NEW APPROACH TO CONTROL OF SYSTEM OF FIRE SAFETY OF MUSEUMS

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At the present time in Russia proper programs of increasing museums fire safety are taking into account their specific character and means are not developed. But the problem of control for fire safety of museums should be solved. In connection with it approximate models for estimation of Level of Fire Safety are developed on the basis of expert's assessment. Proposed approach permits to choose rational variants of fire safety system for specific museum.

Fires in Russian museums and abroad for the last time always reminds of probability of great human losses. At the present time in Russia proper programs of increasing museums fire safety taking into account their specific character and means are not developed. On the basis of physical conceptions it is difficult to determine simultaneous effect of some tens of input factors having influence upon the Level of Fire Safety of museums. But the problem of control for fire safety of museums should be solved. In connection with it approximate models for estimation of Level of Fire Safety are developed on the basis of expert's assessment.

The list of input factors that was models taken into account for estimation of Level of Fire Safety was collected according to the results of processing of Fire Codes, literature data [1], [2] and experts assessments. The list of input factors b_k, where k = 1-74, for estimation of Level of Fire Safety of museums is given in Table1. This list includes factors characterising volumetric-planning and constructive decisions of museum buildings, actual status and codes for system of fire codes for system of fire safety of museums.

Table 1

Input factors for estimation of Level of Fire Safety of museums

Input factors	b_k
1. Aria of building,m^2	b_1
2. Real degree of fire-resistance	b_2
3. Required degree of fire-resistance	b_3
4. Factual number of building storeys	b_4
5. Required number of building storeys	b_5
6. Fire-prevention walls by fact	b_6
7. Fire-prevention walls according to fire codes	b_7
8. The presence of fire doors	b_8
9. The compliece of fire doors with requirements of fire codes	b_9

continuation table 1

Input factors	b_k
10. Fire-prevention barriers	b_{10}
11. Voids in building construction	b_{11}
12. The presence of basements	b_{12}
13. The compliance of basements with fire safety requlations	b_{13}
14. Flame retardance of building constructions	b_{14}
15. Exibits treatment with fire retardant agent	b_{15}
16. The compliance of evacuation routes with standards	b_{16}
17. The presence of smoke control system in a building	b_{17}
18. Fire codes requirements for smoke control system in a building	b_{18}
19. Serviceability of smoke control system	b_{19}
20. The presence of fire alarm system	b_{20}
21. Serviceability of fire alarm system	b_{21}
22. The presence indicating lamps at exits	b_{22}
23. Serviceability of indicating lamps	b_{23}
24. The presence and studying of evacuation plans	b_{24}
25. The presence and studying instructions	b_{25}
26. The presence of fire alarm system	b_{26}
27. New technologies of fire safety control	b_{27}
28. The presence and type of automatic fire-extinguishing system	b_{28}
29. Fire codes requirements for installation of fire-extinguishing system	b_{29}
30. Area of operation of fire alarm system, m^2	b_{30}
31. Area of operation of fire-extinguishing system, m^2	b_{31}
32. Area protected by fire-extinquishing system according to fire codes, m^2	b_{32}
33. Serviceability of fire alarm system	b_{33}
34. Serviceability of fire-extinquishing system	b_{34}
35. Personnel training to operate with fire-extinguishing system	b_{35}
36. Availability of lightning protector	b_{36}
37. Fire codes for lightning protector	b_{37}
38. Serviceability of lightning protector	b_{38}
39. The presence of telephone service with fire brigade	b_{39}
40. Serviceability of telephone service with fire brigade	b_{40}
41. Building heating	b_{41}
42. Wiring in sulation resistance	b_{42}
43. Electro-protection of wiring	b_{43}
44. The presence of emergency lighting	b_{44}
45. Fire codes requirements for emergency lighting	b_{45}
46. Serviceability of emergency lighting	b_{46}
47. The presence of interior fire line	b_{47}
48. Fire codes requirements for interior fire line	b_{48}
49. Pumps of interior fire line	b_{49}
50. Water loss and consumption of interior fire line	b_{50}
51. The presence of external fire line	b_{51}
52. Norms for external fire line	b_{52}
53. Pumps of external fire line	b_{53}
54. Water consumption for external fire line	b_{54}
55. Keeping regulations of fire safety during fire-hazadours works	b_{55}

