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Risk management - Large scientific installations - Risk classification and control measures

风险管理 大科学装置风险分类及控制措施

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Table of Contents

3 Terms and definitions

3.1 Large scientific installation: a large facility built through relatively large investment and engineering work which, after construction, achieves important scientific and technological goals through long-term stable operation and continuing scientific and technical activity.

3.2 and 3.3 Risk is the adverse effect of uncertainty on the whole life cycle of a large scientific installation, and risk management is, in respect of the risks of a large scientific installation, the coordinated activities to direct and control an organization; both are taken from GB/T 23694-2013, modified.

3.4 to 3.8 Core value risk is the situation in which the project result departs from what was expected because of scientific value, technical development and similar factors during construction; social risk is the same situation caused by political factors, policy change, economic conditions and outside comment; organization management risk is that caused by project management, cooperation management, international exchange and supplier management; technology risk is that caused by technical factors; and funding risk is that caused by shortcomings in financing planning, use of funds, securing of funds and analysis of investment return.

4 Classification principles

4.1 Scientific soundness: the classification takes the features of the most basic large scientific installations as the basis for risk analysis, in the light of the significance of the different installations and the characteristics of their fields, so that the classification is complete and soundly reasoned.

4.2 Practicality: the classification is practical and can support the responsible units in design, construction, operation and maintenance. 4.3 Compatibility: the classification stays consistent with existing risk classification principles and methods and takes account of changes in technology and business.

5 Risk classification

5.1 Core value risk covers scientific value risk and technical development risk. The factors that give rise to scientific value risk include a scientific goal that is not forward-looking enough, insufficient urgency in the challenge the project addresses, and the absence of an assessment of the scientific and technological results and of the economic and social benefits. Those behind technical development risk include incomplete or unreliable basic data, failure to track technical developments and changes in scientific value so that the advancement of the project suffers, the possibility that the technology under development does not reach the expected effect, the possibility that the technology ceases to be supported, and incompatibility across systems in hardware or software.

5.2 Social risk covers international political environment risk, policy environment risk, economic environment risk and social stability risk. The factors listed include changing international relations, local wars and unrest, interest rate movements, fluctuation of the international economic environment, trade policy change and inflation; adjustments of development strategy by governments at all levels, changes in laws and regulations such as the tax system, and the making and revision of mandatory standards such as pollutant emission limits in environmental standards; domestic economic factors such as the level and stability of economic development, the market and industrial environment and the uncertainty of the raw material market, which can raise the price of components, raw materials, test equipment and measuring instruments, together with foreign trade, foreign investment and exchange rate factors; and failure to identify the needs and expectations of the internal and external context and of interested parties, unclear effectiveness of education and popularization of scientific knowledge, the effect on residents of noise and air pollution during construction and operation that does not meet national standards, latent threats to local public order, and public opinion risk where explanation and guidance are inadequate.

5.3 Organization management risk covers project management risk, cooperation management risk, supplier and supply chain capability, exchange risk, data management risk, project baseline risk and intellectual property risk. The factors listed include a project leader whose decision-making level is not high enough and an organization whose management capability is insufficient; the absence of an experienced professional management team able to meet the scientific, technical and performance goals of each life cycle stage; failure to define the roles and responsibilities of partners at the different stages, failure to state the responsibilities of partners for delivered and supplied items, failure to allow for the evolution of the partnership and the absence of a sound admission system, and different information standards between partners and between the design and construction units; insufficient market research with single-source procurement or poor supplier selection, a supply chain without enough depth to secure competition, inability to find qualified suppliers or contractors, insufficient capacity, qualifications, experience or skills in the supply chain, availability of materials and parts, and inadequate human resource reserves; failure to set an international exchange policy early and the effect of a changing political environment on such exchange; the absence of a transparent and open data management policy, failure to use advanced electronic infrastructure services for access, processing and management of data and for remote participation, and unstable or unsuitable electronic systems and permission allocation; insufficient consideration in the schedule and cost estimates and inadequate resource planning; and the absence of an intellectual property policy with clear goals, failure to search the literature at the start of the project, failure to protect new technologies and products under development in time, failure to publish and restrict the intellectual property of the parties, the absence of incentives for innovation, technology transfer and intellectual property management, and disregard of the intellectual property evaluation of suppliers and of the products procured from them.

