TECHNICAL REPORT

ISO/TR 20413

First edition
2021-12

Fire safety engineering — Survey of performance-based fire safety design practices in different countries

Ingénierie de la sécurité incendie — Recensement des pratiques nationales sur la conception de la sécurité incendie fondée sur la performance

Reference number
ISO/TR 20413:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 4, *Fire safety engineering*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Since the 1980s, performance-based fire safety design (P-B FSD) have been increasingly popular in many countries. In recent years, the trend has been accelerated by factors such as the emergence of large-scale buildings, diversification of building uses, desire for cost-effective construction and development of new building technologies. However, building control has been traditionally carried out based on prescriptive building/fire regulations and it is unlikely that this conventional system will be changed in the future for the majority of conventional types of buildings.

Since building designs by the P-B FSD method and by prescriptive building/fire regulations are very different, the buildings designed by the P-B FSD method do not smoothly fit into the conventional building control system. Various efforts are underway to devise a new system to control P-B FSD designs but there is a long way to go. Also, it is not clear how widely and in what practical situations the P-B FSD approach is used, and what fire safety engineering (FSE) tools are used in different countries.

It is the mission of ISO/TC 92/SC 4 to promote P-B FSD, and therefore SC 4 is concerned with how it can effectively assist in the establishment of systems for P-B FSD and, more specifically, what documents SC 4 can produce to benefit the development of P-B FSD. For this purpose, it is first necessary to understand the current state and environment of P-B FSD, particularly the legal, administrative and human environment.

This document is a summary of the results of a questionnaire survey conducted as the first step to better understand the actual situation of P-B FSD in different countries.

Similar surveys have already been conducted: twice by CEN/TC 127, *Fire safety in building*, in 2001 and 2017[2], for countries in Europe and several other countries; as well as other surveys with a similar interest[3][4]. Some results of these surveys are cited in this report as notes.

Fire safety engineering — Survey of performance-based fire safety design practices in different countries

1 Scope

This document is a summary of the results of a questionnaire survey, which was conducted to gather information on the current state of performance-based fire safety design (P-B FSD) practices in various countries.

The questions include what types of buildings and areas of fire safety systems are being applied, what are the legislative environments in terms of acceptance of P-B FSD, and what documents are needed/desired from ISO/TC 92/SC 4 if the countries/regions wish to adopt P-B FSD.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms and definitions

3.1.1
authority having jurisdiction
AHJ
authority including national and local governments, committees, officials and other organizations/persons that has jurisdiction

3.1.2
certifier
organization/person to certify buildings and their components that comply with performance-based criteria

3.1.3
peer review
evaluation by third-party authority or engineer in the same field to comply with performance criteria

3.1.4
performance-based fire safety design
P-B FSD
design that is engineered to achieve specified fire safety design objectives based on performance criteria

3.1.5
private certifier
accredited non-governmental *certifier* (3.1.2)

3.1.6
regulatory review
assessment conducted by the *authority having jurisdiction* (3.1.1) to determine if fire safety design complies with performance criteria

3.2 Abbreviated terms

P-B FSD	performance-based fire safety design
FSE	fire safety engineering
CFD model	computational fluid dynamics model
2001-MS	member states of the EU at the year 2001
N-MS	member states of the EU after the year 2001
2016-MS	member states of the EU at the year 2016 ("2001-MS" + "N-MS")

4 Method of survey

The questionnaires were distributed to all the members of ISO/TC 92/SC 4 through the Secretariat of SC 4 during 7 to 10 October 2016. The selection of appropriate responders was left to the discretion of the mirror committee of each country/region. The expected typical responders were architects, fire safety engineers, building officials, etc.

The completed questionnaire was returned by 13 countries before 9 October 2016. Three responses were subsequently added. Finally, the number of countries that responded was 16, of which 8 are European countries.

The questionnaire is given in Annex A. There are 17 questions, which are classified into 4 sections:

— subjects of P-B FSD (see 5.3);

— societal and regulatory systems for P-B FSD (see 5.4);

— design fires and scenarios, criteria and calculation methods (see 5.5);

— the reasons why P-B FSD is not being adopted (see 5.6).

In general, the subjects of P-B FSD are buildings. Nevertheless, aircrafts, ships, trains and other types of built environments such as tunnels are included in the questions.

5 Results of survey

5.1 General

The results of the survey are summarized in 5.2 to 5.6.

The completed questionnaire was returned by 16 countries, of which 11 countries responded with a single answer while the other 5 countries (Canada, Germany, Spain, Sweden and the USA) responded multiple times. The questionnaire answers are wrapped up by each country in the case that two or more responses were received in a same country. The answers are not exactly the same even from the same country. In addition, different countries use different terminology. This is thought to be partly because some countries consist of local governments which retain high level of independence in autonomy and jurisdiction and partly because the responders' familiarity with the issues will not always cover all the local rules and conditions. Remarks are included for the relevant answers.

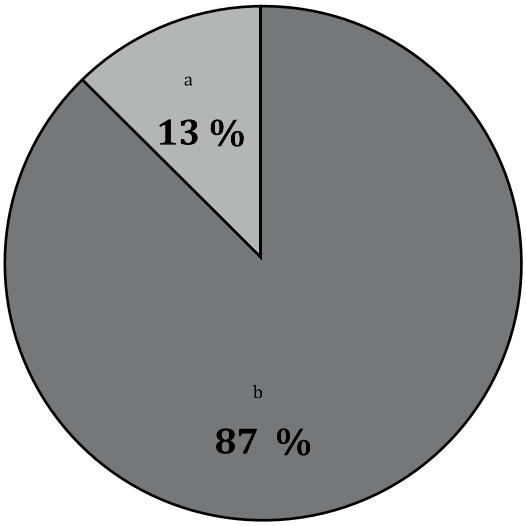
The countries/regions that responded to the questionnaire and the number of responses from each are as follows:

— Austria (EU)	1
— Canada	2
— China	1
— France (EU)	1
— Germany (EU)	2
— Hungary (EU)	1
— Japan	1
— Republic of Korea	1
— Netherlands (EU)	1
— New Zealand	1
— Russian Federation	1
— Slovakia (EU)	1
— Spain (EU)	10
— Sweden (EU)	2
— Turkey	1
— United States of America (USA)	3

5.2 Usage of P-B FSD to actual buildings (answers to Q1)

Q1. Is P-B FSD already being used for actual buildings in your country/region?

Figure 1 shows that P-B FSD is being used in most of the 16 countries with two exceptions: Slovakia and Turkey.



Key

a No, 2: Slovakia and Turkey.

b Yes, 14: Austria, Canada, China, France, Germany, Japan, the Republic of Korea, Hungary, New Zealand, the Netherlands, the Russian Federation, Spain, Sweden and the USA.

Figure 1 — Q1. Is P-B FSD already being used for actual buildings in your country/region?

NOTE In CEN's survey report[2], there is no direct question as Q1, but on the related question "4.5 Alternative approval system or derogation" it is said that alternative and derogation are accepted in most of 2016-MS, although "able to accept by regulatory system" and "being actually accepted" are not necessarily exactly the same.

5.3 Subjects of P-B FSD (answers to Q2 to Q4)

Q2. What are typical types of facilities/uses to which the P-B FSD approach is applied?

Figure 2 shows that every kind of built environment can be a subject of P-B FSD in most countries. However, P-B FSD tends to be applied mostly to high-rise buildings and various large-scale projects, while applications to residential and educational buildings are relatively few. This can suggest that the existing building and/or fire codes have not been able to catch up with the speed of change of height, size, occupancy condition, etc., while several types of buildings (e.g. residential buildings) are relatively simple so still tend to be constructed in a traditional way or omitted from the enforcement of rigorous provisions.

