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ITER

Critical negotiations set for fusion's future

INEEL's Thomas Dolan has said that "I am now very confident we will have fusion reactors within 50 years."

THE FINAL PHASE of negotiations to decide on where to build the planned International Thermonuclear Experimental Reactor (ITER) and other key issues was scheduled to begin in Toronto, Ontario, Canada, on October 4. This negotiating round was intended to produce a draft agreement, which would also set out how to share the construction cost—estimated at $4 billion—by the end of 2002. Governments (including those not taking part in the negotiations) would then, on the basis of the draft, decide whether to participate in the construction, which could start as early as 2003 and take 8–10 years.

In July, the engineering design activities (EDA), which began in 1992, were completed (*NN,* Sept. 2001, p. 17). The EDA envisions a device capable of generating 500 MW fusion power for as long as 1000 seconds.

Work on ITER began in 1978, as a cooperative program of the European Union, Japan, the Soviet Union (later Russia), and the United States, under the auspices of the IAEA. The U.S. withdrew from ITER in 1999, although it continued to participate in the engineering design work at a nongovernmental scientific level. And so, the Toronto talks will involve only the European Union (EU), Japan, and Russia, along with Canada, which is the only country so far to have offered a site. France (on its own or as part of the EU) and Japan have said they would propose sites, but none have been put on the table so far.

"We now have the complete design of a very powerful experiment, and also many details of all the systems that go into the device," Thomas Dolan, former head of the IAEA physics section, told *Nuclear News.* Dolan, who returned to the Idaho National Engineering and Environmental Laboratory in Idaho, added that "in addition to the paper design, many of the key components, or models of them, have been built and tested under cooperative ITER research and development activities in countries of the four original partners."

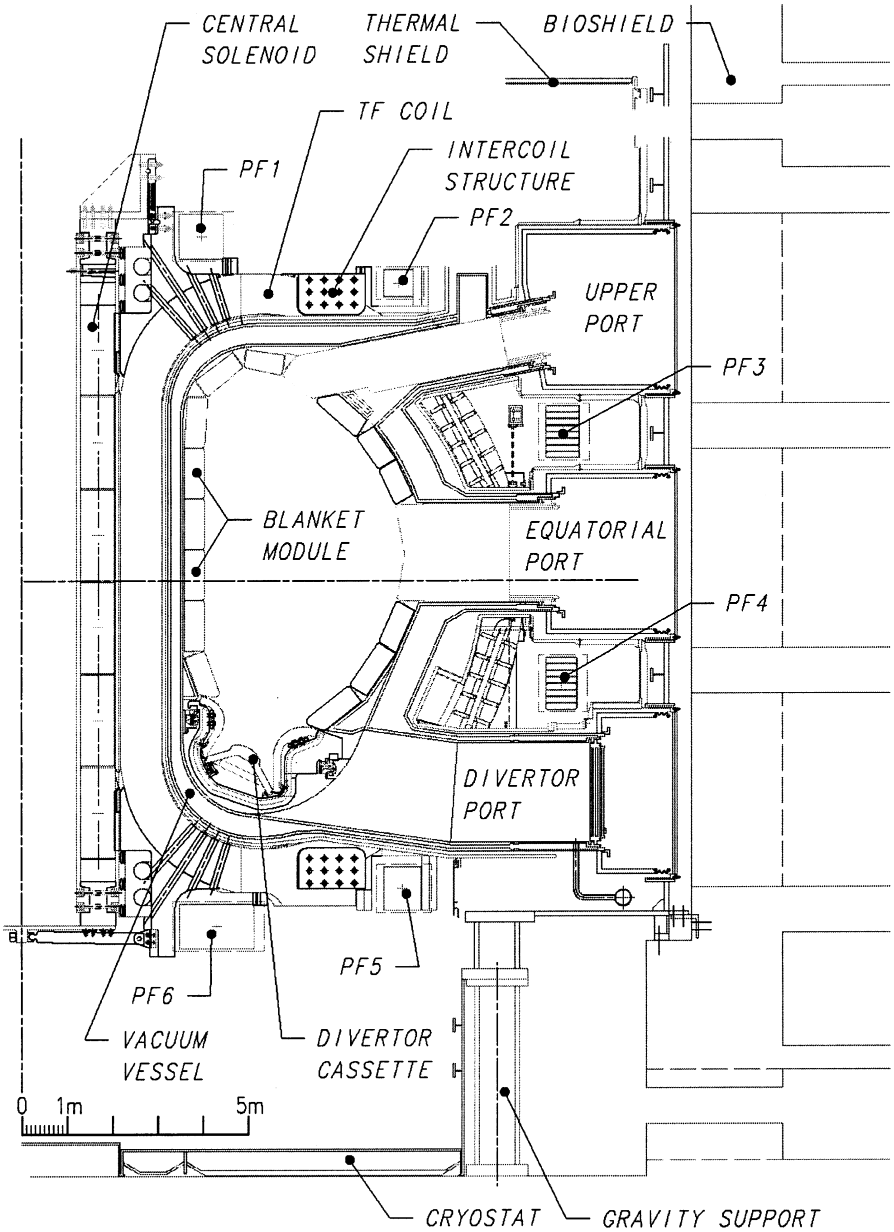
Principal components developed and tested include the central solenoid coil that is pulsed to induce current in the plasma, the toroidal field coil, vacuum vessel segment, blanket module, and diverter cassette, as well as the blanket remote handling and diverter remote handling technologies that allow intervention and repair of activated components. Full-scale tools and facilities have also been developed, along with components for fueling, pumping, tritium processing, heating/current drive and power supplies, and diagnostics.

