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Technical Guide on the Grading Control of Quality Risks of Housing Construction and Municipal Infrastructure Engineering in Beijing

(Trial)

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# 1. General Provisions

**1.0.1** To standardize the quality risk control of construction projects in Beijing, improve the risk prevention and control system as well as the pre-control ability and level of the quality of construction projects, clarify the quality responsibility of construction projects, strengthen the quality management of construction projects, ensure the quality of construction projects, and protect people’s life and property, this Guide is hereby formulated.

**1.0.2** This Guide applies to the grading control of quality risks of housing construction and municipal infrastructure engineering that are newly constructed, expanded or remodeled within the administrative area of Beijing. The rail transit construction projects can refer to this Guide for implementation. Insurance companies can refer to this Guide for quality risk control.

**1.0.3** The quality risk control of construction projects is carried out in accordance with the principles of being comprehensive, systematic, scientific, professional, economical, dynamic and effective.

**1.0.4** In addition to this Guide, the quality risk control of construction projects shall also comply with the provisions of relevant national standards currently in force.

# 2. Basis for Preparation

Classification and code of the hazardous and harmful factors in production process (GB/T 13861)

Risk management - Vocabulary (GB/T 23694)

Risk management - Risk assessment techniques (GB/T 27921)

Risk management - Principles and guidelines on implementation (GB/T 24353)

Unified standard for constructional quality acceptance of building engineering (GB 50300)

Standard for acceptance of construction quality of building foundation (GB 50202)

Code for acceptance of construction quality of masonry engineering (GB50203)

Code for acceptance of constructional quality of concrete structures (GB 50204)

Code for acceptance of construction quality of steel structures (GB50205)

Code for acceptance of construction quality of timber structures (GB50206)

Code for acceptance of construction quality of roofs (GB 50207)

Code for acceptance of construction quality of underground waterproof engineering (GB50208)

Code for acceptance of construction quality of building ground (GB50209)

Standard for construction quality acceptance of building decoration (GB50210)

Code for acceptance of construction quality of water supply and drainage and heating works (GB50242)

Code of acceptance for construction quality of ventilation and air conditioning works (GB50243)

Code for acceptance of construction quality of building electrical engineering (GB50303)

Code for acceptance of energy efficient building construction (GB50411)

Code for fire protection design of buildings (GB50016)

Circular of the Ministry of Housing and Urban-Rural Development on Issuing the Interim Engineering Quality and Safety Manual (Jian Zhi [2018] No. 95)

Circular of the Ministry of Housing and Urban-Rural Development on Issuing Key Points of Technical Risk Control for Major Works (Jian Zhi Han [2018] No. 28)

Provisions on the Fire Safety Supervision and Management of Construction Projects (Decree No. 119 of the Ministry of Public Security)

# 3. Glossary

**3.0.1 Project quality risk**

The possibility that quality defects involving structural safety, important functions and other aspects may occur during construction, and the combination of severe consequences caused thereby.

**3.0.2 Risk source**

The source or condition that may cause personnel injury, property damage, environmental damage, or a combination of these conditions, either tangible or intangible.

**3.0.3 Hazardous and harmful factors**

The cause and condition that causes or increases the probability of occurrence of quality risk accidents or enlarges the scope of losses.

**3.0.4 Risk assessment**

The whole process of risk identification, risk analysis and risk evaluation.

**3.0.5 Risk identification**

The process of identifying, confirming, and describing risks.

**3.0.6 Risk analysis**

The process of understanding the nature of risks and determining their probability of occurrence and severity of consequences.

**3.0.7 Risk assessment**

The process of determining the risk size and level.

**3.0.8 Risk criteria**

Criteria for evaluating the magnitude of quality risks of construction projects.

**3.0.9 Risk control**

The management process of developing countermeasures and taking corresponding control measures for risks at different levels.

**3.0.10 Hierarchical risk management**

Control risks by the risk size and four risk levels (major, high, general and low), and define the severity of risks with four colors of red, orange, yellow and blue.

**3.0.11 Classified risk management**

Adopt different control measures for different types of project quality risk accidents that may occur, and identify the risk control objects.

**3.0.12 Layered risk management**

The construction enterprises, engineering projects, construction teams and parties at different levels conduct layered control over risks according to the risk levels and define the risk control responsibility.

**3.0.13 Risk management by specialty**

Adopt different control measures for different construction specialties involved in project quality risks and identify the control subjects.

**3.0.14 Dynamic risk management**

Conduct risk reassessment, and adjust the risk level and control measures according to internal and external environment changes and other factors in a timely manner.

# 4. Quality Risk Control Responsibility of the Project Participants

## 4.1 General rules

**4.1.1** The project participants shall establish and improve the system and mechanism of project quality risk control, formulate the working system, define the main party responsible, take effective measures to comprehensively and systematically identify risks, and effectively control project quality risks during construction through scientific risk analysis and assessment.

**4.1.2** The project participants shall determine the leading department and leaders responsible for controlling project quality risks, and define the responsibilities, objectives and tasks of relevant functional departments of the enterprises for project quality risk control. The main person in charge of the enterprise is the first person responsible for the quality risk control from the enterprise’s side, and the project manager authorized by the enterprise’s main person in charge is the first person responsible for the quality risk control of the project.

## 4.2 Responsibility of the project owner

**4.2.1** As the primary responsible subject of project quality risk control, the project owner shall get full hold of the quality risk management of the project, and take the lead in organizing the participating entities to implement project quality risk control in accordance with relevant regulations and the contract.

**4.2.2** The project owner shall select appropriate participating entities, and reasonably determine the construction period, cost and other matters according to the actual conditions such as project scale and technical difficulty so as to ensure the project quality and safety.

**4.2.3** The project owner shall specify the standards, requirements, responsibilities and obligations of the project quality risk control for participating entities in the contract, organize relevant entities to identify and evaluate the project quality risks, and inform relevant participating entities of these results to help them conduct their project quality risks evaluation and formulate risk control measures accordingly.

**4.2.4** The project owner shall check the implementation of various project quality risk control measures by participating entities in the whole process of construction, including the accountability mechanism for project quality risk control, the risk control system, the preparation, approval and expert review of the special construction plan before commencement of works, personnel and technical disclosure, preparation of on-site materials, equipment and machines, project management, and the organization of technical personnel and workers, etc.

## 4.3 Responsibility of the construction company

**4.3.1** The construction company is the subject to implement control over project quality risks. The general contractor shall be responsible for overall management and control of the project quality risks, while the specialized contractor and subcontractor shall be responsible for the quality risk management of the project contracted.

**4.3.2** The construction company shall improve the project quality prevention and control system, establish an accountability mechanism and other management systems for project quality risks, clarify the responsibilities of each functional department in project quality risk control, including departments of quality, technology, production, material, and cost, establish a working mechanism of performance evaluation with rewards and punishment, and provide trainings for all staff.

**4.3.3** The construction company shall produce a checklist of the project quality risk sources, prepare an identification list of quality risk sources for the project, implement project quality risk control in the whole process and at every link of the project construction, and effectively control project quality risks through technical, management and emergency measures.

**4.3.4** The project department of the construction company shall implement various systems of the enterprise for managing project quality risks, make clear the job responsibilities and contents of all divisions of the project department, construction teams, management and operation personnel, carry out risk identification, analysis and evaluation, formulate control measures, prepare the project quality risk identification list, make a targeted construction organization plan (including risk pre-control measures and emergency plans), earnestly organize the technical disclosure work regarding project quality risk control, and carry out the quality risk control measures throughout the construction process.

## 4.4 Responsibility of the supervising entity

**4.4.1** As the supervision subject of project quality risk control, the supervising entity shall establish a supervision system related to project quality risk control, integrate the supervision work of project quality risk control into the supervision plan, and prepare the implementation rules for supervision.

**4.4.2** The supervising entity shall supervise the implementation of project quality risk control measures, review relevant materials of the construction company about risk identification, analysis and assessment and formulation of measures, and check the implementation of project quality risk control measures through on-site inspection, standing-aside supervision, patrol inspection and other means.

**4.4.3** If the supervising entity finds that the construction company fails to effectively identify risks, makes wrong assessment on risks, adopts inappropriate control measures or fails to implement control measures and the management system, the construction company shall be required to make rectifications in time. In case of gross violation, the supervising entity shall require the construction company to stop for rectification and report it to the project owner; if the construction company refuses to make rectifications, the supervising entity shall report to the relevant construction project quality supervision agency in a timely manner.

## 4.5 Responsibility of the survey and design entities

**4.5.1** The survey and design entities shall do a good job in related work regarding risk identification and identify quality risks of the construction project at the survey and design stages of the project, and indicate key areas and key links relating to project quality risks in survey and design documents, and propose the opinions, suggestions and specific measures to guarantee project quality, which can be used as a basis for project quality risk control during construction after being approved and signed by the project manager of the survey and design entities.

**4.5.2** The survey and design entities shall participate in the project quality risk control organized by the project owner, guide and review the project quality risk management measures formulated by the construction company, inspect the implementation of related work, and put forward targeted suggestions.

**4.5.3** The survey and design entities shall formulate the early-warning and control indicators of project quality risks, specify the requirements for monitoring and testing, and follow up the implementation of the inspection work.

