D DEMONSTRATON OF FIRE TESTING ON BUILDING MATERIALS

D. DEMONSTRATION OF FIRE TESTING ON BUILDING MATERIALS

D.1 Introduction

Thailand has only one laboratory for fire testing on building materials, which was established in Chulalongkorn University. Only one laboratory cannot test noncombustibility of all building materials in Thailand. Moreover, the testing equipment in the university is not sufficient to check the noncombustibility. As such, the noncombustibility of building materials was not confirmed in the process of building construction in Thailand.

To improve this situation, the Study Team proposed the improvement of the facility in the university and JICA donated DPT the testing equipment. DPT owns the equipment, and it transferred the management of the equipment to the university. The Study Team conducted the fire demonstration, to transfer the operation skill of testing equipment and enlighten the staff in charge of building safety the danger of fire.

D.2 Basic Principle of Fire Testing

The basic but important principle for evaluating the fire preventive performance of building materials is to grasp their combustion characteristics during the growth stage of fire.

A fire occurring in a space inside the building, such as a room, is generally called a room fire or a compartment fire. The behavior of this type of fire depends on not only the fire-resisting performance of interior finish materials, but also various building conditions, including the shape and size of the compartment, walls, calorific property of the ceiling, and the size of openings. It exhibits a burning behavior peculiar to a sectioned space. From the past experimental results obtained from numbers of compartment fires, it is known that the compartment fire is roughly divided into three stages: the fire growth stage, the fire peak stage, and the fire attenuation stage.

During the fire growth stage, the burning behavior is primarily determined by the property of the combustible which became the origin of fire, and not so much affected

by the building conditions such as walls of the compartment. The temperature increase inside the compartment is rather slow and the decrease of oxygen concentration is also gradual. However, as the flame grows and once reached the wall or the ceiling, the fire spreads quickly and causes a flashover phenomenon. The flashover phenomenon is a dangerous phenomenon that calls for the foremost attention when making evacuation or fire fighting action. Its level is influenced by the fire preventive performance of interior finish materials or combustibles placed inside the room.

During the fire peak stage, combustion continues steadily and briskly by extending over the entire area of the compartment and enveloping all the combustibles in flames. The burning behavior in this stage is dependent on various conditions of the compartment and the amount of combustibles.

The fire attenuation stage is the period when combustion weakens after burning up most of the combustibles inside the compartment.

From such burning behavior, it can be concluded that the fire preventive performance of the interior finish materials should be the one that can delay the start of a flashover phenomenon and do not emit harmful smoke or gas that hampers evacuation or fire fighting action. In other words, evaluation of the following properties is essential as to the interior finish materials: ① ignitability ② exothermic property ③ flame propagation property ④ smoke-causing property ⑤ gas toxicity.

D.3 Current Condition of Fire Testing in Thailand

Although evaluating five properties mentioned above is essential, the current condition of fire testing for the interior finish materials in Thailand is not sufficient to thoroughly evaluate them. The Study Team confirmed that fire protection/resistance testing equipment used for the evaluation of building materials and structures in Chulalongkorn University is the only one in Thailand. The equipment consists of two types of fire testing furnaces: one is the vertical type for testing walls, fire doors, and shutters (heating plane : 2.5 m x 2.5 m); the other is the horizontal type for testing small-sized floors, beams, and columns (heating plane : 1 m x 1.5 m x 1.2 m deep).

In Thailand, the following test methods on fire protection/resistance are specified in the 1996 catalog of the Thai Industrial Standard (TIS) by directly introducing from the ISO standards.

Type of Test	Code of TIS	Testing Item
Fire resistance test	TIS 1334	Elements of building construction
	TIS 1335	Door and shutter assemblies
	TIS 1336	Glazed elements
	TIS 1337	Ventilation ducts
Fire tests	TIS 1338	-Building materials -Non-combustibility tests
	TIS 1339	-Building materials -Determination of calorific potential
	TIS 1340	-Reaction to fire -Ignitability of building products
	TIS 1341 Part 1	-Evaluation of performance of Smoke control assemblies. -Part 1 Ambient temperature test

As mentioned above, the only testing equipment currently available in Thailand among those specified in the TIS are the two furnaces installed in Chulalongkorn University. Using those furnaces, tests are being conducted on walls, doors, shutters, small-sized floors and columns based on the ISO 834 fire resistance test – elements of building construction.

However, the thermocouple apparatus (plate type) for temperature measurement specified in the ISO standard is not fitted. It is judged that improvements are also needed with regard to the accuracy of pressure control and temperature control inside the fire testing furnaces.

It is specified in the ISO standard that the effective heating area should be not less than 3.0 m x 3.0 m for the vertical type fire testing furnace and not less than 4.0 m x 6.0 m for the horizontal fire testing type furnace. It is also specified in the same standard that the fire testing furnaces should be equipped with a loading device. Therefore, the two fire testing furnaces currently available at Chulalongkorn University are in need of substantial improvements. In addition, the number of testing method type is too small to cover the above five properties.

D.4 Selection of Testing Method

To minimize the gap between the current condition and the ideal condition, the following three types of testing equipment were introduced in Thailand through the Study.

1) Noncombustibility test ISO 1182
2) Ignitability test ISO 5657
3) Reduced scale model box test ISO DIS 17431

As mentioned above, the evaluation items of fire preventive materials include ignitability, exothermic property, flame propagation, smoke emission, and toxicity of gas. However, all of these properties cannot be tested with only one test method. The ignitability test device (ISO 5657) can compare the relative “ease of ignition” of various materials. It can provide the qualitative relationship between the ease of ignition and the growth of fire, but is not sufficient for the evaluation of fire preventive performance. For this reason, ISO 1182 and ISO DIS 17431 were introduced to thoroughly evaluate fire preventive performance.

About ignitability test, the mainstream test method on the burning behavior of combustible building materials has now moved to the ISO 5660 cone calorimeter method around the world. But, this device was not selected for the current technical transfer, and the ISO 5657 ignitability test device was selected instead. It is because the former device requires very stringent calibration and laboratory conditions, in addition to its high costs and a demand for elaborate operational techniques.

D.5 Outline of Transferred Testing Method

D.5.1 Noncombustibility Test (ISO 1182)

(1) Setting Condition of Equipment

The setting place of the equipment for ISO 5657 also required the room which keep the temperature is 20℃- 25℃, humid is approx. 60% and air speed is less than one meter per second. Besides, it required the experimental tables (use for assembling of the equipment), constant temperature and humid apparatus, automatic balance and smoke exhaust hood in the testing laboratory.

Outline of equipment is shown in D.

(2) Testing Building Materials

- Fiver reinforced cement board (6 mm)
- Gypsum board (12.5 mm)
- Rock wool lagging (30 mm)

(3) Evaluation Criteria

1) Temperature in the furnace

T.max – T.i ≦50℃ (Japanese Stds.)

T.max – T.f ≦50℃ (Japanese Stds.)

T.max: Maximum temperature in the furnace

T.i: Temperature in the furnace at the initiate stage

T.f: Temperature in the furnace at the final stage

2) Flaming

Continued time of the flame: within 10 second (Japanese Stds.)

3) Weight loss

Less than 30% (Japanese Stds.)

D.5.2 Ignitability Test (ISO 5567)

(1) Setting Condition of Equipment

The setting place of the equipment for ISO 5657 required the room which keep the temperature is 20℃- 25℃, humid is approx. 60% and air speed is less than one meter per second. Besides, it required the experimental tables (use for assembling of the equipment), constant temperature and humid apparatus, automatic balance and smoke exhaust hood in the testing laboratory. A table is also required.

(2) Testing Building Materials

- Gypsum board (12.5 mm)
- Gypsum board with wall paper (12.5 mm)
- Rock wool lagging (30 mm)
- Plywood (4m/m)
- Fire retardant treated plywood (5.5 mm)
- Decorative plywood (4 m/m)
- Glass fiver reinforced plastic: FRP (2 mm)

(3) Evaluation Criteria

1) Record of the times to catch fire on the surface of specimen by each radiate strength

2) If there is no catch of fire on the surface of specimen within 15 minutes, this condition is recorded as “Not Ignition”.

D.5.3 Reduced Scale Model Box Test (ISO 17431)

(1) Setting Condition of Equipment

Room for the equipment for ISO DIS 17431. But outside place is available, of cause if rainy and windy time, it could not implement the test.

(2) Building Materials

- Gypsum board (12.5 mm)
- Gypsum board with wall paper (12.5 mm)
- Fire retardant treated plywood (5.5 mm)
- Decorative plywood (4 m/m)

(3) Evaluation Criteria

1) Record of the flashover time

2) Record of the temperature raising of in a room, a part of opening and surface of floor

D.6 Demonstration and Fire Testing in Thailand

(1) Purpose

The demonstration and fire testing in Thailand aims at the followings.

- to raise the awareness of danger by fire
- to learn the operation skill of testing equipment

(2) Type of Test

- Noncombustibility Test (ISO 1182)
- Ignitability Test (ISO 5657)
- Reduced Scale Model Box Test (ISO 17431)

Among the three tests, Reduced Scale Model Box Test was the target of the demonstration. Other two tests were not the target of the demonstration, but they were conducted in the course of the Study.

(3) Schedule

The following table shows the schedule of the demonstration and the guidance about the operation of noncumbustibility test and ignitability test. At first, the activity was main for conducting reduced scale model box test, which is the target test of demonstration. Next, noncumbustibility test and ignitability test were conducted with the technical transfer of operation skill of the testing equipment.

Phase	Date	Activity
Phase 1 "Demonstration"	Oct. 25, 2002	Acceptance and Opening of Package
	Oct. 26	Installation of Testing Equipment and Preparation of Specimen for ISO 17431
	Oct. 27	Rehearsal for Demonstration
	Oct. 28	Demonstration
Phase 2 "Guidance about the Operation of Noncumbustibility Test and Ignitability Test"	Oct. 29	Installation of Testing Equipment for Noncumbustibility Test and Ignitability Test
	Oct. 30	Calibration of Testing Equipment
	Oct. 31	Guidance of Operation Skill of the Equipment
	Nov. 1	ditto
	Nov. 26	ditto
	Nov. 27	ditto
	Nov. 28	ditto
	Nov. 29	Holding of Advisory Committee Meeting

(4) Result of Test

1) Noncombustibility Test (ISO 1182)

As shown in the table below, the result of test shows that the ratio of reduction for weight of specimen of Thai product is higher than that of Japanese product.

Place of Production	Name of Specimen	No. of Specimen	Weight of Specimen (g)				Temperature at Furnace			
			Before Test	After Test	Reduced Weight	Ratio of Reduction (%)	Setting	Max. (A)	End of Test (B)	(A)-(B)
Japan	Gypsum Board (Regular Type) 12.5 mm	1	52.3	45.2	7.1	15.7	748	792.5	792	0.5
		2	53.2	48.4	3.8	7.6	748	787	787	0
	Decorative Gypsum Board 12.5 mm	1	53.0	47.8	5.2	10.9	753	785	775	10.4
	Rock Wool Board 6.0 mm	1	25.0	23.0	2.0	8.7	750	820	795	25.0
		2	30.9	27.6	3.3	10.9	755	824	800	24.0
Thailand	Fire Resistance Gypsum Board 12.0 mm	1	56.1	42.6	13.5	31.7	749	783	782	1.0
		2	57.7	45.7	12.0	26.3	760	786	786	0
		3	56.4	42.8	13.6	31.8	750	782	782	1.0

	Rock Wool Board 15 mm	1	32.1	27.2	4.9	18.0	745	807	807	95.0
		2	31.6	26.9	4.7	16.2	750	790	790	64.0

2) Ignitability Test (ISO 5657)

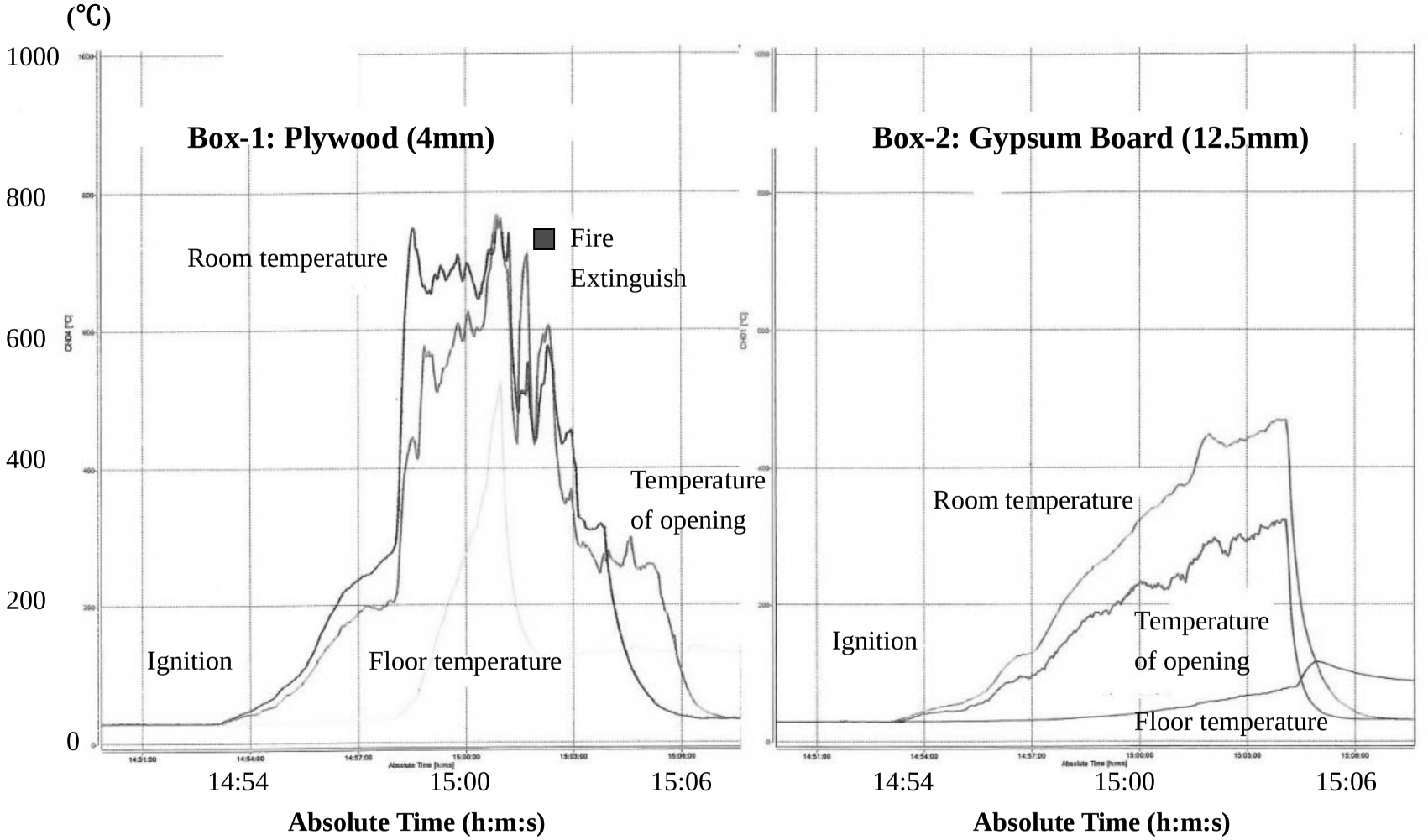
When looking at gypsum boards of Japan and Thailand, the products of Thailand ignited slightly earlier than the products of Japan did. The number of flash of Thai product is greater than the one of Japanese product.

