SUMMARY:
This Project Quality Plan defines the processes, procedures and associated resources which will be implemented by the Centre National de la Recherche Scientifique (CNRS) to meet the requirements of the in-kind contribution to the accelerator of the European Spallation Source (ESS).

<table>
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<tr>
<th>Prepared by</th>
<th>Date</th>
<th>Signature</th>
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<tbody>
<tr>
<td>Patxi DUTHIL</td>
<td>12/07/2017</td>
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<tr>
<td>Véronique POUX</td>
<td>12/07/2017</td>
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<tr>
<td>Sébastien BOUSSON</td>
<td>12/07/2017</td>
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**Verified by**

| Guillaume OLRY       | 13/07/17   |           |
| Denis REYNET         | 13/07/17   |           |
| Matthieu PIERENS     | 13/07/17   |           |

**Approved and Application authorized by**

| Sébastien BOUSSON   | 13/07/17   |           |

**Distribution List**

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## DOCUMENT CHANGE RECORD

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SUMMARY

This Project Quality Plan defines the processes, procedures and associated resources which will be implemented by the Centre National de la Recherche Scientifique (CNRS) to meet the requirements of the in-kind contribution to the accelerator of the European Spallation Source (ESS).

This in-kind contribution includes:
- AIK4.1 - WP4: the supply of 13 Spoke cryomodules;
- AIK11.2 - WP11: the supply and installation of the cryogenic distribution of the Spoke section of the ESS linac;
- AIK-ICS – WPXX (TBD): the control and command system of the cryogenic process of the superconducting part of the ESS linear accelerator.

I. Scope

The purpose of this quality plan is to identify:
- the identification, control, record, validity and accessibility of any document or data,
- the material and human resources,
- the requirements of the in-kind contribution,
- the phases of the in-kind contribution,
- the standards applied,
- the monitoring, control and management,

to ensure a successful functioning of the products and services to deliver with expected performance or efficiency.

The project is limited to the in-kind contribution of the CNRS to the accelerator of the European Spallation Source.

This Plan is open to modifications and will be updated during the course of the project.

II. Input to this quality plan

This document is written based on:
ESS-0037830 Rev 1 - ESS template for Project Quality Plan
ISO 10005 Quality Management Systems – Guidelines for Quality Plans
III. Quality goals

To contribute to the design, development, construction and commissioning of some parts of the ESS accelerator, the CNRS will supply the components or services which are defined in the technical specifications agreed between the ESS and the CNRS (see the references Schedule AIK.n.n in section II). The specifications are completed with a list of requirements (see section VIII) and a schedule so that each product to be supplied shall comply with some quality characteristics (such as its functionality, performance, reliability, suitability, completeness, consistency and timeliness) and fit for the use by ESS.

For promoting an efficient contribution to the ESS accelerator, the Project Quality Plan defines some objectives to be completed:

- to manage efficiently the products design and production;
- to manage the human and material resources;
- to manage all document and data;
- to manage the schedule;
- to manage the cost;
- to manage the organization and interaction with all project partners (ESS, subcontractors and others).
State the quality objectives, and present them in measurable terms for the specific project and in general elaborate how they will be achieved. Quality objectives may be, but are not limited to:

- Specific quality characteristics for the project
- Matters that is especially important to the customer or other interested parties.
- How working methods can be improved

IV. Management responsibilities within this quality plan

For this project:

- Véronique POUX, Quality Manager:
  o is responsible for this Project Quality Plan;
  o develops, maintains and updates the Project Quality Plan with respect to the quality framework of the CNRS, to the input documents (cf. §II) and to the standards (cf. §XXII);
  o provides overall leadership of quality management activities, including managing quality reviews and overseeing follow-on corrective actions;
  o collaborates with the Project Manager, Quality specialists and Process Owners in the development of quality metrics and standards;
  o recommends tools and methodologies for tracking quality and standards to establish acceptable quality levels;
  o provides oversight to the closure of corrective actions arising from quality reviewers.

- Sébastien BOUSSON, Project Manager:
  o is responsible for the CNRS in-kind contributions to the ESS;
  o is responsible for the quality management throughout the duration of the project;
  o is responsible for the application of this PQP to all in-kind contributions;
  o is responsible for the consistency of this PQP with respect to the ESS quality management;
  o is responsible for authorizing deviations from the quality plan;
  o provides oversight to the closure of corrective actions arising from quality reviews;
  o decides how the activities of those in-kind contributions relate and connect to each other.

- Guillaume OLRY, leader of WP4 Spoke cryomodule and responsible for the AIK4.1.
  o implements the Project Quality Plan to ensure that all tasks, processes, and documentation of this contribution are planned, controlled and monitored to be compliant with the plan;
  o mediates the requirements of this PQP to the concerned CNRS personnel and ensures team members compliance with the plan;
  o mediates the requirements of this PQP to the outsourcing suppliers of the in-kind contribution and ensures their compliance with the plan;
o collaborates with the Quality Manager, Quality Specialists, and Process Owners in the development of quality metrics and standards by phase.

- Patxi DUTHIL is responsible for the AIK11.2: Cryogenic distribution for the Spoke linac.
  o implements the Project Quality Plan to ensure that all tasks, processes, and documentation of this contribution are planned, controlled and monitored to be compliant with the plan;
  o mediates the requirements of this PQP to the concerned CNRS personnel and ensures team members compliance with the plan;
  o mediates the requirements of this PQP to the outsourcing suppliers of the in-kind contribution and ensures their compliance with the plan;
  o collaborates with the Quality Manager, Quality Specialists, and Process Owners in the development of quality metrics and standards by phase.
  o steers and controls the application of corrective and preventive actions.

