Buildings Department **Practice Note for Authorized Persons and Registered Structural Engineers** **204**

Guide to Fire Engineering Approach

This practice note provides guidance on fire engineering approach for the design of new buildings or alteration and addition works in existing buildings to meet the fire safety objectives and performance requirements of Building (Construction) Regulation 90, Building (Planning) Regulations 41, 41A, 41B & 41C and as an alternative to the prescriptive requirements set out in the three Codes of Practice for Means of Escape, Means of Access for Firefighting and Rescue and Fire Resisting Construction, covering fire safety in buildings.

Objectives

2. Fire engineering design offers a flexible alternative where it is impracticable to comply with prescriptive provisions in the Codes, especially when designing for special or large and complex buildings or alteration and addition works in existing buildings. The aim is to provide for an overall level of safety that is equivalent to that which would result if fire safety was achieved through full compliance with the prescriptive provisions of the relevant codes of practice. The acceptability of fire engineering approach is recognised in paragraph 3 of the Codes. Fire engineering design provides a framework for practitioners to demonstrate that the performance requirements of legislation are met, or in some cases bettered, even though some of the design solutions adopted fall outside or short of the prescriptive provisions in the Codes when additional fire safety measures are proposed to compensate for the deviation or shortfall.

3. To achieve this objective it is important to understand the performance requirements and the prescriptive provisions that are required as a minimum to comply with the legislation. If the design being considered is not substantially different from the prescriptive provisions or can be readily accommodated by adopting conservative assumptions, it may simply be a case of demonstrating like-for-like substitution or "equivalence" with prescriptive provisions and fire safety objectives without having to embark on a full fire safety strategy. However, practical test may be required where necessary to demonstrate the equivalence by practitioners.

4. The performance requirements of the legislation that have to be addressed in the fire engineering design, and re-expressed in terms of objectives, are as follows :

(a) Given the function and purpose of the building or installation, the design should not present an unacceptable risk of a fire developing and spreading.

(b) Occupants should have time to reach a place of (temporary and/or permanent) safety without being dangerously affected by heat or smoke from a fire.

(c) A fire should not spread to adjacent property.

/(d) A fire ….

(d) A fire (and smoke) should not spread beyond the compartment from which the fire originates.

(e) Firefighting personnel should be able to gain access and mount firefighting and rescue operations without undue risk to their health and safety.

(f) The stability, insulation and structural integrity of the building should be ensured in a fire of specified intensity and duration.

Design Methodology

5. One prevailing method of fire engineering design is based on making predictions of likely outcomes in the event of a fire and selecting appropriate fire safety system components to achieve the required objectives. This is a deterministic method of fire-safety engineering which combines assessment of both risk and hazard. It has been applied to special or unique buildings such as airport terminals, railway stations, convention and exhibition centres, aircraft hangars, stadiums, etc. where the prescriptive requirements of the building regulations are often not appropriate. Application of this method is designed to provide a level of fire safety equivalent to that expected in the legislation. Demonstrating equivalence to the prescriptive provisions is paramount to the acceptance of this method.

6. Risk assessment is introduced in expectation of a fire development, and system performance is based on various fire scenarios. Fire engineering is not sufficiently developed, at least for the time being, to provide simple methods of quantifying the overall fire safety of a building. Hong Kong, moreover, currently lacks local statistical information to support the establishment of appropriate risk factors to cover the range of indigenous building types. Quantitative risk assessment and large-scale fire tests, on the other hand, can only be undertaken for special buildings and installations.

7. Hazard analysis follows the traditional engineering approach based on defined fire loads and demonstrating the ability to resist such loads. It is often assisted by fire models and computational methods which are already established overseas and can offer a more certain indication of achieved safety. Provided the hazards are identified it is usually possible to devise strategies for their management or design solutions which will ensure reasonable safety of the occupants, and the protection of essential emergency plant and equipment.

8. Equivalence can also be readily demonstrated by deterministic means - equal performance between the designed system and what is expected under full compliance with the regulations i.e. the outcome under a given fire scenario should be similar for either the complying system or the alternative being proposed.

/9. Design Procedures .....

Design Procedures

9. The flow chart shown in the Appendix outlines the major steps to be followed in the fire engineering design of a building. The design procedure is essentially a process to analyse the likely effects of a fire given the worst likely location and time of ignition. Knowledge of the fire loads, the number and location of occupants and the fire protection features is essential for assessing whether the performance criteria are met. The first two steps are to determine the geometry, construction and use of the building and to establish performance requirements. The third step is to identify deviations from the prescriptive provisions and to propose alternatives to address the deficiency.

