landscape
- Open Carpark located Outside the Building

If Plan Submissions which are Not Mandatory are Submitted, they shall be Charged at $75 per Submission

Exemption List
(Extracted from the Fire Safety Act)

Plans Involving Only the Followings shall be Rejected at our Front Counter

- Detached Dwellings Not Exceeding 3 Storeys or 3 Levels, including Basement
- Alterations & Additions to Residential Flats, Maisonettes, Townhouses which Do Not Increase the Floor Area or Affect the Common Areas, Entrance Doors, or Walls Separating the Residential Units from the Common Areas
- Swimming Pools in Detached, Semi-Detached and Terrace Houses

Exemption List

- Retaining Walls, Fences and Boundary Walls
- Guard Houses
- Detached Bin Centres
- Oil Sumps and Grease Interceptors
- Chimneys
- Awnings over Windows and Doorways
- Flag Poles and Signboards
- Cooling Towers
- Automated Teller Machines, Ticket Kiosks and Taxi Kiosks, Not being Part of a Building
- Goliath Cranes at Shipyards
- Standalone Single Storey Substation not exceeding 22KV & Standalone Single Storey MDF Room