



PIP-II
616-II

PIP-II PROJECT QUALITY ASSURANCE PLAN

Reference :

PIP-II

PIP-II PROJECT QUALITY ASSURANCE PLAN

	REDACTEUR <i>Edited by</i>	VERIFICATEURS <i>Reviewed by</i>		APPROBATEUR <i>Approved by</i>
NOM Prénom <i>Name</i>	C.Cloué			
Fonctions <i>Functions</i>	Quality manager			
Date et signatures <i>Date and visas</i>				

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 2 sur 22

CARTOUCHE D'EVOLUTION - DOCUMENT REVISION HISTORY			
Éditions	Dates	§ modifiés	Commentaires –
<i>Editions</i>	<i>Dates</i>	<i>Modified part(s)</i>	<i>Observations</i>
1		Tous	Création

LISTE DE DIFFUSION – DISTRIBUTION LIST	
<u>Interne - Internal :</u>	<u>Externe - External :</u>
-	
Copies – Copy to :	

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 3 sur 22

CONTENTS

1	SCOPE	5
2	GLOSSARY	5
3	REFERENCE DOCUMENTS	6
4	APPLICABLE DOCUMENTS	6
5	QUALITY PLAN MANAGEMENT	6
6	PIP-II PARTICLE ACCELERATOR DESCRIPTION	6
7	CEA DELIVERABLES	7
8	ROLES, RESPONSABILITIES AND AUTHORITIES.....	9
8.1	TECHNICAL COORDINATOR	9
8.2	PROJECT MANAGER	9
8.3	SPC LEADER.....	9
8.4	QUALITY ASSURANCE MANAGER	10
9	COMMUNICATION PLAN	10
10	DOCUMENT MANAGEMENT	10
10.1	EDITING	11
10.2	DOCUMENT IDENTIFICATION A REVOIR	13
10.3	CHECK AND APPROVAL	14
10.4	EXTERNAL LIFE CYCLE	14
10.5	EVOLUTION OF THE DOCUMENTS	15
10.6	DOCUMENT ARCHIVING	15
11	CONFIGURATION MANAGEMENT	15
11.1	CONFIGURATION MANAGEMENT	15
11.2	CHANGE REQUEST MANAGEMENT	15
11.3	IDENTIFICATION AND MARKING CEA COMPONENT DELIVERABLES.....	16
12	NON-CONFORMANCE MANAGEMENT.....	16
13	COMPETENCE AND TRAINING	17
14	MANUFACTURING	18
14.1	CONTRACTUAL DOCUMENTS.....	18
14.2	KICK-OFF MEETING	19
14.3	PRODUCTION MONITORING	19
14.4	FACILITY ACCEPTANCE TEST, SITE ACCEPTANCE TEST	19
14.4.1	Factory Acceptance Test (FAT).....	20
14.4.2	System Acceptance Test (SAT).....	20
15	ASSEMBLY AND TESTS	20
15.1	ASSEMBLY AND TESTS DOCUMENTS.....	20
15.2	EXECUTION	20
15.3	CONTROL OF THE ENVIRONMENT	21

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 4 sur 22

16	ACCEPTANCE	21
17	QUALITY FOR STORAGE.....	22
18	QUALITY FOR HANDLING AND TRANSPORT	22
19	MEASURING AND TEST EQUIPMENT MONITORING	22
20	CONTINUOUS IMPROVEMENT.....	22

List of figures

Figure 1 - Organization chart of PIP-II project at CEA	9
Figure 2 – Document management workflow	11
Figure 3 –Non-conformance management workflow.....	17
Figure 4 – Component acceptance flow chart.....	19
Figure 5 – Cryomodule acceptance flow chart.....	21

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 5 sur 22

1 SCOPE

This plan describes the Quality Assurance (QA) provisions in place on the PIP-II project at CEA to ensure:

- the compliance of CEA supplies with the specified requirements,
- the safety of the people in the fulfillment of their duties,
- the safety of the properties and of the environment.

The Quality Assurance Plan will focus on specifying the Quality interfaces between CEA and Fermilab.

The provisions of the Quality Plan apply to all CEA contributions related to Fermilab.

The CEA contributions are managed by Sub-Project Coordinators (SPC) appointed by the Technical Coordinator (TC) and the Project Manager (PM). The contributions involve design activities (hardware and software), qualification, supply, and manufacturing, integration, testing and subcontracting. The Plan defines the QA rules applicable to each of these activities.

The TC, the PM and the SPCs are responsible for the application of the Quality Plan provisions.

These rules are applicable by all entities contributing to the project: CEA units and CEA subcontractors.

2 GLOSSARY

CEA	Commissariat à l’Energie Atomique et aux Energies Alternatives
CoDR	Conceptual Design Review
FAT	Factory Acceptance Test
CM	Cryomodule
CR	Change Request
FDR	Final Design Review
ICD	Interface Control Document
IKC	In-kind Contribution
MRR	Manufacturing Readiness Review
PDR	Preliminary Design Review
PM	Project Manager
PRR	Procurement Readiness Review
QA	Quality Assurance
QAP	Quality Assurance Plan
SAR	System Acceptance Review
SAT	Site Acceptance test
SPC	Sub-Project Coordinator
SEMP	Systems Engineering Management Plan
SOW	Scope of Work
TC	Technical Coordinator
TRR	Transportation Readiness Review
TRP	Technical Review Plan
WBS	Work Breakdown Structure

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 6 sur 22

3 REFERENCE DOCUMENTS

Title	Reference

4 APPLICABLE DOCUMENTS

Title	Reference

5 QUALITY PLAN MANAGEMENT

The Quality Assurance Plan (QAP) is written by the PIP-II Quality Manager, under the authority of the PIP-II TC who validates it.

