Overview of PPPT Implementation

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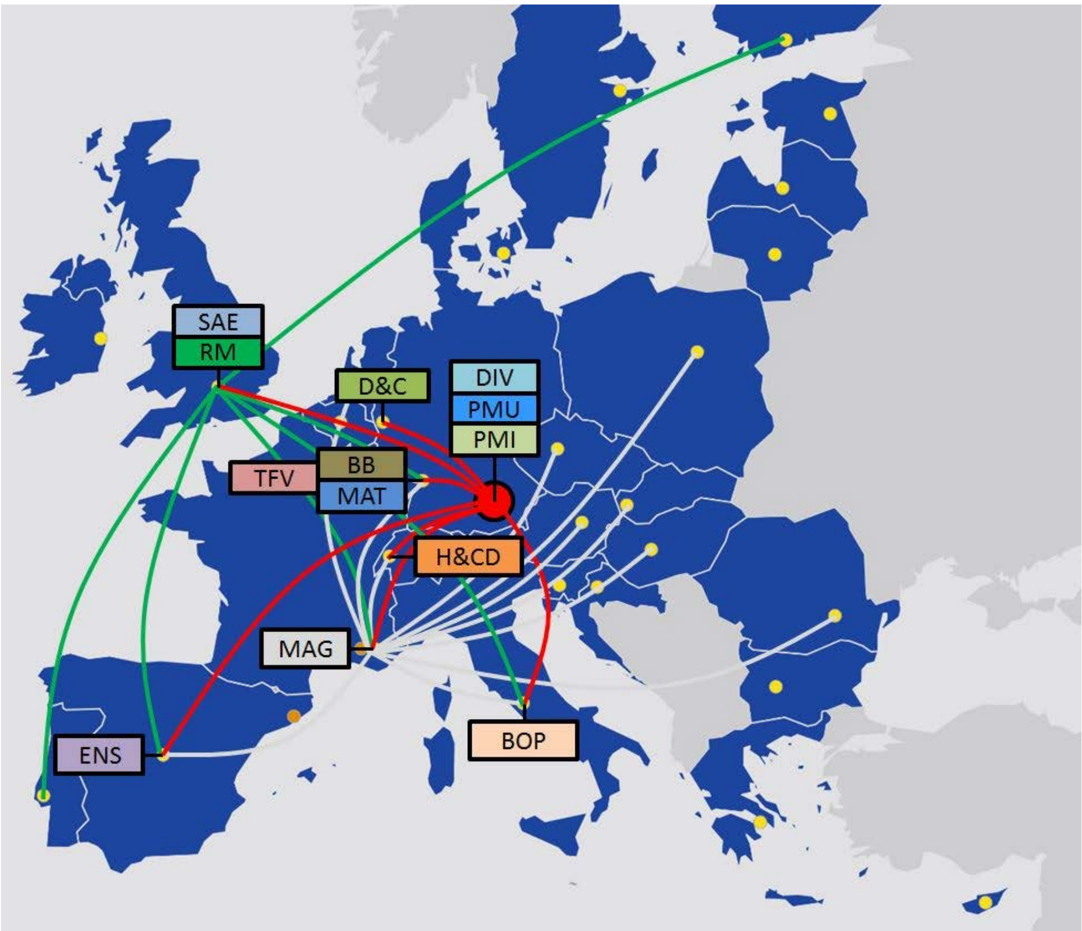
IDM Reference: 2MMYSK

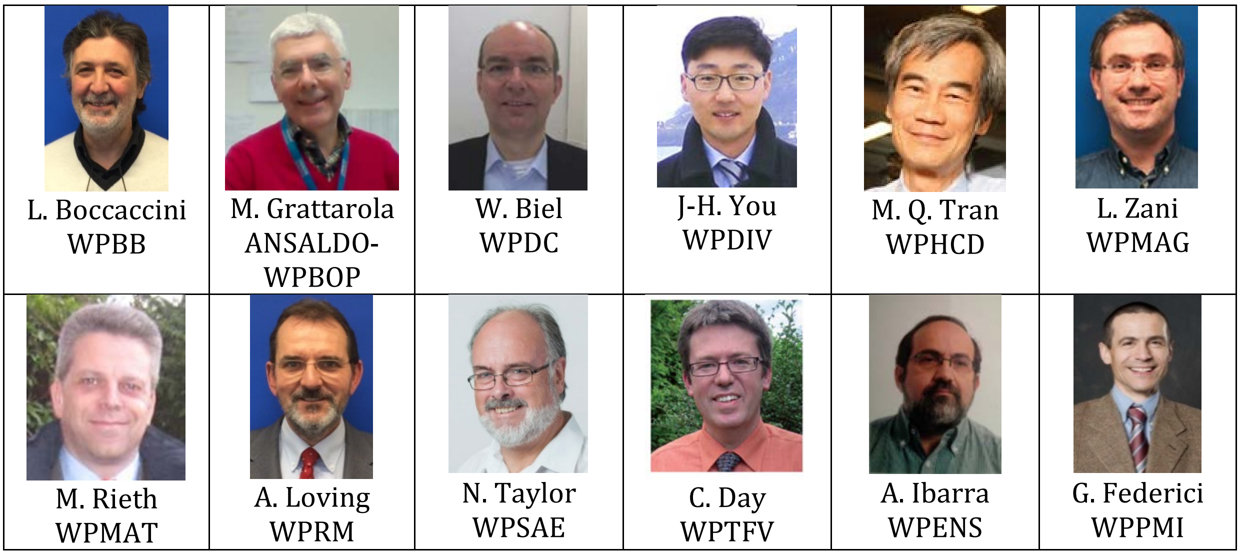
1 INTRODUCTION

An important objective of the new EU fusion roadmap is to lay the foundation of a DEMOnstration (DEMO) Fusion Power Plant to follow ITER, capable of generating several 100MW of net electricity and operating with a closed fuel-cycle around the middle of the century [1]. This roadmap is currently being updated to explore possible adaptations to minimise the impact of the foreseen delays of the ITER project and the resulting slippage that could result on the milestone related to the demonstration of fusion electricity production around the middle of the century [2].