Place of Production	Name of Specimen	Volume of Radiation (W/cm^2)	Weight of Specimen (g)			Number of Flash	Time to Ignite (Sec)
			Before Test	After Test	Reduced Weight		
Japan	Gypsum Board (Regular Type) 12.5 mm	2	230	225	5.0	0	N.I
		3	230	225	5.0	2	115.7
		4	230	220	10.0	0	62.0
		5	230	218	12.0	0	34.1
	Rock Wool Board 6.0 mm	2	89.1	86.9	2.2	0	N.I
		3	90.2	87.1	3.1	0	N.I
		4	88.9	85.2	3.7	0	N.I
		5	89.8	85.1	4.7	0	N.I
	Decorative Plywood 4.0 mm	2	50.4	48.0	2.4	0	N.I
		3	48.3	42.7	5.6	1	83.1
Thailand	Gypsum Board (Regular Type) 9.0 mm	3	168.2	161.6	6.6	1	115.0
		4	162.6	159.1	5.5	1	59.0
		5	167.3	163.7	3.6	0	30.0
	Gypsum Board (Regular Type) 12.0 mm	2	279.4	254.7	24.7	0	N.I
		3	260.1	245.2	34.9	0	N.I
		4	280.0	274.1	5.9	4	89.3
		5	280.9	277.0	3.9	2	50.0
	Rock Wool Board 15.0 mm	2	167.9	157.4	10.5	0	N.I
		4	167.4	165.9	1.5	2	26.6
		5	168.5	166.6	1.9	2	14.4
	Decorative Plywood 4.0 mm	1	68.3	62.2	2.1	0	N.I
		1	67.9	62.8	5.1	0	N.I
		2	68.9	60.4	8.0	3	198.6
		3	66.7	61.9	4.8	2	86.0

3) Reduced Scale Model Box Test (ISO 17431)

Figure in the following page shows the result of reduced scale model box test

Date: 29 Nov. 2002



The Result of Reduced Scale Box Test

D.7 Technical Assistance

Not only donation of equipment from Japan to Thailand but also technology transfer was carried out through counterpart training. Mr. Sitinann, a civil engineer at the PWD of Thailand (counterpart of Japan's BRI), was invited to the Building Research Institute (BRI) in Tsukuba City for four days from Sept. 30 to Oct. 3 in 2002. He participated the training about the operation of the two testing devices : the ISO 1182 non-combustibility test and the ISO 5657 ignitability test.

Technical training was also conducted for three days from Nov. 26 to Nov. 28 in 2002 at Chulalongkorn University in Thailand where the above two devices are installed temporarily. In the training, the non-combustibility test (4 types, 10 tests) and the ignitability test (8 types, 26 tests) were conducted. The training was intended to make Thai engineers understand the concept and the principles of the testing devices and get used to their operation. Demonstration mentioned above was also a part of technical training.

D.8 Proposal of Evaluation Methods

The basic concept of the performance evaluation on the fire resisting structures is more or less similar in any country in the world. It means that building materials, such as a column, beam, wall, floor, door, and shutter, are evaluated by heating and then comparing with the standard heating temperature curve which is specified in the ISO 834 fire resistance test-elements of building construction.

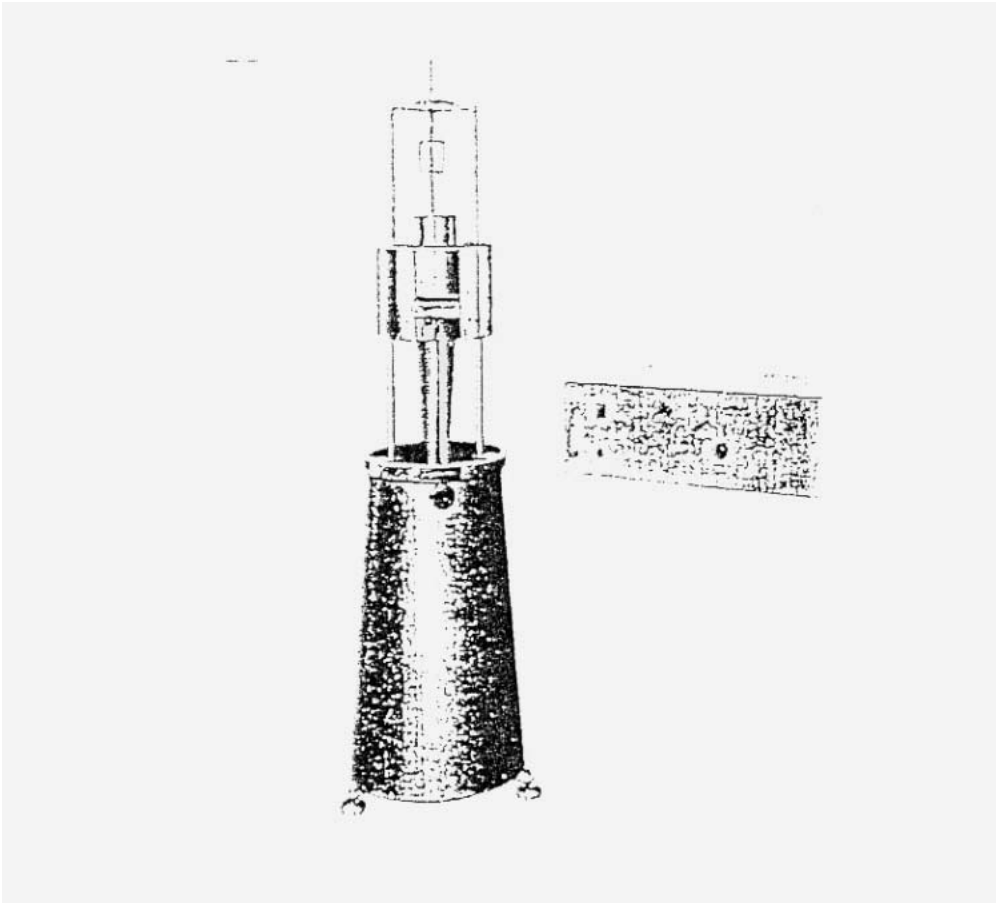
In this test method, the fire resisting performance of structural members is judged by the structural stability, the temperature of the steel materials, and the temperature on the non-heating side (the reverse side) obtained through a test under loading. As to the allowable temperature of the steel materials, the provisions differ slightly from country to country.

The two fire testing furnaces now available at Chulalongkorn University are not furnished with a loading apparatus. Therefore, it is advised that the fire testing furnaces to be installed at the Fire Safety Research Center should be provided with a loading apparatus.

As to the fire resisting performance, many countries in the world have established the required fire resisting time in accordance with the usage, the structure, and the floor level (height) of a building. It is proposed that the same approach should be adopted in Thailand.

D.9 Attachment

(1) Equipment for ISO 1182 Noncombustibility Test

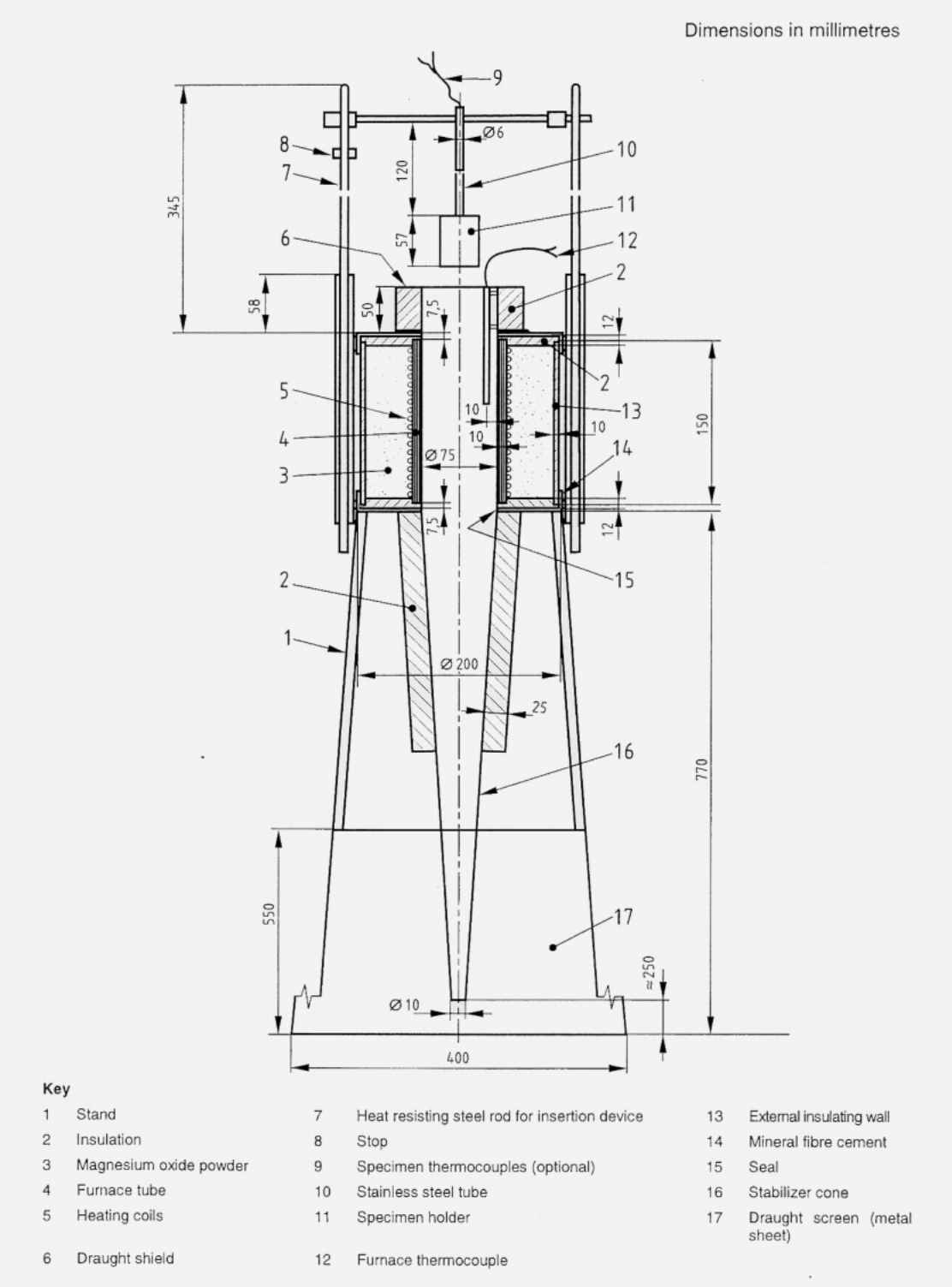


■APPLICATION

This apparatus tests heat resistance of internal finish material and procedure of buildings. It is used for elementary material heat test. The heating furnace is kept in a state of discontinuous (on-off) heating for more than 30 minutes at 750 ± 10 ℃ without inserting test specimen. Judgment for getting through the test is based on the standard that when test specimen of 50 x φ45 mm size is inserted into the preheated furnace, the temperature detected by the thermocouple CA placed at a distance of 10mm from the wall of the furnace should not exceed 50 ℃.

■SPECIFICATIONS

Specimen size	: 50 x φ45 mm
Temprature	: Max. 1000℃
■Testing method	: JIS A 1321, an official notice of the Ministry of Construction No. 1828
■Electric source	: AC 100V 1-P 20A 50/60 Hz.
■Dimensions	: Approx. 30(W) x 30(L) x 125 (H) cm
■Net weight	: Approx. 20 kg

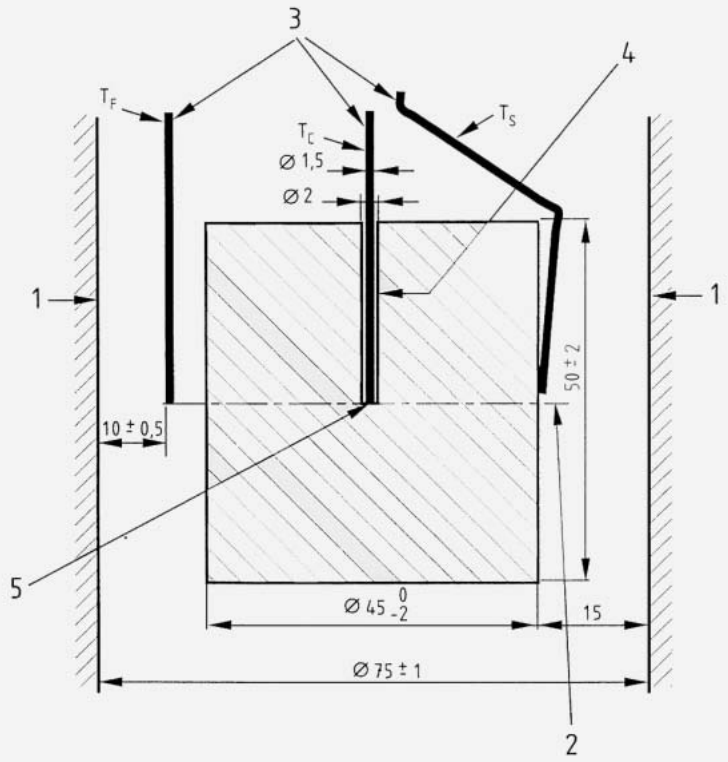


Key

1	Stand	7	Heat resisting steel rod for insertion device	13	External insulating wall
2	Insulation	8	Stop	14	Mineral fibre cement
3	Magnesium oxide powder	9	Specimen thermocouples (optional)	15	Seal
4	Furnace tube	10	Stainless steel tube	16	Stabilizer cone
5	Heating coils	11	Specimen holder	17	Draught screen (metal sheet)
6	Draught shield	12	Furnace thermocouple		