The QAP is an updatable document, expected to be revised during the life of the project. It is managed in configuration according to the provisions defined in the Documentation Management Plan.

6 PIP-II PARTICLE ACCELERATOR DESCRIPTION

The PIP-II particle accelerator will be the new heart of Fermilab, featuring a brand-new, 800-MeV, leading-edge superconducting linear accelerator. Its high intensity proton beam will power a broad range of particle physics experiments for decades to come, and maintain Fermilab’s leadership as one of the world’s premier particle physics laboratories. PIP-II will enable the most intense high-energy neutrino beam for the laboratory’s flagship project—the Long Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE). The Fermilab-hosted LBNF/DUNE is an international project to study neutrinos—tiny particles that could revolutionize our understanding of the universe.

The PIP-II linac will be situated on the infield of the (decommissioned) Tevatron accelerator on the Fermilab site. Negative Hydrogen ions are first emitted from a source and formed into a beam. The beam then speeds down a 250-meter superconducting linear accelerator, or linac, to an energy of 800 million electronvolts (or 800 megaelectronvolts, MeV). The ion beam is steered towards the existing Booster accelerator, where it is stripped and accelerated to 8 billion electronvolts (or gigaelectronvolts, GeV).

Some of the protons exiting the Booster will head directly toward a variety of targets, striking them. These will initiate strings of newly produced particles, of which some fraction eventually decay into muons. The muons will be captured within the MC-1 Building, right on the Fermilab site. There they will enter a detector, where scientists can make measurements of this short-lived particle.

The other protons exiting the Booster will take a different path, continuing down the accelerator chain. They will be transferred and accelerated within the existing Main Injector-Recycler complex — a set of 3.3-kilometer-circumference rings that will produce a beam of protons at an energy of 120 billion

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 7 sur 22

electronvolts (or 120 gigaelectronvolts, GeV). These protons then strike a target, eventually producing neutrinos. The neutrinos will then fly through the Earth at nearly light speed. Under the PIP-II scheme, they will be directed to the Long-Baseline Neutrino Facility experimental area, planned to be built at Homestake, South Dakota, 1,300 kilometers away. The LBNF detectors will help researchers better understand the behavior of neutrinos, which are notoriously difficult to observe because of their flighty nature.

7 CEA DELIVERABLES

CEA has agreed to procure, fabricate, integrate and test one (1) pre-production and nine (9) production low-beta (LB) superconducting 650MHz integrated cryomodules according to Fermilab's specified requirements for the Proton Improvement Plan II accelerator project. The delivery includes procurement of cryomodule subsystem components including:

- I. input couplers;
- II. tuners;
- III. cryomodule cold-mass;
- IV. cryomodule vacuum vessels;
- V. instrumentation;
- VI. alignment fixtures;
- VII. cryogenic pipework & external interfaces.;
- VIII. two transport frames;

Each cryomodule will undergo a complete cryogenic and RF test at CEA-Saclay Laboratory using CEA facilities such as the test bunker, the cryogenic plant to cool down the cryomodule, and the RF amplifiers to power all four cavities in parallel. After their qualification test, the cryomodules will be connected to one transport frame and handed over to Fermilab for shipment.

Within the scope of the CEA delivery, Fermilab will provide all SC-cavities after their RF acceptance test. They will be fully jacketed and with the diphasic transition in place.

CEA will provide the 650 MHz input couplers of the ten LB650 cryomodules, and the three HB650 production cryomodules assembled by STFC. The RF conditioning of the input couplers will be performed at CEA-Saclay Laboratory using the CEA conditioning facility equipped with one 40 kW RF amplifier provided by FNAL

This scope of delivery is conditioned by the allocation by the French Ministry of Superior Education and Research of funds corresponding to CEA's cost-book. CEA expects this allocation to be decided in 2020 and to be available in 2021.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 8 sur 22

In order to facilitate LB650 cryomodule testing at CEA, the existing SRF testing infrastructure will require modification to accommodate the cryogenic and RF distribution systems of the LB650 cryomodules and the requirements in cryogenic and water cooling. This will include:

- I. Adaptations to the cryomodule test facility and associated manipulation tooling;
- II. Procurement of four 15 kW RF amplifiers;
- III. Modifications of cryogenic, cooling water and RF distribution systems;
- IV. Optimization of the RF electronics systems for 650 MHz operating frequency;
- V. Upgrade of the cryogenics liquefying system to allow for sufficient 5K and 50 K LHe distribution;
- VI. Construction and commissioning of the input coupler RF conditioning facility.

Cavity string, cold mass and cryomodule integration tooling and fixtures will be designed, procured, installed and commissioned to enable integrated assembly of the LB650 cryomodule systems.