Unlike conventional projects that are carried out predominantly by a design team sitting in one place, the DEMO design work being done in the Power Plant Physics and Technology Department (PPPT) of the EUROfusion Consortium is rather unconventional, in that the design and R&D work is primarily executed in geographically-distributed projects (see Fig. 1a) with defined scope, deliverables, milestones, time schedules and resource allocation. The responsibility for managing these projects lies in the hands of the Project Leaders (PL) who work in the EUROfusion Research Units (RU) (see Fig 1b). The main role of the PPPT Programme Management Unit (PMU) Department is to provide Project Control, Design Integration and Physics Integration functions to support the projects and ensure that a consistent and integrated DEMO concept design is developed. In executing these functions the PMU is supported by engineering and physics tasks included in the Work Package WPPMI "Plant Level System Engineering, Design Integration and Physics Integration" executed in the EUROfusion RUs. The PPPT PMU is supported by the PPPT Expert Group (PPPT EG), which advises the Programme Manager on the development, implementation, and monitoring of the work packages.



(a)



(b)

Fig. 1: (a) Organisation of Design and R&D Activities. **WPBB:** Breeding Blanket project; **WPBOP:** Heat transfer, Balance-of-Plant and Site project; **WPDC:** Diagnostic and Control project; **WPDIV:** Divertor project; **WPHCD:** Heating and Current Drive systems project **;** **WPMAG:** Magnets System project; **WPMAT:** Materials project; **WPRM:** Remote Maintenance System project**;** **WPSAE:** Safety and Environment project**;** **WPTFV:** Tritium, Fuelling & Vacuum systems project**;** **WPENS:** Early Neutron Source project**;** **WPPMI:** Plant Level System Engineering, Design Integration and Physics Integration. In the scheme, the composition of only the project teams of WPRM and WPMAG are also shown. (b) PPPT Project Leaders.

2 REFERENCED DOCUMENTS

[1] Fusion Electricity – A roadmap to the realisation of fusion energy, F. Romanelli et al., EFDA, 2012. EFDA Fusion Roadmap (2M8JBG)

[2] Revised DEMO Design and Development Plan (As part of the update of the EU Roadmap to Fusion Electricity) 2N2FJB)

[3] DEMO Stakeholder Requirements Document 2MGNEW

[4] DEMO Stakeholder Working Group (SWG) Terms of Reference 2MD269

[5] Input for DEMO Stakeholder Group Meeting 2M778S

[6] Report of the DEMO Stakeholder Group 2M6VKJ

[7] WPPMI Scope and Implementation Basis 2MY9MV

[8] DEMO Plant Requirements Document 2MG7RD

[9] Plant Description Document 2KVWQZ

[10] Plant Break-down Structure 2MJ6WB

[11] DEMO Physics Design Guideline 2MPJUR

[12] DEMO Nuclear Analysis Handbook 2LLZMA

[13] General Safety Principles (draft) 2LJVZ7

[14] DEMO Plant Safety Requirements Document (PSRD) First Draft 2MKFDY

[15] CAD database 2LCVSX

[16] PPPT Expert Group Terms of Reference 2GCX7A

[17] PPPT PMU - Project Management Plan 2MSBRN

[18] Work Plan for the Implementation of the Fusion Roadmap in 2014–2018 2MSEPW

[19] Annual Work Plan 2014 2KWV7V

[20] Annual Work Plan 2015 2LMES5

[21] Annual Work Plan 2016 2MQZFM

[22] DEMO CAD Manual 2MR5HP

[23] Guidelines for neutronic analyses 2L8TR9

[24] PPPT PMU - Technical Management Plan 2LJUAN

3 PPPT PMU OBJECTIVES

The primary and long-term objective of the PPPT PMU department is to deliver a feasible, integrated concept design of the DEMO Plant that, with an acceptable level of confidence, can be shown to meet the Stakeholder Requirements specified in ref. [3] that have been agreed with the DEMO Stakeholders Group (SHG) [4-6]. The purpose of the Workpackage WPPMI is to support the PPPT PMU in delivering its objectives. The scope and implementation of WPPMI are described in ref. [7]

The main objectives of the PPPT PMU department are to:

- Lead and manage the overall PPPT programme providing close support to the PPPT distributed WPs
- Identify and drive the engagement of industry
- Coordinate (both stakeholder and plant-level) requirements capture, definition, and analysis
- Validate requirements through system modelling and plant-level analysis
- Ensure design integration by facilitating inter-project liaison and ensuring that the design and development of plant systems and components is consistent with the plant requirements
- Identify and perform key trade-off studies to ensure that design drivers and sensitivities are adequately explored and the plant design is optimised in line with the top-level requirements
- Carry out a physics input assessment to consolidate the DEMO Physics basis and to ensure that the physics R&D needed is pursued in the relevant Work Packages
- Capture, control and maintain the overall plant configuration and traceability, e.g. requirements, design, experimental results, analysis, etc.
- Identify and manage interfaces among project work packages and between the DEMO systems/components
- Develop / provide the project management & technical processes and tools required
- Organize and facilitate technical reviews

4 PPPT PMU DEPARTMENT FUNCTIONS

The PPPT PMU department functions are briefly outlined in this section.

