Project Execution Plan
for the
U.S. CONTRIBUTIONS TO ITER
SUBPROJECT-1
(US ITER SP-1)

Project Number: 14-SC-60

at

Oak Ridge National Laboratory

Office of Fusion Energy Sciences
Office of Science
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Project Execution Plan for the U.S. Contributions to ITER Subproject-1

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Acronym List

BA	Budget Authority
BAC	budget at completion
CD	Critical Decision
DA	Domestic Agency
DOE	Department of Energy
EAC	estimate at completion
EVMS	Earned Value Management System
FES	Fusion Energy Sciences
FP	First Plasma
FPD	Federal Project Director
FY	fiscal year
I&C	Instrumentation and Controls
IO	ITER Organization
JIA	Joint Implementation Agreement [Agreement on the Establishment of the Fusion Energy Organization for the Joint Implementation of the ITER Project]
MR	Management Reserve
MW	megawatt
OPC	Other Project Costs
ORNL	Oak Ridge National Laboratory
PA	Procurement Arrangement
PCR	Project Change Request
PEP	Project Execution Plan
PME	Project Management Executive
R&D	Research and Development
RMP	Risk Management Plan
S-2	Deputy Secretary of Energy
SC	Office of Science (DOE)
SC-1	Director of the Office of Science
SP	Subproject
TEC	Total Estimated Cost
TPC	Total Project Cost
U.S.	United States
US ITER	U.S. Contributions to ITER
USIPO	US ITER Project Office
UT-Battelle, LLC	University of Tennessee – Battelle, Limited Liability Corporation
WBS	work breakdown structure

1.0 INTRODUCTION

The primary reference document for the background, mission need, alternatives analysis, life cycle cost, organizational structure (including Integrated Project Team), and the acquisition and management approaches for the entire United States (U.S.) Contributions to ITER (US ITER) Project is its Project Execution Plan (PEP). This PEP pertains solely to Subproject-1 (SP-1) [1] and it is subordinate to the US ITER Project PEP. The latter document specifies the management and project execution processes that are used to ensure that SP-1 scope is completed on time and within budget, while this PEP is focused on the subproject's performance baseline scope (including SP-1 completion criteria), cost, schedule, and funding profile. Administrative updates to this PEP can be made from time to time as deemed necessary by the US ITER Federal Project Director (FPD), without going through the formal concurrence and approval process. The FPD will ensure dissemination of the latest updated versions to all project participants and stakeholders.

The US ITER Project is a U.S. Department of Energy (DOE) project that was established to provide the U.S. share of ITER hardware and cash contributions to support ITER construction. The Project Management Executive (PME) for the US ITER Project is the Deputy Secretary of Energy (S-2), and the Director of the Office of Science (SC-1) is the Program Secretarial Officer. The Associate Director for Fusion Energy Sciences (FES) in SC is the "Project Owner" who provides direct Headquarters oversight and all funding for the Project. A US ITER Program Manager in FES is responsible for carrying out those responsibilities on a day-to-day basis. In the field, a qualified FPD from DOE's Oak Ridge National Laboratory (ORNL) Site Office is in place to oversee project execution by the US ITER Project Office (USIPO), which is in Oak Ridge, Tennessee. While ORNL is the lead laboratory, it is supported by two partner laboratories, Princeton Plasma Physics Laboratory and Savannah River National Laboratory. Under DOE's direction, the USIPO has responsibility for planning, managing, and delivering the entire hardware related scope of SP-1. DOE/FES is responsible for managing the U.S. construction cash contribution, and the USIPO will implement the transfers of funds to the ITER Organization (IO) as directed by the US ITER Program Manager.

The scope of the US ITER Project can be viewed as being fundamentally comprised of three elements:

[1] As explained in the Tailoring Strategy section of the US ITER Project PEP, DOE has chosen to divide the Project's hardware scope into two subprojects (SP-1 and SP-2) that can be baselined sequentially and independently from the construction cash contribution component, which has the largest long-term cost uncertainty. Each subproject has its own Performance Baseline and Critical Decisions 2, 3, and 4. Appendix A of the US ITER Project PEP defines the division of scope between SP-1 and SP-2.