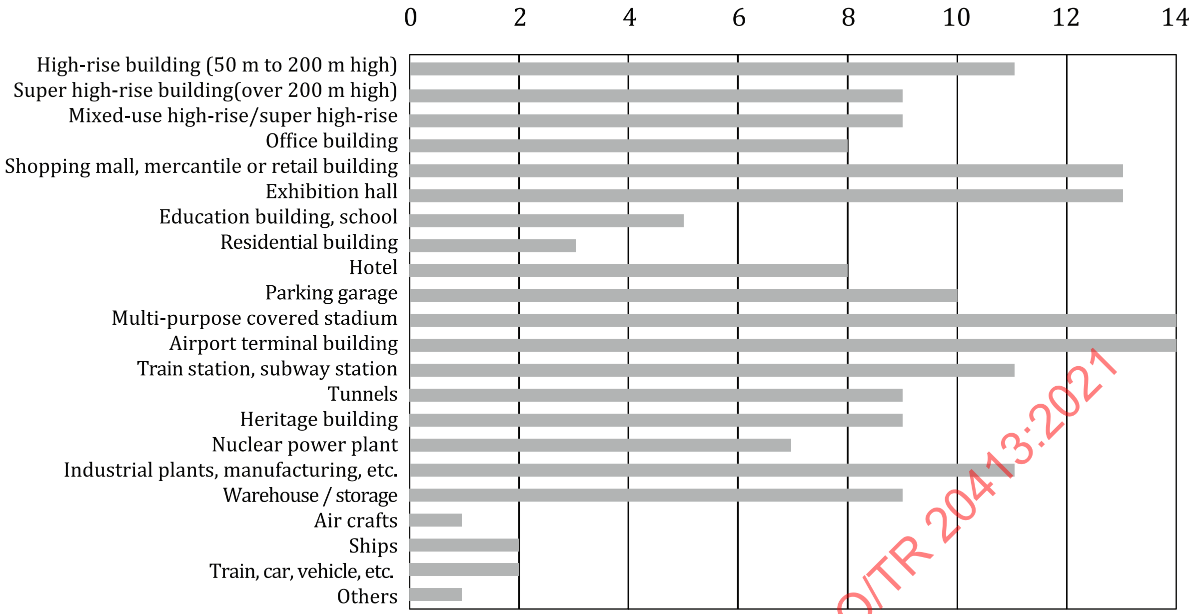


Figure 2 — Q2. What are typical types of facilities/uses to which the P-B FSD approach is applied?

Looking into the answers in Table 1 for the difference by country, the application of P-B FSD to transportation vehicles (e.g. aircrafts, trains, ships) is generally rare. It is suspected that the number of products are relatively much lower than for buildings and expertise is highly specialized; therefore, the safety designs are controlled by some other specialized systems and only a few fire safety engineers can be involved in the design.

Table 1 — Main subjects of P-B FSD in each country (Q2)

Country	Austria	Canada	China	France	Germany	Hungary	Japan	Republic of Korea	New Zealand	Netherlands	Russian Federation	Spain	Sweden	USA
High-rise building (50 m to 200 m high)	x	x		x			x	x	x	x	x	x	x	x
Super high-rise building (over 200 m high)	x	x	x				x	x	x		x	x		x
Mixed-use high-rise/ super high-rise	x	x	x				x		x		x	x	x	x
Office building		x				x	x		x	x		x	x	x
Shopping mall, mercantile or retail building	x	x		x	x	x	x	x	x	x	x	x	x	x
Exhibition hall	x	x	x	x	x	x	x		x	x	x	x	x	x
Educational building, school		x					x		x				x	x
Residential building		x					x		x					
Hotel		x				x	x		x	x		x	x	x
Parking garage		x		x	x	x	x		x	x		x	x	x
Multi-purpose covered stadium	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Airport terminal building	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Train station, subway station		x	x	x	x	x			x	x	x	x	x	x
Tunnels				x	x			x	x	x	x	x	x	x
Heritage building		x		x		x			x	x	x	x	x	x
Nuclear power plant		x		x		x		x				x	x	x
Industrial plants, manufacturing, etc.	x			x	x	x	x		x	x	x	x	x	x
Warehouse/storage				x	x	x		x	x	x		x	x	x
Air crafts														
Ships				x										x
Train, car, vehicle, etc.				x										x
Others	x													

NOTE No P-B FSD is used in Slovakia and Turkey.

NOTE (According to the survey[3][4], responders: > 400 people from 40 countries.) With respect to the application of FSE/PBD methods to fire safety, about 5 % to 10 % of designs are full PBD; depending on country, about 5 % to 20 % are deviation from prescriptive (DTS) provisions using FSE; and the large majority, some 70 % to 90 % designs, are strictly compliant with DTS solution/verification methods.

Q3. Which fire safety systems or features are included in P-B FSD analyses?

Figure 3 shows that any of the fire safety systems or means which are usually installed in buildings have a need to apply the P-B FSD approach. This fact can imply that many building owners are not always satisfied with the existing code provisions for these fire safety systems because of the cost, restriction of design, efficiency or another reason.

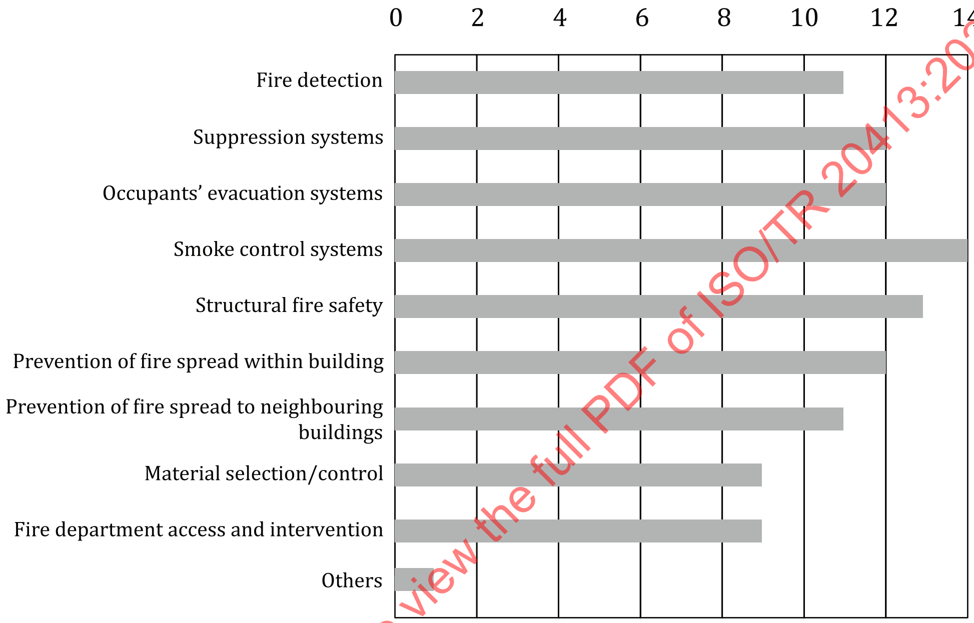


Figure 3 — Q3. Which fire safety systems or features are included in P-B FSD analyses?

NOTE According to the CEN survey[2], according to the assessment for the five initiatives by BeneFeu as to form the basis of regulatory compliance, the focused FSE areas are assessed by member countries as given in Table 2.

Table 2

FSE area	Assessment by CEN/TC 127/WG 8 Member countries		
	Much work	Little work	Mature
SS1: Fire initiation and development	11	7	4
SS2: Smoke propagation	6	9	7
SS3: Compartmentation and stability	2	13	5
SS4: Detection, activation and suppression	5	11	3
SS5: Fire service intervention	11	5	3

Q4. What are the main <u>reasons</u> to apply the P-B FSD approach to buildings?

