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from : Mr Sylvain BISARRE, for the Secretary-General of the European Commission
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Delegations will find attached Commission document SEC(2002) 276.

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COMMISSION OF THE EUROPEAN COMMUNITIES

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COMMISSION STAFF WORKING PAPER

**THE COST TO EUROPE OF ITER JOINT IMPLEMENTATION
ACCORDING TO VARIOUS HOSTING SCENARIOS**

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BACKGROUND

1. At the last Research Council on 10 December 2001, the Commission undertook to submit to the Council at the beginning of 2002, a working document presenting the costs of ITER¹ to Europe beyond the 6th Framework Programme, according to various hosting scenarios.
2. The present document summarises available information on the cost of the joint implementation of ITER according to three possible hosting scenarios: ITER in Europe, ITER in Canada or ITER in Japan. Unless otherwise specified, the cost estimates given in the following are those reported in the “Summary of the ITER Final Design Report”² (FDR).
3. The ITER implementation includes a construction phase lasting about 10 years, an exploitation phase lasting about 20 years and a decommissioning phase.

Assumptions made in the following on possible cost sharing schemes between Parties during these phases should be taken at this stage of the negotiations as a first approximation, prejudging neither the EU’s position in the negotiations nor their outcome.

It should be noted that the financial implications of the possible implementation of ITER in the period up to the end of 2006 are covered within the amount foreseen for fusion in the next Euratom framework programme. The possible financial implications beyond that date cannot prejudice the future financial perspectives of the European Union.

The Negotiation Process for the possible Joint Implementation of ITER

4. By Decision dated 16 November 2000, the Council of the European Union provided directives to the Commission to conduct negotiations on the establishment of an international framework allowing ITER EDA Parties and qualified third countries to prepare jointly for the future establishment of an ITER Legal Entity (ILE) for ITER construction and operation, if and when decided.
5. Canada, Euratom, Japan and the Russian Federation started official negotiations on the future Joint Implementation of ITER on 8-9 November 2001. At this meeting, the Delegations adopted the framework to prepare jointly for the future establishment of an ITER Legal Entity (ILE) as an international organisation under international law. They accepted a Work Plan and Milestones for the Negotiations Process, planned to terminate by the end of 2002. At this stage, if successful, the outcome of the Negotiations process will be submitted to the Participants in the Negotiations for their agreement/ratification.

¹ ‘International Thermonuclear Experimental Reactor’. The aim of ITER is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

² ITER EDA Documentation Series NO. 22, IAEA, Vienna, 2001.

Possible ITER hosting scenarios

6. The current situation with regard to the possible ITER hosting scenarios is as follows:
- Canada has officially proposed a candidate site for ITER (Clarington- Ontario);
 - preparatory work is known to be underway in relation to the possibility for Japan to make proposal for (a) site(s) as soon as Japan’s basic stance on ITER is decided; for the time being the sites known to be under consideration are Rokkasho-Aomori and Naka-Ibaraki;
 - In Europe, the French authorities have asked the European Union to consider Cadarache as a potential candidate site and another possible candidature may emerge from Spain;
 - The Russian Federation has declined to offer a site.
7. The working assumption for the present analysis is that there might be three scenarios for hosting ITER (one in Europe, one in Japan and one in Canada) and therefore three possible cost sharing schemes between participants have to be considered.
8. It should be noted that Canada would be a Party to the ITER Joint Implementation Agreement only if the construction site was Clarington, in which case Canada would only contribute to the construction phase (see 24 to 26 below).

THE CONSTRUCTION PHASE

ITER construction costs evaluation

9. The evaluation of ITER construction costs by the ITER Joint Central Team (JCT) was based on detailed studies of the means of implementing each stage of fabrication of each component, applying unit costs normalised for the project as a whole (e.g. hourly cost of labour; cost of materials on the international market). The cost estimate exercise has been the subject of a wide consultation of the Parties’ industries.
10. The supply of these components and systems was divided into 85 procurement packages, each described in detailed specifications for a plausible contractual arrangement with an industrial supplier. Each ITER Party relied on one or more industrial suppliers to provide, in their national currency at the date of consultation, a costing for the proposed contract and an analysis in the technical terms defined in the specifications. The resulting direct capital cost of ITER construction³, expressed in ITER Units of Account⁴, amounts to 2,755 kIUA.
11. For technical reasons, a number of spares, the cost of which would in principle be charged to the operation phase, will have to be ordered as part of the contracts for the main supply. The delivery of other items can be deferred a few years after the start of operations, as

³ The direct capital cost is the sum of the cost of all equipment and systems “within the perimeter of the ITER site” that are necessary to commission the facilities and start of the operation phase.