CEA technical staff will engage with the respective Fermilab technical teams to ensure that ongoing cryomodule design processes are effectively capturing CEA responsibilities and that final LB650 cryomodule and sub-system components designs consider CEA input. This will ensure appropriate planning and preparation work at CEA can be implemented, maintained and effectively managed. LB650 cryomodule sub-system components identified above will be procured by CEA. Chosen equipment suppliers will be managed by CEA to ensure component delivery is successfully achieved to Fermilab design specifications and QA protocols.

CEA will have responsibility for acceptance testing all cryomodule sub-system components and where appropriate performing all necessary component tests as stipulated and agreed with Fermilab. Assembly of the LB650 SRF cavity strings in the ISO4 cleanroom under commonly agreed CEA-FNAL assembly procedures in order to maintain the internal surface integrity of the LB650 SRF cavities. Each cavity string will then be connected to the LB650 cold-mass system per procedures commonly agreed by CEA and FNAL. In the final stage of integration into the outer LB650 cryomodule vessel, all internal cryogenic distribution systems, instrumentation, heat exchanger systems and external interfacing connections will be completed. Throughout these critical assembly stages, it is anticipated that Fermilab technical support will be made available to ensure processes conducted at CEA are effectively governed and controlled.

Once assembled, a series of acceptance tests (SAR1) will be undertaken to assess system conformance (physical and electrical parameters) against Fermilab's specifications. CEA will also perform cryogenic and high power RF acceptance tests (SAR2) at 2K on complete cryomodules prior to cryomodule shipment to Fermilab. Completion of cold validation, post-cold validation testing acceptance, and SAR2 are required to transfer title from CEA to FNAL. These activities are defined in the Acceptance Plan document.

CEA will work with Fermilab and other PIP-II international technical experts to develop a suitable transport frame design for the safe transport of the complete cryomodules from CEA-Saclay Laboratory to Fermilab. Shipment and post-shipment acceptance tests will be the Fermilab responsibility.

8 ROLES, RESPONSABILITIES AND AUTHORITIES

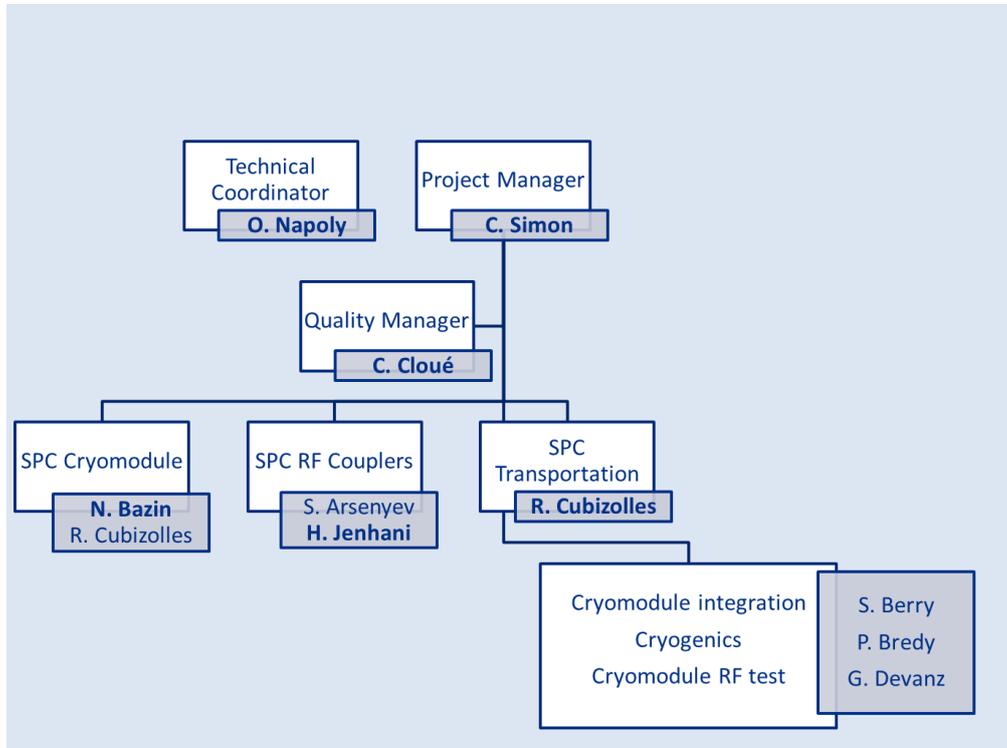


Figure 1 - Organization chart of PIP-II project at CEA

8.1 Technical coordinator

The PIP-II Technical coordinator ensures the project management and positions himself as the guarantor of the delivery of the components described in the contracts signed between CEA and Fermilab. To achieve this objective, the TC is in charge of setting up an organization, proposing the main stages of the project that allow the objectives to be achieved, evaluating the necessary human resources as well as the financial and calendar framework.

The TC also monitors contracts signed between CEA and Fermilab.

8.2 Project manager

The project manager shall ensure:

- Budget management,
- Human resources management through the workload plan and the animation of teams,
- Risk management,
- Implementation and monitoring of reporting,
- Communication,
- Documentation management.

