The Status of the ITER Design

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Abstract. In parallel with a rapid build up to almost 300 people within the International Organization (IO) at Cadarache, the project team, including many from the member countries represented by their Domestic Agencies (DA), has concentrated its effort on an overall design review of ITER. An updated technical baseline was presented to council at the end of 2007. Several additional improvements were included during spring 2008 and it is probable that the results of the review will be accepted by Council. As a result, the ITER design today provides a robust basis for a technical design that allows operation over a wide range of physical parameters, a design that can operate stably with high gain and can exploit the full scientific potential of the device. In the technical area, design changes have been integrated to improve performance, provide more robust subsystems and to minimize technical or operational risks. All of the adaptations required to support the licensing process as a Nuclear Facility in France (INB) have been made. In parallel major components are already under construction within the DAs. A full overview of the status of ITER design and construction, including the detailed discussion of the 2007 ITER baseline, will be given. In addition, the construction status and the overall project review will be presented.

1. Introduction

The signature of the ITER Agreement on the 21 November 2006, marked the foundation of the ITER Organization (IO). In the ITER Council meeting held immediately afterwards, the IO was asked to undertake a Design Review of ITER, recognizing the need to update the baseline for the construction project in line with the evolution of the project and R&D. Four main lines of activities were identified:

1. Perform a major review of the project technical scope to identify deficiencies, incorporate the resent results from fusion experience, identify the major technical risks and establish a new baseline for the technical scope,
2. Analyse and re-baseline the project schedule. Identify the critical activities for the completion of the project and launch the procurement activities of the long lead items, in particular the magnet conductors, the preparation of the site and the definition of the facilities for the fabrication of the coils,
3. Establish the project organization and build up the rules for effective management and coordination of the procurement activities with the Domestic Agencies (DA),
4. Complete the licensing files, submit the application for the construction license and initiate discussions with the licensing authority.

The conclusions of the design review were presented in October 2007 and it was agreed that several issues should be addressed. The outcome of the process was the adaptation of the design to take into account the choice of Cadarache as the site, the implementation of French nuclear regulations and the identification by the Scientific and Technical Advisory Committee (STAC) of a number of technical issues which should be resolved.

ITER will be procured largely through in-kind contributions from the ITER members. The responsibility for the management in-kind procurement activities is assigned by each Member to entities called Domestic Agencies (DAs). During the same period that IO was established at the Cadarache site, the Domestic Agencies were set up.

Today the ITER site has been cleared and work has started on the basic infrastructure and construction of a number of major components has started in the DAs.
2. Design Review

When the IO was founded, over 200 issues relating to the design remained unresolved. At the same time, members of the fusion community and scientific organizations in the ITER Member countries expressed concern over design solutions for many of the ITER components and their impact on either the performance of the device or its reliability. The reasons for these concerns were manifold, but a significant part was due to new physics results from existing experiments, indicating for example, higher sensitivity to magnetic ripple and the problem of edge localised mode (ELM) loads on the divertor and on the first wall. The main goal of the Design Review was therefore to examine the unresolved issues and to establish a new baseline design. This new baseline could then be used as input to the Preliminary Safety Report which was due for submission to the French Nuclear Authorities at the end of 2007 [1].

The Design Review was performed by 8 working groups which were chaired by scientists and engineers from outside of the ITER team with a co-chairman from the IO. The working groups had a total of approximately 150 members comprising leading experts drawn from the worldwide community. 80 Professional Person Years (PPY) were contributed from the ITER member countries in order to perform more complex studies, design analysis and design work to support the working groups. At the beginning of 2007 a total of around 500 issues on the ITER design were registered in the database. These issues were reviewed and prioritised and effort was concentrated on the 13 areas of major technical risk (see TABLE. I.) which had been given high priority – the issues which would have an impact on the long lead items (magnets, vacuum vessel, buildings and Preliminary Safety Report).

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The Design Review was very successful in tackling all high and medium priority issues and in producing practical and cost-conscious solutions. Thus, the new 2007 ITER baseline design was endorsed by the STAC as a good basis for starting construction.