1. Subproject-1 (SP-1), which includes fabrication and delivery of U.S. hardware contributions needed for First Plasma[2] (FP), as well as the design of all U.S. hardware, and all U.S. in-kind cash[3] contributions;
2. Subproject-2 (SP-2), which consists of fabrication and delivery of all remaining U.S. hardware contributions (i.e., those not in SP-1); and
3. Construction cash contributions to the IO.

2.0 TAILORING OF THE SP-1 EXECUTION STRATEGY

The US ITER Project has a number of features that require tailoring of the standard processes prescribed by DOE Order 413.3B. It is not a conventional DOE capital asset project for the following reasons:

- The US ITER Project will not result in a facility owned by DOE. Instead, the ultimate owner will be the IO located at the facility's site at St. Paul lez Durance, France.

- The U.S. Government is not responsible for overall ITER integration, system engineering, safety basis and licensing, civil construction, installation of hardware, commissioning, and delivery of the other Members' hardware components.

- The IO has the authority, subject to guidance from the ITER Council (of which the U.S. is a member) to set the ITER construction schedule that includes the Members' hardware delivery milestones.

Given the above, the overall tailoring strategy for the US ITER Project (and its subprojects) is to manage it, to the extent practicable, according to the policies, principles, and processes of DOE Order 413.3B as follows:

- The PME is the Deputy Secretary of Energy (S-2), who is responsible for approving all future Critical Decisions (CDs) and Level 0 changes to the Performance Baseline after CD-2.

- Subproject implementation will conform to SC project management requirements, processes and procedures, to include conducting periodic DOE/SC Independent Project Reviews and other external technical peer reviews, as required.

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[2] First Plasma is the initial operation of the tokamak with a confined plasma, which is an important milestone indicating that all basic machine assembly and commissioning steps have been successfully accomplished and a large number of major project risks have been retired.

[3] Because of modest adjustments in hardware procurement sharing among the IO and Domestic Agencies (DA) that have been made for various reasons over the past few years, the total credit value of U.S. hardware contributions has fallen below the specified 9.09 percent level. In order to make up the difference, the U.S. is obligated to contribute so called "in-kind" cash to the IO. The "in-kind" cash is part of SP-1 scope because it is required during the SP-1time frame of the overall US ITER Project.

- Both subprojects will be managed within the common USIPO organizational structure, but they will have their own individual work breakdown structures (WBS), schedules, CDs, project completion criteria, cost estimates, and funding profiles. For SP-1, this is information is contained in Section 3.0 (Subproject Baseline) of this PEP.

- Recognizing that there has already been substantial progress in fabricating certain SP-1 hardware items, CD-2 and CD-3 will be combined.

- In assessing readiness for CD-3, the approach is to rely on the US ITER Final Design Plan, which defines the requisite state of design maturity in each element of SP-1 hardware scope in order to start fabrication. Because the US ITER hardware systems are essentially independent of each other, the hardware designs do not follow a linear design process in which all systems reach final design at the same time. The Final Design Plan provides for a phased completion of the final designs and ensures that designs are sufficiently mature to start procurements, while enabling the most cost-effective schedule for completing the designs in line with the IO's overall project schedule. While the designs for SP-1 hardware may not all be complete before CD-3, the designs will at least be sufficiently mature to start phased procurements for fabrication. At the DOE/SC Independent Project Review for SP-1, CD-3, the overall design will be 86 percent complete for the SP-1 Hardware, based on a fabrication cost-weighted value. Any incomplete design carries minimal risk to the successful completion of the subproject.

- The US ITER Project will not deliver an entire integrated operating facility, as would a typical DOE construction project. Instead, in-kind U.S. hardware contributions, for the most part, represent portions of technical subsystems for the ITER facility. Consequently, demonstrating Key Performance Parameters in the traditional sense as a means for determining project completion (CD-4) is neither appropriate nor possible. Rather, this PEP defines project completion as delivery and IO acceptance of an approved scope of deliverables. Acceptance of the hardware by the IO will be in accordance with the hardware Procurement Arrangements, including elements such as Manufacturing and Inspection Plans. SP-1 also includes the design of all U.S. hardware contributions. Design completion/acceptance will be based on IO approval of the Final Designs.

