BrightnESS

Building a research infrastructure and synergies for highest scientific impact on ESS

H2020-INFRADEV-1-2015-1

Grant Agreement Number: 676548

Deliverable Report: D2.1 Risk Assessment and Mitigation Plan

1 Project Deliverable Information Sheet

BrightnESS Project	Project Ref. No. 676548	
	Project Title: BrightnESS - Building a research infrastructure and synergies for highest scientific impact on ESS	
	Project Website: https://brightness.esss.se/	
	Deliverable No.: 2.1	
	Deliverable Type: Report	
	Dissemination Level: Public	Contractual Delivery Date: 01 Dec 2015
		Actual Delivery Date: 01 Dec 2015
	EC Project Officer: Bernhard Fabianek	

2 Document Control Sheet

Document	Title: 20151201_BrightnESS_Deliverable 2.1	
	Version: 1.0	
	Available at: https://brightness.esss.se	
	Files: 1	
Authorship	Written by	Carlo Bocchetta, Senior Officer, BrightnESS WP2 Leader Allen Weeks, Head of Communications & External Relations Division
	Contributors	Gábor Németh, ESS Head of Collaboration Joel Wollberg, Risk Manager
	Reviewed by	Ute Gunsenheimer, BrightnESS Project Leader
	Approved by	BrightnESS Steering Board

3 List of Abbreviations

CH	Swiss Confederation
CZ	The Czech Republic
DE	Federal Republic of Germany
DG	Director General
DK	The Kingdom of Denmark
EE	The Republic of Estonia
EMT	ESS Management Team
EPG	ESS Programme Group
ERIC	European research Infrastructure Consortium
ES	The Kingdom of Spain
ESS	European Spallation Source
ES&H	Environmental Safety and Health
FR	The French Republic
HU	The Republic of Hungary
HQ	Headquarters
IK	In-Kind
IKC	In-Kind Contribution
IKCM	In-Kind Contribution Management
ILO	Industry Liasion Officer
IT	The Republic of Italy
IS	The Republic of Iceland
LOI	Letter Of Intent
LT	The Republic of Lithuania
LV	The Republic of Latvia
NL	The Kingdom of the Netherlands
NO	The Kingdom of Norway
PL	The Republic of Poland
RAMP	Risk Assessment and Management Plan
R&D	Research and Development
TA	Technical Annex
UK	The United Kingdom of Great Britain and Northern Ireland
SE	The Kingdom of Sweden
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Department)
WP	Work Package

4 List of Tables and Figures

Table 1: Top 10 ESS Risks 10
Table 2: Top risks relative to IKC 12
Table 3: Risks Associated to Individual ESS Projects 14
Table 4: Risks relative to IKC Partners 15
Figure 1: The generic ESS Risk Management Process 21
Figure 2: The Process Map 21
Figure 3: Five regional hubs act as main point of contact for all ESS IKC partners in the region and enable effective regional quality control 24

Table of Contents

1 Project Deliverable Information Sheet 2
2 Document Control Sheet 3
3 List of Abbreviations 4
4 List of Tables and Figures 4
5 Executive Summary 6
6 Report on Implementation Process and Status of Deliverable 7
7 Technical Content 8
7.1 Overview of types of In-Kind Contributions and the phases of participation in the ESS project 8
7.1.1 In-Kind Contributions at the European Spallation Source 8
7.1.2 The In-Kind Process at the European Spallation Source 8
7.2 Baseline risk assessment for the ESS arising from IKC 9
7.2.1 High-level ESS risks associated with IKC for ESS Management 12
7.2.2 IK Risks to be held by the Individual ESS Projects 14
7.2.3 Risks for Partners and the Successful Implementation of IKCs 15
7.3 ESS Risk Management Policy 18
7.3.1 List of terms and definitions 18
7.3.2 Objectives 18
7.3.3 Activities and Basic principles 18
7.3.4 Risk Management Responsibilities 19
7.4 Implementing and Maintaining Risk Management at the ESS 20
7.4.1 Risk identification and assessment 20
7.4.2 Monitoring and reviewing risks 20
7.4.3 Risk Response Plans 20
7.4.4 Risk register 20
7.4.5 Reporting 20
7.5 ESS Risk Management Process 21
7.5.1 Process Map 21
7.5.1.1 Activities and Tasks 22
7.5.1.2 Input 22
7.5.1.3 Outcome 22
7.6 Risk Mitigation for IKC in the Context of Brightness 22
7.6.1 Approach to Risk Mitigation for IKC 22
7.6.1.1 Assume and/or Accept 22
7.6.1.2 Avoid 23
7.6.1.3 Control 23
7.6.1.4 Transfer 23
7.6.1.5 Watch/Monitor 23
7.6.2 IKC Field Support Officers and Regional Hubs 24
7.6.3 In-Kind Information System For Coordinating IKC Activities 25
8 Conclusion 26
9 List of Publications 26

5 Executive Summary

The construction of ESS is as unique as the ESS itself; this new next generation spallation source is being built on a greenfield site, physically located in Sweden and Denmark. For both countries, the experience of building research infrastructures of this scale is new. To build ESS, most of the necessary skills for its development need to be imported through In-kind Contributions (hereafter IKC) from participating institutes and companies in the member states. The IKC approach is intended to foster collaborations between national academia and industry, representing the entire supply chain.

The mission for the ESS is the construction of the world's leading neutron source for material research. In order to achieve this mission it is necessary to build an ESS Organisation with the necessary skills to oversee the project and support its Partners with the capability to manage and integrate IKC into a one highly integrated machine. This heavy reliance on IKC from many partners, poses significant challenges in terms of the management of the technologies, interoperability, integration, quality and timeliness of delivery/construction/operation for a complex and technologically advanced project like ESS.

'In-Kind' is defined as non-cash contribution by a Member Country to ESS is in the form of:

- Technical components for the facility (also personnel needed to perform the testing, installation and/or integration)
- R&D work (also personnel needed to perform the work)
- Personnel made available for specific tasks during the construction phase
- Other products and services relevant for the completion of the facility

The ESS has fully recognised the risks associated with IKC and has taken necessary steps to handle and minimise them. To meet these needs, the ESS has developed a Risk Management Policy, which is based on three documents, including the ESS Risk Management Policy [1], the ESS Risk Management Process [2] and the ESS Risk Management Plan [3] as well as the risk register for the entire facility, which are described in further detail below.

