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The Use Of Intumescent Paints For Protection To Structural Steel

By

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THE USE OF INTUMESCENT PAINTS FOR PROTECTION TO STRUCTURAL STEEL

INTRODUCTION

1. The use of steel structures as part of the architectural feature in today's modern building design is becoming increasingly popular. As more emphasis is placed on aesthetics as well as buildability in today's building design, it is envisaged that more consultants will adopt bare steel design in the construction of buildings. This is especially so as countries, including Singapore, have adopted or will be adopting performance based design for fire safety. However, when steel structure is expressed in this manner, it is important to protect the steel structures from exposure to the heat produced by building fires. This is because unprotected structural steel loses its strength at high temperatures.

2. The most common and satisfactory method of protecting structural steel members is by encasing them in masonry construction e.g. concrete, brick-wall, etc. to increase its fire resistance. This method of protection though reliable, would however deprive the advantage of having exposed steel in procuring excellent aesthetical view. In addition, the process of construction is onerous and time consuming.

3. Beside the conventional method, there are other ways of passive fire protection such as fire-rated board, sprays, intumescent paint etc that can be utilised for protection of structural steel. This paper discusses how intumescent paint can be used for protection to structural steel members in buildings.

BASIS OF ACCEPTANCE OF THE USE OF INTUMESCENT PAINTS FOR PROTECTION TO STRUCTURAL STEEL

4. In the context of Fire Code, intumescent paint is not permitted to be used as a passive protection system for the following reasons:

a. Initial lack of a comprehensive testing method to determine the environmental effect on the intumescent paint.

b. The chemicals used in the paint may deteriorate over time and thus affect its service life. This deterioration may take the form of colour fading, chalking, peeling, or corrosion.

c. Inherent property of intumescent paint may be affected if a different type of paint is unknowingly coated over it or if chemical agents are used to clean its surface.

5. After the joined study between FSSB, PSB and the various professional bodies, FSSB has decided to allow intumescent paint as an alternative mean for protection to structural steel based on the understanding that:

a. The performance of intumescent paints for protection of structural steel, in terms of insulation property, could be assessed by fire tests to derive the appropriate thickness of paints in order to match the various grades and sizes of steel. The intumescent paint would be assessed together with the solvent (water or organic-based).

b. Test methods are made available for evaluating the durability of intumescent paints under different environmental conditions with high humidity.

c. Coating of the paint system will be carried out by 'specialists', who are appointed and trained by manufacturer/supplier.

MECHANISM OF INTUMESCENT PAINT SYSTEMS

6. Fundamentally, intumescent paint consists of a layer of primer (0.05-0.1 mm thickness), the intumescent paint (0.5- 6 mm thickness) and a decorative and protective top coating (0.05-0.1 mm thickness). Intumescent paint is normally in mixture form with different types of solvents, either water, epoxy or acrylic.

7. When intumescent paint is exposed to heat, it gradually swells due to the resulting endothermic reaction and produces a thick insulating charred layer on the surface of structural steel. The charred layer can be 50 times thicker than the original paint layer thickness. Due to its of low conductive property, the charred layer is able to maintain its temperature approximately between 200°C and 250°C. While the charred layer is expanding, it simultaneously blocks off massive heat transfer from the fire to the surface of the structural steel. This way, the charred layer prevents the structural steel from reaching its critical temperature, at which point, the steel is liable to collapse. Generally the critical temperature of steel is about 550°C, depending on its grade and thickness.

8. Basically, the thickness of intumescent paint needed to protect a particular steel member depends on the Section Factor (Hp/A) which is being defined as below:

Perimeter of the steel exposed to flames—Hp

The cross-sectional area of the section—A

Section Factor = Hp/A



High Hp, low A, fast heating

Low Hp, high A, slow heating

9. A series of fire tests must be conducted for a particular grade of structural steel element in order to derive a sustainable table containing a range of thickness of intumescent paint. The tests are also carried out in relation to the various sizes (expressed in Hp/A) of the structure element for fire resistance rating ranging from ½-hr to 4-hr. The tests have shown that heavy sections (lower Hp/A) heat up more slowly than light sections (higher Hp/A). Therefore, a heavy section requires less insulation then a light section. In other words, for a specific fire resistance rating, thickness of intumescent paint to be applied on a heavy section is comparatively thinner than that to be applied on a light section.

ADVANTAGES COATING OF INTUMESCENT PAINT TO STRUCTURAL STEEL MEMBERS

10. The primary advantages, amongst the many others, in using intumescent paints to protect structural steel members are :

a. The thin film coatings allow the underlying steel to be expressed for aesthetic purposes while still providing the required fire resistance rating. Such a protection system offers the building designers an additional option, and the structural steel members need no longer be hidden behind masonry works or dry board.

b. The weight of the thin layer coatings is very light and thus allows greater spans to be achieved within the building structure. This is particularly useful when designing large bay warehouse and sports stadium, for example.

CRITERIA OF ACCEPTANCE

13. In considering the use of intumescent paint for protection to steel structures, two fundamental areas needed to be addressed, namely its fire resistance performance and durability under high humidity environment. In this respect, FSSB has decided to adopt

BS 8202: Part 2:1992— "Code of practice for the use of intumescent coating systems to metallic substrates for providing fire resistance" for evaluating the performance of intumescent paints. The relevant requirements for the intumescent paints are covered under the standard which encompasses a wide scope including guidance on appraisal of fire test data; methods of assessing durability and ageing; methods of application and site quality control procedures and maintenance in use.

14. The standard requires that steel members be subjected to simulated test environments similar to the indoor and outdoor environments that the steel coated with intumescent paint would be exposed to in actual applications. The intumescent paint is deemed to have met the criteria of weathering tests if the weathered specimens are able to achieve fire resistance performance, when subjected to fire test BS 476 Part 21, of not less than 75% of the control specimen (specimen that has not exposed to weathering tests).

CONSIDERATIONS RELEVANT TO INSTALLATION OF INTUMESCENT PAINT

15. Apart from the fire-resistant materials used to protect the structural skeleton, there are other factors that fundamental to the fire safety in buildings. Ignorance of these factors can lead to a premature collapse of the building in the event of a fire. These are:

a. A basic understanding of the principles of passive fire protection and regulations as applied to buildings.

b. Comprehensive knowledge of the installation requirements of the 'specialist materials' being used, in this case intumescent paint and its associated components, and the structural steel.

c. Recognising the proprietary work specific to each intumescent paint system.

d. A need to apply the correct calculated or determined level of intumescent paint protection.

e. A need to conduct periodical checks.

16. To address these considerations, it is important to set-up basic training in both technical (knowledge of fire safety) and practical (knowledge of installation of passive fire protection system) aspects for persons responsible, including fire safety managers, in installing, inspecting as well as maintaining the completed fire safety works.

17. The need for training in the practical aspect can be addressed under the PSB Product Listing Scheme (PLS). Under this scheme, licensees are required to provide basic

training for the installers who are 'registered' with them to do the installation of passive fire protection systems. The scheduled training program is included in the 'Product Quality Assurance Scheme Plan', a requisite document under the Product Listing Scheme. This way, installers will be trained and equipped with the basic skills to install the listed intumescent paint system.

AREAS OF APPLICATION

18. Intumescent paints may be be approved as for use as passive fire protection system for steel beams and columns with the following conditions :

a. Intumescent paint is not permitted for industrial buildings (Purpose Group VI & VIII).

b. (i) For buildings less than 24m habitable height, the structural columns and beams can be protected by intumescent paint systems.

(ii) For buildings more than 24m habitable height, only the structural beams, excluding load transfer beams, are allowed to be protected by inumescent paint systems.

The restriction on the height of the building is to minimize the grave consequence of a structural failure of the essential columns and beams for higher buildings under fire situation.

c. For purpose of determining the fire resistance performance, intumescent paints shall be subjected to the test of BS 476 Pt 21 or its equivalent, which include ASTM E119, AS 1530 Pt 4, ISO 834, etc., so long as the standard adopted is of a national level and that the laboratories conducting the fire tests are accredited in accordance with the ISO standard.

d. Intumescent paints shall be subjected to weathering tests as detailed in BS 8202: Part 2: 1992. A fire test for fire resistance performance shall be conducted to the specimens after the weathering tests. The fire resistance rating of the tested specimen shall be maintained not less than 75% of the original prototype.

e. Project QP shall submit a separate set of plan indicating the locations of the structural steel members that are coated with intumescent paint. If building exceeds 24m in habitable height, the plan shall be submitted together with a fire safety report.

f. Intumescent paint systems shall be listed under PSB's Product Listing Scheme.

g. A signage depicting at least the following information shall be prominently displayed :

i) Name of supplier.

ii) Rating of the intumescent paint.

iii) Date of the installation and next expected date of re-painting.

iv) Caution note that no other paint/coating can be applied to the surface of intumescent paint.

h. In terms of operation and maintenance, the following shall be complied with :

i) The Fire Safety Manager (FSM) shall carry out regular inspection checks to ensure that the intumescent paint is not damaged or tempered with.

ii) For any form of additions & alteration works :-

- The Owner or Tenants, assisted by the FSM, must engage a Qualified Person (Registered Architect/ Civil or Structural PE) who will submit building plans to SCDF. The building plans shall be accompanied by the QP's declaration as to whether the existing columns or beams coated with the intumescent paint are affected.

- Certificate of Registered Inspector (RI) inspection is required. This can be done by a Registered Architect or Civil/Structural PE.

- The Fire Safety Report shall be updated accordingly

iii) For buildings which require a Fire Certificate:-

- The annual renewal of the Fire Certificate shall also include the inspection of the columns and beams coated with intumescent paint.

- The inspection is to be carried out by a Registered Architect or Civil/Structural PE.

iv) The owner shall undertake to adhere to the manufacturer's specifications. For example, the manufacturer can specify the paint durability to be 5 years before re-painting is required. The owner therefore has to undertake to adhere to this requirement. However, the manufacturer shall be able to specify the reliability of the paint system from test observations recorded after the intumescent coating is continually exposed to specific spray tests for a certain number of hours.

i. There shall be no highly flammable/combustible materials stored within the vicinity where structural steel members protected by intumescent paint. Protection to steel members depends on the thickness of the charred layer of intumescent paint. The abrupt rise in temperature may cause adverse effects to the expansion of charred layer thus causing the steel members to lose their loading strength before the paint could be fully intumescesed.

CONCLUSION

19. The use of intumescent paint systems can provide the building designer with added flexibility in material selection. This allows for more innovative designs. The building industry can also benefit from the enhanced buildability from the use of intumescent paint structural steel protection.

Field Modeling
It's Use In Analysing
The Air-Well Design

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FIELD MODELLING – IT'S USE IN ANALYSING THE AIR-WELL DESIGN

INTRODUCTION

The Code of Practice for Fire Precautions in Buildings, 1997 permits the design of air-wells (Clause 2.2.13 (a)(iii)) with dimensions of minimum width 6m and an area of not less than 93 m^2. This is required for smoke and heat ventilation so that the approaches to exit staircases can be made smoke-free. This implies that ventilation of smoke and heat from the air-well would be deemed acceptable and applicable for any building height and configuration. The extent to which this assumption is valid has to be investigated.

Collaboration was initiated between the Fire Safety Bureau (FSB) and Ngee Ann Polytechnic's Fire Engineering Technology Centre (FETC) to study the ventilation of smoke and heat through an air-well using the computational fluid dynamics (CFD) modeling program. A high performance workstation including a 3D graphical interface was used for generation and visualization of the 3D flow patterns and temperature profiles of the naturally ventilated air-well under different fire load situations. The results show that there is a direct relationship between the clear width and area of an air-well. It has been shown that the existing requirements (Clause 2.2.12(a)(iii)) for an air-well are only applicable for buildings of heights less than 9 m.

