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**FIFTEENTH MEETING OF THE UJNR  
PANEL ON FIRE RESEARCH AND SAFETY  
MARCH 1-7, 2000**

**VOLUME 1**

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# **OUTLINE OF REFORMING THE BUILDING STANDARD LAW IN JAPAN**

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## **INTRODUCTION**

The Draft Cabinet Order or Enforcement Order related to fire safety has opened for public comments on February 14, 2000, following "The Law to amend the Building Standard Law" issued on June 1998. This revision partly includes recent progress in the comprehensive studies aiming at performance based fire safety design method made by two MOC (Ministry of Construction) *Sopuro*. These are "Design of Total Building Fire Safety (conducted in 1982 through 1986; Fire safety Sopuro) and "Development of Assessment Method for Fire Performance of Building Materials and Structures (1993 through 1997; Fire Test Sopuro). The technical studies in view of the revision of fire safety provisions in Building Standard Law and its associated government orders (model building codes) are being carried out by Building Guidance Division of MOC with technical support by BRI fire research staff. The purpose of the Fire Test Sopuro was twofold, i.e. to develop new fire test method which can be globally accepted and can measure the data useful for fire safety engineering tools and to improve and complete the fire safety design method introduced as the result of Fire safety Sopuro. The fire test method consisted of material combustibility test, fire resistance tests and opening assembly tests. The harmonization with ISO test method was stressed in the former two. As for improvement and completion of fire safety design method, the criteria for compliance verifications to the requirements are newly developed or reconsidered. The design fires were reconsidered and practical FSE tools, often computable by the use of hand calculator, were developed. The related Notifications of MOC, which include prescriptive codes and FSE tools, will be published by June this year.

This paper is written to introduce the background and outline of revised draft Enforcement Order of the Building Standard Law focused on a performance-based code in the field of fire safety. As a result of the work for change to performance-based criteria, the outline of structural fire resistance assessment and performance of egress safety is described. The Provision related to materials is in the appendix

## **BACKGROUND**

To changing the Building Standard Law towards performance-based standard is world-wide movement and there are two main reason i.e., the technological limitation of prescriptive criteria and new knowledge in fire safety engineering to correspond with internationalization of fire safety technology.

Regarding the change of Building Standard Law (legal part) last June, there are various movements under "performance-based criteria." Disregard the movement outside of Japan, three types of movements are discussed regarding "performance-based criteria". At first, change various technological criteria to harmonize ISO or replace to ISO then change the law, which are related to it. There is a group calling this as process for changing to performance-based criteria but there are some "prescriptive criteria" in ISO standards, which do not have any relationship to performance and it should be pointed out as process to the internationalization.

Second, because of the word "performance" has many meaning, it is interpreted as "the performance-based design"(Build by designer and/or contractor and user agreed on performance level of building. The system that designer and/or contractor are required to take responsibility of product liability based on agreed performance level.)is supported by this criteria.

Third, this is the main subject of this paper. The current law, which stated by specification, is so much out of date, to change performance (function) base has to start from the area that is technically clear. But in actual work including internationalization and it has to consider the continuity to the law. So, I have to admit that there may be some contradiction regarding performance-based criteria.

## **1. Performance-based evaluation**

One of main change in the Building Standard Law is to introduce the regulation that if certain level of performance is satisfied, you may use various material, equipment and structural system. The performance-based criteria object to fire safety can make a choice by item from which states in the text of performance criteria, as long as you are able to show the way of assessment for performance and judgement criteria. Specifically as indicated in figure 1 below, assessment for the structural fireproof will be introduce due to change part of the fireproof regulation (Article 27: Special Buildings Which Ought to be Fireproof or Quasi-fireproof Buildings, Article 61-62: Buildings in fire protection Districts) and Prohibition of large wooden structure (Article 21). Assessment of egress safety performance regulation will be introduced corresponding to an evacuation facility, smoke exhaust system or interior material limitation. Hereafter we call them performance rout. Even though the performance-based methods are introduced, basically the prescriptive methods will be remained after some rationalization as an alternative. To choose from performance-based method or prescriptive method is depend upon designer' decision, but either way the content of regulation will be same. A part, which does not correspond to performance-based method, will remain as existing prescriptive method. The prescriptive method, which stays in new law will be rationalized the testing method or related items and replaced by corresponding ISO standards and seeks to harmonize with performance-based assessment. Specifically testing method of materials and fireproof is changed to rational method which is based on ISO standards and the new testing method will be introduced to the area of which did not have any specific testing method or only has prescriptive method.