The risks associated with IKC are analysed on different levels: High-level ESS risks associated with IKC for ESS Management, IK Risks to be held by the Individual Projects Accelerator, Target, NSS, as well as for the risks for IKC Partners across Europe and the successful implementation of IKCs.

One overarching aim is to support ESS in the smooth transition from initiation/planning to the implementation, construction and subsequent operation of the facilities. The project will develop a jointly managed approach that will minimise critical risks of delay and overspending by increasing coordination with a robust set of procedures, processes and tools; this will also help other/future research infrastructures to manage large-scale in-kind contributions from their members and thus create a stronger European Research Area.

BrightnESS, combines (A) the development of an integrated IKC management and monitoring system and (B) the creation of a truly collaborative community, very experienced European Research Organisation, as well as less experienced countries and institutes. This will be executed by Five Regional Hubs, which will assist the institutes in all Partner Countries to facilitate the IKC per country and support securing agreements with ESS, and comply with the qualitative and quantitative delivery of the In-kind Packages. The Regional Hubs will encourage collaboration and cooperation between institutes wherever possible.

6 Report on Implementation Process and Status of Deliverable

This report constitutes Deliverable 2.1 of the BrightnESS project, which is the Risk Assessment and Mitigation Plan (RAMP) for In-Kind Contributions (IKCs) by the ESS technical projects. BrightnESS enables ESS and its Partners to focus resources on high-risk activities, in this case managing and coordinating IKCs. It is intended to increase the overall possibility of success of the project, and mitigate potential problems by lowering the degree of uncertainty faced in a large, complex and distributed project.

Management of risk is a normal aspect of project management in the ESS project, but IKCs have been identified as particularly concerning because of the high degree of communication and coordination required to be successful. This work package will develop a mitigation plan to manage, eliminate, or reduce that risk to an acceptable level. The plan will be continually monitored to assess its effectiveness, and adapted where needed.

This document describes the ways in which risk-trajectories of IKCs are tracked, and mitigated, as well as procedures to alert ESS and relevant stakeholders about changing risk-levels and contingency options in case of delays, potential cost overshoots or quality issues. The RAMP provides a way to identify options soon enough for ESS to ensure success in achieving technical performance objectives and avoid costly construction delays or rework.

This document includes:

1. An overview of types of In-Kind contributions and the phases of participation in the ESS Project;
2. Baseline In-Kind risk assessment for:
    - High-level ESS risks associated with IKC for ESS Management (Section 7.2.1);
    - Baseline risks from Accelerator, Target, Integrated Control Systems and Neutron Scattering Systems (Section 7.2.2);
    - High-level risks identified by In-Kind Partners (Section 7.2.3).
3. The process for overall ESS risk management planning, procedures and decision-making.
4. Risk mitigation actions for IKC in the context of BrightnESS.

This document is delivered in the context of the BrightnESS as a baseline deliverable, but is envisioned as a dynamic, changing document, intended to inform management decision making in the context of fast-developing, construction project. Regular versioning will be maintained for reference and comparison.

In the context of the ESS project, *Risk mitigation planning* is the process of identifying and assessing specific risks and then developing actions to enhance opportunities and reduce threats to project objectives. *Risk mitigation implementation* is the process of executing risk mitigation actions. *Risk mitigation monitoring* includes tracking identified risks, identifying new risks, and evaluating risk management effectiveness throughout the project.

7 Technical Content

7.1 Overview of types of In-Kind Contributions and the phases of participation in the ESS project

7.1.1 In-Kind Contributions at the European Spallation Source

At least 15 European countries will together construct and operate the European Spallation Source ERIC (ESS). With a baseline construction cost of €1.843 billion, an important financing objective is to deliver €750 million by partners in the form of In-Kind Contributions (IKCs). This involves nearly 100 partner institutes/laboratories and more than 200 work packages. First neutrons on the target are expected in 2019, the user program planned for 2023.

'In-Kind' is defined as non-cash contribution by a Member Country to ESS is in the form of:

- Technical components for the facility (also personnel needed to perform the testing, installation and/or integration)
- R&D work (also personnel needed to perform the work)
- Personnel made available for specific tasks during the construction phase
- Other products and services relevant for the completion of the facility.

7.1.2 The In-Kind Process at the European Spallation Source

The In-Kind process is described in the "In-Kind Contribution Management Plan" [4] where three phases are identified in the delivery of partner contributions, namely:

Preparation: A precondition of IKC Implementation activities is to have a signed contract between ESS and the relevant IKC Partner. The implementation process will cover the planning, design process, production, quality acceptance testing, integration, commissioning and the final approval of the product, solution or services delivered by the IKC Partner.

Implementation: Based on the IKC contract and its annexes the Partner shall perform the work as agreed in the schedules and prepare the relevant deliverables according to the phases, milestones defined by the agreement. Execution of work may trigger changes (delays, variations, defects). In addition continuous control, quality assurance and acceptance tests have to be performed and reported and project management controls followed.

Conclusion: The final phase accomplishing a final evaluation of the performance of the In-Kind contribution and its accreditation.

Major issues identified with In-Kind contributions include:

- The potential difficulties to control multiple relationships and interfaces;
- A lack of resources to ensure standards definition and enforcement;
- Delays arising from mismanagement of the many (decentralized) dependencies and interfaces between partners;
- Weakened communication between partners due to the geographic distances that can impact information between milestones and the high-level of coordination required for integration at Lund and integration of sub-assemblies.

These high-level issues present risks to the ESS project, in that they contribute to uncertainty in being able to deliver the intended result relative to a plan. They are addressed in the BrightnESS program of activities and tasks in more detail.

7.2 Baseline risk assessment for the ESS arising from IKC

ESS has established a specific Risk Management Policy and Risk Management Processes (as described below) that guide risk management processes and controls them during the whole Programme lifecycle. IKC related risks have to be managed according to the generic Risk Management procedure. The table in this section summarizes the top risks for the ESS. The columns show the potential event, the causes, the impact on the ESS and mitigation actions.

To do that successfully, all relevant stakeholders, including the projects and the Partners should be committed to address risk management proactively and consistently throughout the project.

In particular, IKCs have been identified as a source of risk to the project due to the uncertainty associated with cooperation among nearly a hundred partners in 17 countries. These partners are heterogeneous, including large and established laboratories, university departments, and industrial partners.

IKC related risk identification activities may start at the Preparation phase. Since it is an iterative process, new risks may evolve or become known as the project progresses through its life cycle during any Phase of the IKC process.