Employing CFD tools has been useful in achieving a higher level of confidence for fire safety design in buildings. It has also demonstrated the ease with which building professionals can make use of scientific means to achieve fire safety in buildings.

OBJECTIVE

The objective of this study is to determine the minimum size of an air-well for different heights, clear widths and fire loads (1-5 MW), such that in the event of a fire, smoke and heat can be readily dispersed to a level of safety comparable to that of an external open space.

APPROACH TO STUDY

The approach to this study is shown in the following stages:

(a) Stage 1: Simplify the problem.

(b) Stage 2: Specify fire source and model configuration.

(c) Stage 3: Decide on grid mesh and modeling matrix.

(d) Stage 4: "Shadow" and validate the results.

Stage 1: Simplify the problem

Firstly, the problem is simplified [1] as the amount of details incorporated in a CFD model is critical to the computer processing time. This means that appropriate assumptions have to be made and details have to be evaluated so that the simulation results will not be affected.

(a) Structural details

Structural features such as corridors and staircases which are commonly found in air-wells were not modeled since the aim is to study the ventilation through the air-well.

(b) Stack Effect

Heat energy generated by humans, appliances and other activities is considered insignificant compared to the amount of air movement generated by the fire load (1 –5 MW). It is assumed that heating is evenly distributed throughout the entire building. Any source of process heat which generate large amounts of energy at a specific location should be considered separately.

(c) Natural Ventilation Openings (from occupied space or void deck)

In this study, only the vertical air-well is modeled. Other natural ventilation openings were not considered. This is to reduce the complexity of the model. The amount of natural ventilation openings to the air-well is difficult to assume for different times of the day.

(d) Weather effects

Effects of weather such as wind and rain will have a significant impact on the ventilation of the air-well. However, the frequency of their occurrence is to quantify and their effects are omitted from the study.

(e) Fire Load

The types of combustible materials present in a building vary. The fire load is also dependent on the distribution of the combustible materials and their intended usage. This is especially evident in industrial buildings where highly combustible and flammable materials are stored. To cater to the wide range of fire conditions, two fire loads of 1 MW and 5 MW are used in this study to simulate a small and a large fire.

(f) Building Construction

Building construction refers to the type of construction materials such as whether the walls and ceilings are made of materials like timber which promotes rapid combustion or non-combustible materials like cement, bricks which have minimal effects. Thermally, the walls and floors of the building are assumed to be adiabatic.

(g) Fire Origin and Compartment

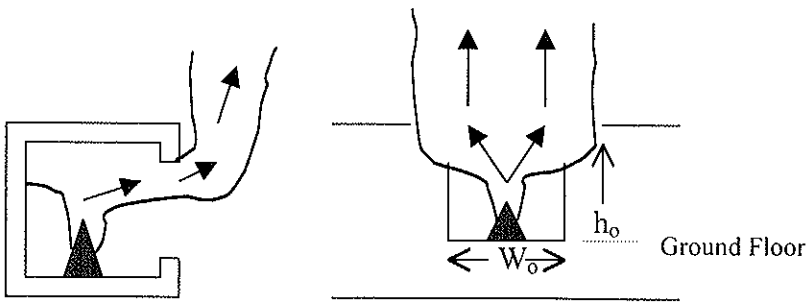
The fire can occur in any location of a building. But the worst case is when the fire originates from the lowest level of a building, as in this study. This means that the amount of air mixing between the combustion gases and the incoming outdoor air would be at the maximum. The fire compartment was modeled to a size of 10 m by 6 m.

(h) Flow Conditions

The condition of air flow in a fire is assumed to be fully turbulent. This involves activating the appropriate turbulent flow functions.

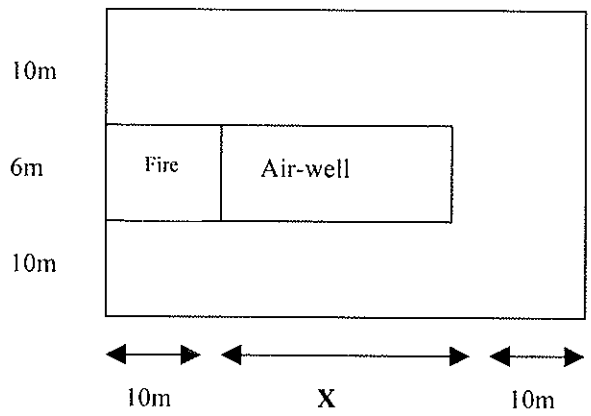
Stage 2 : Specify fire source and model configuration

A typical smoke plume produced by the fire source as it emerges into the air-well is shown below :

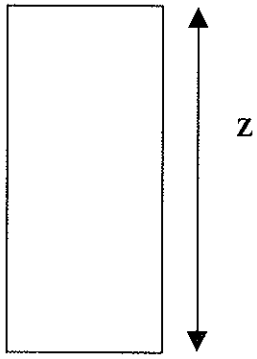


Section View **Front View**

W_o is the width of the opening to the air-well. It is assumed to be 6m to represent the front opening of a shop unit. The position of the shop in the air-well is shown below. It is compartmented by two walls separating it from the rest of the floor.



Plan View of Model

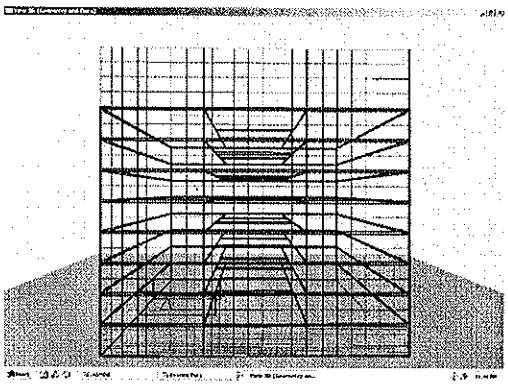


Elevation View of Model

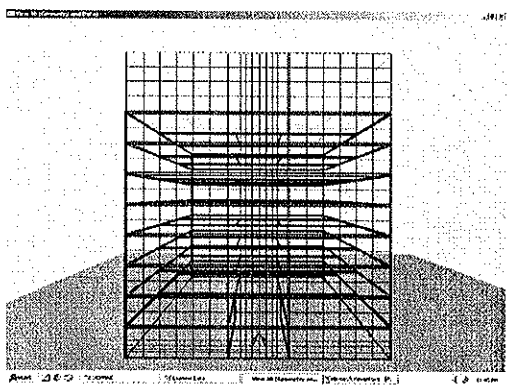
The model was simulated by varying building height (**Z**), fire size (1-5 MW) and the clear width (**X**) of the air-well.

Stage 3: Decide on grid mesh and modeling matrix

Grid lines are uniformly distributed for the building but a finer grid mesh was used for the fire source and the near-wall positions. The estimated number of cells used is in the range of 70,000 to 80,000.



Side View (varying) of grid lines for Air-well



Side View (fixed) of grid lines for Air-well

The domain above the air-well is extended to a distance of 6 m above the top of the building to account for the atmospheric boundary condition. This domain is maintained constant for all the simulations. The modeling matrix consists of three variables : height of building, clear width of air-well and fire load (1 MW and 5 MW). This is shown below.

X/Z	Clear Width (m)				
Height (m)	**6**	**8**	**10**	**12**	**14**
9	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW
18	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW
24	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW
36	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW
48	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW
60	1&5MW	1&5MW	1&5MW	1&5MW	1&5MW

Stage 4: "Shadow" and validate the results

Each simulation run was deemed to have converged if the :

(a) Number of sweeps > 1000

(b) Residual value < 0.1

X/Z	Clear Width (m)				
Height (m)	**6**	**8**	**10**	**12**	**14**
9	F1&5	P1&P5	P1&5	P1&5	P1&5
18	F1&5	P1&F5	P1&5	P1&5	P1&5
24	F1&5	P1&F5	F1&P5	P1&5	P1&5
36	F1&5	F1&5	P1&F5	P1&5	P1&5
48	F1&5	F1&5	F1&5	P1&5	P1&5
60	F1&5	F1&5	F1&5	F1&5	P1&5

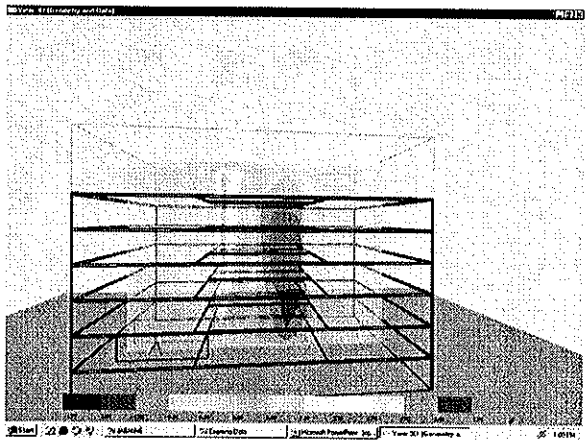
P = Pass condition,

F = Fail condition,

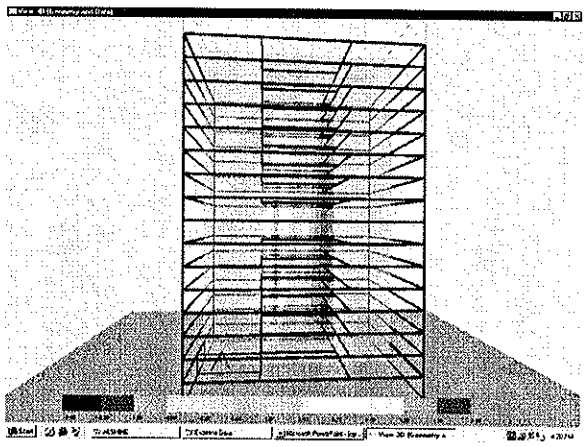
1 and 5 denote fire size of 1MW and 5MW respectively.

Each situation is adjudged to have 'pass' or 'fail' based on the smoke movement and a safe temperature profile as shown in the graphical output.

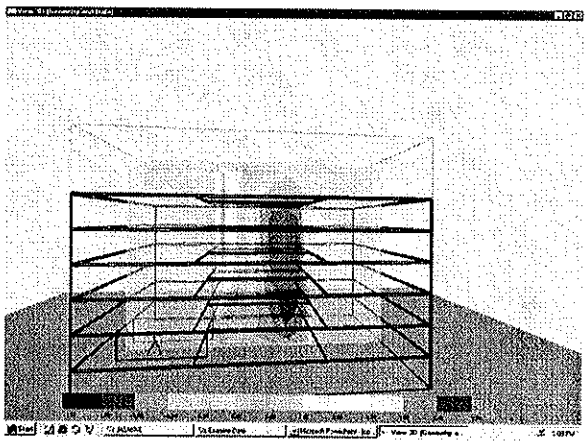
Examples of 'fail' situations :



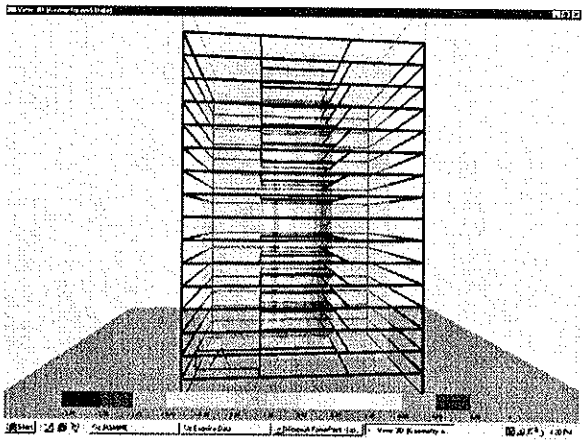
18m high, 6m long courtyard
Y - plane W contour (1MW)



48 m high, 10 m long courtyard
Y - plane W contour (1 MW)



18m high, 12m long courtyard
Y - plane W contour (1MW)



48m high, 12m long courtyard
Y - plane W contour (5MW)

Acceptable Conditions for Air-well

The following factors are used to determine the effectiveness of a smoke ventilation system :

(a) Exposure to toxic products of fire causing incapacitation or death
(b) Exposure to high temperatures causing burns and risk of hypothermia
(c) Level of visibility, preventing or delaying occupant escape

To better understand the involvement of the above parameters in a fire, site visits to existing buildings were conducted. A fire investigation case was also studied. This case involved a market fire and the situation closely resembles an air-well fire.