Typical Arrangement of Test Apparatus

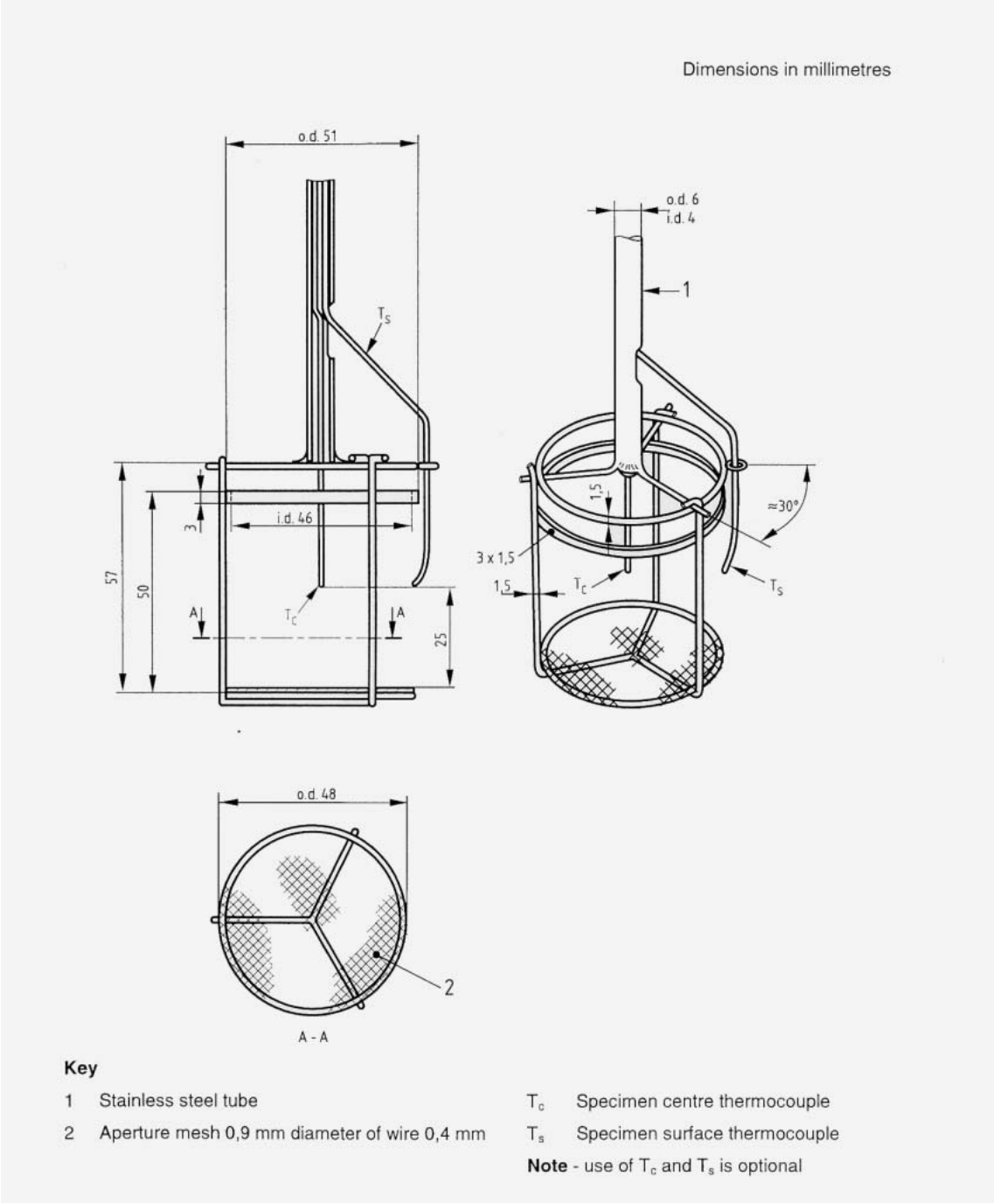
Dimensions in millimetres



Key

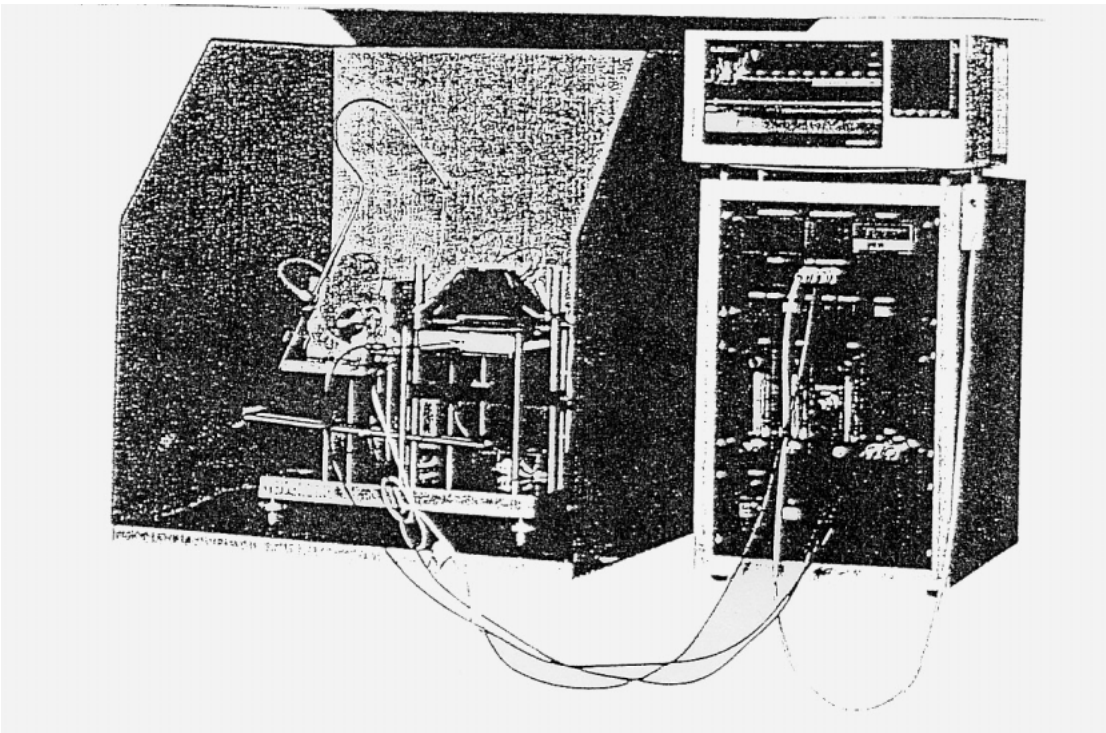
1	Furnace wall	T_F	Furnace thermocouple
2	Mid-height of constant temperature zone	T_C	Specimen centre thermocouple
3	Sheathed thermocouples	T_S	Specimen surface thermocouple
4	2 mm diameter hole		
5	Contact between thermocouple and material	NOTE	Use of T_C and T_S is optional.

Relative Position of Furnace, Specimen and Thermocouple



Specimen Holder

(2) Equipment for ISO 5657 Ignitability Test



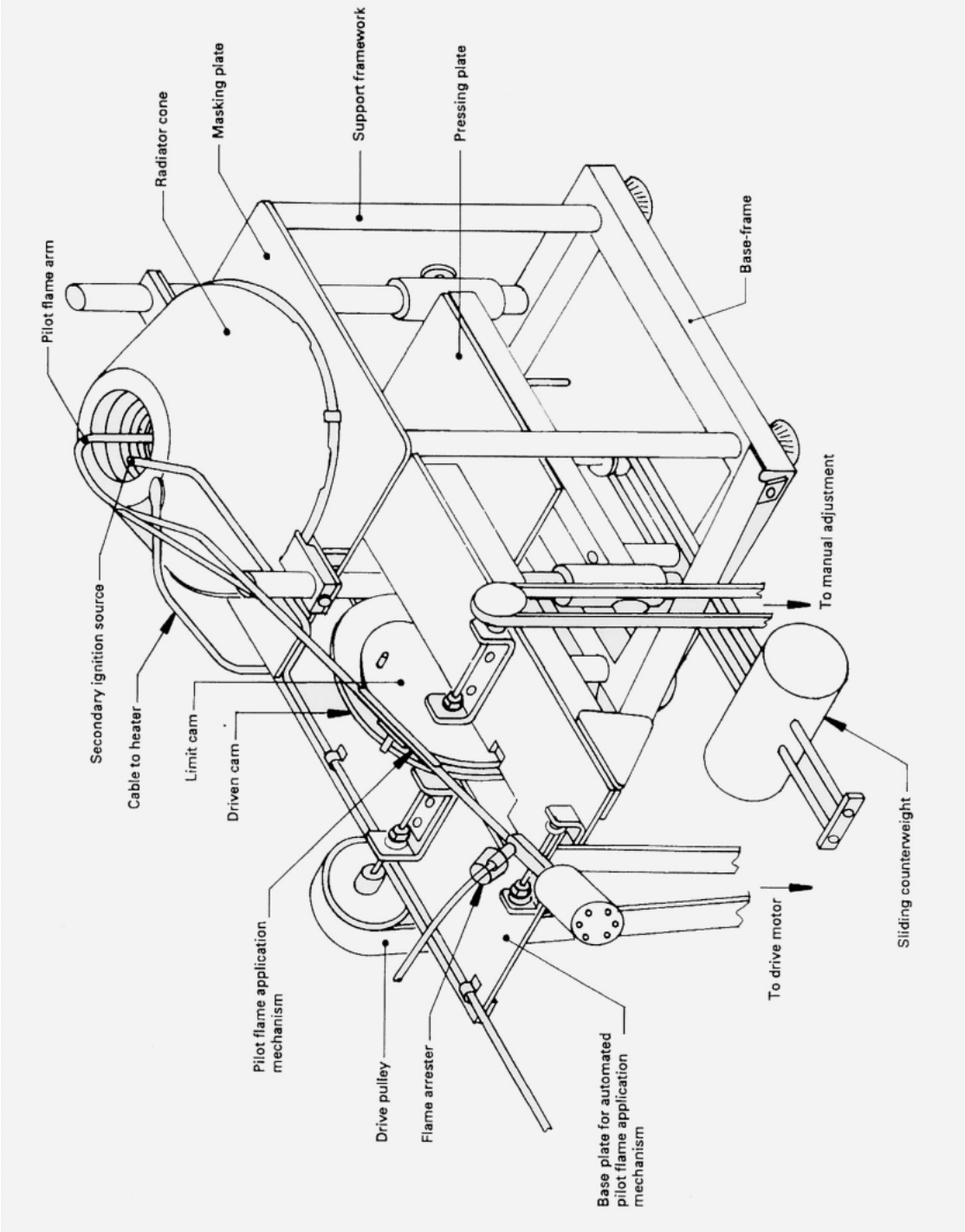
■APPLICATION

Evaluates flammability of construction materials by radiant heat according to ISO TC-92. Radiant heat from a conical furnace corrected by a radiantion meter is applied to test specimen supported horizontally, a pilot flame is moved in close to the surface of test specimen at a fixed repetition cycle and the time required till the test specimen catches fire is measured.

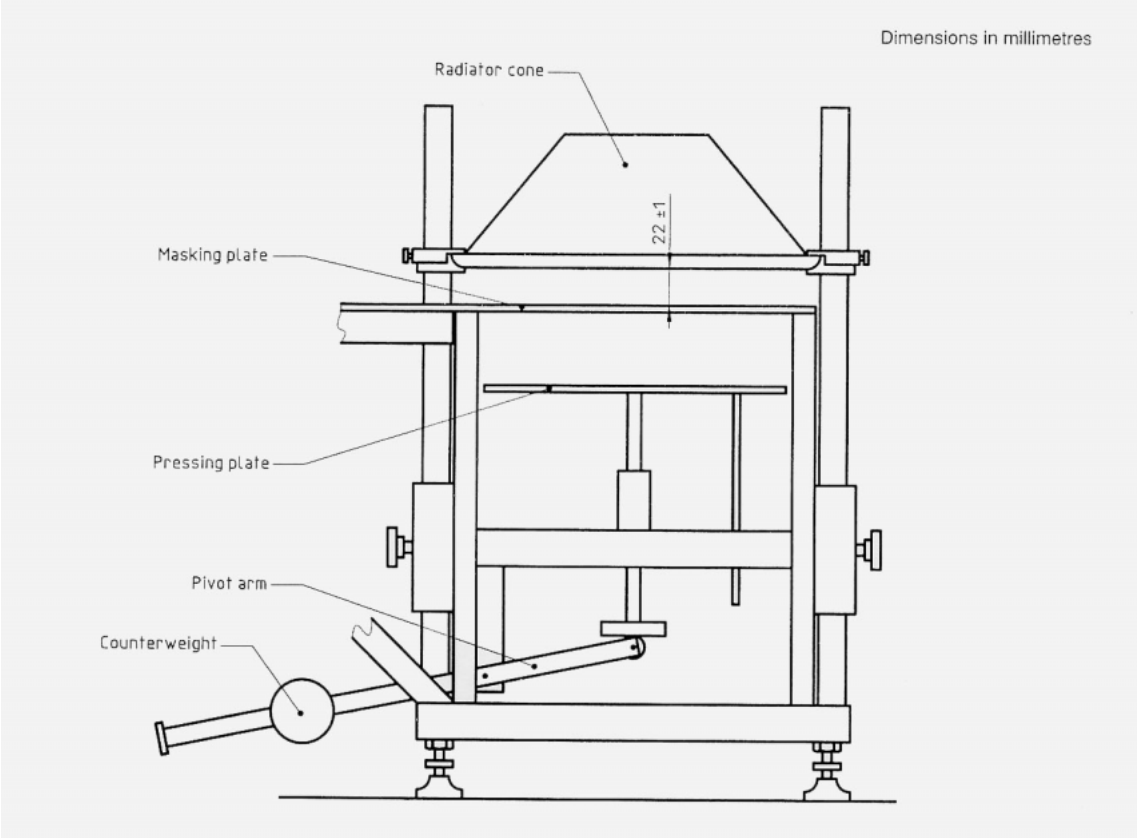
■SPECIFICATIONS

Dimensions of Specimen : 165 x 165 x 70 mm (Max.thickness)
Radiant Heat Capacity : 1 to 5 W/cm^2 (Heater : 200V, 3kW)
Pilot Flame : Length 10 mm. approach cycle 4 sec.
Radiation Meter : Digital indication, water cooling system, sensor
(made by Hy-Cal Engineering Co., Ltd., USA)

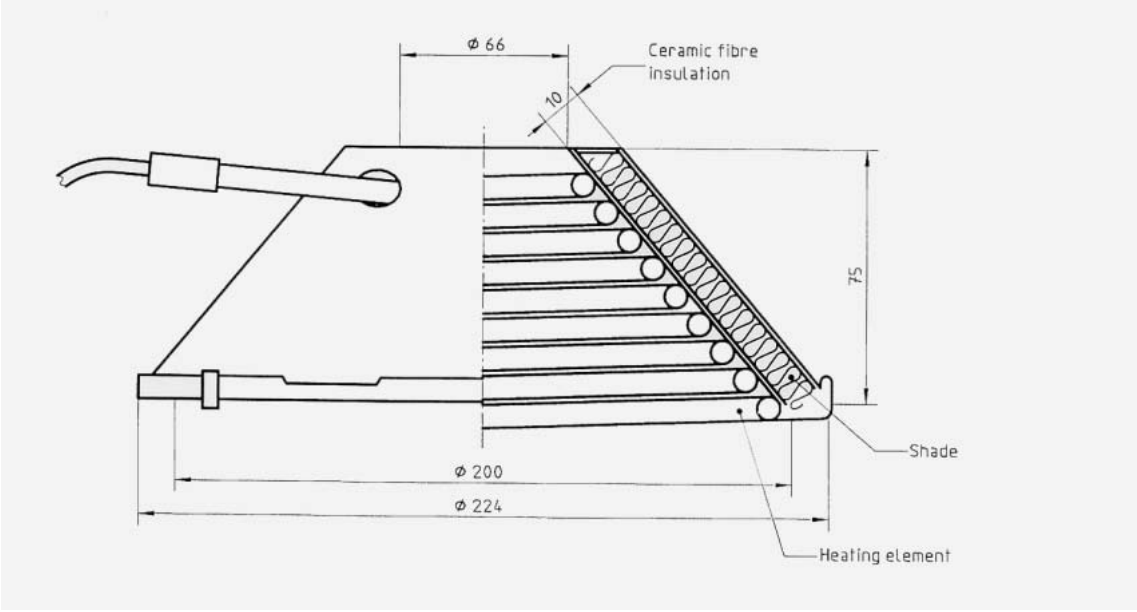
■Testing method : ISO TC-92
■Electric source : AC 100V 1-P 15A 50/60 Hz.
■Dimensions : Main unit approx. 100(W) x 80(L) x 150 (H) cm
Control panel approx. 54(W) x 45(L) x 150(H) cm
■Net weight : Main unit approx. 40 kg, Control panel approx. 50 kg.