The recommended format of the risk statements should be consistent with the requirements of ESS Risk Management Team to ensure that each risk is understood clearly and unambiguously in order to support effective analysis and response development.

The IKC risk identification process involves the ESS Risk Management Team, the ESS In-Kind Contribution Management (IKCM), the related ESS Projects and IKC Partners so they can develop and maintain a sense of ownership and responsibility for the risks and associated risk response actions. Risks will be analysed and categorized according to recommended methodologies used by the ESS Risk Management Team.

To be able to manage IKC related risks successfully, all relevant stakeholders, including the Projects and the Partners should be committed to address risk management proactively and consistently throughout the project. IKCM is to be informed on these risks as soon as possible.

Based on the analyses IKCM risk impact has to be defined and the strategy determined. Risk handling (avoidance, mitigation, acceptance or transfer) will be planned together with the involved Parties and the Risk Management team.

IKCM related risks will be registered according to the standard Risk Management Process of ESS and these risks have to be re-evaluated, updated regularly.

The listed events are potential risks that *may* arise in the course of project execution. The chance of an event occurring depends on various factors. Identification of these potential events and their cause permits preemptive actions that will either eliminate or lessen consequential harmful effects to the successful conclusion of ESS construction and its scope.

Table 1: Top 10 ESS Risks

Potential Event	Cause	Impact	Mitigation
Mid level requirements not set and communicated in time, or being completed with insufficient quality.	*Lack of overview. *Lack of synchronization between projects. *Lack of communication between projects.	*Late freeze of design and failure to meet project requirements, causing late changes and redesign.	*Adopt appropriate Systems engineering implementation tools and methods. *Correct implementation of Technical Coordination. *Conduct Design Reviews.
Failure to reach the identified level of possible IKC and to have contracts in place.	*Lack of detailed technical baseline. *Unsuccessful negotiations on individual contracts. *Uncertainties in WP scope *Lack of resources, eg. in project and in-kind management. *IKC partners lacking green light from their funding agencies to sign *IKC agreements.	*Increased use of cash resources, cost overruns, schedule delays and quality and function issues. *Also, cash-flow may become a problem	*In depth analysis of ESS work packages for IKC. *IKC test cases. *IKC principles R&R Finalize Schedule template. *Cascading information IKC template IKC potentials.
Failure to incorporate Operations requirements in the design. e.g. regarding property maintenance, staffing, user requirements, safety etc.	*Lack of interest/competence amongst designers as regards Operations. *Lack of input and defined requirements as regards Operations.	*Poor function, increased operational costs, project cost overruns and schedule delays due to late changes and adjustments	*Systems engineering need to be fully involved. *Experienced staff need to be hired. *Commissioning and operations plans need to be developed
Delivered IKC equipment does not fulfill requirements (technical, functional and/or ES&H)	*Insufficient technical specifications in contracts. *Lack of uniform/sufficient interaction with IKC/partner labs. *Lack of procedures and tools data exchange and knowledge transfer.	*Poor quality and function, schedule delays and potential ES&H issues	*Make sure that the appropriate Technical expertise is available at both partner and ESS. *Appropiate Procedures and tools need to be put in place
Coordination, breakdown, and implementation of ES&H requirement fails	*Unclear responsibilities between projects and ES&H functions. Lack of ES&H competence and/or focus among designers. *Lack of focus on ES&H from ESS management. *Too few ES&H resources. *Too weak and late involvement of ES&H in design process	*Poor ES&H solutions, schedule delays due to redesign, delayed permits 1,2,3 from SSM or permits temporarily withdrawn. *Minor or severe accidents or injuries.	*Adher to the Recruitment ES&H plan. *Uphold good communications with SSM. *Coordination of resources System engineering vs ES&H.

Potential Event	Cause	Impact	Mitigation
Several key employees leave ESS during Construction phase.	*Compensation levels. Taxation rules - 36 months of expert taxation. *Poor group dynamics. *Relocation money is spent	*Loss of crucial competence, quality of deliverables and schedule delays.	*Increase the flow of Information to Employees. Initiate Dialogue with the host countries. Greater Spouse support, alternative place of residence.
ESS fails to coordinate procurement of raw materials and/or key components needed in several projects	*Time is inadequate for supply needs. *Material needs not properly defined. *Inadequate monitoring of price development on world market.	*Cost increases. Opportunity to decrease cost if managed properly	*Identify key suppliers. *Identify common standards (i.e. electronics, cryogenics, etc.). *Develop Advance Procurement Plans for Target, Accelterator, ICS and NSS.
Inappropriate level of property protection in Operations	*Lack of guidance from management on what level of property loss that can be accepted. *White spots in requirements, not covering property protection perspective Sub-optimization between Construction phase and Operations phase.	*Large risk exposure as regards property damage; increased operations cost through damages, down time and costly insurance solutions; *Poor flexibility/ scalability for future needs; sub-optimization between different protective systems.	*Conduct Stakeholder analysis. *Develop Facility benchmarking. *Define a comprehensive strategy for operations
Critical procurement fails, or many major procurements fail.	*Lack of procurement resources. *Lack of procurement experience within project teams. *Vague/unclear procurement processes, or overly complicated procurement processes. *Insufficient procurement plans, and lack of overview of coming critical and procurements.	*Schedule delays, poor quality or function, and/or cost overruns. *Increased operational costs.	*Identify external causes of failure. *Improve Procurement processes with more robust Procurement planning. *Enhance Procurement Resources
Lack of interim storage, workshops, office space and test labs during construction, installation and commissioning.	*Insufficient overview and coordination of requirements Insufficient funding	*Schedule delays, costly reactive solutions, poorly adjusted installations and potentially personal injuries.	*Recruit a Logistics Manager. *Immediate stop of lease agreements to save funds. *Outsource Logistics. *Identify and document needs for logistics.

Three areas of risk are identified as elements impacting ESS project objectives. The first area deals with risks that affect the general ESS management of the project (finances, resources and timeline), the second deals with technological aspects of IK risk to the ESS projects (i.e., accelerator, target, scientific instruments, etc.), while the third area deals with risks to the partners arising from their undertaking of activities for the ESS, whether these are high level management risks or technical risks.

7.2.1 High-level ESS risks associated with IKC for ESS Management

ESS management may be exposed to high-level risks arising from IKC's. Such risks are associated to broad areas affecting primary project objectives (budget, milestones and scope). At a lower level they can affect the organizational structure of the ESS (i.e., formation of specific groups to handle IKC activities or requirements from groups such as standards and quality assurance or in this particularly relevant case the creation of the BrightnESS project).