(a) Site Visits to Existing Buildings

The site visits were intended to provide an experience of what would be expected in an air-well. The air-well serves to provide lighting and ventilation to the building as shown in Photograph 1. Typical courtyard type of air-wells are commonly found in primary and secondary schools, conservation/old non-conservation shop-houses and industrial premises. This means that different fire loads according to their usage and building heights have to be included in the modeling.

The site visits also took us to a number of buildings which had complied with the prescriptive requirements of air-wells. However the actual site conditions did not instill confidence that the air-well can sufficiently disperse the smoke and heat. Fortunately, such buildings are few and far between.



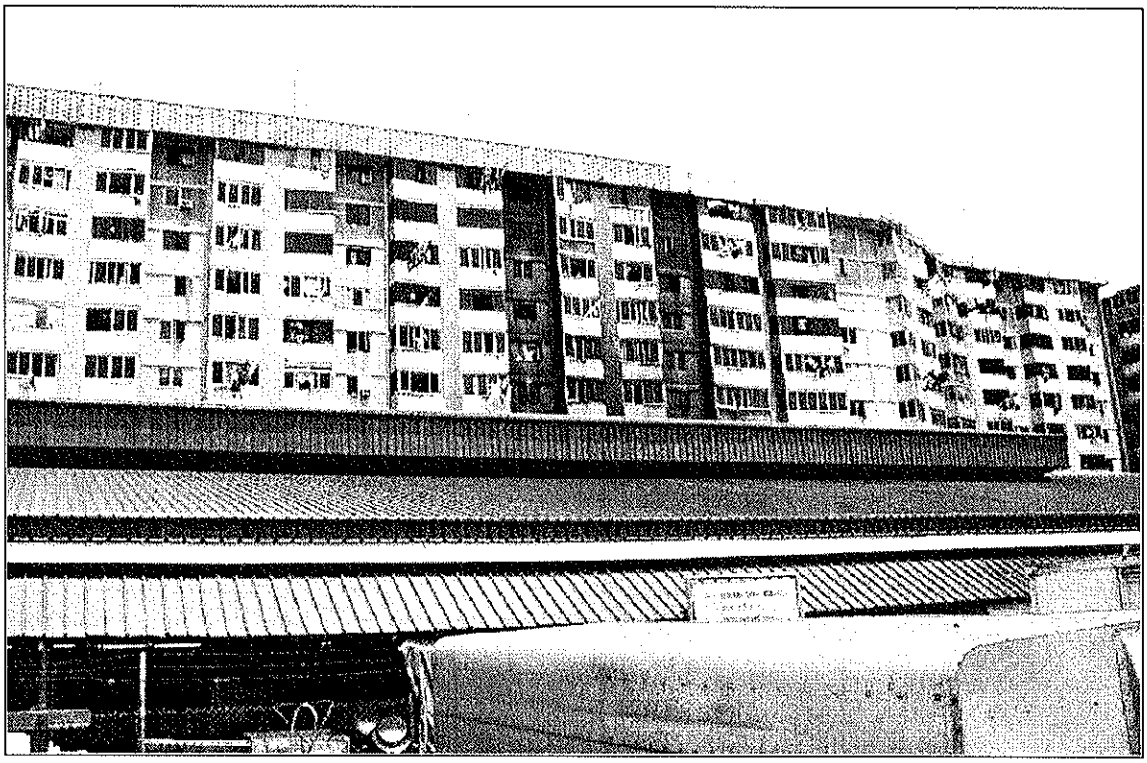
PHOTOGRAPH 1 : EXAMPLE OF AN AIR-WELL USED FOR VENTILATION AND LIGHTING IN A 25-STOREY BUILDING

(b) Investigation of an External Building Fire

A search of past records revealed that the Geylang Serai Market fire was a case of an external fire incident. The fire happened near a block of HDB flats. The distance between the fire origin and the block of flats is 1.5 m. Due to the rapid growth rate, as plastic and paper materials were involved, there was considerable fire damage to both the block of flats and the market. The fire was estimated to have an intensity of about 3 MW at the peak of the fire.

The effects of smoke and heat on the block of flats was felt from the ground level up to the tenth level as shown in Photograph 2. It is likely that such an effect will be present in an air-well too. From the investigations conducted, it was observed that two conditions were critical for occupant escape :

(a) Air temperature inside air-well at 100°C
(b) Level of visibility (5-8 m)



PHOTOGRAPH 2 : FIRE DAMAGE TO A HDB BLOCK OF FLATS

Sensitivity Tests on the Model

Sensitivity tests were conducted according to the following :

(a) Changing the domain above the air-well from 6m to 12m.

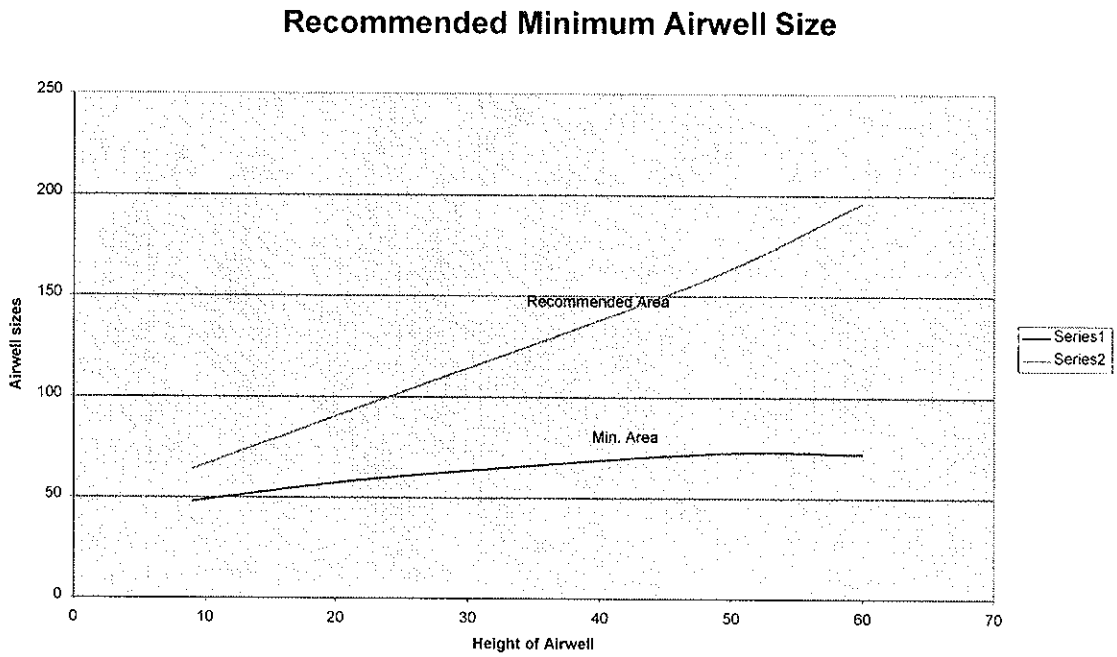
This is to determine whether the movement of smoke is restricted by the domain above the air-well. Selective tests have shown that the results are not dependent on the height of the domain.

(b) Doubling the number of grid line and cells

Increasing the number of grid line and cells will ensure that the results produced are not sensitive to the refinement of the grid mesh generated. In this study, the grid mesh over the fire source and the near-wall areas were doubled that of the surrounding areas.

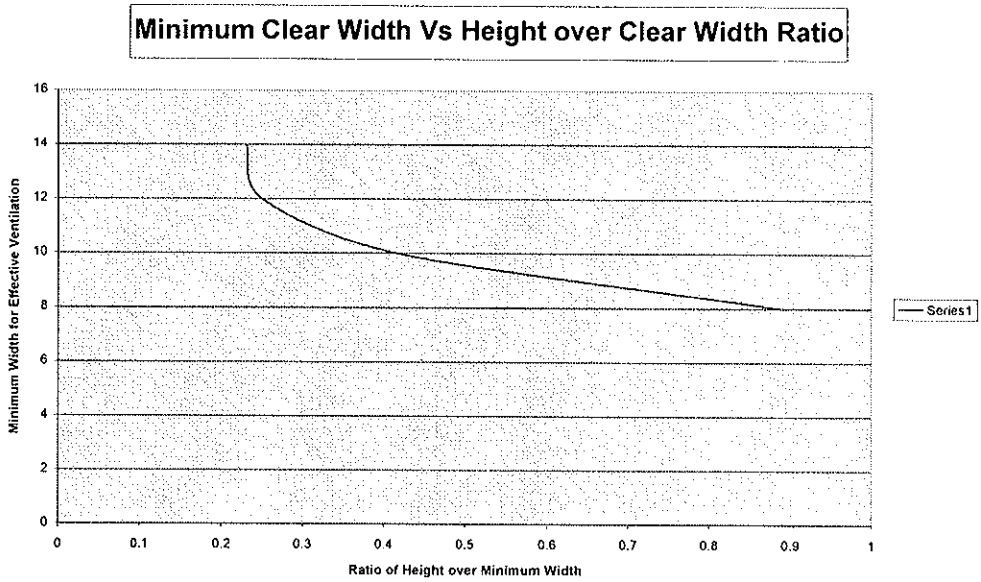
RECOMMENDATIONS

The results show that there is a direct relationship between the clear width in the air-well and the height of the building as illustrated in the graph below:



Height of Building (m)	Minimum Clear Width of Air-well (m)
18	10
24	11
36	12
48	13
60	14

Note: The recommended area is used after considering the possibility of fire occurring on different sides of the air-well.



Plotting the **Minimum clear width** against the **Ratio of height over clear width**, shows that there is a limit to the size of the opening as the curve straightens vertically at around the 0.2 ratio.

CONCLUSIONS

This study has served to demonstrate the effectiveness of the fire modeling tool. This demonstration is merely the tip of an iceberg as to how computers can aid us in ensuring fire safety. The findings made in this study have been forwarded to the Fire Code Review Committee for revamping the existing air-well requirements.

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5. BR 258 – Design approaches for smoke control in atrium buildings

Common Problems Encountered By Registered Inspectors

By

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COMMON PROBLEMS ENCOUNTERED BY REGISTERED INSPECTORS

INTRODUCTION

1. The Registered Inspectors' scheme came into effect on July 1994 and with it, the issuance of an Inspection Certificate by Registered Inspectors was a pre-requisite for the application of the TFP/FSC. To-date there are a total of 190 RIs registered with FSSB, ie 122 RI(Architecture) and 62 RI(M & E).

2. The RI scheme has been functioning fairly well and FSSB would like to see more RIs actively participating in inspecting projects. The RI scheme has also been strengthened over the years with feedback from the RIs themselves. In this respect, an inquiry system has been established to investigate poor practices by RIs. With the passing of the amendments to the Fire Safety Act, a wider range of penalties can now be imposed on RIs who have performed their inspection duties unsatisfactorily.