4.1 Programme Management and Control

It provides an overall programme management function and support to the PPPT WPs through the following functions:

- Support Project Leaders in the overall budget allocation of resources and track actual spend against budget
- Develop and maintain the overall integrated Programme Schedule and track progress of tasks against milestones and acceptance of deliverables
- Coordinate the preparation of Annual Work Plan documents
- Prepare monitoring and progress reports at programme level
- Support Project Leaders in the preparation and update of Project Management Plans and technical task specifications as necessary
- Administer the acceptance, review and storage of project deliverables
- Arrange Project Management Meetings and other progress reviews as required
- Carry out monitoring actions and overall programme control
- Develop and maintain together with the Project Leaders an overall risk register and perform risk management activities for the most critical project and technical risks
- Provide and manage shared tools for the administration of the projects
- Resolve issues of communication among the projects

4.2 Systems Engineering & Design Integration

It develops Systems Engineering processes, provides related tools, ensures the population of related databases, defines the plant architecture through assessments of alternative options, and provides and maintains the technical description of a DEMO baseline through the following functions:

- Management, analysis and control of Technical Requirements
- Management, analysis and control of Plant / System Design Definition
- Management and control of Technical Issues Register
- Lead the design integration and interface management of plant systems
- Assimilation and assessment of project outcomes into overall plant design
- Conduct Design Configuration Meetings (DCM) to manage the DEMO Baseline Design
- Ensure through the performance of trade-off studies that the plant design is optimised in line with the plant requirements
- Conduct system-level analyses to assess the behaviour of multiple-system assemblies, study interface issues, and define interface requirements
- Identify suitable system configurations to facilitate the development of integrated design solutions in collaboration with the system designers
- Ensure the identification of a feasible and practical solution for the integration of all related components including installation, maintenance, refurbishment, and commissioning aspects
- Ensure that the technical interfaces are being defined
- Plan and organize integration reviews to ensure that the integrated design of the interfacing systems is progressing and consistent with the design considered in the projects
- Support and facilitate the assessment, evaluation and selection of design options
- Lead the definition, development and management of technical process, method and tools
- Development of a Systems Engineering database tool
- Preparation and maintenance of DEMO high-level technical documentation, including:
  - SHRD - DEMO Stakeholder Requirements Document [3]
  - PRD - Plant Requirements Document [8]
  - PDD – Plant Description Document [9]

- PBS – Plant Breakdown Structure [10]
- DEMO States and Modes
- DEMO Physics Design Guideline [11]
- Load specification
- DEMO Nuclear analysis handbook [12]
- General Safety Principles [13]
- DEMO Plant Safety Requirements Document (PSRD) [14]
- CAD database [15]
- Requirements database
- Interface database

4.3 Management of Physics Integration

It manages the physics assessment in areas, which have an impact on the overall DEMO design requirements and therefore cannot be managed at WP level. These areas include:

- The development of DEMO design points: System codes are used to develop DEMO design points, which are consistent with respect to all relevant areas of physics and engineering. The development of these codes representing an entire plant is carried out in cooperation with activities in the area of physics (e.g. scenario modelling) and also the projects developing the concept design for DEMO components.
- The development of the DEMO Physics Basis: A key activity is the prediction of all relevant aspects of the physics of DEMO. This information is used for the development of the DEMO design points and also by the projects developing the concept design for DEMO components. The main areas of DEMO Physics Basis Development are Plasma Scenario Modelling, Heating & Current Drive Physics, Transport, MHD, Fast Particles, Specification of Wall Loads, Plasma Wall Interaction and Disruptions.
- Aspects of DEMO Physics Design Integration: In a number of areas integration of physics and engineering expertise is needed. Priority topics include, thermal load specifications for In-Vessel Components, Vertical stability analysis, Plasma Disruption Analysis and TF ripple in view of number of TF coils.

4.4 Development Containment Structure Systems

An additional PPPT work package had initially been foreseen to design Containment Structures (WPCS). The primary objective of the Work Package was set to develop a feasible, sufficiently integrated concept design of the DEMO vacuum vessel (VV), cryostat, thermal shields, vacuum vessel pressure suppression system (VVPSS) and tokamak building. The technologies and designs of these systems are expected to benefit significantly from experience acquired during the ITER design and construction and hence no major R&D is expected to be required in the conceptual design phase. In addition, rather than in the development of the WPCS systems themselves, the challenge of their development lays in their integration with other tokamak systems. As the PMU-PPPT is responsible for the DEMO design and physics integration, with work executed via WPPMI tasks, the responsibility to develop the containment structure system was added to the WPPMI's scope as of 2016.

5 PPPT ORGANISATION

5.1 Contextual Overview

The overall organisation of the EUROfusion Consortium is shown in Figure 2. The PMU is divided into the following departments:

- Power Plant Physics & Technology (PPPT) department
- ITER Physics (IPH) department
- Administration department
- Communications office