Table 2: Top risks relative to IKC

Potential Event	Cause	Impact	Mitigation
ESS as a whole fails to reach the required percentage of In-Kind contributions	* Extensive delays in setting up the IK Agreements means that work is done in house to maintain the schedule * No IK Partners are willing to do the IKC are found or Partners who could have done the IKC have already fulfilled their In-Kind quotas * Work was not specified sufficiently well to allow IK partners to bid for it * Lack of resources at the ESS, eg. in project and in-kind management, to identify and manage IKCs * Lack of resources at Partners eg. in project and in-kind management, to set up and manage IKCs.	*Requires a higher share of cash to fund the project.	* Expedite documentation covering IKCs that are on or close to ESS' critical path * Encourage IK partners to take on unfavourable work packages * Make sure all IKCs are properly defined * Ensure that ESS provides suitable resources to manage IKC * Encourage partners to provide sufficient resources to manage IKC
Approval of IKC Agreements are delayed	* Partners are waiting for the ERIC to be signed before agreeing to IKC Agreements and TAs * Lack of urgency with partners and country/institute internal delays in funding streams and approvals * Lack of Partner resources to work with IK, ESS and to compile documentation * Lack of ESS resources to work with IK partners and to compile IK documentation	*Delay to overall project schedule	* Ensure resources and management emphasis is applied to the completion of IK documentation * Priortise IKCs * Provide assistance to partner countries and institutes to expedite funding and approvals. Encourage partners to adopt efficient and timely approach * Support the quick transfer of ERIC status to ESS

Potential Event	Cause	Impact	Mitigation
IK deliverables do not achieve ESS expectations	* Poorly specified agreement documentation * Poor IK management from the ESS (including communication of quality assurance requirements, standards and the clarity of interfaces) * Poor support from Partner countries and institutes towards the IK activity (resources and priorities)	*Delay in subsystems and reworking require additional funds. *Delay in project milestones.	* Detailed contractual documents addressing all aspects of the IKC to avoid future issues * Good IK oversight from ESS. Regular, open project meetings. * Encourage partner countries to provide appropriate guidance and resources to institutes to manage IKCs.
Poor relationships between ESS and Key IK Partners	* Disagreements caused by lack of clarity in obligations between the ESS and Partners. This is due to contractual documentation omitting or confusing obligations. * Poor communication between partners and ESS. * Lack of appropriate forums to manage IK partners and resolve issues quickly and with minimal impact	* Delays, extra cost, poor working relationships in Operations. * Partners reduce funding and support for ESS construction and Operations. In worse case partners leave ESS	* Ensure transparency in all obligations. Detailed documents addressing all aspects to avoid future misunderstandings * Hold regular, open communication during the preparation, execution and closure of IKCs in appropriate forums with the relevant personnel * Detailed procedures to resolve issues quickly and effectively reducing the impact on the programme

7.2.2 IK Risks to be held by the Individual ESS Projects

The ESS is composed of many technological work packages, termed "projects", both in hardware and software spanning the accelerator, target, instruments and control systems. These technological projects have potential risks associated to them that may arise in the course of IK activities. The following table illustrates potential relevant technological risks to the ESS projects.

Table 3: Risks Associated to Individual ESS Projects

Potential Event	Cause	Impact	Mitigation
Projects fail to reach the percentage of IK contribution required	* Extensive delays in setting up the IK Agreements means that work is done in house to maintain the schedule * No IK Partners willing to do the IKC are found or Partners who could have done the IKC have already fulfilled their In-Kind quotas * Work was not specified sufficiently to allow IK partners to bid for it * Lack of resources at ESS, eg. in project and in-kind management, to identify and manage IKCs	*Greater cash funding is required.	* Expedite documentation covering IKCs that are on or close to ESS' critical path * Persuade IK partners to take on unfavourable work packages * Make sure all IKCs are properly defined * Ensure that ESS provides suitable resources to manage IKC * Encourage partners to provide sufficient resources to manage IKC
Approval of IKC agreements are delayed	* Lack of ESS resource to identity IKCs and to work with IK partners and compile IKC agreements and technical annexes	*Delays to the schedule	* Ensure resources and management emphasis is applied to the completion of IK documentation * Priortise IKCs
IK deliverables do not achieve ESS expectations	* Poorly specified agreement documentation * Poor IK management (including Quality Control) * IK Partner does not contribute sufficient resources and support to achieve the tasks on time and to the required performance	*Delays and reworks require additional funds	* Detailed contractual documents addressing all aspects of the IKC to avoid future issues * Good IK oversight from ESS. Regular, open project meetings. * Encourage partners to provide appropriate guidance and resources to institutes to manage IKC.
Poor relationships between ESS and IK Partners	* Lack of clarity in obligations between ESS and Partners * Lack of procedures to resolve issues	*Delays, extra cost, poor working relationships in Operations	* Ensure transparency in all obligations. Detailed contractual documentation addressing all obligations to avoid future misunderstandings * Hold regular, open communication during the preparation, execution and close of IKCs in appropriate forums with the relevant personnel * Detailed procedures to resolve issues quickly and effectively reducing the impact on the programme

7.2.3 Risks for Partners and the Successful Implementation of IKCs

In a manner analogous to the ESS, partners are also exposed to risks both at the management and technological level. The nature of these risks is similar from the technological perspective but may differ when considered at the management level.

A large aspect of the risks associated with IKC lie in the area of responsibility of the partners. The partners are heterogeneous, ranging from large and established laboratories to newer and smaller institutes with varying degrees of experience and levels of funding. Each contributing partner has a different approach to handling IK and the related risks that come with it due to the fact that they operate under different conditions.

To be able to manage IKC related risks successfully, all relevant stakeholders, including the Projects and the Partners should be committed to have a common approach and address risk management proactively and consistently throughout the project.

The majority of identified partners already has extensive and comprehensive risk management and risk mitigation policies in place and are experienced project leaders and coordinators in highly specialized technological areas. Risk management in these world-leading laboratories is standard practice. Smaller institutes may have less advanced approaches and will be assisted in setting up ESS compliant procedures.