3. RIs have also been keeping FSB informed over these years of some of the common problems encountered by them prior to issuing their inspection certificates and we wish to highlight them to the Qualified Persons. By doing so FSB hopes that this will help QPs complete their projects without much of a problem.

AIM

4. The aim of this paper is to inform QPs about some of common problems faced by RIs in their application for TFP/FSC.

COMMON PROBLEMS

Tenancy Works (Separate Submission)

5. Very often, RIs have complained that tenancy works have been carried out to the main building which they are inspecting. The tenancy works are usually submitted under separate plans by another QP and they are not engaged as the RIs for these projects. This has made it difficult for RIs to inspect and issue their Inspection Certificates especially when the tenancy works done have been extensive. The main QP is therefore advised to restrict any tenancy works being carried out before the RIs can conduct their inspection and issue their Inspection Certificates. If tenancy works are carried out for some reason, then such works must be supported by approved plans and be limited in scale.

Certificates /Test Reports / Certification

6. Many a time, RIs have called FSB to complain that their requests for PSB certificates and test reports have not been entertained by QPs. This has made it difficult for RIs to conduct a thorough check for the issuance of their inspection certificates. QPs are reminded that all

PSB certificates whether it is for fire doors, special building materials, etc, are to be produced for checking by the RIs and this is clearly stated in form FSC 1. The non-production of such documents will jeopardise the issuance of the TFP/FSC.

Appointment of RIs

7. QPs are reminded that it is not proper to have more than one RI type at the same time for their projects because this will complicate the processing of the TFP/FSC application. We do receive complaints that another RI had been appointed concurrently and in such situations we will put "on hold" the processing of the application until the matter is resolved. If there is a need to change an RI, the RI Relinquishment form must be submitted before another RI can be appointed. QPs are to advise their clients on the procedures & rules regarding appointment & relinquishment of RIs if they do not want their projects to be stalled by such issues.

Presence of Site Offices and Workers Quarters

8. Another common non-compliance issue noted by RIs is the presence of site offices and workers quarters within the building. Normally the temporary site offices, store rooms and workers' accommodation are found to be occupying the basement carpark. For the application of the TFP/FSC, all such facilities must be totally cleared from within the building. QPs should inform the contractors to find other alternative sites for temporary structures when making their application.

"Homing" of Lifts

9. "Homing" of lifts causes some confusion because it seems that the lift contractors are not properly informed of the correct sequence and therefore carry out incorrect programming of the lifts. QPs should test and ensure that the lifts function in accordance to the fire safety requirements and not leave it to the RIs to carry out the inspection and expect them to advice the lift contractors. RIs have provided feedback that they usually have to advise on the correct sequence of lift operation during their inspection.

DECAM Connection

10. QPs are reminded to ensure that the DECAM connection whether through permanent or temporary line is ready for testing of the automatic fire alarm signal. The successful testing of the DECAM line is a pre-requisite for the issuance of the Temporary Fire Permit and QPs are to ensure that the DECAM line is up for the RI inspection and testing. It is quite common for QPs to request for a "last minute" waiver of this requirement because the DECAM line is not ready during the TFP stage and to cite that the owner undertakes to install it as soon as possible. These are not acceptable to FSB.

Fire Engine Accessways

11. Fire engine accessways which are not fully completed usually make it difficult for RIs to access whether there will be any obstruction to the movement of the fire engines. Uncompleted fire engine accessways especially at condominium projects pose a problem to RIs. Quite often, gantry barriers and road dividers are built at the entrances after the issuance of the TFP and these have affected the entry of fire engine to the premises. There has been a number of complaints about fire engines being unable to manoeuvre through condominiums and the reason for this is because of additions on site which were not shown in the approved plans. Uncompleted landscaped accessways are another problem area where RIs find it difficult to determine whether there will be problems to fire engine accessibility. Therefore, QPs are required to ensure that the fire engine accessways are fully completed and clearly defined to enable the RIs to make a good assessment before issuing their inspection certificates.

Firemen's Access Panels

12. This is a common problem where the sizes / dimensions are not in accordance to the fire code requirements. Firemen's Access Panels are usually not taken seriously by QPs and this has given rise to problems when it comes to an inspection by the RI. To fully comply, there are many dimensions to abide by and deviations from these dimensions as pointed out by the RIs in their inspection certificates can affect the TFP/FSC application. QPs are advised to either seek early waiver or rectify the deviations from the fire code requirements.

Timber Finishes and Combustible Materials

13. This is a perennial problem area where both QPs and RIs may interpret the fire code requirements differently. There has been a lot of controversy as to what is allowed and how much is allowed. QPs are therefore urged to comply with the requirements given in clauses 3.13 & 3. 15 from the very beginning of their project as well as produce the relevant PSB certificates & test reports to the RIs for inspection for the application of the TFP/FSC. The PSB certificates / test reports are to confirm the surface flame spread rating of the materials used and this will allow the RIs to assess without undue delay and avoid lengthy consultation with FSB. QPs who are unclear of the requirements are advised to seek early consultation with FSB and to check whether their suppliers' materials are applicable.

Consultation Records and Waivers

14. With the introduction of the Self-Regulation scheme in October 1998, QPs are required to seek early consultation and waivers for their projects before implementing them. This is to avoid ending up with a project with non-compliances which have serious implications. All such consultation records and waivers are to be made available to RIs for the issuance of their inspection certificates. RIs may dispute certain aspects of the approved plans when conducting their inspections and withholding consultation records from RIs and failure to obtain waivers will only cause further delay. QPs who are not in agreement with the RIs' comments can always consult FSB further to clarify any such outstanding aspects.

Other minor issues

15. Other minor issues pointed out by RIs during their inspections are the non-provision of fire extinguishers especially in the plant rooms, the provision of fire doors with 2-way locking devices and hosereel cabinets with a locking mechanism. Although these are quite minor issues they will still affect the issuance of the TFP/FSC and QPs are requested to comply before making the application.

INSPECTION BY RI

16. As mentioned earlier, FSB has noted that most RIs are performing their duties diligently. However, we would like to take this opportunity to mention a few points for RIs to take into consideration so that they would avoid committing mistakes.

17. All RIs are expected to personally inspect every project for which they are engaged, no matter how small the projects are because they are still directly answerable for any non-compliance items detected on site. We note that most RIs are strictly observing this rule and are also aware of some RIs who are not abiding by this rule at times and these RIs are been monitored. As an example, one such RI was fined after our spot-check when he provided misleading information for the non-compliance detected.

18. RIs are also reminded that no matter how big the project is, they are still required to conduct a full check. In such instances, RIs are required to have a team of competent staff to assist them in inspecting the project. In large projects, the minor issues are usually overlooked and these can be a problem especially when a complaint is raised. Some of the examples are:

    a. Fire-stopping not fully or properly completed.
    b. Door swing clearance into exit staircase is less than 1m.
    c. Landing valves of risers not strapped and padlocked.
    d. Sprinkler point spray pattern affected by duct works and beams.

19. To-date, there has been only a few cases which we have taken action against the RIs for not pointing out non-compliance items on site. The mistakes committed were as a result of overlooking and ignorance. Without giving specific details the cases involved:

    a. Use of fire-rated glass at wrong locations.
    b. Separation wall not fully completed to the underside of the roof.
    c. Use of timber finishes / combustible material.

CONCLUSION

20. The above are some of the more common problems encountered by RIs which may affect a QP's application for the project's TFP/FSC. Although not an exhaustive list, we hope this paper has made it easier for QP's to have a better appreciation of the RIs' requirements when it comes to them issuing their inspection certificates.

Update From Fire Plan Auditing And Waiver Applications

By

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Update from Fire Safety Plan Auditing and Waiver Applications

1. INTRODUCTION

Since the self-regulation system was implemented in September 1998, Fire Safety & Shelter Bureau (FSSB) has been consistently monitoring the progress of the system using statistics and data that are regularly gathered, studied and analysed. Besides providing quality feedback on how well the authority and Qualified Persons are adapting in the self-regulation mode of operations, the findings from the analysis of the data collated have also become meaningful tools to identify areas where improvements can be made. This is particularly so when reviews and updates are being made to the Fire Code to meet the change in demands of the building industry, and in view of the real problems faced at the design, planning and construction stages. This paper shall focus on the lessons learned from two of our more important processes, namely the plans auditing and waiver application processes that form the backbone of the self-regulation system.

2. AIM

This paper aims to highlight the more common non-compliant items arising from both the audit and waiver application processes during the period June 2000 to June 2001 and the actions taken by the FSSB in regularising some of the items in the recent set of updates of the Fire Code.

3. WAIVER

There were a total of 3330 waiver applications received during the period from June 2000 to June 2001 with the highest average being in the 2nd quarter of this year, where 848 applications were processed. Table 1 contains the more common waiver items applied for consideration during this period of time.

Table 1

s/no	Waiver items
1	To allow the use of pre-action sprinkler system
2	Unable to comply with the remoteness of exit doors (1/2 Diagonal distance for non-sprinkler bldg and 1/3 Diagonal distance for sprinkler bldg)
3	Unable to comply with placing the breeching inlet at the foot of riser stack (for purpose group II)
4	Exit staircases not discharging to the external safe area
5	Fire fighting lobby exceeding the max 10m2
6	One-way travel distance exceeding the max permitted
7	To permit vents to furniture stores, canteen stores in schools (instead of compartmentation)
8	To allow the use of dry board protection to steel structures*
9	To waive RI Inspection for stand alone substation and MDF bldg *
10	To permit water mist system to protect special rooms *
11	To permit private lifts *
12	To permit gas services through smoke stop lobby *
13	To permit the use of sliding doors and card access exit doors *
14	Separation of scissors exit staircase doors *
15	Separation distance of 3m at the entry of an internal staircase from any unprotected openings *

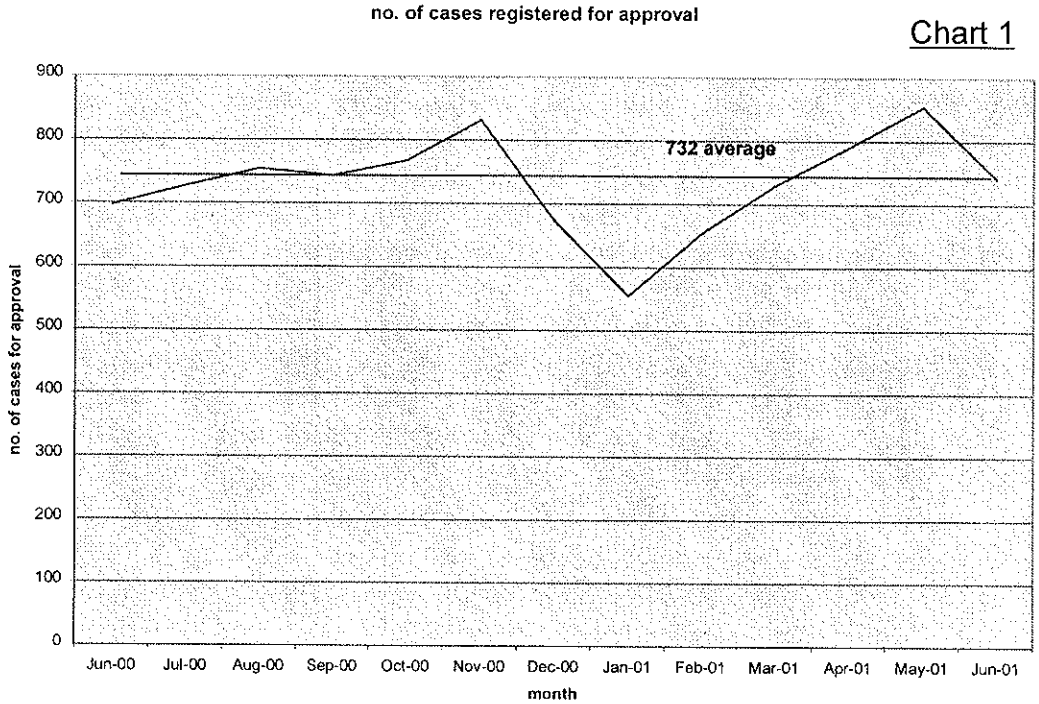
The waiver items affixed with an asterix (*) were then identified for further evaluation to see how these can be regularised as fire safety requirements in the fire code.

