On the Idea of Performance Based Lift Codes

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ABSTRACT

As the economy is becoming more and more globalized, clients are demanding more and more high quality products that are world wide acceptable. However, owing to the existing rigid prescriptive approach, lift codes may not be easily understood or accepted by all countries. We may imagine a trend in the future that the prescriptive codes will gradually be replaced by universal codes with emphasis on general performance rather than the technical details down to accurate figures. Performance-based codes have several advantages, such as clear definition of code objectives, high transparency, high flexibility in overall design to suit different applications, and the employment of analytical methods, data and assumptions formalized in a single code of practice. As a matter of fact, the fire protection codes have been aiming at this approach for years. This paper attempts to examine the possibility of the replacement of the lift code from a rigid to a more flexible approach by adopting the performance-based manner. It is not intended to create anything solid here. The authors merely want to initiate discussions and debates in this direction of development in the elevator industry.

1. INTRODUCTION

The concepts of performance-based codes came from the pioneer countries such as United States, Australia, Great Britain and Japan and their approach to develop performance-based building fire safety codes.

Since early 1970s, the availability of many engineering tools and the evolution of performance-based building and fire regulations in many countries has resulted in an increasing interest in performance-based building fire safety design.

In April 1971, an International Conference on Fire Safety in high-rise building in Airlie, Virginia was convened. From that time, many papers regarding the performance-based regulations for fire safety were presented.

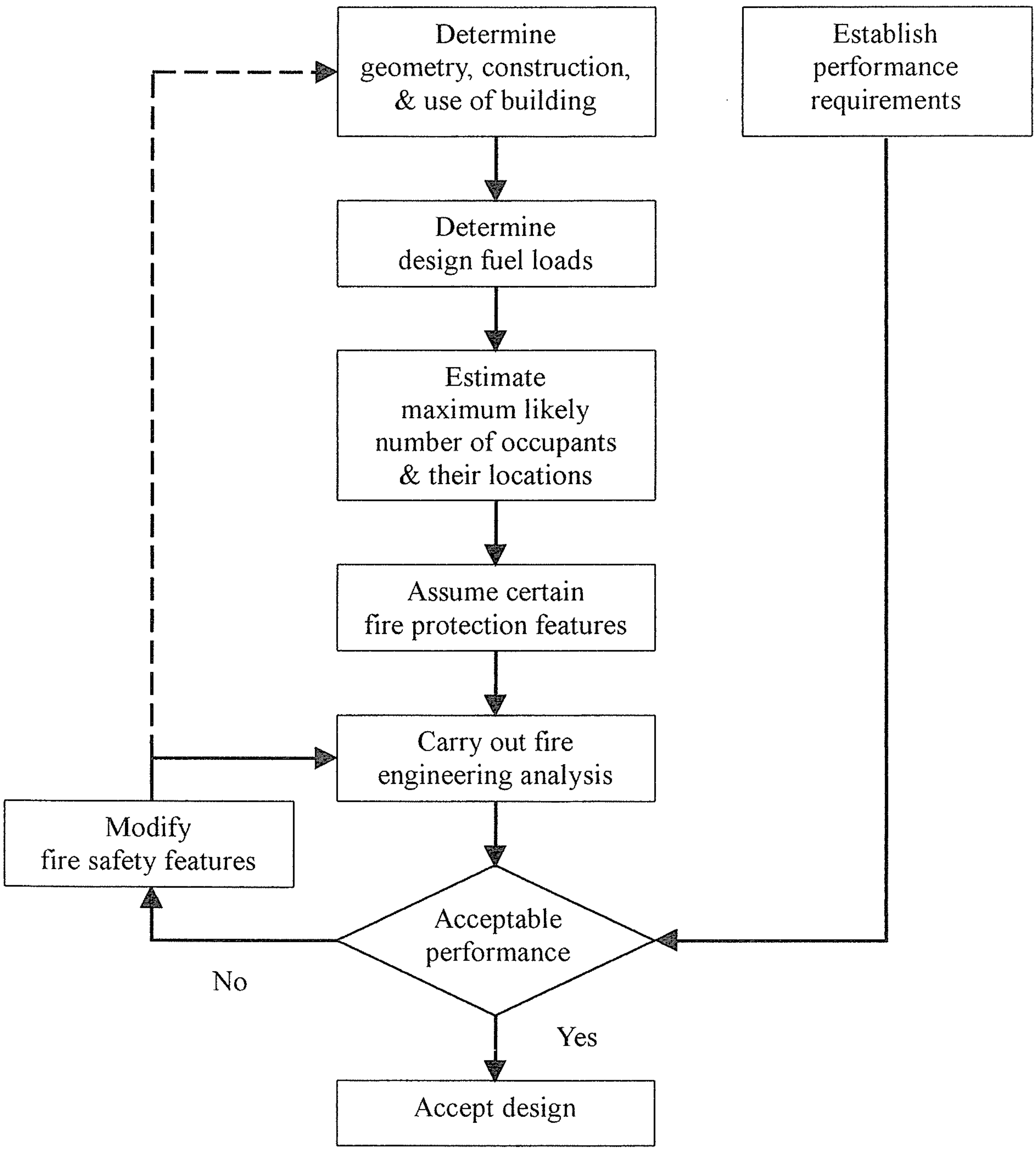
In the mid-1980s, Great Britain and Japan, both issued "The Building Regulations" and "Total Fire Safety Design System of Building" respectively based on performance-oriented regulations. This gained worldwide attention through the "Warren Center Report" from Australia in the late 1980s. This move towards minimizing prescriptive constraints and maximizing design flexibility in building codes of fire safety has become increasingly widespread.

