Electron-Ion Collider Plan

IKC Risk Management Plan

April 10, 2024

**Prepared by:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Irina Sourikova, Risk Manager

Electron-Ion Collider

Brookhaven National Laboratory

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Paolo Berrutti, IKC Engineer

Electron-Ion Collider

Brookhaven National Laboratory

**Reviewed by:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

James Fast, Deputy Director for the TJNAF Partnership

Electron-Ion Collider

Thomas Jefferson National Accelerator Facility

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Jim Yeck, Project Director

Electron-Ion Collider

Brookhaven National Laboratory

**Approved by:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** Date: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Luisella Lari, Project Manager

Electron-Ion Collider

Brookhaven National Laboratory

REVISION HISTORY

|  |  |  |
| --- | --- | --- |
| **Revision #** | **Effective Date** | **Summary of Change** |
| 01 | April 10, 2024 | Initial release |
|  |  |  |

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LIST OF ACRONYMS

|  |  |
| --- | --- |
| BHSO | Brookhaven Site Offices |
| BNL | Brookhaven National Laboratory |
| CAM | Control Account Manager |
| CD | Critical Decision |
| DOE | Department of Energy |
| EAC | Estimate at Completion |
| EIC | Electron-Ion Collider |
| ESS&H | Environment, Safety, Security and Health |
| EU | Estimate Uncertainty |
| FPD | Federal Project Director |
| IPD | Integrated Project Database |
| ISMS | Integrated Safety Management System |
| NP | Nuclear Physics |
| PD | Project Director |
| PM | Project Manager |
| QA | Quality Assurance |
| R&D | Research & Development |
| RHIC | Relativistic Heavy Ion Collider |
| RLS | Resource Loaded Schedule |
| RMB | Risk Management Board |
| RMP | Risk Management Plan |
| TD | Technical Director |
| TJNAF | Thomas Jefferson National Accelerator Facility |
| WBS | Work Breakdown Structure |

**IKC Risk Management Plan**

# Introduction

## Scope

This IKC Risk Management Plan (RMP) describes the processes to plan, identify, assess, categorize, quantify, handle and track/report risks associated with the achievement of the project requirements and goals. This RMP will help assuring that the IKC to the EIC project is consistent with DOE O 413.3B, *Project Management for the Acquisition of Capital Assets,* DOE 413.3-7 *Risk Management Guide,* and strives to incorporate “best practices” from other large-scale construction projects around the DOE complex.

The definition of risk for this RMP is an uncertain event or condition that, if it occurs, could either positively or negatively impact the In-Kind Contribution objectives. A risk has a probability of occurrence and consequences or “impacts” if it occurs. Risks with negative consequences are threats and risks with positive consequences are opportunities.

Managing risks is a key element of the project management process for both the planning and the performance phases of any project and its In-Kind Contributions.

This document defines the risk management processes that will help <Partner Institution> to successfully complete their agreed deliverables to the EIC project according to specifications, on-time, and within cost. The risk processes described herein apply to:

1. <Partner Institution> risks that do not directly impact the EIC project or other partners; and

2. Handover risks to the <Partner Institution> deliverables to the EIC project or another partner (or vice-versa).

## Project Summary

The Electron-Ion Collider (EIC) will enable the nuclear physics community to take a significant step forward in the centuries-old quest to understand the nature of matter at its most fundamental level, providing the clearest picture yet of how the elemental quarks and gluons interact to form the basic structure of atoms and nuclei. In a comprehensive White Paper, the U.S Nuclear Physics community, with world-wide support, has compiled a detailed description of the potential for such a facility to realize important new understanding and discoveries regarding the nature of visible matter in our universe at its most fundamental level.

The primary objective of the EIC Project at Brookhaven National Laboratory is to use the existing RHIC ion-ion collider to build an EIC by adding an electron accelerator and an electron storage ring to enable center of mass collision energies ranging between 29 GeV and 140 GeV for electron-proton collisions with a luminosity of up to 1x1034cm-2s-1. The design of EIC has been produced jointly by nuclear physicists and accelerator scientists, enabling large-acceptance experiments with unprecedented resolving power in the domain of quarks and gluons.

## Roles and Responsibilities

The <Partner Institution> **Technical Representative** (TR) is ultimately responsible for managing risk associated to their IKC deliverables. The <Partner Institution> TR – working closely with the <Partner Institution> Project Manager (PM) – establishes a risk management plan, helps identify and analyze risks, monitors risks, and executes risk response plans throughout the project. The <Partner Institution> PM or TR chairs the <Partner Institution> partner Risk Management Board (p-RMB), whose membership includes the Sub-Project Coordinators and their Leaders (SPCs and SPCLs), and other project staff as required, such as ES&H personnel, and subject-matter project engineers. The p-RMB may simply be a dedicated session of an existing management meeting. The RMB meets approximately once per quarter.