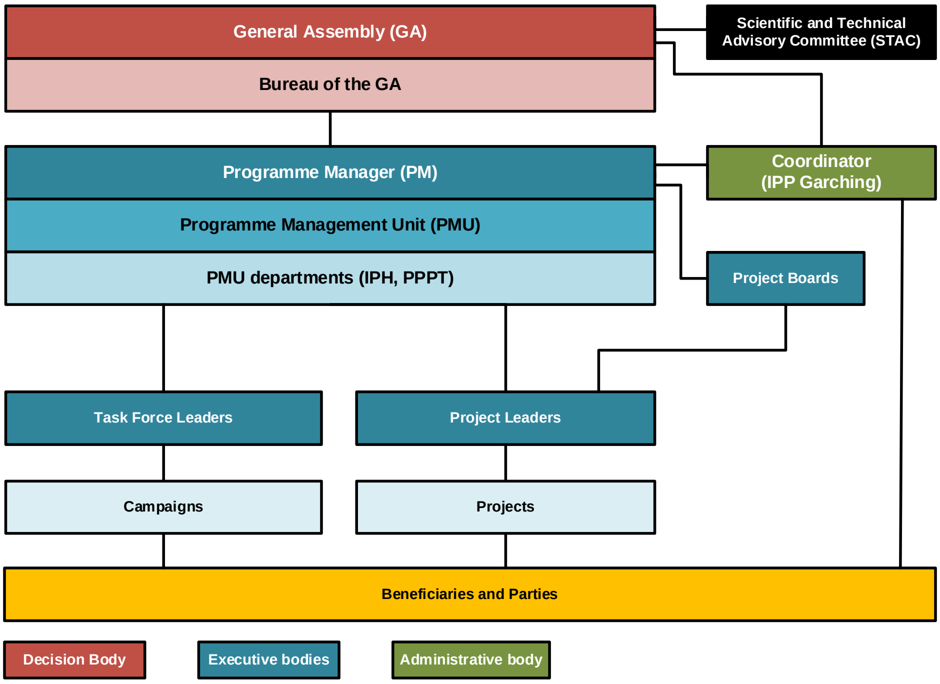
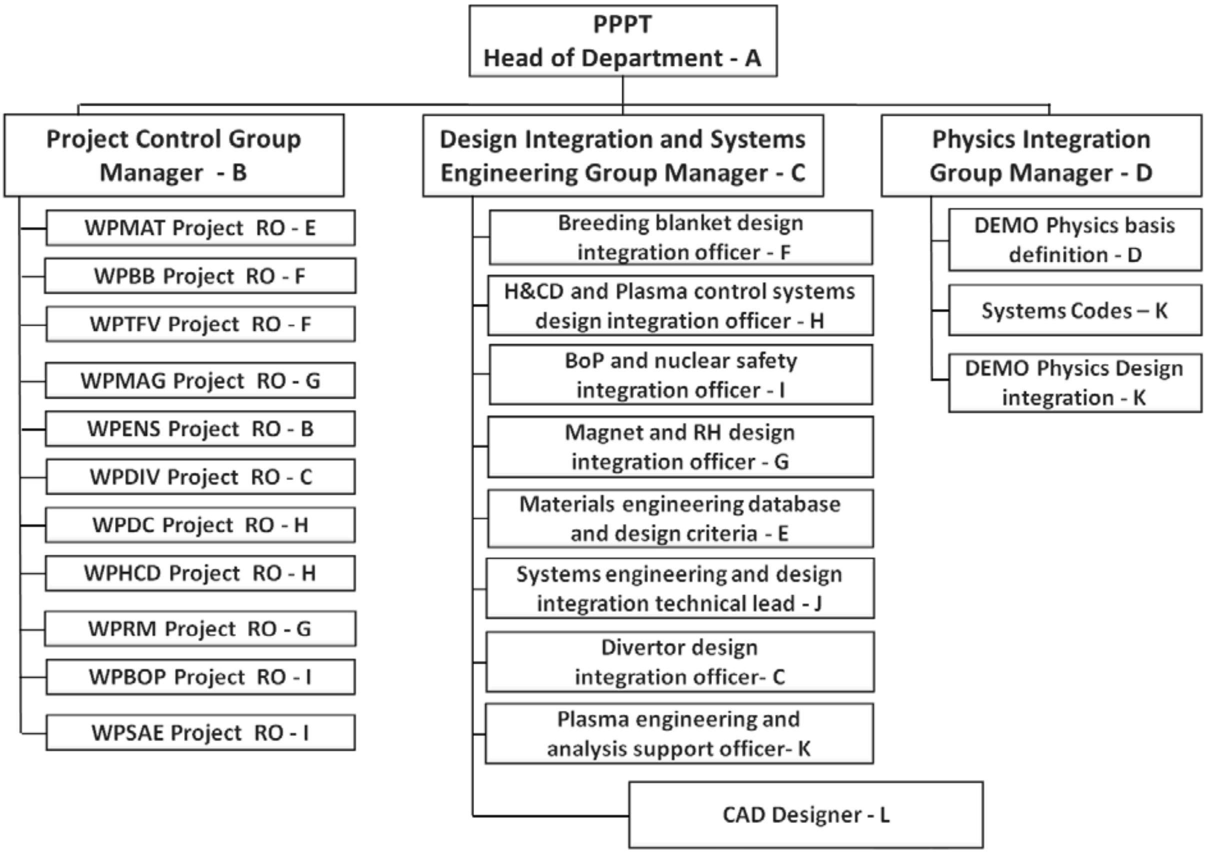


Fig. 2: EUROfusion Consortium Organisation. Colours indicate the principal role of the entities – that is decision making (red), administration (green) and execution (blue).

5.2 PPPT PMU Organization

The organisational structure for the PPPT PMU department in the EUROfusion Consortium is shown in Fig. 2. The organisation reflects the PPPT functions as described in section 4 above and is operated as a matrix structure with staff members providing one or more roles as required by the Group Managers and HoD.



(a)

 G. Federici **A**	 B. Meszaros **B**	 C. Bachmann **C**	 R. Wenninger **D**	 E. Diegele **E**	 F. Cismondi **F**
 M. Coleman **G**	 T. Franke **H**	 S. Ciattaglia **I**	 R. Brown **J**	 F. Maviglia **K**	 C. Gliss **L**

(b)

Figure 3: (a) PPPT Dept. (roles); (b) PPPT Dept. (staff)

5.3 Relationship between PPPT PMU and other Organizational Entities

5.3.1 DEMO Stakeholder Group

Key to the success of any technology development program is the early and continuous engagement of technology stakeholders to ensure that the work conducted is valuable to the eventual adopters of the technology. We are currently engaging experts (including industry, utilities, grids, safety, licensing and operators) to establish realistic top level requirements for the DEMO plant and a self-consistent Integrated Conceptual Plant Design assessment approach that should include a better integration of safety assessments and power conversion aspect typical of a fusion nuclear plant into the design process. This will ensure that their perspectives are captured in the initial identification of leading technologies, and the down-selection for the most promising design options.