Nowadays, there are more than thirteen countries, namely Australia, Canada, Finland, France, Great Britain, Japan, Netherlands, New Zealand, Norway, Poland, Spain, Sweden and the

United States and two international organizations (the International Organization for Standardization and the International Council for Building Research and Documentation) using or developing performance-based codes for their fire safety design.

In 1992, the version of the New Zealand Building Code, issued by the New Zealand Government, was promulgated as a performance-based document that considers Outbreak of Fire, Means of Escape, Spread of Fire and Structural Stability During Fire as specific fire safety criteria that must be addressed by any building design. A guidance document "The Fire Engineering Design Guide" contains not only fire safety design criteria and methods, but also the applicable portion of the New Zealand Code.

A basic flow chart of the specific fire engineering design process is shown below:



Overview of Specific Fire Engineering Design

It is also feasible to apply this kind of concept to the lift and escalator industry. Although it is not easy to change dramatically from the traditional codes to the performance-based codes in a short period, there are important advantages to encourage countries to adopt this kind of concept in the lift and escalator codes.

2. PERFORMANCE-BASED LIFT CODES UNDER FOUR CATEGORIES

2.1 Category I

Very often, exact figures have been quoted in the lift and escalator codes that make the design and manufacturing easier. However, this could also hinder improvement of the machinery, in particular, those related to the safety features. Figures need to be flexible while the intention and background theories supporting the specific code must be given. Then, the manufacturers will clearly know the spirit behind the code and design the best configuration. Examples are:

EN81-1: 1998 Part1: Electric lifts

Clause 5.2.2.1.1
Inspection doors shall have a minimum height of 1.40m and a minimum width of 0.60m.
Emergency doors shall have a minimum height of 1.8m and a minimum width of 0.35m.
Inspection traps shall have a maximum height of 0.5m and a maximum width of 0.5m.

Performance-based lift codes:-
Inspection doors and trap doors shall be flexibly designed to allow a person to pass through without difficulty.
Emergency doors shall be so designed for giving a clear passage for a person.

Clause 5.2.2.1.2
When the distance between consecutive landing doorsills exceeds 11m, intermediate emergency doors shall be provided, such that the distance between sills is not more than 11m. This requirement is not called for in the case of adjacent cars each fitted with an emergency door, provision for which is made in 8.12.3.

Performance-based lift codes:-
When the distance between consecutive landing doorsills exceeds 11m, the lift installation shall be equipped with a specific rescue function that allows the rescuer to release the trapped passenger inside the lift cage. This requirement is not called for in the case of adjacent cars each fitted with an emergency door, provision for which is made in 8.12.3.