# 5. Risk Identification

## 5.1 Risk identification method

The project quality risk identification can be carried out in accordance with the *Key Points of Technical Risk Control for Major Works (Jian Zhi Han [2018] No. 28)*, *Engineering Quality and Safety Manual (Jian Zhi [2018] No. 95)*, *Unified Standard for Constructional Quality Acceptance of Building Engineering (GB 50300)*, *Code for Acceptance of Constructional Quality of Concrete Structures (GB50204)*, *Standard for Acceptance of Construction Quality of Building Foundation (GB50202)* and other regulations so that the main hazardous and harmful factors during construction as well as the types of quality accident risks can be identified.

## 5.2 Risk identification scope

**5.2.1** Hazardous and harmful factors during construction

Using historical data, theoretical analysis, expert opinions, stakeholder requirements and other information to check the construction materials, components, equipment and facilities, operating activities, personnel and operating environment, covering factors of people, materials, process, environment, management, etc., and list the hazardous and harmful factors identified one by one, including but not limited to the following categories:

**Table 5.2.1 Types of hazardous and harmful factors**

|  |  |  |
| --- | --- | --- |
| **Code** | **Types of hazardous and harmful factors** | **Hazardous and harmful factors** |
| 01 | Human factors | Excess load: exceed the limit of physical load, etc. |
| Abnormal health conditions: injury, disease period, etc. |
| Occupational skill defects: being unskilled, etc. |
| Command error: command error, command against regulations, etc. |
| Operation error: misoperation, work against regulations, failure to follow drawings, plans and technical standards in construction, etc.  |
| Other human factors |
| 02 | Material factors | Raw materials of substandard quality |
| Components of substandard quality |
| Equipment of substandard quality |
| Semi-finished products of substandard quality |
| Measuring and testing instruments of substandard quality |
| Construction machines and tools of substandard quality |
| Other factors concerning materials |
| 03 | Process factors | Immature construction process and technology |
| Misapplication of construction process and technology |
| Imperfect construction organization design and special construction plan |
| Wrong quotation of construction technical standard  |
| Defects in technical disclosure |
| Other process factors |
| 04 | Environmental factors | Weather factors: harsh weather and climate (rainstorm, cold winters, hot summers, flood and rainy seasons), unsuited temperature, humidity and air pressure of the working site |
| Geological and hydrological factors: thixotropic soft soil, drift sand formation, shallow stagnant water, (micro-) confined water, underground obstacles, methane layer, faultage, crushed zone, etc. |
| Construction environment factors: urban roads, underground pipelines, rail transit, surrounding buildings (structures), surrounding rivers and flood walls, etc. |
| Other environmental factors: |
| 05 | Management factors | Unsound organization |
| Accountability mechanism not being implemented |
| Imperfect management regulations and systems: operating procedures not being standardized, imperfect training system, etc. |
| Special operation personnel take on the job without getting certified as required by regulations |
| Compressed construction period, underfunded |
| Poor management: inadequate training, technical disclosure, and subcontract management |
| Joint review of drawings not implemented |
| Inspection and test system not implemented |
| Project quality inspection and acceptance system not implemented |
| Incorrect disposition of substandard products and unqualified test reports |
| Other management factors |

These hazardous and harmful factors listed above are for the reference of enterprises when identifying the project quality risks. All enterprises can supplement, refine and adjust these factors based on actual conditions, and make updates and improvements in a continuous way.

**5.2.2** Types of accidents likely to occur

Risk identification parties shall fully consider the possible consequences and identify the types of accidents that may occur, including but not limited to:

**Table 5.2.2 Types of common quality accidents (problems) in construction**

|  |  |  |  |
| --- | --- | --- | --- |
| **Code** | **Types of accidents (problems)** | **Code** | **Types of accidents (problems)** |
| 01 | Collapse | 16 | Insulation performance fails to meet design or specification standards |
| 02 | Differential settlement | 17 | Energy-saving performance fails to meet design or specification standards |
| 03 | Insufficient bearing capacity of the pile foundation | 18 | Main use functions fail to meet design or specification standards |
| 04 | Insufficient bearing capacity of the foundation | 19 | Combustion performance fails to meet design or specification standards |
| 05 | Insufficient structural bearing capacity | 20 | Indoor environmental pollution |
| 06 | Insufficient intensity  | 21 | Flooded road |
| 07 | Prestress failure | 22 | Road collapse |
| 08 | Poor durability | 23 | Poor subgrade stability |
| 09 | Poor weather resistance | 24 | Intrusion of surface water |
| 10 | Dimensional deviation | 25 | Fire |
| 11 | Positional deviation | 26 | Thunder strike |
| 12 | Leakage | 27 | Electric shock |
| 13 | Falloff | 28 | Seriously defective appearance quality |
| 14 | Falloff of insulation panel on external wall | 29 | Other types (leakage, personal injury, deformation, etc.) |
| 15 | Insulating layer of the external wall and roof damaged |  |  |
| Note: The accident types are subject to adjustment and supplement according to actual needs |

## 5.3 Risk identification procedure

**5.3.1** Preparation before risk identification

1. Extensively collect various materials related to risk assessment, mainly including:

—National and municipal laws and regulations, standards and specifications and relevant documents;

—Organizations, positions, personnel, responsibilities, rules of the enterprise;

—Standards, operating procedures and processes of the enterprise;

—Main construction machines, equipment, facilities and materials of the enterprise;

—Project survey documents, design documents, contract documents, construction organization design (plans), and special construction plans;

—Surrounding environmental and on-site survey documents of the project;

—Statistical data, including historical accidents of the same industry, the city and the enterprise, quality complaints of the enterprise, etc.

—Other related documents.

2. Determination of risk criteria

Risk criterion is an important basis for enterprises to carry out risk assessment and risk control. Once the risk management process begins, the enterprise shall scientifically and reasonably determine its project quality risk criteria according to external and internal environmental information of its project quality management, and make examination and improvement in a continuous way. When determining the risk criteria, it’s necessary to consider the following principles:

—Requirements of relevant laws, regulations, standards and specifications;

—Requirements of contract documents;

—Specific risk control requirements of the city;

—Risk management policy, objective and development strategy of the enterprise;

—Quality risks acceptable for the enterprise.

**5.3.2** Initial determination of risk source

Sort out the hazardous and harmful factors that may exist in the construction site of the project, systematically classify the potential risk factors, and preliminarily determine the project quality risk sources according to the list of hazardous and harmful factors through qualitative methods such as field survey, onsite measurement, experience analysis and referring to historical data.

**5.3.3** Screening risk sources

Make necessary screening, exclusion and adjustment to the sources of project quality risks that have already been analyzed and identified, to form a risk source identification list for the project department and for the enterprise, by taking into account the specific purpose and scope of risk assessment and the enterprise’s project quality risk criteria.

## 5.4 Checklist of the risk sources

Enterprises can produce their own checklists of risk sources by referring to the following list and taking into full account their actual situations, and continuously make updates and improvements so that the project department can refer to these checklists when identifying project quality risk sources.