The USIPO has appropriately detailed cost and milestone schedule information for all elements of SP-1 scope to permit the use of Earned Value Management System (EVMS) techniques in measuring overall progress and cost/schedule performance. The SP-1 cost and schedule performance baselines take into account the risks associated with the corresponding scope by identifying and including appropriate amounts of cost and schedule contingency. Management of funds will be exercised in such a way to maximize the amount of work that can be accomplished in every fiscal year (FY).

3.0 SUBPROJECT BASELINE

This section describes the aspects of scope, cost, schedule, and funding that together comprise the Performance Baseline for SP-1. Any changes to these Performance Baselines, once approved, must be made in accordance with PEP Section 4.1, Change Management.

3.1 Scope

The SP-1 scope consists of providing: the design and fabrication of the U.S. hardware needed for FP as specified by the IO (see Appendix B of the US ITER Project PEP); all remaining preliminary/final design effort for the post-FP hardware; a defined amount of in-kind cash to fulfill the remainder of the U.S. FP credit obligation; and the associated USIPO management effort.

Table 1 on the following page, describes the SP-1 scope (refer to Appendix B of the US ITER Project PEP for the specific SP-1 hardware).

The criterion for achieving CD-4 for SP-1 is the delivery to and acceptance by the IO of the SP-1 hardware, plus IO acceptance/ approval of the Final Designs for all U.S. hardware. It will also require payment of all the in-kind cash due to the IO. The USIPO will present verification of the SP-1 completion criteria to the FPD for review and approval. Upon confirmation that they have been met and all SP-1 WBS scope has been delivered (including all in-kind cash), the FPD will recommend to the PME that SP-1 is ready for CD-4 approval.

Table 1. SP-1 Scope Description

System/Subsystem	Description
Central Solenoid Magnet System	Provide 7 (including spare) independent coil packs made of superconducting niobium-tin providing 13 Tesla at 45 kA, the vertical pre-compression structure, and assembly tooling.
Toroidal Field Magnet Conductor	Provide 9 active lengths (~765m), 1 dummy length (~765m) for winding trials and 2 active lengths (~100m each) for superconducting qualification.
Steady State Electrical Network	Provide components for a large AC power distribution system (transformers, switches, circuit breakers, etc.) at high-voltage (400kV) and medium-voltage (22kV) levels.
Tokamak Cooling Water System	Provide Final Designs for major industrial components (heat exchangers, pumps, valves, pressurizers, etc.) capable of removing 1 GW of heat. Among those components, also fabricate and deliver certain IO-designated items.
Diagnostics	Provide Final Designs for 4 diagnostic port plugs and 7 instrumentation systems (Core Imaging X-ray Spectrometer, Electron Cyclotron Emission Radiometer, Low Field Side Reflectometer, Motional Stark Effect Polarimeter, Residual Gas Analyzer, Toroidal Interferometer/Polarimeter, and Upper IR/Visible Cameras). Among those components, also fabricate and deliver certain IO-designated items.
Electron Cyclotron Heating Transmission Lines	Provide Final Designs for approximately 4 km of aluminum waveguide lines (24 lines) capable of transmitting up to 1.5 MW per line. Among those components, also fabricate and deliver certain IO-designated items.
Ion Cyclotron Heating Transmission Lines	Provide Final Designs for approximately 1.5 km of coaxial transmission lines (8 lines) capable of transmitting up to 6 MW per line. Among those components, also fabricate and deliver certain IO-designated items.
Pellet Injection System	Provide Final Designs for injector system capable of delivering deuterium/tritium fuel pellets up to 16 times per second. Among those components, also fabricate and deliver certain IO-designated items.
Vacuum Roughing Pumps	Provide Final Designs for a matrix of pump trains consisting of approximately 400 vacuum pumps. Among those components, also fabricate and deliver certain IO-designated items.
Vacuum Auxiliary Systems	Provide Final Designs for vacuum system components (valves, pipe manifolds, auxiliary pumps, etc.) and approximately 6 km of vacuum piping. Among those components, also fabricate and deliver certain IO-designated items.
Tokamak Exhaust Processing System	Provide Final Designs for an exhaust separation system for hydrogen isotopes and non-hydrogen gases.
Disruption Mitigation System	Provide design, and research and development (R&D) (up to a limit of $25M*) for a system to mitigate plasma disruptions that could cause damage to the tokamak inner walls and components.

