Fire Protection and Fire Risk Assessment in Historic Buildings

T I K H O N O V A  N A T A L I A

INTERNATIONAL SCIENTIFIC
INNOVATIVE CENTER OF
CONSTRUCTION AND FIRE SAFETY

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HISTORICAL AND CULTURAL HERITAGE PRESERVATION

«Everybody should take care of historical and cultural heritage preservation, save monuments of history and culture.»
Constitution of the Russian Federation, art. 44.3

«Streets, squares, canals, houses, parks remind, remind... Remembrances unassumingly enter the inner world, and the person enters the past with open heart; learns to respect parents and to understand what is necessary for children. He learns responsibility – moral responsibility to people from past and at the same time – to people from future.»
Academician Likhachev D.
CULTURAL HERITAGE OBJECTS

Federal Law of 25.06.2002 № 73-FL
«On cultural heritage objects (historical and cultural monuments) of people in Russian Federation»

Cultural heritage objects (historical and cultural monuments) of people in Russian Federation - reality (including archeologic heritage objects) and other objects with associated historical territories, paintings, sculpture, decorative and applied arts, science and technique objects, and other objects of material culture, created within historic events, which are valuable from the point of view of history, archeology, architecture, city development, art, science and technique, esthetics, ethnology or anthropology, social culture and are witnesses of epochs and civilizations, real sources of information on culture origin.

ADAPTATION OF CULTURAL HERITAGE OBJECTS

Federal Law of 25.06.2002 № 73-FL
«On cultural heritage objects (historical and cultural monuments) of people in Russian Federation»

Adaption – science and research, designing and production works aimed at providing conditions for modern use of cultural heritage object without change of its specialties, which are protected, including also restauration of the object and its elements.

Main trends:

• Multifunctional complexes, business-centers, hotels, educational institutions;
• Adaptation of industrial architecture for exhibitions, concert venues, art-venues;
• Regeneration of historic building complexes.
FIRE SAFETY REQUIREMENTS IN NORMATIVE DOCUMENTS

**Federal Law of 22.07.2008 № 123-FL**
«Technical Regulation on Fire Safety Requirements»

**RF Government regulation of 25.04.2012 № 390**
“Fire Safety Arrangements”

**13-01-94 «Fire Safety Rules for Cultural Establishments in Russian Federation»**

Building regulations
**21-01-97 “Fire Safety of Buildings and Structures”**

Territorial building regulations
**21-305-2003 St.Petersburg**
«Reconstruction of buildings and premises of different fire danger classes in historically formed districts of St.Petersburg. Fire safety requirements»

Territorial building regulations
**30-306-2002 St.Petersburg**
«Reconstruction and redevelopment in historically formed districts of St.Petersburg»

NORMATIVE REQUIREMENTS CONTRADICTIONS

Fire safety normative documents rather often come into conflict with the requirements of protection documents for cultural heritage objects, in particular:

- Egress paths in the building, access roads for fire brigades;
- Location and application of automatic fire suppression systems;
- Necessary correction of design documentation for historical and cultural heritage objects;
- Quantity of people at the object (due to change of fire danger class);
- New buildings in historically formed complex;
- Fire compartmentation;
- Building constructions;
- Inspection protocol;
- Instructions for personnel.

It's necessary to develop Russian normative document with fire safety requirements for historical and cultural heritage objects.
INTERNATIONAL NORMATIVE DOCUMENTS

2015 NFPA 914 Code for Fire Protection of Historic Structures


CFPA-E-30-2013 Managing Fire Protection in Historic Buildings
INTERNATIONAL NORMATIVE DOCUMENTS

CFPA-EUROPE®

CFPA-E-30-2013 Managing Fire Protection in Historic Buildings

Check-list for fire protection actions in historic buildings

- Safe evacuation
- Fire compartmentation (preventing fire spread)
- Engineering systems of the building
- Fire suppression equipment
- Assess for fire brigades
- Water supply for fire suppression
- Instruction on technical control and maintenance
- Evacuation plans

Sprinkler at column capitel

Sprinklers at dome of Congressional Library, USA
INTERNATIONAL NORMATIVE DOCUMENTS

National Fire Protection Association
The authority on fire, electrical, and building safety

2015 NFPA 914 Code for Fire Protection of Historic Structures

Fire safety check-list:
• Life safety
• Fire safe equipment
• Maintenance, storage
• Dangerous liquids
• Exhibitions / Collections / Book stack
• Auditorium, classes
• Restaurants and food zones
• Shops / Laboratories / Storage
• Exterior and adjacent areas
• Personnel / Training
• Changes in the building after the previous inspection