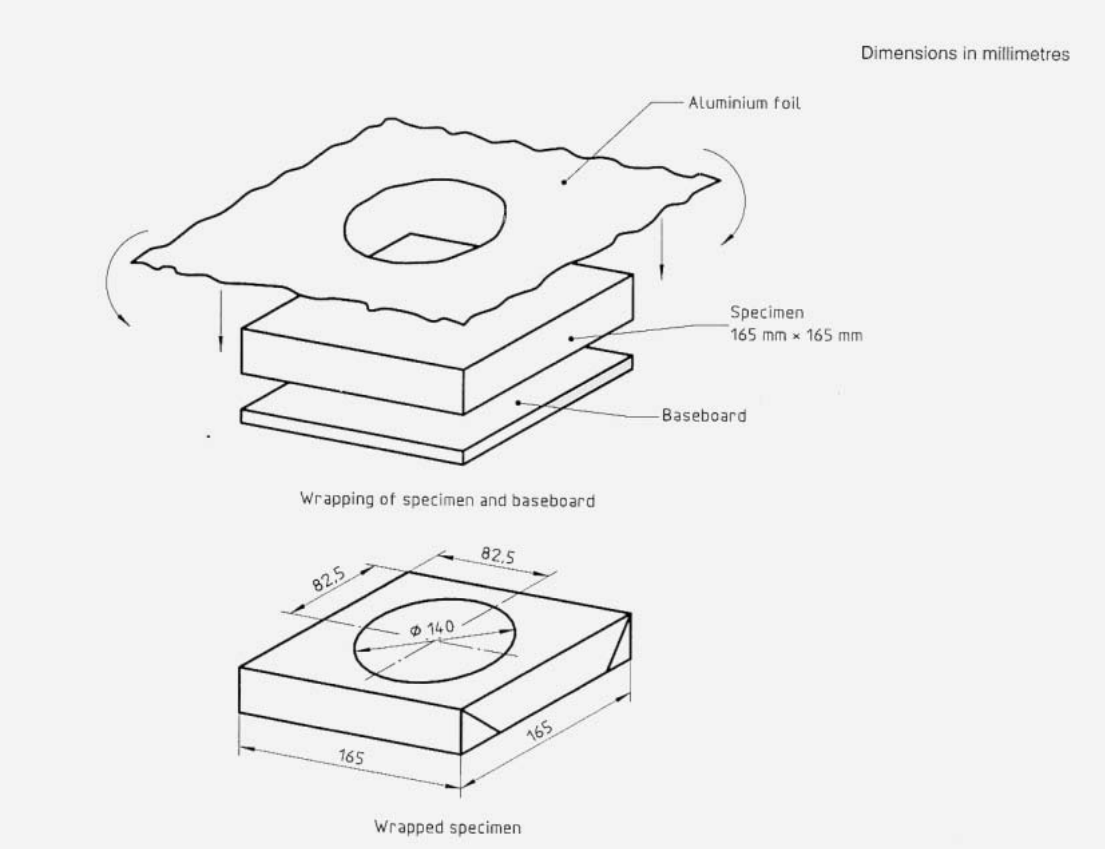
Ignitability Test Apparatus – General View



Specimen Support Framework and Radiator Cone

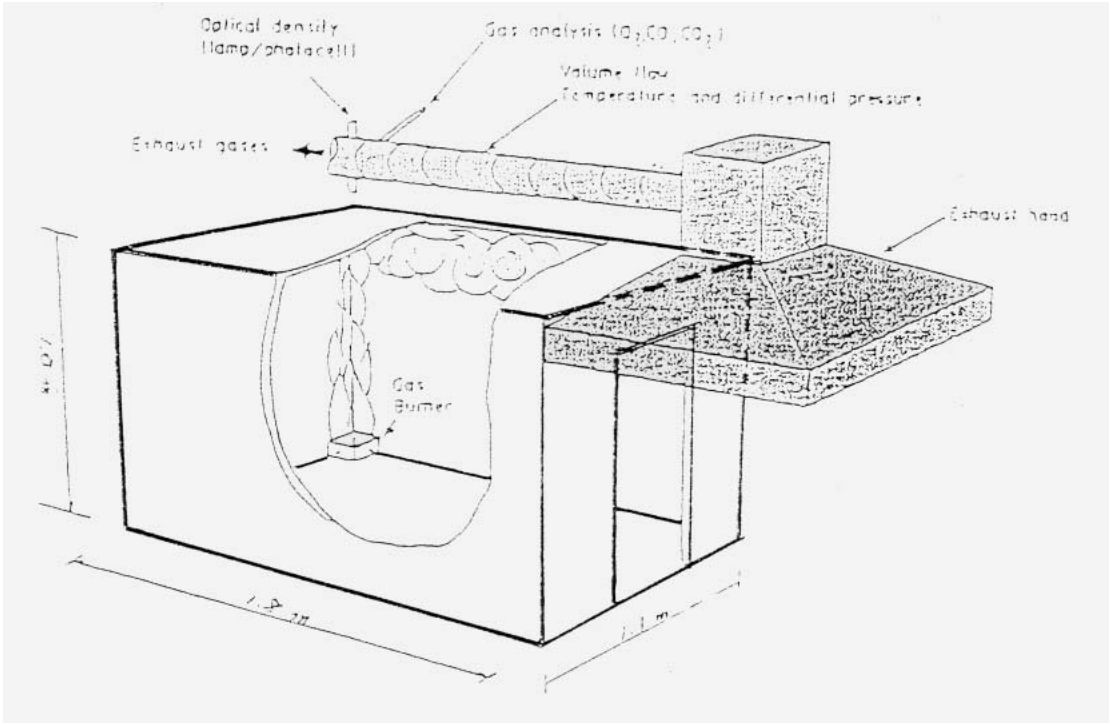


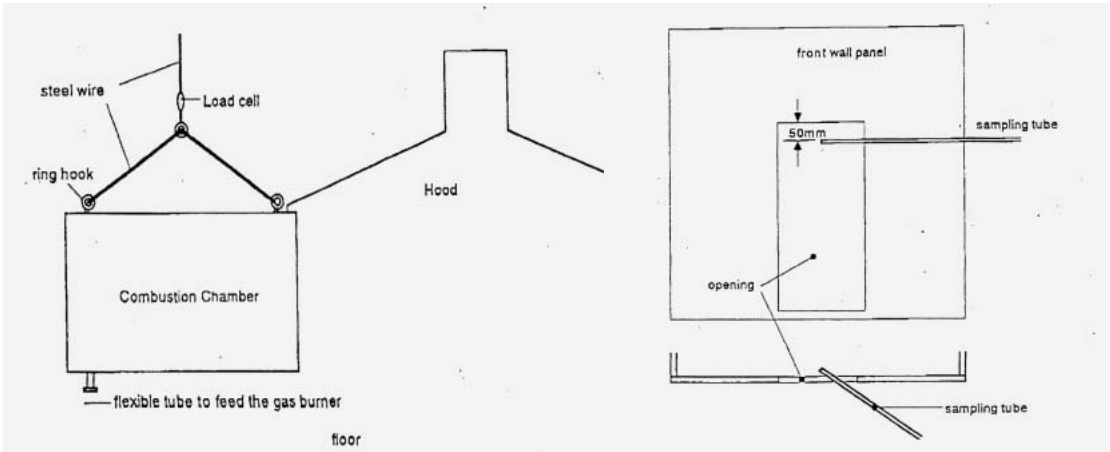
Radiator Cone



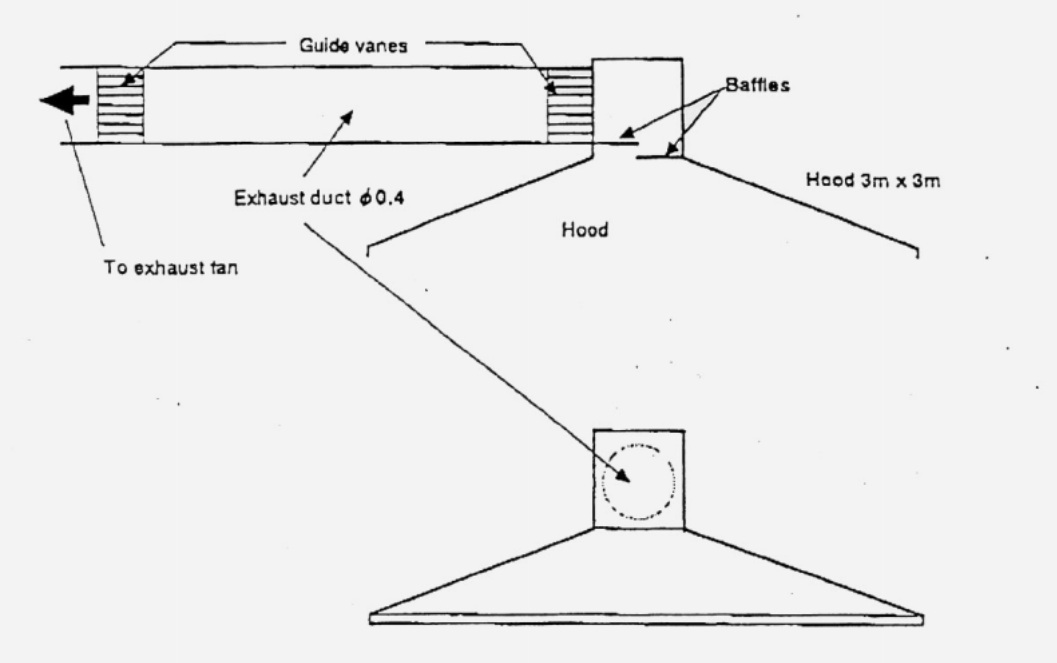
Wrapping of the Specimen

(3) Equipment for ISO DIS 17431 Reduced Scale Model Box Test

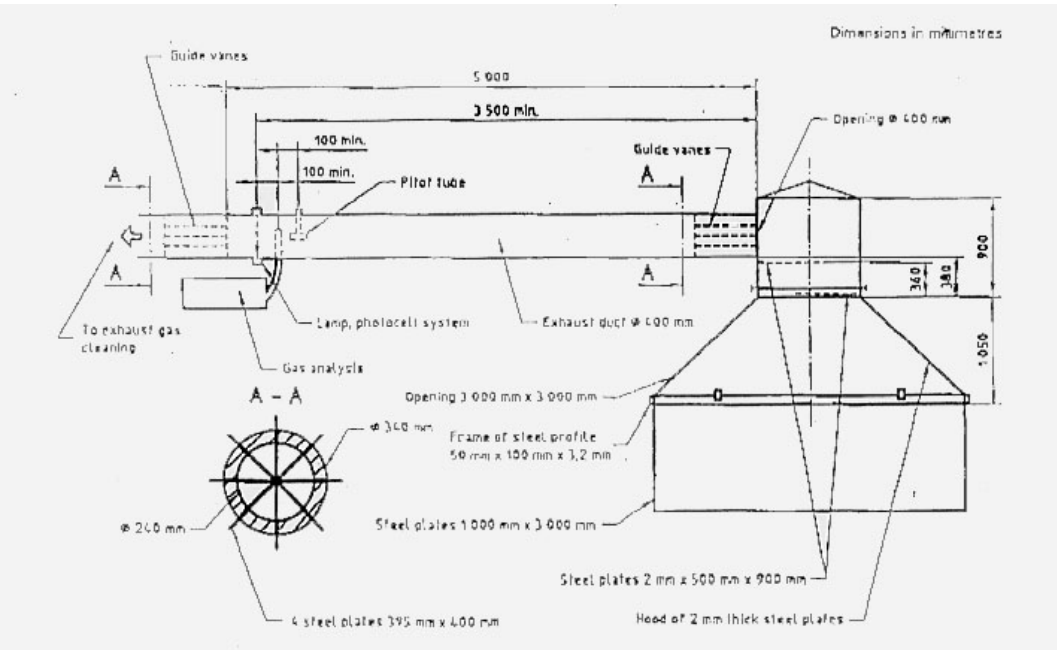




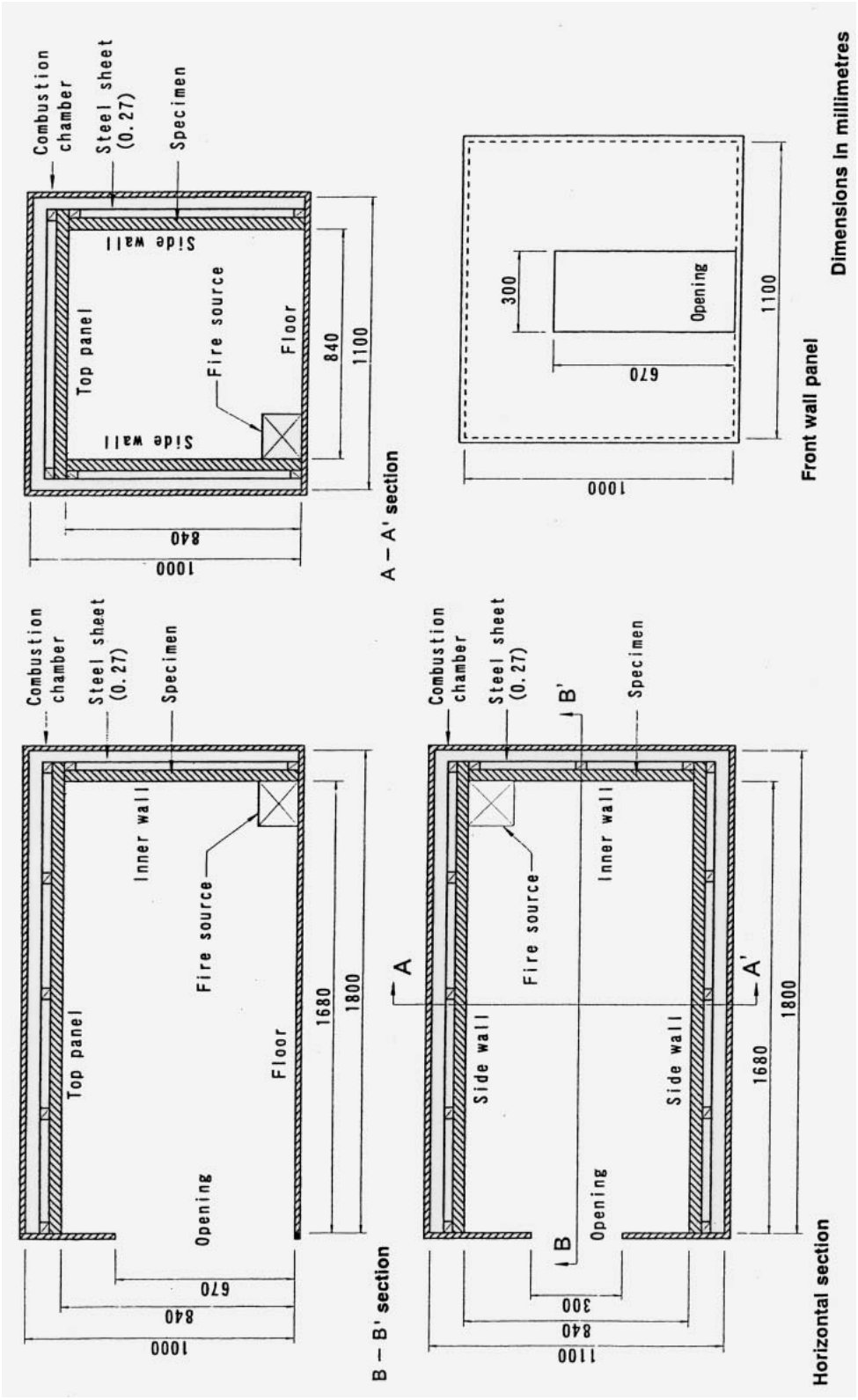
Location for the Gas Sampling on the Opening



Principal Design



Details of Exhaust System and Locations of Sampling Probes



Combustion Chamber with Specimen Panels, Front Wall Panel and Ignition Source

E FIRE PREVENTION SYSTEMS IN JAPAN AND DIFFERENT COUNTRIES

E. FIRE PREVENTION SYSTEM IN JAPAN AND OTHER COUNTRIES

E.1 JAPAN

(1) Reviews of Amendment on the Building Standard Law

The Building Standard Law (BSL) in Japan has been enforced in November 1950, which is the fundamental for building control. Having modified some parts of sections and articles in the BSL with a drastic modification to meet the advanced technology and social circumstances in 1970, the BSL was amended again to adapt to the international harmonization trend and new formation of the building administration in 1998. The major issues of the amendments are as listed below.

- Rationalization of building confirmation procedures by 1) consigning the building confirmations and inspections to private organizations, and 2) the incorporating of performance-based regulations.
- Adoption of procedures for promoting effective land use.
- Ensuring the effective enforcement of regulation by 1) interim inspections, and 2) public perusal of documents of building confirmation and inspections.

The following table summarizes three significant issues of the amendments, which could relate to the Study, with backgrounds, purposes, and expected effectiveness.