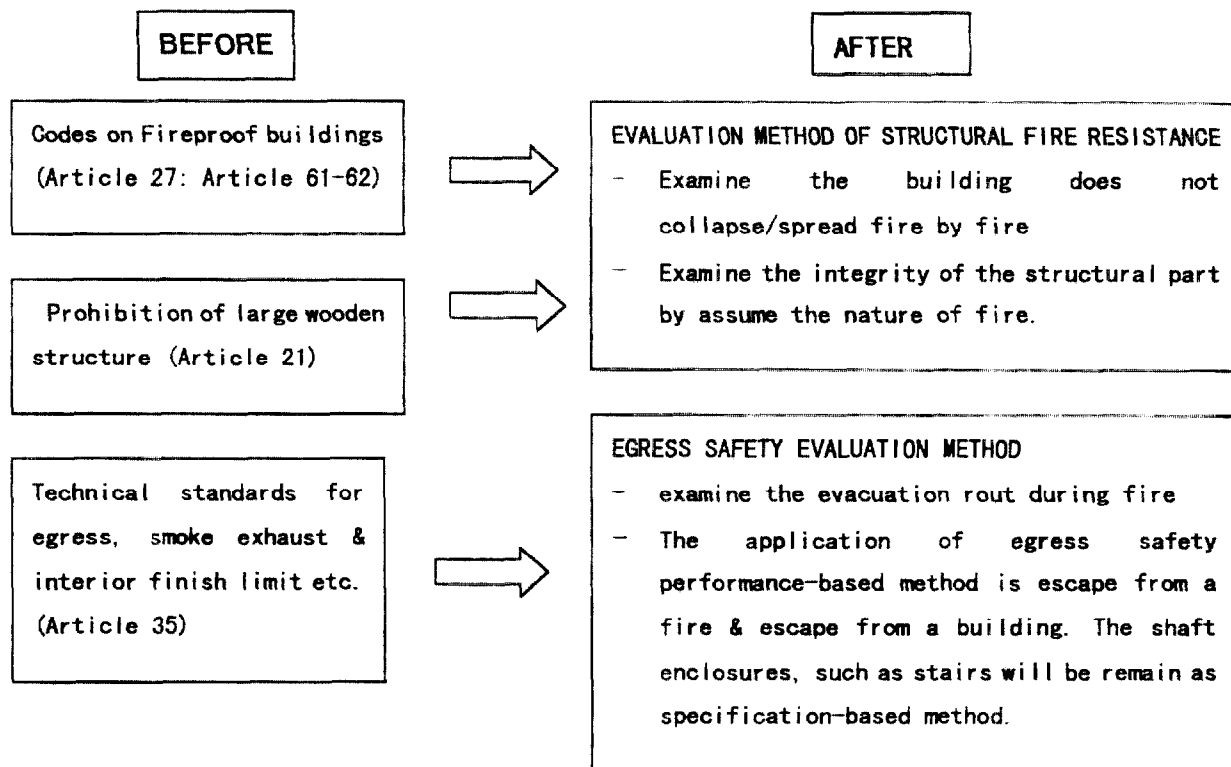


Fig.1. The area which change to performance-based method

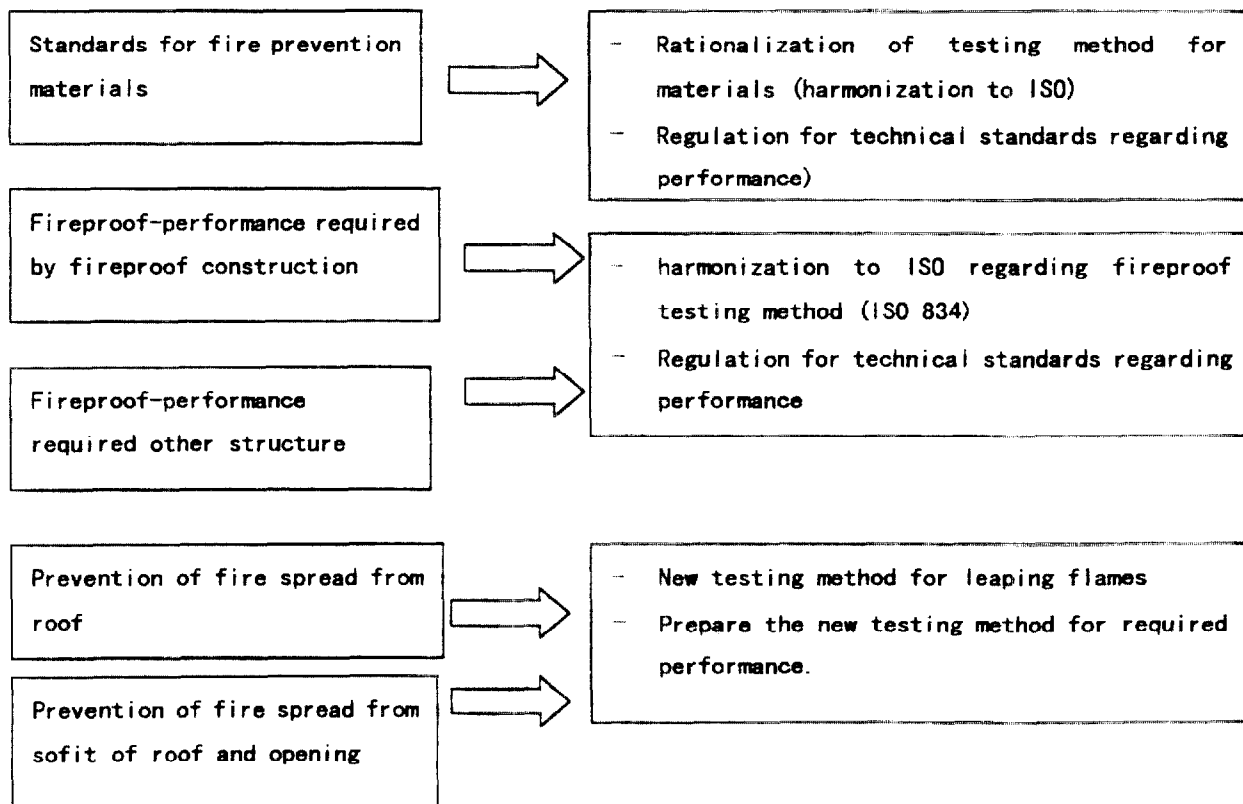


Fig.2 Remain as prescriptive regulation but harmonizes to performance-based regulation with some rationalization.

## 2. Outline of performance-based evaluation

### 2.1 Constitution

The function needed for fire safety of building is following five points: prevention of fire initiation, provision of means of egress, prevention of collapse of building, provision of fire base and access and prevention of fire spread to/from adjacent buildings. To reach the ideal performance level is to introduce the performance standard for each item. This is the first step for the change. Mainly two items in above, i.e., egress safety and prevention of collapse of building are preparing as regulation of performance-based criteria.

### 2.2 Design Fire

It is very important for determine the prediction method of fire behavior to introduce performance-based approach. We are not thinking to consider the frequency for outbreak of fire in depth at this point. To assume the origin of fire is equivalent in engineering terms to express the process of fire growth in architectural space. But it is very difficult to assume how the combustible material (interior finishing, contents, and fixed furniture) burns in space. In the Enforcement Order, simple equations are shown for calculation method and actual equations will be described in the Notification. Fire duration time for evaluation is calculated using heat release rate, total heat release of fuel, under conditions of a room.

## 3. Performance-based evaluation in the Draft Enforcement Order

### 3.1 Evaluation Method of Structural Fire Resistance

Performance-based evaluation method of structural fire resistance assesses “The structure must not collapse.” The possibility for using structure after fire is out of scope, because if the fire is only limited area then it can be assessed the durability diagnosis and repair can be done.