A SHG report has been produced [6]. This can be summarized as dictating the principle missions for the current DEMO programme as being: (i) safety and environmental sustainability; (ii) plant performance; and (iii) assessment of economic viability.Regular meeting are held with the DEMO SHG (typically once per year) and it is expected that they will help define a set of Key Performance Indicators (KPIs) for the projects and plant to allow definition, measurement, monitoring, and tracking of performance over time.

Before embarking on a stakeholder engagement process, a number of meetings were held with advanced Gen-IV Fission projects such as ASTRID and MYRRHA and the following lessons were learned:

- Fission projects follow a pattern of evolution in each successive plant design, with careful progression in key areas backed up by some operational data. ASTRID has drawn from Superphenix and the Phenix machine before that. MYRRHA has matured from extensive test bed development and operation of the MEGAPIE experiments.
- The plant design should drive R&D and not the other way round, but the design should be kept flexible enough to incorporate possible R&D breakthroughs in areas where they would have a large impact.
- It is important to consider from the beginning that fusion as a nuclear technology will be assessed with full nuclear scrutiny by the regulator. To this end, early engagement with a licensing consultant is needed to understand and tackle potential safety implications through design amelioration.
- There is a need for a traceable design process with a rigorous Systems Engineering approach. Design choices should be made within a traceable context of functions and requirements so that future lurches from one decision path to another are not made without full understanding of the requirements originally assigned and the potential implications.
- The production of electricity should be the main objective of a fusion development program.
- The technical solution should be based on maintaining proven design features (e.g., using mostly near-ITER technology where possible) to minimize technological risks, but both highlighted the need to take risks when the reward is significant and there is a back-up plan.
- Reliability and maintainability should be key drivers: allow for design margin (over-design) where technology limits and budget will allow, since this will increase machine longevity, reliability and capability, when considering enhancements.

5.3.2 PPPT Expert Group

The purpose of the PPPT Expert Group (PPPT EG) is to provide the Programme Manager with timely and expert guidance pertaining to the development, implementation and monitoring the work package: WPPMI "Plant Level System Engineering, Design Integration and Physics Integration". The PPPT

EG contains experts from both within the fusion community (i.e. STAC, ITER IO, F4E members) and from outside (i.e. Industry) in order to provide a balanced view across the areas of Programme Management, Systems Engineering, Design Integration and Physics Integration.

The terms of reference for the PPPT EG can be found in [16].

5.3.3 PPPT Projects

The PPPT Department within the PMU will provide overall Systems Engineering and Design Integration functions. The interface between the PMI Activities and the rest of the PPPT WPs will be managed through the PPPT PMU.

5.3.4 Project Boards

A Project Board (PB) for each project has been formed with the responsibility for the regular oversight of the projects. The PB includes one representative of each of the members who are participating in the project. The PBs will decide on any issue arising with availability of resources, change of schedule and technical decisions that do not impact on other WPs. The members of the PBs have been carefully selected in order to bring specific skills, knowledge and experience to each project. Due to the deeply interrelated and integrated nature of both WPBB and WPBOP, these two project boards were combined into one for simplicity.

The allocation of resources and the RUs involved is shown in Annex 7.2.

5.3.5 Fusion for Energy (F4E)

Strong emphasis will be given to the synergies between the F4E programme and the EUROfusion programme, as both are ultimately directed to prepare DEMO and to realize fusion power.

It is clearly recognised in the Fusion Roadmap [1,2] that the knowledge and experience gained through the ITER programme must be brought to bear in the execution of the DEMO programme. Many of the key design decisions made on ITER will have an influence on the design choices and rationale for DEMO. Furthermore, technology employed on ITER will be demonstrated in mission-relevant conditions once ITER is commissioned and operational, thereby reducing the risk of application to DEMO.

The conduit for such engagement between DEMO and ITER is the F4E organisation. F4E experts have been involved from the start in each of the PPPT PBs. Their role is to share their ITER experience with the PLs in order to ensure that previous relevant work is identified and that the lessons from the pioneering work on ITER are applied. Furthermore, it is expected that F4E experts will be involved at the project operational level and key technical reviews.

The open dialogue with F4E experts on technical and governance matters and their involvement as observers in the Project Boards will facilitate the transition from the Conceptual Design Phase (CDA) to be done under EUROfusion to an Engineering Design Phase (EDA) expected be conducted under the auspices of F4E.

5.3.6 ITER International Organization (IO)

There are also areas where direct links with the ITER Organization (IO) are needed to ensure that we benefit as much as possible from their design experience. This includes, for example materials data and structural design criteria and consultation to understand their future plans. There is a pressing need to progress these issues and to establish a mechanism to exchange information with IO, otherwise there is a risk of significant delay to activities in some of the areas (e.g., Engineering Data and Design Integration) and of wasting resources in reproducing what has already been achieved by IO or duplicating what IO plans to do in the coming years. Only via an open exchange can we assure that we effectively target gaps and specific issues that are not being covered.

The framework for this open exchange needs to be discussed and agreed at a higher level.

5.3.7 Industry and the Fusion Industry Innovation Forum (FIIF)

The involvement of industry, especially in the early DEMO definition and design, is explicitly included in the Fusion Roadmap [1,2]: "*The evolution of the programme requires that industry progressively shifts its role from that of provider of high-tech components to that of driver of fusion development. Industry must be able to take full responsibility for the commercial fusion power plant after successful DEMO operation. For this reason, DEMO cannot be defined and designed by research laboratories alone, but requires the full involvement of industry in all technological and systems aspects of the design. Industry involvement needs a policy to maintain industrial competence. An early launch of the DEMO engineering design after the completion of ITER would facilitate maintaining industrial competences*".