Major Amendments of the Building Standard Law in Japan

Consigning Building Confirmations and Inspections to Private Organizations	Revision to Performance-based Building Regulations	Adoption of Interim Inspections
(1) Background: The building confirmations and inspections have been performed by the building officials of designated administrative agencies. As circumstances prevent the agencies from fully and efficiently performing building confirmations and inspections, it is essential to create a reliable and efficient system for execution by reviewing the roles shared by public and private sectors. **(2) Purposes:** Independent and neutral private organizations perform the building confirmations and inspections which have been conducted by the designated administrative agencies. Possessing the required assessment competence, the private organizations can be the designated confirmation and inspection bodies. **(3) Expected Effectiveness:** 1) Effective building confirmation and inspection services can be provided to satisfy the demands of building owners. 2) Upon the utilization of the designated confirmation and inspection bodies, governments will concentrate on indirect controls in audits, the enforcement of corrective action and penalties to ensure the effectiveness of the building confirmation and inspection system.	**(1) Background:** It has become necessary to allow more flexibility in building design and rectify the high-cost system of construction. In so doing, regulatory items must be reviewed, and a building regulatory system introduced to permit technological innovations and to facilitate the use of building materials and components from overseas. **(2) Purposes:** Appropriate regulatory procedures (performance-based building regulations) is adopted so that varieties of building materials, equipment, and construction methods can be used whenever they satisfy certain performance requirements. In addition, regulatory items for individual buildings are reviewed. **(3) Expected Effectiveness:** 1) Performance-based building regulations will eliminate the regulations which specify physical means of construction and will increase the design flexibility. 2) Definite performance-based regulations will promote technological development and the use of overseas materials. It will result in introduction of building techniques rationally and reasonably, and will contribute to stimulate the building industry.	**(1) Background:** The Great hanshin-Awaji Earthquake disaster demonstrated the need to ensure the safety of buildings (of the 6,425 fatalities, 80% were caused by the collapse of buildings). It is necessary to establish a system for allowing inspections while buildings are still under construction as required. **(2) Purposes:** Designated administrative agencies will, as necessary, designate the construction processes that must undergo interim inspections for buildings of a given structure, or for specific uses. Unless a building so designated has received a required interim inspection by a building official or by a designated confirmation and inspection body, construction of the building will be suspended. **(3) Expected Effectiveness:** The safety of buildings will be ensured by more thorough and complete inspections.

(2) Legal Framework

Building Standard Law (BSL) is issued by the Ministry of Land, Infrastructure and Transport (MOLIT). The BSL is enforced along with the Enforcement Order, Ministry Order, and Notifications. All of them are prepared by the MOLIT. Furthermore the local authorities issue the Ordinances to relieve or restrict more strictly for appropriateness in the regional conditions.

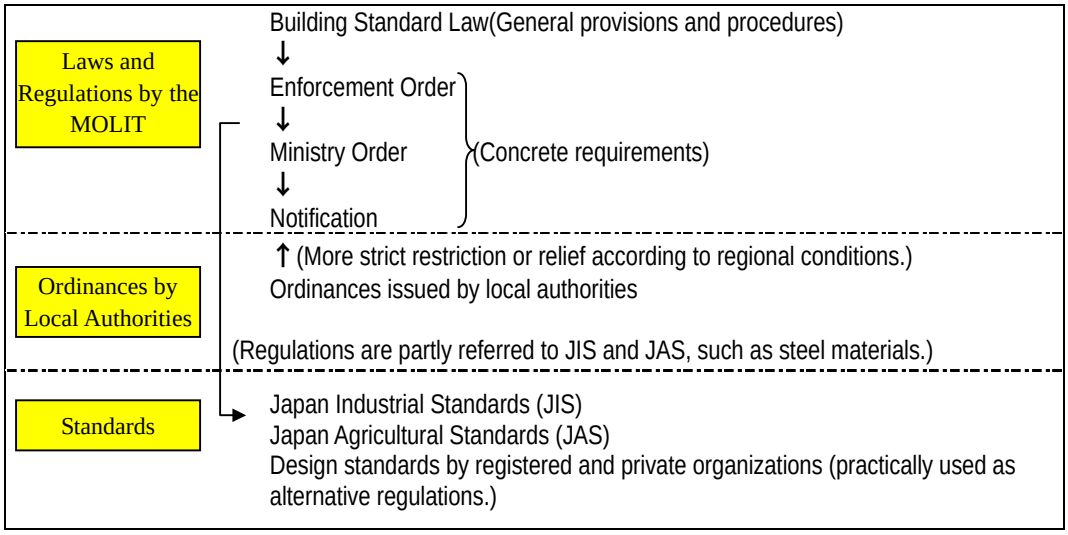
A part of regulations are referred to the Japan Industrial Standards (JIS) and Japan Agricultural Standards (JAS), such as metal materials. Apart from them, design standards issued by public and private organizations are practically used as mandatory requirements.

Characteristics

The MOLIT formulates principal structure of the legal framework by issuing the BSL along with the Enforcement Order and others.

The local authorities issue the Ordinances, following the requirements in the laws and regulations. In the practical way, requirements issued by private and public organizations are enforced as mandatory regulations.

Legal System for Building Control in Japan



(3) Implementation System

The Study examined the implementation system according to the process of the building permission, as mentioned below.

Building confirmation: Building officials in the local authorities or confirmation and inspection body, which is private organizations designated by the MOLIT independently and neutrally, perform the building confirmations. In case that new and high-degree technology and materials are used, evaluation bodies designated by the minister of MOLIT issue the Evaluation Reports (E/R) to the building official and the Appraisal Documents to the minister of MOLIT who issues the Approved Documents (A/R). Upon the issuance of the E/R and A/R, the building officials can give the permission.

Interim inspection under construction: Interim inspections for specific buildings are conducted by the building officials in local authorities and designated private organizations. Timing of the inspections is defined by the local authorities.

Inspection of completion: Certificate of inspection issued by building officials in local authorities or designated private bodies is required for building use. In case that small-scale buildings are constructed in accordance with approved design documents and with supervision of qualified architects, a part of inspections can

be omitted.

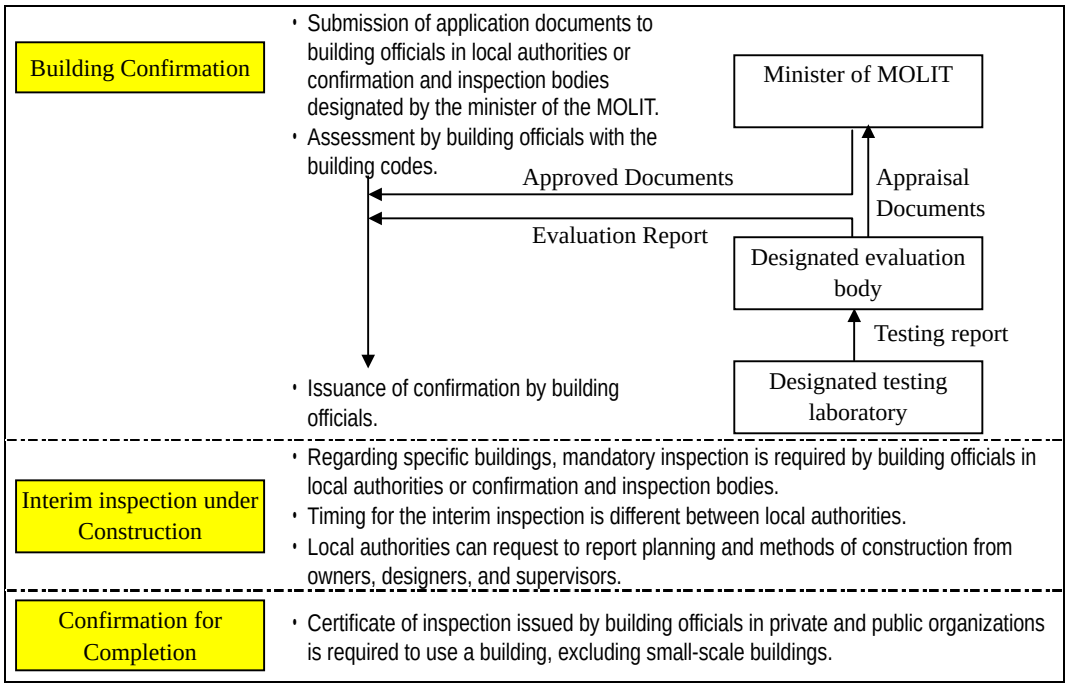
Qualification: There are two qualifications of Architect and Building Official. The Architect is required to design and supervise construction of buildings which have a specific scale.

Characteristics

The building officials in private confirmation and inspection bodies designated by the minister of MOLIT can perform assessment works. Evaluation bodies, designated by the minister of the MOLIT, support technical evaluation, which include private and public organizations.

Correspondingly, the private organizations are involved in the building control under the jurisdiction of the central government or MOLIT.

Implementation System for Building Control in Japan



Remarks: Statistical data of building control in Japan and Yokohama City

In Japan

- Number of building administration officials: 7,536 persons
- Number of building officials: 1,775 persons
- Number of building permission: 1,025,263 cases (136 cases/person)

In Yokohama City

- Number of Population: 3.3 million persons
- Number of building administration officials: 192 persons
- Number of building officials: 21 persons
- Number of building permission: 20,124 cases (105 cases/person)

(4) Laws and Regulations for Fire Prevention System

Mandatory regulations for fire prevention are catered by the BSL and the Fire Fighting Act (FFA) along with their regulations. The BSL stipulate requirements on building itself, such as fire separation, noncombustible interior finishing, and evacuation facilities, while the FFA specify fire preventive equipment and dangerous objectives.

The requirements in the FFA is secured in the course of the building permission. Because the building owner have to obtain consent of fire defense agencies in local authorities before construction and in completion. Specific building is additionally required to conduct periodical, which are reported to the fire defense agencies.

Requirements for Fire Prevention in the Three Laws

Regulations		Building Standard Law	Fire Fighting Act
Structure	General provisions	○	
	Fire rates	○	
Evacuation equipment	Emergency exit	○	
	Longest distance of evacuation route	○	
Extinguishing equipment	General provision		○
	Hydrant, sprinkler, hose reel, and portable extinguisher		○
Alarm	Alarm		○
Others	Dangerous object		○
	Emergency elevator	○	

E.2 United States

(1) Legal Framework

Authority of legislation is allocated by categories of acts to the federal or states. The legislation of building codes is entrusted to the states.

Building Code Models (BCMs) are issued by the private groups in the United States. The local governments legislate the building codes by entrusting to the BCMs. Practically the BCMs are enforced as mandatory regulations.

In 1994, the International Code Council (ICC) was formed to integrate three BCMs into a single set, namely National Building Code. The three BCMs had been issued by the following private groups.

- The Building Officials and Code Administrators, International (BOCAI, established in 1915) for National Building Code (NBC), of which first version was issued in 1950,
- International Conference of Building Officials (ICBO, established in 1922) for Uniform Building Code (UBC), of which the first version was issued in 1927, and
- Southern Building Code Congress (SBCCI, established in 1946) for Standard Building Code (SBC), of which the first version was issued in 1946.

Requirements in the building codes are secured in detail by standards issued by private organizations. Especially standards of National Fire Prevention Association have strong relation with the building codes. Major organizations of the standards in the United States are listed below.

- National Fire Prevention Association (NFPA) was established in 1930 to conduct 1) issuing fire prevention regulations, 2) advisory services, 3) education, 4) publishing, 5) fire safety investigation, and 6) cooperation with public fire fighting organizations.
- American Society for Testing and Materials (ASTM), specifying materials and testing methods, which are frequently referred by the building codes.
- American Society of Mechanical Engineers (ASME), standardizing products of mechanical engineering, especially for boilers and pressuring vessels.
- Underwriters Laboratories (UL), was established as a testing and research organization by the property insurance industry to analyze safety of products in 1894. It conducts testing and inspection for securing safety of human lives

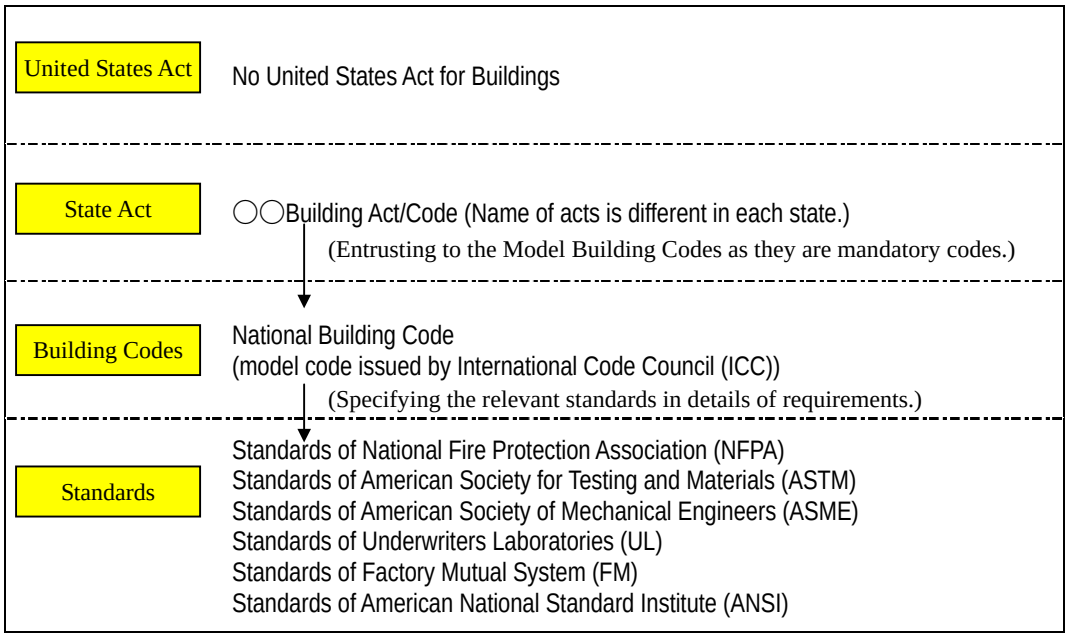
and properties including fire safety.

- Factory Mutual System (FM), was established as a fire insurance company to cover insurance of factories and commercial facilities in 1835. It conducts fire resistant testing by its own testing facilities to specify fire prevention standards.
- American National Standard Institute (ANSI), approves and enforces the standards, drafted by members of the ANSI, such as industrial groups and academic groups.

Characteristics

Upon explanation of the legal system presented above, the legal system of building control in the United States has significant characteristics that 1) legislation of building codes are involved in authority of the states, and 2) preparation of building codes and standards are strongly secured by private organizations. The perspective of the legal system for building control is depicted in the following figure.

Legal System for Building Control in the United States



Note: Organizations, issuing the Model Building Codes and standards, are private, such as ICC, NFPA, ASTM, ASME, UL, FM, and ANSI.

(2) Implementation System

The Study examined the implementation system of building control, following the building permission process, as described below.

Building permission: Building officials in the local authorities conduct technical assessment on application documents attached with drawings, structural calculations, specifications, and geotechnical survey reports. In case that new technology and materials are used in buildings, the building officials give permission upon advises by private experts (called 'pier review') and evaluation reports issued by evaluation bodies (called 'evaluation service/ES'), registered by related industry groups. The evaluation reports are based on testing report by registered testing laboratories.

BOCAI, ICBO, and SBCCI have the evaluation bodies, while the National Evaluation Services (NES) issues the evaluation reports for the whole country.

Inspection under construction: Inspections are divided into two types: 1) mandatory basis by building officials and 2) volunteer basis by specific inspectors employed by building owners. The mandatory inspection has to be conducted five times in the course of construction, otherwise construction will be suspended. The voluntary inspection program is implemented on concrete works and welding periodically or continuously.

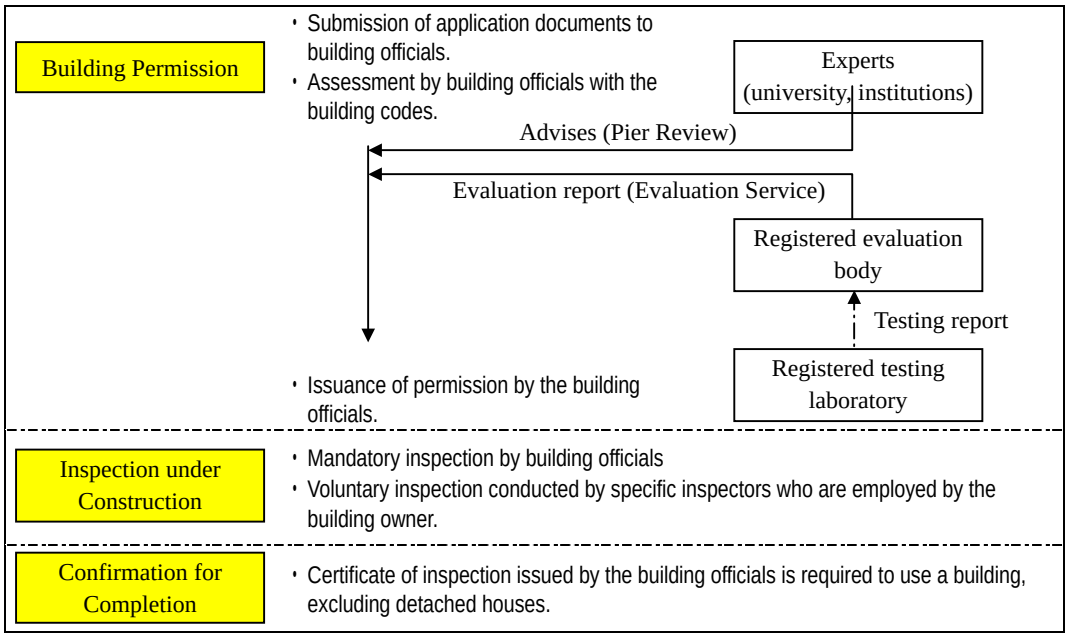
Inspection of completion: Certificate of inspection issued by building officials is required for building use, excluding detached houses.