Considerations for review on selected waiver items were based on several discussions with the building industry professionals and the findings of in-house study teams formed to carry out a more in-depth study when necessary. The teams' findings were tabled regularly at the FSSB Standing Committee meetings for discussion and deliberation prior to reflecting them as changes in the fire code. By relaxing these requirements or addressing them in a more elaborate manner in relevant areas of the fire code, we have saved QPs the trouble of making applications to waive some requirements, repeatedly. An obvious example is the installation of a private lift, for ferrying occupants right up to the doorstep of their apartments, as it becomes a popular feature in most high-rise residential apartment developments. Fire safety requirements on the housing of the private lifts have now been addressed in greater details.

4. PLANS APPROVAL PROCESS

We have also received an average number of 732 plans registered for approval each month, for both fire protection and building plans submissions. (see chart 1).

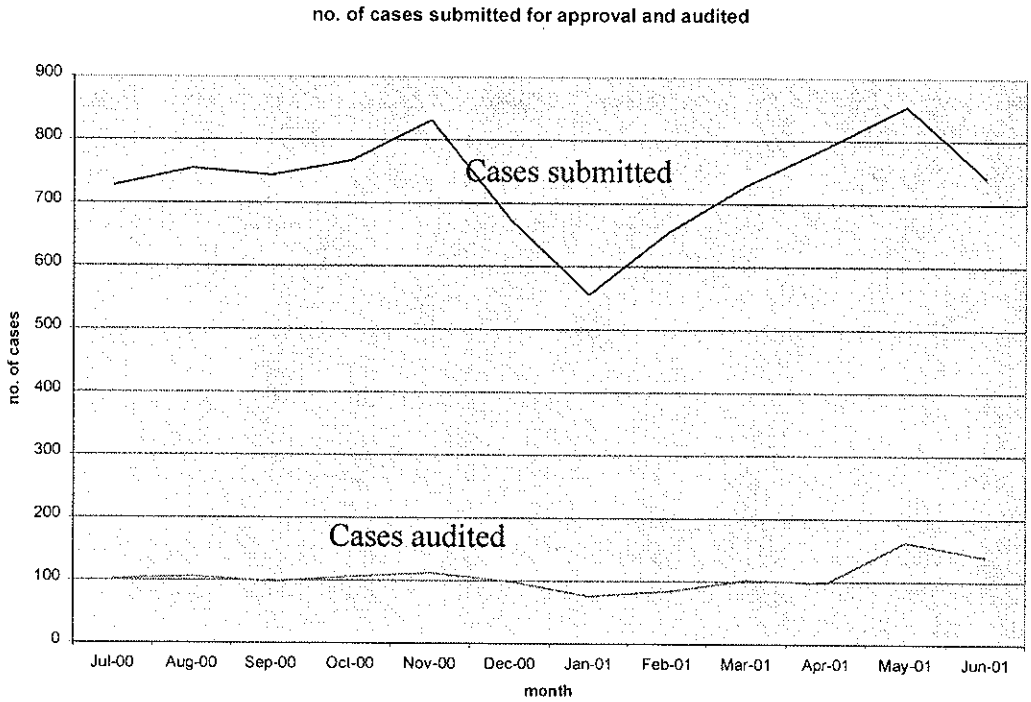
Chart 1



Generally, audit checks are done on 10% of all plans submitted. These plans are randomly selected for audit by the computer system. Out of the total 9516 plan submissions done at our counters, 1391 plans have been audited. This makes up 14.6% of the plans submitted which is higher than the 10% targeted for audit. This is because, in some instances, cases were referred for audit by our Licensing & Enforcement Branch or upon acting on public complaints received. These were cases where major deviations were detected at the plans approval stage by our processing officers.

Chart 2 shows an average of 107 cases audited each month out of the average of 732 cases submitted monthly.

Chart 2



From the audit findings, a set of common non-compliant items have been identified and tabulated in Table 2 below.

Table 2

s/no	Non-compliant items
1	Use of polycarbonate as roofing materials
2	Exit staircases not discharging to safe external space
3	Exit door swings in a direction which impedes the escape path
4	No smoke-stop lobby for buildings exceeding 4 sty above ground
5	Insufficient exit door provisions
6	Incorrectly computed setback distances
7	Exit staircase within 3m/1.5m of unprotected openings
8	No provision of sprinkler system to basement carparks
9	Minimum width of exit passageways not complied with
10	No provision of hosereels
11	In-effective cross-ventilation to lift lobby for a single exit staircase provision
12	Exit staircase not protected
13	No provision of dry riser mains at basements
14	Escape through another occupied space - very common in exit staircases
15	Hardstanding exceeding the max distance from the Fireman Access Panels

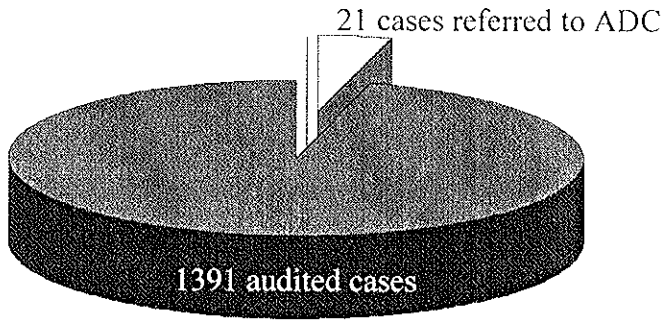
We hope that the QPs would take note and pay attention to these items highlighted and avoid making the same mistakes in their plan submissions for approvals.

5. ANALYSIS OF AUDIT RESULTS

To date, since the implementation of the self-regulation system, a total of 73 cases have been referred to the Audit Disciplinary Committee (ADC). Of them, 21 cases occurred during the period of assessment. Chart 3 shows the comparison between the number of cases referred to ADC with the total number of plan submissions during the same period.

Chart 3

Pie chart of cases referred to Audit Disciplinary Committee



By comparison, the number of cases referred to ADC (21 cases) against the total number of audited cases (1391 cases) is only 1.6%. The total number of warning letters and Fire Safety Offences (FSO) issued so far is 23 and 15, respectively, since the implementation of the self-regulation system.

Month	Cases registered	Cases selected for auditing	Check cases	Non-compliance cases	Cases referred to Disciplinary Committee	Action taken by Disciplinary Committee
June 2000	697	105	81	24	0	0
July 2000	727	102	74	28	2	1 Warning Letter 1 Fire Safety Offence
August 2000	754	106	75	31	2	1 Warning Letter 1 Fire Safety Offence
September 2000	743	98	63	35	3	2 Warning Letters 1 Fire Safety Offence

October 2000	767	106	79	27	3	2 Warning Letters 1 Fire Safety Offence
November 2000	831	112	79	33	2	2 Warning Letters
December 2000	673	99	81	18	1	1 Fire Safety Offence
January 2001	555	76	64	12	0	0
February 2001	654	84	71	13	1	1 Warning Letter
March 2001	730	102	70	32	0	0
April 2001	790	98	78	20	2	1 Warning Letter 1 Fire Safety Offence
May 2001	854	163	114	49	3	2 Warning Letters 1 Fire Safety Offence
June 2001	741	140	100	40	2	2 Warning Letters
Total	**9516**	**1391**	**1062**	**329**	**21**	**21**

6. CONCLUSION

FSSB will continue to be proactive in resolving issues which are of real constraints to the QPs and developers/owners especially those posed at site by intensifying our studies on waiver issues which can be moderated and regularised into our fire code. At the same time, we would like to take this opportunity to seek the co-operation of the QPs to provide us with valuable feedback on areas where improvements can be made to better facilitate two way communications in making improvements in the area of fire safety.

A New Approach To Private Hydrant Provision

By

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A NEW APPROACH TO PRIVATE HYDRANT PROVISION

INTRODUCTION

The requirement to provide private hydrants is related to the provision of fire engine accessway. The Fire Code requires that every part along the fire engine accessway shall be within an unobstructed distance of 50m from a hydrant. Where a public hydrant conforming to such requirement is not available, private hydrant shall be provided.

2 The distance from the fire engine to the nearest hydrant is an important factor as it enables the hoses to be set-up promptly. But if the hydrant concerned cannot provide good water pressure and water supply, the fire fighting operation is also unable to carry out effectively. Therefore, it's essential that hydrant water supply is available at all times for any given location (both above and below reduced level (RL) 125).

3 After studying into the various factors (operational capability, operational needs, PUB water supply, etc), FSSB has developed a set of requirements (refer to ANNEX A) to allow for both effective fire fighting in different occupancies and enable design flexibility in designing the private hydrant system.

CURRENT PROVISIONS

4 Currently, the requirements of water supply for private hydrant is broadly divided into two categories. Those hydrants located below RL 125m and above RL 125m.

a. Hydrant below reduced level 125 m
For those hydrants located not higher than reduced level 125m, they can receive direct supply from PUB mains. It is assume that with the direct supply from the PUB main, flow and pressure of the hydrant should generally be able to cater for a fire fighting operation. Nevertheless, FSSB has informed all QP that the minimum pressure and flow rate of private hydrants must still meet the pressure and flow rate for both residential and non- residential requirements stated in Table 1 "Water storage tank capacity for fire hydrants" of CP 29: 1998.

b. Hydrant above reduced level 125 m
For hydrants that are provided above reduced level 125m, storage and pumping arrangements of water supply shall comply with those of Table 1 mentioned above (when there are more than one private hydrant that are located above reduce level 125 m within the same plot).

DRAWBACKS OF EXISTING PROVISIONS

5 Some feedback were received from the FSSB Standing Committee that some private hydrants (located below reduced level 125 m) fail to comply with the flow rate or water pressure, or both requirements. One likely cause of the low flow rate and pressure for the private hydrants within the private development was due to poor water supply from the public PUB main. It is therefore not justifiable to require the private hydrants located in such areas to be designed to meet the stipulated requirements. FSSB had made a survey on the water supply for hydrant and had found out that indeed there were some small pocket of area where the pressure and flow rate were lower than the requirements.

6 Furthermore, the water supply requirements for hydrants located above reduced level 125 m appear to be stringent (calculation based on 1000 m^2). High cost and space for the construction of water tank and pump would be incurred. Also, the current provisions did not consider those buildings protected by sprinkler system (with the sprinkler protection, the fire size will be reduced and that translate to less water demand for fire fighting).

PROPOSED GUIDELINES

7 With the inputs from professional bodies, Operational Department, SCDF and comparisons with other countries practices, FSSB had developed a revised set of requirements to address those feedback and constraints.