Figure 4 shows the major reasons that P-B FSD is used in building designs. The two major reasons are "the type of building is out of scope of the existing prescriptive regulations" and "a desired aspect of the building does not comply with the building or fire regulation", followed by "economize building cost" and "realize attractive/innovative building space". These are, of course, considered to come from the general feeling that the existing provisions are too restrictive, which can be reasonable or a poor understanding of fire risk.

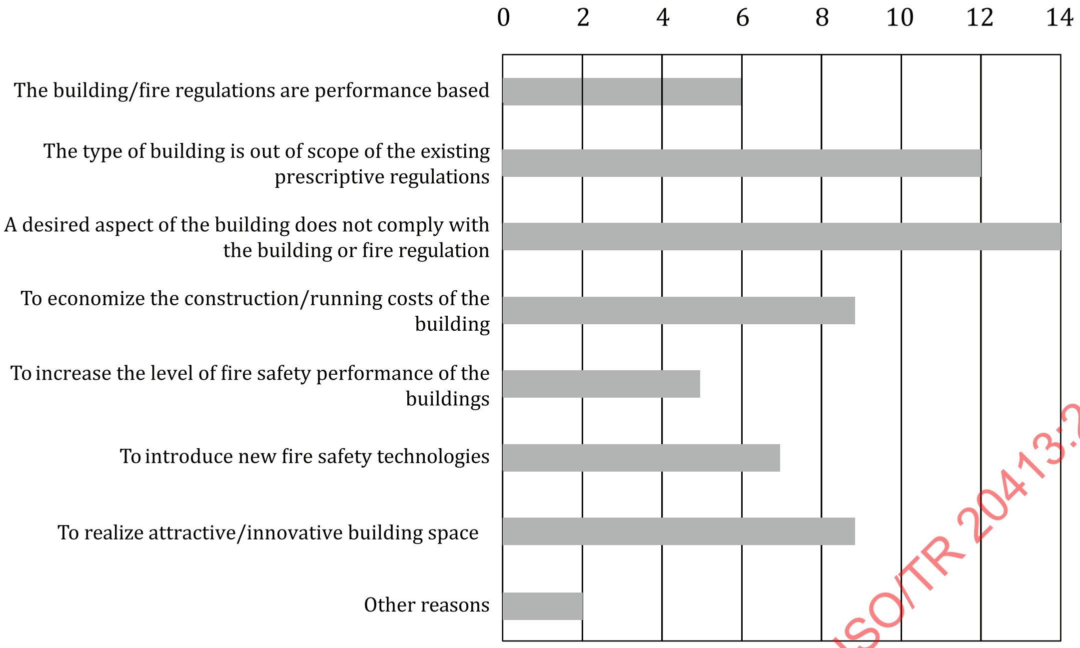


Figure 4 — Q4. What are the main reasons to apply the P-B FSD approach to buildings?

NOTE According to the survey[3][4], performance-based code has been introduced in Australia (1996), Japan (2000), the Netherlands (1992), Spain (1999), Sweden (early 1990s) and Scotland (function-based system, 2005).

5.4 Societal and regulatory systems (answers to Q5 to Q9)

Q5. What regulatory systems make it possible to apply the P-B FSD to buildings?

The results of the answers in Figure 5 show that societal and regulatory systems vary among the countries. The most common regulatory system that enables P-B FSD is the building/fire regulation, either national or local, having some clause to allow buildings that do not comply with the specifications of the regulations. Also, some countries have already established a system to accept P-B FSD. These counties total 27, while another 8 countries accept P-B FSD by the discretion of building/fire officials and 3 countries accept P-B FSD by designated approval organizations. It is possible this is because administrative organizations in these countries are more discretionary or because these countries have multiple ways to accept P-B FSD. Further clarification is desired.

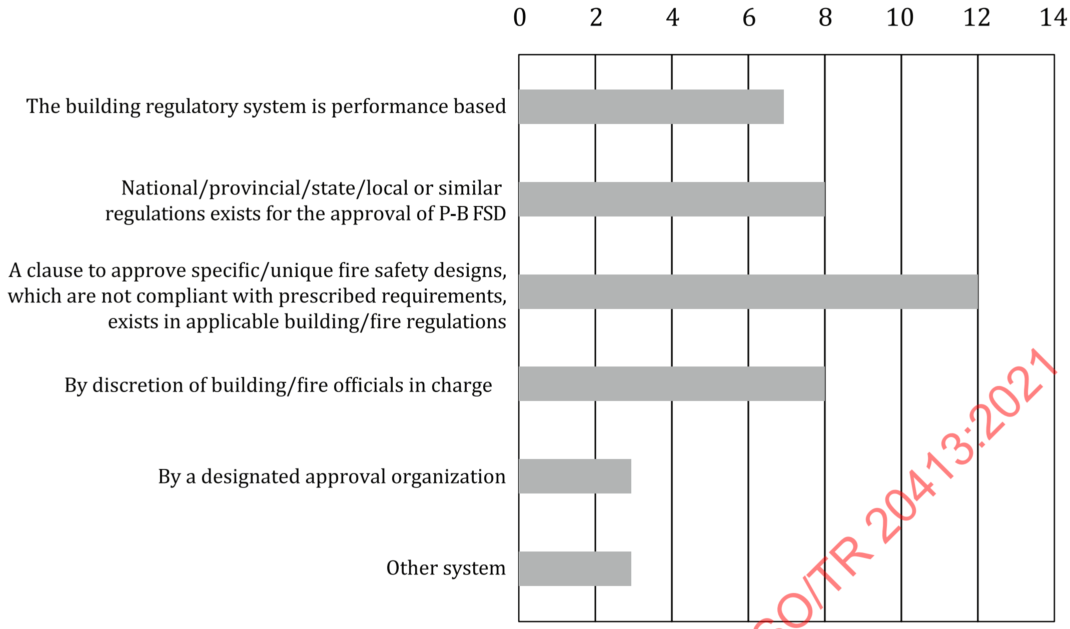


Figure 5 — Q5. What regulatory systems make it possible to apply the P-B FSD to buildings?

Q6. Which body/bodies perform a regulatory review of P-B FSD?

Most countries perform regulatory review both by an AHJ and designated approval organizations, engineer/firms, authorized by the AHJ (see Figure 6 and Table 3).