⁴ As economic conditions in the Parties vary widely over time, it has been found necessary to establish an ITER Unit of Account (1 IUA = \$US 1000 at January 1989 economic conditions), independent of currency fluctuations and domestic inflation factors.

they need not to be commissioned at the start of operations. However, for simplicity, the capital cost considered in the following will include such spares and deferred items, the costs of which are estimated to be 258 kIUA.

12. In addition to the above, a certain amount of R&D will still be necessary during construction, estimated to fall in the range 60-80 kIUA.

13. Finally, to estimate the cost of management and support, assumptions were made by the JCT on the structure of the future organisation to execute the construction and on the manner procurement would be managed, which in turn have an effect on the size of the ITER Team. The management and support costs (largely manpower) would also depend on where ITER would eventually be sited. Assumptions were also made on the cost of professionals and support staff and on the ratio between these two categories. The total man-years for the ILE Team were estimated at 1,800 professional personnel.year and 2,760 support personnel.year. The total cost for management and support is estimated at 477 kIUA.

14. All included the cost for construction is thus estimated at 3,570 kIUA

15. Following the EU domestic assessment of the ITER Engineering Design Activities (ITER-EDA) Final Design Report, the CCE-FU⁵ concluded that the methodology followed by the ITER JCT in evaluating the cost of ITER is sound and provides the correct basis for entering into the negotiations concerning the sharing of contributions, percentage-wise, among the different components and systems of the ITER machine, based on the supply of components “in kind” among the Parties.

16. Costs will be shared between Parties according to sharing schemes that will result from the negotiations and which will reflect each Party’s willingness to contribute equitably (see Point 21). To allow the Parties to estimate the possible budgetary effects of their participation into ITER, each of them must be able to estimate the cost in its own currency that it would incur to provide its contribution. Global conversion factors were calculated by the ITER JCT using exchange rates and standard inflation factors in each of the Parties. For Europe the ITER Unit of Account has been estimated by the ITER JCT to be equivalent to about 1.28 k euro at December 2000 economic conditions.

17. Using this factor, the total cost, including spares, deferred items, R&D, management and support is thus estimated at 4,570 Mio euro (see Table 1):

⁵ Consultative Committee for the Euratom specific research and training programme in the field of nuclear energy (Fusion).

Table 1: Estimated total cost of construction of ITER

Costs	Mio €
Direct capital cost	3,530
Spares and deferred items	330
Cost for R&D during construction	100
<i>Total investment costs</i>	<i>3,960</i>
Management and support	610
Total cost	4,570

18. In a previous Commission's Services Working Paper ⁶, a direct capital cost in the range 3.5 to 4 Bio euro was quoted, based on preliminary cost estimates. The more precise cost estimates including spares and deferred items established since then of 3,860 Mio euro, is compatible with this preliminary estimate. This cost closely matches the figure estimated by European industry.

Basic assumptions for cost sharing for construction

19. Site preparations, including infrastructure external to the site, to satisfy the ITER Site Requirements should be undertaken by the Host Party at its cost. For a European site, this cost is assumed to be borne by the host country. In the case of the Cadarache site, this cost has been estimated to be about 100 Mio euro.

20. The direct capital cost of construction covers all equipment and systems within the perimeter of the ITER site. It is composed of:

- Cost in the **common area** of construction that should be shared among the Parties following a formula to be determined during negotiations;
- Cost in the so-called **non-common area** of construction, that should be borne by the Host (e.g. construction of buildings).

21. During the exploratory non-committal discussions held between ITER EDA Parties in 2000, the procurements that could be assigned to the non-common area of construction were estimated to fall in a bracket centred around 20 % of the ITER direct capital cost. The cost in the common area of construction to be shared between potential Parties could therefore be estimated to about 80 %.

It is assumed in the following that the cost sharing schemes for construction in the common area will be broadly independent of siting and reflect the willingness of each Participant in the negotiations to contribute equitably. Management and support costs should be shared in the

⁶ Fusion research in Europe and the ITER Project – Possible application to energy production, state of progress, options for the future; SEC(2001)385, 5 March 2001.

same proportion as capital costs. Canada would not participate in the financing of the common area.

22. Informal consultations carried out by the Director of the ITER JCT in the last stage of the ITER EDA indicate that the Russian Federation would be ready to provide a contribution in kind of about 14 % of the direct construction cost wherever ITER would be hosted. It is assumed that the remaining (80-14) % = 66 % would be equally shared between Europe and Japan.