**Table 5.4.1 Risk source checklist (material factors)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Risk code | Engineering entity type | Code of risk source | Name of risk source | Types of accidents likely to incurr |
| 01000103 | **Raw materials, components, equipment (01)** | 0001 | Rebar | Insufficient bearing capacity of the pile foundation |
| 01000105 | Insufficient structural bearing capacity |
| 01000203 | 0002 | Concrete mix | Insufficient bearing capacity of the pile foundation |
| 01000206 | Insufficient intensity  |
| 01000305 | 0003 | Quality of steel, welding materials, fastening standard parts for connection, welding balls, bolt balls, metal pressure plate, etc. | Insufficient structural bearing capacity |
| 01000405 | 0004 | Prestress steel strand, anchor fixture, bellows | Insufficient structural bearing capacity |
| 01000518 | 0005 | Glass, profiles, silicone structural adhesive and other curtain materials | Main use functions fail to meet design or specification standards |
| 01000509 | Poor weather resistance |
| 01000618 | 0006 | Door, window, safety glasses | Main use functions fail to meet design or specification standards |
| 01000720 | 0007 | Aluminum-plastic composite panel, coating, putty, adhesive, wood-based panel, decorative panels, stone, porcelain tiles, etc. | Indoor environmental pollution  |
| 01000719 | Combustion performance of decorative materials | Combustion performance fails to meet design or specification standards |
| 01000725 | Fire |
| 01000812 | 0008 | Waterproof materials | Leakage |
| 01000916 | 0009 | Thermal insulation materials, heat insulating materials, anticorrosive and fireproof coating materials | Insulation performance fails to meet design or specification standards |
| 01000925 | Fire |
| 01001017 | 0010 | Electric wires and cables | Energy-saving performance fails to meet design or specification standards |
| 01001025 | Electric wires and cables | Fire |
| 01001117 | 0011 | Radiators, fan coil quality, valves, pipes | Energy-saving performance fails to meet design or specification standards |
| 01001218 | 0012 | Plastic pipe, composite pipe, copper pipe, galvanized steel pipe, air duct | Main use functions fail to meet design or specification standards |
| 01001325 | 0013 | Fire door, fire window, fire resisting shutter, fire valve, smoke exhaust fan, water pump, hydrant, fire detector, etc. used in fire protection system | Fire |
| 01XXXXXX | XXXX | Others risk sources | …… |
| 02000104 | **Ground and foundation works (02)** | 0001 | Foundation load-bearing stratum control (basement elevation, disturbance, water immersion, freeze thawing) | Insufficient bearing capacity of the foundation |
| 02000204 | 0002 | Composite foundation construction | Insufficient bearing capacity of the foundation |
| 02000303 | 0003 | Pile foundation concrete construction (pile hole-forming, pile shaft) | Insufficient bearing capacity of the pile foundation |
| 02000308 | Poor durability |
| 02000401 | 0004 | Floor reinforcement construction | Collapse |
| 02000508 | 0005 | Thickness control of bottom reinforcement protective layer | Poor durability |
| 02000602 | 0006 | Backfill construction (control of thickness, compactness and moisture content) | Differential settlement |
| 02000712 | 0007 | Underground waterproof construction (deformation joints, construction joints, post-cast belt, through-wall pipe, external wall bolts, pile head and other waterproof details) | Leakage |
| 02XXXXXX | XXXX | Others risk sources | …… |
| 03000110 | **Concrete structure works (03)** | 0001 | Formwork bracing (frame beam) | Dimensional deviation |
| 03000208 | 0002 | Form removal | Poor durability |
| 03000206 | Insufficient intensity  |
| 03000305 | 0003 | Reinforcement construction (processing, connection, installation, protective layer control) | Insufficient structural bearing capacity |
| 03000405 | 0004 | Position control of negative bending moment bars for cantilever components | Insufficient structural bearing capacity |
| 03000401 | Collapse |
| 03000505 | 0005 | Floor reinforcement position | Insufficient structural bearing capacity |
| 03000606 | 0006 | Premixed concrete production (mix design, implementation, delivery inspection) | Insufficient intensity  |
| 03000608 | Poor durability |
| 03000706 | 0007 | Premixed concrete receiving inspection | Insufficient intensity  |
| 03000708 | Poor durability |
| 03000806 | 0008 | Concrete pouring and vibrating | Insufficient intensity  |
| 03000828 | Seriously defective appearance quality |
| 03000906 | 0009 | Concrete curing | Insufficient intensity  |
| 03001006 | 0010 | Production of concrete samples | Insufficient intensity  |
| 03001106 | 0011 | Concrete construction in winter | Insufficient intensity  |
| 03001201 | 0012 | Beamless floor construction | Collapse |
| 03XXXXXX | XXXX | Others risk sources | …… |
| 04000101 | **Masonry structure (04)** | 0001 | Masonry engineering construction (mortar plumpness, steel reinforcement, joint treatment) | Collapse |
| 04000201 | 0002 | Connection of masonry structure with the main structure | Collapse |
| 04000306 | 0003 | Tie column, enclose girder construction | Insufficient intensity  |
| 04XXXXXX | XXXX | Others risk sources | …… |
| 05000107 | **Prestress works (05)** | 0001 | Installation of prestress tendons (anchors, pore passages) | Prestress failure |
| 05000105 | Insufficient structural bearing capacity |
| 05000207 | 0002 | Bellows (fracture, mortar leakage) | Prestress failure |
| 05000305 | 0003 | Beam arch camber | Insufficient structural bearing capacity |
| 05000405 | 0004 | Prestress tension (tensile stress of prestress steel strand, elongation control) | Insufficient structural bearing capacity |
| 05000505 | 0005 | Position offset of reserved pore passages | Insufficient structural bearing capacity |
| 05000605 | 0006 | Collapsing, jamming, and bending of pore passages | Insufficient structural bearing capacity |
| 05000705 | 0007 | Prestress grouting and anchor sealing | Insufficient structural bearing capacity |
| 05XXXXXX | XXXX | Others risk sources | …… |
| 06000105 | **Steel structure works (06)** | 0001 | Pedestal grouting | Insufficient structural bearing capacity |
| 06000205 | 0002 | Welding process | Insufficient structural bearing capacity |
| 06000305 | 0003 | Welding sequence | Insufficient structural bearing capacity |
| 06000405 | 0004 | Stud welding | Insufficient structural bearing capacity |
| 06000505 | 0005 | Component installation accuracy | Insufficient structural bearing capacity |
| 06000605 | 0006 | High-strength bolt torque | Insufficient structural bearing capacity |
| 06000728 | 0007 | Anti-corrosion coating, fire coating thickness control | Seriously defective appearance quality |
| 06000725 | Fire |
| 06000805 | 0008 | Cable-membrane structure (support points, installation) | Insufficient structural bearing capacity |
| 06XXXXXX | XXXX | Others risk sources | …… |
| 07000105 | **Fabricated structural works (07)** | 0001 | Quality acceptance of receiving components | Insufficient structural bearing capacity |
| 07000108 | Poor durability |
| 07000110 | Dimensional deviation |
| 07000205 | 0002 | Installation of components | Insufficient structural bearing capacity |
| 07000208 | Poor durability |
| 07000305 | 0003 | Grouting | Insufficient structural bearing capacity |
| 07000308 | Poor durability |
| 07XXXXXX | XXXX | Others risk sources | …… |
| 08000106 | **Architectural decoration works (08)** | 0001 | Glass partition, railing, poling | Insufficient intensity  |
| 08000213 | 0002 | Stone cladding | Falloff |
| 08000313 | 0003 | Rear embedded anchorage of wall ceiling | Falloff |
| 08000425 | 0004 | Structural settlement joints, expansion joints, seismic joints | Fire |
| 08000412 | Leakage |
| 08XXXXXX | XXXX | Others risk sources | …… |
| 09000112 | **Door and window works (09)** | 0001 | Fixation of external doors, windows and structures | Leakage |
| 09000213 | Falloff |
| 09000312 | 0002 | Waterproof structures of external doors and windows | Leakage |
| 09000312 | 0003 | Glue sealing of doors and windows | Leakage |
| 09XXXXXX | XXXX | Others risk sources | …… |
| 10000112 | **Toilet waterproofing works (10)** | 0001 | Waterproofer thickness control | Leakage |
| 10000212 | 0002 | Wall waterproofer height control | Leakage |
| 10000312 | 0003 | Waterproofer construction at the entrance | Leakage |
| 10000412 | 0004 | Pipe root, floor drain, sanitary ware and other details | Leakage |
| 10000512 | 0005 | Finished product protection of waterproofer | Leakage |
| 10XXXXXX | XXXX | Others risk sources | …… |
| 11000105 | **Curtain wall works (11)** | 0001 | Installation of embedded parts, pendants and connectors for curtain wall | Insufficient structural bearing capacity |
| 11000113 | Falloff |
| 11000225 | 0002 | Setting of fire barrier | Fire |
| 11000325 | 0003 | Construction of thermal insulation materials | Fire |
| 11000412 | 0004 | Structural glue, sealant application | Leakage |
| 11000409 | Poor weather resistance |
| 11XXXXXX | XXXX | Others risk sources | …… |
| 12000113 | **Roof works (12)** | 0001 | Connection and installation of metal roof (wind resistance test condition, undercut works) | Falloff |
| 12000212 | 0002 | Works of detail joints of waterproofer (parapet, gable, deformation joint, roof pipes, gutter, and eave gutter) | Leakage |
| 12000313 | 0003 | Works of sintering tiles and concrete tiles | Falloff |
| 12XXXXXX | XXXX | Others risk sources | …… |
| 13000113 | **Energy conservation** **Works of buildings (13)** | 0001 | Bonding or fixing of insulation board (bonding area, number, position and depth of anchors)  | Falloff |
| 13000116 | Insulation performance fails to meet design or specification standards |
| 13000216 | 0002 | Detail operation of energy conservation | Insulation performance fails to meet design or specification standards |
| 13XXXXXX | XXXX | Others risk sources | …… |
| 14000118 | **Water** **supply,** **drainage and heating works of buildings (14)** | 0001 | Connection of water supply inlet pipe | Main use functions fail to meet design or specification standards |
| 14000218 | 0002 | Radiant floor heating installation | Main use functions fail to meet design or specification standards |
| 14000212 | Leakage |
| 14000306 | 0003 | Pipeline installation (welding, soldering), pipeline anti-corrosion quality | Insufficient intensity  |
| 14000329 | Leakage |
| 14000405 | 0004 | Installation of pipe crossing joins including expansion joints, seismic joints and settlement joints | Insufficient structural bearing capacity |
| 14000413 | Falloff |
| 14000518 | 0005 | Installation of drinking water supply pipes, fittings, sterilizers and other equipment | Main use functions fail to meet design or specification standards |
| 14000529 | Leakage |
| 14000618 | 0006 | Strength and tightness test of water supply pipeline and ball-passing test of drainage pipeline | Main use functions fail to meet design or specification standards |
| 14000705 | 0007 | Installation of piping rack and hanger | Insufficient bearing capacity |
| 14000713 | Falloff |
| 14000829 | 0008 | PVC pipe firestop collars and expansion joints | Deformation |
| 14XXXXXX | XXXX | Others risk sources | …… |
| 15000118 | **Ventilation and air-conditioning works (15)** | 0001 | Processing and installation of air ducts | Main use functions fail to meet design or specification standards |
| 15000218 | 0002 | Installation of fan coils and equipment | Main use functions fail to meet design or specification standards |
| 15000305 | 0003 | Installation of support, hanger and seismic support | Insufficient bearing capacity |
| 15000313 | Falloff |
| 15000418 | 0004 | Strength tightness test and strength pressure test of air-conditioning water piping system | Main use functions fail to meet design or specification standards |
| 15000518 | 0005 | Commissioning of ventilation and air conditioning systems | Main use functions fail to meet design or specification standards |
| 15XXXXXX | XXXX | Others risk sources | …… |
| 16000113 | **Electrical** **works of buildings(16)**  | 0001 | Installation of large lamps and lanterns | Falloff |
| 16000226 | 0002 | Connection to ground grid and ground electrode | Thunder strike |
| 16000227 | Electric shock |
| 16000327 | 0003 | Duct interior threading | Electric shock |
| 16000425 | 0004 | Fireproof sealing | Fire |
| 16000526 | 0005 | Installation of lightning-proof downlead and lightning arrester | Thunder strike |
| 16000627 | 0006 | Installation of transformer, distribution cabinet, etc. | Electric shock |
| 16000625 | Fire |
| 16000618 | Main use functions fail to meet design or specification standards |
| 16000725 | 0007 | Separate laying of three-phase AC cable through the steel conduit | Fire |
| 16XXXXXX | XXXX | Others risk sources | …… |
| 17000104 | **Road works (17)** | 0001 | Subgrade filling | Insufficient bearing capacity of the foundation |
| 17000102 | Differential settlement |
| 17000202 | 0002 | Special subgrade construction (soft soil, loess, saline soil, expansive soil, frozen soil, etc.) | Differential settlement |
| 17000204 | Insufficient bearing capacity of the foundation |
| 17000223 | Poor subgrade stability  |
| 17000222 | Road collapse |
| 17000305 | 0003 | Base construction | Insufficient structural bearing capacity |
| 17000306 | Insufficient intensity  |
| 17000323 | Poor subgrade stability |
| 17000418 | 0004 | Pavement construction (asphalt concrete, cement concrete) | Main use functions fail to meet design or specification standards |
| 17000406 | Insufficient intensity  |
| 17000408 | Poor durability |
| 17000502 | 0005 | Trench backfill of culvert (pipe), underground structure, check well perimeters, etc. | Differential settlement |
| 17000505 | Insufficient structural bearing capacity |
| 17000522 | Road collapse |
| 17000621 | 0006 | Construction of road drainage facilities | Flooded road |
| 17XXXXXX | XXXX | Others risk sources | …… |
| 18000106 | **Bridge works (18)** | 0001 | Mass concrete construction | Insufficient intensity  |
| 18000108 | Poor durability |
| 18000110 | Dimensional deviation |
| 18000111 | Positional deviation |
| 18000206 | 0002 | Construction of bridge blocks or other seismic facilities | Insufficient intensity  |
| 18000210 | Dimensional deviation |
| 18000211 | Positional deviation |
| 18000306 | 0003 | Installation of pedestals | Insufficient intensity  |
| 18000308 | Poor durability |
| 18000311 | Positional deviation |
| 18000401 | 0004 | Installation of prefabricated beams and slabs | Collapse |
| 18000411 | Positional deviation |
| 18000501 | 0005 | Construction of cast-in-situ concrete beams and slabs | Collapse |
| 18000511 | Positional deviation |
| 18000621 | 0006 | Construction of bridge deck drainage facilities | Flooded road |
| 18000706 | 0007 | Construction of deck pavement | Insufficient intensity  |
| 18000806 | 0008 | Construction of crash barriers | Insufficient intensity  |
| 18000813 | Falloff |
| 18000918 | 0009 | Construction of bridge expansion devices | Main use functions fail to meet design or specification standards |
| 18001018 | 0010 | Bridge abutment backfill, construction of bridge end transition slab | Main use functions fail to meet design or specification standards |
| 18001002 | Differential settlement |
| 18XXXXXX | XXXX | Others risk sources | …… |
| 19000102 | **Urban comprehensive pipeline works****(19)** | 0001 | Pipeline backfill construction (two sides and the upper roof) | Differential settlement |
| 19000122 | Road collapse |
| 19000212 | 0002 | Waterproof concrete construction | Leakage |
| 19000206 | Insufficient intensity  |
| 19000208 | Poor durability |
| 19000311 | 0003 | Installation of support and crane span structure | Positional deviation |
| 19000313 | Falloff |
| 19000429 | 0004 | Professional pipeline installation | Breakage |
| 19000510 | 0005 | Maintenance access | Dimensional deviation |
| 19000624 | 0006 | Construction of hoisting opening, inlet and outlet, personnel entrance and exit and other parts | Intrusion of surface water |
| 19XXXXXX | XXXX | Others risk sources | …… |
| 20000125 | **Fire protection works (20)** | 0001 | General layout and plane layout (fire separation, fire control room, fire pump room, etc.), building type and fire rating | Fire |
| 20000225 | 0002 | Building insulation as well as decoration and fire prevention of the external wall (combustion performance of thermal insulation materials, fire barrier), interior decoration and fire prevention of the building (fire insulation measures for electrical installation, barrier facilities that affect the use of fire facilities as well as the emergency exit and staircase) | Fire |
| 20000325 | 0003 | Fire and smoke prevention separation, explosion protection (combustion performance of main components, pressure relief opening, electrical explosion protection, firewall, fire shutter, fire door, vertical pipeline well) | Fire |
| 20000429 | 0004 | Safety evacuation and fire elevator (emergency exit, evacuation staircase, front chamber, evacuation aisle, refuge floor, fire elevator, emergency lighting) | Personal injury |
| 20000525 | 0005 | Fire water supply (natural water source, municipal water supply, fire pool, fire water tank) | Fire |
| 20000625 | 0006 | Fire electrical facilities (main power supply, standby generator, electrical substation, fire distribution, electricity facilities, electrical fire monitoring system) | Fire |
| 20000725 | 0007 | Installation of water fire extinguishing system (system setting, fire pump, pipe network, outdoor hydrant, system function, indoor hydrant, water pump binder, alarm valve set of automatic sprinkler system, pipe network and spray-head of automatic sprinkler system) | Fire |
| 20000825 | 0008 | Installation of automatic fire alarm system (fire alarm, fire communication, wiring, emergency broadcast, fire alarm control unit and linkage equipment, system function) | Fire |
| 20000925 | 0009 | Installation of smoke control and exhaust system (natural smoke extraction, mechanical smoke vent, smoke control and exhaust fan, pipe, air supply outlet, smoke exhaust fire room, system function, fire valve) | Fire |
| 20001025 | 0010 |  Fire extinguisher of buildings (type, number, distance, location)  | Fire |
| 20001125 | 0011 | Foam extinguishing system (protective zone, foam storage tank, proportional foam mixing, foam generating device, system function), gas fire extinguishing system (protection zone, storage room, extinguishing agent storage device, drive device, pipe network, spray nozzle, system function) | Fire |
| 20XXXXXX | XXXX | Others risk sources | …… |
| Note: For road works, bridge works, and urban comprehensive pipelines, this table only lists their unique risk sources different from other types of engineering entities. When identifying specific project quality risks, one shall supplement and improve the risk sources by referring to other types of engineering entities. |