The <Partner Institution> PM and TR are responsible for working with their teams and other stakeholders to: identify risks to their subproject; assess their probabilities and impacts; and develop and execute risk mitigation and response plans throughout the project. The <Partner Institution> PM and TR assign a Risk Owner to each risk – typically the subject matter expert (SME) who is responsible for managing the risk – who helps to analyze the risk and develop and execute mitigation and response plans.

Table 1 shows the <Partner Institution> risk management responsibility assignment matrix.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Process / Responsible | Technical  Representative | Project  Manager | SPCs/SPCLs | Risk Owner |
| Plan Risk  Management | Accountable | Contributes | Contributes | Contributes |
| Identify  Risks | Accountable | Contributes | Contributes | Contributes |
| Perform Qualitative Risk Analysis | Accountable | Contributes | Contributes | Performs |
| Perform Quantitative Risk Analysis | Accountable | Contributes | Contributes | Contributes |
| Plan Risk  Responses | Accountable | Contributes | Performs | Performs |
| Monitor and  Control Risks | Accountable | Contributes | Performs | Performs |

Table 1 Primary responsibilities in the risk responsibility assignment matrix.

## Key Definitions

The following key definitions will be used to implement EIC IKC risk management.

**Bias:** A repeated or systematic distortion of a statistic or value, imbalanced about its mean.

**Brainstorming:** Interactive technique designed for developing new ideas with a group of people.

**Change Control:** A process that ensures changes to the approved baseline are properly identified, reviewed, approved, implemented and tested, and documented.

**Consequence:** Outcome of an event. (Normally includes scope, schedule, and cost).

**External Risks:** Risks outside the project control or global risks inherent in any project such as global economic downturn, trade difficulties affecting deliverables such as construction materials or political actions that are beyond the direct control of the project.

**Feedback:** System concept where a portion of the output is fed back to the input.

**Internal Risks:** Risks that the project has direct control over, such as organizational behavior and dynamics, organizational structure, resources, performance, financing, and management support.

**Lessons Learned:** Formal or informal set of “learnings” collected from project or program experience that can be applied to future projects or programs after a risk evaluation. Can be gathered at any point during the life of the project or program.

**Mitigate:** To eliminate or lessen the likelihood and/or consequence of a risk.

**Opportunity:** Risk with positive impact.

**Primary Risk:** Initial risk entry in the risk register. A residual or secondary risk can become a primary risk if in case of a residual risk the primary risk is closed and then Project Manager determines the residual risk should be made the primary risk or the risk entry in the risk register. The secondary risk can become the primary risk in the risk register if the Project Manager determines that it should become the risk entry based upon the realization of the trigger metric or other determining factor.

**Probability:** Likelihood of an event occurring, expressed as a qualitative and/or quantitative metric.

**Project Risk:** Risks that are captured within the scope, cost, or schedule of the project.

**Qualitative Risk Analysis:** Involves assessing the probability and impact of project risks using a variety of subjective and judgmental techniques to rank or prioritize the risks.

**Quantitative Risk Analysis:** Involves assessing the probability and impact of project risks and using more numerically based techniques, such as simulation and decision tree analysis for determining risk implications.

**Residual Risk:** Risk that remains after all risk mitigations have been implemented.

**Risk:** An uncertain event that, if it occurs, has an outcome that could either positively or negatively impact project objectives.

**Risk Acceptance:** An informed and deliberate decision to accept consequences and the likelihood of a particular risk.

**Risk Analysis:** Process by which risks are examined in further detail to determine the extent of risks, how they related to each other, and which ones are the highest risks.

**Risk Assessment:** Identification and analysis of project and program risks to ensure an understanding of each risk in terms of probability and consequences.

**Risk Assumption:** Any assumptions pertaining to the risk itself.

**Risk Communication:** An exchange or sharing of information about risk between the decision-maker(s), stakeholders, and project team. (The information can relate to various information sources such as the existence of nature, form, probability, severity, acceptability, treatment, or other aspects of risk).

**Risk Documentation:** The recording, maintaining, and reporting assessments, handling analysis and plans, and monitoring results.

**Risk Handling Strategy:** Process that identifies, evaluates, selects, and implements options to set risk at acceptable levels given project constraints and objectives. Includes specific actions, when they should be accomplished, who is the owner, and what is the cost and schedule.

**Risk Identification:** Process to find, list and characterize elements of risk.

**Risk Management:** The handling of risks through specific methods and techniques.

**Risk Management Plan:** Documents how the risk processes will be carried out during the project/program.

**Risk Mitigation:** Process to reduce the consequence and/or probability of a risk.

**Risk Monitoring and Tracking:** Process of systematically watching over time the evolution of the project risks and evaluating the effectiveness of risk strategies against established metrics.