Preliminary cost sharing schemes for construction

23. On the basis of the above mentioned assumptions, a preliminary simplified breakdown of cost sharing of the capital cost for construction could be as follows:

Table 2: Preliminary sharing schemes of the capital cost

Participants	ITER in Canada (*)	ITER in Europe	ITER in Japan
Canada	18 %	-	-
Europe	34 %	(33 + 20) %	33 %
Japan	34 %	33 %	(33 + 20) %
Russian Federation	14 %	14 %	14 %

(*) *Cash flow during the construction phase, see Points 24 to 26 below*

24. The assumption made that the Canadian contribution during the period of construction would amount to 18% is based on information released during technical discussions made in the framework of Negotiations. It does not prejudice any endorsement of this figure by the other Participants in the Negotiations.

25. The Canadian offer to host ITER is based on an innovative financing plan, which combines Ontario government and private funds, and on a number of financial arrangements and obligations between the ILE and the Canadian domestic organisation, ITER Canada. The Canadian bid refers to the government of Ontario willingness to commit funding to support ITER being sited in Ontario (understood to be of the order of 300 Mio Can \$), subject to satisfactory terms and conditions in the final ITER project agreements.

A financial group set up for this purpose would be responsible for raising in the international financial markets the complement of funds required, on the basis of the ITER Parties' commitment to build and operate ITER over a given period of time and of payment guarantees from the non-host ITER Parties to the Host to be included in the Joint Implementation Agreement. A variety of loan instruments would be issued. Finally, ITER Canada would enter into a Host Services Contract with the ILE, spanning the entire life of the ITER project, which, it is claimed, would provide host related goods and services at rates below current ITER estimates, yet that would, over the years, generate enough revenue to allow the payment of the loan contracted during the construction phase. It should be emphasised that the Joint Implementation Agreement would include payment guarantees from the non-host Parties to the host Party to cover any short fall in revenue.

26. Except for the possible Ontario Government's contribution, the cost of the non-common area of construction would thus have to be borne by, and shared between, the non-host Parties. The proposed financial plan has however the advantage of facilitating cash flow problems during construction when the rate of spending is at its highest. Such expenditure would be spread over a longer period of time when yearly costs to be borne in the operation phase are less.

The possible risks attached with this financial plan for Europe, due in particular to possible changes in economic conditions (rates of exchange, inflation, cost of money on financial market) over such a long period of time, and the issue of payment guarantees, will have to be assessed in detail.

Comparison of costs to Euratom for ITER construction inside/outside Europe

27. The cost corresponding to the European participation in the Common area is mostly site independent. It could amount to 33 % of 4,570 Mio euro = 1,508 Mio euro. It is assumed that, as was the case for the JET Joint Undertaking, most of this cost would have to be borne by Euratom. Similarly, the national laboratories associated with Euratom (the Associates) could be invited to take a share of this expenditure. It is assumed in the following that this could amount to around 10% in the common area (about 15 Mio euro per year). For comparison, the contribution they currently bring to the joint use of the JET Facilities (Joint Fund) is about 7.5 Mio euro per year.

28. If ITER were hosted in Europe, it could be considered to share the cost in the non-common area of construction equally between Euratom and the Host country. The Euratom share of the non-common area would amount to 10 % of 4,570 Mio euro, i.e. 457 Mio euro. Assuming that the construction period would last 10 years (made up of 2 years of preparatory activities to set-up the organisation, prepare the calls for tender and proceed with the licensing issues, and 8 years of effective construction work), the additional investment cost to Euratom for having ITER built in Europe would therefore be about 46 Mio euro per year.

Table 3: Possible sharing of the European contribution to total costs during the construction phase.

	Non-common Area Total EU: 914 Mio €		Common Area Total EU: 1 508 Mio €	
Euratom	457	50 %	1 358	90 %
Host Member State	457	50 %	-	-
All EU Associates	-	-	150	10 %
Total	914	100 %	1 508	100 %

Concluding remarks on construction costs

29. There is technically no obstacle excluding the possibility of envisaging solutions to the European financial engineering of ITER similar to those proposed by the Canadians. Such solutions remain however to be explored. As already stressed above, they present the advantage of smoothing expenditure profiles over time by postponing part of the expenditure incurred during the construction phase to the operation phase, which on average has a yearly

cost about half the yearly cost of the construction phase. Of course the servicing of the debts incurred would result into an increase in the overall costs of ITER over its entire life.

30. The European contribution to the joint implementation of ITER, if and when decided, will become the focus of the European fusion programme. If ITER were hosted in Europe, the Associate in the country where ITER would be located might reduce significantly its domestic activities and Euratom would save an amount comparable to its support to the activities of this Associate. As indicated in the Commission's Services Working Paper referred to under Point 18 above, it should also be pointed that the closing down of the operation of the JET facilities under EFDA at an appropriate time would enable the corresponding resources to be transferred to ITER.