Table 4: Risks relative to IKC Partners

Potential Event	Cause	Impact	Mitigation
Poor In-kind documentation templates	* Does not sufficiently cover all project, risk, legal and quality obligations * Documentation is not flexible enough to cover all the varieties of IK Contributions (such as secondment or IK partners being prime contractors) * Documentation is confusing to read * Key partners unwilling to sign documentation	* Time wasted compiling confusing documentation * Documentation is confusing or not suitable for IK Partners. Partners do not understand their obligations to ESS and hence deliverables are adversely impacted * IK partners do not sign documentation causing delays, rewrites and a breakdown of a common set of documents for all partners	* Ensure that the contractual documentation covers all the obligations of the IKCs for both parties * Ensure that the contractual documentation is flexible enough to cover all the varieties of IKCs * Train personnel in writing the documentation
Projects adopt differing IK working practices and documentation	* Projects are too autonomous and don't follow templates, recommendations and guidelines from IK Management team * Guidelines and templates for IK are missing, poor quality or not suitable to all varieties of IKCs.	Each project handles IK separately leading to confusion internally to control IK and with partners having different conditions according to the project involved. Externally it is confusing for partners and leads to a reduction of creditability of ESS	* Ensure that clear, easy to use documentation is available. * Train the projects in the use of the documentation * Follow up on the working practices of the various projects to make sure a common standard is adopted * Approve all documentation and don't be afraid to reject documentation that doesn't reach the common standard

Potential Event	Cause	Impact	Mitigation
Provision of In-Kind metrics is inaccurate	* Information in P6 is obsolete and/or confusing/inaccurate and is not labeled in an appropriate manner to allow data to be extracted. * Projects do not provide regular accurate data on the status of the IK Contributions and agreements	* Hard to judge the true status of IK and to make appropriate management decisions * Loss of creditability of the IK group reporting both internally and externally	* Ensure the planners together with the WP Managers and Project Management regularly input accurate and useful data into P6. * Ensure the correct settings and tools are available in P6 to extract useful data * Create an environment in which projects provide regular, correct and useful information on the status of IK
Poor provision made in contractual documentation for support of equipment during Operations	* Provision of initial spares missing from IK documentation * Provision of maintenance procedures missing from IK documentation * Lack of strategy for operations support when compiling IKC construction agreements	* No support for equipment after delivery causing downtime and additional expense and delays * Need time and resource compiling additional negotiations and agreements to cover operational support. * Partners might not agree to maintenance support which could have made a difference when selecting a partner	* Include provisions for initial spare packages and maintenance routines in IKC construction documentation * Have discussions on models for operations support during negotiations for IKCs
Not enough technical staff available	*Not enough staff with the right technical competence	*Delays in project schedule	*Establish duties and responsibilities. *Study the profile of the positions needed. *Hire appropriate employees with the right technical-profile. *Subcontracting of engineering companies.
Different standards in Quality Assurance	*Implementation of a Quality Management System different from the Partner Institute/Laboratory. *Delay in defining the Quality Standards from ESS or the Quality standards are too high.	*Increased workload not considered in the planning. Increasing costs, Possible delays.	*Direct and constant contact with Quality department from ESS. *Negotiation of quality standards between ESS and the partners.

Potential Event	Cause	Impact	Mitigation
Poor coordination and communication with ESS	*Requirements not set and communicated on time. Constantly changing requirements even during the manufacturing/ construction phase. *Requirements sets only under technical criteria, not having costs on mind. Contradictory requirements for different groups from ESS. *Unclear use of DOORS and CHESS applications. ESS changes the requirements without negotiation/communication with the in-kind partner responsible of the task (WP).	*Delays in project schedule, not meeting full scope *Increase in costs *Change of scope in other areas of the project – impacts other partners and ESS	*Reinforcement of communication with ESS. Better use (efficient use) of tools to manage and share documents. *Set requirements in the early stages of the project (they can not be changed) and with the budget on mind. *Knowledge and acceptance of the requirements for all the departments involved and the partners. *Rigorous change control
Standardization process	*The standardization process is being developed in ESS only under technical criteria, not having budget or costs on mind. *Unable to fulfil the standards inside the cost book. *The standards (still to be defined) are going to be set after the negotiation, with a closed budget for the IK work.	*Delays in project schedule, increased costs	*Set technical standards by ESS including the costs related (ASAP). *New negotiation with partners.
People working for the IKC in Sweden. Problems with secondment.	It is not possible for partners to send people to work to Sweden (ESS), as part of IK work, longer than 180 days because of tax problems	*Delays in project schedule	*New tax law for great scientific consortiums in Sweden. *Sweden and Denmark to fulfil the previous promises/compromise from the candidature period.
Interface issues	*The equipment design for IK work involves a very important part of coordination and integration between different departments of a partner as well as with different groups of ESS. *Interface issues. Too many people, too many opinions.	*Delays in project schedule, failure at integration, malfunction	*Strong coordination work of the interfaces by ESS is needed. *An interface coordinator for each WP should be appointed inside ESS and inside the partner institute/laboratory. *Constant communication and exchange of information between them. *Regular meetings.

7.3 ESS Risk Management Policy

The Risk Management framework at the ESS is based on three documents and the risk register. The ESS Risk Management Policy [1] contains vision, objectives and main principles for the risk management efforts within ESS as a whole, the ESS Risk Management Process [2] describes universal processes, flowcharts and criteria for risk assessment, whereas the ESS Risk Management Plan [3] specifies roles, responsibilities and time frames as regards risk related activities at different levels of the organization. A template for the risk register can be found in ref [6].

The ESS Risk Management Team, a part of the Project Support Division, manages the ESS risk register based on ESS criteria defined in the "ESS Procedure for Risk Management" [5].

This section summarizes the contents of this framework.

7.3.1 List of terms and definitions

Term	Definition
Risk	Risk is effect of uncertainty on objectives, expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence.
Risk Management	Coordinated activities to direct and control an organization with regard to risk.
Uncertainty	Limitation of knowledge, understanding and/or lack of information of a state or an event, its likelihood or consequence.
Risk response	The process and measures being taken in order to modify the risk to an acceptable level.
Risk register	The record containing relevant and updated information about risks and risk treatments.
Risk level	Magnitude of a risk or combination of risks. Depending on assessed combinations of likelihood and consequence, the risk level can be described as high, medium or low.
Risk criteria	Defined scales for likelihood and consequence used to assess risks in a uniform way.

7.3.2 Objectives

The objectives for the Risk Management efforts are to have frequent and open risk communication within the ESS, with IKC partners, suppliers and vendors, enabling clear and common views of risks and uncertainties. The aim is to decreased risk exposure by rapid and active implementation of risk responses. Focus and attention on potential issues is to be achieved by effective internal and external risk reporting. With that information, effective decisions and strategic adjustments can be made in a timely way. In addition to downside risks, there may be opportunities identified and integrated into plans and solutions as a result of risk analyses and risk response implementation.