**Risk Owner:** The individual responsible for managing a specified risk and ensuring effective treatment plans are developed and implemented.

**Risk Planning:** Process of developing and documenting an organized, comprehensive, and interactive strategy and methods for identifying and tracking risk, performing continuous risk assessments to determine how risks have changed, developing risk handling plans, monitoring the performance of risk handling actions, and assigning adequate resources.

**Risk Register:** Database for risks associated with the project. (Also known as risk database or risk log.)

**Risk Threshold:** Defined or agreed level of acceptable risk that risk handling strategies are expected to meet.

**Risk Transfer:** Movement of the risk ownership to another organizational element. (However, to be successfully and fully transferred, the risk should be accepted by the organization to which the risk is being transferred.)

**Secondary Risk:** Risk arising as a direct result of implementing a risk handling strategy.

**Simulation, (Monte Carlo):** Process for modeling the behavior of a stochastic (probabilistic) system. (A sampling technique is used to obtain trial values for key uncertain model input variables. By repeating the process for many trials, a frequency distribution is built up, which approximates the true probability distribution for the system’s output. This random sampling process, averaged over many trials, is effectively the same as integrating what is usually a very difficult or impossible equation.)

**Technical Risk:** Risks that include disciplines such as mechanical, electrical, chemical engineering, safety, safeguards and security, chemistry, biology, etc.

**Threat:** Risk with negative consequences.

**Trigger Metric:** Event, occurrence or sequence of events that indicates the risk may be about to occur, or the pre-step for the risk indicating that the risk will be initiated.

**Uncertainty:** A condition that could change project cost or schedule, but it is not attributed to an event.

# Risk Management Process

The EIC IKC risk management consists of the following processes:

## Risk Management Planning

The Plan Risk Management process takes into account the existing procedures, standards and policies related to risk management in many areas. The main output of the Plan Risk Management process is the partner Risk Management Plan (p-RMP).

## Risk Identification

The “Identify Risks” process assesses all aspects of the Project to produce a comprehensive list of risks. Risks associated with project scope, cost, schedule and technical objectives are identified by systematically challenging the scope, assumptions, logic, cost and schedule of the project. Risks are identified using a number of techniques, including reviews of project documents (e.g. PPDs and the Technical Design Reports); brainstorming; interviews with subject matter experts (SMEs); risk workshops with the project team and external experts; and reviews of other projects’ risks.

All EIC project Partner Institutions members have a responsibility to continuously assess project activities and identify future events that may affect project objectives. Once an event has been identified, risk description is formulated into a concise statement describing the event and its associated impact as follows:

**If <Event Description> happens, then <CONSEQUENCE> will <IMPACT> <PROJECT OBJECTIVE>.**

## Risk Assessment

Risks are assessed to determine their likelihood and impacts on the IKCs scope, cost, schedule, and technical objectives. A probability vs. consequences matrix is shown in Table 2. Qualitative Risk Analysis Matrix is used to rank the risks. The Project tailored the matrix to ensure that the high and medium rank risks are monitored by TR and PM at the <Partner Institution>. The bottom part of this matrix depicts risk likelihood categories that are used to assign primary risk probabilities.

**Table 2. Qualitative Risk Analysis Matrix**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Consequence | | | | | | |
| Probability |  | Negligible | Marginal | Significant | Critical | Crisis |
| Cost | ≤ $250k | > $250K ≤ $1M | >$1M ≤ $5M | >$5M ≤ $30M | > $30M |
|
| Schedule | ≤3mo | >3mo ≤6mo | >6mo ≤12mo | >12mo ≤24mo | >24mo |
| Technical | Minimal or no impact to threshold or objective KPP | Possible impact to objective KPP, but no impact to threshold KPP | Impact to objective KPP, but no impact to threshold KPP | Impact to objective KPP. Possible impact to threshold KPP. | Impact to threshold KPP. |
| Very High > 65% | Low | Moderate | High | High | High |
|
| High  >40% to < 65% | Low | Moderate | Moderate | High | High |
|
| Moderate  >25% to  < 40% | Low | Low | Moderate | Moderate | High |
|
| Low >10% to < 25% | Low | Low | Low | Moderate | Moderate |
|
| Very Low <10% | Low | Low | Low | Low | Moderate |
|

## Risk Analysis: qualitative and quantitative

This analysis provides risk ranks based on probability and consequences by using a qualitative risk analysis matrix (described in previous section). Qualitative analysis is performed without considering risk mitigations and helps to group risks into overall risk categories – low, moderate, and high.