8.3 SPC leader

Each SPC leader within the PIP-II project is responsible for:

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 10 sur 22

- the technical definition of the subsystems,
- the organization of the team and tasks on its perimeter,
- the technical performance management,
- the implementation of the technical monitoring
- monthly reporting to the project meeting
- the deployment of standards given by the management project

8.4 Quality assurance manager

Under the authority of the TC and the PM, the Quality Assurance manager ensures the following activities for all components of the project:

- Advises the TC, the PM and the SPCs within the framework of QA;
- Develops the Quality Assurance Plan of the project and follows up on its implementation;
- Supervises the non-conformance process and the change request process;
- Verifies the compliance with QA requirements of documents produced by the team (referencing of documents, control of the versioning of documents, control of the signature workflow...);
- Guarantees the continuous improvement for all the PIP-II activities;
- Prepare the QA documents required by the QAP, including the Quality specifications of subcontracted activities;
- Approve the QAP issued by the subcontractors in answer to the project QA specifications; supervise their proper application, in particular the implementation of controls, hold points and acceptances by benefiting from controller support;
- Verify the conformity of the products manufactured according to the design, and establish precisely the configuration of the product.

9 COMMUNICATION PLAN

Bimonthly meetings are chaired by the TC to follow progresses and give general information.

Communication of upcoming hold, notification, or approval points by the Partner to the respective PIP-II L2 Manager is done two times per month to ensure adequate surveillance and execution of hold points. Bimonthly meetings amongst all 650 MHz Partners are held to know the overall status for different activities.

10 DOCUMENT MANAGEMENT

All the project actors should have reliable and updated information, whenever needed.

In addition, all the records made during the various activities must be retained to ensure the traceability of the operations and to prove the conformity of the results with the specifications. These records include but are not limited to: test reports, test results, follow-up sheets, acceptance reports, non-conformance reports, change request reports.

The Document Management Plan of the project specifies the applicable provisions to reach these goals. In particular, it defines the rules of identification, approval, evolution and diffusion of documents as well as the

archiving procedure. The Document Management Plan will be written in French and will be intended for CEA staff.

The document management is based on the I2I Document Management system (sharepoint), chosen as a tool for sharing and archiving information related to the PIP-II project. The main functions of this system are:

- The elaboration of documents in collaborative mode;
- The document referencing ;
- The automatic incrementation of versions and storing of the previous versions;
- The arborescence built on the project WBS/PBS;
- The research and filtering of documents according to various criteria (keywords, author's name, date of issue, etc.) or full text research,
- The protection of confidential files controlled by access rights.

The flowchart below shows the different steps involved in the process of the document management.

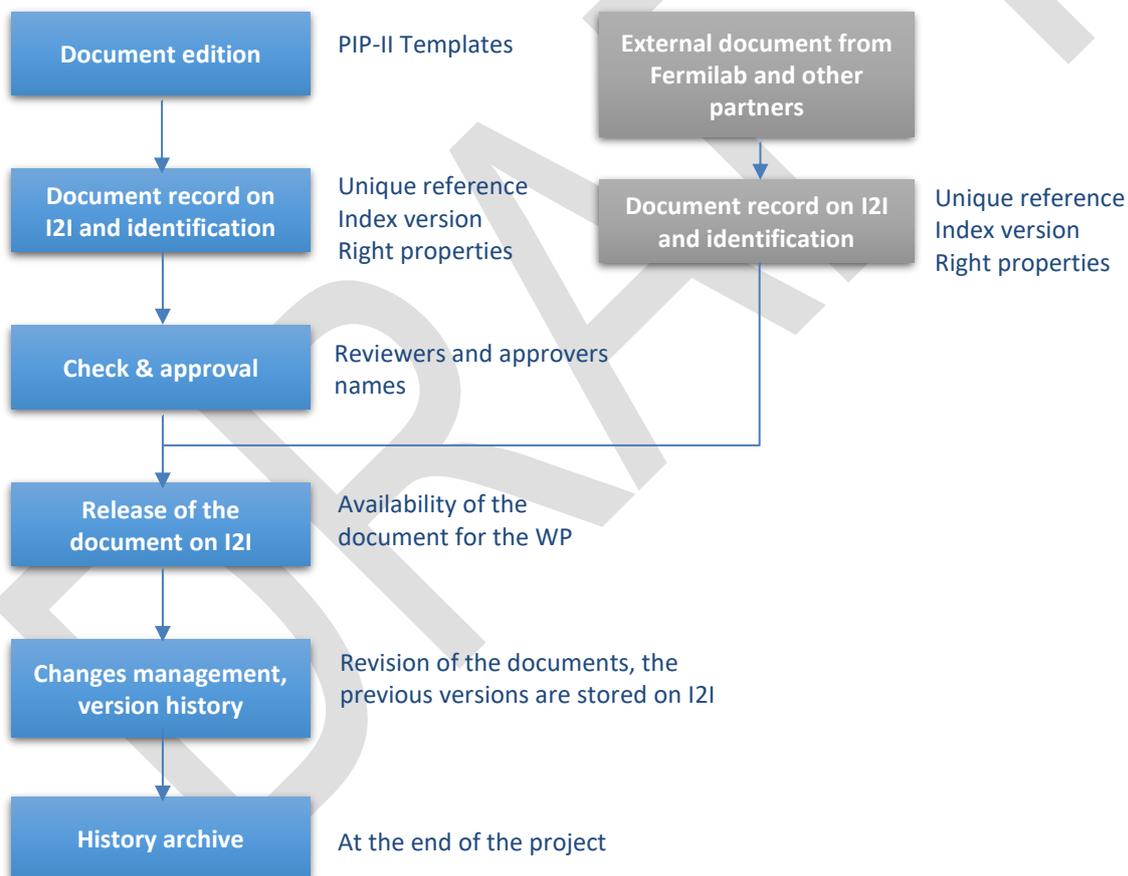


Figure 2 – Document management workflow

10.1 Editing

In order to harmonize the presentation and facilitate the writing, templates of the main document types are available at the following address \\dapdc5\Manip\PIP2\03_Qualite and on I2I document management system.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 12 sur 22

Documents are written in French or in English according to their use and recipients.