7.3.3 Activities and Basic principles

A common view of what Risk Management is and how it is conducted is taken. Definitions of key concepts and terminology are uniform on all levels. This is achieved through education in Risk Management principles and in workshops in which the principles are utilised.

The Director General (DG) has the ultimate responsibility for all risks and risk responses; though it is central that risks are managed at the most appropriate level using the best available competence in each area. The ESS Directors are responsible for developing and implementing Risk Management plans for their respective Directorates. The execution of the Risk Management efforts may, in accordance with the Risk Management plans, be delegated to Managers and Group Leaders within the Directorates. Moreover, escalation is carried out without delay, when deemed necessary according to the risk acceptance criteria. Everyone in the entire ESS organization continuously identifies and communicates risks and uncertainties. Only the DG, Directors, and Project Managers are risk owners, however, ownership of risk responses may be delegated further.

Identified risks and related risk responses are, when deemed relevant and efficient, mapped to other processes within ESS, e.g. Configuration Management, Change Control Process, Procurement, In-Kind process, and Communications. Risks are thereby treated by the most suitable expertise and duplication of work is avoided.

Recurring stakeholder analyses provide input to risk identification and important perspective when assessing probability and consequence. In addition a clear view of stakeholders enables effective communication of risks.

Frequent and coordinated risk reporting, including feedback loops, enables common views on risks, support decision-making and enable strategic adjustments under consideration of risks and uncertainties.

7.3.4 Risk Management Responsibilities

The DG has the overall responsibility for risks and risk responses at ESS. The day-to-day work required is delegated to the Risk Management function.

The ESS Management Team (EMT) supports the DG by implementing Risk Management in the Directorates respectively (see below). EMT members can be delegated ownership of ESS level risks and related risk responses.
The ESS Project Directors are responsible for: Implementing and maintaining Risk Management, the Directorate's risks and opportunities, Actively treating Directorate's risks, Maintaining the Directorate's risk register and Communicating the Directorate's risk exposure.

The ESS Project Manager is responsible for: Continuous work with risk identification, risk analysis, and risk evaluation, the Project's risks and opportunities, actively treating Project risks and maintaining the Project's risk register and communicating the Project's risks exposure.

The ESS Risk Management team is responsible for the definition, implementation, maintenance and improvements of the ESS Risk Management framework, including Policy, Process and Plan. They are also charged with ensuring quality assurance of the ESS Risk Management Process across the organization and actively supporting the entire ESS organization.

7.4 Implementing and Maintaining Risk Management at the ESS

7.4.1 Risk identification and assessment

Risk identification is part of the daily interactions of the ESS teams. Project Managers are responsible for planning and executing Project-level risk workshops on a quarterly basis, as minimum. The extent, set-up and the level of detail is adapted to the situation. The Risk Management function is responsible for planning and executing ESS risk workshops as well as cross-functional workshops for specific topics on demand or on request by anyone in the ESS organization. Workshop support is provided by the Risk Management function.

7.4.2 Monitoring and reviewing risks

Routines for monitoring and reviewing risk on all levels are established and scheduled. This includes re-assessments, following up on the completeness of risk responses and deadlines.

Status updates as regards risk exposure are a standing item on the agenda on the weekly management meetings and the Monthly Project Review meetings, including review of the risk register and risk response status, level of completeness and treatment plans. The Risk Management function arranges monthly meetings with risk register administrators. The purpose is to process identified risks, refine information when necessary and to ensure quality of the risk registers. The Risk Management function furthermore arranges meetings with owners of specific risks on demand, or when requested.

7.4.3 Risk Response Plans

Risk Response Plans are reviewed and approved at the most appropriate level, within the given mandate.

7.4.4 Risk register

It is in the responsibility of the Project Directors to ensure that the risk registers are updated. The software package Exonaut Risk is used as the main tool for maintaining and monitoring risk registers.

7.4.5 Reporting

ESS Risk Reports, primarily used for external reporting, are prepared and updated monthly by the Risk Management function and present the top risks of the Project and to ESS. The Risk Management function develops and maintains performance measurements that are used for internal reporting and feedback loops within the organization.

7.5 ESS Risk Management Process

The ESS Risk Management Process [5] describes the flowchart and instructions regarding definitions, methods, risk acceptance criteria (probability, consequence), risk responses, and reporting (see below).

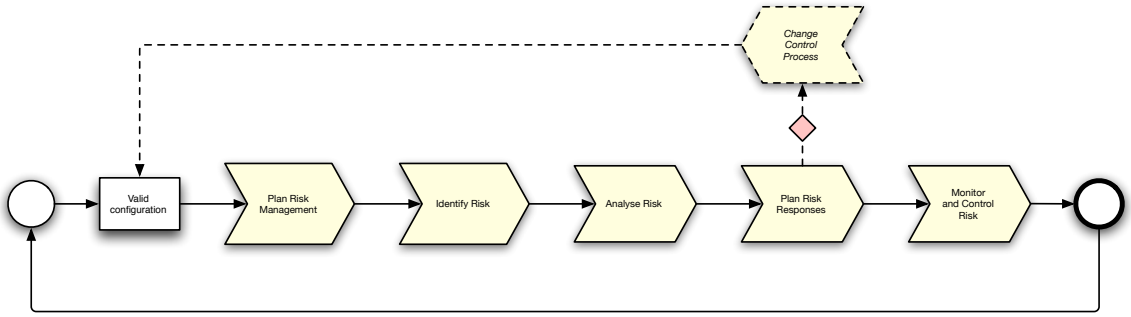

Figure 1: The generic ESS Risk Management Process

The purpose of the Risk Management Process is to identify, analyze, treat and monitor the risks continuously. The Risk Management Process is a continuous process for systematically addressing risk throughout the lifecycle of a system product or service. It can be applied to risks related to the acquisition, development, maintenance or operation of a system and to in-kind contributions, whether they be services or systems. The process applies to all staff working within European Spallation Source. The Risk Management Process is iterative, following the steps in Figure 1.

Risks identified within a specific project are compiled on project level. Assessments follow the agreed Risk Acceptance Criteria, and that documentation on project level is done in the appointed risk register. The project internal workflow may however vary between projects.
The Risk Management function compiles the largest risks from all projects as well as major risks from specific functions and risks identified in cross-functional workshops. Moreover, top management, who also assign risk responses, appoint ownership and delegate actions to instances concerned, and assesses consequences for the ESS project as a whole.