5.4 Technology risk covers natural environment risk, requirement and scope risk, design risk, manufacturing and machining risk, construction risk, interface, integration and assembly risk, commissioning and operation risk, and safety and quality risk. The factors listed include the absence of an environmental assessment and known or latent environmental problems, failure to allow for environmental permits, ecological pollution and degradation, and undefined methods for disposing of scrapped equipment; undefined, incomplete or unclear requirements or functions, inadequate requirement analysis, unstable requirement sources, requirements that are hard to trace and measure, non-compliant or invalid requirements, failure to agree with interested parties on the foreseeable scope, time and cost, failure to assess the gap between requirements and scope, and unreasonable work package breakdown; failure to justify complex design features, too many unproven new technologies, incompatibility between designs, numerous or unclear assumptions, aspects of the design left unresolved because requirements and scope are unclear, inadequate or wrongly applied design criteria, known or latent errors or omissions, uncontrolled change processes and known or latent design integration problems; inadequate design documents for a valid manufacturing plan or control specification, a manufacturing process that cannot produce parts to the design standard, incomplete functional breakdown in the systems engineering, accumulated tolerances that put manufacture and assembly at risk, out-of-tolerance production, possible mechanical failure at the manufacturing stage, poor information transfer between the design, manufacturing and assembly teams, verification testing cut short for budget or schedule reasons, and the possibility that equipment cannot be used; ground conditions on site that differ from what was expected, no simulation or testing of the suitability of the building interfaces, quality change of equipment and parts from transport and storage, interference between the building and the plant installation, unidentified maintenance problems in stored equipment, and site safety systems and site management that do not keep the workers safe; unstable or unfrozen interfaces, possible insufficient system integration between buildings and systems and between systems, interference between the working areas of the parties, an insufficiently defined assembly plan, difficulty in running a multi-shift assembly model, limited space inside the building, limited function of tooling and equipment, possible rework from incompatibility of components or systems, and assembly tolerances already beyond what is allowed; possible failure of major parts or equipment at the operating stage, unplanned interference where several subcontractors work in the same area, problems from insufficiently defined maintenance procedures, and a shortage of spare parts; and hazardous substances, potential serious pollution, a new design basis that introduces accident risk or unreviewed safety risk, safety grading or systems with safety risk, problems in the running of the quality management system, poor information transfer between the design, manufacturing and assembly teams, change requests carried out without careful analysis, verification testing cut short for budget or schedule reasons, and out-of-tolerance production.

5.5 Funding risk. The factors listed are the absence of a balanced ratio between the cash and in-kind contributions of the partners, the absence of sound guidance for valuing liabilities or real property, the absence of a reasonable plan for using funds in step with the progress of the project, the effect of changing equipment reliability and depreciation on maintenance costs, changes in the financing environment, diversified funding sources calling for a sound plan for securing the money, an over-optimistic investment return plan with a weak demonstration effect, and, where additional investment is needed later in the project or the budget falls short, the capacity to secure funds, the reasonableness of their allocation and delay in their arrival.

6 Risk control measures

6.1 Before a risk event occurs, the aim is to choose economical, reasonable and effective methods that reduce or avoid it and bring its likelihood and consequences down as far as possible; after one occurs, the parties work together, apply the contingency plan and the measures at once so as to limit casualties and economic loss and the effects on the surrounding environment, on reputation and image and on the political situation, and remove the latent hazard.

6.2 At the preliminary research stage the core value measures are to set up a science and technology committee and hold a project justification, covering feasibility and alignment with international goals and strategy, the urgency of the practical need, the opportunity the project gives national science and engineering for frontier research, the transferability of the technology adopted and the high priority of the field; to win broad support from the research and education community; and to build a relatively broad user base able to meet the research and education goals and the needs of the stated number of users. The social risk measures include investigating the credit and business standing of the parties, building up