It should be noted that Gen IV has been successful in leveraging industry support. The motivation for early involvement of industry in fusion is to ensure that in the designs of planned facilities and reactors early and sufficient attention is given to industrial feasibility, costs, nuclear safety and licensing aspects. The key areas of industrial involvement include:

- Project / Programme Management
- Plant engineering tools and processes: Systems Engineering and Design Integration
- Nuclear safety Engineering & Licensing Support
- Reliability / Dependability Engineering
- Digital Engineering (i.e. CAD, CAE, VR)
- Design for Manufacture
- Design for Assembly & Maintenance (including remote handling)
- Balance of Plant design and integration
- Cost Analysis / Cost optimisation
- Manufacturing process development
- Cost, risk, safety and RAMI analysis
- Evaluation and selection of design alternatives
- Technology assessment i.e. technology audits, TRL assessment, etc.
- Design for robustness and manufacture of critical components/systems; include design simplification/ reduce fabrication costs
- Development of Codes and Standards

From the work conducted to date, a number of issues have been identified that lead to some difficulties in securing an efficient support. Some of the above issues are being discussed and solutions are sought involving the Commission and the Fusion Industry and Innovation Forum (FIIF), formed by industrial organizations that are involved in the development of fusion energy. The aim is to support the integration of industry in the development of DEMO design process and the related training and education activities.

5.3.8 International Collaborations

Exploitation of international collaborations has been advocated in the EU Fusion Roadmap [1,2]. The following collaborations are acknowledged:

- **Japan: Broader Approach - IFERC (as of 2011)**
  Joint DEMO Design Activities (DDA) were established to address the most critical DEMO design issues and investigate feasible DEMO design concepts.

The preparation activities for DEMO that arise from the Broader Approach (BA) Agreement between Europe and Japan are part of the statutory tasks of Fusion for Energy. However, due the priority given to the ITER construction activities, F4E has not engaged directly in this work, but has established since 2014 a collaboration with EUROfusion (formerly with EFDA) to conduct the domestic activities in the DEMO area as part of the work programme of the EUROfusion PPPT Department.

- **China: DEMO/ CFETR technical exchange and joint design task forces**
  Joint Design Activities do not exist at the moment but there are plans to improve technical exchange in this area. As of 2016 work is being organised on:
    - Systems codes, comparing/ benchmarking EU and CN codes
    - Divertor configuration and performance, in particular alternative divertor geometries and their potential implementation in CFETR / EU-DEMO / DTT
    - Collaborations on breeding blanket design and R&D (to be defined in 2016)

- **University of California Los Angeles (DCLL)**
  A collaboration to aid the design and development of a Dual Coolant Lithium Lead (DCLL) breeding blanket concept (and in general of PbLi loops technology for liquid breeder blankets) is foreseen with the University of California Los Angeles (UCLA) as of 2016 to upgrade and exploit its existing MaPLE facility for combined magneto-hydrodynamic (MHD) thermo-fluids and fluid-materials interaction experiments. The MaPLE upgrade is important to simulate multiple effects of magnetic field, orientation with respect to gravity, and nuclear heating and temperature and their gradients. These result in new phenomena and improve understanding of liquid metal flow and interactions in the fusion environment.

- **Fission Reactor Irradiation Experiment**
  Collaborations to use materials test reactors outside of Europe for high fluence irradiation experiments to close gaps in the EUROFER data base.

5.4 PPPT PMU Meetings

The PPPT PMU will take the lead role in ensuring effective communications occur across and between the PPPT WPs through the facilitation of regular programme-level meetings. The scope of such meetings is described below (see Table 1).

Table 1: Project Meetings Matrix

Meeting	Description	Frequency	Format	Participants	Relevant Documents	Chaired by
Project Management Meeting (PMM)	To review progress and status of all PPPT Projects	Quarterly	Face-to-face meeting	PLs; PMU	Progress Status Reports	Project Control GM
Design Configuration Meeting (DCM)	To discuss requested modifications of baseline design configuration	Quarterly	Face-to-face meeting	PLs; PMU	DEMO baseline documents; Design Change Request(s)	Sys. Eng & Design Int. GM
Project Progress Review	Review of design and technology developments within a project	1-4 times/ year	Face-to-face meeting	Project Team, PL, PMU RO	Meeting material	PL
Design progress review meeting (DR)	To evaluate the project technical progress on key aspects	1-2 times/ year	Face-to-face meeting	PL, LEs, PMU, EUROfusion experts, external experts	Meeting material	PMU RO
Design integration review	Review the progress on the integrated design by tokamak areas	Annually	Face-to-face meeting	PMU RO, LEs	CAD Configuration Model	PMU RO

Key: PL: Project Leader; LE: Lead engineer, GM: Group Manager, RO: Responsible Officer

Project Management Meeting scope:

- Review the status of all projects in the Programme and discuss corrective actions if needed
- Check that the overall Programme is under control in terms of achieving major milestones within the agreed budget and schedule
- Identify any major changes requiring Project Change Requests (PCRs) in scope, budget and schedule
- Review the status of any critical project risks

Design Configuration Meeting scope:

- Discuss and decide new design change requests (DCR) and review the status of ongoing DCRs
- Manage the overall Design Configuration, i.e. agree on configuration items; manage changes to the baseline in a controlled manner; add/delete branches to the design configuration (i.e. to reflect design developments, etc.)
- Define and adapt the DEMO technical design development framework, e.g. technical processes, inter-project collaboration, central design integration, etc.