**Table 5.4.2 Risk source checklist (factors of human, process, environment and management)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Risk code** | **Type of hazardous and harmful factors** | **Risk source** | **Types of accidents** **likely to incur** |
| **Code of risk source** | **Name of risk source** |
| 210001XX | **Human factors (21)** | 0001 | being unskilled | All accident types |
| 210002XX | 0002 | Wrong command | All accident types |
| 210003XX | 0003 | Command error | All accident types |
| 210004XX | 0004 | Command against regulations | All accident types |
| 210005XX | 0005 | Misoperation | All accident types |
| 210006XX | 0006 | Work against regulations | All accident types |
| 210007XX | 0007 | Construction not in accordance with the drawing | All accident types |
| 210008XX | 0008 | Construction not in accordance with the plan | All accident types |
| 210009XX | 0009 | Construction not in accordance with the technical standard | All accident types |
| 21XXXXXX | XXXX | Others risk sources | …… |
| 220001XX | **Process factors (22)** | 0001 | Immature construction process | All accident types |
| 220002XX | 0002 | Immature construction technology | All accident types |
| 220003XX | 0003 | Improper application of construction process | All accident types |
| 220004XX | 0004 | Improper application of construction technology | All accident types |
| 220005XX | 0005 | Imperfect construction management plan and special construction plan | All accident types |
| 220006XX | 0006 | Wrong reference of construction technical standard  | All accident types |
| 220007XX | 0007 | Defects in technical disclosure | All accident types |
| 22XXXXXX | XXXX | Others risk sources | …… |
| 230001XX | **Environmental factors (23)** | 0001 | Extreme weather (gale, thunderstorm, storm, snow, high temperature, etc.) | All accident types |
| 230002XX | 0002 | Construction in winter | Insufficient structural bearing capacity |
| 230002XX | Seriously defective appearance quality |
| 230003XX | 0003 | Flood and rainy season | Leakage |
| 230004XX | 0004 | Poor geological and hydrological conditions | Insufficient bearing capacity of the foundation |
| 230004XX | Insufficient structural bearing capacity |
| 230005XX | 0005 | Underground pipeline, rail transit, surrounding buildings (structures), surrounding rivers and other complex surrounding environments | Insufficient bearing capacity of the foundation |
| 23XXXXXX | XXXX | Others risk sources | …… |
| 240001XX | **Management factors (24)** | 0001 | Unsound quality control agency | All accident types |
| 240002XX | 0002 | Quality management accountability not implemented | All accident types |
| 240003XX | 0003 | Imperfect quality management rules and regulations: | All accident types |
| 240004XX | 0004 | Failure of key quality management personnel in performing duties | All accident types |
| 240005XX | 0005 | Inadequate technical disclosure | All accident types |
| 240006XX | 0006 | Inadequate subcontract management | All accident types |
| 240007XX | 0007 | Operating procedures not standardized | All accident types |
| 240008XX | 0008 | Imperfect education and training system | All accident types |
| 240009XX | 0009 | Special operation personnel started work not with certificates according to the regulations | All accident types |
| 240010XX | 0010 | Compressed time limit | All accident types |
| 240011XX | 0011 | Underfunded | All accident types |
| 240012XX | 0012 | Joint review of drawings not implemented | All accident types |
| 240013XX | 0013 | Inspection and test system not implemented | All accident types |
| 240014XX | 0014 | Project quality inspection and acceptance system not implemented | All accident types |
| 240015XX | 0015 | Incorrect disposition of nonconforming products and test reports | All accident types |
| 24XXXXXX | XXXX | Others risk sources | …… |

Note: ①The risk code consists of eight digits, of which the first two digits represent the type of engineering entities or the type of hazardous and harmful factors, the middle four digits represent the risk source, and the last two digits represent the major types of accidents that are likely to occur. For example, the risk code of construction collapse of beamless floor system is 03001201, of which 03 represents that the type of engineering entities or hazardous and harmful factors is concrete structure engineering, 0012 represents that the risk source is beamless floor system construction, and 01 represents that the type of major accidents likely to occur is collapse. ②The risk source checklist lists the major types of accidents likely to occur, which can be adjusted and supplemented by the enterprise based on actual needs.