Qualification: There are two qualifications of Architect and Civil Engineer who are required to design buildings which are more than a specific scale.

Characteristics

In the building permission, building officials are technically supported by experts and registered evaluation bodies in the private sector. In inspections under construction, inspection procedure seems to have two types: 1) mandatory inspection by inspectors of local authorities and 2) voluntary inspection by private inspectors for critical parts of a building.

Implementation System for Building Control in the United States



Remarks: Statistical data of building control in Los Angels City

- Number of Population: 3.5 million persons
- Number of officials: 900 persons
- Number of building officials: 1 person, Inspector: 500 persons, Technician: 200 persons
- Number of building permission: 61,863 cases (in FY 1990-1991)
- Number of building permission per officials: 69 cases/person

(3) Laws and Regulations for Fire Prevention System

Laws and regulations for fire prevention are basically formed by NBC, NFPA, and the Occupational Safety and Health Act of 1970 (OSHA), which is situated in the United Sates Acts. The OSHA has the Occupational Safety and Health Standards specifying concrete requirements of safety for the labors.

The following table summarized the categories required by the three laws. The NBC seems to compose entire requirements for the fire prevention system with collaboration of NFPA.

Requirements for Fire Prevention in the Three Laws

Regulations		OSHA	Building Code	NFPA
Structure	General provisions	○	○	
	Fire rates		○	○
	Acceptable height and floor area of building		○	
Evacuation equipment	Emergency exit	○	○	○
	Longest distance of evacuation route		○	○
Extinguishing equipment	General provision		○	○
	Hydrant, sprinkler, hose reel, and portable extinguisher	○	Referred to NFPA	○
Alarm	Alarm	○	○	○
Others	Dangerous object	○	○	○

Apart from the mandatory regulations, standards of High Protected Risk (HPR), applied by the insurance companies, is practically enforced as mandatory regulations. The HPR is dealt by insurance companies, namely Industrial Risk Insurers, Factory Mutual Group, and Kemper Group. Though it requires higher fire prevention than mandatory regulations, 90% of major enterprises in the US adopt the HPR. Upon inspections in buildings, premium of insurance is settled, which can be reduced to one-sixth of normal insurance premium.

It seems that the mandatory regulations require the minimum safety level or safety for human lives, and the HPR stipulates the higher requirements of safety for human lives and properties.

E.3 England

(1) Legal Framework

The Building Act 1984 (BA) is fundamental of legal framework for building control in England and Wales. The Building Regulations 1991 (BRs) under the BA specify functional requirements. Supporting those mandatory regulations, acceptable solutions are specified in Approved Documents (ADs) which have strong relation with the British Standards (BS).

The British Standards are issued by the British Standards Institution (BSI) which is the unique private organization for issuing standards upon designation by the Royal Decree. The BSI also conducts testing, inspection, and technical consulting services. Following the international standardization, the BSI is registered as a member of CEN and the International Organization for Standardization (ISO). According to the EU Free Trade Agreement (FTA), the BS introduces the EN standards under the CEN.

There are other standards, which are generally functioned as the internal standards of related private industry groups.

Characteristics

Legal framework in England is characterized by three aspects as follows.

- The BA and the BRs stipulates the purpose and functional requirements, while concrete requirements are specified in the ADs and BS.
- Legal system is highly complicated and specialized. In practical way, the technical decision is entrusted to building officials with supports by private standards and administrative guidelines (or Ads) with prescriptive specifications.
- The British Standards have strong relation with the EN standards under the CEN.

Legal System for Building Control in England

Act	Building Act (issued by the central government)	Mandatory requirements
Regulations	Building Regulation(issued by the central government)	
Guidelines	Approved Documents (issued by the central government)	

Standards	British Standards (BS) Other Standards issued by private organizations EN Standards

(2) Implementation System

Implementation of building control is organized as mentioned.

Building permission: Building owners submit application documents to local authorities or Approved Inspector who are authorized by the minister of environment. In case that a building is not required fire resistant structure, the building owner only submits a notification of construction with planning scheme.

The local authorities proceed assessment and permit for construction. On the other hand, the approved inspector firstly submits the initial notification to local authorities and issue permission to the building owner and local authorities. The approved inspector is required to apply insurance for damages.

In case of new materials, either approval is necessary, which are issued by the British Conference of Agrement or the provincial authorities.

Inspection under construction: Local authorities and the approved inspectors can request building owners to make corrections on violation to the regulations. Upon no obedience to the request, the building permission could be repealed.

Inspection of completion: Upon notification of completion by building owners, local authorities issue the certificate of completion, which confirms fire prevention related to the regulations. The approved inspectors issue the final certification to local authorities and the building owners.

Qualification: There are three qualifications including Architect, Engineer, and Surveyor. However it is not required in regulations, that qualified those persons take in charge of designing and construction supervision of buildings.

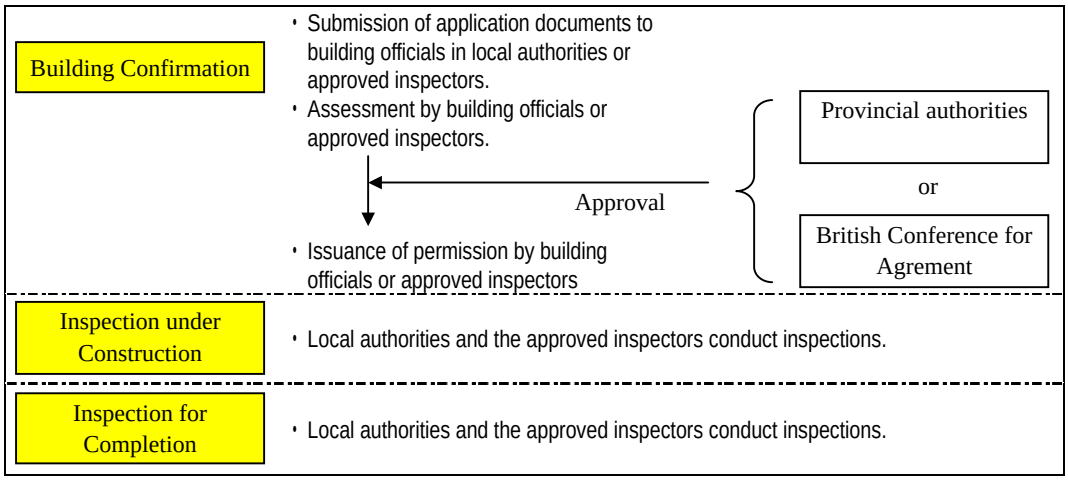
Characteristics

The building permission is conducted by local authorities and private approved inspectors. Those persons seem to be entrusted large responsibility for technical evaluation. The approved inspectors have to apply the insurance for damage.

Similarly to the legal framework that the central governments form the abstract basic structure for the building control, local authorities and private persons

practically take responsibility for its implementation.

Implementation System for Building Control in England and Wales



Remarks: Statistical data of building control in England and Wales
- Number of population: 51.6 million persons
- Number of building officials: 4,000 persons
- Number of building permission by local authorities: 420,000 cases/year
- Number of building permission by the approved inspectors: 68,500 cases/year

(3) Laws and Regulations for Fire Prevention System

Looking at fire prevention, there are three major related laws and regulations, namely Fire Precautions Act (FPA), Building Act (BA), and Health and Safety at Work etc. Act (NSWA).

The BA focuses on buildings newly constructed and modified, while the FPA regulates existing buildings. The requirements of the major three Acts for fire prevention are briefly compared in the following table.

Requirements for Fire Prevention in the Three Major Laws

Regulations		FPA	BA	NSWA
Structure	General provisions	○		○ (for maintenance)
	Fire rates		○	
	Fire separation		○	
Evacuation equipment	Emergency exit	○	○	
	Longest distance of evacuation route	○	○	○ (for maintenance)
Extinguishing equipment	General provision	○		
	Hydrant, sprinkler, hose reel, and portable extinguisher	○		
Alarm	Alarm	○		

Others	Dangerous object			○
	Others	Proper maintenance for	Proper design for fire fighting	

To secure requirements in the FPA, the fire brigade issues the Fire Certificate through building inspections in completion. The fire certificate is required before building use, as stipulated in the EPA for specific buildings including hotel, dormitory, factory, office, shop, and railway.

Furthermore the Approved Documents under the BA stipulate that the Property Protection should be taken care by the insurance industry, as the property protection requires high-degree system. In other words, the requirements in the BA focus on safety of human lives. Correspondingly, the Loss Prevention Council (LPC), which is a private organization of the insurance industry, issues standards covering fire preventive equipment, and fire separation. The LPC standards specify more strict fire prevention system than the requirements under the BA. The LPC has testing facilities and conduct approval on fire preventive equipment and contractors.

E.4 Australia

(1) Legal Framework

In Australia, building control is under the jurisdiction of the states. However, in order to utilize a single building code, every states stipulates to comply with the Building Control of Australia (BCA) issued by the Australian Building Codes Board (ABCB), on behalf of the Commonwealth, State and Territory Governments. The ABCB was formerly the Australian Uniform Building Regulations Co-ordinating Council (AUBRCC) under the Department of Industry, Technology and Commerce.

Under the BCA specifying the purpose and performance, the regulations stipulate methods of be 'Deemed to Satisfy' which refer to Standards Australia (SA) issued by the Standards Association of Australia (SAA). Along with them, technical manuals of private associations, such as steel-frame industry and woods industry is dealt as the regulations of 'Deemed to Satisfy'.

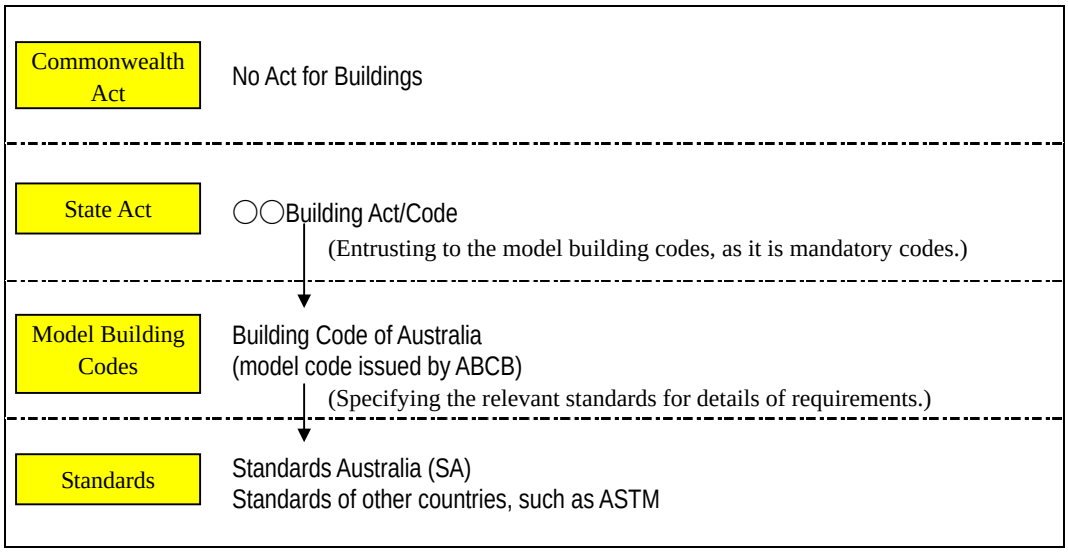
By the strong relation with UK, the BCA and SA have similarity with the BA and BS. Nowadays the SA, however, adopts a part of the ASTM and other standards, following current closing relation with the USA.

Characteristics

Practically the States entrusts the BCA which is the model building code issued by the ABCB, while the States has authority to issue the building codes independently. Therefore fundamental of legal framework is practically formulated by the central government with entrusting by the States.

Upon a historical background, the BCA has strong connection with the BA, while the standards currently involve standards of other countries, such as ASTM.

Legal System for Building Control in Australia



(2) Implementation System

The Study examined the implementation system of the building control, following the building permission processes.

Prior consultation: Permission procedure is specified in the regulations under the building acts of each state. Prior consultation is practically done to ease the proceeding works, while it is not required in the regulations.

In the prior consultation, applicant can clarify related organizations and dangerous objectives to proceed smoothly the following building permission.

Permission for development: A building owner submits application documents to the municipal building surveyors in local authorities for the development, which includes building construction and land readjustment, etc. The assessment usually takes from two to six weeks.

Permission for building: Upon the permission for development, the Municipal Building Surveyor, registered by the provincial government, of the local authority examines assessment or application documents attached with drawings, specifications, structure plan, equipment plan. The assessment works can be alternatively conducted by the Private Building Certifier, who is registered by the building control division of the provincial government and required to apply insurance.

The assessment usually takes one to three weeks.

In case of advanced technology, the building owner is required to submit certificate issued by the ABCB, evaluation bodies, or engineers.

Permission for commencement of construction: Before the commencement of the construction, the building owner is required to obtain permission from the Work Cover Authority for safety and sanitation of labors.

Inspection under construction: The inspector of the local authoirty or the private inspector conducts inspection on the construction site normally five times.

Inspection of completion: Procedures of completion permission can be divided into two categories.

Firstly, the building owner is required to obtain the fire certificate issued by the fire brigade after the site inspection or licensed association. In the latter case, contractors of each fire prevention facilities submit evaluation reports for compliance with the regulations. The licenses could be divested when an accident occurs in the building.

Secondly, the building owner starts to use the building after the issuance of the Certificate of Classification by the Council. In case that the building is more than 25m high, the certificate from the Board of Fire Commissioners is required, prior to the application to the Council.

Qualification: There are four kinds of qualification including the building surveyor, inspector, engineer, and architect. All of them are required of registration by provincial governments. The engineer and architect are not required for designing and supervision.

Consideration:

Private sector is involved in the building permission and inspection by the qualified experts, who are registered by the provinces.

In the inspection of completion, the fire safety is secured by the inspection by the fire brigade or reports by contractors for the fire preventive equipment.

Implementation System for Building Control in Australia

Permission for Development	・Submission to the Council for permission of development including building construction. ・For a period of 2～6 weeks.
Permission for Construction	・Submission of application documents to the Municipal Building Surveyor or Private Building Certifier. ・Assessment by the surveyor or certifier. Certificate (ABCB or Evaluation bodies or Engineers) ・Issuance of permission by the surveyor or certifier 1～3 weeks after the receiving.
Inspection under Construction	・Site inspection under construction by the municipal inspector and private inspector.
Inspection for Completion	・Issuance of the fire certificate by the fire brigade. ・Issuance of the Certificate of Classification by the Council.