Clause 5.7.1.1
When the counterweight rests on its fully compressed buffer(s), the following four conditions shall be satisfied at the same time:-

a) the car guide rail lengths shall be..., of at least $0.1+0.035v^2$;
b) the free vertical distance between the level of the highest area on the car roof..., shall be at least $1.0+0.035v^2$;
c) the free vertical distance...
    1) the highest pieces of equipment..., shall be at least $0.1+0.035v^2$;
    2) the highest part of the guide shoes..., shall be at least $0.1+0.035v^2$;

d) there shall be above the car sufficient space to accommodate a rectangular block not less than 0.50m×0.60m×0.80m resting on one of its faces.

Performance-based lift codes:-
When the counterweight rests on its fully compressed buffer(s), the top clearance shall be sufficient:
a) to prevent the lift car from clashing with the lift shaft ceiling;
b) to allow a person to be accommodated at the car top in a safe manner.

<u>Clause 5.9</u>
The well shall be provided with permanently installed electric lighting, giving an intensity of illumination of at least 50 lux, 1m above the car roof and the pit floor, even when all doors are closed.

Performance-based lift codes:-
The well shall be provided with permanently installed electric lighting sufficient for working safely even when all doors are closed.

<u>Clause 6.3.2.1</u>
The dimensions of machine rooms shall be sufficient to permit easy and safe working on equipment, especially the electrical equipment.
In particular there shall be provided at least a clear height of 2m at working areas, and:
a) a clear horizontal area in front of the control panels and the cabinets. This area is defined as follows:
 1) depth,...at least 0.7m;
 2) width, the greater of the following values: 0.5m or the full width of the cabinet or panel;
b) a clear horizontal area of at least 0.5m×0.6m for maintenance and inspection of moving parts at points where this is necessary and, if need be, manual emergency operation.

Performance-based lift codes:-
The dimensions of machine rooms shall be sufficient to permit easy and safe working on equipment, especially the electrical equipment.

<u>Clause 6.3.2.5</u>
When the floor of the machine rooms has any recesses greater than 0.5m deep and less than 0.5m wide, or and ducts, they shall be covered.

Performance-based lift codes:-
When the floor of the machine rooms has any recesses, risk assessment shall be carried out to prevent any accident from happening and protective means shall be provided.

<u>Clause 6.3.6</u>
The machine room shall be provided with permanently installed electric lighting on the basis of at least 200 lux at floor level.

Performance-based lift codes:-
The machine room shall be provided with permanently installed electric lighting, which shall provide sufficient illumination for the purpose of safe working conditions.

<u>Clause 7.1</u>

The openings in the well giving access to the lift car shall be provided with imperforate landing doors.

When closed, the clearance between panels, or between panels and uprights, lintels or sills, shall be as small as possible.

This condition is considered to be fulfilled when the operational clearances do not exceed 6mm. This value, due to wear, may reach 10mm. These clearances are measured at the back of recesses, if present.

Performance-based lift codes:-

The openings in the well giving access to the lift car shall be provided with imperforate landing doors.

When closed, the clearance between panels, or between panels and uprights, lintels or sills, shall be as small as possible.

This condition is considered to be fulfilled when the operational clearances do not exceed the value that will cause trapping of the passenger's fingers. These clearances shall be provided with suitable protective means to cover future enlargement due to wear. These clearances are measured at the back of recesses, if present.

<u>Clause 7.5.2.1.1.1</u>

The effort needed to prevent the door closing shall not exceed 150N. This measurement shall not be made in the first third of the travel of the door.

Performance-based lift codes:-

The effort needed to prevent the door closing shall not exceed the pushing force by a person. This measurement shall not be made in the first third of the travel of the door.

<u>Clause 7.6.2</u>

In the case of landing doors with manual opening, the user needs to know, before opening the door, whether the car is there or not.

To this effect, there shall be installed, either:

a) one or more transparent vision panels conforming to the following four conditions at the same time:
    1) mechanical strength...;
    2) minimum thickness of 6mm;
    3) minimum glazed area per landing door of $0.015m^2$ with a minimum of $0.01m^2$ per vision panel;
    4) width of at least 60mm, and at most 150mm. The lower edge of vision panels which are wider than 80mm shall be at least 1m above floor level.

Performance-based lift codes:-

In the case of landing doors with manual opening, the user needs to know, before opening the door, whether the car is there or not. To this effect, there shall be installed, either one or more transparent vision panels with sufficient mechanical strength and of suitable height and size.