# 6. Risk analysis

Risk analysis shall be carried out from two aspects of the probability and severity of accidents (events) caused by a certain risk identified, so as to provide information support for determining the risk level and whether the risk needs to be treated and controlled. The identified risk accident (event) with potentially serious consequences can be directly determined as a major risk, for which the risk control shall be implemented immediately.

## 6.1. Probability analysis

**6.1.1 Previous probability** P1 (See Appendix A for details)

**1.** Previous probability across the industry in China P1.1, level value determined according to the number of such project quality accidents in the past N years.

**2.** Previous probability across the industry in the city P1.2, level value determined according to the number of such project quality accidents in the past N years.

**3.** Previous probability of the enterprise P1.3, level value determined according to the number of such project quality accidents in the past N years.

**4.** Previous probability of project quality complaints P1.4, level value determined according to the number of such project quality complaints in the past N years due to this risk.

**6.1.2** Management level of the construction site P2 (See Appendix A for details)

**1.** Quality management level of the enterprise P2.1, for which the level value is determined according to the enterprise’s credit rating.

**2.** Management ability and level of the project manager P2.2, for which the level value is determined according to the credit evaluation score of the project manager.

**3.** Management ability and level of the project department P2.3, for which the level value is determined according to the management staffing of the project department.

**6.1.3** Level of the project scale P3 (See Appendix A for details)

**1.** For housing construction works, the level value is determined according to the building height, single building area, group building area and other factors.

**2.** For municipal infrastructure works, the level value is determined according to the investment amount, bridge span length and other factors.

**6.1.4** Level of project quality control difficulty P4 (See Appendix A for details)

The statistics of large dangerous projects that exceed a certain size is made and the level value is determined according to Appendix 3 to the *Detailed Rules for Safety Management and Implementation of Dangerous Partitioned Projects and Sub-projects of the Housing Construction and Municipal Infrastructure Projects in Beijing*.

**6.1.5** Probability level P

$$P=\frac{\left（N\_{1}\*P1.1+N\_{2}\*P1.2+N\_{3}\*P1.3+N\_{4}\*P1.4\right）+\left（N\_{5}\*P2.1+N\_{6}\*P2.2+N\_{7}\*P2.3\right）++N\_{8}\*P3+N\_{9}\*P4}{4}$$

Note: The weighted value (N) in the calculation formula of probability level can be determined according to the risk type or the enterprise’s actual conditions, for which the recommended values are $N\_{1}=$0.1, $N\_{2}=$0.2, $N\_{3}=$0.5, $N\_{4}=$0.2 ($N\_{1}+N\_{2}+N\_{3}+N\_{4}=1$); $N\_{5}$=0.3, $N\_{6}$=0.4$, N\_{7}$=0.3 ($N\_{5}+N\_{6}+N\_{7}=1$); $N\_{8}=1; N\_{9}=1$

**6.1.6** Direct determination circumstances

When one of the following circumstances occurs, the probability of risk occurrence can be directly determined as level 5:

**1.** The enterprise has one quality accident at the general level or above within one year, receives group complaint or causes bad social influence due to quality problems within one year;

**2.** The project or construction company has been included into the negative list of comprehensive quality and safety management;

**3.** Adopt new technology, process, equipment and materials for which there are no current national, industrial and local technical standards and that may bring great risks to the construction quality;

**4.** Fail to take specific technical measures to ensure the project quality and safety during the compressed time limit;

**5.** Residential projects are not insured against potential defects of residential project quality as required.

## 6.2 Severity analysis of consequences

**6.2.1** Quality influence degree level of engineering entity R1 (See Appendix B for details)

Make judgment according to the severity of affecting the structural safety or usage features, and determine the level value.

**6.2.2** Severity level of economic loss R2

Determine the level value according to the severity of casualties and direct economic loss Direct economic loss refers to the cost of compensation and treatment for casualties and the loss incurred to engineering entities caused by the failure of quality risk control measures during construction.

**6.2.3** Severity level of the influence of peripheral sensitive targets R3 (See Appendix B for details)

Determine the level value according to the geographical location of the project, as well as the distance, type and other factors of peripheral sensitive targets.

**6.2.4** Level of social attention R4 (See Appendix B for details)

Determine the level value according to the importance of the project’s social function.

**6.2.5** Level of the engineering function R5 (See Appendix B (continued) for details)

Make comprehensive judgment and determine the level value according to the scale, specific use, function and other aspects of the project

**6.2.6** Influence scope level of the quality of engineering entities R6 (See Appendix B (continued) for details)

Determine the level value according to the influence scope of the quality of engineering entities.

**6.2.7** Influence degree level of fire danger R7 (See Appendix B (continued) for details)

The influence degree of fire danger is determined according to the combustion performance and fire resistance limit of corresponding components of the building.

**6.2.8** Severity level of consequences

R=N1R1+N2R2+N3R3+N4R4+N5R5+N6R6+N7R7…+NnRn

Where:

R——severity level of consequences;

N——weight coefficient, which can be adjusted based on actual engineering conditions, N1+N2+N3+N4+N5+N6+N7...+Nn=1

R**1**——Influence degree level of the entity quality, for which the recommended weight coefficient is 0.2

R**2**—— Severity level of economic loss, for which the recommended weight coefficient is 0.2

R**3**——Severity level of the influence of peripheral sensitive targets, for which the recommended weight coefficient is 0.1

R**4**——Level of social attention, for which the recommended value is 0.1

R**5**——Level of the engineering function, for which the recommended value is 0.1

R**6**——Influence scope level of the quality of engineering entities, for which the recommended value is 0.2

R**7**——Influence degree level of fire danger, for which the recommended value is 0.1

...

Rn——Other relevant factors that may influence the severity of consequences

**6.2.9** Circumstances where the severity of consequences can be directly determined

When one of the following circumstances occurs, the severity of consequences can be directly determined as level 5:

1. Either indicator of R**1**, R**2** and R**5** is level 5.

**6.3 Remarks**

**6.3.1** When decimals emerge, use 0.5 as the indicator to separate the integers above or below (e.g. determine level between 3.5-4.4 as level 4).

**6.3.2** In case R3, R4 and R5 are not involved or the influence degree of other indicators is too large, the weights can be adjusted based on actual engineering conditions.

**6.3.3** The terms ‘above’ indicated in each table contain this number ,and the terms ‘below’ don’t contain (in case of more than 1 person and less than 3 persons, it’s defined as 1 person and 2 persons).

# 7. Risk assessment level

## 7.1 Risk assessment method

The enterprise can conduct risk assessment through the risk level matrix method, or choose other appropriate risk assessment methods according to the enterprise’s own situation and construction situation of the project. Several risk assessment methods can also be adopted to verify each other at the same time to ensure the accuracy of risk assessment.

## 7.2 Risk level

**7.2.1** Major risks expressed with Ⅰ indicate risk at the highest level, great difficulty in risk control of onsite project quality, and very serious risk consequence. Such risks are quite likely to cause large-scale or above quality accidents, incur large economic loss or generate bad social influence;

**7.2.2** High risks expressed with Ⅱ indicate risk at a high level, big difficulty in risk control of onsite project quality, and serious risk consequence. Such risks are quite likely to cause general quality accidents, or incur general economic loss;

**7.2.3** General risks expressed with Ⅲ indicate risk at a general level , general difficulty in risk control of onsite project quality, and general risk consequence. Such risks are likely to cause a large number of people to get seriously injured, or incur certain economic loss;

**7.2.4** Low risks expressed with Ⅳ indicate risk at a low level, small difficulty in risk control of onsite project quality, and minor risk consequence. Such risks are likely to cause a small number of people to get seriously injured, or incur less economic loss.

## 7.3 Evaluation and rating of project quality risk level

The quality risk evaluation level is mainly determined by the probability level and severity level of consequences according to the table below.