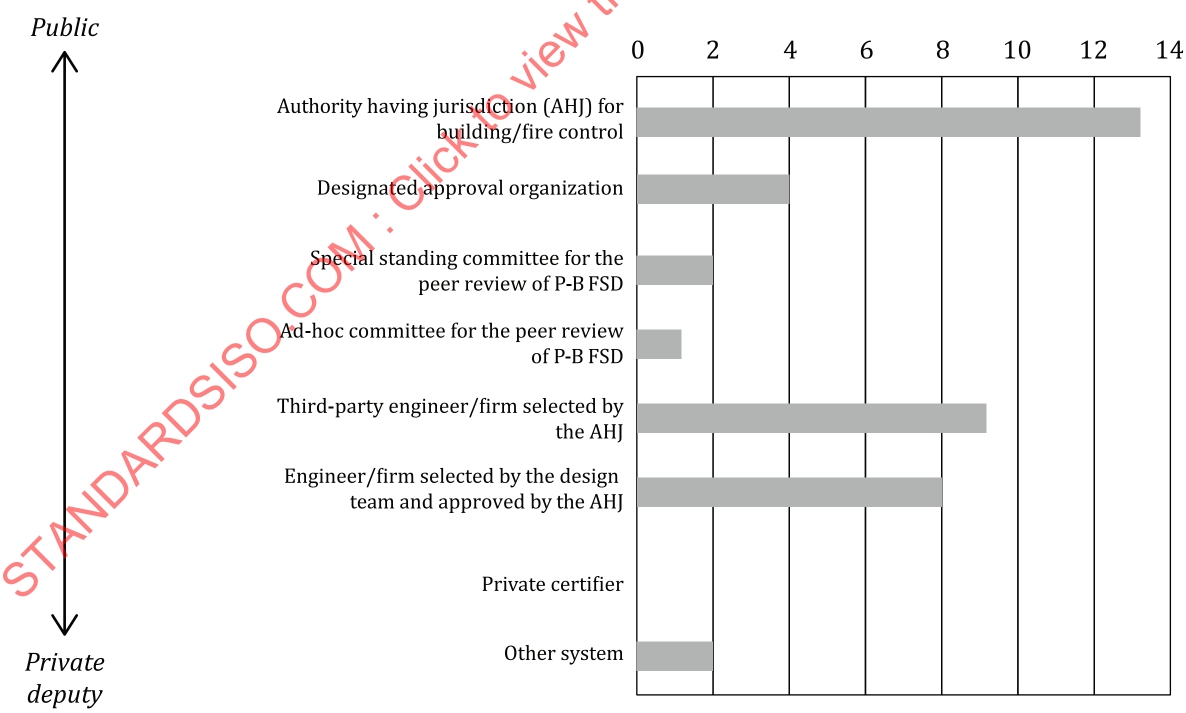


Figure 6 — Q6. Which body/bodies perform a regulatory review of P-B FSD?

Only the AHJ shall/can perform regulatory review of the P-B FSD in Austria and China. On the other hand, Sweden seems to be very unique in that AHJ is not, neither directly nor indirectly, involved in the review. It will be interesting to check the system more in detail to see how it works.

Table 3 — Body/bodies for regulatory review in different countries (Q6)

Country	Austria	Canada	China	France	Germany	Hungary	Japan	Republic of Korea	New Zealand	Netherlands	Russian Federation	Spain	Sweden	USA
AHJ for building/fire control	x	x	x	x	x	x	x	x	x	x	x	x		x
Designated approval organization		x									x	x		x
Special standing committee for the peer review of P-B FSD								x						x
Ad hoc committee for the peer review of P-B FSD														x
Third-party engineer/firm selected by the AHJ		x		x	x	x	x		x	x		x		x
Engineer/firm selected by the design team and approved by the AHJ				x	x				x	x	x	x	x	x
Private certifier														
Others												x	x	

NOTE According to the CEN survey[2], in 2001, most of the countries (16 of 17 MS) approved designs based on calculations, only 14 accepted ad hoc tests and 15 expert judgement. Fifteen years later, the use of calculations is accepted by Portugal, and Greece has introduced expert judgement as a tool for justifying an alternative or derogation.

Q7. What professional qualification is required for the regulatory reviewers?

The requirements of professional qualification for the regulatory reviewers also vary. The professional qualifications as a reviewer are issued or acknowledged typically by the government or a relevant professional association. However, nearly half of the countries have no explicitly defined qualification (see Figure 7). This can depend on how popular P-B FSD is in particular countries. If the number of P-B FSDs is limited, it can be enough to assign relevant distinguished experts on a case-by-case basis as reviewers.

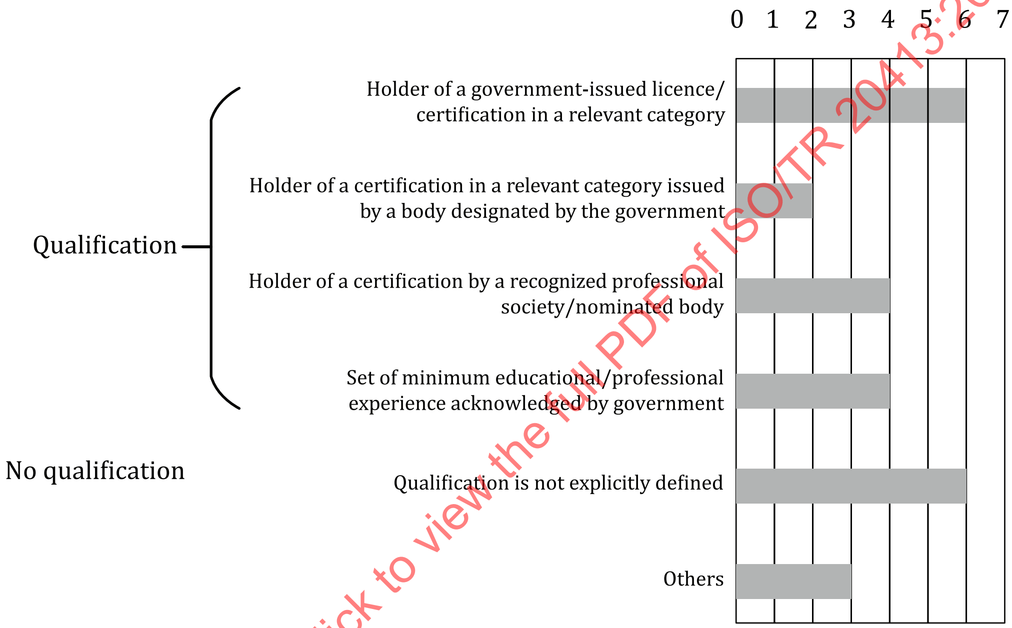


Figure 7 — Q7. What professional qualification is required for the regulatory reviewers?

The answers of Canada, France and Spain are checked both at "required" and "not defined", because each state, city, etc. has its own building control system within the same country (see Table 4).

Table 4 — Qualification of a reviewer of P-B FSD

Country	Austria	Canada	China	France	Germany	Hungary	Japan	Republic of Korea	New Zealand	Netherlands	Russian Federation	Spain	Sweden	USA
Holder of a government-issued licence/certification in a relevant category		x		x		x		x				x		x
Holder of a certification in a relevant category issued by a body designated by the government					x		x							
Holder of a certification by a recognized professional society/nominated body		x							x		x			x
Set of minimum educational/professional experience acknowledged by government			x			x		x			x			
Qualification is not explicitly defined	x	x		x						x		x	x	
Others	x					x						x		

Q8. Is there any peer review by a private certifier or similar, not only by regulatory review?

Although the meaning of each choice for this question is not always clear, there seems to be a legal system to license private certifiers in some countries. However, regardless of whether such a system exists, private certifiers are not often involved in the certification of P-B FSD.

There are peer reviews by a private certifier or similar in Sweden and in parts of Canada, France and the USA. It can seem to be a contradiction that France, Canada and the USA have checked both the second and third answers, but this is thought to be because the local governments in these countries have their own jurisdictions and independent building control administrations, and therefore the introduction of a private certifier is not uniform in the country (see Figure 8).

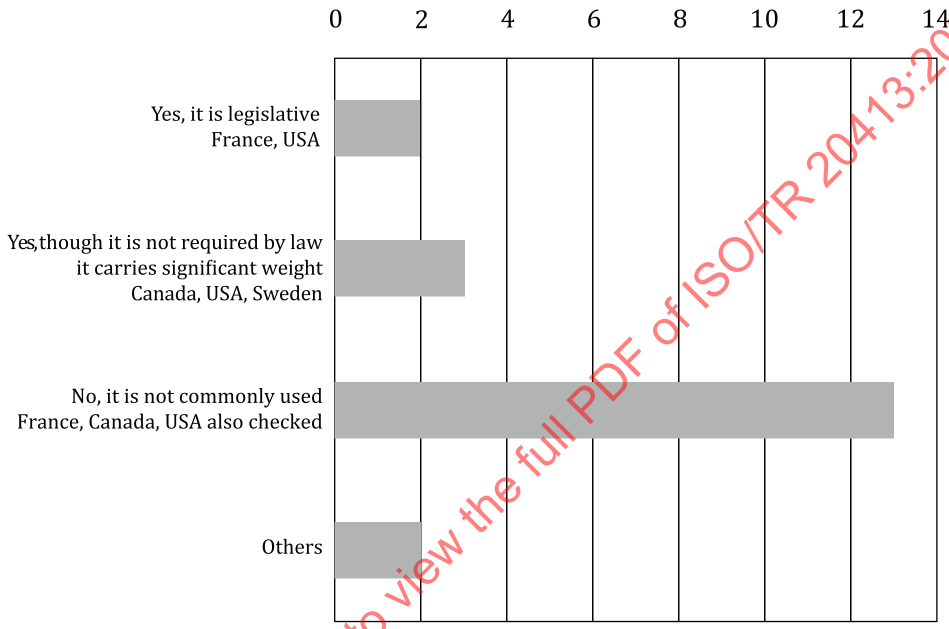


Figure 8 — Q8. Is there any peer review by private certifier or similar, not only by regulatory review?