This analysis will be carried out by the <Partner Institution>, that will analyze the risk events linked into a proposed schedule for the IKC deliverables. Cost risk to <Partner Institution> scope is borne and managed by the <Partner Institution>, for example by setting aside risk contingency funds in advance, or by making supplemental funding requests if risks occur. Schedule risk to the <Partner Institution> scope is managed by the <Partner Institution>, with the aim of ensuring the main deliverable milestones are not delayed by risks. Typical actions to recover risk delays include parallelizing work that was previously executed in series or accelerating activities by applying additional resources. The net effects of risks on the timely delivery of the <Partner Institution>’s main deliverables are captured in handover risks, which are jointly managed by <Partner Institution> and EIC project.

The Quantitative Risk Analysis process refines the estimates of the impacts of individual risks and then estimates the aggregate cost and schedule impacts of all risks. Risk scenario analysis is used to aggregate the approximate schedule and cost impacts of all risks together.

## Risk Handling

Risk handling covers several risk strategies, including risk acceptance, avoidance, mitigation, and transfer. When weighing these approaches, the risk owner will consider the following when working with all the stakeholders:

* The options’ feasibility in terms of the project’s objectives, and baseline funding and schedule.
* The expected effectiveness of the risk handling strategy.
* The result of a cost/benefit analysis.
* The impact on other technical portions of the project.
* Any other analysis deemed relevant to the decision process.

The cost for the risk handling strategy for the primary risk will be included in the baseline. There may be occasions when a primary risk is not added to the baseline until a change control action, such as when it is predicted during a monthly project review, or a review of lessons learned.

Risk handling strategies will be continually reviewed for their affordability, effectiveness, and resource availability as required by the risk management plan.

### Acceptance

Acceptance as a risk handling strategy is a deliberate decision documented in the risk register. Acceptance of the risk does not mean that the risk is ignored. The risk is included in the cost and schedule contingency impact analysis.

### Avoidance/Exploit

Avoidance, as a risk handling strategy, is done by planning the project activities in such a way as to eliminate the potential threat. Avoidance will be considered the most desirable risk handling strategy. However, avoidance will be analyzed for its cost/benefit to the project within the current funded boundaries of the project. The cost/benefit analysis will also take into consideration the impact on the overall project and the impact of the available funding for handling the other identified risks.

Exploit is an opportunity handling strategy and is accomplished by planning the project activities to take advantage of or implement a potential opportunity. An opportunity will be analyzed for its beneficial impact on the project. The cost/benefit analysis for an opportunity will take into consideration the impact on the overall project and the impact of the available funding for handling the identified risks.

### Mitigation/Enhance

Mitigation is a risk handling strategy that is taken to reduce the likelihood of occurrence and/or impact of an identified negative risk or threat, or to increase the likelihood of occurrence and/or benefit of an identified positive risk or opportunity. The goal of the mitigation risk handling strategy is to reduce the risk to an acceptable level.

The risk’s mitigation strategy will be developed as a stepwise plan that can be included in the IKC planning. The mitigation plan will be analyzed to ensure that it is feasible and that resources are available.

The term enhance is used for positive benefit risks. To enhance an opportunity is to increase the likelihood that it will occur. The necessity of identifying the trigger event is highlighted by attempting to enhance the opportunity by reinforcing the conditions identified in the trigger event.

## Residual Risk

Residual risk is the risk that is determined to remain after the risk handling strategy (accept, avoid, mitigate, or transfer) has been performed. A residual risk may end up being the same risk as the original risk if the risk handling strategy does not reduce or mitigate the risk or the risk is one that recurs.

## Risk Monitoring

The Monitor Risks process includes the monitoring and updating of identified risks, the implementation of risk mitigations and response plans, the management of residual and secondary risk, the retirement of risks that are no longer current, and the identification of new risks. It also includes the continual evaluation and improvement of the risk management process.

The <Partner Institution> TR, PM, and SPCs/SPCLs are responsible for leading the <Partner Institution> risk handling activities, together with the risk owners. High- and medium-rank risks, and all handover risks, are monitored by the <Partner Institution> PM and TR, who report on them to the EIEB and the relevant technical forums. Low Rank risks are monitored and handled by the sub-project managers and risk owners.

The Monitor and Control Risks process includes the approval and usage of risk contingency, if any, according to any agreed expenditure thresholds.

The PM and TR are ensuring that the risk register is accurate and up-to-date, and by preparing risk reports that address, for example: status of open risks; proposed new risks; changes to existing risks; and results of risk analyses.

Project risk reviews and workshops are carried out as required to ensure that the risk analysis and risk management processes are current and effective, which may lead to updated risk assessments and refinements of the risk management process. In particular, the EIC project will organize periodic reviews of all the project-wide risks, together with the relevant partners.