**Table 7.3 Matrix technique of the risk level of risk sources**

|  |  |
| --- | --- |
| Risk level | Severity level of consequences (R) |
| 1 | 2 | 3 | 4 | 5 |
| Probability level (P) | 1 | Low (Ⅳ) | Low (Ⅳ) | Low (Ⅳ) | General (Ⅲ) | General (Ⅲ) |
| 2 | Low (Ⅳ) | Low (Ⅳ) | General (Ⅲ) | General (Ⅲ) | High (Ⅱ) |
| 3 | Low (Ⅳ) | General (Ⅲ) | General (Ⅲ) | High (Ⅱ) | Large (Ⅱ) |
| 4 | General (Ⅲ) | General (Ⅲ) | Large (Ⅱ) | High (Ⅱ) | Major (Ⅰ) |
| 5 | General (Ⅲ) | High (Ⅱ) | Large (Ⅱ) | Major (Ⅰ) | Major (Ⅰ) |
| Note: Ⅳ represents low risk, Ⅲ represents general risk, Ⅱ represents high risk, and Ⅰ represents major risk |

**7.4 Evaluation and rating of project quality risk level**

**7.4.1** Project quality risk coefficient M, calculated according to the following formula:

M=$K\_{1}\*N\_{1}+K\_{2}\*N\_{2}+K\_{3}\*N\_{3}+K\_{4}\*N\_{4}$

N**1**——Number of project risks at level Ⅰ;

N**2**——Number of project risks at level Ⅱ;

N**3**——Number of project risks at level Ⅲ;

N**4**——Number of project risks at level Ⅳ;

K**1**——Weight coefficient of project risks at level Ⅰ, valued at 1;

K**2**——Weight coefficient of project risks at level Ⅱ, valued at 0.7;

K**3**——Weight coefficient of project risks at level Ⅲ, valued at 0.4;

K**4**——Weight coefficient of project risks at level Ⅳ, valued at 0.1;

**7.4.2** The quantity of project quality risks Fz is determined in line with the ranking value A of the city’s project quality risk coefficient M that ranks from large to small and according to Table 7.4.

**Table 7.4 Classification of project quality risk levels**

|  |  |
| --- | --- |
| Project quality risk level (Fz) | Ranking of project quality risk coefficient M |
| Major (level Ⅰ) | 1≤A＜0.1X |
| Large (level Ⅱ) | 0.1X≤A＜0.25X |
| General (level Ⅲ) | 0.25X≤A＜0.65X |
| Low (level Ⅳ) | 0.65X≤A＜X |
| Note: The total number of projects in the city is X, and the ranking ordinal value of M value is A (A=1, 2, 3……X) |

**7.4.3** For projects that are included into the negative list of comprehensive management of quality and safety pursuant to the *Regulation of Beijing Municipal Commission of Housing and Urban-Rural Development on Establishing and Improving the System of Law Enforcement Inspection for Engineering Quality and Safety based on Risk Management* (Jing Jian Fa [2019] No. 165), the project quality risk level can be lifted during management.

# 8. Control of project quality risks

## 8.1 Control principle of project quality risks by level

**8.1.1** The project quality risks shall be controlled by level, category, layer and specialty, and the severity, objects, responsibilities and entities shall be clarified.

**8.1.2** Project quality risk control shall comply with the principle that the higher level of risks is, the higher control level will be, as well as the following requirements:

**1.** Focus on controlling major and high risks.

**2.** For project quality risks controlled by the superior level, the relevant department at a lower level shall be responsible for specific control matters, and the concrete measures shall be implemented level by level.

**3.** The control level can be increased or lifted.

**8.1.3** The construction entity shall reasonably determine the control level of risks at all levels (generally divided into the enterprise level and project level) according to the risk control principle and the setting of organizational structure. It can also increase the level of risk control based on its actual conditions.

**1.** The major risks (level Ⅰ) and high risks (level Ⅱ) shall be controlled by the enterprise.

**2.** The general risks (level Ⅲ) and low risks (level Ⅳ) shall be controlled by the project department.

**3.** For major risks (level Ⅰ) and high risks (level Ⅱ), the enterprise shall implement key control over the project.

## 8.2 Preparation and announcement of the identification list of project quality risk sources

**8.2.1** The construction company shall prepare and regularly update the *Enterprise’s Checklist of Project Quality Risk Sources* (Appendix C), which will be announced after being approved by the technical director of the construction company.

**8.2.2** Before construction, the project department of the construction company shall identify and analyze the existing risk sources of the project, determine the level of project quality risks upon evaluation, and adjust and update the level based on detection, monitoring and the changes in internal and external environments.

**8.2.3** The project department of the construction company shall prepare the *Project Department’s Identification List of Project Quality Risk Sources* (Appendix D), which will be submitted to the construction company after being signed and confirmed by the project manager.

**8.2.4** The *Project Department’s Identification List of Project Quality Risk Sources* approved by the construction company shall be submitted to the project owner and supervising entity for approval. Only after being signed and confirmed by the project manager of the project owner and the chief supervisory engineer of the supervising entity can the construction be started.

**8.2.5** The construction company shall review the *Project Department’s Identification List of Project Quality Risk Sources*, prepare and regularly update the *Enterprise’s Identification List of Project Quality Risk Sources* (Appendix E), which will be released after being approved by the technical director of the construction company.

**8.2.6** The project department of the construction company shall announce the project quality risks that have been identified:

**1.** A bulletin board of project quality risks shall be set both at the construction site and the dangerous area;

**2.** The contents of project quality risks to be announced include: main project quality risks, types of accidents likely to occur, accident consequences, control measures, emergency measures and reporting methods, etc.

**3.** Clear signs shall be set at workplaces and posts with major project quality risks, and the detection, monitoring and early-warning of risk sources shall be enhanced.

## 8.3 Measures to control project quality risks by levels

**8.3.1** The measures to control project quality risks shall be developed according to relevant laws, regulations, standards and provisions of the state, so as to reduce and eliminate risks and make risks preventable and controllable. The control measures mainly include technical measures, management measures, emergency measures and so on:

**1.** Technical measures mainly include advanced construction technology, construction process, operating procedures, equipment and facilities, materials and accessories, information technology, testing and monitoring technology, etc.

**2**. The management measures mainly include the formulation of the organizational system, responsibility system, assessment system, training system and other management systems, as well as the decision-making to avoid risks by giving up some activities and behaviors that may lead to risks.

**3**. The emergency measures mainly include the establishment of emergency teams, storage of emergency supplies, implementation of targeted emergency drills, etc.

**8.3.2** For major risks and high risks, the construction company shall prepare special construction plans, and the technical director of the construction company shall organize the departments of technology, quality, safety, material, production, cost, etc. to review the control measures in special construction plans according to Article 8.3.1 of this Guide. He/she shall also organize the implementation of these measures by regularly listening to the report, making organization scheduling, carrying out regular inspection, supervising the implementation progress, making assessment summary, etc.

**8.3.3** For general risks and low risks, the technical director of the construction company shall organize the departments of technology, quality, safety, material, production, cost, etc. to prepare the construction plan and define the control measures according to Article 8.3.1 of this Guide. He/she shall also review and sign the construction plan, and organize the implementation of these measures by making organization scheduling, carrying out regular or irregular inspection, supervising the implementation progress, making assessment summary, etc.

**8.3.4** The (special) construction plan approved by the construction company shall be submitted to the project owner and supervising entity for approval, and be signed and confirmed by the project manager of the project owner and the chief supervision engineer of the supervising entity.

**8.3.5** The project department of the construction company shall inform the personnel at various posts of the project quality risk factors, risk levels, preventive measures, control standards and emergency methods of their posts through onsite training and education, pre-meeting of construction teams, technical disclosure and other means, so as to make them master the methods to avoid risks and fully implement these methods in practice.

**8.3.6** The construction company shall implement the IT-based and dynamic management of project quality risks, establish the enterprise’s electronic map of project quality risks and share information with the city’s quality risk control information system. The main contents include the list of project quality risks, the risk level (color), the department/personnel undertaking main responsibilities, the influence scope, emergency resources and other information.

**8.3.7** The participating entities shall establish the internal communication mechanism among different departments and levels as well as the external communication mechanism with other parties, so as to deliver project quality risk information in a timely and effective way and improve the efficiency of risk control.

## 8.4 Measures to control project quality risks by levels

**8.4.1** For major project quality risks (level Ⅰ) and large project quality risks (level Ⅱ), the project owner shall implement key control over the project implementation.

**1.** Formulate the project quality risk control work plan, in which the responsible person for risk control at each stage, the specific implementation scope and objects of quality risk control, the specific implementation plan of risk management at each stage, the key nodes or key processes of risk control, the inspection frequency, and the emergency response plan shall be clarified;

**2.** For key components and links involving large and major project quality risks, organize project managers, technical directors and relevant personnel of the designer, construction company and supervising entity to comprehensively review relevant technical measures so as to ensure project quality and safety;

**3.** Organize the construction company and supervising entity to carry out spot checks on key nodes or working procedures involving major and high risks.

**8.4.2** For major project quality risks (level Ⅰ) and large project quality risks (level Ⅱ), the construction company shall develop the enterprise’s list of large and major project quality risks (Appendix F), focus on monitoring work of the project department, strengthen supervision and guidance, and strictly implement the risk control measures.

**1**. The technical director of the construction company shall organize experts to review the construction organization and design;

**2**. The technical director of the construction company shall organize experts to demonstrate relevant special construction plans;

**3**. The construction company shall implement special checks on key nodes or working procedures involving major and high risks, develop check records and submit them to the technical director of the construction company for signature and confirmation;

**4**. The technical director of the construction company shall organize key inspection and acceptance of the implementation of quality risk control measures.

