

Formalization of regulatory information (using the example of SR 30.13330.2020 Internal water supply and sewerage of building)

Elena Kitaytseva^{1,*}

¹Moscow State University Of Civil Engineering, Yaroslavskoe shosse, 26, Moscow, 129337, Russia

Abstract. The article is devoted to the development of databases of the factographic reference system. The method of formalization of normative information is proposed. The classification of tables into “descriptive” and “prescriptive” has been introduced. The article describes an approach to the formalization of “prescriptive” tables, all the parameters of which are divided into two groups – quantitative and qualitative. SR 30.13330.2020 Internal water supply and sewerage of buildings Chapter 7 “Fire-fighting water supply” and Appendix J “Water consumption for firefighting” were chosen as the object of formalization. The data structure required to determine the internal fire extinguishing device, the number of fire cranes and water consumption is presented. A fragment of the database “Water consumption” and screen forms of the developed application “Water consumption for firefighting” are presented. The input data for the application is the type of building and the parameters depending on the type of building, the result is information about the need for fire-fighting plumbing and a link to the document. The presented example of expanding the database with information from SR 486.1311500.2020 indicates the flexibility of the proposed approach. Keywords: internal fire-fighting water supply, formalization, factual reference systems, databases

Introduction

It is difficult to imagine that the designer will look for the answer to the question he needs in the paper version of the normative or reference literature. Everyone has switched to electronic texts a long time ago. The current regulations have been digitized, and the relevance of the information is checked regularly. Only now the designer is flipping through the electronic version in search of the necessary information. Even if there is a full-fledged version of the search system, it remains necessary to conduct an independent manual search for information in those documents that the search engine offers. Instead of the expected short answer, the system outputs a list of documents that contain a word or words from the question asked. The number of documents to be reviewed will strongly depend on the wording of the question – the closer the wording of the question is to the wording of the

*Corresponding author: KitaytsevaEH@mgsu.ru

document text, the better. This is how all information reference systems work, the storage unit of which is a document. In contrast, fact-based reference systems store facts.

The article considers an example of creating a factographic reference system based on SR 30.13330.2020 Internal water supply and sewerage of building [1].

The information presented in the normative and reference literature most often has 4 forms of representation – text, formulas, tables and images. In the code of rules under consideration, there is 1 figure and 41 formulas for 96 total pages. The appendix to the main text contains 22 pages, the entire volume of the appendix is occupied by tables and small comments on them. In the main part of the text there are 6 small tables that take up no more than two pages. Thus, the tables occupy about a quarter of the total document volume. The information presented in the tables is the most formalized.

Conventionally, all tables can be divided into two groups. The tables of the first group contain the results of calculations or experiments describing a physical process. Examples of such tables are Tables 5.1, 12.2, B.1, B.2, J.3 and others [1]. Unfortunately, neither the functional dependencies themselves, according to which the values in the tables were obtained, nor references to them, are presented. This state of affairs is a common practice. Tables often contain a comment that suggests getting intermediate values using interpolation. Usually, all the parameters of the tables are quantitative. In the future, such tables are called “descriptive”.

For example, Table J.3 relates the height of the compact part of the jet and the pressure at the dictating fire crane to the flow rate of the fire barrel. The results are presented for fire hoses of different lengths and diameters. Another parameter is the diameter of the outlet opening of the fire hose. The volume of the article does not allow us to describe approaches to the formalization of “descriptive” tables.

The tables of the second group are designed to get a specific answer with the appropriate set of parameters. In the future, they are called “prescriptive”. Examples of such tables are tables 15.1, 18.1, 18.2, 21.1, A.1, A.2, J.1, J.2, etc. [1]. The tables contain quantitative and qualitative parameters. For example, Table J.2 [1] contains qualitative parameters – the degree of fire resistance of the building, the category of the building according to fire danger, the class of constructive fire danger, and quantitative parameters – the height and volume of the building, the number of fire cranes, the minimum consumption for a dictating fire crane. Table J.1 contains the parameter – the type of building, and Table J.2 is entirely devoted to 2 types of buildings – production and warehouse, and these types are indicated in the name of the table.