Project Progress Meeting scope:

- Review the status of the activities in one single project.
- Discuss future development strategies and corresponding activities
- Discuss any project-internal matters and matters concerning the collaboration with other project and the PMU

Design Progress Review Meeting scope[1]:

- Provide impartial expert design advice and guidance to the systems/ components development proposals and other design related matters
- Review the design progress and ensure that the designs evolve consistently with the requirements and that all the design integration aspects are properly accounted for.
- Identify critical technical problems and recommend actions for improvement/ameliorations
- Consult on the future development strategy.

Design Integration Review Meeting scope:

- Collect all related system designs (of any maturity) available and include them in the corresponding General Arrangement CAD model
- Collect / update interface requirements of the systems to be integrated in the relevant Plant and Tokamak zones
- Review the space allocation and interfaces of the systems in the pertinent Tokamak zone
- Develop integrated design configuration solutions
- Evaluate the outcome of studies of multiple design integration solutions
- Review the interfaces of the relevant Tokamak zone with systems in adjacent zones

[1] These meetings are organised involving external technically competent and independent experts.

6 PPPT PMU MANAGEMENT PROCESSES

Further details of the PPPT management activities can be found in the *PPPT PMU Project Management Plan* [17].

6.1 Programme Scope Management

The Programme and Project Scope Management is being accomplished through the definition, regular review, update and approval of the programme management documents. The scope will flow in a top-down direction - following the implementation steps of the program - starting at the Fusion Roadmap [1] and then down into the Work Plan 2014-18 [18], then subsequently to the Annual Work Plans [19-21], Project Management Plans and, ultimately, Task Specifications (TSs).

6.2 Budget & Resource Control

A master budget and resource allocation table is produced and maintained by the PPPT Programme Control Group Manager. This budget and resource allocation table includes for each PPPT Project and the PMI activities the overall indicative budget for each year in terms of manpower in the laboratories and industry and hardware broken down to sub-project level.

It should be noted though, that resource allocations are formally agreed on an annual basis by the General Assembly based on the Annual Work Plan for each year, therefore the master table is updated accordingly to reflect: i) the recording of the final allocation of resources to the past year; ii) the allocation of resources to the coming year as approved by the General Assembly; and iii) the update of the indicative resource allocation for the future years.

6.3 Integrated Schedule Management

The objectives of the Integrated Schedule Management process are to ensure that:

- The timing of key activities, milestones and decision points that have a significant impact on the overall delivery of the programme are identified and tracked
- Dependencies on achieving key milestone and taking key decisions are identified and tracked
- Time schedule information from the Projects relating to key activities, milestones and decision points is integrated and updated regularly in an overall Integrated Schedule
- The Integrated Schedule is placed under change control and managed through base-lining
- Significant deviations (see below) from the agreed Schedule baseline are brought to the attention of the Programme Manager with corrective actions

Based on the above objectives the following strategy has been developed to create and manage an integrated schedule (currently under implementation):

- The WPs are responsible to create and update their planning on a quarterly manner, as well as identifying key decisions internally. These key decisions need to reflect the ten most important decisions during the lifecycle of the pre-conceptual design phase of the project, and naturally need to be linked to major project activities.
- The design integration team however is responsible to create a schedule of overarching key integration decisions that allow the timely delivery of the pre-conceptual design results – as defined by the Fusion Roadmap - and drive the timeline of the project decisions to some extent.
- The above information is then combined and cross-linked in an integrated schedule which provides the basis of the core database that could be interrogated by various predefined filters

to allow reporting to various management levels, e.g. Programme Manager, Project Boards, Project teams, etc.

The review of the integrated schedule shall be done quarterly and the identified cross-project scheduling issues solved in the frame of the Project Management Meeting (see 5.4 above).

6.4 Document Management

All documents required to manage the PPPT programme and WPs shall be uploaded to IDM. These are documents defining the scope of work, the execution and the deliverables of the individual tasks. In other words, all documents generated by the “contractual” workflow of the activities. In addition, project deliverables that are in the form of documents i.e. reports shall also be stored in IDM. The built-in electronic review and approval functions of IDM shall be used. As such, all documents of contractual, technical or formal nature that are going through such a process are to be stored, “signed”, reviewed and approved in IDM.

6.5 Project Change Management

Proposed changes that have a significant impact on PPPT projects i.e. scope, budget, schedule, are evaluated and agreed through a PCR procedure. During the approval procedure the following actors are requested to carry out the following actions:

- The initiator, a member or the PL of a project, needs to describe the case and indicate the motivation of the requested change.
- The PL of the corresponding project needs to make an assessment of the requested change, whether it has an impact on the project scope, schedule or resources, and if it is acceptable from his/ her point of view.
- The PPPT PMU checks if the requested changes are in line with the global strategy, budget and other constraints as presented in the approved Work Plan and will assess what changes have to be implemented.
- The PL together with the PPPT PMU creates a summary of the proposed change and the assessment with special attention to the scope, schedule and resources.
- The PB is the decision making body that approves or rejects the request.

6.6 Project Reporting & Monitoring

PLs report the current status of their WP at the PMM (see 5.4 above). The progress status of all running project deliverables needs to be updated in the online deliverable table to indicate task status using a simple “traffic light” system. i.e. Green: OK – task running as planned; Yellow: Delayed – task running but deliverables expected later than planned; Red: Blocked – task stopped i.e. no progress; Grey: Cancelled – Task no longer required.

6.7 Quality Management

The PPPT PMU Department ensures the quality of technical work and the relevance of outputs through the definition and control of work processes and the release of work guidelines:

- All programme and project document are stored in the electronic, version-controlled IDM including the traceable review and approval process.
- All CAD models are centrally controlled regarding consistency in design as well as in their preparation. The corresponding guidelines are provided in the CAD Manual [22].