**8.4.3** For major project quality risks (level Ⅰ) and large project quality risks (level Ⅱ), the supervising entity shall comprehensively check the materials about controlling project quality risks by level, and verify the implementation progress of project quality risk control measures; the project’s supervision agency shall prepare specific and operable supervision implementation rules based on special construction plans, and carry out special inspection. The construction company that fails to effectively implement the control measures shall be immediately ordered to stop work for rectification.

## 8.5 Supervision and inspection

**8.5.1** The project owner (supervising entity) shall supervise and inspect the implementation of the project quality risk control system and the control measures of the construction company at least once a month, review the rectification of problems and develop inspection records.

**8.5.2** For major project quality risks (level Ⅰ) and large project quality risks (level Ⅱ), the person chiefly in charge of the construction company shall organize special inspections at least every six months, focus on inspecting the implementation progress of risk control measures, make rectification measures for problems identified, assign relevant personnel responsible for rectification, and keep inspection records.

**8.5.3** For major risks and high risks, the technical director of the construction company shall organize special inspections at least every quarter, focus on inspecting the implementation progress of risk control measures, make rectification measures, follow up the implementation of these measures, and keep inspection records.

**8.5.4** For major risks and high risks, the quality department of the construction company shall organize the technology and production departments to implement special inspections at least once a month, focus on inspecting the implementation progress of risk control measures, make rectification measures for problems identified, follow up the implementation of these measures, and develop inspection records.

**8.5.5** For risks at all levels, the project manager of the construction company shall organize inspections on a regular or irregular basis, develop inspection records, make rectification measures for problems identified, and report to the project owner (supervising entity) for review after the rectification is completed.

## 8.6 Continuous improvement

**8.6.1** In case of the following situations, the construction company shall adjust the project quality risk control measures in time:

**1.** Changes in national, local and industry-related laws, regulations, standards and norms;

**2.** New project quality risks at large level or above emerge due to changes in internal and external environment of the construction site;

**3.** Changes in construction processes and technologies;

**4.** Major adjustments during construction;

**5.** Major changes in emergency resources at the construction site;

**6.** The occurrence of quality and safety accidents;

**7.** Existing project quality risk control measures didn’t work;

**8.** Major adjustments in the enterprise or project organization;

**9.** The area is within 200m away from the surrounding area where major events take place;

**10.** Other circumstances subject to adjustment.

**8.6.2** The construction company shall evaluate the control progress of project quality risks:

**1.** The project department of the construction company shall evaluate the control progress of project quality risks at least once a quarter;

**2.** The construction company shall organize the departments of technology, quality, material, etc. to identify and evaluate the enterprise’s project quality risks, and assess the control progress every six months, so as to find out the problems in time and improve the control measures accordingly;

**3.** The evaluation results of project quality risk control shall be included in the enterprise’s internal annual performance appraisal.

**8.6.3** After updating the information on major project quality risks, the participating entity shall provide trainings for relevant personnel in a timely manner.

## 8.7 Document and record

**8.7.1** The participating entity and project department shall keep all records of the project quality risk control process, and incorporate them into the technical data management.

**8.7.2** The project quality risk control records mainly include the project quality risk control system, the project quality risk list, the training disclosure record, the supervision and inspection record, the project quality risk control evaluation record and so on.

**8.8 Supervision, law enforcement and inspection**

**8.8.1** For projects with low quality risks, the project quality and safety supervision organization shall carry out one inspection during construction, with the inspection time of at most one day.

**8.8.2** In case the project quality and safety supervision organizations are separately established, the quality supervision organization shall take the lead to carry out quality and safety inspection on projects with low quality risks during construction in cooperation with the safety supervision organization.

**8.8.3** For projects with general quality risks, the project quality and safety supervision organization shall implement at least three spot checks in principle (more than once for decoration works), and at least one spot check every three months, with a focus on the parts such as engineering foundation and main structure as well as the completion acceptance.

**8.8.4** For construction projects with high risks, the project quality and safety supervision organization shall implement spot checks according to the *Regulations of Quality Supervision on Beijing’s House Construction and Municipal Infrastructure Projects*, appropriately increase the frequency of onsite spot checks, and focus on checking the control and treatment of risks.

**8.8.5** For construction projects with high risks, the project quality and safety supervision organization shall implement spot checks according to the *Regulations of Quality Supervision on Beijing’s House Construction and Municipal Infrastructure Projects*, increase the frequency of onsite spot checks based on quality and safety control requirements of the construction site, and organize at least one spot check on each project in principle on a monthly basis.

# Appendix A: Probability analysis factor of project quality risks

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Level** | **Probability** | **Previous probability P1** | **Management level of the construction site P2** | **Level of the project scale P3** | **Level of project quality control difficulty P4** |
| **Previous probability across the country P1.1** | **Previous probability in the city P1.2** | **Previous probability of the enterprise P1.3** | **Previous probability of complaints P1.4** | **Quality management level of the enterprise P2.1** | **Management ability and level of the project manager P2.2** | **Management ability and level of the project department P2.3** | **Housing construction works** | **Municipal infrastructure engineering** |
| 5 | Very likely | more than once in the past year | more than once in the past three years | more than once in the past five years | more than once in the past year | The enterprise’s credit rating score ranks below 20% | The project manager’s credit rating score is below 60 | The management staffing of the project department violates relevant regulations | Projects exceeding the height and roof limit as well as certain regulations; civil buildings exceeding the height of 100m; public buildings with a single-building area of more than 100,000 m2 or group-building area of more than 300,000 m2 | Urban comprehensive pipeline works; municipal works with an investment of more than RMB 200 million; the porous span of the extra large bridge longer than 1,000m or the single-hole span of the extra large bridge longer than 150m. | Involving many types of large dangerous projects that exceed a certain size (four types and above) |
| 4 | Relatively likely | once in the past two years | once in the past five years | once in the past ten years | once in the past two years | The enterprise’s credit rating score ranks above 20% and below 40% | The project manager’s credit rating score is between 60 and 65 | The management staffing of the project department conforms to relevant regulations and the project managers have a low ability level | Civil buildings with a height between 75m-100m; public buildings with a single-building area between 50,000 m2 and 100,000 m2 or group-building area between 200,000 m2-300,000 m2; residential areas with a floor area of more than 100,000 m2 | Municipal works with an investment between RMB 100 million and RMB 200 million; 100m ≤ the porous span of the extra large bridge ≤ 1,000m or 40m ≤ the single-hole span of the extra large bridge <150m. | Involving several types of large dangerous projects that exceed a certain size (three types) |
| 3 | Likely | once in the past five years | once in the past ten years | once in the past 15 years | once in the past five years | The enterprise’s credit rating score ranks above 40% and below 60% | The project manager’s credit rating score is between 65 and 70 | The management staffing of the project department conforms to relevant regulations and the project managers have a general ability level | Civil buildings with a height between 54m-75m; public buildings with a single-building area between 20,000 m2 and50,000 m2 or group-building area between 100,000 m2 and 200,000 m2; residential areas with a floor area between 50,000 m2-100,000 m2 | Municipal works with an investment between RMB 30 million and RMB 100 million; the medium bridge 30m < the porous span of the large bridge < 100m or 20m ≤ the single-hole span < 40m. | Generally involving some types of large dangerous projects that exceed a certain size (two types) |
| 2 | Less likely | once over the past five years | once over the past 10 years | once over the past 15 years | once over the past 10 years | The enterprise’s credit rating score ranks above 60% and below 80% | The project manager’s credit rating score is between 70 and 80 or the project manager wins the quality award at ministerial and provincial levels | The management staffing of the project department conforms to relevant regulations and the project managers have a good ability level | Civil buildings with a height between 24m-54m; public buildings with a single-building area between 10,000 m2 and 20,000 m2 or group-building area of less than 100,000 m2; residential areas with a floor area between 10,000 m2 and 50,000 m2 | Municipal works with an investment between RMB 10 million and RMB 30 million; the small bridge 8m ≤ the porous span of the large bridge ≤ 30m or 5m ≤ the single-hole span < 20m. | Involving less types of large dangerous projects that exceed a certain size (one type) |
| 1 | Almost impossible | Never happen in the past | Never happen in the past | Never happen in the past | Never happen in the past | The enterprise’s credit rating score ranks above 80% | The project manager’s credit rating score is above 80 or the project manager wins the quality award at the state level | The management staffing of the project department conforms to relevant regulations and the project managers have an excellent ability level | Civil buildings with a height of less than 24m and a single-building area of less than 10,000 m2 | Municipal works with an investment of less than RMB 10 million; other types of bridges | No large dangerous projects that exceed a certain size involved |