Methods

When formalizing tabular data, it is proposed to use the following sequence of actions.

1. Define all the parameters mentioned in the table.
2. Assign a name to each parameter, specify the dimension (if any).
3. Divide all parameters into 2 groups – input and output.
4. For input parameters:
5. To identify the essence, i.e. the most “main” independent parameter.
6. Define all secondary input parameters.
7. Set the equivalence or hierarchy of parameters (if necessary).
8. Divide the input parameters into 2 subgroups: quantitative and qualitative.

For each quantitative parameter, determine:

- independence from other parameters;
- acceptable range of variation;
- cumulative checks (if necessary);
- boundaries of decision-making areas.

For each qualitative parameter, determine:

- independence from other parameters;
- a list of acceptable values.

It should be borne in mind that some of the information related to the table is presented in the form of notes at the bottom of the table or in the form of the main text of chapters. For example, paragraph 7.7 [1] clarifies the information in Table J.1, introducing a new parameter “Availability of combustible finishes” for halls with a mass stay of people, paragraph 7.8 clarifies the boundaries of the ranges of parameters “Height” and “Volume” for industrial and warehouse buildings.

The top positions in the hierarchy should be occupied by independent parameters.

Results

The proposed method was tested in the formalization of information of Chapter 7 “Fire-fighting water supply” and Appendix J “Water consumption for fire fighting”.

The text of the chapter 7 under consideration contains 20 points. The first eight points are related to the determination of water consumption for firefighting. They contain links to 3 tables in Appendix J.

Tables J.1 and J.2 of Appendix J. are used to solve one problem – determining the number of fire cranes (number of jets) and the minimum water consumption of the dictating fire crane. The number of parameters and their heterogeneity were probably an obstacle to presenting information in a single table. It should be noted that the form of the table is determined by the convenience and compactness of placing information on a paper page. This is probably why the parameters in Table J.2 are placed in separate columns, and in Table J.1 – as a comment on the types of buildings.

The purpose of the work is to develop an application layout for determining water consumption for firefighting.

It follows from the analysis of the information that the “main” parameter is the type of building/structure. In Table J.1, the type is contained in a separate column, in Table J.2 it is included in the table header. In addition, section 7.2 lists the types of buildings for which an internal fire water supply (IFWS) device is not required.

Let's introduce the concept of an object type, which includes a set of parameters and rules that determine the cost of firefighting. For example, for polyclinics (Table J.1, point 2) and for hospitals (Table J.1, point 3), the parameters are the number of floors and the height of the building. But the height values that form the flow rate rule are different, so these buildings have different types.

9 types of objects have been identified, information about which is presented in Table 1 – quantitative parameters and in Table 2 - qualitative parameters. The first 7 types are combined with the selected groups in Table J.1 [1]. Type 8 corresponds to industrial and agricultural buildings (Table J.2), type 9 – objects for which an IFWS device is not required (point 7.2 [1]).

Table 3 contains the names of the rules and the boundaries of the ranges of quantitative parameters. For example, the attributes of the “h_1” rule are applied to the “Height” parameter for objects of type 1 (Table 1, first row). Columns 2 and 3 of Table 3 define the general range of parameter variation (from 3 to 75 m), the remaining columns set the height gradation – 30 m, 50 m and 75 m (see Table J. 1, point 1). Another example, the rule “l_1” (row 8 of Table 3) is used for the type of objects 1 for the “Corridor length” parameter (see Table 1, line 1). The permissible range of variation is from 1 to 20 m. If the parameter value is less than or equal to 10, the water flow rate will differ from the flow rate if the parameter value is greater than 10.

All quantitative parameters are independent of each other.

Table 1. Types of objects, quantitative parameters.