Whenever a risk or a risk response impacts on the valid configuration or baseline, the Change Control Process is to be applied.

7.5.1 Process Map

The risk management flow chart is show in Figure 2 and is composed of an identification and input of activities and tasks, followed by management of risks, management of the risk profile and the analysis, treatment and monitoring of risks with an evaluation of the process applied.

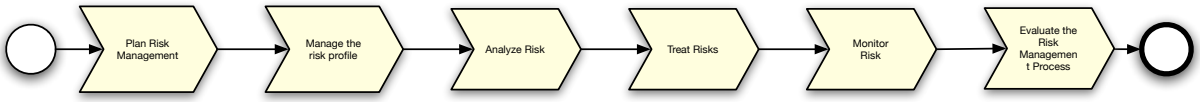

Figure 2: The Process Map

7.5.1.1 Activities and Tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Risk Management Process.

7.5.1.2 Input

Input comes from Stakeholder analysis, goal statements, project plans, and requirements. Periodically review risk information on the risks identified, their treatment, and the success of the treatments for the purposes of identifying systemic project and organizational risks.

7.5.1.3 Outcome

Appropriate risk management strategies are defined and implemented. Risks are identified as they develop and during the conduct of the project. Risks are analyzed, and the priority in which to apply resources to treatment of these risks is determined. Risk measures are defined, applied, and assessed to determine changes in the status of risk and the progress of the treatment activities. Appropriate treatment is taken to correct or avoid the impact of risk based on its priority, probability, and consequence or other defined risk threshold.

7.6 Risk Mitigation for IKC in the Context of Brightness

The aim of BrightnESS is help move the ESS research infrastructure from its initial/planning phase to the implementation phase and to keep physical construction of the site and development and delivery of vital equipment and components aligned.

With regard to explicit risk mitigation, BrightnESS will establish a management and coordination system for In-kind Contributions of Partners. This consists of a) an approach to risk specific and explicit for all stakeholders b) a network of trained engineers working daily to identify and resolve issues at an early stage, and c) an information database specifically for the purpose of sharing information relative to IKC. This will help the ESS ensure a smooth transition from initiation/planning to the implementation, construction and subsequent operation of its facilities and improve the possibility of success in the collaboration.

7.6.1 Approach to Risk Mitigation for IKC

The specific approach to risk mitigation, as it applies to In-Kind work and Partners is outlined in the following section. The underlying principle is to become aware of risks, make them explicit to all the relevant project stakeholders, and then be in a position to make a decision on how to handle the risks in a meaningful time frame. There are, roughly speaking, five approaches ESS will use respond to IKC risk. None should be applied as a single approach, but as a set of strategies, used together to enable a range of options.

7.6.1.1 Assume and/or Accept

The first approach may be to assume and or accept certain risks. It may be necessary to simply acknowledge the existence of a particular risk relative to In-Kind, and decide to accept it without engaging in special efforts to control it. Collaboration with IKC partners to create a collective understanding of risks and their implications is a precondition. Risks may be characterized as impacting cost, schedule, and performance parameters. Risks should also be characterized as impact to mission performance resulting from reduced technical performance or capability. Bringing IKC partners into the impact characterization is important to selecting which "assume/accept" option is ultimately chosen. The IKC partners and project leaders together will decide whether accepting the

consequences of a risk is acceptable. The IKC partners must be aware of the vulnerabilities affecting a risk, countermeasures that can be performed, and residual risk that may occur.

7.6.1.2 Avoid

Adjust requirements or constraints to eliminate or reduce the risk. This adjustment could be accommodated by a change in cost, schedule, or technical requirements. It is important again to work with IKC partners to achieve a collective understanding of the implications of risks. They must be given forecasted schedule adjustments needed to reduce risk. Capabilities are identified that will be delay any impacts resulting from dependencies on other efforts. This information better enables IKC partners to interpret the operational implications of an "avoid" option.

7.6.1.3 Control

Control risks by performing analyses of various mitigation options. For example, one option is to use a commercially available capability instead of a developed one. In developing options for controlling risk in a project, it may be necessary to seek out potential solutions from similar risk situations of other IKC partners, industry, and academia. When considering a solution from another organization, special care must be taken in assessing any architectural changes needed and their implications.

7.6.1.4 Transfer

Reassigning accountability, responsibility, or authority for a risk area to another organization can be a double-edged sword. It may make sense when the risk involves a narrow specialized area of expertise not normally found, but transferring a risk to another IKC Partner, or the ESS Organisation, can result in dependencies and loss of control that lead to other complications.

7.6.1.5 Watch/Monitor

Once a risk has been identified and a plan put in place to manage it, there can be a tendency to adopt a "heads down" attitude, particularly if the execution of the mitigation appears to be operating on automatically. It is important to periodically revisit the basic assumptions and premises of the risk. The environment is regularly scanned to see whether the situation has changed in a way that affects the nature or impact of the risk. The risk may have changed sufficiently so that the current mitigation is ineffective and needs to be scrapped in favor of a different one. On the other hand, the risk may have diminished in a way that allows resources devoted to it to be redirected.

Each of these options requires developing a plan that is implemented and monitored for effectiveness. The availability of resources to respond to risk may also be an important factor when determining the approach.

Once risks do appear, the methods of risk reduction or mitigation with identified program risks include the following, listed in order of increasing seriousness of the risk:

1. Intensified technical and management reviews of the engineering process
2. Special attention to designated components and their design and engineering
3. Special analysis and testing of critical design items
4. Prototyping and test feedback
5. Consider of relaxing design requirements
6. Initiate fallback/backup parallel developments

It is up to the BrightnESS WP2 leader, along with the ESS Head of In-Kind and respective project leaders, to assess the performance, schedule, and cost impacts of respective mitigation strategies.

7.6.2 IKC Field Support Officers and Regional Hubs

A key strategy for risk mitigation as supported by BrightnESS activities is to establish a management and coordination system for In-kind Contributions of Partners. This will help the ESS ensure a smooth transition from initiation/planning to the implementation, construction and subsequent operation of its facilities. The primary initiative to this end is the establishment of a network of IKC Field Support Officers and Regional Hubs, located in the field with IKC Partners. An important aspect of this is that is takes into account local issues and enables information to flow back to ESS sooner. It also puts resources in place to ensure early understanding of potential issues and better coordination.