3. Design Review Follow-up

After the presentation of the Design Review to the Council, STAC and Management Advisory Committee (MAC), a number of significant changes were introduced to the project.
3.1. Vertical Stability and Mitigation of Edge Localised Modes (ELMs)

A review of experiments on present devices has led to the recommendation to increase the performance of the ITER vertical stabilization system [2]. In particular it was noted, that in the current ramp-up and flat-top of the 15 MA, Q=10 reference scenario, the internal inductance, \( l_i(3) \), can reach values as low as \( l_i(3) = 0.6 \) and during the current decay \( l_i(3) \) can rise to higher values than previously foreseen. In this phase adjustments (e.g. reducing elongation) will be required to maintain acceptable vertical stability. It was recommended to adopt the parameter \( \Delta Z_{\text{max}}/a \) (where \( \Delta Z_{\text{max}} \) indicates the maximum “sudden” vertical displacement of the plasma that can be recovered and \( a \) is the plasma minor radius) as an appropriate figure of merit for the characterizing the effectiveness of vertical stabilization. It was also recommended that the vertical stabilization system should be able to achieve reliable vertical stabilization for \( \Delta Z_{\text{max}}/a > 0.05 \), as in many present devices.

Three approaches for the improvement of vertical stabilization have been studied [3]:

(a) improving the passive stability by either forming toroidally conducting rows of blanket modules, or adding thin (1-2 mm) toroidal rings of copper to the vacuum vessel wall;
(b) improving the characteristics of the present vertical stabilization system by increasing the applied voltage in the existing circuit (VS1 consisting of PF2, PF3, PF4 and PF5) from ±6 kV to ±9 kV and adding a second stabilization circuit (VS2) to the CS2U and CS2L modules of the central solenoid which would operate at ±6 kV;
(c) developing a new set of in-vessel coils, with an appropriate power supply and connections, to produce an additional radial field on a significantly shorter timescale than the existing external vertical stabilization circuit is capable of.

Edge Localized Modes are magnetohydrodynamic (MHD) instabilities that destroy the magnetic confinement near the plasma boundary. The onset of large ELMs is driven by the large pressure gradients and current densities associated with the reduced thermal energy transport in the high-confinement plasma mode (H-mode) which is essential to achieve ITER high gain operation (Q>10). The scientific community has found increasing evidence that ELMs are potentially more damaging than originally thought [4]. A reduction by about a factor of 40 in the energy deposition by the ELMs is required in order to minimize the risk. Port plug mounted coils proposed during the design review appear incapable of mitigating such events with acceptable impact on plasma performance.

However, with joint efforts by the international fusion community, the Domestic Agencies and the IO’s scientific and engineering resources, this effect was analyzed in much more detail and a satisfactory solution was found. From five different options, which were developed in parallel, coils inside the vacuum vessel will be pursued [5]. This choice has the additional benefit that it will tackle vertical stability and resistive wall mode control at the same time.

The current concept, based on coils mounted on the inner wall of the vacuum vessel (see FIG 1), will see high electromagnetic and thermal loads and must accommodate significant thermal expansion. Ensuring high reliability for 20 years, plus accommodating replacement (if needed) using a remote handling system, are critical requirements. Space constraints between the vacuum vessel and the blanket increase the complexity of the task.
3.2. Operational Space

Although no changes were required in the Poloidal Field (PF) coils for vertical stability purposes, some changes to accommodate shaping capability, flux capability and internal inductance (l_i) control were identified. It was shown that the current capability of the new conductor design allows the field to be increased by 15-20% [6, 7, 8]. By also expanding PF6 to include an extra double pancake, using sub-cooling and increasing PF2 turns by 10% it is possible to extend the accessible range of inductance so that \( 0.65 \leq l_i \leq 1.2 \) [9, 10, 11] – a substantial improvement from the previous values of \( 0.7 \leq l_i \leq 1.0 \).

Further changes aimed at improving the operational space include:

- increasing the limit on the CS vertical separation forces (from 75 MN to 120 MN);
- upward shift (by 15 cm) of the PF6, into the volume currently occupied by the lower error field correction coil;
- expansion of the PF6 by adding an extra double pancake;
- modification of the divertor dome, reducing the height by ~10 cm, thus providing more rooms for the plasma.