continuation table 1

Input factors	b_k
56. Control of situation at building closing	b_{56}
57. Active access to keys in case of fire	b_{57}
58. Keeping regulations of fire in case of smoking	b_{58}
59. Provision of initial fire fighting means	b_{59}
60. Sings of fire safety	b_{60}
61. The presence of other renting the area organisations in a building	b_{61}
62. The presence of documention concerning renting organisations	b_{62}
63. Approval of rent contracts by Fire Service	b_{63}
64. The usage of flammable and combustible liquids	b_{64}
65. Keeping fire regulations in case of works with flammable and combustible liquids	b_{65}
66. The number of fires for 20 years	b_{66}
67. The presence of technical fire control post in premise	b_{67}
68. Work efficiency of technical fire control post	b_{68}
69. The presence of voluntary fire brigade in the area of building constructions	b_{69}
70. Work efficiency of voluntary fire brigade	b_{70}
71. Implementation of prescripts Fire Service (in percent)	b_{71}
72. The presence of premise fire brigade	b_{72}
73. The distance to fire brigade, Km	b_{73}
74. The time of arriving of fire brigade, min	b_{74}

Initial data concerning museums are gathered in form of questionnairy. It is filled in the process of investigation of museum according to developed instruction. Collected information is entered into computer data bank.

Input factors b_k are transformed by program of data processing into values of generalized parameters φ_j (j=1-39).

Models of estimation are created for each of generalized parameter and are described in the Report All-Russian Research Institute for Fire Protection [4]. This paper should be limited, therefore possibility is absent to give description of models for 39 parameters here. The example of estimation is given for parameter number 10 "Smoke removal in routes of evacuation", which be transformed from input factors:

17. The presence of smoke control system in a building («Yes» - b_{17}=1, or «No» - b_{17}=0)
18. Fire codes requirements for smoke control system in a building («Yes» - b_{18}=1, or «No» - b_{18}=0)
19. Serviceability of smoke control system («Yes» - b_{19}=1, or «No» - b_{19}=0)

For b_{19}=0

φ_{10}= b_{19}- b_{18},

else φ_{10}= b_{17}* b_{18}* b_{19}.

Dependence of values of generalized parameters φ_{10} from values of input factors b_{17}, b_{18}, b_{19} are given in Table 2.

Table 2

Dependence of values of generalized parameters from values of input factors

b_{17}	b_{18}	b_{19}	φ_{10}
0	1	0	-1
1	0	0	0
0	0	0	0
1	1	1	1
0	1	1	0
1	0	1	0

Weight coefficients a_j (j=1-39) of generalized parameters φ_j were determined on the basis of experts assessment. Their mean values are given in Table 3.

Table 3

Values of weight coefficients for generalized parameters

Weight coefficients	a_j	Weight coefficients	a_j
1 Degree of fire-resistance	0.050	21.Museum heating	0.022
2. The number of building storeys	0.010	22.The state of wiring	0.040
3. Fire-prevention walls	0.024	23.Emergency lighting	0.021
4. Fire doors	0.017	24.Interior fire line	0.037
5. Fire-prevention barriers	0.019	25.External fire line	0.037
6. Ways of concealed fire development	0.018	26.Keeping regulations of fire safety during fire-hazadours works	0.028
7. The presence of basement	0.018	27.Control of situation at building closing	0.023
8. Flame retardance of structure buildings and treatment of exubits	0.016	28.Access to keys	0.015
9. Routes of evacuation	0.035	29.Keeping regulations of fire in case of smoking	0.016
10.Smoke removal in routes of evacuation	0.015	30.Initial fire fighting means	0.020
11.Means of warning	0.023	31.Sings of fire safety	0.013
12.Indicating lamps at exits	0.015	32.Renting organisations	0.011
13.Studying of evacuation plans	0.024	33.The usage of flammable and combustible liquids	0.024
14.Fire alarm system	0.060	34.Fires for last yeares	0.016
15.New technologies of control of fire safety	0.021	35.The activity of technical fire control post and voluntary fire brigade	0.014
16.Stationary automatic fire--extingishing system	0.050	36.Implementation of prescripts of Fire Service	0.018
17.Area protected of operation of fire alarm system	0.025	37.The presence of premise fire brigade	0.078
18.Personnel training to operate with fire-extinguishing system	0.044	38.The distance to fire brigade	0.030
19.Lightning protector	0.020	39.The time of arriving of fire brigade	0.036
20.Telephone service with fire brigade	0.018		