10. The following steps revolve around scenario analysis, considering all possible scenarios. Some parts of the analysis can possibly be quantified with numbers, but much of the analysis requires subjective judgement as to the likely movement and consequences of a fire and the likely location and movement of people. If the performance criteria are not met, then either the building geometry or the fire protection features must be modified until satisfactory performance is achieved. This process must be repeated for all possible fire scenarios.

Fire Safety Strategy Report

11. The compilation of a fire safety strategy report is the most effective way of identifying and setting out the tactics for the fire safety design of a building. Contents of the report may be set out as follows with some sections assuming a greater or lesser degree of importance depending on the particular project :

(a) *Introduction* : sets out the overall objectives of the fire strategy and the parameters of the report. Nature of the problems should be stated.

(b) *Description of the development* : describes the intended function of the building or project; outlining special features and inter-relationship with other properties.

(c) *Sources of Information* : lists the codes, legislation and guidance documents used in the compilation of the report and the features which are based on fire engineering principles.

(d) *Means of Escape* : establishes the objectives of the means of escape philosophy and, if necessary, refers to escape times and extended travel distances, behaviour, reaction and way finding pattern of the occupants.

(e) *Design fires* : in complex buildings, where necessary, establishes the design fire size by calculation of fire load and type so that the effect of fire and smoke can be assessed. This is particularly important when considering smoke extract calculations and the effect of heat on the building structure.

/(f) Smoke .....

(f) *Smoke control* : describes the purpose of smoke control system where required to maintain clear layer height and to limit temperatures to keep escape routes safe and clear, and to provide indication on the toxicity of gases.

(g) *Fire spread control* : states the combustibility of wall and ceiling linings, furnishings, the integrity rating of structure and compartment walls, the control of the rate of spread of fire, the resistance of the effect of a fire and the capacity of fire containing. This section would also contain details of compartment size and external fire spread with due regard to the insulation, stability and integrity of the building.

(h) *Structural Performance* : predicts the thermal response and structural response of fire resisting elements at elevated temperatures and determines their equivalent fire resistance ratings; attention should also be given to the structural safety of adjacent buildings due to heat radiation near the site boundary.

(i) *Sprinkler system* : where sprinklers are proposed, states the hazard classification, water supplies, extent of coverage and system standard; identifies special features such as fast response sprinklers used in areas of smoke control.

(j) *Alarm system* : describes the type and extent of the alarm system; for example type and coverage of fire detectors, manual call points, communication of alarm, technical features of the system, position of panels. Where the alarm system is also used to activate dampers, pressurise stairs, or send a signal to the Fire Services Communication Centre, suitable references will be made.

(k) *First-aid firefighting* : describes the provisions of first-aid firefighting equipment e.g. hosereels and portable fire extinguishers available to the occupants of the building.

(l) *Facilities for firefighting personnel :* describes the facilities which should be made available to the firefighting appliance and personnel including access, and sometimes water supplies for firefighting, firefighting and rescue staircases, fireman's lift, fire control centre/panel, smoke clearance and point of assembly.

(m) *Emergency lighting and signs* : outlines the standards and operating principles.

/(n) Role .....

(n) *Role of management* : defines clearly the management role and states clearly the arrangements that could ensure the continued maintenance of any fire protection system. This is an important element of the fire safety strategy which should be clearly defined. Management may play an active part in minimizing the outbreak of fire by restricting smoking, ensuring good housekeeping and security. Management will also be responsible for ensuring that maintenance and testing procedures are in place to ensure that the fire systems within the building will respond to a fire.

The report should contain calculations, sketches and diagrams to support the conclusions and aims of the report. Detailed information should include smoke filling, design fire and egress calculations where these are appropriate.

Consultation

12. It is important that practitioners consider the implications of fire safety on the building design at an early stage and establish a consultative procedure with the Buildings Department and Fire Services Department so that the fire safety objectives can be agreed between the parties at the outset. In this connection, the Buildings Department and Fire Services Department should be approached prior to submission of building plans for agreement in principle to any fire engineering design being considered.

13. As yet there is no accreditation of fire engineers, authorized persons (APs) meanwhile must assume the pivotal role in the consultative procedures when the fire strategy and fire engineering design is being developed. Practitioners from other disciplines are expected, however, to provide their specialist input as well.

References

14. The range of overseas codes and standards applicable to fire safety is constantly increasing and individual publications are frequently amended or revised. Although practitioners may not have all relevant information readily to hand, they should be aware of these publications. Product data and articles in fire safety journals, also help keep practitioners up-to-date with new developments in fire safety matters. Various standard documents are available describing fire engineering approaches to design such as the draft British Standard, the Australian Code, NFPA (National Fire Protection Association) and SFPE (Society of Fire Protection Engineer) Handbooks. These documents provide specific guidance on fire load, smoke control, egress from buildings for specialised occupancies, equations and relationships, calculation methods along with valuable data for use in the development of the case to demonstrate adequacy.