- Matthieu PIERENS is responsible for the AIK-ICS: C&C
  o implements the Project Quality Plan to ensure that all tasks, processes, and documentation of this contribution are planned, controlled and monitored to be compliant with the plan;
  o mediates the requirements of this PQP to the concerned CNRS personnel and ensures team members compliance with the plan;
  o mediates the requirements of this PQP to the outsourcing suppliers of the in-kind contribution and ensures their compliance with the plan;
  o collaborates with the Quality Manager, Quality Specialists, and Process Owners in the development of quality metrics and standards by phase.
  o steers and controls the application of corrective and preventive actions.

- Denis Reynet, System Engineer:
  o provides oversight to the interactions between products and activities within those in-kind and with ESS;
  o collaborates with the Project Manager, the in-kind leaders, Quality Manager, Quality Specialists, and Process Owners in the development of quality metrics and standards by phase;
  o participates in quality reviews as required.

<<Specify the person or persons within your organisation that for this specific project are responsible for:

• Nominate the Person Responsible for the Quality Plan


• Ensuring that the required activities/processes defined in the Quality Plan are being planned, implemented, controlled and monitored.
• Decide how these activities/processes relates and connect to each other.
• Mediate requirements on to concerned departments and functions, sub-suppliers and customers and deal with problems that might arise in the interfaces between these.
• Review results of any audits
• Authorize deviations from the management system or from the quality plan
• Steer and control application of corrective and preventive actions >>
V. Documentation and storage of data

Any document of the project will be referenced with an internal code including project Id, WP code, type of document and number, type of product if relevant.

According CNRS-IN2P3 project documentation rules, all the documentation of the project will be registered on the Document Management System “ATRIUM” in a restricted area, dedicated to the project, with security access to persons involved in the project.

Document will be reviewed and approved, by the internal work package unit leader or work task leader depending on the type of document or/and the criticality of the product.

Data will also be approved by the internal work package unit leader or work task leader depending on the type of document or/and the criticality of the product.

Documents and data will be available in the database for the concerned people and can be the object of so necessary notification. Access to the database is given by the Support service of the database at the request of the Project Manager or WP or task leaders.

«Describe how documents and data for this Quality Plan will be identified. Describe who will review and approve documents and data for this Quality Plan. Describe to whom the documents are distributed and how concerned personnel can access the required documents or data.»

VI. Control of records within this quality plan

Technical documents, assembly and tests records, process measurements, analysis data will be kept on the Document Management System Database “ATRIUM” for 10 years at least. If needed, any paper document will be scanned to be kept in the database. This database is maintained by the datacenter of the Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), an institute from the CNRS.

According to schedule in-kind agreements (see section II), some documents will be part of deliverables and therefore transmitted to ESS at defined milestones.

According to the standards (see Annex I), regulatory documentation will be transmitted to ESS during the construction phase of the project and will be part of the deliverables.

Data needed to run the ESS facility will be transferred to CHESS at the end of the project according to the process established and tested between CNRS-IPNO and ESS.

«Specify all records that are generated during this project, where they are archived and on what media and their retention period. (i.e please see the below table)
If there are certain contractual or regulatory requirements on the records; describe how these are satisfied. Describe how records are made available, how this is ensured safely and how disposal of records are being done. Describe which records that are supplied to customer and if applicable; the language these are written in. >>

VII. Resources
<<Describe types of resources in general (materials, human resources, infrastructure and work environment) needed for the successful execution of the project. In the case of any potential conflict in terms of material needs and availability elaborate on the solution for the smooth execution of the Quality Plan. >>

VII.1. Materials
Materials to be used in the manufacturing of components to be delivered to ESS within the project will comply with:
- the lists of requirements established and agreed between the CNRS and ESS;
- the schedules AIK.n.n and their related documents;
- the standards listed in section XXII.
<<Describe all material resources needed for the project. In case of specific characteristics for the required materials outline the standard to which materials have to conform in order to complete the project as per the Quality Plan. >>

VII.2. Human resources
Completion of CNRS commitments towards the ESS accelerator relies on the knowhow, expertise and past experience of the IPN Orsay Accelerator Division staff.
The IPN Orsay Accelerator Division is in charge of research and development linked to particle accelerators. Composed of about 80 Physicists, Engineers and Technicians, the Division is structured around two major facilities: the ALTO facility, which hosts 2 accelerators delivering beams of interest for the international nuclear physicist community, and the SupraTech technological platform, which hosts all the important and high-tech equipment required for performing R&D on superconducting accelerators. Transversally to these two facilities and their associated accelerator development activities, 3 groups are completing the Division competences and expertise: beam physics and simulation, accelerator electronics and RF, and a specialized design office.
The accelerator topics under investigation include:
- Target and ion source for stable and radioactive beams;
- Superconducting RF (SRF) accelerating cavities and associated RF equipment;
- Instrumentation, including accelerator electronics and beam diagnostics;
• Cryogenic systems.

In the past, IPN Orsay has strongly contributed to many accelerators project such as LHC, SPIRAL-1, AGOR, MACSE, TTF-FLASH,...