In addition to the improvement of the PF system outlined above, it is proposed to modify the current ramp-up scenario to include tools such as the variations in the current ramp rate (which has been experimentally demonstrated recently in several devices [12]) and include the use of additional heating and possibly current drive during current ramp-up.

3.3. Cold testing

The necessity to cold test the coils and where to do it was reviewed in several WGs and later by the Magnet Risk Assessment Group (MRAG). It was clear that testing under full operating conditions is too difficult and almost impossible due to the mechanical loads, budget and...
schedule limitations. The MRAG majority recommendation was to perform acceptance tests at 4.5 K with low current (1-2kA) on each winding pack. These tests will confirm acceptable joint resistance, make a helium leak test and subject the insulation to a thermal cycle prior to low pressure helium electrical breakdown tests. At the same time, subsections of the casings and support which contain the completed He cooling pipes will be leak tested at 77K. The implementation of these tests will substantially reduce the risk of coil failure in a cost effective way.

3.4 Divertor Armour

The ITER divertor includes the cassette body (CB) and three plasma-facing components (PFCs), namely the inner and outer vertical target (VT) and the dome (DO). The PFCs consist of a plasma-facing material, the armour, which is made of either carbon fibre reinforced carbon composite (CFC) or tungsten (W). The armour is joined onto an actively cooled substrate, the heat sink, made of precipitation hardened copper alloy CuCrZr. Operation with a CFC target is considered to have advantages for the start of ITER operation given its proven range of compatibility with a number of plasma conditions in present devices, particularly at low densities with significant additional heating. However, CFC has several disadvantages including a relatively high physical sputtering rate and a chemical reactivity with the hydrogenic fuel. The resultant high erosion rate could potentially limit experimental operation in the DT phase (due to co-deposition of tritium with carbon). Excessive co-deposition raises regulatory concerns relating to tritium inventory limits. It is this feature of carbon which has spurred interest in W for ITER for many years. Following the design review it has been agreed that the divertor will initially use carbon but that a fully tungsten divertor will be installed before the D-T phase of operation.

3.5 First Wall/Blanket Design

It was recognised during the Design Review that the ITER programme should make an important contribution to the suitability of different plasma facing materials for fusion reactors and that a change of material during the lifetime of the machine would be likely. It was also made clear that no design of plasma facing components would be able to survive the worst case heat loads without some damage. It is therefore necessary to have a reliable and expedient method of replacing some or all of the plasma facing components. For the divertor, which was designed to be able to be replaced several times in the lifetime of ITER, reparability and replaceability were considered acceptable. However, for the first wall where front access was restricted, the reliability of welding and cutting operations on the hydraulic connector could not be guaranteed. Plasma loading of the in-vessel components was also revisited and in particular the need to use the detailed geometry in estimating the steady state and off-normal power loads to the surface was highlighted. This is also true for the flow of halo currents during VDEs. All of these elements have pointed to a need to re-address the details of the First Wall shaping.

In response to these needs the ITER team, working together with the Members’ DAs, has embarked on a design programme to address the detailed design of the First Wall and Shielding Module, whilst limiting the impact on the construction schedule [13]. The underlying principle of the re-design is to ensure a reliable procedure for cutting and re-welding of the hydraulic connector, by providing generous frontal access. This is achieved by shaping of the First Wall elements to provide a shadowed central region, which will also be used to accommodate an mechanical attachment between the First Wall and Shield Module which can be accessed in-situ, further simplifying the exchange procedure. On a global level,
the First Wall shaping must ensure that no edges are exposed to the parallel heat flux and it must also account for the variable toroidal field ripple and the penetrations in the port plugs. On the low field side this is achieved by slightly advancing the First Wall panels between the ports. In this way it has been possible to produce a First Wall design with sufficient power handling capability which will probably render the start-up limiters redundant.

3.6. Vacuum Vessel Design

Following new information on the sideways force from JET experiments and after performing new simulations which include the latest physics models, a re-evaluation of the sideways and vertical forces and the tilting moment on the vacuum vessel structure has been performed. As a result of these analyses, the poloidal gusset thickness of the vacuum vessel support structure has been increased to accommodate the higher vertical loads [9].