According to the Building Standard Law, the performance requirements for principal building elements of fireproof buildings are as follows:

#### (1) Principal building parts of fireproof buildings

- ① of fireproof construction, or
- ② of construction that meets the technical requirements laid down by Enforcement Order concerning their ability to withstand the heat until the fire is extinguished

The performance-base method is applied for above ②. Performance requirements are as follows;

- ① The following requirements must be satisfied when exposed to heat generated by a fire likely to take place within the building:
  - (a) Bearing walls, columns, floors, beams, roofs and stairs must not be damaged under the stress of dead or live load.
  - (b) Walls and floors must possess heat insulation property.
  - (c) Exterior walls and roofs must possess flame insulation property.
- ② Exterior walls must satisfy the following requirements when exposed to heat caused by fire taking place outside of the building:

(a) Exterior walls constituting bearing walls must not be damaged under the stress of dead or live load.

(b) Exterior walls and roofs must possess flame insulation property.

“Non-damage ability” means that the building part in question suffers no damage detrimental to structural strength. And this is part of performance evaluation. “Heat insulation property” means that the temperature of surface other than the surface exposed to heat will not rise up to a point where combustible materials touching any of the surfaces start burning. “Flame insulation property” means that the part in question suffers no damage such that flames become visible from the outside of the building.

Outline of Fireproof property verification method is as follows;

① Regarding indoor fires, the predicted duration of a fire in each room of a building and the period of time for which the principal building elements of the room concerned can withstand the fire shall first be obtained. The latter is called “Retaining Fireproof Time (Critical Time, hereafter) of Indoor Fire.” Then it shall be confirmed that the former is less than the latter.