Nowadays, the whole activity is carried out within national and international projects or collaborations such as ALTO, ANDROMEDE, Spiral2, IPHI, MYRRHA, ESS,... In each project, IPNO plays a major role as a leader or an important partner. The activity covers the three general areas of the accelerator domain:

• Accelerator components (particle sources, injectors, RF devices, magnets, diagnostics...);
• Accelerator technologies needed for the operation of an accelerator facility (vacuum, RF, cryogenics, electronics...);
• New accelerator concepts.

More specifically, several groups of the IPN Orsay Accelerator Division will be involved in ESS:

• The Design Office contributes to ESS through 5 persons being competent in numerical analyses and computer aided design technologies for the design of particle accelerators. Their expertise in thermal, hydraulic and mechanical design is associated to their experience in superconducting and cryogenic technologies. The design Office is also able to manage system manufacturing in leading technical projects. The staff is mainly composed of engineers having 15-20 years experiences as well as younger ones which are trained to the needed technologies. The participation to the construction of LHC in CERN, for the design and supervising manufacturing of cryomodules construction; to the design, manufacturing, and test of cavities and cryomodules B and the cryogenic distribution line in SPIRAL2 accelerator project in Ganil are some of its experiences.

• The SupraTech platform gather all the required skilled and experienced staff for the design, preparation, assembly and test of superconducting linac components such as SC cavities, power couplers, cold tuning systems and cryomodules. Almost all of the 23 persons of the platform are contributing to ESS, either through design activities or technical operations such as chemical etching, clean room assembly or cryogenic tests.

• The accelerator electronic group is also contributing to ESS, specifically on the power couplers, RF source operation, electronic systems design and fabrication for interlocks (power coupler conditioning) or for cavity control during the cryogenic tests (LLRF). They have recent past experience in similar activities for instance for Spiral-2 and several R&D programs.

New collaborators will be hired at IPNO for ESS, especially for preparation and assembly of cryomodules components. Knowledge in cryogenic or vacuum technologies, in instrumentation and RF, in project management and quality can be learned at CNRS and at IN2P3 with already existing internal training courses for new agents.
VII.3. Infrastructure and work environment

The contribution of CNRS to the ESS Accelerator heavily relies on the specific infrastructures available at IPN Orsay: the SupraTech platform and the work environment of the design office.

SupraTech is a technological platform dedicated to the research and developments on superconducting cavities for the future high power and high energy particle accelerators. The platform provides all necessary equipment to prepare, process, assemble and test superconducting cavities for the superconducting technology based projects in which the IPNO is involved.

All the equipment is recent, as it has been progressively installed and commissioned since 2006. It is now fully operational and has proven its performances on past projects.

Since 2012, several brand new pieces of equipment have completed the platform and are of highest interest for ESS:

- new helium pumping stations to allow cryostat operation down to 1.6 K;
- a surface characterization laboratory with an optical microscope, a confocal microscope and a secondary ion mass spectrometry (used for ESS in the prototyping phase);
- a new RF power source at 352 MHz, 2.8 MW peak, fully adapted to the ESS duty cycle;
- a 1300°C furnace dedicated to thermal treatments of cavities under vacuum (hydrogen degasing).

The Design office is equipped with:

- Computer Aided Design software CATIA with a Technical Document Management System dedicated;
- SmarTeam environment for the Bill Of Materials and database management of CATIA data;
- engineering simulation software ANSYS;
- MS Office for office document;
- Ms Project for management of the schedule and resources.

Moreover, in general, project documentation management is performed using the ATRIUM platform. All IPN Orsay collaborators working on ESS are trained to this document management software.

VIII. Requirements

In collaboration with ESS a requirement list has been settled for this in-kind contribution and for its interfaces with other sub-systems of the ESS. Each interface requirement was agreed by each partner
responsible for each interface. This agreement was indicated to ESS by mail or via the Electronic Document Management system: Confluence.

For each requirement, the method to verify the conformity of the delivered products to the requirement is indicated in this list. All those requirements were referenced by ESS, stored in the ESS Electronic Document Management system CHESS and are accessible to the CNRS.

At the time of the creation of the present Quality Plan, this list is still under progress.

<<List and describe the requirements specific for this project and outline if there are conflicts within the requirements. Specify when, how and by whom the requirements will be reviewed and conflicts within requirements resolved. Describe how the results of the review will be recorded. >>

IX. Communication with partner

For each in-kind contribution of the project, reporting to ESS is carried out on a monthly basis with the transmission of a brief report. This report states the monthly progress of the activities of the contribution. It lists the activities which are planned for the next month and indicates if the partner foresees any risk related to the contribution. A conference call meeting is then performed to discuss the contents of the report.

Bi-weekly meetings are set up with ESS management for the in-kind contributions follow-up.

Technical meetings are carried out on a weekly basis.

The ESS Technical Board (TB) is a forum and decision body for technical matters of common interests to all ESS projects during the ESS Construction Phase. Technical board occurs four times a year.

<<Specify by name and title who is responsible for communication with customer in particular cases and how communication is done. Describe the process to be followed for the customer feedback and describe which records are kept of customer communication. >>

X. Design and development

X.1. Design and development process

The objectives of the design and the development are to answer in an effective and efficient way to the needs and expectations concerning the products for the in-kind contribution to the ESS accelerator. Any product which is supplied by the CNRS within this in-kind contribution to the ESS accelerator is designed and developed in the framework of applicable codes, standards and regulatory requirements. Their quality characteristics, such as their functionality, performance, reliability, suitability, completeness and consistency are to be evaluated within this framework and to comply with the complementary information given in the technical specifications and in the list of the requirements defined and agreed with ESS.