DRAFT

10.2 Document identification A REVOIR

Documents produced internally are identified with a reference in the following format:

CEA / PIP2 / WP / Type of document / chronological number / revision.

			Code subsystem			Code doc		Chronological number				Revision				
C	E	A	-	P	I	P	-	X	X	X	-	X	X	-	X	Y

Subsystem code (3 characters) :

Code WP	Name
CM0	<u>Pre-production Cryomodule</u>
CMS	<u>Serial Cryomodule</u>
RFC	<u>RF Couplers</u>
CRY	<u>Cryogenics</u>
RFT	RF Tests
PJT	General project management

Document type code (2 characters) :

Code doc	Name
CR	Summary (of meeting, mission, ...)
RP	Report (technical, reporting, offer analysis, design ...)
NT	Technical Note
ST	Technical Specification
PR	Procedure
AQ	Quality Assurance
NC	Non-Conformance
PL	Drawing
NG	General Note
LR	Letter
DC	Contractual document
BR	Delivery receipt
DM	Change request
P0	Presentation

The chronological number is automatically assigned by the I2I document management system.

Since the implementation of PIP-II project document management under I2I, the document revision index has 2 digits X.Y: X.0 main version, Y secondary version (draft). Only the main revisions are published.

Since the implementation of the document management tool, the document reference is generated by I2I.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 14 sur 22

10.3 Check and approval

Each document created should have its contents verified and validated, then its dispatching is approved by an authority at the right level.

Validations are attested by the signature of areas "written by", "checked by", "approved by" and "authorized by" in front page of the document.

- Area "checked by": the signatory checks and validates the contents of the document. Two auditors are usually identified: a technical expert and the quality engineer.
- Area "approved by": the signatory, usually the SPC, attests the validity of the document.
- Area "authorized by": the signatory is the TC or the PM, he or she authorizes the distribution of the document to the recipients identified in the diffusion list.

After signature, the document is committing for the project; therefore, regarding the documents distributed outside, the signatory "authorized by" is necessarily the TC, or the PM, or the SPC if he has received delegation (to be clearly defined).

The signatures of the reviewers and approvers are affixed on the first page of the documents. Then, the signed documents are scanned and stored under the document management system I2I. Internal lifecycle.

The purpose of the distribution rules is to ensure the transmission of authorized documents to the right persons and to assure their traceability.

Any document issued should include a diffusion list identifying the recipients. Finalized or approved documents are recorded on I2I tool.

On the I2I platform, access rights to documents for a user are governed by the group to which he/she belongs. There are 3 categories of groups:

- The Owners (TC, PM and Quality Team), managers of the I2I tool for PIP-II, are responsible for the definition of the documentary tree structure, the layout of the home page and the management of users' access rights;
- The SPCs have read and write access throughout the I2I space;
- The teams have read and write access throughout the I2I space, except for restricted access files.

Documents with a confidential character related to commercial aspects are stored in dedicated directories (restricted management) with restricted access.

10.4 External life cycle

Every actor of the project receiving an external document will save it and archive it in the "External documents" library of I2I system, respecting the defined classification and then dispatching it to those who need it.

Documents issued by CEA requiring an approval by the PIP-II team will be stored in the TeamCenter system. The TeamCenter system has an approval workflow (to be confirmed).

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 15 sur 22

10.5 Evolution of the documents

Documents destined to evolve during the project life (specifications, procedures, technical files...) are managed in configuration. The various evolutions are marked by the indication of revision and the evolutions are traced. Each new version will be approved according to the same validation circuit as the original version.

The modifications of the binding documents, particularly those implying possible contractual consequences (specifications...), should be authorized in advance by a project manager: TC, PM or/and SPC.

10.6 Document archiving

Historical archives gather the essential documents that should be kept following the end of the project for memory and feedback. Eligible documents will be selected by the PM.

A statement of the historical archives is made during the end of project review meeting.

11 CONFIGURATION MANAGEMENT

11.1 Configuration Management

Configuration is defined as the set of functional and physical characteristics of a system or product as they are defined in the documentation and achieved in the production. Configuration management ensures the consistency of the system definition, the conformity of the deliverables, and the control of their evolution by managing the impacts of all their modifications. Configuration management involves a process which must be planned and set up in order to guarantee a good mastery of the configuration all along the lifecycle of the system. Configuration management is used to have a status of the system regarding to the PIP-II requirements at any time.

The configuration management aims to fulfill the following objectives:

- To identify the baseline configuration and the applied configuration, to detect and trace deviations during production, testing and shipment of the deliverables;
- To know the technical description of the products and their components at any time in the lifecycle, using reliable approved documentation;
- To monitor any changes in the technical description of the CEA PIP-II project;
- To provide traceability of developments in the technical description of the CEA PIP-II project;
- To verify that the documentation is and remains the exact picture of the products it describes;
- To enable PIP-II (as a user) to know the operational capabilities and possibly the limitations of each component and, if deviated, know which component is affected.