INTERNATIONAL NORMATIVE DOCUMENTS

National Fire Protection Association
The authority on fire, electrical, and building safety


Check-list for cultural heritage objects inspection:
• All building floors (from the top floor to basement)
• Working premises and storage zones
• Public zones, auditorium, food zones
• Kitchens
• Exterior inspection
HARMONIZATION CONCEPTION

Harmonization of Russian and international normative documents in the area of fire safety

The development of the conception was suggested by Government

**Main goals:**

Fire safety refinement in Russian Federation
Production development in accordance with international fire safety requirements
Russian Federation Integration into world economics

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INNOVATIVE FIRE SAFETY SOLUTIONS FOR HISTORICAL AND CULTURAL HERITAGE OBJECTS

- Fire-protective curtain wallings, glassed constructions
- Individual protective devices (self-rescue)
- Rise of fire-resistance limit for building constructions
CURTAIN WALLINGS

Apollo Gallery in Louvre Museum (curtain walling for disable people to assess lifts/platforms)

PROTECTIVE GLASSED CONSTRUCTIONS

Museum constructions preventing fire spread
SELF-RESCUE

REFINEMENT OF NORMATIVE AND LEGAL BASE IN THE AREA OF FIRE RESISTANCE OF BUILDING CONSTRUCTIONS
HISTORIC BUILDING RECONSTRUCTION: MALLS

Central Universal Shop (Moscow) – Former mall «Muhr and Merilize»

DLT (St.Petersburg) – former Leningrad Trade House

HISTORIC BUILDING RECONSTRUCTION: HOTELS

Hotel at Mars Field (St.Petersburg) – Former quarters of Paul regiment

Hotel in Pavlovsk (St.Petersburg) – Former park fortress BIP (Bibs)
COMPLEX OF BUILDINGS

State Academic Capella (St.Petersburg)

EDUCATIONAL INSTITUTIONS

Math and Physics liceum № 30 (St.Petersburg) – the first building in Russia for city basic colleges

Management high school in SPb State University – palace and park complex “Mikhail summer residence”
EDUCATIONAL INSTITUTIONS

St. Petersburg State Technical University
(complex of buildings)

BUSINESS CENTERS, OFFICE BUILDINGS

Business center in Moscow at Myasnitskaya street
CULTURE CENTER

Beloselsky-Belozersky Palace (St.Petersburg)

EXHIBITION CENTER

Bobrinsky town mansion (Moscow)
DETERMINISTIC APPROACH TO FIRE RISK ASSESSMENT

Fire risk calculation

\[ Q = Q_n \cdot (1 - R_{AVITT}) \cdot P_{np} \cdot (1 - P_\text{эв}) \cdot (1 - P_{II3}) \]

Probability of effective work of fire safety systems

\[ P_{II3} = 1 - (1 - R_{обн} \cdot R_{COUЭ}) \cdot (1 - R_{обн} \cdot R_{II3}) \]

ISO 16733 “FIRE SAFETY ENGINEERING — SELECTION OF DESIGN FIRE SCENARIOS AND DESIGN FIRES”

10-step procedure for fire scenario design:

1. Fire location
2. Fire type
3. Potential fire hazards
4. Systems and features impacting on fire
5. Occupant response
   Scenario selection:
6. Event tree
7. Consideration of probability
8. Consideration of consequences (life loss/injury or the expected fire cost)
9. Risk ranking
10. Final selection and documentation
FIRE RISK VALUE

Fire risk is acceptable: $Q < 10^{-6}$ per year

Fire Safety Supplement if $Q > 10^{-6}$:

Changes in space and layout design
Added escape routes
Warning system improvement
Smoke control system
Number of people limitation

COMPARISON OF THE APPROACHES

Deterministic approach (Design-basis fire)

- RELIABILITY MARGIN
- UNREASONABLE EXPENSES

Probabilistic approach

- FLEXIBILITY
- PROBABILITIES AND CONSEQUENCES EVALUATION
PROPOSALS ON NORMATIVE BASE REFINEMENTS

Improvement of normative documentation in the area of fire safety for historical and cultural heritage objects:

- Fire compartmentation, taking into account fire-protective constructions (curtain wallings);
- Individual protection devices (self-rescue) for visiting children groups;
- Fire resistance evaluation for fasades of constructions and buildings in accordance with harmonized standards;
- Changes in methods of fire risk assessment in order to use check-lists and probabilistic approach for historical and cultural heritage objects.

THANK YOU FOR YOUR ATTENTION!