3.7. Test Blanket Modules (TBMs)

The second meeting of the ITER Council (IC) endorsed the proposal to implement the Test Blanket Module Programme within the framework of the ITER Agreement on the basis of the principles set out by the ITER Organization. These principles envisage the testing in ITER of six different concepts of TBM systems (2 TBMs per test port), each TBM being developed by a member or by a consortium of two or more members. For each TBM system, a member will act as TBM Leader, with the responsibility for the timely delivery of the corresponding TBM system to ITER. Integration issues within each port will be managed by a member acting as Port Master. The ITER Organization has responsibility for accommodating, installing and safely operating the TBM systems in ITER. As a consequence, in the short term, the ITER Organization has been asked to prepare a proposal for the implementation of the TBM Programme, including the membership and terms of reference of the planned TBM Programme Committee. This committee is expected to act as the IC Advisory Committee for matters dealing with the implementation of the TBM R&D programme by the Members and the corresponding organization among the Members.

3.8. Neutral Beam Test Facility (NBTF)

As part of the project-wide risk assessment, the early construction and exploitation of the 1MV NBTF was identified as the main risk mitigation required for the neutral beams. Good progress has been made on the NBTF and the Ion Source Test Facility (ISTF) to be built in Padua (Italy). The building design has been prepared and the building permit has been obtained. The NBTF is well supported by the European Domestic Agency, with the Italian laboratory RFX taking the lead, but many European laboratories are also actively supporting the work.

3.9. Hot Cell Facility

The design of the hot cell facility was examined during the review and it was clear that significant changes were required. Several strategies were evaluated and the design has now been revised. It was necessary to make space available for equipment which had not been considered previously and also to find space for parking of the casks and TBM related equipment. It has been agreed that the storage for radioactive waste should be in the basement, which will be the full size of the building. The current design comprises a
substantial concrete, stand-alone building of four floors above ground and the basement (70 × 62 m and about 22 m in height – the current volume is about 91 000 m³ above ground).

4. The New Baseline

The ITER baseline aims to (a) ensure the consistency between the technical requirements and the design solutions adopted, (b) provide a reference configuration against which the impact of future changes can be tracked and (c) define a realistic schedule for the execution of the procurement activities.

The ITER project baseline includes three primary elements that define the scope of the project:

- **Technical scope**, which describes the performance capabilities that the project must provide at the end of the construction phase in order to achieve mission requirements,
- **Schedule**, which defines the time within which the project is to provide the required these capabilities, and
- **Cost**, which describes the total cost of the work for which the IO is responsible (this includes activities of IO employees and FUND work).

Some, but not all of the reasons, why cost and schedule had to be reviewed are:

- The prices of basic commodities and construction index have been rising much faster than the average rate of inflation.
- The 2001 design was a generic design where it was unclear in many cases what site conditions and infrastructure would be available.
- In 2001, three Members were foreseen to execute the Project, while today seven Members are involved but the staffing plan was not changed to reflect this.

![FIG. 2. THE REFERENCE INTEGRATED PROJECT SCHEDULE AS PRESENTED TO COUNCIL IN 2008](image-url)
• The resource estimates in 2001 and the ITER Agreement signed in 2006 were developed under the assumption that the design was completed, which is not the case.
• Changes requested from the scientific community to minimize operational risk and to increase the operation space, change and/or increase the scope and lead to cost changes.
• The build-up of an international organization staffing from 7 to more than 250 people in less than two years is a major undertaking. These organizational activities compete with the technical ones and require substantial effort.

The project schedule was reviewed in the period from October 2007 to February 2008 with the goal of establishing a reasonably aggressive, but acceptable risk, schedule that can realistically deliver the ITER facility on the planned completion date. After scheduling all hardware deliveries to be ‘just in time’ to meet the ‘need dates’ for assembly and several iterations, the schedule shown in FIG. 2 was established.