<u>Clause 8.13.2</u>

The car roof shall have at one point a clear area for standing of at least $0.12m^2$, in which the lesser dimension is at least 0.25m.

Performance-based lift codes:-
The car roof shall have at one point a clear area for standing of at least two persons for carrying out lift work, in which the lesser dimension shall be at least enough for the person to stand comfortably.

Clause 8.13.3.2
Considering the free distance in a horizontal plane beyond the outer edge of the handrail of the balustrade, its height shall be at least:
a) 0.70m where the free distance is up to 0.85m;
b) 1.10m where the free distance exceeds 0.85m.

Performance-based lift codes:-
Considering the free distance in a horizontal plane beyond the outer edge of the handrail of the balustrade, its height shall be sufficient to prevent a person from falling down into the lift well.

Clause 8.16
8.16.1 Cars with imperforate doors shall be provided with ventilation apertures in the upper and lower parts of the car.
8.16.2 The effective area of ventilation apertures situated in the upper part of the car shall be at least 1% of the available car area, and the same also applies for the apertures in the lower part of the car.
The gaps round the car doors may be taken into account in the calculation of the area of ventilation holes, up to 50% of the required effective area.
8.16.3 Ventilation apertures shall be built or arranged in such a way that it is not possible to pass a straight rigid rod 10mm in diameter through the car walls from the inside.

Performance-based lift codes:-
Car with imperforate doors shall be provided with ventilation apertures in the car. The ventilation apertures shall be sufficient and of suitable size to make passengers feel comfortable and avoid potential hazard.

Clause 11.3
The car and its associated components shall be at a distance of at least 50mm from the counterweight or balancing weight (if there is one) and its associated components.

Performance-based lift codes:-
The car and its associated components shall be at a distance which is safe enough to prevent collision with the counterweight or balancing weight (if there is one), even after the wear of the lift guiding equipment (i.e. guide shoes and guide rollers).

EN115: 1995

Clause 5.2.4
Where building obstacles can cause injuries, appropriate preventive measures shall be taken. In particular, at floor intersections and on criss-cross escalators or passenger conveyors, a vertical obstruction of not less than 0.3m in height, not presenting any sharp cutting edges shall be placed above the balustrade decking, e.g. as an imperforate triangle. It is not necessary to comply with these requirements when the distance between the centreline of the handrail and any obstacles is equal to or greater than 0.5m.

Performance-based lift codes:-
Where building obstacles can cause injuries, appropriate preventive measures shall be taken. In particular, at floor intersections and on criss-cross escalators or passenger conveyors, a suitable vertical obstruction can be used. This requirement is not necessary when the distance between the centreline of the handrail and any obstacles does not impose hazards to the passengers.

2.2 Category II

Very often, a specific clause refers the reader to another clause that may be inside the same code or in another code. First of all, it is very inconvenient even though the user may have a copy of another code. Second, this kind of cross referral may create confusion and even cause the designer to make mistakes. Therefore, each code should stand alone as much as possible so that it is self-explanatory. If it is necessary to refer to another code, the spirit and reason of the other code must be as detailed as possible to avoid confusion and for more effective understanding. Examples are:

<u>EN81-1: 1998 Part1: Electric lifts</u>

<u>Clause 6.3.6</u>
Same as above mentioned under Category I

<u>Clause 6.3.7</u>
One or more metal supports or hooks with the indication of the safe working load, as appropriate, are provided in the machine room ceiling or on the beams, conveniently positioned to permit the hoisting of heavy equipment.

Performance-based lift codes:-
The machine room shall be so constructed as to accommodate the hoisting equipment used for the lifting of heavy components of the lift system, otherwise, suitable metal supports or hooks with the indication of the safe working load, as appropriate, shall be provided in the machine room ceiling or on the beams.

<u>Clause 6.4.7</u>
The pulley room shall be provided with permanently installed electric lighting, giving an intensity of illumination of at least 100 lux at the pulley(s).

Performance-based lift codes:-
The pulley room shall have a lighting intensity of at least 100 lux at floor level. The illumination shall be from either permanently installed electric lighting inside the pulley room or at the control equipment of the lift system.