8 The approach consist of two different sets of requirements tailored for private hydrants located below RL 125 and above RL 125 respectively.

a. Hydrant below reduced level 125 m

i) The intention is to minimum the amount or extent of pressure/flow rate loss in the designing of the new hydrant system. The total loss of pressure and flow rate from the nearest pubic hydrant to the most remote private hydrant inside the development shall not exceed 10% of the pressure/flow rate of the nearest public hydrant.

ii) When calculating the frictional losses in the pipes (e.g. Hazen Williams formule), the minimum nominal size of the hydrant pipe shall be of at least 150mm in diameter.

iii) The QP is allowed to use pipe diameter size larger than the 150 mm or constructing the hydrants in a ring main system to reduce the loss in the proposed hydrant system.

iv) Hydrant system that fail to comply with the stipulated 10% loss shall comply with the new guidelines for private hydrant for above RL 125m.

v) In determining the pressure and flow of the nearest public hydrant, QP could conduct hydrant testing at the public hydrant to ascertain the pressure and flow rate or they can submit a application to HQ SCDF, Hydrant Section for the related information pertaining to the nearest public hydrant.

b. Hydrant below reduced level 125 m

i) The set of requirements for the storage and pump capacity for hydrant located above 125 m is as shown in **ANNEX A**.

ii) The minimum running pressure of 2 bars instead of the previous 3.5 bars was used as the operational requirement for the hydrant to supply water to the fire appliances (use the appliance's pump to increase the pressure for the fire fighting operation) instead of using the hydrant for direct fire fighting was adopted.

iii) The storage duration (from 45 mins to 90 mins) for the industrial premises had been increased to cater for additional fire load and risks while that for the other occupancies types remain the same. The largest compartment floor area instead of the largest floor area has been adopted and also a larger area of 5000 m^2 instead of the 1000 m^2 has been used for calculating the additional subsequence hydrant.

iv) The reduction of 19L/s for the specified duration for building protected with sprinkler protection has been introduced to take account of the anticipated reduction in fire size.

BENEFITS OF NEW GUIDELINES

9 The new guidelines for private hydrants will seek to benefit through the following:

a. By setting the criteria of not more than 10% losses in both pressure and flow rate, QP is given the various options (changing pipe size, ring main system, etc) in designing the hydrant system to comply with the requirements.

b. The current guidelines for private hydrants located above RL 125m do not consider buildings protected by sprinkler system. With the revised guidelines, there will be substantial saving in cost and space for the developer.

c. The use of the largest compartment floor area instead of the gross floor area will enable building to adopt and apply sub-compartmentation of the premises and this will lead to lower hydrant storage capacity and pump size as the number of hydrant is much reduced.

d. The minimum running pressure of 2 bars instead of 3.5 bars will reduce the size of the pump need and in turn reduces installation cost.

CONCLUSION

10 It is imperative that private hydrants located along fire engine accessway should be able to provide the required flow rate and pressure at all times for fire fighting operation to be carry-out effectively by SCDF. The new approach for the design of water supply in hydrants system enable both flexibility of design and effective fire fighting.

ANNEX A

WATER SUPPLY FOR PRIVATE FIRE HYDRANTS

Provision of water supply for private fire hydrant system where required by the Fire Code shall comply with the following requirements:

1 Private Hydrants Located at reduced level 125 m and below

Private fire hydrants installed at reduced level 125m and below can receive direct supply from PUB mains provided;

a) The nominal bore of the hydrant pipe shall not be less than 150mm in diameter.

b) The running pressure/flow at the hydraulically most unfavorable hydrant of the private hydrant system shall not be less than 90% of the prevailing pressure/flow at the public hydrant nearest to the premises.

Note:

In calculating the frictional loss for the private hydrant system, the design flow rates shown in Table 1 shall be used.

2 Private Hydrants Located at above reduced level 125 m

Private fire hydrant located at above reduced level 125 m shall meet the requirements stipulated in Table 1 below.

Table 1 – Water Supply & Storage requirements for fire hydrant

Purpose Group/ Requirements	**Purpose Group I&II**	**Purpose Group III, IV, V, VII(*)**	**Purpose Group VI & VIII (*)**
Minimum Running Pressure	**2 bars**	**2 bars**	**2 bars**
Minimum Flow rate	**27 L/s**	**<1000 m^2 – 38 L/s <5000 m^2 – 57 L/s <10000m^2 – 76 L/s (57 L/s if sprinkler protected) Additional 19 L/s for subsequence 5000 m^2**	**<500 m^2 – 38 L/s <5000 m^2 – 57 L/s <10000 m^2 – 76 L/s (57 L/s if sprinkler protected) Additional 19 L/s for subsequence 5000 m^2**
Minimum Duration	**45 mins**	**45 mins**	**90 mins**

* - Base on the floor area of the largest compartment

Update on Review of Fire Code 1997

Part I

By

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Fire Safety & Shelter Bureau

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Part II

By

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&
Mdm Goh Siam Imm (HDB)

3rd Update on Review of Fire Code 1997

1 Introduction

1.1 The first and second updates on the changes/amendments to Fire Code were approved by the Fire Code Review Committee and issued to the professional bodies via FSB's circulars dated 4/12/2000 and 18/5/2001 respectively.

1.2 The changes/amendments to the Fire Code up to September 2001 which 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

The revised changes/amendments are highlighted in italic font

(A) External Exit Staircase

Existing Clause

1.2.29 External Exit Staircase

External exit staircase

(a) An exit staircase which serves as a required exit shall be located outside the building and open to the outdoor air, and enclosed by parapet walls or railing only

Proposed additional sub-clause1.2.2(b) is to be read as follows:

1.2.29 (b) An external staircase shall qualify as an external exit staircase if it is located within or abutting an air-well (which is open to sky and is required to provide lighting and ventilation to the occupancy areas) having the minimum size in relation to the habitable height of the building as given in the Table 1.2.29 below :

Table 1.2.29
Minimum Air-well Size

Max. Habitable Height of Building	*Min. Clear width of Air-well*
18m	*10m*
24m	*11m*
36m	*12m*
48m	*13m*
60m and above	*14m*

Note:
In determining the clear area for the above air-well, any area with structure (like partial roof-over, trellis etc) that may cause obstruct to air movement shall not be consider.

The Fire Code Review Committee was of the view that the size of air-well in relation to the habitable height of the building should be introduced to address the concern whether an air-well of certain size could be treated as an external space. This would help to determine whether an external staircase located within or abutting the airwell could be considered as an external exit staircase.

(B) Fire Fighting Lobby

Existing Clause

1.2.34 A smoke-stop lobby which is adjacent to a fire lift and designated for use by the fire fighting team during an emergency. The size of the lobby shall not be smaller than 6 sq m and not greater than 10 sq m. The clear width of the lobby shall not be less than 2000 mm. — Fire-fighting lobby

Revised clause 1.2.34 to be read as follows :

1.2.34 A smoke-stop lobby which is adjacent to a fire lift and designated for use by the fire fighting team during an emergency. ***The lobby shall not be used for any other purposes and the size of the lobby shall not be smaller than 6 sq m and with no dimension smaller than 2m*** — *Fire-fighting lobby*

The FCRC agreed to remove the max 10.sq m control on the size of the fire fighting lobby. It addressed the concern that if part of a large fire fighting lobby would be converted to other uses, the building management should take appropriate action. Hence ,the fire code needs to control the min. size of the lobby only.

(C) Number of exits from rooms and spaces

Existing Clause

2.2.10 There shall be at least two door openings remote from each other and leading to exits from every room or enclosed space in which the total occupant load exceeds the maximum permissible occupant load for one door as listed in the table below: — Number of exits from rooms and spaces

Type of Occupancy	Maximum Occupant Load with One Door
High Hazard	10
Patient accommodation area	15
Classrooms	25
Dormitories	20
Godowns, stores, and factories not being of high hazard type	50
Rooms and spaces with occupancy of more than 50 persons shall comply with the requirements for `Number and Width of Exits' under Cl.2.8.2 for Assembly Occupancy.	

Revised clause 2.2.10 to be read as follows :

2.2.10 There shall be at least two door openings remote from each other and leading to exits from every room or enclosed space in which the total occupant load exceeds the maximum permissible occupant load for one door as listed in the table below: — Number of exits from rooms and spaces

Type of Occupancy	Maximum Occupant Load with One Door
(a) High Hazard	***25***
(b) Others including:	
Patient accommodation area	***50***
Classrooms	***50***
Dormitories	***50***
Godowns, stores, and factories not being of high hazard type	**50**
Assembly	***50***
Rooms and spaces with occupancy of more than 50 persons shall comply with the requirements for `Number and Width of Exits' under Cl.2.8.2 for Assembly Occupancy.	

FSSB proposed to standardise the max. occupancy load for rooms and spaces, which are not of high hazard, to not more than 50 persons. In high hazard occupancy, the existing max. occupancy load for one exit has been revised to 25 persons. The above changes would simplify the requirement, make it easier to apply and eliminate unnecessary waiver application.

(D) Area of refuge and exit

Existing Clause

2.2.15 Area of refuge and exit

When a floor area has access to Area of Refuge in compliance with following requirements in this Clause, the occupant load for which vertical exits are to be accounted for the floor area may be reduced to half when one Area of Refuge is provided and to one-third when two or more Areas of Refuge are provided.

Area of refuge and exit reduction

(a) An Area of Refuge shall be adequate in size to hold the occupant load it receives from the floor area it serves as provision for required exit, in addition to its own occupant load calculated on the basis of 0.3 m^2 per person except for Health Care Occupancies when the occupant load shall comply with the provisions under Cl. 2.5.3 , and

Proposed addition of a new-sub-clause 2.2.15(a)(ii) is to be read as follows:

2.2.15 Area of refuge and exit

(a) An Area Of Refuge shall be :

(i) Adequate in size to hold the occupant load it receives from the floor area it serves as provision for required exit, in addition to its own occupant load calculated on the basis of 0.3m^2 per person except for Health Care Occupancies when the occupant load shall comply with the provisions under Cl.2.5.3;

(ii) Provided with at least one staircase for use by the occupants to gain access to other exit staircases or the ground level directly to an exterior open space; and

The Fire Code Review Committee was of the view that minimum width of the staircase should be maintained at minimum 1m irrespective of the occupant load of the floor to be served. Therefore under sub-clause 2.2.15(a)(ii) it would mean that an open roof deck on another part of a building could be used as an area of refuge, provided there is at least one staircase "for use by the occupants to gain access to other exit staircase or ground level directly to an exterior open space"

(E) New Clause 3.15.13 : Fire rated glass wall/door to smoke stop & fire fighting lobbies

In buildings which are protected by an automatic sprinkler system, fire rated glass can be used for the construction of enclosures to smoke stop and fire fighting lobbies, subject to the following :

(a) the walls and doors shall have the necessary fire resistance, including insulation, when subject to test under BS 476: Part 20-23; and

(b) the walls and doors shall meet the class A of the Impact Performance requirements when subject to test under BS 6206 or AS 2208 .

The Fire Code Review Committee agreed to accept fire rated glass doors and fire rated glass walls to smoke stop or fire fighting lobbies. The relaxation took into consideration the changes in technology and the numerous waiver applications that were received to have glass enclosures to the protected lobbies for aesthetics reasons.

(F) External exit passageway

Existing Clause

2.3.2 (c) External exit passageway:

(i) an external exit passageway may be used as a required exit in lieu of an internal exit passageway, provided that the external wall between the exit passageway and the rest of the floor space may have ventilation openings of non-combustible construction, fixed at or above a level 1.8m, measured from the finished floor level of the passageway to the sill level of the openings and such ventilation openings shall be located not less than 3.0 m from any opening of an exit staircase, and

External exit passageway

(ii) an external exit passageway may not be subjected to the limitations of a maximum of two exit doors opening into the exit passageway, and

(iii) an external exit passageway may be roofed over provided the depth of the roofed over portion shall not exceed 3m to avoid smoke logging, and

(iv) an external exit passageway may be enclosed on the open side by only a parapet wall or solid balustrade of not more than 1.0 m in height, and

(v) exit doors opening into an external exit passageway shall have fire resistance for at least half an hour and fitted with automatic self-closing device.