11.2 Change request management

Once the reference configuration has been adopted, all configuration change wishes are formalized and are subject to a Change Request (CR).

These requests strictly concern the products, as well as specifications and requirements to which they must comply.

The requests may be issued by CEA teams, subcontractors or Fermilab PIP-II project.

Change requests are managed according to change request process defined by Fermilab for PIP-II.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 16 sur 22

11.3 Identification and marking CEA component deliverables

Each deliverable cryomodule and each of its subsystems, are individually identified by a serial number. The marking method depends on the nature of the component: engraving, label...

A specific document will describe the deliverables identification of the CEA components, the rules to follow for the identification of all the components and the marking place.

The rules of identification shall be indicated in the technical specification for the supply of any components or, at the latest, during the kick off meeting.

12 NON-CONFORMANCE MANAGEMENT

Non-conformances affecting equipment are subject to formalized management and treatment once the reference configuration is established.

The non-conformance handling support is the non-conformance Report (NCR), it will be written in French for internal use at CEA or for communication with a French language supplier. If the non-conformance needs to be sent to Fermilab or to a foreign supplier, the English form will be used.

Non-conformance reports are issued by whoever notices a non-conformance: CEA teams or subcontractors. Subcontractors can use their own templates.

The non-conformities are classified in 3 levels according to the following criteria:

- Minor (L1): NCR that will affect internal interfaces, performances and functional requirements with no impact at the Fermilab level. It is processed internally by the CEA team. Fermilab is not informed immediately. A summary is provided to Fermilab once a month, or is included in the component (e.g. cryomodule) traveler.
- Moderate (L2): NCR that will affect interfaces, safety, lifetime, performances, functional requirements with an impact at Fermilab level. After corrective actions, the item is compliant to all specified requirements. The actions are implemented after CEA approval. Fermilab is informed of occurrence and mitigation/repair plan. Fermilab can request reclassification to L3.
- Critical (L3): NCR that will affect interfaces, safety, lifetime, performances, and functional requirements with an impact at Fermilab level. Fermilab is informed of occurrence, is invited to partake in the definition and approval of the mitigation/repair plan, and is requested to approve NCR closure.

The following diagram shows the sequence of non-conformance.

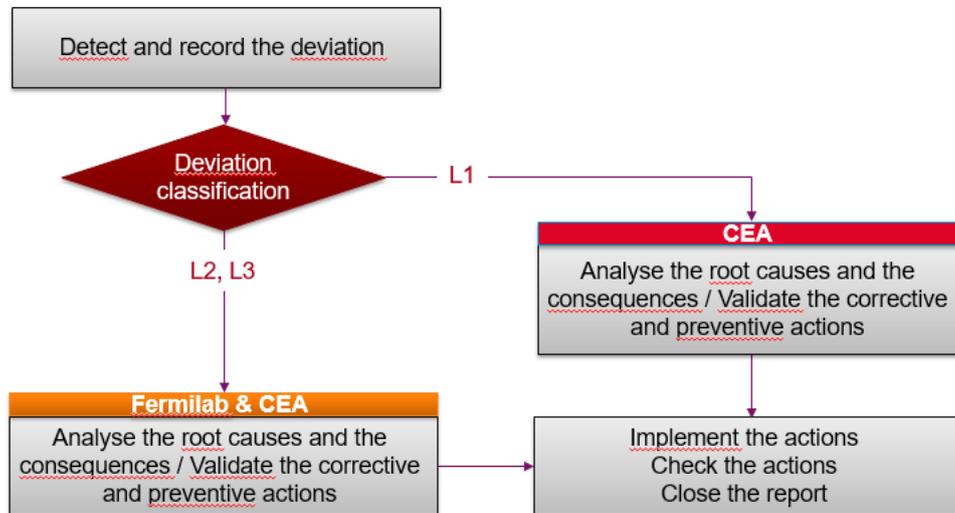


Figure 3 –Non-conformance management workflow

Regular meetings are organized by the Quality Manager at CEA in order to deal with any deviations and modifications recorded in that timespan. These meetings are held for the following purposes:

- Characterize the deviations (L1, L2, L3),
- Present the current status of the non-conformance and change request in progress, including possible actions (corrective et preventive),
- Prepare the reviews,
- Update the configuration.

13 COMPETENCE AND TRAINING

The mastery of human resources, in the sense of competence of the actors of the project, is essential to guarantee compliance with quality requirements.

The PM and the TC should:

- Determine the skills useful for carrying out the design and the integration of cryomodules according to the requirements expressed by CEA.
- Check that the project stakeholders are aware of the relevance and importance of their activities, as well as how they contribute to the achievement of quality objectives.

As part of the integration of cryomodules by a service provider, special attention must be paid to the qualifications, selection and training of recruited staff.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 18 sur 22

The personnel assigned to assembly and integration must receive specific training on the procedures and skills necessary for carrying out their tasks:

- machining and tooling usage,
- metrology operations,
- vacuum and ultra-vacuum operations,
- welding operations,
- work in clean room (ISO4, ISO5 and ISO7),
- understanding of the documentation provided,
- relationships between their activities and the quality,
- workstation safety.