*any additional costs would be funded by the IO

3.2 Cost

The Performance Baseline Total Project Cost (TPC) for SP-1 is $2.5billion. At the time of SP-1 CD-2 approval, there is 46 percent contingency on the remaining hardware-related work. The cost contingency, although originally estimated from individual cost elements, is held at the subproject level by the FPD. A WBS Level 3 baseline cost summary for SP-1 is shown in Table 2.

Table 2. SP-1 Cost Breakdown at WBS Level 3

	$M
1.1.1 Magnet Systems	519.8
1.1.2 First Wall and Shield Systems	29.2
1.1.3 Port Limiters	0.6
1.1.4 Equatorial Port-Mounted Blanket Shield Modules	0.7
1.2.1 Tokamak Cooling Water Systems	350.3
1.3.1 Vacuum Pumping and Fueling Systems	174.8
1.3.2 Tokamak Exhaust Processing System	46.5
1.4.1 Steady State Electrical Network	38.4
1.5.1 Ion Cyclotron System	92.7
1.5.2 Electron Cyclotron	91.9
1.5.3 Diagnostics	151.9
1.6 Project Support	200.7
1.7 Support to International Organization	171.5
1.8 Supplemental Task Agreements	22.8
1.9 Instrumentation and Controls	114.6
Budget at Completion	**2,006.5**
Contingency	493.5
Total Project Cost - Subproject 1	**2,500.0**

The overall TPC for SP-1 is divided into two components: the Total Estimated Cost (TEC), and Other Project Costs (OPC). All of the SP-1 scope is funded within the TEC with the exception of $80.7M within the OPC category for R&D activities related to the U.S. hardware contributions. Over 90 percent of all R&D work has already been finished and costed. There are no costs associated with ITER commissioning and start-up activities that would typically be funded within OPC. As is typical of SC projects, all of the project contingency is contained in the TEC.

3.3 Schedule

Following, in Figure 1, is the summary schedule for SP-1. As already mentioned in the PEP, the individual hardware delivery schedules are driven by the IO's need dates, which are derived from the overall ITER Project construction schedule.