In short, the proposed device would be able to demonstrate the feasibility of producing plasma from the fusion of deuterium-tritium (D-T) fuel, generation of helium and neutrons, and containment of plasma in a steady state. In the sun's core, hydrogen is heated to 10–15 million °C. A fusion reactor would subject the D-T fuel to temperatures as high as 100-million-plus °C.

"We know that the engineering features [of the experimental device] will work," Dolan said. "What remains to be done is to assemble it, turn it on, and operate it to see what the plasma will do. We have very good computer programs that predict what the plasma will do; we need to do the experiments to verify those predictions." Dolan said the completed design is a general design that can be built almost anywhere and that the engineering design specified the site requirements in detail.

The site at Clarington, proposed by Canada, was visited by ITER Council members and senior officials following the Council's meeting in Toronto in February. It was announced at the meeting that Canadian industries had pledged $23 million to cover costs of environmental assessment, licensing, and design adjustment. The site, 184 hectares and an hour's drive from Toronto, is situated between a large cement plant and the Darlington nuclear power plant. Both neighbors are considered significant in that cement is a vital construction material and proximity to the nuclear power plant would ease the licensing process for the device.

The site boasts a number of other features noted in ITER reports: It has a very strong electrical grid that meets ITER requirements, and access to other infrastructure; it is located close to the tritium removal facility where



ITER cross section: Engineering design activities were completed in July (Source: ITER)

tritium is stored; it lies on the ocean-going St. Lawrence Seaway and the docks, which were used when building the nuclear power plant, are currently serving the cement company, and will allow direct transportation of fully fabricated ITER components from supplying countries; and it has a railway link running through the site.

France and Japan (and any other country) could still submit site offers, theoretically, at least, until the construction negotiations close at the end of next year. But a senior ITER source, who did not wish to be identified, told *Nuclear News* in September that another bid appeared unlikely at this stage. "Site offers require host government support, not only for the licensing process, but financial commitment for groundwork stretched over the 10-year construction period, and this usually takes a lot of time for governments to decide," he explained. He agreed that main construction costs would be borne by ITER and that the groundwork would not add up to much, "provided the site situation and essential facilities already exist, as they seem to do in Canada."

The experimental device will not generate electricity, Dolan explained. The device is concentrating on the high-power burning of plasma for long periods of time. Experiments have been done in many countries and achieved a number of successes in Tokomak plasma confinement in different types of Tokomak reactors.

"In those terms the most notable achievements so far, in Tokomak research, [have] been about 10 MW of fusion power for . . . about a second in the U.S., about 15 MW for [about] a second in England, and plasma [generation] with comparable capabilities in Japan—although they did not use the deuterium-tritium fuel mixture that would have produced such a high power. The ITER experiment will use D-T to produce about 500 MW thermal for hundreds or maybe even thousands of seconds."

Because the ultimate aim is to sustain high-power fusion plasma for a long time and to use the heat to generate electricity, it is necessary to show that the plasma can produce high power and that the reactor walls can handle the power without being damaged. "You have to confine the plasma, maintain the purity of the fuel and the plasma so that it stays hot and continues to produce fusion reactions, and you have to cool the walls so that they do not overheat. And you need to do that for a long enough time to show convincingly that it could be done indefinitely," said Dolan.

The next step after ITER is to build a demonstration power plant that will be like ITER, but with the additional equipment to generate electricity, Dolan said. "I am now very confident we will have fusion reactors within 50 years," he added, "though of course you cannot be sure, because sometimes you do experiments and unexpected things happen. We have to do the big experiments to really find out the answers. And we will need to operate the demonstration plant for a reasonable time to answer the question of reliability, that it operates without something breaking down."