Q9. What qualification is required to engage in P-B FSD practices?

The qualifications for P-B FSD practitioners are required in half of the countries and not in the other half. In Canada, China, Germany, Hungry and the Republic of Korea, some kind of licence or certification is “required”. In Austria, Japan, New Zealand, the Russian Federation and Sweden, the qualification is “not defined” (see Figure 9).

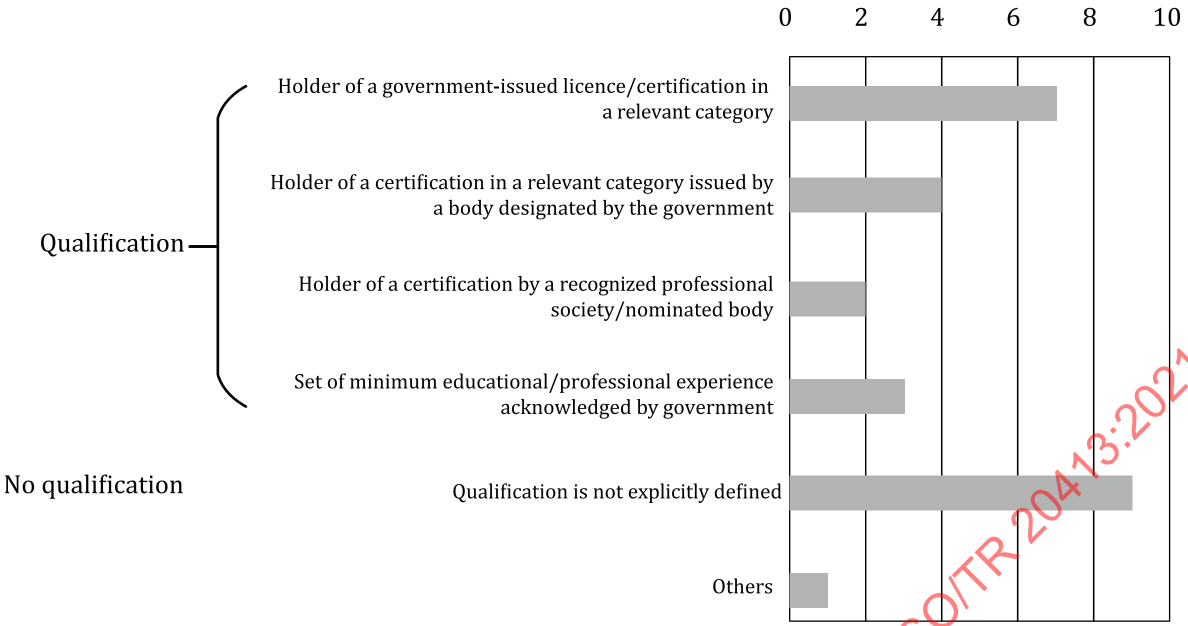


Figure 9 — Q9. What qualification is required to engage in P-B FSD practices?

In France, Spain and the USA, both "required" and "not defined" exist (see Table 5).

NOTE 1 According to the survey[3][4], the way building control is performed in Spain differs from the other European, or western, countries in that it relies solely on the qualification of professionals, normally architects but sometimes civil engineers, who have ultimate responsibility for projects (much like registered architects in Japan).

Table 5 — Qualification of engineer for P-B FSD

Country	Austria	Canada	China	France	Germany	Hungary	Japan	Republic of Korea	New Zealand	Netherlands	Russian Federation	Spain	Sweden	USA
Holder of a government-issued licence/certification in a relevant category		x	x	x		x		x				x		x
Holder of a certification in a relevant category issued by a body designated by the government			x	x	x									x
Holder of a certification by a recognized professional society/nominated body		x	x											
Set of minimum educational/ professional experience acknowledged by government						x		x				x		
Qualification is not explicitly defined	x			x			x		x	x	x	x	x	x
Others		x												

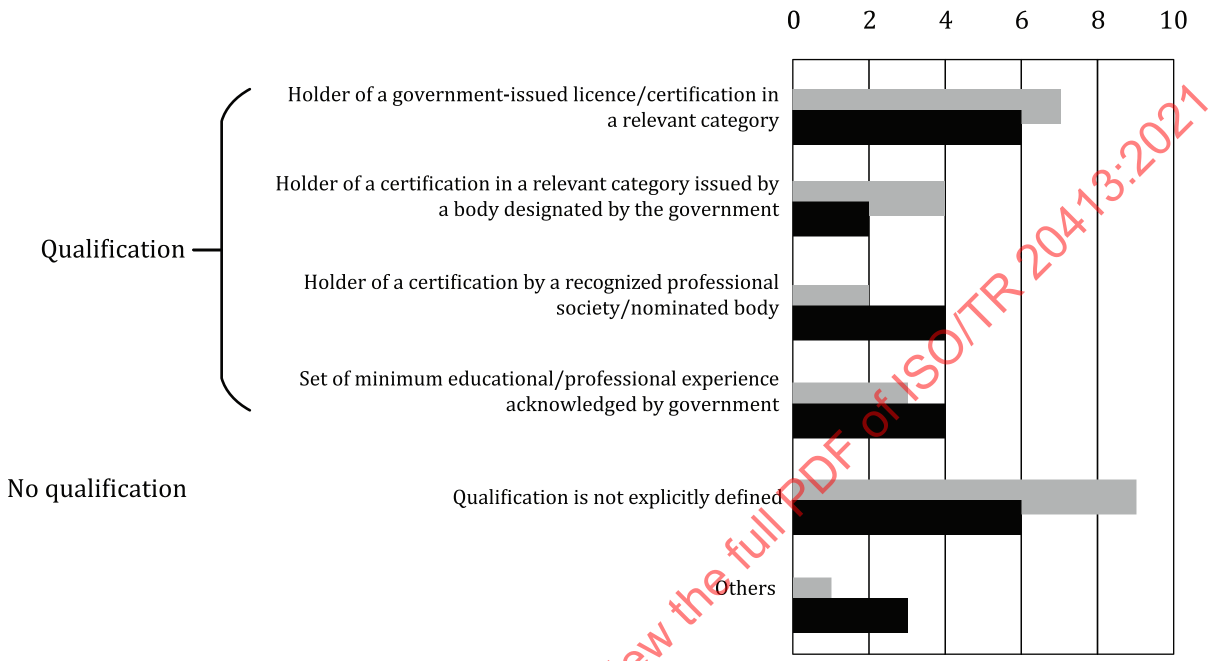
Key

required

both

not defined

The requirements of professional qualification for the regulatory reviewers and for P-B FSD practices are similar with the qualification of P-B FSD practitioners in each country (see Figure 10).



Key

for practitioners

for reviewers

Figure 10 — Comparison of Q7 and Q9

NOTE 2 According to the CEN survey[2], educational support for professionals is only 25 % of the N-MS. However, about 50 % of the 2016-MS offer educational courses for professionals.

NOTE 3 According to this (questionnaire) survey[3][4], the percentages of qualified FSE are very low, around 1/4, across all countries surveyed, yet P-B FSD at each stage (e.g. design, peer review, approval, enforcement) is being run not only by qualified FSE but largely by poorly qualified engineers.