Type	Number of parameters		Name of the parameter			Name of the rule		
	total	quant.						
1	3	3	Height, m	Number of floors	Corridor length, m	h_1	f_1	l_1
2	2	2	Height, m	Number of floors	-	h_7	f_4	-
3	2	2	Height, m	Number of floors	-	h_2	f_2	-
4	2	2	Height, m	Number of floors	-	h_3	f_3	-
5	2	1	The capacity of the hall, people.	-	-	c_1	-	-
6	2	2	Height, m	Total area, thousand m ²	-	h_4	s_1	-
7	2	2	Height, m	Number of floors	-	h_5	f_3	-
8	5	2	Height, m	Volume, thousand m ³	-	h_6	v_1	-
9	0	0	-	-	-	-	-	-

Table 2. Types of objects, qualitative parameters.

Type	Name of the parameter			Name of the list		
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	Combustible finish	-	-	Finishing	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	Degree of fire resistance	Fire hazard category	Constructive fire hazard class	Fire_resistance	Fire_hazard_3_A	Constructive_fire_hazard_classes_20
9	-	-	-	-	-	-

Table 3. Rule attributes for quantitative variables.

Name of the rule	Range		Boundary			Name of the rule	Range		Boundary		
	min	max					min	max			
h_1	3	75	30	50	75	f_1	1	25	12	16	25
h_2	3	50	18	30	50	f_2	1	16	6	10	16
h_3	3	50	8			f_3	1	10	3		
h_4	3	50	50			f_4	1	16	10	16	
h_5	3	28	8	28		c_1	10	700	30		
h_6	3	100	50			s_1	0,1	100	2,5		
h_7	3	50	28			v_1	0,1	150	0,5	15	150
l_1	1	20	10								

The qualitative parameter (table 2, line 5) “Combustible finish” independent, it can take one of two values - "Yes"/"No".

The qualitative parameters of the object 8 are dependent. At the top of the hierarchy is the parameter “Degree of fire resistance”. The lists of possible values of the parameter “Fire hazard category” (Table 2, line 8) depend on the value of parameter “Degree of fire resistance”. Its are present in Table 4. The list of values of the parameter “Constructive fire

hazard class” depends on the combination of values of the parameters “Degree of fire resistance” and “Fire hazard category” (Table 5).

Table 4. Lists of possible values of fire hazard categories.

Degree of fire resistance	Name of the list	Possible values of categories
I	Fire hazard 3 A	A, Б, В
II	Fire hazard 3 A	A, Б, В
III	Fire hazard 5	A, Б, В, Г, Д
IV	Fire hazard 5	A, Б, В, Г, Д
V	Fire hazard 3 B	Б, Г, Д

Table 5. Lists of possible values of constructive fire hazard classes.

Degree of fire resistance - Fire hazard category	Name of the list	Possible class values	Degree of fire resistance - Fire hazard category	Name of the list	Possible class values
I-A	C F C 20	C0, C1	III-B	C F C 1	C0
I-Б	C F C 20	C0, C1	III-Г	C F C 20	C0, C1
I-В	C F C 20	C0, C1	III-Д	C F C 20	C0, C1
II-A	C F C 20	C0, C1	IV-A	C F C 1	C0
II-Б	C F C 20	C0, C1	IV-Б	C F C 1	C0
II-В	C F C 20	C0, C1	IV-В	C F C 4	C0, C1, C2, C3
III-A	C F C 1	C0	IV-Г	C F C 4	C0, C1, C2, C3
III-Б	C F C 1	C0	IV-Д	C F C 4	C0, C1, C2, C3

The fragment of the database “Water consumption” is presented in Table 6. The database has 11 fields. The fields corresponding to the quantitative parameters contain the number of the range in which the current parameter value falls. The fields corresponding to the qualitative parameters contain the selected value. The key is a bunch of values from the first 7 fields. The “-” character is used as a separator. The key is generated automatically.

Table 6. Database fragment.