In this in-kind contribution to the ESS accelerator:
- standards which are used by CNRS are given in Annex I;
- technical specifications are referenced in section II;
- requirements are indicated in section VIII.

This framework can be extended to the Production phase (see section XII).

The methodology for the evaluation of the quality characteristics of the different products and the criteria are described in the documents listed in section II. To sum-up, different stages of the project development are defined:
- stage 1: detailed design phase
  o preliminary design
  o detailed design
- stage 2: realization and verification (including installation when applicable).

Each stage or phase (or sub-phase) ends at a defined date (a milestone) with the delivery to ESS of a set of deliverables. Those deliverables are evaluated and reviewed. Validation, recommendations or warnings are provided by the reviewers in a report.

<<Refer to the plan(s) for design and development and summarize how this is proceeding in the quality plan. Also refer to:

- Relevant standards, codes, standards, specifications, quality characteristics and regulatory requirements.
- Guidelines or methods used for design and development process (i.e. ISO 9004)
- Criteria’s for approving design and development inputs and outputs.
- How, by whom and when outputs of design and development must be reviewed, verified and validated. >>

X.2. Control of Design and Development changes

Needed changes from CNRS collaboration are reported to the Work Package or task leaders and then addressed to the ESS Technical Coordinators by mail or during meetings and vice-versa.

Depending on the design requests and consequences, the modification is discussed within the concerned technical team (of CNRS or ESS) and design changes approved or rejected. The answer is transmitted by work package leaders to the ESS WP coordinators by mail or during meetings and vice-versa.

The design changes are verified during the different reviews of the project (see section X.1). The principal validation methods are the tests achieved during the prototype phase.

The ESS Technical Board (TB) has the authority to make decisions on subjects that do not require use of the Change Control procedure (e.g. creation/cancellation of working groups, decisions on
standardisation). The TB can review changes, issued by the contribution leader, before their submission to the ESS Change Control Board (CCB). During the TB, the CCB leader lists the change requests which have to be approved (or rejected) by the TB.

The ESS Change Control Board (CCB) was established to address Class A and B changes to the baseline related to the scope, schedule, cost and/or risks during the ESS Construction Phase. The CCB reviews change requests and may ask for additional information as well as consultation with some individuals prior to deciding. See ESS-0001879 for additional information related to the CCB.

<<Describe:

- How request for change to the design is steered
- Who is authorized to request a change in design
- How request for changes are reviewed
- Who is authorized to approve or reject changes
- How approved changes are implemented and verified

Note, that even if the project does not involve any Design and Development process, control of changes can still be required (for instance on existing designs). >>

XI. Purchasing

In the CNRS in-kind contribution to the ESS accelerator, all components supplied to the ESS will be purchased to a sub-contractor by the CNRS (a very few of them will be supplied by ESS). Some services, e.g. components assembly, controls or tests, might also be outsourced.

The purchasing phasing of a product or a service can be defined as follow:

- A technical specification is written by the CNRS and defines the requirements and quality characteristics of the product or of the service. Methods to measure or to validate those characteristics (including specific tests and quality controls) are specified when imposed by CNRS or are parts of a questioner submitted to the sub-contractor. Those requirements are in accordance with those defined with ESS (see section VIII). This specification also indicates, when applicable, the codes and standards which are to be implemented by the sub-contractor to supply or manufacture the product or to execute the service (see section Annexe I). A schedule is included in this specification defining some milestones, check points or delivery dates to conform to the schedule of the in-kind contribution. Experience of the sub-contractor in supplying the required component or service is also to be described and justified in a questioner added to this specification.
- An administrative specification is also written by the CNRS defining the legal conditions of tendering and of executing the contract\(^1\). It includes (most of the) elements of the present quality plan such as:
  o the organization of the sub-contractor with respect to the contract execution (resources, communication, quality);
  o the identification and traceability;
  o the control documents, the control of nonconformities.
- The procurement phase (call for tender) is set according to the European regulations for public procurement and this(ose) specification(s) is (are) published.
- Selection of the sub-contractor is based on the compatibility of the supplier’s offer to the specification(s) written by the CNRS.

At CNRS, the procurement process and the administrative entity in charge of the procurement depend on the product cost estimate (see table below). This induces different tendering rules: duration of tendering, regulations for tendering, plea (appeal) conditions, etc.

<table>
<thead>
<tr>
<th>Product cost estimate</th>
<th>Procurement process type</th>
<th>Administrative entity in charge of the procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product cost &lt; 25 k€HT</td>
<td>No publicity (only request for quotations)</td>
<td>Laboratory</td>
</tr>
<tr>
<td>25 k€HT&lt; Product cost &lt; 90 k€HT</td>
<td>Adapted procurement process with publicity via PUMA (website of CNRS for this procurement process)</td>
<td>Laboratory</td>
</tr>
<tr>
<td>90 k€HT &lt; Product cost &lt; 135 k€HT</td>
<td>Adapted procurement process with publicity via PUMA</td>
<td>Laboratory, with a pre-agreement by the CNRS regional procurement office</td>
</tr>
<tr>
<td>135 k€ &lt; Product cost &lt; 1 000 k€</td>
<td>Formalized procurement process with publicity (European call for tender)</td>
<td>CNRS regional procurement office</td>
</tr>
<tr>
<td>Product cost &gt; 1 000 k€</td>
<td>Formalized procurement process with publicity (European call for tender)</td>
<td>CNRS national procurement office</td>
</tr>
<tr>
<td>Product cost &gt; 2 000 k€</td>
<td>Formalized procurement process with publicity (European call for tender)</td>
<td>CNRS national procurement office. Agreement is mandatory before publication of the call for tender by a special commission (CPA)</td>
</tr>
</tbody>
</table>