5.5 Design fires and scenarios, criteria and calculation methods (answers to Q10 to Q15)

Q10. How are the fire scenarios identified in a P-B FSD project?

According to the answers, the fire scenarios in a P-B FSD project are prescribed in the regulations in more than a half of the countries. It is quite interesting, or rather surprising, that the fire scenario sets have been already established for P-B FSD practices in the regulations of many countries. On the other hand, the fire scenarios are decided by the discretion of building officials and approval organizations in the other countries (see Figure 11).

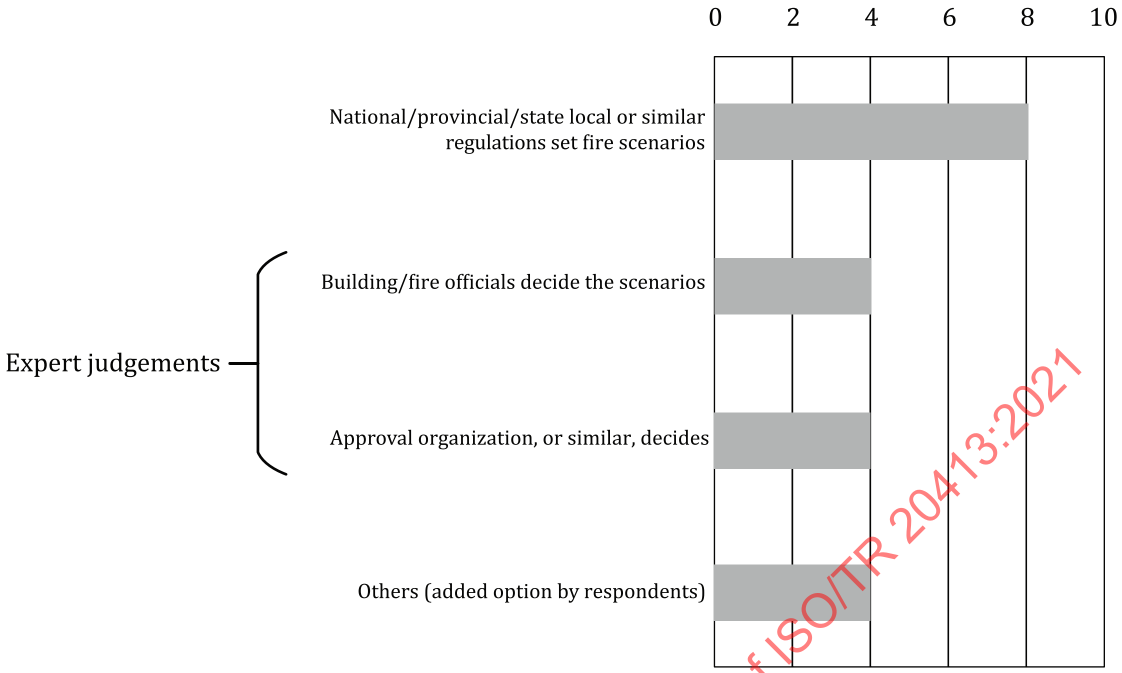


Figure 11 — Q10. How are the fire scenarios identified in a P-B FSD project?

Q11. How are the design fires determined in a P-B FSD project?

Design fires are prescribed in the regulations of only four countries. All of the others are basically determined by experts' discretion, whether the experts are a fire safety engineer, building/fire official, peer reviewer or a group of them. As expected, they use pertinent documents (e.g. pertinent domestic documents, internationally recognized documents, if any) when determining the design fires. This can imply that some guideline documents on how to rationally determine the design fires are helpful both for FSE practitioners and building/fire officials (see Figure 12).

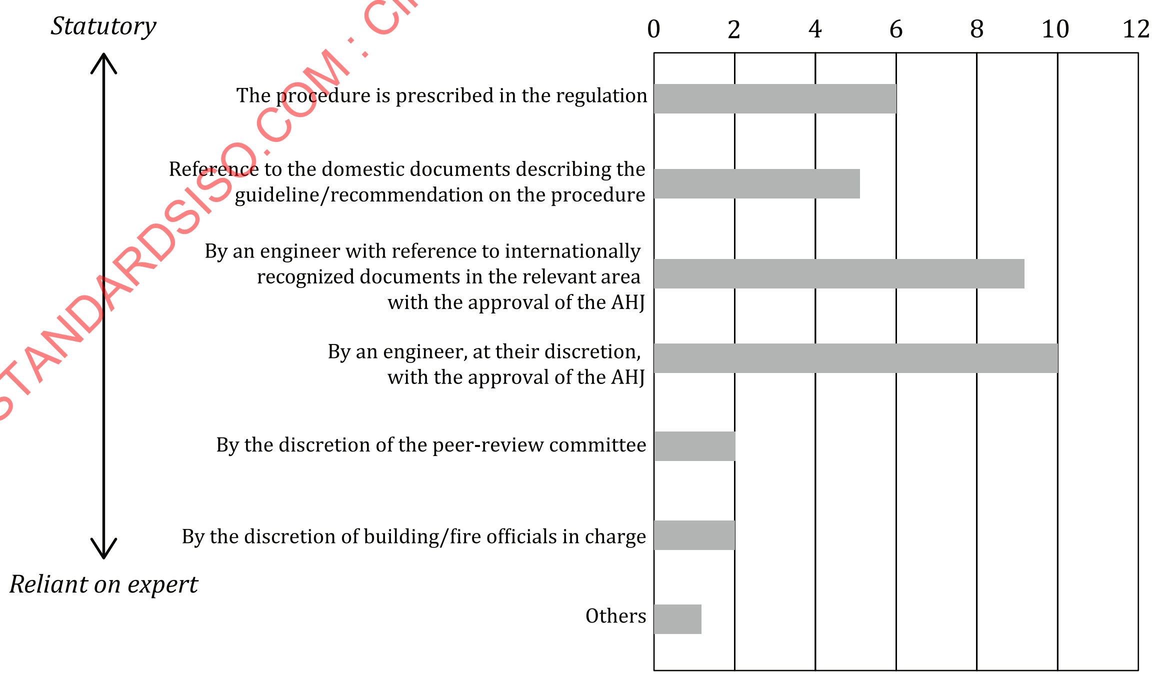


Figure 12 — Q11. How are the design fires determined in a P-B FSD project?

NOTE According to the report[3], the C/VM2 (Fire Compliance/Verification Method 2012 in New Zealand) includes 10 standard design scenarios, prescribed design fires and various movement of people parameters.

Q12. How are the safety criteria determined in a P-B FSD project?

Although the number of countries in which the procedure of determining safety criteria is prescribed in the regulations is slightly larger than in the case of design fire, the safety criteria in a P-B FSD project are determined in basically the same way as for the design fire, i.e. at the experts' discretion. Pertinent documents, whether domestic or international, are thought to be useful in this process as well (see Figure 13).