<u>Clause 8.2.1</u>
To prevent an overloading of the car by persons, the available area of the car shall be limited. To this effect the relationship between rated load and maximum available area is given in Table 1.1.

Performance-based lift codes:
To prevent overloading of the car by persons, the available area of the car shall be limited. To this effect the relationship between rated load and maximum available area shall depend on

the lift type (i.e. passenger lift or cargo lift) and the weight of the handling devices. The relationship given in Table 1.1 is for reference.

Clause 8.2.3
The number of passengers shall be obtained from:

a) either, the formula, $\frac{\text{rated load}}{75}$,...or
b) Table 1.2 which gives the smaller value

Performance-based lift codes:
The number of passengers shall be obtained from:

a) either, the formula, $\frac{\text{rated load}}{75}$,...or
b) Table 1.2 which gives the smaller value.

The figure 75kg can be flexible and changed to suit an average person's weight in the particular country.

2.3 Category III

Very often, clauses in the code give the methods in terms of figures to achieve certain results. However, the figures of a process to arrive at a result are not always that meaningful. We should aim at the figures appropriate to the result. There may be hundreds of ways to achieve a result or a figure. Examples are:

EN81-1: 1998 Part1: Electric lifts

Clause 5.2.2.1.1
Same as above mentioned under Category I

Clause 5.9
Same as above mentioned under Category I

2.4 Category IV

Very often, the code tells you how to design a component or a sub-system of an elevator system. New inventions and innovations cannot be easily implemented due to the hindrance of existing codes. Updating of codes is usually a very slow process, taking years. But modern technology goes through a revolution almost every five years. How can our codes catch up with the new technologies? The code should specify alternative means to fulfill something and welcome new technologies. Whenever a new technology evolves, the code maker just changes the part on the alternative means. Examples are:

new drives; multi-car design; new braking method; new proximity sensor; new machine room/hoistway ventilation method etc.

Indeed, the given examples under the four categories are just suggestions to demonstrate what a category means. The examples have not gone through any rigorous consideration and therefore they may not be comprehensive. They show the philosophy behind the thinking, not the content being prime of importance.

3. ADVANTAGES AND DISADVANTAGES OF PERFORMANCE-BASED CODES

From the above mentioned four categories and the respective examples, the advantages of adopting the performance-based codes to suit the high technological developments of this century are self-evident. We summarize some advantages and disadvantages of the performance-based codes:

Advantages are:
- Easy to match up with new technologies;
- Universally applied in all countries around the world;
- More flexible from the manufacturer's point of view;
- Safety standards can be upgraded easily because people know exactly what is required (i.e. the background theory of every code).

Disadvantages are:
- Quality control is more difficult;
- Legally complicated as it is difficult to judge responsibilities;
- Technologies used may not be well proven;
- Maintenance becomes difficult when one company takes up the maintenance responsibility of another company. Therefore, more thorough studies on this aspect must be made.

4. CONCLUSION

Even though the advantages of the performance-based codes seem to be suited to the high technological developments of this century, the implementation may not be so easy in less developed Asian countries.

China, Hong Kong, Singapore and Japan, all have different systems designed to approve and inspect the newly installed lifts and escalators. In Hong Kong, the operation of lifts and escalators is certified by the Registered Lift and Escalator Engineers; in Singapore, the operation is certified by the Registered Professional Engineers; and in China, the inspection and testing is conducted by a representative of the government. It is therefore more difficult to justify the design and prove that the design reaches the required safe operation.

We believe that the performance-based codes can be universally applied but this should only be after a period of development and improvement to ensure safe application of the codes.

5. REFERENCES

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6. BIOGRAPHICAL DETAILS

Mr. H.S. Kuok, the Deputy Managing Director of Chevalier International Holdings Limited, joined the Chevalier Group in 1972, and is the Vice Chairman of Chevalier Construction Holdings Limited and a Director of Chevalier iTech Holdings Limited and Chevalier Singapore Holdings Limited. He is also the President of the Lift and Escalator Contractors Association in Hong Kong, the Vice-Chairman of the International Association of Elevator Engineers (Hong Kong-China Branch) and a Registered Lift and Escalator Engineer in Hong Kong. In 1998, he was appointed as a member of the Chinese People's Political Consultative Conference, Guangzhou.

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