\(^1\) NB: this administrative specification can be compiled with the technical specification described in the previous paragraph to form a unique general specification. Or it can be a separate document.
<<Specify which services will be outsourced. Describe which products will be purchased and their critical characteristics that can affect the quality of the products or services. Describe how these requirements are communicated to the suppliers in order for them to control critical characteristics. Describe the methods, which will be used to evaluate, select and control suppliers. Describe requirements for Supplier quality plans or any other plans if appropriate. Specify which methods will be used to satisfy relevant requirements for quality assurance and regulatory requirements. Describe how verification of purchased products conformity towards specified requirements will be performed. >>

XII. Production and service provision
Any product or service which is supplied by the CNRS within this in-kind contribution to the ESS accelerator is produced in the framework of applicable codes, standards, (regulatory) requirements and specifications.

The beginning of production is the starting point of the product life cycle defined from the Product Breakdown Structure (PBS) (see Annexe II).

The manufacturing and assembly process will be analysed and the sequencing of the various steps thoroughly planned. Surveillance of manufacturing and assembly activities will be performed by the designated personnel by means of inspections and control of critical parameters of the process.

Planning the inspections will take into account the complexity of the operations.

The manufacturing and assembly sequences, together with associated inspections, relevant procedures, facilities used, and their cleanliness conditions will be documented in product life cycle documents.

<<Describe the complete processes for Production and service provision and how these relate to each other, specifically for this project, either in text or in process maps. Specify their inputs, realization activities and outputs. Specify how production processes are controlled in order to ensure that they are capable of delivering required output and to verify the results (controls, process validation, monitoring and measurements). For the applicable areas, describe:

- All process steps
- Refer to all the applicable standard operating procedures and work instructions
- Tools, equipment, techniques and methods that will be used to achieve the specified results. This includes information about required certification of materials, products and processes.
- Required controlled conditions to meet planned results and how compliance is determined, for instance process controls methods.
- Details about specific qualification or certification of involved staff, other regulatory requirements and industry practices >>

XII.1. Installation
In the frame of AIK11.2 and AIK-ICS (C&C), CNRS is in charge of the installation of products or components at ESS site. This installation phase is a service provision which is (partly) outsourced and
processed as for a product to be delivered to ESS: from the technical specification, to the production (installation) and to the conformance controls (see previous section).

Technical specifications of the installations phases are described in the schedules of AIK11.2 and AIK-ICS (C&C). They comply with the applicable codes, standards and (regulatory) requirements.

Procurement of this service is the same process as for a product (see section XI).

Installation work at ESS will be planned and organized in order to minimize the mounting work on the ESS site. Prior to the start-up of the installation activity, the list of preparatory and organizational measures is established by ESS and CNRS and described in the Work and Safety Coordination Plan (WSCP - see ESS-0085649). This document defines the applicable documentation and regulatory framework of the installation: Swedish regulations, ESS & Skanska regulations and applicable documentation. It presents the work coordination plan and the safety coordination plan.

<<Describe if applicable, how the product will be installed and how this will be verified and validated. If the project includes further post-delivery activities such as support or maintenance, describe how this will be performed and how to assure conformance to applicable regulatory requirements and industry practices. If certain competence, training or technical support is required specify this. >>

XIII. Identification and traceability
Identification for the components traceability will be in conformance with the ESS naming convention [ESS-0000757] and with the standards listed in Annex I.

Identification and traceability also includes some of the processes during the manufacturing and installation phase.

Each product or process is identified with appropriated means all along the project. This identification will allow knowing the state of the product or its components at any time and is used to demonstrate the conformity with the expected requirements.

<<If identification of products is applicable, describe methods, product scope and level of detail. The methods should include how requirements in agreements and regulatory constitutions are identified and established. Describe how this is traceable in related product documentation and how documentation is controlled. Specify how product test status is identifiable and traceable. >>

XIV. Customer property
Some components might be delivered by ESS to the CNRS:

- whether to be assembled onto the products to be delivered by the CNRS to ESS; in that case the component becomes a part of the product to be delivered to ESS;
• or to perform some operations (such as controls) with the products to be delivered by the CNRS to ESS; in that case, the component will not be part of the product to be delivered to ESS.

In any case, the component will be delivered with an ESS identification number. When installed onto a product to be delivered to ESS, a new name will be associated to this component based on the related PBS and ESS naming convention (see section XIII). When not installed onto a product to be delivered to ESS, the identification number might not be changed.

The component delivered by ESS will be controlled when received at IPNO. Those controls aim at verifying the integrity and functionality of the component. For a component to be part of a product to be delivered to ESS, those controls might be carried out to verify the compliance of the component with respect to the requirement list (see section VIII).

<<Describe how customer property is identified within your organisation and how it is controlled. Seen as an input, describe how it is verified that the provided customer property fulfils the stated requirements before use, and if they are not; how these nonconformities are handled. Specify how lost or damaged property of customer is handled. >>

XV. Preservation of product

Procedures and instructions will be written and available to be used for the handling, packaging, transporting and storing of all products to be delivered by CNRS in the frame of this in-kind contribution to ensure and maintain:

- their integrity;
- tolerable environment conditions (such as cleanliness, humidity, temperature, pressure, vibration and shock) with criteria defined throughout the project; preventing any deterioration and damage.