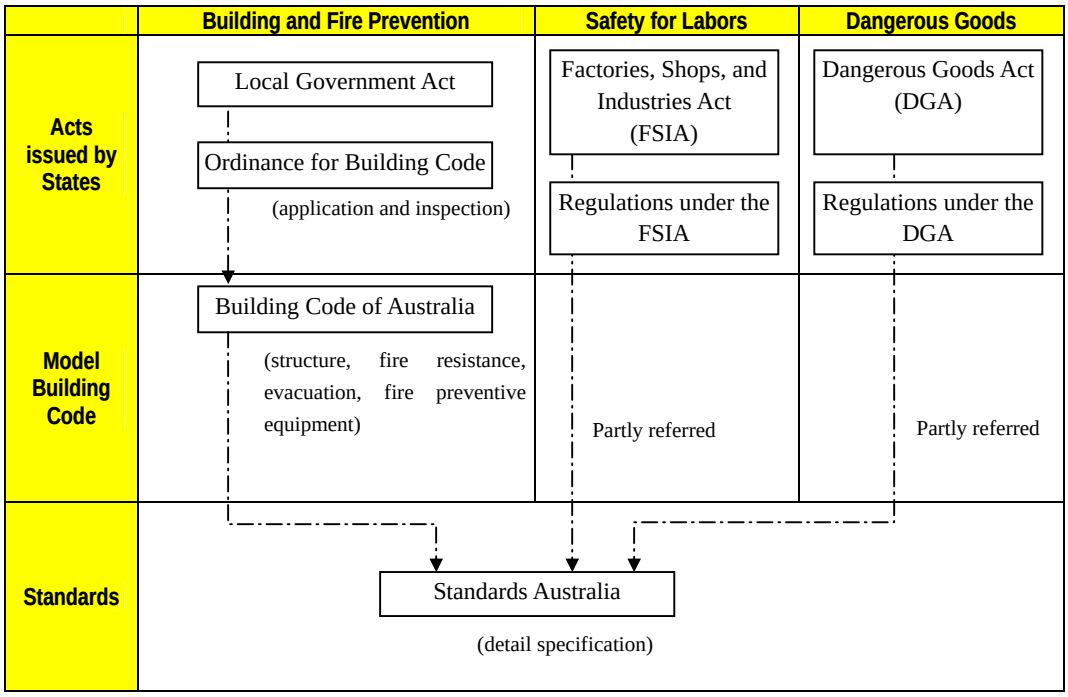
Remarks: Statistical data of building control in Melbourne
- Number of population: 3 million persons
- Number of municipal building surveyor: 290 persons
- Number of private building certifier: 300 persons
- Number of municipal building inspector:200 persons
- Number of private inspector: 400 persons

(3) Laws and Regulations for Fire Prevention System

The BCA regulates general requirements for fire prevention, such as fire resistant structure and evacuation. Apart from the BCA, there are two Acts concerning with fire prevention for the specific buildings and combustible objects, namely the Factories, Shops, and Industries Act (FSIA) and the Dangerous Goods Act (DGA).

Perspective of those code and acts are shown in the following figure.

Requirements for Fire Prevention in the Three Major Laws



E.5 Malaysia

(1) Legal Framework

Malaysia administratively consists of 13 States and two Federal Territories. The constitution stipulates that jurisdiction of building codes are under the cooperation by the federal and state governments.

In the history of Malaysia, local authorities took responsibility for legislation for building control and fire prevention in 1970s. Having experienced large accidents in the same decade including building collapse at Jalan Raja Laut and a fire at Holiday Inn Hotel, the Ministry of Housing and Local Government (MOHLG) issued the Street, Drainage and Building Act, 1974 (SDBA), as a federal act, covering the eastern part of the country.

Furthermore, in order to integrate the regulation, the MOHLG issued the Uniform Building By-laws, 1984 (UBB), which regulated structure, maintenance, and safety, while the SDBA entrusted the legislation of the by-laws to local authorities.

Because of a historical background that the legal system has been developed upon consultation with the laws and regulations in UK and India, the SDBA has similarity with the building codes in UK and Singapore, which also has basis from the BA. Particularly, the UBB was drawn up based on the assistance from the various professional bodies from UK, Australia, and US. For instance, the Institution of Fire Engineering (UK) cooperates with the Malaysia Fire Protection Associate, and Fire and Rescue Department.

Regarding the standards, the SDBB refers the BS and SA, because the Malaysian Standards (MS) have no standard for fire prevention, which is issued by the Standards and Industrial Research Institute of Malaysia. The referred BS covers extinguishing equipment, alarm, smoke control, etc. The MS also introduces the standards of other countries, such as the ASTM, and JIS.

Consideration

Legal framework is characterized that the legislation for building control is issued as the federal acts by the central government, while the constitution stipulates the legislation are under common jurisdiction of the federal and local authorities.

The building codes and regulations (or by-laws) are developed with referring to the codes and regulations in the other countries, such as the BA, BS, ASTM, and JIS.

(2) Implementation System

The implementation system in Malaysia has been examined as described below.

Building permission: A building owner submits a sketch plan to a local authority. After the assessment based on the SDBA and UBB by the local authority, comments of modifications are given two or three weeks later, if necessary. Following the comments, the building owner submits details and calculations of structural plan to the local authority. After the instruction by the local authority, the building permission is issued.

The building owner has to submit also to the fire brigade to obtain the fire certificate, which is required of annual renewal.

Notifications under construction: The building owner have to notify the local authority at the specific stages of building construction, such as 1) commencement of construction, 2) readiness of construction, and 3) completion of foundation. If any modification from original plans, the building owner has to reapply to the building permission.

Permission of completion: The Professional Engineer of designing and supervising has to submit application documents to the local authority. After the receiving the Certificate of Fitness for Occupation from the local authority, the building owner can start building use.

In parallel with these works, the designer for fire prevention system submits application documents for completion of installment to the fire brigade.

Qualification: There are three kinds of qualification including Architect, Registered Building Draughtsman, and Professional Engineer (PE). Application documents are required to attach the certificate with signature of the PE.

Consideration:

The local authorities have responsibility for building control with no private participation. Building control covers the entire period of building, including before construction, under construction, completion, and during building use, upon cooperation with the fire brigade. The fire certificate is a part of import

from the building control system in UK.

Implementation System for Building Control in Malaysia

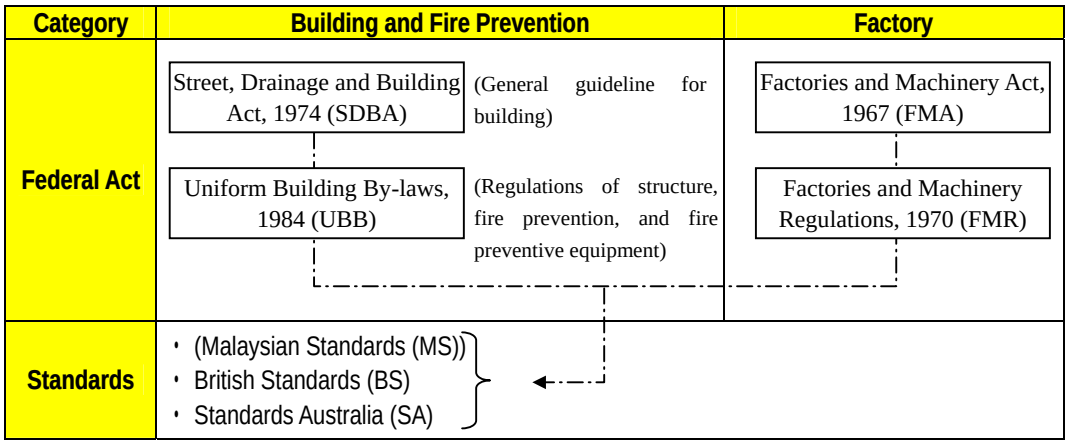
Permission for Construction	・Submission of a sketch plan to a local authority ・Submission of details and calculations of structural plan to the local authority ・Issuance of permission by the local authority
Notification for Construction	・Notification to the local authority at three specific stages of construction
Permission of Completion	・Notification of completion to the local authority ・Issuance of the Fire Certificate by the fire brigade ・Submission of application documents for the Certificate of Fitness for Occupation to the local authority ・Issuance of the Certificate of Fitness for Occupation by the local authority

(3) Laws and Regulations for Fire Prevention System

Looking at legal framework for the fire prevention, the SDBA covers most of requirements and the Factories and Machinery Act, 1967 regulates the requirements for labor safety in factories. The outline of the framework is depicted in the following figure.

As for the additional information, it is recognized that there are similar characteristics with the building codes in Thailand. Because of 1) insufficient regulations in details, 2) insufficient clarity I regulations, especially definition of words, and 3) standards, building officials and applicant have to make negotiations to clarify the requirement in the regulations. As a method of solution, the building designers adopt the standards in other countries, such as NFPA, ASTM, JIS, and BS.

Legal Framework for Fire Prevention in Malaysia



E.6 Indonesia

(1) Legal Framework

Indonesia is still in the steps to prepare the necessary laws and regulations. Some of principle laws have been enforced since the colonial period.

The legal framework has two major characteristics making itself complicated that 1) each ethnic group has original laws, based on its custom, and 2) laws are ordinarily revised or repeated by the President Order, Ministerial Order, and Notification by General Director.

The Ministry of Public Works takes in charge of legislation of the National Building Code (NBC or Keputusan Menteri). Though provinces have authority to adjust the requirements in the NBC to regional conditions, provinces except Jakarta adopt the NBC without any changes, because the local authorities consider the NBC is still appropriate.

The NBC was legislated by the integration of the Governmental Order 168/1948, Governmental Order 40/1949, Acts 5/1974, President Decision 44/1974, President Decision 45/1983, President Order 4/1969, Decision of the Minister of Public Works 60/1980, and Decision of the Minister of Public Works 211/1984. It stipulates spirits of the regulations and is insufficient for requirements. Therefore persons in charge of building control have to deal with large discretion.

(2) Standards

In the past, various organizations issued their own standards without any coordination, which totally amounted to 28 kinds. In 1994, the Standardization Council of Indonesia, consisting of related ministers, issued the integrated standards, namely Standar Negara Indonesia (SNI).

The SNI introduces the standards of ISO, and standards modified from the ASTM, JIS, and DIN.

(3) Implementation System

Indonesia consists of 27 provinces (or first grade local authority) which can be divided into prefectures and towns (or second grade local authority). The second grade authorities have responsibility to issue building permission.

(4) Laws and Regulations for Fire Prevention System

NBC regulates for fire prevention system as summarized below.

- Structural requirements including fire rate with no requirements for fire separation,
- Evacuation facilities,
- Fire detectors, alarms, and automatic fire extinguisher, and
- Fire-fighting equipment.

F EVALUATION METHOD FOR FIRE INSURANCE

F.1 EVALUATION METHOD OF PREMIUM RATE IN THAILAND

The Department of Insurance, the Ministry of Commerce issues a standard of premium rate for fire insurance as follows.

(1) Basic Premium Rate

- The rate of premium per year is to claim of 1,000 Baht.
- The group of risk premises shall be added the premium rate.
- The premises that separate by wall shall consider their premises and the premium shall be separated as well.

(2) Discount Rate by Fire Protection Equipment

- The sum of discount rate for all fire protection equipment must be accumulated at least 7.5% to get a premium discount.
- The sum of discount rate for all fire protection equipment must be accumulated and not over than 25%, except installation of sprinkler system.

Fire Protection Equipment	Premium Discount Rate (%)
1. Portable fire extinguishers	2.5
2. Standpipe	5
3. Hose reel	5
4. Standpipe with wet system	7.5
5. Automatic fire alarm	2.5
6. Portable fire pump	7.5
7. Fire water pipe connected to public water main pipe that has a fire pump without reservoir, has a fire pump permanently installed that operates by manual or automatic method.	5, 7.5 and 10
8. Automatic sprinkler system in -light hazard (4,831 m2/main pipe) ,-ordinary hazard (4,831 m2/main pipe) and -extra hazard (2,323 m2/main pipe)	during 25 to 30,during 30 to 40 and,during 40 to 50(Note: Above rates apply to premises that protection with automatic sprinkler system. If apply sprinkler rate, it can not add to other fire protection equipment rate.
9. Other fire protection equipment	Less than 10 %

(3) Construction Classifications

- Class 1 shall add 0.20% per claim of 1,000 Baht.
- Class 2 shall add 0.55% per claim of 1,000 Baht.
- Class 1 shall add 0.65% per claim of 1,000 Baht.

Structures	Class	Fire Resistance Rating(Hour)
Column	Class 1	3
	Class 2	2
	Class 3	Less than 2
Load Bearing Wall	Class 1	3
	Class 2	2
	Class 3	Less than 2
Beam	Class 1	2
	Class 2	1
	Class 3	Less than 1
Floor	Class 1	2
	Class 2	1
	Class 3	Less than 1

(4) Shop-house

Occupancy	Construction Classification	
	Class 1	Class 3
Automobile repair shop	3.05	10.20
Electric shop	1.95	6.8
Food shop	1.65	7
Gas shop	2.55	9.2
Karaoke shop	3.1	18.25
Retail shop	2.15	7.45
Tailor shop	1.8	6.05

(5) Hotel

Floor No.	Occupancy	Class 1	Class 3	Rate of Premium		Sum of Premium	
				No Standpipe	Standpipe	No Standpipe	Standpipe
1	Mercantile	2.15	7.45			2.15/7.45	2.15/7.45
2	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
3	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
4	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
5	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
6	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
7	Gust rooms	2.00	10.05			2.00/10.05	2.00/10.05
8	Gust rooms	2.00	10.05	0.08	0.04	2.08/10.13	2.04/10.09
9	Gust rooms	2.00	10.05	0.16	0.08	2.16/10.21	2.08/10.13
10	Gust room	2.00	10.05	0.24	0.12	2.24/10.29	2.12/10.17
11	Gust rooms	2.00	10.05	0.32	0.16	2.32/10.37	2.16/10.21
12	Gust rooms	2.00	10.05	0.40	0.20	2.4/10.45	2.2/10.25
13	Gust room	2.00	10.05	0.48	0.24	2.48/10.53	2.24/10.29
14	Gust rooms	2.00	10.05	0.56	0.28	2.56/10.61	2.28/10.33
15	Gust rooms	2.00	10.05	0.64	0.32	2.64/10.69	2.32/10.37
16	Gust rooms	2.00	10.05	0.72	0.36	2.72/10.77	2.36/10.41
17	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
18	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
19	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
20	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
21	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
22	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
23	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
24	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
25	Gust rooms	2.00	10.05	0.80	0.40	2.8/10.85	2.4/10.45
26	Restaurant	1.65	7	0.80	0.40	2.45/7.8	2.05/7.4
Sum of Premium						61.4/257.2	55.6/251.4
Average of Premium						***2.37***/9.9	2.14/***9.7***

- The premium rate of before modification is 9.7, and after medication is 2.37, and installation of automatic sprinkler system through out the building shall reduce 40% that final premium is 1.422 of total premium.

(6) Multi-complex Building

- The premium for class 1 construction is 2.7 and will be 1.62 after installation of automatic sprinkler system (reduce 40%).
- The premium for class 3 construction is 9.4 before modification.

(7) Multi-stories Housing (less than 7 stories)

- The premium for class 1 construction is 1.00 and will reduce 40% when

install automatic sprinkler system.

- The premium for class 3 construction is 4.45 before modification.

(8) Hospital (less than 7 stories)

- The premium for class 1 construction is 1.00 and will reduce 40% when install automatic sprinkler system.
- The premium for class 3 construction is 3.5 before modification.

(9) Factory

Occupancy	Construction Classification	
	Class 1	Class3
Office	1.00	3.55
Fiber Glass Process	4.7	16.2

- The premium for class 1 construction is 4.7 and will reduce 50% when install automatic sprinkler system.
- The premium for class 3 construction is 16.2 before modification.

F.2 EVALUATION METHOD OF FIRE INSURACE IN JAPAN

(1) Hospital

1) Evaluation Item

The evaluation item is divided into seven aspects as follows.

- Prevention of fire outbreak
- Prevention of initial fire spreading and first fire extinguish
- Evacuation
- Smoke control
- Prevention of enlargement of fire spreading
- Reutilization of the building
- Rescue and full-scale fire fighting

2) Classification

Above-mentioned evaluation criteria are subdivided three grades.

- Grade-A is most high class building design and planning.
- Grade-B is well-balanced building design and planning.
- Grade-C is moderate class building design and planning.