The parameters forming these baselines were formally established at the ratification of the project and are described in documents that are subject to formal configuration (change) control. The relationship among the different elements of the project baselines, at the level of approval for the changes are indicated in the baseline structure illustrated in FIG. 3.

The ITER physical configuration is defined by a series of 3D CAD models and 2D Drawings that are under configuration control. The set of the 3D models representing the configuration at the completion of the construction phase is called the ITER Digital Mock-up (DMU).

5. Organisational Developments

5.1. Ratification of the ITER Joint Implementation Agreement

On Wednesday, 24 October 2007, the ITER Organization formally entered into force. Although the ITER Agreement had been signed in November 2006, it had to be ratified by the governments of all of the Members and it was only after this final stage that the ITER
Organization could really start to function. This date therefore gave the green light for many activities.

5.2. Headquarters Agreement

The Headquarters Agreement establishing the legal status of the ITER Organization in France was signed on 7 November 2007. This Agreement sets out the terms of cooperation between the new International Organization and the French authorities, in particular compliance with French regulations related to public safety and security, environmental protection, nuclear safety and radiological protection. The agreement entered into force on 9 April 2008 after ratification by the French government.

5.3. ITER Organisation – Domestic Agencies (IO-DA) Coordination

Since the ratification of the ITER Agreement each Member has established its Domestic Agency. The roles of the IO and the DAs are defined within the ITER Agreement: the IO bears the final responsibility for the quality of all aspects of the ITER project and must be provided with the means necessary to exercise this responsibility, in particular to allow for verification of progress and quality in accordance with the French nuclear safety regulations. It is also specified that a coordinating body should be established between the IO and the DAs and a proposal for the IO-DA Coordination Group was presented to Council in July 2007. This proposal was approved and the group was mandated to coordinate shared issues in order to expedite project execution and the implementation of all the DAs’ contributions reliably and efficiently. Since its first meeting in November 2007, the group has met on a monthly basis and has addressed a wide range of issues and is providing effective communication on the technical level.

5.4. ITPA

The proposal for the revised International Tokamak Physics Activity (ITPA) Charter, which will allow further developments in ITPA structures and activities to adapt it to ITER’s needs during construction was signed by the ITER Director-General in February 2008. The first meeting of the ITPA Coordinating Committee since its incorporation under the auspices of ITER took place in Aix-en-Provence at the end of June 2008. Since its inception in July 2001, the ITPA has been operating under the auspices of the International Fusion Research Council of the International Atomic Energy Agency (IAEA). The ITPA continues the tokamak physics R&D activities that have been conducted on an international level for many years resulting in the achievement of a broad physics basis not only essential for the ITER design but useful for all fusion programmes and for progress toward fusion energy generally.

The Participants in the ITPA are the Members of ITER, and the organizational structure, as defined in its new Charter, consists of a Coordinating Committee and seven Topical Physics Groups. The ITPA Coordinating Committee is composed of three representatives from each Participant and the ITER Organization.

Each ITPA Topical Group will be putting together an R&D programme in its own area of expertise which will address key issues that need to be resolved in the development of the ITER scientific programme. Integration of experimental results from the international tokamak programme will be essential, as will the development of validated models of burning plasma behaviour.
5.5. Collaboration, Cooperation and Partnership Agreements

On Wednesday, 16 January 2008, the ITER Director General Kaname Ikeda and his Excellency, the Minister of the Principality of Monaco, Monsieur Jean Paul Proust, signed a Partnership Arrangement which includes a contribution to ITER by the Principality of 5.5 Million Euro over a ten year period. The donation will be used to set up five Postdoctoral Fellowships and to establish an annual International Conference on ITER-related research. The Arrangement was signed in the Ministerial Palace in the presence of His Serene Highness Prince Albert II. 28 persons from all seven ITER member states have applied for the Fellowship Programme in 2008, amongst them five women. The successful candidates are expected to arrive on site in February 2009.

The ITER Organization and the European Organization for Nuclear Research, CERN, signed a co-operation agreement in March 2008. The agreement provides the opportunity for CERN and ITER to co-operate not only in the fields of technology such as superconductors, magnets, cryogenics, control and data acquisition and complex civil engineering, but also in administrative domains such as finance, purchasing and human resources, including software programmes. The Co-operation Arrangement has been concluded for a five year period and entered into force immediately.