Revised clause 2.3.2 (c) is to be read as follows :

2.3.2 (c) External exit passageway:

(i) an external exit passageway may be used as a required exit in lieu of an internal exit passageway, provided that the external wall between the exit passageway and the rest of the floor space may have ventilation openings of non-combustible construction, fixed at or above a level 1.8m, measured from the finished floor level of the passageway to the sill level of the openings and such ventilation openings shall be located not less than 3.0 m from any opening of an exit staircase, and

External exit passageway

(ii) an external exit passageway may not be subjected to the limitations of a maximum of two exit doors opening into the exit passageway, and

(iii) an external exit passageway may be roofed over provided the depth of the roofed over portion shall not exceed 3m to avoid smoke logging, and

(iv) an external exit passageway may be enclosed on the open side by only a parapet wall or solid balustrade of not less than 1.0m or more than 1.1 m in height ***and the vertical height of the unobstructed ventilation opening measured from the parapet wall or solid balustrade up to the top edge of the opening or eaves of overhang shall not be less than 1.2m, and***

(v) exit doors opening into an external exit passageway shall have fire resistance for at least half an hour and fitted with automatic self-closing device.

The Fire Code Review Committee proposed to stipulate the height of 1.1m parapet wall and the net unobstructed vertical openings above the parapet wall to be not less than 1.2m. The rationale is that the external exit passageway is an extension of the vertical exit. Hence, the requirement to have parapet wall or solid balustrade on the open side of the corridor is to prevent direct impingement of heat from flame rising from lower floor on occupants escaping along the corridor.

(G) Provision of cross-ventilated lobby for residential buildings exceeding 24m in height

Existing Clause

2.4.5 **(f)** Provision for buildings exceeding 24m in height

Approach to the exit staircase shall be through cross-ventilated lobby. The ventilation openings having a minimum width of 2000mm shall be unobstructed from parapet wall or balustrade level upwards and be positioned on opposite sides of the lobby such that they provide cross-ventilation throughout the entire space of the lobby. Where multiple ventilation openings are provided on opposites sides of the lobby, the minimum width of each opening shall not be less than 1000mm, provided the aggregate width of the openings at each opposite side is not less than 2000mm . See diagram 2.4.5(f)

Revised clause 2.4.5(f) to be read as follows :

2.4.5 **(f)** Provision for buildings exceeding 24m in height

Approach to the exit staircase shall be through cross-ventilated lobby. The ventilation openings having a minimum width of 2000mm ***and a minimum height of 1200mm*** shall be unobstructed from parapet wall or balustrade level upwards and be positioned on opposite sides of the lobby such that they provide cross-ventilation throughout the entire space of the lobby. Where multiple ventilation openings are provided on opposite sides of the lobby, the minimum width ***and height*** of each opening shall not be less than 1000mm ***and 1200mm respectively,*** provided the aggregate width of the openings at each opposite side is not less than 2000mm . See diagram 2.4.5(f)

The Fire Code Review Committee proposed to stipulate the height of ventilation opening for ease of application and control.

(H) Smoke free approach to exit staircase

Existing Clause

2.4.8 In a block of residential apartments or maisonettes, smoke free approach to an exit staircase may be permitted by means of an external corridor subject to compliance with the following: Smoke free approach to exit staircase

(a) Such external corridors conform to the requirements of external exit passageways for minimum width, headroom clearance, changes in floor level, provision of parapet wall or solid balustrade which shall not exceed 1000mm height along the outer side of the corridor. The corridor may be roofed over, provided the depth of the roofed over portion shall not exceed 3000mm.

(b) The residential apartment or maisonette shall be separated from the external corridor by an external wall with fire resistance rating of at least 1 hour, except that ventilation openings of non-combustible construction may be fixed at or above a level of 1.1 m, measured from the finished floor level of the external corridor to the sill level of the opening.

Revised clause 2.4.8(a) is to be read as follow:

2.4.8 In a block of residential apartments or maisonettes, smoke free approach to an exit staircase may be permitted by means of an external corridor subject to compliance with the following: Smoke free approach to exit staircase

(a) Such external corridors conform to the requirements of external exit passageways for minimum width, headroom clearance, changes in floor level. ***The provision of parapet wall or balustrade shall not exceed 1.1m or lower than 1m in height*** along the outer side of the corridor. ***The vertical height of the unobstructed ventilation opening measured from the parapet wall or balustrade up to the top edge of the opening or eaves of overhang shall not be less than 1.2m.*** The corridor may be roofed over, provided the depth of the roofed over portion shall not exceed 3000mm.

(b) The residential apartment or maisonette shall be separated from the external corridor by an external wall with fire resistance rating of at least 1 hour, except that ventilation openings of non-combustible construction may be fixed at or above a level of 1.1 m, measured from the finished floor level of the external corridor to the sill level of the opening.

FCRC agreed to amend sub-clause 2.4.8(a) to reflect the requirements on the height of parapet wall or balustrade and the vertical height of the ventilation opening to the external corridor.

(I) External exit staircases

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 3m vertically below, or adjacent or facing(subject to adequate separation complying with cl.3.5) any part of the external exit staircase;

Exception:

In building designed with external corridor access, the access to the external exit staircase shall be permitted by means of the open sided external corridor adjoining the occupancy areas, subject to the following

a) the external corridor shall be served by at least 2 exit staircases; and

b) that unobstructed ventilation openings shall be provided along the long side of the external corridor above the parapet or balustrade: and

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

The above sub-clause 2.3.3(b)(ii) is being expanded with the inclusion of an exception to permit smoke free approach to external exit staircase via an open-sided external corridor. This exception would allow the provision of unprotected openings to be located along the wall between the occupancy area and the external corridor adjoining the external exit staircase

(J) Exit doors and Exit Access doors

Existing Clause

2.3.9 Exit doors and exit access doors shall comply with the following: — Exit doors and Exit access doors

(a) Exit doors shall be capable of being opened manually, without the use of a key, tool, special knowledge or effort for operation from the inside of the building; and

(b) Exit doors which are required to have fire resistance rating shall comply with the relevant provisions for fire resisting doors under cl.3.9.2; and

(c) Exit doors and exit access doors shall open in the direction of exit travel: — Door swing

(i) when used in an exit, or

(ii) when used in protected enclosure, such as smoke stop and fire fighting lobbies in a building, or

(iii) when serving a high hazard area, or

(iv) when serving a room or space with more than 50 persons, and

Revised clause 2.3.9(c) to be read as follows :

2.3.9 Exit doors and exit access doors shall comply with the following: — Exit doors and Exit access doors

(a) Exit doors shall be capable of being opened manually, without the use of a key, tool, special knowledge or effort for operation from the inside of the building; and

(b) Exit doors which are required to have fire resistance rating shall comply with the relevant provisions for fire resisting doors under cl.3.9.2; and

(c) Exit doors and exit access doors shall open in the direction of exit travel: — Door swing

(i) when lead to an area of refuge and exit passageway, or

(ii) when used in exit enclosure, including smoke stop and fire fighting lobbies in a building. It shall not apply to doors of individual residential units that open directly into an exit enclosure, or

(iii) when serving a high hazard area, or

(iv) when serving a room or space with more than 50 occupants, and

The Fire Code Review Committee was of the view that the amendments as given in sub-clause 2.3.9 (c) would provide clarity over the existing clause in stating the situation which require the exit doors and exit access doors to swing in the direction of exit travel.

(K) OFFICE/SHOP/FACTORY/WAREHOUSE OCUPANCY

Existing Clause

2.6.1 In an office, shop, factory and warehouse building, at least two independent exit staircases or other exits shall be provided in compliance with the requirements of Cl. 2.2.11, except that one exit staircase may be permitted if the building is of non-combustible construction and not exceeding four storeys, subject to:

Number of exit staircases or exits per storey

(a) The maximum travel distance on any storey complying with column (ii) of Table 2.2A; and

(b) Exit staircase conforming to the requirements of Cl.2.3.3 , and

(c) With the exception of office building, the gross floor area of shop, factory and warehouse building not exceeding 185m² on any storey, including service ducts, lift shafts, toilets, staircase etc.

(d) The habitable height of the shop, factory or warehouse building not exceeding 15m measured from the outside average ground level to the finished floor level of the highest floor or 4-storey whichever is lower; and

(e) Access to the building for fire fighting appliances being provided for in compliance with the requirements in Chapter 4.

Revised clause 2.6.1 to be read as follows :

2.6.1 **In an office, shop, factory and warehouse building, at least two independent exit staircases or other exits shall be provided in compliance with the requirements of Cl. 2.2.11, except that one exit staircase *is* permitted *to serve the upper storeys,* if the building is of non-combustible construction and not exceeding 4 storeys, subject to:**

Number of exit staircases or exits per storey

(a) **The maximum travel distance on any storey *served by single exit staircase complying* with column (ii) of Table 2.2A; and**

(b) Exit staircase conforming to the requirements of Cl.2.3.3 , and

(c) **The gross floor area of *each upper storey of* shop, factory and warehouse building not exceeding *200m²,*** including service ducts, lift shafts, toilets, staircase etc.

(d) The habitable height of the shop, factory or warehouse building not exceeding 15m; and

(e) Access to the building for fire fighting appliances provided in compliance with the requirements in Chapter 4.

The Fire Code Review Committee agreed to the amendments as the exiting clause conveys the impression that 1st storey is subject to floor area control and provision of one exit. The FCRC also revised the max floor area from 185 m2 to 200m2 in sub-clause 2.6.1 (c) to be consistent with the requirement of min area that would require manual fire alarm detection provision.

(L) Vertical fire spread

Existing Clause

3.5.7 For high and low parts of different compartments of a building abutting each other, either one of the following requirements shall be complied with to prevent spread of fire from the roof close to and lower than the external of the higher part:

(a) the roof over the lower part of the building shall be fire rated in accordance with the element of structure for minimum 1 hour for a distance of 5m measured horizontally from the external wall of the higher part of building; or

(b) the external wall of the higher part of building overlooking the roof below shall have the necessary fire resistance rating in accordance with the element of structures for minimum 1 hour for a vertical height of not less than 9m measured from the roof of the lower part of the building.

Revised clause 3.5.7 to be read as follows :

3.5.7 For high and low parts of different compartments of a building abutting each other, either one of the following requirements shall be complied with to prevent spread of fire from the roof close to and lower than the external of the higher part:

(a) the roof over the lower part of the building shall be fire rated in accordance with the element of structure for minimum 1 hour for a distance of 5m measured horizontally from the external wall of the higher part of building; or

(b) the external wall of the higher part of building overlooking the roof below shall have the necessary fire resistance rating in accordance with the element of structures for minimum 1 hour for a vertical height of not less than 9m measured from the roof of the lower part of the building*; or*

(c) the above requirements shall not be applicable to buildings or lower parts of the building which are sprinkler protected, or old shophouses which are subject to URA's Conservation Programme or built before 1969 referred to under cl.1.1.1 and cl.1.1.2.

The Fire Code Review Committee was of the view that in a sprinkler protected building, it is less likely that the fire spread from lower part would spread to higher part of different compartments. The above amendments also exempt old shophouses designated for conservation or built before 1969, in view of the nature of the buildings.