The clean room and cryomodule integration activities managers must define and conduct training and qualification programs for the service provider's operators.

14 MANUFACTURING

All purchases and subcontracts comply with the rules prescribed by the CEA General Conditions of Purchase.

14.1 Contractual documents

Each contract is supported by two documents:

- The commercial contract, backed by the CEA general purchase clauses,
- The technical specifications of the product which specify the technical and Quality Assurance requirements. This document also includes the management specifications which express the monitoring and reporting requirements of the contract.

The Technical specifications are attached to the call for tenders. They are approved by the PM and the TC.

The activity phasing is identical for the manufacturing of the main components. After the contract has been signed by the subcontractor and the CEA, the procurement process is organized as follows:

Phases	
1	Kick-off meeting (cf § 14.2) between CEA and subcontractor
2	The manufacturer establishes the manufacturing file with technical studies if required. The manufacturer prepares during this phase all the elements of the manufacturing file, manufacturing drawings, manufacturing procedures (welding, special processes, tests ...), and follow-up documents. The subcontractor launches the supply of the machines, the tools and the material necessary for the realization of the components specified in the market.
3	Delivery of the manufacturing file produced by the manufacturer
4	During the Production Readiness Review, validation of the manufacturing file by CEA.
5	Manufacturing of pre-serial components (quantity of pre-serial components depends on the market). Factory Acceptance Test (FAT) of the pre-serial components
6	Delivery of pre-serial components to CEA. Inspection and control of components, Site Acceptance Test (SAT) at CEA Saclay. Components will be ready for assembly
7	The validation pre-production components triggers the production launch of the serial components.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 19 sur 22

8	Production of serial components and FAT of the serial components.
9	Delivery to CEA of all or part of the serial components. Inspection and control of components (SAT) at CEA Saclay. Components will be ready for assembly after ESS acceptance.

14.2 Kick-off meeting

Before the beginning of the operations by the subcontractor, the technical manager of the contract organizes a kick-off meeting.

The purpose of the kick-off meeting is to ensure that:

- The subcontractor fully understands all the requirements, whether technical, quality-related or managerial,
- Responsibilities are clearly established between the two parties,
- In the case of manufacturing, the subcontractor has the up-to-date manufacturing file,
- Both parties agree on the technical validation steps and provisions, the procedures for monitoring and controlling the operations, milestones and billing conditions,
- Both parties agree on the conditions of components delivery, in particular the documentation.

14.3 Production monitoring

Each contract is followed by a CEA Business Manager to ensure compliance with the provisions agreed with the subcontractor.

The Business Manager organizes with the subcontractor the validation reviews and the key points; he ensures the participation of the necessary CEA people: experts of the relevant fields and Quality Manager. He analyzes the reports issued by the manufacturer, informs the Commercial group of the evolution of billing milestones, and triggers the progress meetings with the subcontractor.

14.4 Factory Acceptance Test, Site Acceptance Test

Each component or set of components must be declared Ready For Assembly (RFA) before being sent to the assembly team. The RFA status is reached when the component has successfully passed the Factory Acceptance Test (FAT) and the Site Acceptance test (SAT).

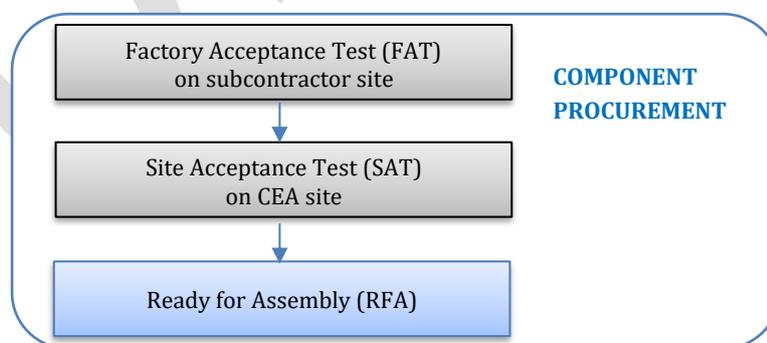


Figure 4 – Component acceptance flow chart

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 20 sur 22

14.4.1 Factory Acceptance Test (FAT)

The CEA Business Manager organizes the acceptance review with the subcontractor, and convenes the necessary CEA personnel. This step is recognized as Factory Acceptance Tests (FAT) in the agreements signed between the CEA and Fermilab. The FAT of the component is carried out on the subcontractor site.

The review includes two parts:

- A technical acceptance after checking compliance with the requirements, according to the provisions defined in the Technical specification and confirmed during the kick-off meeting.
- Verification of the deliverable documentation, including a certificate of conformity, signed by the Director and the Quality Manager of the subcontractor company, which attests that the product meets all the requirements of the contract (in particular regulatory and reliability requirements), except derogations formally accepted by the CEA.

If the review is successful, minutes of the acceptance are signed by the CEA manager who has authority to do it: TC or PM.

14.4.2 System Acceptance Test (SAT)

After the delivery of a component to CEA, a Site Acceptance Test (SAT) is performed by CEA.

During the SAT a visual inspection will be conducted to verify the integrity of the component delivered. Some complementary tests can be carried out.

15 ASSEMBLY AND CRYOGENIC TESTING

15.1 Assembly and tests documents

Each mounting operation is supported by a procedure or an operating instruction. The document also specifies the tools and equipment required for assembly, the environmental conditions (temperature, hygrometry, cleanliness), the constraints of execution (wearing of gloves, mask ...) as well as the criteria of success of the operation.