(a) The duration of fire shall be calculated by dividing the total calorific value of combustible materials found in the room concerned by rate of heat release. The total calorific value shall be calculated according to the use of the room and the interior materials used in accordance with the method laid down by the Minister of Construction. The rate of heat release shall be calculated according to the use of the room and the shape of openings, etc. in accordance with the method laid down by the Minister of Construction.

(b) The Critical Time of Indoor Fire of principal building elements shall be calculated according to the structural type, the stress generated in the elements due to dead load, etc. and changes in temperatures resulting from an anticipated fire, by means of method specified by the Minister of Construction.

② Regarding outdoor fires for exterior walls. (Omission)

It is possible to interpret the testing results for building design condition. The testing method can be defined as the way to get property value of materials/components to assess architectural design in the performance-based method. It is not yet established the technological method to rationally control the fire, which burned through two stories at this point of engineering knowledge. Therefore even this method has limitations. It means that area of fire must not spread through floors. Prevention of spread of fire is always required for going up stairs through openings or shafts.

Example of evaluation is introduced in “Evaluation method of structural fire resistance” by Ohmiya et al for this 15th UJNR meeting.

### 3.2 Evaluation Method of Egress Safety

The functional requirements of egress safety are that all occupants of a building are able to escape without difficulties and dangers from the design fire. The performance of “free from smoke” is selected for evaluation using engineering tools and defined as the required performance of egress safety.

The evaluation method consist of estimating smoke condition and escape condition. Smoke condition is estimated by taking account of the performance of smoke control equipment and the

performance of compartment walls and openings. Escape condition is estimated including the escape start time. The evaluation is done by comparing the life threat time caused by smoke and the escape finish time. In the Enforcement Order, the evaluation of egress safety consists of two parts, escape from a fire floor and escape from a building. The escape from a fire floor includes the escape from a fire room. In each part, the life threat time by smoke is compared to the escape finish time. If the performance of egress safety is verified, some specifications such as such as number of escape stairs, travel distance to stairs, stairs width, smoke exhaust equipment, limitation of lining materials, etc will not be required.

Escape from a fire room, from a fire floor, from a fire building and calculation tools are introduced in "Evaluation method of egress safety" by Hagiwara for this 15th UJNR meeting.

## **CONCLUDING REMARK**

After the revision of the Building Standard Law and the Enforcement Order, it is expected that, on one hand, new technology that was so far treated in Article 38 (deleted in this amendment) will meet clear objective and be verified under the Law. On the other, to give impact to progress performance-based evaluation and development of related engineering tools in the field of fire safety. This could be a beginning of epoch making although there remain some inconsistency which should be solved.

### **(Reference)**

- 1) Tsujimoto, M., Hagiwara, I., Harada, K., Takahashi, W., Takeichi, N., "Evaluation method of fire prevention and evacuation code in Building Standard Law", Fire, Vol. 49(1), pp.7-15,1999
- 2) Ohmiya, Y., Yusa, S., Harada, K., "Evaluation method of structural fire resistance", presented at 15<sup>th</sup> UJNR Panel on Fire Research
- 3) Hagiwara, I. "Evaluation methods of Egress safety", presented at 15<sup>th</sup> UJNR Panel on Fire Research
- 4) Building Guidance Division, Housing Bureau, Ministry of Construction, "Outline of draft enforcement order of the Building Standard Law," Feb., 14, 2000



## II REVISIONS RELATED TO FIRE PREVENTION

### 1. Improvements to technical standards related to materials, structures, etc.

#### (1) Provisions related to materials (noncombustible, quasi-noncombustible and fire-retardant materials)

In response to Article 2, item (9) of the Building Standard Law which provides that noncombustibility (i.e., performance required of noncombustible materials) and the technical requirements concerning such performance shall be laid down by Enforcement Order, Article 108-2 of Enforcement Order establishes provisions concerning such noncombustibility and technical requirements applying thereto. Since every regulation thereunder is controlled by Enforcement Order, the performance and requirements in respect of quasi-noncombustible materials and fire-retardant materials as defined by Enforcement Order shall likewise be clarified. The performance required of each category of materials shall be as follows.

#### <Technical requirements for noncombustible materials>

When exposed to the flame and heat of normal fires the material concerned must satisfy the requirements as well as withstand the heat for a duration shown in the following table after heating has started:

Type of material	Duration	Requirements
Noncombustible material (per Enforcement Order, Art. 108-2)	20 minutes	* Does not burn * Does not suffer damage detrimental to fire prevention * Does not generate smoke or gas that obstructs evacuation
Quasi-noncombustible material (per Enforcement Order, Art. 1)	10 minutes	Ditto
Fire-retardant material (per Enforcement Order, Art.1)	5 minutes	Ditto

#### (2) Provisions related to construction