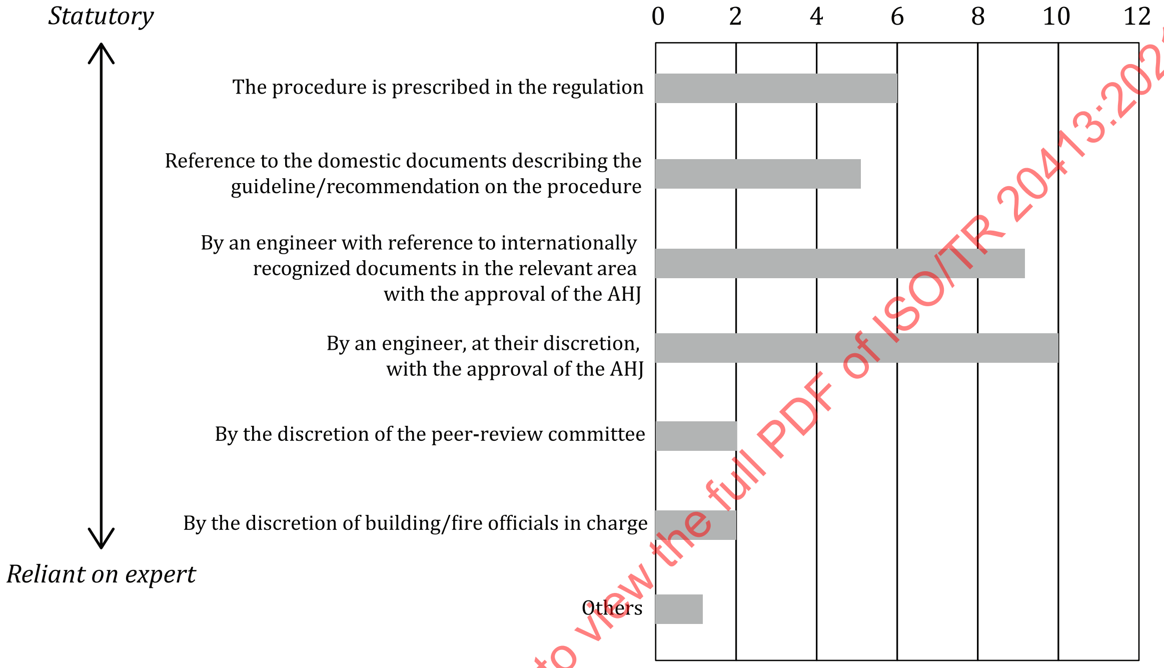


Figure 13 — Q12. How are the safety criteria determined in a P-B FSD project?

Q13. What calculation methods are used for the predictions of fire, smoke, structural response, evacuation, etc.?

Although the calculation methods to be used in P-B FSD are designated or described in the standards of the building/fire regulations in some countries, various types of documents (e.g. relevant documents issued by academic/professional society and peer-reviewed papers in journals/conference proceedings) are also widely used. However, the proportion of the documents provided by regulation or academic/professional societies is larger than that of peer-reviewed papers in journals, etc., probably because the former types of document are easier to access to share knowledge both for practitioners and building control officials than the latter peer-review type papers (see Figure 14).

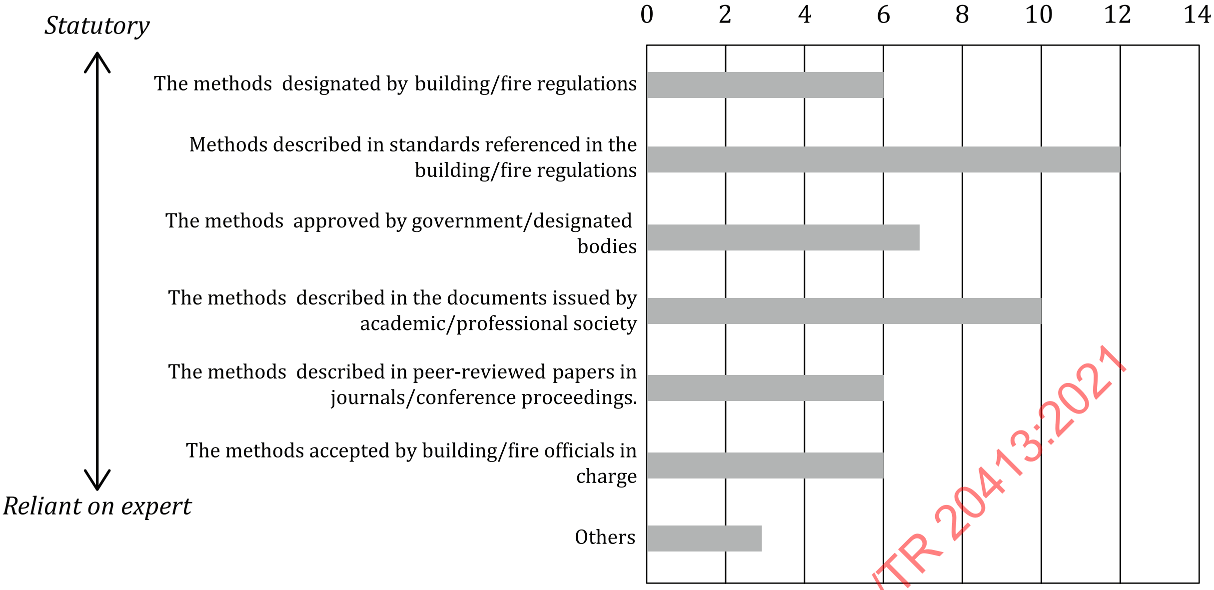


Figure 14 — Q13. What calculation methods are used for the predictions of fire, smoke, structural response, evacuation, etc.?

Q14. In your point of view, on <u>what topics should ISO/TC 92/SC 4 develop documents</u> to benefit the P-B FSD practices in your country/region?

The items of this question are basically the same as the working items on which SC 4 has been engaged for years. As shown in Figure 15, the needs are generally high for every topic. This is considered to imply that SC 4 is addressing the right goals: those which meet the needs of the practitioners who are involved in P-B FSD. The fact that the scores on “selection of design fire and design fire scenarios” and “determination of fire safety criteria” are particularly high can imply that these are the issues that people often encounter in P-B FSD practices.

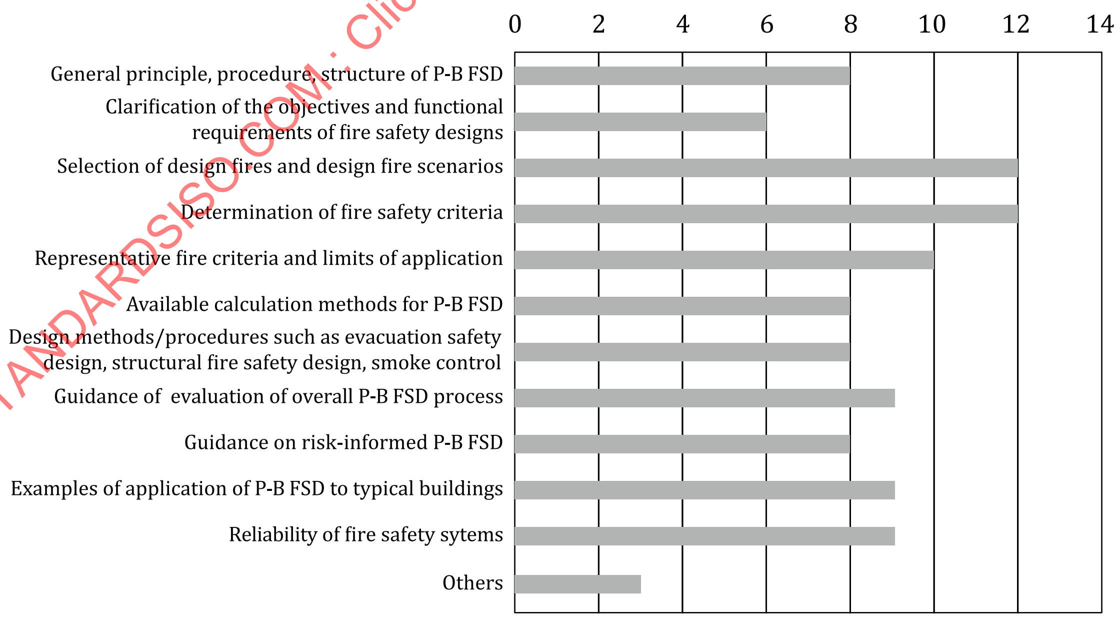


Figure 15 — Q14. In your point of view, on what topics should ISO/TC 92/SC 4 develop documents to benefit the P-B FSD practices in your country/region?