A conformance and traceability matrix is edited to summarize in a synthetic way the response of the equipment to all the specified requirements (functional, performance and other). The method (inspection, test, simulation...) foreseen to validate compliance with each requirement shall be indicated.

In addition, a verification plan will list the various tests and events planned to verify performance and other technical requirements, this document will specify the conditions of the tests.

The SPC and the PM will ensure that safety requirements and the necessary authorizations are taken into account.

15.2 Execution

A traveler is associated to each device / system being integrated. The execution of the various operations as well as the serial numbers of the components are recorded in the traveler or in a configuration file as the integration takes place.

The results of the check-ups, inspections, tests, etc. are systematically recorded: verification report, test report...

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 21 sur 22

15.3 Control of the environment

Several integration operations must be carried out in controlled atmosphere: cleanliness, temperature, and hygrometry. They are performed in a clean room (ISO4) or mobile laminar flow (ISO5).

The clean room manager ensures the maintenance of the clean rooms under operational conditions. Environmental conditions in clean rooms are continuously recorded during their periods of use.

16 ACCEPTANCE

Prior to delivery to Fermilab a System Acceptance Review (SAR2) is organized for each cryomodule with representatives of Fermilab. The acceptance by PIP-II is pronounced at the end of the review. The final acceptance conditions are defined in the Acceptance Plan.

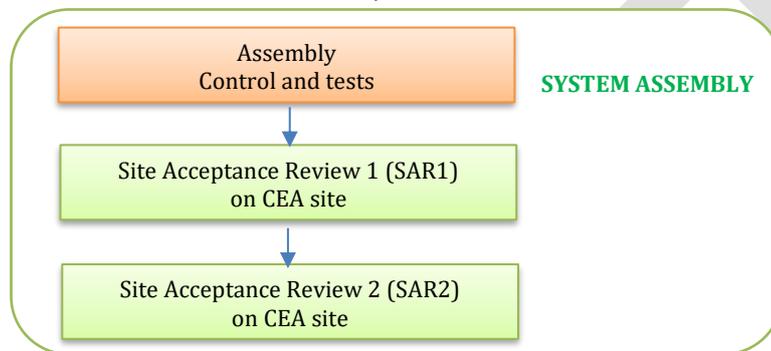


Figure 5 – Cryomodule acceptance flow chart

During SAR2, the deliverable documentation (ADP: Acceptance Data Package) is examined.

The composition of the ADP is agreed jointly by CEA and Fermilab. It includes (non-exhaustive list):

- Conformity certificate of the device to the Fermilab specifications, signed by the PM and the Quality Engineer,
- Product Breakdown Structure of the device,
- Assembly configuration (As built configuration status list) specifying the serial numbers of the device and its sub-assemblies, as well as the manufacturing file,
- Travelers filled during assembly,
- List of tests carried out and the corresponding test reports,
- Certificates of compliance with regulatory requirements (when applicable),
- List of non-conformances and a copy of non-conformance of levels L2 and L3,
- Maintenance Manual (when applicable),
- User Manual (when applicable),
- Handling and transport procedure.

The conditions and provisions applicable to the transfer of responsibility and the transfer of title of cryomodules and other equipment are specified in the Project Planning Documents.

 	PIP-II PROJECT QUALITY ASSURANCE PLAN	Référence :
	PIP-II	Page 22 sur 22

17 QUALITY FOR STORAGE

The components are stored in premises that ensure their integrity and compliance with environmental requirements.

The parts sensitive to contamination are packed with specific protection (double bag, clean cover, nitrogen containers ...) even if they are stored in a clean room.

18 QUALITY FOR HANDLING AND TRANSPORT

The handling and transport operations are carried out in such a way as to guarantee the integrity of the equipment and the respect of environmental requirements.

A transport and handling procedure is written for each equipment; it specifies the references of the tools, the containers if necessary, the operating procedures and constraints of execution (wearing gloves ...). An English version will be available outside the container.

Handling equipment and transport containers are managed in configuration. Handling for truck loading is under CEA responsibility and cryomodule transport is under Fermilab responsibility.

19 MEASURING AND TEST EQUIPMENT MONITORING

The equipment (measuring devices, equipment used for assemblies) requiring periodic maintenance and calibration are the subject of an intervention program which specifies the frequencies and responsibilities.

These maintenance and measurement operations are carried out by:

- Specialized companies in the maintenance and calibration of measurement and testing equipment, chosen from the list of accredited laboratories attached to the national calibration chains,
- The manufacturer or the supplier of the equipment.

The records relating to the maintenance and calibration operations (life record, verification report, calibration documents, etc.) are kept by the quality manager in accordance with the rules for the control of the records.

20 CONTINUOUS IMPROVEMENT

On a daily basis, the continuous improvement is fed by the non-conformance and change request management system. The definition and the subsequent implementation of the corrective and preventive actions insure the feedback and capitalization of lessons learnt to the technical teams.

At the end of the project, the review meeting initiated by the PM with the participation of all the actors aims to produce a general feedback on all phases and components of the project (organization, relations, technical aspects...). The conclusions of this review meeting are forwarded to the CEA management in order to enrich the Institute's good project management practices.