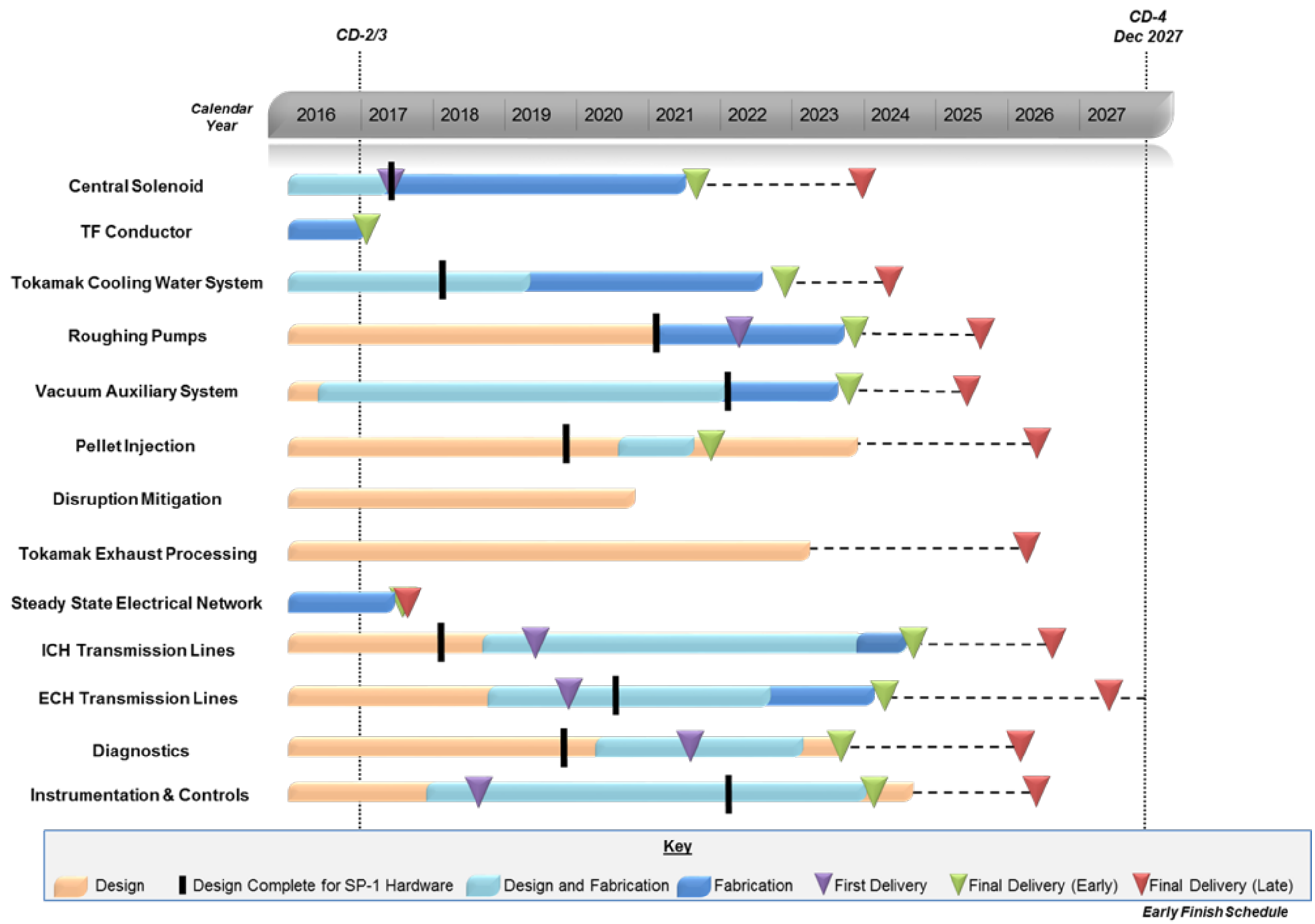

Figure 1. SP-1 Summary Schedule

As shown in Table 3, the SP-1 baseline schedule dates for the key milestones of CD-2/3 and CD-4 for SP-1 are December 2016 and December 2027, respectively. This CD-4 date is consistent with supporting an ITER FP in December 2028. It includes 39 percent (40 months) months of schedule contingency on the last scope element early-finish schedule (the Ion Cyclotron Heating Transmission Lines).

Table 3. Schedule of Critical Decisions for SP-1

Level 0 Milestone	Schedule
CD-0 Approve Mission Need	July 2005 (Actual)
CD-1 Approve Alternative Selection and Cost Range	January 2008 (Actual)
CD-2/3 Approve Performance Baseline and Start of Fabrication	December 2016
CD-4 Approve Completion	December 2027

Baseline schedule milestones at Levels 1 and 2 are identified in Appendix A. Level 3 milestones will also be established and tracked/managed by the Project Manager. The SP-1 cost and schedule baselines assume the realization of its corresponding baseline funding profile as specified in Section 3.5.

3.4 Work Breakdown Structure (WBS)

The SP-1 Level 3 WBS is shown in the table below. It forms the basis for planning, executing, and controlling project activities.

Table 4. SP-1 WBS

1.1	Tokamak
1.1.1	Magnet Systems
1.1.2	First Wall and Shield Systems
1.1.3	Port Limiters
1.1.4	Equatorial Port-Mounted Blanket Shield Modules
1.2	Tokamak Ancillary Equipment and Cryostat
1.2.1	Tokamak Cooling Water Systems
1.3	Tokamak Fluids
1.3.1	Vacuum Pumping and Fueling Systems
1.3.2	Tokamak Exhaust Processing System
1.4	Electrical Systems
1.4.1	Steady State Electrical Network
1.5	Port Interfacing Systems
1.5.1	Ion Cyclotron System
1.5.2	Electron Cyclotron System
1.5.3	Diagnostics
1.6	Project Support
1.7	Support to International Organization
1.7.1	Secondees and Taxes
1.7.2	Remaining In-Kind Cash
1.8	Supplemental Task Agreements with IO
1.9	Instrumentation and Controls (I&C)
1.9.1	Common I&C Services
1.9.2	Tokamak Cooling Water System I&C
1.9.3	Vacuum Pumping and Fueling I&C
1.9.5	Ion Cyclotron I&C
1.9.6	Electron Cyclotron I&C
1.9.7	Diagnostics I&C

3.5 Funding Profile

The baseline Budget Authority (BA) funding profile for SP-1 is shown in the table below. It fundamentally underpins the SP-1 baseline schedule and cost.