15. This .....

15. This practice note cannot possibly outline all the fire engineering design technology required for use on every specific building. Rather, it simply outlines one recommended framework for fire engineering design activities. As fire engineering approach is new to both the practitioners and the authorities, this practice note would serve as an initial guideline. In the longer run, we need to develop fire safety standards (e.g. safe evacuation time, tenability level of exit routes, etc.) and develop control over tools (e.g. computer modules) for predicting risks or demonstrating compliance and over the service of professionals (e.g. fire engineers). This guideline will be reviewed regularly. Any suggestion for improvement is welcome.

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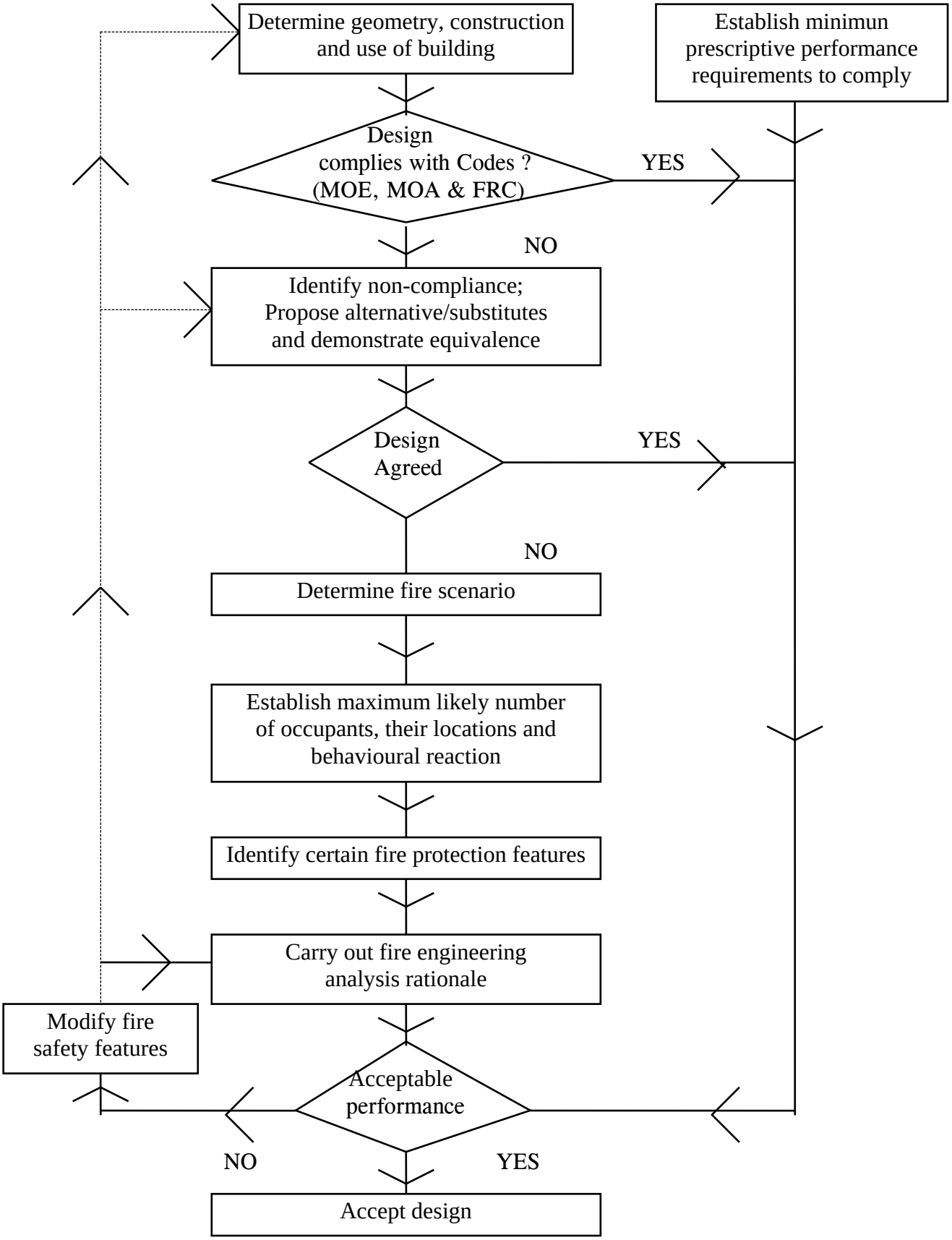

Appendix : Overview of Fire Engineering Design