The Level of Fire Safety of museum premises (Y) is expressed through the Levels of Fire Safety of separate museum buildings (Y_i).

$$Y = \sum_{i=1}^{N} Y_i / S \qquad (1)$$

where, S - total area of museum buildings; N - number of taken into account museum buildings having an influence on museum fire safety,

$$Y_i = \sum_{j=1}^{39} a_j * \varphi_{ji} \qquad (2)$$

where, φ_{ji} - generalized parameters for each museum building.
Value of Level of Fire Safety of museum have tendency to 1 ($Y \Rightarrow 1$). Some estimates of Level of Fire Safety of some museums are given in Table 4.

Table 4

Evaluation of Level of Fire Safety (LFS) of some museums in Russia

Name of museum	Values LFS
1. State Museum of Fine Art named after A.Pushkin	0.700
2. Russian Museum	0.688
3. State Hermitage	0.684
4. Museum of Anthropology and ethnography	0.516
5. Tretjakovskaja Gallery	0.907
6. State Museum of History	0.545
7. Polytechnical Museum	0.732

Having available these estimates it is possible to determine museums where there is the most fire hazard. Computer program gives posibility to identify contribution of generalized parameters φ_{ji} to Level of Fire Safety of museum. As an example the values φ_{ji} for Russian Museum are given in Table 5.
On the basis of data analogy of data from table 5 it is possible to determine parameters for which $\varphi_{ji} \leq 0$. Thus for increasing of museum fire safety it is advisable to analyse specific buildings and fire-prevention measures. Computer program allows user to estimate efficiency of supplementary fire-prevention measures. In the program it is realized by changing input data with address < i,j >.

Table 5.

Values of generalized parameters and of Level of Fire Safety for Russian Museum

Generalized parameters	φ_{ji}	Generalized parameters	φ_{ji}
1 Degree of fire-resistance	1.00	21.Museum heating	1.00
2. The number of building storeys	1.67	22.The state of wiring	1.00
3. Fire-prevention walls	0.00	23.Emergency lighting	1.00
4. Fire doors	0.00	24.Interior fire line	1.00
5. Fire-prevention barriers	1.00	25.External fire line	1.00
6. Ways of concealed fire development	0.00	26.Keeping regulations of fire safety during fire-hazadours works	1.00
7. The presence of basement	-1.00	27.Control of situation at building closing	1.00
8. Flame retardance of structure buildings and treatment of exubits	1.00	28.Access to keys	1.00
9. Routes of evacuation	1.00	29.Keeping regulations of fire in case of smoking	1.00
10.Smoke removal in routes of evacuation	0.00	30.Initial fire fighting means	1.00
11.Means of warning	1.00	31.Sings of fire safety	1.00
12.Indicating lamps at exits	1.00	32.Renting organisations	-1.00
13.Studying of evacuation plans	1.00	33.The usage of flammable and combustible liquids	1.00
14.Fire alarm system	1.00	34.Fires for last yeares	0.00
15.New technologies of control of fire safety	0.00	35.The activity of technical fire control post and voluntary fire brigade	0.00
16.Stationary automatic fire--extingishing system	-1.00	36.Implementation of prescripts of Fire Service	0.70
17.Area protected of operation of fire alarm system	0.21	37.The presence of premise fire brigade	1.00
18.Personnel training to operate with fire-extinguishing system	1.00	38.The distance to fire brigade	1.00
19.Lightning protector	0.00	39.The time of arriving of fire brigade	1.25
20.Telephone service with fire brigade	1.00		
The Level of Fire Safety of Russian Museum			0,688

Proposed approach permits to choose rational variants of fire safety system for specific museum on the basis models for estimation of Level of Fire Safety of museums.

List of literature

1. E.Hunter, Vulnerability Assessment and Hazard Analysis, National Park Service, US, September, 1978.
2. Museum Security by the International Committee on Museum Security International council of museums. Paris, 1981.
3. V. Prisadkov, A. Jirjakov, Capital reconstruction of fire alarm and security system and provision State museum-national park "Kolomenskoe" with modern and technical alarm equipment and means of fire extinguishing. Report All-Russian Research Institute for Fire Protection. Moscow, 1993
4. V. Prisadkov, S. Muslakova, The method of estimate of Level of Fire Safety for museums. Report All-Russian Research Institute for Fire Protection. Moscow, 1996