Table 5. Baseline Annual Budget Authority Funding Profile for SP-1 (in $M)

($M)	Prior Years*	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	Total
SP-1	1,012	100	122	163	168	157	148	140	148	140	122	80	2,500

* The SP-1 TPC includes all prior year US ITER Hardware Costs,

4.0 BASELINE MANAGEMENT

The US ITER Project manages changes in functional or physical scope requirements and evaluates the impact of changes on cost and schedule through a formal baseline change control process. The essential elements of configuration control are a well-defined baseline, and an effective method of communicating, evaluating, and documenting changes to that baseline. This promotes orderly evolution of the baseline design, and ensures that the effect of changes on cost, schedule, and technical scope are properly evaluated and documented by project management. A Project Change Request (PCR) must be initiated when a proposed change to the project will have an impact on any of the cost, schedule, or scope baselines.

The baseline change control process is administered by a Change Control Board consisting of members of the US ITER Project. The board includes the chairman (the US ITER Project Manager), a change control manager, and board members. The board members review the technical, cost, and schedule implications of proposed changes and advise the chairman. A record of all PCR actions is maintained in a change control log.

4.1 Change Management

PCRs are processed through a hierarchy of change control levels with progressively structured authority for approval/ disapproval of changes. The DOE and contractor change control levels for the US ITER Project are described in Table 6. These will be utilized to manage changes to the Performance Baseline for SP-1.

Table 6. SP-1 Project Change Control Thresholds

	Level 0 Project Management Executive* (S-2)	**Level 1 Associate Director for FES (SC-24)**	**Level 2 Federal Project Director**	**Level 3 US ITER Project Manager**
Scope	Any deletions or additions to the total U.S. share of the in-kind hardware as defined in the JIA.	Any transfer of U.S. in-kind hardware scope to the IO or to another DA. Any U.S. voluntary (i.e., non-creditable) contributions to the IO. Any changes to SP-1 scope at WBS Level 3.	Any scope change to a PA that would require using contingency.	Any scope change to U.S. PAs whose cost impact can be accommodated by using Management Reserve. Any change to the WBS.
Cost	Any increase in the SP-1 TPC.	The cumulative use of over 25% of total project contingency. *	Any change that requires use of contingency.**	Any change to Budget at Completion (BAC) that does not require use of contingency. Any use of Management Reserve.
Schedule	Any change in a Level 0 milestone.	Any change to a Level 1 milestone.	Any change to a Level 2 milestone.	Any change to a Level 3 milestone.
Funding	Any change to the funding profile for SP-1 that negatively impacts its Performance Baseline.			

* After the cumulative threshold has been reached and the next higher change authority has been notified and has approved the changes, the cumulative cost thresholds will reset.

** US ITER FPD will notify the US ITER Program Manager of any cost contingency usage.

4.2 Performance Measurement

The actual cost of work performed, using accrued costs and progress on the project (earned value or budgeted cost of work performed), is being collected using a project-wide reporting and controls system. Monthly earned value reporting to DOE at WBS Level 4 has already been implemented. Project performance data will then be tracked against the baselines, variance analyses will be performed, needed corrective actions will be implemented, and future risks will be identified. UT-Battelle, LLC has a certified EVMS.

4.3 Contingency Management

In general, the TPC is the sum of the Budget-at-Completion (BAC) plus cost contingency. At CD-2, the SP-1 BAC will be developed by the USIPO to represent the most realistic estimate of probable costs for all WBS elements. Contingency funds are necessary to cover costs that result from incomplete design, uncertainties associated with market conditions, technical difficulties, schedule delays, event risks, and other circumstances commonly encountered during project execution. Contingency estimates will also be developed at CD-2 for each major cost element, usually at WBS Level 4 or lower, using a risk-based contingency approach that reflects the status of hardware design, procurement, and fabrication. Once contingency is developed and baselined for SP-2 and for construction cash, those amounts will be combined with the SP-1 contingency and held at the Project level. The process for contingency development is further described in the USIPO Risk Management Plan (RMP).