3) Grading Rule on the Total Evaluation

According to the comprehensive evaluation, it will be classified three ranks as follows.

- Rank-A: the building, which gained all Grade-A.
- Rank-B: the building, which gained nearly half of Grade-A.
- Rank-C: the building, which gained less than half of Grade-A.

4) Purpose

a) Prevention of outbreak of fire

To prevent the arson and an accidental fire. Also in a case of fire outbreak, to prevent the fire of building (s).

b) Prevention of initial fire development

After the fire outbreak, to control the fire growth in an early stage and minimization of damage(s).

c) Evacuation

To ensuring the smooth and safety evacuation from each room including the room, which occurred the fire, are required.

Considering the week person (patient), as evacuators are required.

d) Smoke control

To avoid the difficulties of evacuation activities and smoke spreading in a building, are required.

e) Prevention of fire spread

To mitigate of fire damages and keep the fire in certain spaces after became the enlargement of fire stage.

f) Reutilization

To recovering non-fire damage area as a daily operation promptly.

g) Rescue and full-scale fire fighting

To support the fire fighting activities.

h) Prevention of exposure fire

To escape the catch fire from other building and check the spread of the fire to other buildings

Evaluation Criteria in Prevention of Outbreak of Fire (Hospital) -1/7

Criteria	Grade-C	Grade-B	Grade-A
1) spaces which easily maintain for the prevent of fire outbreak	a) There are not many dead space in the spaces which have a possibility of human's enter from outside.	a) There are not many dead space in the spaces which have a possibility of human's enter from outside. b) garbage store space are enclosed by fire proof compartment or easily observe as a maintenance	as same as left
2) eliminate the possibility of the fire by source of heat	a) In a case of utilization of the gas as a source of heat, the detector of gas leakage is installed	a) no use of gas as a source of heat b) if case of use, it required both of measures, i) exist the gas leakage detector and 24 hours monitoring at command center, ii) installation of emergency gas safety shut-off devices	as same as left a) and b) c) no rooms which utilize the fire
3) minimization of combustible objectives in order to prevent the fire	a) no use of combustible materials near the place which expected the fire b) interior finishing materials are quasi-noncombustible for most of rooms	as same as left	a) no use of combustible materials near the place which expected the fire b) interior finishing materials are noncombustible for most of rooms

Evaluation Criteria in Prevention of Initial Fire Development (Hospital) -2/7

Criteria	Grade-C	Grade-B	Grade-A
1) quickly arrive at the fire occurred place	a) shot time arrival at any places in the building so as to confirm the fire place from the central monitoring room (fire command center)	as same as left a) b) central monitoring room (command center) is located at near to staircases and emergency lift(s)	as same as left
2) early findings of the fire occurred place	a) installation of appropriate detectors (smoke, heat, etc) which meet to the characteristics of space in a most of the entire building	as same as left a) b) range of detectors are installed subdivided depend on safety separation, rooms, others	c) planned the high reliance of devices, early findings of the fire and measurement on the prevention of the false alarm
3) prevent the fire spreading by burning of finishing materials	a) interior finishing materials are quasi or more upper level of noncombustible materials for most of all rooms	as same as left a) b) finishing (surface) materials of the curtains, blinds, partitions are treated by flame retardation agent	a) interior finishing materials are noncombustible materials for most of all rooms b) as same as left
4) automatic fire extinguish in a initiate stage without person(s) in the building			a) automatic fire extinguisher such as sprinklers are installed properly depend on the usage type of rooms
5) minimization of fire damage space by the area compartment		a) no rooms which use a fire, or properly fire compartment to the source of heat b) not only the fire compartment also noncombustible separation as multiplex system	as same as left

Evaluation Criteria in Evacuation (Hospital) -3/7.1

Criteria	Grade-C	Grade-B	Grade-A
1) building manager and habitants in a fire floor recognize the fire, then they inform the fire to all peoples in the building.	a) installation of appropriate detectors, alarming equipment and emergency bells which meet to the characteristics of space in a most of the entire building b) installed the emergency broadcasting system, then it provide the broadcast in entire building	as same as left	as same as left addition to b), planned the high reliance of devices, early findings of the fire and measurement on the prevention of the false alarm
2) evacuation from the rooms can smoothly and safety	a) rooms over the 200 sq. m, it required plural number of evacuation doors and these location is at random.	as same as left a) b) outer area of rooms are exterior area or safety zone	as same as left
3) evacuation routes are clearly understood and evacuate safety and smoothly	a) corridors which use for evacuation route (including openings) , it required the compartment using the noncombustible materials b) assure the width of corridors, doors and staircases in order to avoid the over delay.	as same as left a) and b) c) no blind alleys, no the dead end of corridors d) well balanced design of staircase and safety area zoning e) evacuation floor is directly connect to exterior area and/or connecting route from evacuation route to exterior area, it required the fire compartment.	as same as left f) evacuation route as same as daily used corridors g) no duplicate of evacuation route which connect to 2 direction of evacuation staircases
S-1) the area which exist the person (patients) who could not easily evacuate, it required fire compartment (including store for flammable objects and dangerous space of fire) and smoke barrier planning more strictly.(confined compartment)	a) planned the fireproof and smoke barrier, and openings must use the fire doors b) do not layout the rooms which likely occur the fire such as kitchen at lower floor and/or next zone c) rule of the restriction on the use of fire, installation of fire equipment d) rest room for staff, dressing rooms and storage which likely to occur the fire, it required the fire partition and smoke barrier planning e) easily access route for the fireman f) operate the ventilation system and electrical supply until rescue activities completely finished	as same as left g) opening (inspection door) for the carry EV., it installed fire door and smoke integrity door (double door) h) smoke extraction and AC ducts are not penetrate the confined compartment	as same as left
S-2) perfect planning of fire partition and smoke barrier for corridors and other space which use for evacuation as a first priority safety zone. (safety zoning of corridors and other spaces)	a) eliminate the smoke route such as grill b) smoke shut-out using the automatic closing system c) rest/break rooms, dressing rooms and storage which likely occur the fire in a nurses' station, it require the noncombustible materials to floor d) transportation facilities in a nurse station, it require the smoke barrier planning, not dangling wall.	as same as left a), b), d) c) noncombustible compartment to the nurse station and corridors up to floor. And openings are used the noncombustible doors	as same as left a), b) and d) c) rest/break rooms, dressing rooms and storage which likely to occur the fire in a nurses' station, it required the noncombustible compartment including floor, besides a nurses' station and corridors are required noncombustible partition or fire-proof and smoke barrier are provided to nurse station and corridors.

Evaluation Criteria in Evacuation (Hospital) -3/7.2

Criteria	Grade-C	Grade-B	Grade-A
S-3) for evacuate to safety and easier rescue area in a short time, it require the balconies in the building (install the balconies)	a) ladder truck can reach to the balconies b) effective delay area of the balconies are without the evacuation hatch	as same as left b) a) provide the horizontal evacuation route to evacuation staircases, emergency EV. and other safety compartment from the balconies not passing the fire compartment which has a fired room b) planned the enough width of balconies for wheelchairs	as same as a), b), c) d) route from safety zone to balconies, it require the non-difference in level for wheel chair passing, if exists, the gap is less than 2 cm. e) it required the sweep out style windows between the patient rooms and balconies
S-4) provide the temporally safety waiting area for patients	a) openings of the partition for the horizontal evacuation, it required the fire door which connecting with smoke detectors b) smoke extraction and air conditioning ducts never penetrate the partition for the horizontal evacuation c) any places of fire outbreak, it can escape to evacuation staircases which not passing the fire zone. the evacuation route, it required mechanical smoke extraction system or natural ventilation which not enter to deep void space. d) doors along the escape route, it require to open toward the exit and not any obstacle for evacuators including the passing the wheelchairs.	as same as left b), c) a) openings of the partition for the horizontal evacuation, it required the fire door with movable dangling wall which connects with smoke detector. d) escape staircases are required for all fire compartments	as same as left b), c), d) a) openings of the partition for the horizontal evacuation, it required the fire door with fixed dangling wall which connecting with smoke detector. e) it require the smooth movement to the priority safety area in the evacuation starting floor before arrive the fire/rescue fighters such as the steps and additional rooms which connect to the evacuation staircase, emergency staircases and lobby of the emergency EV. f) it require the leaving and/or storage spaces for stretchers and wheel chairs.

Evaluation Criteria in Smoke Control (Hospital) -4/7.1

Criteria	Grade-C	Grade-B	Grade-A
1) to minimize the smoke damage, it required the smoke keep in a limited space by smoke barriers	a) 30cm dangling wall from the ceiling at the entrances of partitions b) effective solutions on the prevention for trouble of shutter closing which installed openings of the partitions that likely to leaking of smoke c) smoke prevention measurement for EV shafts d) no inspection doors and/or any openings of equipment & machine rooms, storage, other shafts at all staircases	as same as left a), c) and d) b) effective solutions on the prevention design with the fixed wall such as glass screen at the upper floors for trouble of shutter closing which installed openings of the partitions that likely to leaking of smoke e) layer to layer partition by each floor to EPS and PS	as same as left a), c), d) and e) b) no use the shutters to the partitions which likely to leaking of smoke f) if additional or front rooms are attached to all staircases, it require to design not as a smoke transmission route
2) to avoid the smoke spreading by facilities and effective smoke exhaust system	a) air conditioning equipment are planned individually by floor b) automatic stopping system of air conditioning equipment which an interlocking devices of fire alarm are installed c) well balanced of location of smoke exhaust outlets	as same as left a) and b) c) in a case of the mechanical smoke exhaust: - well balanced of location of smoke exhaust outlets - area of partitions are at most small for each smoke exhaust fan and these areas are respectively same	as same as left c) in a case of the mechanical smoke exhaust - in a safety compartments, it require the properly air supply route for effective smoke exhaust

Evaluation Criteria in Smoke Control (Hospital) -4/7.2

Criteria	Grade-C	Grade-B	Grade-A
2) to avoid the smoke spreading by facilities and effective smoke exhaust system		- to avoid the friction (pressure) loss and air leaking in the horizontally long ducts - network of ducts of the mechanical smoke exhaust of kitchen and other rooms which using the fire, it require the separate to other ducts network before reach to vertical ducts - appropriate location is require for the air supply inlets and air exhaust outlets both of which faced to out side of building d) in a case of the natural smoke exhaust: - well balanced of location of exhaust outlets - smoke exhaust outlets and operation devices are located at easily recognize and operation	- mechanical smoke exhaust ducts of rooms and safety compartment must separately before reach to vertical ducts - starting of smoke exhaust devices are connect to several fire detector or remote operation from fire command center d) in a case of the natural smoke exhaust - in a safety compartments, it require the properly air supply route for effective smoke exhaust - starting of smoke exhaust devices are connect to several fire detector or remote operation from fire command center

Evaluation Criteria in Prevention of Fire Spread (Hospital) -5/7

Criteria	Grade-C	Grade-B	Grade-A
1) to minimize the fire damage, it required the fire keep in a limited space	a) consideration on the prevention of trouble of shutter descending stage which located at fire partition - no accumulation space of combustible objectives at descending space - installation of sprinklers at descending space b) the room which use the fire such as kitchen, it require the fire partition	as same as left b) c) most of the wall of fire partition are fire proof structure	as same as left d) fire doors installed the fire partitions are always closed and automatic closing devices are attached
2) to avoid the fire spreading to other floors	a) consideration on the prevention of trouble of shutter descending stage which located at vertical fire partition of atrium - no accumulation space of combustible objectives at descending space - installation of glass screens at shutter partition	a) consideration on the prevention of trouble of shutter descending stage which located at vertical fire partition of atrium (more certainly) - no accumulation space of combustible objectives at descending space - installation of glass screens at shutter partition	a) there are no big void spade such as atrium and not so many partition with fire shutters
3) properly design solution on the penetration at the partitions and well balanced zoning		a) layer to layer partition by each floor to EPS and PS b) part of penetration such as ducts are very few and there no penetration part at the partition which require the more high level of fire integrity	as same as left c) same zoning between the zone of air condition and smoke exhaust and the zone of major fire partitions

Evaluation Criteria in Reutilization of a Building (Hospital) -6/7

Criteria	Grade-C	Grade-B	Grade-A
1) to mitigate the damage by hose stream		a) water proof construction for the upper floor of electric rooms, computer rooms and other important rooms	a) water proof construction for the upper floor of electric rooms, computer rooms, fire command center and other important rooms b) drainage system is require to emergency EV lobby c) drainage system is require to the bottom of EV shafts
2) to avoid the damage to building infrastructure such as electric supply and others		a) back-up networking system for EPS. Or double partition of layer to layer and vertical b) scattering planning of PS. Or double partition of layer to layer and vertical for PS	as same as left

Evaluation Criteria in Reuse and Full-scale Fire Fighting (Hospital) -7/7

Criteria	Grade-C	Grade-B	Grade-A
1) to protect the smoke impact during the fire fighting	a) provision of fire fighting base which not dangerous of smoke for all floors	a) provision of the fire fighting base which has fire partition for all floors b) this space require the smoke control devices	a) provision of the fire fighting base which has fire partition for all floors b) this space require the smoke control devices (individually)
2) to fire protect the space for fire fighting at the fire occurred floor	a) fire partition for the command center	as same as left	as same as left b) fire partition are located between rooms and first grade safety compartment with few openings
3) to smooth and safety operation of fire fighting, it require to provide the adequate space on the building site and facilities	a) assure the enough space for the fire fighting b) easily access from out side to command center	as same as left c) emergency EV and access point for ladder truck are required	as same as left d) easily access to emergency EV from out side of building e) if basement floors exist, it require the sprinkler system

(2) Hotel and Supermarket

Th evaluation criteria of hotels and supermarkets presented in the following tables show only additional criteria to those of Hospital. In order to achieve the fire safety, all criteria are available to other use of the buildings. Selection of the criteria are depend on the size of spaces, characteristics of space and buildings.

Evaluation Criteria for Hotels

Criteria	Grade-C	Grade-B	Grade-A
1. Prevention of outbreak of fire			
1) spaces which easily maintain for the prevent of outbreak of fire	a) Fire compartment for the linen rooms of all floors	as same as left	as same as left
3. Evacuation			
2) evacuation from the rooms can smoothly and safety			The opening direction of doors which located at banquet rooms are require the direction toward the orientation of evacuation routes
3) evacuation routes are clearly understood and evacuate safety and smoothly		clear planning of the evacuation route	as same as left
4) Secure of the safety for tentative escape for provision of delay of evacuators		a) require the enough and clear space for basket of the ladder truck at the guest rooms floors b) the door of guest rooms are require to use the fire door	as same as left c) designed of balcony which connect to other guest rooms
5. Prevention of fire spread			
2) to avoid the fire spreading to other floors	Fire proof performance for the spandrel (beam, fastener, exterior panel and others) are required more than one hour fire resistance Height of the spandrel are required the prevention of fire to upper floors	as same as left	as same as left

Evaluation Criteria for Supermarkets

Criteria	Grade-C	Grade-B	Grade-A
3. Evacuation			
2) evacuation from the rooms can smoothly and safety	The doors of shops require to open toward to corridors	as same as left	as same as left
3) evacuation routes are clearly understood and evacuate safety and smoothly	c) If connect to difference use of space, it require the correspond to differences of utilizable time d) Less than 50% of horizontal evacuation route	c) If connect to difference use of space, it require the correspond to differences of utilizable time d) Less than 50% of horizontal evacuate route e) It require the individual evacuation planning for difference of use f) Well balanced planning of location of staircases and safety separations g) Clear planning of the evacuation routes h) Less than 40% of horizontal evacuation route	as same as left h) Less than 30% of horizontal evacuation route I) Directory exit to outside from the staircase of evacuation floor
4. Smoke control			
1) to minimize the smoke damage, it required the smoke keep in a limited space by smoke barriers	e) On the staircase use for the evacuation, it require the fire proof structure except openings f) In a case of the location of parking floors under the commercial floors, and vertical connecting each others, it require the additional room for staircase at parking floors g) If put other use of spaces, fixed wall partitions or fire shutter with dangling glass separations are required		