Type	Parameters						Key	Number of fire cranes	Min. consumption of dictating fire crane l/s	Rationale
	quant.			qual.						
	1	2	3	1	2	3				
8	1	2		1	A	C0	8-1-2--1-A-C0	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2
8	1	2		1	A	C1	8-1-2--1-A-C1	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2
8	1	2		1	Б	C0	8-1-2--1-Б-C0	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2
8	1	2		1	Б	C1	8-1-2--1-Б-C1	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2
8	1	2		1	В	C0	8-1-2--1-В-C0	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2
8	1	2		1	В	C1	8-1-2--1-В-C1	2	2,5	SR 30.13330.2020 Chap.7, p.7.8, ap. J.2

The layout of the application “Water consumption for firefighting” is implemented in the Excel environment. The application allows you to get information about the need for an internal fire water supply system, the number of fire cranes and the minimum consumption

of a dictating fire crane. The user selects the type of building (Fig.1.a). The type of the building is automatically determined by the type of the object (Table 1).

Depending on the type of object, the names of the parameters that the user needs to enter appear (compare Figures 1.b, 1.c and 1.e).

In Figure 1.b, an object is selected (Tables 1 and 2 - type 9), for which no additional parameters are required. Figures 1.c and 1.d show the selection of an object having type 1 and requiring the input of quantitative parameters. All values of quantitative parameters are checked for falling within the acceptable range in accordance with Table 3. Figures 1.e and 1.f show the selection of an object having type 8 and requiring input of both quantitative and qualitative parameters. The plug-in lists of possible parameter values change dynamically depending on the previously entered values in accordance with Tables 4 and 5.

Depending on the entered values, the need for an internal fire water supply system, the number of fire taps and water consumption are determined. The name of the set of rules and the point of the chapter on the basis of which the result was obtained are highlighted in red font.