The FPD will control distribution of the contingency in accordance with the baseline change control process and in close coordination with USIPO management and the FES US ITER Program Manager. Formal baseline changes will normally be made following a subproject-wide Estimate-at-Completion (EAC) process done annually or on individual elements when the existing baseline no longer provides a reasonable basis for performance measurement.

The USIPO Project Manager is responsible for managing and approving the use of Management Reserve (MR) funds. MR funds are derived from cost savings across the subprojects and assignment of DOE contingency. MR will be used by the contractor as a management tool to facilitate project changes within the contractor's change thresholds.

4.4 Estimate at Completion (EAC)

One of the most important indicators of the financial health of a project is management's realistic estimate of the cost to complete the project. When added to the cost already incurred, the result is the EAC. Because of the dynamic nature of projects such as the US ITER Project, the formal performance measurement baseline will always lag behind this estimate of "management's best judgment."

5.0 PROJECT MANAGEMENT/OVERSIGHT

5.1 Risk Management

Risk management will be performed throughout the life of the US ITER Project. A complete methodology that describes the approach and processes to be used is documented in the US ITER Project RMP. In addition to providing both a qualitative and quantitative evaluation of the risk items related to scope, schedule, and cost. The key risks related to the international interfaces are identified and evaluated to ensure successful project completion.

The US ITER Project Manager has overall responsibility for SP-1 risk management. The activities required to implement the RMP are performed by the Deputy Project Manager, Project Risk Coordinator, Division Directors, and the WBS Team Leaders for performing detailed risk analyses, mitigation planning, performing periodic reviews, and maintaining the Risk Management Information System that contains the Risk Registry. The Risk Registry includes potential impacts and related mitigation plans for each identified risk. Continually monitoring and mitigating risks, when appropriate, throughout the life of the project and appropriately updating the risk register will result in the downgrading or retiring of risks.

Performance monitoring against the established mitigation plans is being done for risk elements as part of the monthly metrics and performance monitoring meetings. In addition, risk management issues and updates are also covered as part of regular weekly project team meetings and management meetings between the FPD and senior managers of the US ITER Project.

At this stage of the project, identified high-level risks to US ITER hardware include:

- Timely deliveries of information and equipment from other DAs or the IO, and
- Manufacture of first-of-a-kind, high-technology equipment.

5.2 Transition to Operations

In accordance with the ITER Joint Implementation Agreement (JIA), the U.S. will participate in ITER's operations phase, which is envisioned to span a nominal 20-year period. The U.S. commitment during ITER operations consists of providing resources to the IO for personnel and facility operations. There will also be a US ITER Research Program that supports scientists and engineers who will participate (in person and remotely) in experiments on ITER. DOE will budget for the U.S. share of ITER operations as well as the scientific research program separately from the US ITER Project TPC.

5.3 Subproject Closeout

As SP-1 progresses toward completion, there will be a gradual transition of activities into SP-2. This transition is expected to begin in about FY 2021 when funding initially becomes available for SP-2. In preparation for seeking approval of CD-4 for SP-1, the USIPO and the FPD will jointly develop a draft SP-1 Closeout Report. Ninety days after SP-1 CD-4 has been approved, the FPD will submit the SP-1 Closeout Report to the US ITER Program Manager in FES. The Closeout Report will contain the final cost of SP-1, subproject lessons learned, and performance achieved at SP-1 completion. Once all financial closeout activities have been completed the Final Closeout Report for SP-1 will be issued.