(M) Materials for Construction

Existing Clause

3.15.12 Composite panels which consist of plastic or combustible core shall not be used either for the construction of external walls or as claddings to external walls of all buildings unless otherwise permitted by the Relevant Authority

Proposed addition of sub-clause 3.15.12(b) is to be read as follows:

3.15.12 ***(a)*** Composite panels which consist of plastic or combustible core shall not be used either for the construction of external walls or as claddings to external walls of all buildings unless otherwise permitted by the Relevant Authority

(b) Materials with surface flame spread rating of not lower than Class 2 shall be permitted to be used for the construction of partitions for toilet cubicles only.

The Fire Code Review Committee was of the view that the above relaxation under sub-clause 3.15.12(b) would be confined to toilet areas as they are usually located within a wet area and are relatively safe.

(N) Protection of hydrant mains in buildings

Existing Clause

4.4.3 All hydrant mains which pass through a building shall have its full length within the building encased in masonry. However, in areas considered to be of low fire risk by the Relevant Authority, the mains are allowed to be protected by fire resisting construction, provided the following requirements shall be complied with :

Protection of hydrant mains in buildings

(a) The protective enclosure to the mains shall have the same fire resistance as the elements of structure of the building where the mains are located;

(b) The hydrant mains shall be located in common circulation areas, such as carparking spaces and driveways; ie they shall not pass through private or confined spaces;

(C) No services (except sprinkler pipes) shall be located above or crossing over the hydrant mains;

(d) The hydrant mains shall be located away from explosion risk areas; and

(e) The protective enclosure to the hydrant mains shall be labelled with the words "HYDRANT MAIN" of minimum 50mm height at suitable intervals.

Revised clause 4.4.3 to be read as follows :

Protection of hydrant mains in buildings

4.4.3 All hydrant mains which pass through a building shall have its full length within the building *protected with fire resistance construction complying with Cl.3.8.7(c) of at least the same fire resistance as the element of structure, provided the following requirements are complied with : -*

(a) The hydrant mains shall be located in common circulation areas, such as carparking spaces and driveways; ie they shall not pass through private or confined spaces;

(b) No services (except sprinkler pipes) shall be located above or crossing over the hydrant mains;

(c) The hydrant mains shall be located away from explosion risk areas; and

(d) The protective enclosure to the hydrant mains shall be labelled with the words "HYDRANT MAIN" of minimum 50mm height at suitable intervals.

The Fire Code Review Committee agreed that the above clause should tie -up with cl.3.8.7 on the use of drywall construction for protecting structure. Thus, hydrant pipes located in the building can now be protected by fire rated boards, sprayed on materials or masonry.

(O) Homing of Lifts

Proposed new subclause 6.6.4 is to be read as follows:

6.6.4 *(a)* ***Homing of lifts for buildings which are required to be provided with fire alarm system*** ***Homing of Lifts***

In a fire emergency when any one of the fire detection devices or fire alarm systems is activated, all the passenger lifts shall be brought to the designated floor (usually 1st storey) and park there with the lift/landing doors remaining opened.

(b) ***Homing of lifts for buildings which are required to have standby generating plant***

In the event of power failure or power interruption in the building, the supply to the lifts shall be automatically switched over to the emergency power supply from the generating plant and the lifts shall be brought to the designated floor and park there with the lift landing doors remaining opened.

(c) ***Homing of lifts for buildings which are not required to have standby generating plant***

All passenger lifts, including hydraulic lifts, shall be provided with Automatic Rescue Device (ARD). The ARD shall permit the lifts to move and park at the nearest lift landing floor with the lift/landing doors in the opened position in the event of power failure. Homing any of the lifts to a basement storey is not permitted.

(d) ***Homing of lifts for Mixed developments comprising residential and non-residential components***

(i) ***All passenger lifts which serve the residential and non-residential floors shall be required to home to the designated or alternative designated floor in the event of power failure and/or fire. The lifts shall be provided with secondary power supplies from standby generating plant of sufficient capacity.***

(ii) ***Where the passenger lifts serve only the residential floors and by-pass the non-residential floors in a protected shafts, the lifts shall be required to be installed with Automatic Rescue Device (ARD), provided the habitable height of the highest floor does not exceed 60m.***

(iii) Where the passenger lifts serve the upper residential floors and the basement non-residential floor/s, including car parks, the lifts shall be provided with emergency power supply from standby generating plant for homing to the designated floor when there is a power failure in the building. In a fire emergency, the passenger lifts shall be brought to the designated floor when any of the fire alarm systems in the basement non-residential floor/s is activated.

(e) Alternative designated floor

(i) Where the lifts open directly into an occupancy area in a designated floor, for example, a shopping floor or an office floor, an alternative designated floor (eg 2nd storey) shall be also be identified. The lifts shall be brought to the alternative floor in the event that there is a fire in the designated floor, in close vicinity of the lift landing door. The activation of any detector or sprinkler head covering the lift landing space at the designated floor would cause the lift to be re-directed to home to the alternative floor.

(ii) In buildings under (e)(i) which are not provided with sprinkler or automatic fire alarm system, suitable sensors shall be provided at ceiling level to cover the lift landing space. The activation of any sensor would cause the lifts to be re-directed to home to the alternative floor.

The alternative floor shall have minimum fire hazard and pre-selected for the homing of passenger lifts, and where people can escape to safety to an exit staircase or other exit from the lift landing door.

(iii) The above requirements on homing of lifts to an alternative floor need not be applied to standalone open-sided carpark and residential buildings under purpose groups I & II.

(f) Hydraulic lifts

Where a hydraulic lift serves two upper storeys only, the lower of which has a final exit leading to the exterior space, the provision of an alternative power supply or ARD is not required, provided the lift car is arranged to lower itself to the 1st storey by gravity during power failure mode.

Since the lift homing requirements have been omitted from CP 2, the Fire Code Review Committee was of the view that the Fire Code should address the situations, including hydraulic lifts. However, all fire safety provisions, which are stipulated in CP 2 including lift homing, should apply to all electric and hydraulic lifts, for example, the provision of lift car enclosures, lift landing doors are required to comply with CP 2 and that electric lifts and hydraulic lifts are to home to the designated floor during power failure or under fire alarm mode.

(P) Buildings which require the provision of Standby Generating Plants.

Existing Clause

6.6.2 (b) Provisions for special emergency operations for lifts in public buildings shall comply with the requirements in the above Code of Practice.

Revised clause 6.6.2(b) to be read as follows :

6.6 2 (b) ***Buildings which require the provision of standby generating plant for special emergency operations.***

Provision for special emergency operation for lifts shall comply with the requirements in SS CP 2 for the following:

(i) Public buildings;

(ii) Buildings under purpose group II exceeding the habitable height of 60m;

(iii) Buildings under purpose group II where the passenger lifts serve the upper storey residential floors and the non-residential basement ;

(iv) Mixed developments where the passenger lifts serve both the residential and non-residential floors;

(v) Industrial buildings under purpose groups VI and VIII, which are multi-storey.

(vi) All basement occupancies

Existing clause 6.6.2(b) is being expanded to include non-public buildings which require the provision of standby generating plant for the evacuation of its occupants in a fire emergency.

(Q) Voice Communication System And Fire Command Centre

Existing Clause

8.2.1 A voice communication system shall be provided as follows:

(a) For all buildings belonging to purpose groups III, IV, V and VII the habitable height of which is between 24m and 60m, an ordinary public address system and a Fire Command Centre shall be provided. Two way emergency communication system shall also be provided between the Fire Command Centre and every fire fighting lobby.

For all buildings belonging to purpose groups III, IV, V and VII of more than 60m in habitable height, one way emergency communication system and a Fire Command Centre shall be provided. Two way emergency communication system shall also be provided between the Fire Command Centre and the following areas:-

(i) every fire fighting lobby, including 1st storey;

(ii) all fire fighting related mechanical equipment rooms inclusive of sprinkler pump room, wet rising main pump room, hose reel pump room, etc

(iii) all rooms housing smoke control equipment;

(iv) all lift machine rooms;

(v) any other locations as may be required by the Relevant Authority.

Revised clause 8.2.1 is to be read as follows :

8.2.1(a) ***One way emergency communication system and a fire command centre shall be provided as follows:***

(i) For all large buildings under Purpose groups III, IV, V & VII (gross floor area greater than 5000 sq m or having a total occupant load exceeding 1000 persons) and large industrial buildings under Purpose groups VI & VIII, including mega warehouses, (gross floor area greater than 5000 sq m).

(ii) For all buildings belonging to purpose groups III, IV, V, VI, VII, and VIII of more than 24m in habitable height.

(iii) ***For hotel or health care occupancies of less than 24m in habitable height. Loudspeakers for the public address system shall be provided in every lift lobby, staircase enclosure and other strategic positions within audible distance of all parts of all storeys of the building.***

(b) ***Two way emergency communication system shall be provided between the Fire Command Centre, under sub-clauses 8,2.1(a), (i) and (ii) above, and the following area:***

(i) every fire fighting lobby, including 1st storey;

(ii) all fire fighting related mechanical equipment rooms inclusive of sprinkler pump room, wet rising main pump room , *hose reel pump room,* ***switch rooms and generator rooms;***

(iii) all rooms housing smoke control equipment;

(iv) all lift machine rooms;

(v) ***fire lift;***

(vi) ***each area of refuge; and***

(vii) ***air-handling control rooms.***

(c) For a building of mixed commercial-cum residential usage, the requirements of sub-clauses ***a(ii)*** of this clause shall be applicable provided that:

where the commercial component of the building occupies only the lower portion of the building and is separated from the residential occupancies, then for the purpose of compliance with the said requirements, the measurement of habitable height shall be taken to *that* part ***of the commercial component*** of the building, and

where a commercial component of the building is located above any residential occupancies, the provisions of *a* ***(ii) shall be applicable if the habitable height of the building exceeds 24m.***

Existing clause 8.2.1 is being expanded to cover changes in building designs for industrial occupancies. Under sub-clause 8.2.1(a)(ii) all non-residential buildings exceed 24m in habitable height would need to provide dedicated one-way communication system. Similarly, for hotel and health care occupancies of less than 24m, dedicated one-way communication system is required instead of ordinary public address system

(R) Voice Communication in Basements

Existing Clause 8.2.4

Radio communication

When required by the Relevant Authority, basemen levels shall be provided with approved fixed radio communication facilities. Such fixed facilities should be located at protected locations such as fire command centre or protected lobbies. The radio communication equipment shall be capable of operating in the frequency band of 470-490 MHZ range.

Proposed New Clause to replace existing CL 8.2.4

All basement levels of Purpose group III to VII occupancies shall be provided with two way emergency communication system between the Fire Command Centre and the following area:

(i) ***every fire fighting lobby, including 1st storey. In building comprising 2,3 or 4 basements, one of the smoke stop lobbies shall be designated as a fire fighting lobby. In situation where there is only one basement level, the two way emergency communication system shall be located inside one of the exit staircases.***

,

(ii) ***all fire fighting related mechanical equipment rooms inclusive of sprinkler pump room, wet rising main pump room, hosereel pump, switch rooms and generator rooms***

(iii) ***all rooms housing smoke control equipment;***

(iv) ***fire lift;***

(v) ***each area of refuge; and***

(vi) ***air-handling control rooms.***

Existing clause 8.2.4 has been replaced by the above. Radio communication has been found to be not so efficient because of the interference of structures, such as columns and beams and the low floor to floor height in the basements. The provision of two way emergency communication system would enhance communication in basements.

3 Conclusion

3.1 The review which covers the 3rd update of the Fire Code 1997 also looked into the need to introduce requirements to complement the Codes of Practice for CP 2 and CP 25 in respect of homing of lifts, Emergency voice Communication Systems etc.

3.2 Regular updating on the changes / amendments to the Fire Code 1997 would help us to maintain an updated Code. This would help the building owners, QPs and SCDF and the public at large.