With an increasing awareness of the implications of climate change and the cost of energy there has been interest from a number of countries, such as Kazakhstan, Australia and Brazil in joining ITER. Discussions with representatives from all of the interested parties exploring the possibilities are on going.

6. Technical Developments

6.1. PF Insert Test

![PF Insert Test Image](image_url)

FIG. 4: PF INSERT COIL BEING INSTALLED IN THE BORE OF THE CS MODEL COIL IN THE TEST FACILITY AT NAKA, JAEA

The Poloidal Field test coil, named "PF Insert Coil" [6], was wound by the EU using a superconductor supplied by the Russian Federation. It was transported from the UK, where
the coil winding was performed, to JAEA in Naka for testing last year. The PF Insert Coil is made from a 40m length of conductor that corresponds very closely to the conductor to be used in the PF6 coil. The PF Insert Coil has an outer diameter of 1.6 m, a height of 3.4 m and a weight of 6 tons. It is wound as a single layer solenoid that is placed inside the bore of the Central Solenoid Model Coil facility which provides the background field (about 6T). During the testing, which took place between June and August 2008, the coil exceeded expectations, with performance equivalent to the NbTi strands which make up the cable. There was no degradation and no unexpected stability limits that have been known to reduce performance in NbTi coils (using different conductor designs). After 9000 cycles the there was a slight change in the AC losses, but the conductor current sharing performance was unaffected. These tests have qualified the PF coil design and have confirmed the results of performance estimates.

6.2. TF conductor development

The superconducting strands that make up the cable for the ITER Toroidal Field coils must be qualified for ITER operation [8]. At the Sultan test facility at the Centre de Recherches en Physique des Plasmas (CRPP, Switzerland), a first 3.5m conductor sample, cabled from strands and produced by the company EAS, was tested with positive results. The conductor used for the sample was fabricated under supervision of the Italian fusion institute ENEA and the sample was prepared, heat treated and assembled at CRPP.

The test programme involves the operation under conditions representative of the operation in ITER of a TF coil. The sample was therefore tested with a current of 68 kA, in the Sultan background magnetic field of 10.8 Tesla and more than 1000 cycles from zero to full current were applied. The performance of the cable proved to be stable under these tests and the sample passed the acceptance criteria (5.7 K current sharing temperature after 1000 cycles). The EAS strand is therefore considered qualified for the ITER TF coil conductor. Overload tests at 80 kA and at a background field of 11T, which were performed after the cycling, did not show any degradation.

Tests of strands from other Members are also being made and a prototype Nb3Sn sample was fabricated by (CRPP) and the Paul Scherer Institute (PSI) in Switzerland using conductor provided by the United States Domestic Agency. Two cable configurations were tested at the Sultan high field test facility. The two strands of the sample comprised the TF reference and a US derived configuration. At 70kA and 11.8T maximum field, the TF reference conductor achieved about 7K after 200 charging cycles and the other strand 0.7K less. The strand was manufactured by Oxford Superconductor Technologies following the internal tin route process. Research continues into contact resistance distributions in joints and terminations at the University of Twente in the Netherlands.

6.3. In-vessel component performance tests

The divertor plasma-facing components, together with the toroidal field magnet conductors and the blanket modules, require the accreditation of the Member prior to the start of the procurement. This means that each of the three Members allocated one of these critical procurement packages must first "qualify" by demonstrating their technical capability. With regard to the divertor, this is achieved in two steps: first, at least two medium-size "qualification prototypes" have to be manufactured and meet all the prescribed acceptance criteria, then at least one of them must withstand the high heat flux performance tests. On 24 July 2008, the ITER Organization formally accepted the first two qualification prototypes supplied by the European Domestic Agency. These two prototypes were manufactured by the
Austrian company Plansee and will be soon followed by a third prototype, supplied by the Italian company Ansaldo Ricerche. These components will be shipped to the Efremov Institute in St Petersburg, Russian Federation, where they will be subject to high heat flux performance tests.