- To ensure consistent approaches and assumptions are made in the performance of neutronic analyses a guideline is provided [23]. It includes the computational tools to be used, the data to be applied, specifications of geometry models and the neutron source, etc.
- Technical management processes are defined (see chapter 6.9) in order to control the quality of the technical work performed.

In addition the budget figures of the PPPT programme and its projects will be controlled through an Information Management System (IMS). This system shall provide the required consistency among the contractual information on the EUROfusion projects in a consistent manner, i.e. budget indication, work break-down structure, task specifications accepted through a review procedure, resource allocation, progress tracking, links to final reports, etc.

6.8 Risk Management

A master risk register for the PPPT programme shall be produced and maintained by the PPPT Programme Control Group Manager. This master risk register will include the critical risks that are identified at both programme level and from the individual project risk registers maintained by the PLs. Any mitigations / corrective actions that have been identified for each risk will also be recorded and tracked.

6.9 Technical Processes

In order to manage and control the quality of the technical work performed by the PPPT Project and within the work package PMI and number of technical process are also required within the PPPT department such as:

- Stakeholder Requirements Definition
- Technical Requirements Definition
- Technical Solution Definition
- Technical Planning
- Decision Analysis
- Technical Data Management
- Design Change and Configuration Management
- Technical Risk Management
- Interface Management
- Technical Review Management
- Technology Assessment & Gap Analysis
- Technology Maturation Management

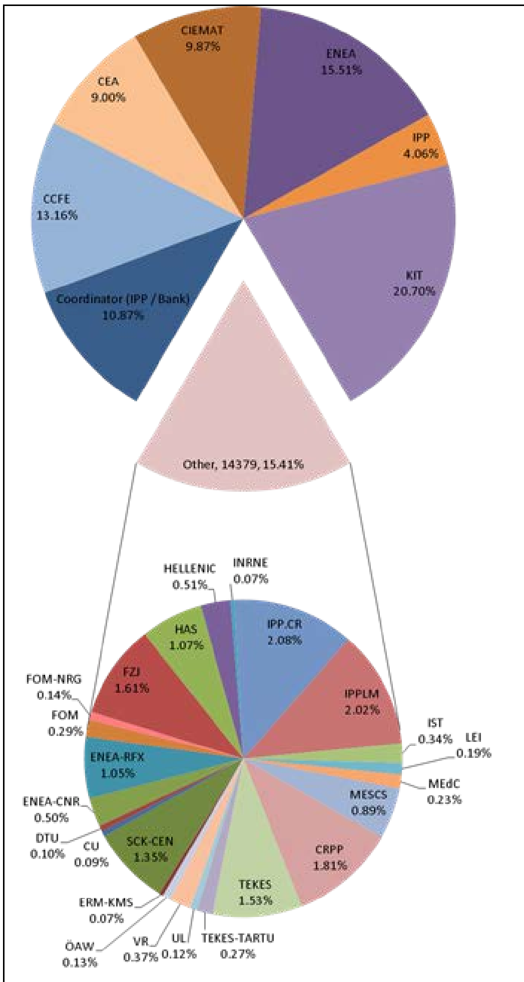
Each of the above processes is to be described in detail with the Technical Management Plan [24].

7 ANNEXES

7.1 Summary of abbreviations

Acronym	Name
ASTRID	Assessment of Source Term for emergency Response based on Installation Data
BA	Broader Approach
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CDA	Conceptual Design Activity
CFETR	China Fusion Engineering Test Reactor
DCLL	Dual Coolant Lithium Lead
DCM	Design Configuration Meeting
DDA	DEMO Design Activity
DR	Design Review
DTT	Divertor Test Tokamak
EDA	Engineering Design Activity
EG	Expert Group
FIIF	Fusion Industry Innovation Forum
IDM	ITER Document Management
IFERC	International Fusion Energy Research Center
IPH	ITER Physics Department
KPI	Key Performance Indicators
MaPLE	Magnetohydrodynamic PbLi Experiment
MHD	Magneto-Hydrodynamic
MYRRHA	Multi-purpose Hybrid Research Reactor for High-tech Applications
PBS	Plant breakdown structure
PDD	Plant description document
PMM	Project Management Meeting
PMU	Programme Management Unit
PPPT	Power Plant Physics and Technology Department
PRD	Plant requirements document
RAMI	Reliability, Abvailability, Maintainability, Inspectability
RU	Research Unit
SHG	Stake Holder Group
SHRD	Stakeholder Requirements Document
STAC	Scientific and Technical Advisory Committee
TF	Toroidal Field
TRL	Technology Readiness Level
UCLA	University of California Los Angeles
VR	Virtual Reality
VVPSS	Vacuum Vessel Pressure Suppression System

7.2 Allocation of Resources within the Projects (period 2014-18)



	Ppy labs(a)	**Ppy ind.**(b)	**HW (k€)**(c)	**#RUs**(d)
Balance of Plant	11.5	6.3	340	4
Breeding Blanket	263	19.6	8,387	7
Diagnostic and control	22	1.2	0	8
Divertor	53	1.5	1,326	6
Early Neutron Source definition and design	187.7	37.7	1,692	11
H&CD systems	85.4	1.5	942	11
Magnet system	36	0.8	826	13
Materials	283	29.3	9,339	22
Plant level system engineering, design integration and physics integration	128	20.2	0	14
Remote maintenance system	108.6	11.2	1,249	7
Safety	62	8.2	558	7
Tritium Fuelling and vacuum system	28.6	1.4	552	8
Grand Total[2]	1,268.8	138.9	25,211	-

(a) ppy laboratories
(b) ppy industry
(c) hardware
(d) number of participating research units

[2] The numbers quoted for the hardware represent foreseen resources provided by the EU Commission.