ESS Field coordinators will be in charge of establishing everyday communication with In-Kind partners through utilizing knowledge of both the In-Kind processes and procedures, ESS needs, as well as local industrial and institutional capacities. These individuals will act as representatives of ESS, providing support in key components of In-Kind collaboration.

The first and foremost responsibility IKC Field Coordinators will have is coordination between ESS and its respective partners. This coordination may include different types of interactions, responsibilities and tasks. Firstly, the IKC Field Coordinators will support ESS in securing work packages with potential IKC partners in partner countries. They will offer assistance in evaluating merits and partner capabilities, which they will be familiar with the most, given their work profile. The IKC Field Coordinators will report their activities in Lund and to the partners, keeping a strong connection between the Work Unit coordinators and IKC Partners. With this in action, they will also have a task of harmonizing efforts with local ILOs, bridging the ever-present gap between industry and institutes.

Furthermore, IKC Field Coordinators will observe and facilitate transfer and transportation of in-kind instruments and parts to and from ESS facility in Lund. In collaboration with a strategic partner, specialized tracking services will be provided in order to facilitate tracking of goods and services in transit.

IKC Field Coordinators will be expected to spend a majority of their time on the road, constantly interacting with potential and current partners. Their responsibilities will be defined on a geographical basis.

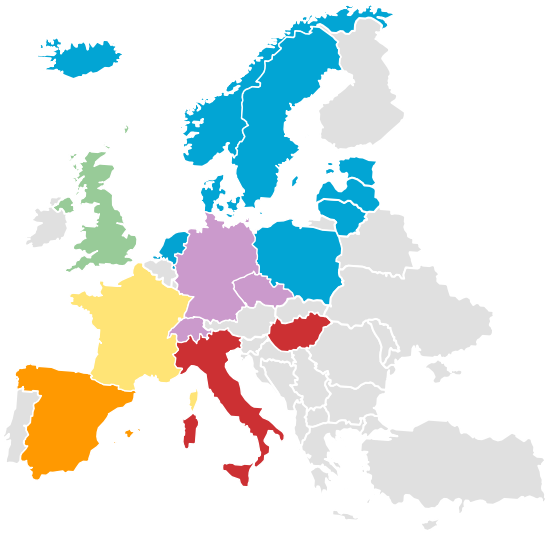

Figure 3: Five regional hubs act as main point of contact for all ESS IKC partners in the region and enable effective regional quality control

The five regional hubs and the ESS HQ hub are defined as follows:

- North-West: UK
- Central: DE, CH, CZ, PL
- Iberia: ES
- Gallia: FR
- South-East: IT, HU
- ESS HQ: SE, DK, NO, NL, IS, LT, LV, EE

Regional hubs are expected to supervise the timely and qualitative delivery of IKC in their region. They will be involved and support all three phases of the IKC process. Regular meetings between the ESS HQ and the regional hubs will take place twice a year.

7.6.3 In-Kind Information System For Coordinating IKC Activities

The ESS IKC activities entail interactions between more than 200 work package and multiple project leaders in ESS. Combined with multiple corresponding partner representatives the number and quality of interactions between the ESS and IKC partners represents a significant management challenge. There will be multiple opportunities for misunderstanding and miscommunication on a daily basis for a project that will remain in construction for a decade. This is a large potential risk space and requires a specific solution to help enable and monitor information flows relative to IKC activities.

The aim is to establish a centralized database that will provide support to the In-Kind Management coordination office, management, and governance of the ESS Project. This involves using technology to organize, automate and synchronize IKCs, project management, ESS service to partners, and technical support. The system will benchmark industrial customer relationship management systems, and adapt relative to the unique needs of a large, distributed, infrastructure project. It will provide project intelligence and offer interactive, real-time management information to cover key activities in ESS:

1. Activity reporting
2. Project management status reports
3. Documentary evidence for quality assurance and control
4. Process tracking
5. Relations management

The specific aims of Task 3.1 are provide the ESS Project with an active database to establish matching the work breakdown structure in Primavera and work package realization according to work plans with IKC Partners. The result is to maximize on-time deliverables by mapping and monitoring key processes and activities in real-time.

The system enables ESS to systematically track potential versus planned IKC agreements. All steps of the preparation, implementation and conclusion of specific IKC contracts are entered into the system. This enables reporting and tracing delivered in-kind contributions in a fully documented and quality-controlled system. Key performance indicators for managing in-kind contribution are tracked. This allows any deviation in schedule or performance to be understood and actions may be taken to prevent delays, defects, or incompatibility issues. For final crediting of IKC value, the system can track identified IKCs in member countries. The system must enable the possibility track the communication status of IKC partners and provide a complete database for stakeholders and enable access to information about each partner.

8 Conclusion

BrightnESS Work Package 2 addresses risks and risk mitigation by building on the procedures and methods in place at the ESS. These procedures are well established and risks have been identified in management and technological areas. These have been further analysed in terms of IKC activities and recognised that there are potential difficulties to control multiple relationships and interfaces; A lack of resources to ensure standards definition and enforcement may create issues related to non-harmonization of components. Delays may arise from the complexity of managing many (decentralized) dependencies and interfaces between partners. Weakened communication between partners due to the geographic distances can negatively impact information between milestones and the high-level of coordination required for integration at Lund and integration of sub-assemblies.

The risk analysis performed both at the ESS and major partner institutes address both technical and non-technical factors that may impact project success. The identification and subsequent mitigation activities form the basis of the BrightnESS work plans.

The BrightnESS initiatives support partner laboratories with the implementation (where necessary) of a functional risk mitigation programme. Regular communication via Hub managers, relative to potential problems to project stakeholders, and a risk analysis and mitigation process, will be implemented to help ensure the successful delivery of the ESS Construction Project.

9 List of Publications

[1] ESS-0000111: ESS Risk Management Policy
[2] ESS-0000263: ESS Risk Management Process
http://europeanspallationsource.se/sites/default/files/ess_risk_management_process-3.pdf
[3] ESS-0004460: ESS Risk Management Plan
[4] ESS-0005887: In-Kind Contribution Management Plan
[5] ESS-0020044: ESS Procedure for Risk Management
http://europeanspallationsource.se/sites/default/files/risk_management_procedure_-_ess-0020044.pdf
[6] Example IKC Risk Register
http://europeanspallationsource.se/sites/default/files/example_ikc_risk_register.pdf