For some products, such procedures will be defined and/or imposed by use of the standards listed in Annex I.

These requirements are also applicable to subcontractors.

XV.1. Handling

Procedures and instructions will be written and available.

Only qualified persons will be authorized to handle a product or component. Depending on the product and handling operation (use of travelling crane, clean room environment, etc), the qualification of the staff involved in handling activities will be delivered after begin train by the CNRS, a contractor, or a notified body.
XV.2. Packaging and transportation
All package or bagged item will be clearly marked or labelled to identify the environment and conditions required when package is opened.
As a general framework and if necessary or applicable; when products are to be transported:
- they will be placed in air-tight bags with some desiccant;
- containers or boxes will be used;
- containers (or box) will be fitted with shock absorbers;
- containers (or box) will be fitted with lifting attachments as necessary to facilitate transportation and prevent damage.
Shipping of components will be done with the appropriate accompanying documentation, handling instructions, packaging and transportation procedures.

XV.3. Storage
For the manufacturing processes, procedures will be defined for the storage (or removal from storage) in order to guarantee personnel safety and maintain product quality and integrity.
During production, some areas will be dedicated to the storage of the components of those in-kind contributions to ESS: at IPNO and at the sub-contractors premises. Those areas might include cabinets and shelves. When necessary:
- components will be placed in air-tight bags with some desiccant;
- containers or boxes will be used.
After the delivery of any product to ESS (or to any ESS partner), the property of the products is transferred to ESS (or its partner). ESS is hence responsible for the storage of the products after the delivery. Storage before installation shall be considered in environmental conditions close to the nominal operating conditions of the products.

<<State all requirements for handling, storage, packaging and delivery of product and how those will be fulfilled. If your organisation is responsible for delivery, the same aspects must be considered and fulfilled securing delivery of product with requested characteristics.>>

XVI. Control of non-conforming product
All anomalous conditions that occur during manufacture, assembly and test of deliverable product will be recorded/reported and subjected to the Non-conformance control system for analysis and corrective/preventive actions.
Non-Conformances (NC) shall be classified as MAJOR or MINOR on the basis of their consequences, using the following criteria.
Major non-conformances are those affecting:
- safety of people or equipment;
- the operational, functional or contractual requirements;
• reliability, maintainability, availability;
• lifetime;
• functional or dimensional interchangeability;
• interfaces (electrical, mechanical, thermal...).

All other non-conformances are considered to be minor.
The classification can be reviewed during the NC process.

When a NC is detected, immediate actions (labelled and moved apart) are taken to avoid to use by mistake the NC product.

An Internal NC group, including work package leaders, will evaluate the NC and determine:
• The cause of the discrepancy, with the help of experts or other external agencies.
• The disposition with corrective and preventive actions including:
  o “Scrap”,
  o “Use as is”,
  o “Repair”: with standard methods or non-standard methods to be qualified.
  o Preventive and corrective actions which may also be necessary for other models or similar items.
• Re-verification to be performed after the repair or rework which may consist of re-inspection, re-test (a late modification may also affect the validity of previous qualification tests) and update of previously established design analyses.
• The NC classification (major or minor)

At CNRS level, any NC will be recorded and documented in the NC table. A Non-conformance report is fulfilled and recorded for major NC.

Major NC are notified to ESS coordinators working group by mail or during meetings. NC treatment is discussed and agreed with ESS.

<<Describe how nonconforming products or components are handled. Nonconforming products must be isolated and controlled in order to prevent misuse until concession, rework or disposal has been completed. State what degree of rework or repair that is allowed, and how rework and concessions are approved and made traceable. >>

XVII. Monitoring and measurement
Most of the specific inspection, control or test plans are defined in:
- the schedule agreement (see section II);
- the technical specifications (see section II);
- the standards (see Annexe I).

Additional controls, tests and measurements are provided with the life cycle analysis of a product (see section XVII).
All measuring equipment used to control items or to validate tests shall be calibrated. If necessary a calibration programme of this equipment will be performed during the project life.

Each of this equipment shall be marked with the last and future date of calibration and maintenance. The CNRS shall ensure that all measuring instruments are carefully used and stored in order to avoid impairment of their original accuracy.

Measuring equipment will be selected to be appropriate in quality and accuracy for the task in question.

These requirements are also applicable to subcontractors.

The certificate of calibration of the subcontractor test and measuring equipment shall be made available to the CNRS, on request. It shall be specified in the procurement specifications.

Metrology and uncertainties evaluation will be based on ISO/CEI Guide 99, ISO 5725 and specific standards related to the evaluation of the product measured (when applicable).

<<If specific inspection, control or test plans are available, please refer to these.

In order to provide objective evidence of conformity define:

- Monitoring and measurements activities of processes and product that will be applied and specify in which stages.
- Which characteristics will be measured and monitored in different stages
- Routines and criteria for acceptance of measurements
- Any applied method of statistical analysis
- Inspections or tests required to be performed or witnessed by an external part or regulatory authorities (such as type testing, site acceptance test, product verification or validation).
- Third parties inspections or tests
- Criteria for product release
- The control measures used in order to ensure that equipment for monitoring and measurement are controlled and calibrated. This includes records of calibration/verification and information about equipment status >>

XVIII. Audits

To monitor the implementation of the quality plan, the conformity of product at any phase of the project, several audits might be carried out:

- audits of the CNRS by ESS:
  - at each end of any project phase as defined in the schedule agreements (see section II); as described in section X.1, a set of deliverables is then given to ESS and submitted to a review.
  - the production, by CNRS on a monthly basis, of an activity progress report
- audits of sub-contractors by CNRS:
Describe all types of audits that will be done related to this project and their purpose, such as:

- Monitor the establishment and implementation of the quality plan(s)
- Monitor and verify the conformity to requirements
- Monitor supplier performance
- Objectively assess the compliance to customers and stakeholders needs.