6.4. Other facilities (EAST, KSTAR, JET, ASDEX Upgrade)

ITER maintains close links with other facilities and a team from IO was present at the final cool down of KSTAR. Negotiations aimed at establishing collaborative exchanges with EAST in China and KSTAR in Korea started in the summer. Developments at JET and ASDEX Upgrade concerning the use of beryllium and tungsten first walls are being closely followed.

7. Project Progress and Plans

7.1. Procurement

ITER will be built largely (90 %) through in-kind contribution by the 7 Members. The IO is not directly involved in the management of the industrial contracts for in-kind procurement, but has the role of defining the procurement specifications, which vary from build-to-print specifications to functional specifications. The IO also is responsible for the integration of the whole process during the design and assembly phase.

In the case of functional specifications, a large part of the design activities, which are based on requirements and design constraints provided by the IO, is performed by one of the Members. For procurement based on build-to-print specifications, the Member executes the construction activities strictly following the design developed by the IO. Sharing of the procurement scope was agreed at an early stage of the design development and has led to the definition of about 90 Procurement Packages, each of which is allocated to more than one Member, leading to a total number of about 200 work packages allocated to the ITER Members. This has had the consequence that functional interfaces among the different Procurement Packages handled by the Members have been added to the large number of physics and functional interfaces among different systems.

Although a small number of Procurement Arrangements were signed in late 2007, procurement activities accelerated significantly during 2008 – with about one third of the total in-kind procurement value being attributed during the year. The main Procurement Arrangements which have been launched concern the PF and TF magnet coils and the vacuum vessel.
7.2. Staff

At the end of August 2008 the IO had 269 staff comprising 235 direct employed staff, 34 seconded staff, 18 temporary staff and 3 visiting researchers. The profile of staff numbers in the coming years is set to increase steadily. Currently there are detailed discussions among the IO and the DAs to re-evaluate the staff numbers required to meet the needs of the project.

7.3. Construction

Works are progressing rapidly on the ITER site with the close collaboration of ITER's Civil Construction and Site Support Office, Agence ITER France (AIF) and the European Domestic Agency.

Currently the major and most impressive activity is the site levelling which will provide the 80 hectare level platform on which most of the ITER facility will be built. This task is making progress — though a little more slowly than expected due to the stronger-than-expected subsurface rock structure. Over 700,000 cubic metres of rock have been removed by blasting and it is expected that the remaining 1,000,000 cubic metres to be removed by blasting will be completed by early 2009. Integrated with the platform levelling work is a new campaign of site investigation which will ensure that the best possible knowledge of the rock conditions is obtained prior to the start of building construction. In addition, excellent progress has been made on completing the many kilometres of access roads, drainage pipes, retention basins and other infrastructure required to support the construction of the ITER facility. The JWS-2 temporary building, which will house 300 ITER staff, is almost ready. Completion of this building, which will be fully commissioned by the end of October 2008, is
a milestone in ITER's history as it will be the first building to be occupied on the ITER site and will serve as the ITER Headquarters until the completion of the permanent office building in 2011. The architectural drawings for this permanent building are complete and the calls for tender for the construction of the building will be launched in early 2009, with construction expected to start in the second half of the year. Acknowledgement is due to the civil engineering teams of ITER, Agence ITER France and the European Domestic Agency, as well as the numerous companies who have been involved in the site preparation activities. Their hard work and dedication means that the construction of ITER is now well underway. The next major milestone will be the start of the Tokamak Building excavation in 2009.

8. Conclusions

The new 2007 ITER baseline design was endorsed by the STAC as a good basis to start construction and subsequently the Council approved the Project Specification (PS) and endorsed the incorporation of the design changes into a revised ITER reference design. The Council has agreed that the ITER Organization and Domestic Agencies should use the Overall Project Schedule (OPS), which shows the first plasma in July 2018, as a reference schedule for planning purposes. An Integrated Project Schedule which represents an aggressive, but achievable with minimum risk, plan has been prepared. In technical areas some of the major R&D activities have obtained successful results confirming design choices and options. Against this background the IO and DAs are building up their staff numbers and procurement is getting up to speed.

References


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