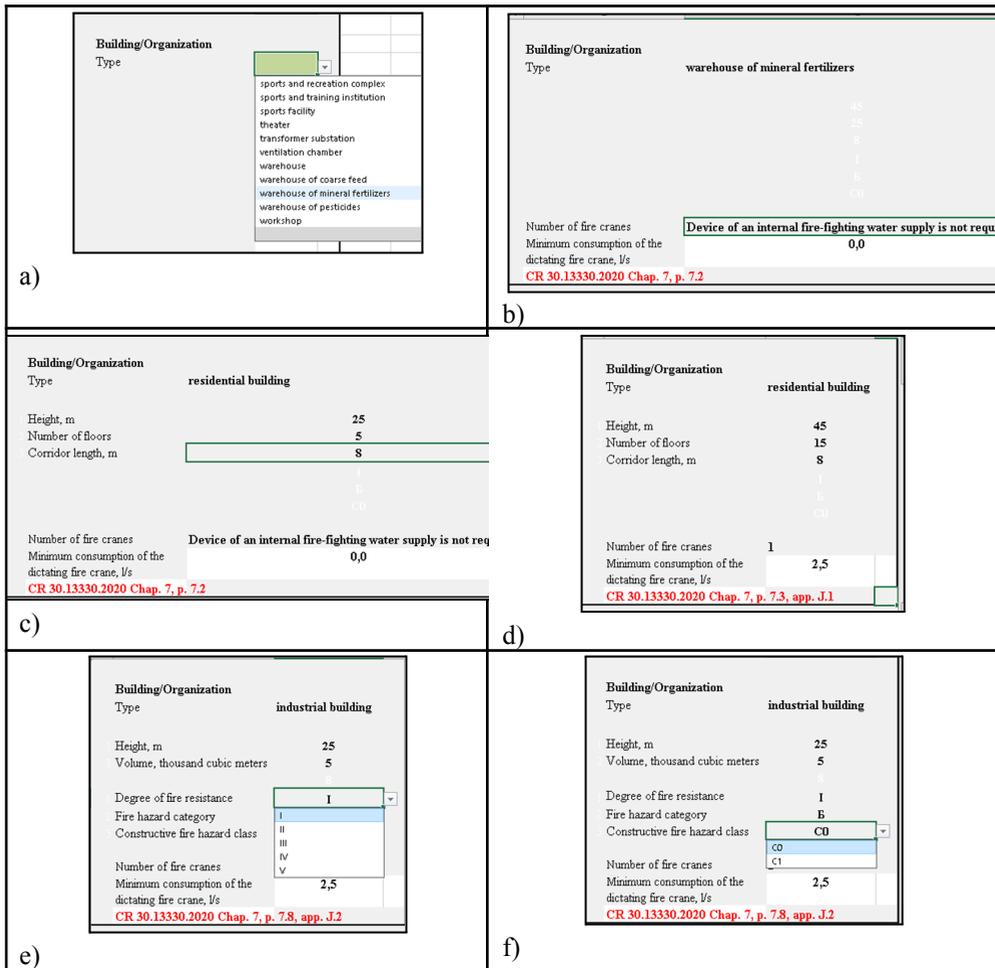


Figure 1. On-screen forms of the application “Water consumption for firefighting”.

Discussion

The parameters, ranges of acceptable values and boundaries of decision-making areas presented in Tables 1-6 are based on the information in Chapter 7 and Appendices J.1 and J.2 [1].

Information from Appendix J.1, for example, for residential buildings (see paragraph J.1.1), limits the decision-making area to a building height in the range from 30 to 75 m. Point 7.2 expands the decision-making area for buildings up to and including 30 m high -“7.2 The device of an internal fire water supply is not required: - in buildings and premises with a volume or height less than those specified in Tables J.1 and J.2;.....” [1].

The solution for buildings with a height exceeding 75 m is defined in a Set of Rules 486.1311500.2020, point 4.8 and Table 1 [2]. According to this document, an automatic fire extinguishing system (AFES) should be used for buildings with a height of more than 75 m. In order to take this information in the application, it is necessary to change the maximum value of the “Height” parameter for a building of type 1, which includes residential buildings (Table 3, row 1, column 3) from 75 m to 400 m.

The second step is to expand the database (Table 6) by 8 rows (Table 7). The values of the “Object type” field (1 column) contain 1, “AFES” is entered in the “Number of fire cranes” field. The indices of quantitative parameters correspond to the added conditions - a height of more than 75 m and all combinations of the number of floors and the length of the corridor.

Table 7. A fragment of the database that takes into account the automatic installation of fire extinguishing for buildings with a height of more than 75 m.

Type of building	Parameters						Key	Number of fire cranes	Min.consumption of a dictating fire crane l/s	Rationale
	quant.			qual.						
	1	2	3	1	2	3				
1	4	1	1				1-4-1-1---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	1	2				1-4-1-2---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	2	1				1-4-2-1---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	2	2				1-4-2-2---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	3	1				1-4-3-1---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	3	2				1-4-3-2---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	4	1				1-4-4-1---	AFES		SR 486.1311500.2020 t.1,p.6.3
1	4	4	2				1-4-4-1---	AFES		SR 486.1311500.2020 t.1,p.6.3

Conclusions

The method of formalization of normative literature is proposed. The technique was tested on the material of Chapter 7 “Fire-fighting water supply” SR 30.13330.2020 Internal water supply and sewerage of building.

The parameters determining the need for an internal fire water supply system in buildings of various types have been identified. The number of fire cranes and water consumption are determined by the type of building and its parameters. The parameters differ from each other not only in their essence - for example, height and capacity, but also in the quantitative values of the boundaries, on which the number of fire cranes and water consumption.

The developed database includes not only formalized information Table J.1 and J.2 of Appendix J., but also points of Chapter 7.

An example of updating the database with information from SR 486.1311500.2020 is given.

Fact-based reference systems can be used both to obtain information and to automatically verify decisions made.

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