Describe when audits will be performed and how they are carried out. Specify who is responsible for carrying out audits and authorized to approve actions based on the results.

XIX. Implementation and revision of the quality plan

XIX.1. Review and acceptance of the quality plan

This Project Quality Plan, as well as all the provisions put in place within the framework of this plan, may be revised, as a result of significant changes or audits, on the initiative of the Project Manager, the Work Package or task leaders, the System Engineer and the Quality Manager and approved by the Project Manager.

Describe from what aspects the quality plan is being reviewed and which designated role or group of representatives of adequate parts of the organisation that has reviewed it and formally approved it. Also describe which persons and roles that are authorized to review and approve changes to the quality plan. Specify if the quality plan according to agreements is to be reviewed and accepted by ESS Lund before approval.

XIX.2. Implementation of the quality plan

The PQP is implemented in the GED Atrium and transmitted to all team the CNRS team by a mail notification. Details information concerning the changes is also commented in the monthly technical meeting which follows the change.

From previous experience and internal trainings most of the project engineers are used to quality management and are informed about the application of this Quality Plan. The rest of the team is actively involved in the definition of any specification, procedure and data record related to control, assembly, test of the products and processes of this in-kind contribution. They are parts of the development and the evolution of this quality plan.

This quality Plan is monitored by the Project Manager, the Work Package or task leaders, the System Engineer and the Quality Manager and discussed during:

- monthly internal technical meetings,
- Technical Board meetings (TB) at ESS
- reviews ending each stage of the project.
Describe how you inform and distribute the quality plan among concerned parts and how you separate controlled copies which are being used and updated accordingly and copies that are distributed as information only. Describe how it is ensured that everyone concerned of the quality plan knows how to use it and if there are any training sessions for non-regular Quality Plan users. Describe how you internally monitor and control that the quality plan is being followed (for instance; audits, milestones, reviews). Specify how monitoring of Quality Plan conformity will be done in collaboration with ESS Lund (organisational commitment assessment, practical implementation of the Quality plan, risk analyses, corrective and preventive actions, improvement opportunities).

XIX.3. Revision of the quality plan
Anyone who is working on the project can initiate revisions of the quality plan.
The revision of the Project Quality Plan will be discussed by the project manager, the work package leaders, the system engineer and the quality coordinator.
The PQP document is modified and a new version is released and clearly identified. The reasons of the changes are clearly indicated. This new released document, approved by the project manager, is implemented in the GED Atrium and transmitted to all team the CNRS team by a mail notification. Details information concerning the changes is also commented in the monthly technical meeting which follows the change.

Describe which sources have the authority and in which format they can initiate a revision (i.e. changes and improvements) of the quality plan. Describe how revisions in the quality plan are made known to everyone using the plan. Describe how it is ensured that all documents affected by revisions in the quality plan are changed. Describe how ESS Lund will be informed and involved in the Quality Plan revisions (communication, application of revision).

XIX.4. Authorized deviations to this quality plan
The authorized deviations of the Project Quality Plan will be discussed by the project manager, the work package leaders, the system engineer and the quality coordinator and approved by the project manager.

Specify who is authorized to approve or reject these deviations.

XX. Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>CDS-SL</td>
<td>Cryogenic distribution system for the Spoke linac</td>
</tr>
<tr>
<td>CCB</td>
<td>ESS Change Control Board (CCB)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>CNRS</td>
<td>Centre National de la Recherche Scientifique: is the major French public organization for research. Its activities are carried out within several thematic institutes.</td>
</tr>
<tr>
<td>ESS</td>
<td>European Spallation Source: is a European Research Infrastructure Consortium (ERIC), a multi-disciplinary research facility based on the world’s most powerful neutron source.</td>
</tr>
<tr>
<td>TB</td>
<td>ESS Technical Board</td>
</tr>
<tr>
<td>IN2P3</td>
<td>Institut National de Physique Nucléaire et de Physique des Particules: is one of the CNRS institutes. It drives the national research in nuclear physics and particles physics.</td>
</tr>
<tr>
<td>IPNO</td>
<td>Institut de Physique Nucléaire d’Orsay: is a laboratory of the IN2P3 and the University of Paris-Sud (Paris Saclay).</td>
</tr>
<tr>
<td>NC</td>
<td>Non conformances</td>
</tr>
</tbody>
</table>

XXI. References

XXII. Annexe I – Standards

For AIK4.2 and AIK11.2, the following standards might be used.

**Quality management**

ISO 10005      Quality management systems – Guidelines for quality plans.
ISO 10007      Quality Management Systems – Guidelines for configuration management
ISO 10013      Guidelines for quality management system documentation

**Pressure vessels, cryogenic equipment**

EN 13445     Unfired pressure vessels – Parts 1 to 5.
EN 13458     Cryogenic vessels - Static vacuum insulated vessels - Parts 1 to 8.
EN 13480     Metallic industrial piping - Parts 1 to 8.

**Design drawing**

EN ISO 1101  Geometrical product specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out.
EN ISO 5459  Geometrical product specifications (GPS) - Geometrical tolerancing - Datums and datum systems.
EN 22768 (ISO 2768)  General tolerances - Parts 1 and 2.