NOTE According to the CEN survey[2], while the main regulatory goals (safety of occupants, fire fighters and neighbours) are unchanged (i.e. covered in regulations from 2001), Denmark excluded property and structure protection as a regulatory goal, and Finland included protection of business, heritage and social activity.

Q15. If you chose only “Air crafts”, “Ships” or “Train, car, vehicle, etc.” in Q4, please let us know the abstract.

There are no valid answers.

5.6 Why P-B FSD is not being adopted (answers to Q16 to Q17)

Q16. What are the main reasons that P-B FSD is not being adopted in your country/region?

Four countries (the Russian Federation, Slovakia, Spain and Turkey) answered that P-B FSD is not used for actual buildings. Each country has multiple reasons. The major obstacles to the introduction of P-B FSD include the authority’s reluctance to introduce a system to allow P-B FSD, lack of human resources and lack of technically competent engineers for P-B FSD. The scarcity of positive AHJ staff members for P-B FSD and the lack of infrastructure components are common in these countries (see Figure 16).

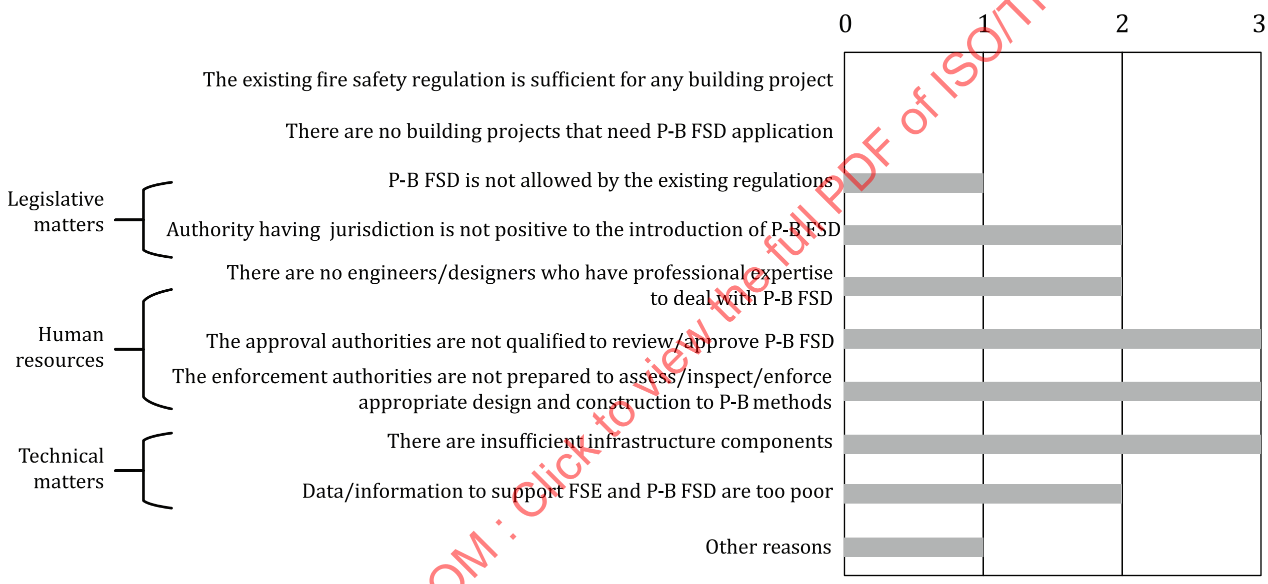
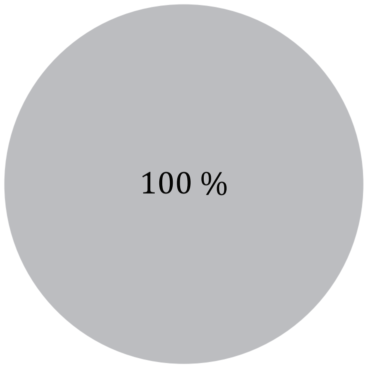


Figure 16 — Q16. What are the main reasons that P-B FSD is not being adopted in your country/region?

Q17. Is the information on P-B FSD from ISO/TC 92/SC 4 necessary for your country/region?

As a final result, all the countries that responded to the questionnaire unanimously agreed the necessity of the information on P-B FSD produced from the activities of ISO/TC 92/SC 4 (see Figure 17).



Key

- very necessary
- currently not necessary but may become important in near future
- not necessary for the time being

Figure 17 — Q17. Is the information on P-B FSD from ISO/TC 92/SC 4 necessary for your country/region?

6 Conclusion

The results of this survey on P-B FSD show the global trend from prescriptive regulations to P-B FSD. It is considered that the trend is driven by the emergence of various non-traditional buildings (e.g. super high-rise buildings, multi-purpose large-scale facilities, designers' wish to realize innovative spaces) and by fact that many of such buildings do not comply with the prescriptive provisions of existing building/fire regulations.

Some countries have already changed the regulations or introduced new systems in the regulations to accept P-B FSD for such buildings.

For the smooth operation of the systems of P-B FSD, professional knowledge and understanding on FSE are required on both sides for practitioners and regulators. At present, it seems that the P-B FSD practices are hindered by the scarcity of sufficient information and useful documents on various aspects of P-B FSD.

The design fires and design fire scenarios, which are core factors of P-B FSD, are being determined mostly by experts' empirical judgement. It seems to be rather rare that they are determined through a clear and logical procedure. The reasonable procedure should be developed as early as possible.

As regulators usually do not have a desired level of understanding on fire safety engineering, professional FSEs tend to regard prescriptive provisions as unreasonable. However, it should be born in mind that the prescriptive provisions have been developed by learning the weak points of buildings against fire from numerous fires in the past, even if it is true that the provisions can lack solid scientific bases. It is possible that regulators' negative attitude towards P-B FSD is due to doubts as to whether P-B FSD can truly meet the current level of fire safety requirements. Since both P-B FSD and the existing fire regulations address the same goal, some framework that bridges the two should be developed.

Annex A
(informative)

Questionnaire survey for performance-based fire safety design practices in different countries/regions

The International Organization for Standardization (ISO), through Technical Committee (TC) 92, Sub-Committee (SC) 4, *Fire safety engineering*, is developing various documents. The work done by ISO TC 92/SC 4 is in response to the widely recognized trend that performance-based fire safety design (P-B FSD) approach is increasingly applied to fire safety design of actual buildings over the world.

However, it is not sufficiently clear how widely, in what practical situations, and using what FSE tools, P-B FSD is being conducted in different countries. Since ISO/TC 92/SC 4 intends on developing additional documents on P-B FSD, it is very important that we obtain a more complete understanding of the application of P-B FSD practices around the world.

Therefore, ISO/TC 92/SC 4 has prepared a questionnaire to gather input on the current practice in countries in which P-B FSD is being used, including the types of building where P-B FSD is applied, the breadth of fire safety systems which are included in P-B FSD, and the legislative environment which allows P-B FSD, as well as to gather input on needs/desires for P-B FSD guidance in countries/regions where P-B FSD is not currently used or permitted. ISO/TC 92/SC 4 would like to ask your kind cooperation in completing this questionnaire to help them in understanding needs and developing useful documents.

Target audience for this questionnaire:

— Architect, fire safety engineer, building official, etc.

NOTE We hope to have many answers from various types of responders in each country or region.

Abbreviations:

— P-B FSD: performance-based fire safety design

— FSE: fire safety engineering

— CFD model: computational fluid dynamics model

Responder information (mandatory):

Name:	(......................................)
Affiliation:	(......................................)
Occupation:	(......................................)
Country/region:	(......................................)
Contact address:	(......................................)

Q1. Is P-B FSD already being used for actual buildings in your country/region?

☐ YES → Please go to **Part 1** and answer questions 2 to 15

☐ NO → Please go to **Part 2** and answer questions 16 and 17.