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U.S. CONTRIBUTIONS TO ITER

SUBPROJECT-1

PROJECT EXECUTION PLAN

Appendix A

Baseline Schedule Milestones at Levels 1 and 2

System	Milestone Title	Completion Date
Level 1 Milestones		
Toroidal Field Conductor	Receipt & acceptance of all TF conductor complete	14-Jul-17
Steady State Electrical Network	Receipt & acceptance of all SSEN complete	25-Oct-17
Instrumentation & Controls	Begin fabrication for I&C	19-Jan-18
Ion Cyclotron Heating Transmission Line	Begin fabrication for ICH	15-Dec-18
Electron Cyclotron Heating Transmission Lines	Begin fabrication for ECH	30-Sep-19
Central Solenoid Assembly Tooling	Receipt & acceptance of all AT complete	25-Nov-19
Pellet Injection	Begin fabrication for PI	14-Feb-22
Central Solenoid Structure	Receipt & acceptance of all CS structure components complete	08-Apr-22
Roughing Pump Sets	Begin fabrication for RPS	20-Jun-22
Tokamak Cooling Water System	TCWS SP-1 scope (design and hardware deliveries) complete	02-Apr-24
Central Solenoid Modules	Receipt & acceptance of all CS modules complete	30-Sep-24
Vacuum Auxiliary Systems	VAS SP-1 scope (design and hardware deliveries) complete	04-Jun-25
Roughing Pump Sets	RPS SP-1 scope (design and hardware deliveries) complete	29-Sep-25
Diagnostics	Diagnostics SP-1 scope (design and hardware deliveries) complete	11-Dec-25
Tokamak Exhaust Processing	TEP design complete	11-Feb-26
Instrumentation & Controls	I&C SP-1 scope (design and hardware deliveries) complete	27-Mar-26
Pellet Injection	PI SP-1 scope (design and hardware deliveries) complete	21-Apr-26
Ion Cyclotron Heating Transmission Line	ICH SP-1 scope (design and hardware deliveries) complete	04-Aug-26
Electron Cyclotron Heating Transmission Lines	ECH SP-1 scope (design and hardware deliveries) complete	05-Apr-27

System	Milestone Title	Completion Date
Level 2 Milestones		
Central Solenoid Assembly Tooling	CS Assembly Platform fabrication complete	23-Jun-17
Central Solenoid Assembly Tooling	CS Lifting Fixture fabrication complete	02-Jan-18
Central Solenoid Assembly Tooling	CS Rotating Fixture fabrication complete	19-Apr-18
Central Solenoid Structure	CS Structure Lower Key Block and Isolation Plate fabrication complete	10-May-18
Central Solenoid Modules	CS Mock-up testing complete	31-Oct-18
Tokamak Cooling Water System	TCWS 1st Plasma final design complete	13-Dec-18
Central Solenoid Structure	CS Upper keyblock, load distribution plate, pre-compression components fabrication complete	30-Nov-19
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #1	30-Sep-20
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #2	31-Mar-21
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #3	30-Nov-21
Roughing Pump Sets	RPS design complete	09-Mar-22
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #4	31-May-22
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #5	31-Dec-22
Central Solenoid Structure	CS Structure Tie Plates fabrication complete	31-Dec-22
Pellet Injection	PI SP-1 fabrication complete	21-Feb-23
Tokamak Cooling Water System	TCWS Drain & Refill fabrication complete	10-Apr-23
Tokamak Cooling Water System	TCWS VV PHTS fabrication complete	24-Apr-23
Central Solenoid Modules	Manufacturing and full-current/4K cold-testing complete for Central Solenoid Module #6	31-Jul-23
Vacuum Auxiliary Systems	VAS design complete	08-Aug-23
Tokamak Cooling Water System	TCWS Drying System fabrication complete	16-Oct-23
Diagnostics	Diagnostics SP-1 fabrication complete	08-Jul-24
Vacuum Auxiliary Systems	VAS SP-1 fabrication complete	18-Mar-25
Roughing Pump Sets	RPS SP-1 fabrication complete	03-Apr-25
Electron Cyclotron Heating Transmission Lines	ECH design complete	08-Apr-25
Diagnostics	Diagnostics design complete	11-Dec-25
Instrumentation & Controls	I&C design complete	30-Dec-25
Instrumentation & Controls	I&C SP-1 fabrication complete	15-Jan-26
Ion Cyclotron Heating Transmission Line	ICH SP-1 fabrication complete	02-Feb-26
Pellet Injection	PI design complete	21-Apr-26
Ion Cyclotron Heating Transmission Line	ICH design complete	04-Aug-26
Electron Cyclotron Heating Transmission Lines	ECH SP-1 fabrication complete	05-Apr-27