**Materials**

EN 485  Aluminium and aluminium alloys - Sheet, strip and plate - Parts 1 and 2.
EN 573  Aluminium and aluminium alloys - Chemical composition and form of wrought products - Parts 1 and 3.
EN 1252-2  Cryogenic vessels - Materials - Part 2: Toughness requirements for temperatures below -80 °C.
EN 10222-5  Steel forgings for pressure purposes - Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.
EN 10225  Hot rolled products of structural steels - Parts 1, 2 and 5.
EN 10028  Flat products made of steels for pressure purposes – Parts 1 to 7.
EN 10088  Stainless steels - Parts 1 to 5.
EN 10204  Metallic products - Types of inspection documents.
EN 10216-5  Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 5: stainless steel tubes.
EN 10217-7  Welded steel tubes for pressure purposes - Technical delivery conditions - Part 7: stainless steel tubes.
ASTM B391-09e1 Standard Specification for Niobium and Niobium Ingot Alloys.

**Welding and brasing**
EN ISO 3834 Quality requirements for fusion welding of metallic materials - Part 1, 3 and 5.
EN ISO 9606 Qualification testing of welders - Fusion welding - Parts 1, 2, 3 and 5.
EN 14732 Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials.
EN 15614-1 Specification and qualification of welding procedures for metallic materials - Welding procedure test - Parts 1, 2, 5 and 6.
EN ISO 13585 Brazing - Qualification test of brazers and brazing operators.
EN 13134 Brazing - Procedure approval.

**Manufacturing**
EN ISO 898 Mechanical properties of fasteners made of carbon steel and alloy steel – Parts 1 and 2.
EN ISO 3506 Mechanical properties of corrosion-resistant stainless steel fasteners - Parts 1 to 4.
EN ISO 4287 Geometrical Product Specification (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters.
EN ISO 8735 Parallel pins with internal thread, of hardened steel or martensitic stainless steel
EN 12300 Cryogenic vessels - Cleanliness for cryogenic service.
EN 14917 Metal bellows expansion joints for pressure applications.
EN 28839 Mechanical properties of fasteners - Bolts, screws, studs and nuts made of non-ferrous metals
EN 60534 Industrial Process Control Valves – Parts 1 to 9.
ASTM A380 Practice for cleaning, descaling and passivation of stainless steel parts, equipment and systems.

**Tests and controls**
EN 1779 Non-destructive testing - Leak testing - Criteria for method and technique selection.
EN 3452 Non-destructive testing - Penetrant testing – Parts 1, 2 and 4.
ISO 5817 Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections.
ISO 9712  Non-destructive testing - Qualification et certification of NDT personnel.
EN 10042  Welding - Arc-welded joints in aluminium and its alloys - Quality levels for imperfections.
EN 10204  Metallic products - Types of inspection documents.
EN 12799  Brazing - Non-destructive examination of brazed joints.
EN 13185  Non-destructive testing - Leak testing – Tracer gas method.
EN ISO 17635  Non-destructive testing of welds - General rules for metallic materials.
EN ISO 17636  Non-destructive testing of welds - Radiographic testing - Parts 1 and 2.
EN ISO 17637  Non-destructive testing of welds - Visual testing of fusion-welded.

Handling
EN ISO 3266  Forged steel eyebolts grade 4 for general lifting purposes.

Instrumentation and sensors
CEI UNI ENV 13005  Guide to the expression of the uncertainty in measurement.
ISO 5725  Accuracy (trueness and precision) of measurement methods and results - Parts 1 to 6.
EN ISO 10012  Measurement management systems - Requirements for measurement processes and measuring equipment.
EN ISO 10012  Measurement management systems - Requirements for measurement processes and measuring equipment.
FD X 07-011  Constat de vérification des moyens de mesure.
FD X 07-012  Certificat d’étalonnage des moyens de mesure.
FD X 07-028  Métrologie - Procédure d’étalonnage et de vérification des thermomètres - Estimation des incertitudes sur les mesures de température.

Others
2006/42/EC (ex- 95/16/EC)  Machinery Directive
2014/35/EU (ex- 2006/95/EC)  Low Voltage Directive
XXIII. Annex II – Products Breakdown Structures

XXIII.1. AIK4.1 Spoke cryomodules

1. Cavity
   1.1. Pick-up
   1.2. Cavity

2. Equipped coupler
   2.1. Coupler
   2.2. Double-wall tube
   2.3. Flange detector
   2.4. Vacuum gauge
   2.5. Electron pick-up

3. Equipped cryostat
   3.1. Equipped vacuum vessel
   3.1.1. Dish ends (2)
   3.1.2. Top dish
   3.1.3. Coupler bells (2)
   3.1.4. Nicked plate
   3.1.5. Burst disk excludes (2)
   3.2. Cryogenic lines
   3.3. Thermal shield
   3.4. Support

4. Tuner
   4.1. Phase
   4.2. Motor
   4.3. Ballscrew

5. Instrumentation
   5.1. Temperature
   5.2. Pressure
   5.3. Cables
   5.4. Connectors
   5.5. Vacuum valves

6. Support and alignment frame

7. Tooling
   7.1. Cavity
   7.2. Coupler
   7.3. Tuner
   7.4. Cryomodule

8. Transportation

9. On-site installation
XXIII.2. AIK11.2 Cryogenic distribution for Spoke linac

Cryogenic Distribution System for the Spoke linac (CDS-SL)

XXIII.1. AIK-ICS C&C

TBC