# Appendix B: Severity analysis factor of project quality risk consequences

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Level** | **Description** | **Quality influence degree level of engineering entity R1** | **Severity level of economic loss R2** | **Severity level of the influence of peripheral sensitive targets R3** | **Level of social attention R4** |
|
| 5 | Very high | Seriously affecting the safety of the structure or use functions, requiring to be dismantled and rebuilt | More than 30 people died, or more than 100 people were seriously injured, or a direct economic loss of more than RMB 100 million was caused | The construction site during construction(1) There are buildings (structures), underground pipelines (water, electricity, gas, heat, etc.) and important public facilities within a safe distance; (2) In the capital’s core functional area (administrative regions of Dongcheng and Xicheng Districts), within 200m from both sides of Chang’an Avenue and its extension (extending from the east to west with Tiananmen Square as the center. The distance from Fuxingmen to Jianguomen is about 7 km, extending westward to Shougang Park, Yongding River’s water system and Xishan Mountain, and eastward to Beijing’s sub-center as well as the water system of North Canal and Chaobai River); (3) There are Party and government organs, military management areas, culture relic protection sites, schools, hospitals, assembly occupancies, residential areas, large bus hubs, large forests, chemical plants, petrol stations and so on within the surrounding area 200m away; (4) There are residents and public areas in operation within or near the construction area (reconstruction and expansion works that are operated normally in part or in whole); (5) Within the scope where the guarantee for major activities is provided by Beijing City | Key projects, landmark projects, secret projects and policy housing projects of Beijing and the state |
| 4 | High | Affecting the safety of the structure or use functions, which can be repaired through rework or reinforcement | More than 10 but less than 30 people died, or more than 50 but less than 100 people were seriously injured, or a direct economic loss between RMB 50 million and RMB 100 million was caused | There are Party and government organs, military management areas, culture relic protection sites, schools, hospitals, assembly occupancies, residential areas, large bus hubs, large forests, chemical plants, petrol stations and so on within the surrounding area 200m to 500m away | Infrastructure projects, commercial housing projects |
| 3 | General | Slightly affecting the safety of the structure or use functions, which can be repaired through rework | More than 3 but less than 10 people died, or more than 10 but less than 50 people were seriously injured, or a direct economic loss between RMB 10 million and 50 million was caused | There are Party and government organs, military management areas, culture relic protection sites, schools, hospitals, assembly occupancies, residential areas, large bus hubs, large forests, chemical plants, petrol stations and so on within the surrounding area 500m to 2,000m away | General social investment projects |
| 2 | Low | Not affecting the safety of the structure and slightly affecting the use functions, which can be repaired through rework | More than 1 but less than 3 people died, or more than 1 but less than 10 people were seriously injured, or a direct economic loss between RMB 1 million and RMB 10 million was caused | There are Party and government organs, military management areas, culture relic protection sites, schools, hospitals, assembly occupancies, residential areas, large bus hubs, large forests, chemical plants, petrol stations and so on within the surrounding area more than 2,000m away | Other projects except those mentioned above |
| 1 | Very low | Not affecting the safety of the structure or use functions | No people died or were seriously injured, and the direct economic loss was less than RMB 1 million | There are no buildings, residential areas, public places, etc. in the surrounding area |

**Appendix B: Severity analysis factor of project quality risk consequences (continued)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Level** | **Description** | **Engineering use nature R5** | **Quality influence scope level of engineering entity R6** | **Influence degree level of fire danger R7** |
| **Office** | **Commerce** | **Public service facilities** | **Warehouse** | **Plant** | **Residence** |
| 5 | Very high | — | Interior activity space for children with a gross floor area of more than 1,000 m2 such as the children’s amusement arcade | Hospital outpatient buildings, buildings, libraries and canteens of the universities with a gross floor area of more than 2,500 m2; nurseries and children rooms of the kindergartens, nursing homes, welfare homes, inpatient buildings of the hospitals and nursing homes, teaching buildings, libraries and canteens of the primary and secondary schools, and school dormitories with a gross floor area of more than 1,000 m2 | — | — | — | Unit project | Combustible materials |
| 4 | High | Office buildings and power dispatching buildings of state organs, telecommunication buildings, post office buildings, disaster prevention commanding and dispatching buildings, radio and television buildings and archives buildings | Hotels, restaurants, shopping malls, and markets with a gross floor area of more than 10,000 m2; cinemas, theatres, reading rooms of the public libraries, commercial indoor fitness and leisure venues with a gross floor area of more than 2,500 m2; dance halls, video halls, screening halls, KTVs, nightclubs, game rooms, sauna bathrooms, Internet cafes, bars, as well as the restaurants, teahouses, cafes with entertainment functions that have a gross floor area of more than 500 m2 | Stadiums, auditoriums, public exhibition venues, and exhibitions halls of the museums with a gross floor area of more than 20,000 m2; terminals of the civil airports, waiting rooms of the passenger stations, and waiting rooms of the passenger docks with a gross floor area of more than 15,000 m2; temples and churches with a gross floor area of more than 2,500 m2; employee dormitories of labor-intensive enterprises with a gross floor area of more than 1,000 m2; filling and loading stations, supply stations and pressure regulating stations of inflammable and explosive gases and liquids; urban comprehensive pipelines, as well as municipal roads and bridges | Warehouses producing, storing, loading and unloading inflammable and explosive dangerous goods | Factories producing, storing, loading and unloading inflammable and explosive dangerous goods; production and processing workshops of labor-intensive enterprises with a gross floor area of more than 2,500 m2 | Category I high-rise residences | Partitioned project | Combustible materials, 0﹤fire endurance ≤ 0.5h |
| Common public buildings with a height of more than 50m and a single-building area of more than 40,000 m2 |
| 3 | General | Common public buildings with a height of less than 50m and a single-building area between 20,000 m2 and 40,000 m2 | Residences with a building height of less than 54m | Sub-project | Flame retardant materials, 0.15 h ≤ fire endurance ≤ 0.5 h |
| 2 | Low | Common public buildings with a height of less than 50m and a single-building area of less than 20,000 m2 | — | Inspection lot | Incombustible materials, 0.25h ≤ fire endurance ﹤ 2h |
| 1 | Very low | Offices with an area of less than 10,000m2 and a building height of less than 24m (without chemical or biological laboratories) | Commerce with an area of less than 10,000m2 and a building height of less than 24m (not for selling flammable, explosive, toxic or hazardous materials, and not producing soot and odor) | Public service facilities with an area of less than 10,000m2 and a building height of less than 24m (without chemical or biological laboratories) | Warehouses with an area of less than 10,000m2 and a building height of less than 24m (not for storing flammable, explosive, toxic, hazardous materials or dangerous materials) | Plants with an area of less than 10,000m2 and a building height of less than 24m (not for producing flammable, explosive, toxic, hazardous materials or dangerous materials) | Residences with an area of less than 10,000m2 and a building height of less than 24m (excluding contiguous development projects) | Monomer components | Incombustible materials, 2.00h ≤ fire endurance ≤ 3.00h |

# Appendix C: The Enterprise’s Checklist of Project Quality Risk Sources

Name of the enterprise: Determination date:

|  |  |  |  |
| --- | --- | --- | --- |
| SN | Risk source | Types of accidentslikely to occur | Hazardous and harmful factors |
| 1 | Fill in according to Chapter V of this Guide | Fill in according to Chapter V of this Guide | Fill in according to Chapter V of this Guide |
| 2 | …… | …… | …… |

Technical director of the construction company:

Notes:

1. The enterprise’s checklist of project quality risk sources can be prepared based on actual conditions;

2. This list database shall be updated in line with changes in the enterprise’s works as well as internal and external environments in a timely manner.

# Appendix D: The Project Department’s Identification List of Project Quality Risk Sources

Name of the works: Site of the works: Identification date:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SN | Risk level | Risk source | Types of accidentslikely to occur | Control level | Department chiefly in charge | Personnel chiefly in charge | Main control measures |
| Technical measures | Management measures | Emergency measures |
| 1 | Fill in according to Chapter VII of this Guide | Fill in according to Chapter V of this Guide | Fill in according to Chapter V of this Guide | Enterprise level or project level | …… | …… | …… | …… | …… |
| 2 | …… | …… | …… | …… | …… | …… | …… | …… | …… |

Project manager of the construction company: Chief supervision engineer of the supervising entity: Project manager of the project owner:

Notes: This list shall be updated in line with changes in the monitoring situation as well as internal and external environments in a timely manner.

# Appendix E: The Enterprise’s Identification List of Project Quality Risk Sources

Name of the enterprise: Identification date:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SN | Risk level | Risk source | Types of accidentslikely to occur | Control level | Department chiefly in charge | Personnel chiefly in charge | Main control measures | Name of the works with this risk |
| Technical measures | Management measures | Emergency measures |
| 1 | Fill in according to Chapter VII of this Guide | Fill in according to Chapter V of this Guide | Fill in according to Chapter V of this Guide | Enterprise level or project level | …… | …… | …… | …… | …… | …… |
| 2 | …… | …… | …… | …… | …… | …… | …… | …… | …… | …… |

Technical director of the construction company:

Notes: This list shall be updated in line with changes in the enterprise’s works as well as internal and external environments in a timely manner.

# Appendix F: The Enterprise’s List of Large and Major Project Quality Risks

Name of the enterprise: Identification date:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SN | Name of the project | Quality risk level of the project | Whether to increase the quality risk level of the project | Main risk sources | Control level | Department chiefly in charge | Personnel chiefly in charge | Main control measures |
| Technical measures | Management measures | Emergency measures |
| 1 | …… | Fill in according to Chapter VII of this Guide | Fill in according to Chapter VII of this Guide | Fill in according to Chapter V of this Guide | Enterprise level or project level | …… | …… | …… | …… | …… |
| …… | …… | …… | …… | …… | …… | …… |
| …… | …… | …… | …… | …… | …… | …… |
| 2 | …… | …… | …… | …… | …… | …… | …… | …… | …… | …… |

Main person in charge of the enterprise or the authorized technical director:

Notes: This list shall be updated in line with changes in the enterprise’s works as well as internal and external environments in a timely manner.