THE OPERATION PHASE

31. The evaluations carried out by the ITER JCT include the cost of personnel located on-site for the functioning of the installations (plus general costs), energy and fuel (tritium) costs, the cost of some new capital investments (enhancement), spares and maintenance. As for the construction costs, these estimates are expressed in IUA and adjusted according to normalised costs.

32. According to the planning proposed in the ITER EDA Final Design Report, the exploitation phase would be sub-divided into two main sub-phases: the first 10 years corresponding to an experimental physics oriented programme, the following 10 years to an intensive, technology oriented, use of the facilities. It should be noted that the evaluation of the cost of operation after the first 10 years depends on the programme of work, which will be decided according to the results of the first sub-phase.

However, an estimate of the average expenditure over the whole exploitation period has been made by the JCT and results in about 240 Mio euro per year.

In addition, as explained below, yearly provision for decommissioning (not including the deactivation phase – see Point 35) will have to be made and shared among Parties according to the scheme used for the operation. This provision (including long-term disposal of waste) will depend on the Host country. Preliminary estimations in Europe indicate (Points 36-37) that it could be of the order of 25 Mio euro per year, bringing the estimated yearly funding to a total of 265 Mio euro.

33. The cost sharing scheme between ITER Parties during operation is a matter for negotiations. In the following, it is assumed that the sharing of the whole costs for operation would reproduce the scheme used for the common area during construction, as long as the Parties remain the same (i.e. about 42 % for Europe). Accordingly the European contribution would be about 111 Mio euro per year, wherever ITER would be hosted.

34. The cost sharing between Euratom and its European partners would of course be different depending on whether ITER is hosted in Europe or not as the support expected from the Host would no longer exist. In the following it is assumed that the amount of the Associates' contribution would remain at the same level.

A possible cost sharing scheme for operation within/outside Europe (per year) between Euratom, the host Member State (if applicable) and all Associates is suggested in Table 4.

Table 4: Possible cost sharing for operation within/outside Europe (Mio €/year, %)

	ITER within EU		ITER outside EU	
Euratom	82	~75 %	104	~95 %
Host Member State	22	~20 %	-	-
EU Associates	7	~5 %	7	~ 5 %
TOTAL	111	100 %	111	100 %

DECOMMISSIONING PHASE

35. The plan described in the ITER Final Design Report assumes that, at the end of the exploitation phase, the ITER organisation will be responsible for starting the machine decommissioning through a de-activation period lasting about 5 years. The cost would depend on the site. Following the estimate given in the Final Design Report the yearly cost for this phase would be about 86 Mio euro.

36. The above cost estimate does not include the dismantling of the buildings and of the non-active components, or the disposal of wastes from the decommissioning, which again depends heavily on the host country regulations and practices. Therefore, at the end of this phase, the facility will be handed over to a new organisation in the ITER host country that will be responsible for the final phase of decommissioning after a dormant period for radioactive decay.

37. In the final report on the exploratory non-committal discussions held between ITER EDA Parties in 2000, it is proposed that the costs of this second phase of ITER decommissioning be shared among the Parties. The financial provisions for decommissioning and management of the activated materials which belong to the ILE should be made jointly by the Parties through a fund to be established under the agreement and built up during the period of the project in accordance with the licensing requirements. The conduct by the host of the final decommissioning phase would then be entirely funded from the reserve set up for this purpose during the preceding phases (see Point 32).

CONCLUDING REMARKS

38. The following table provides a summary of the cost estimates for the various phases of the realisation of ITER according to two scenarios, ITER inside or outside of Europe. It provides also the costs to Europe and to Euratom according to the cost sharing schemes hypothesised in this paper. The yearly average costs are estimated assuming they are evenly distributed on the duration of the corresponding phase, i.e. 10 years for construction, 20 years for operation and 5 years for de-activation. It is recalled that the cost for decommissioning is provisioned during the operation phase and included in the cost of this phase.

Table 5: Summary of the cost estimates for the realisation of ITER

Phases		Construction	Operation *	De-activation	Total
Total		4,570	5,300	430	10,300
Yearly average cost		457	265	86	
<i>ITER inside Europe</i>					
Cost to Europe	Total	2,422	2,220	180	4,824
	Yearly av.	242	111	36	
of which	Total	1,815	1,640	180	3,635
Cost to Euratom	Yearly av.	182	82	36	
<i>ITER outside Europe</i>	<i>See note</i>				
Cost to Europe	Total	1,508	2,220	180	3,910
	Yearly av.	151	111	36	
of which	Total	1,358	2,080	180	3,618
Cost to Euratom	Yearly av.	136	104	36	

* including provisions for decommissioning

Note: The specificity of the Canadian offer cannot be summarised in a table of this type

39. Among the key issues to be addressed for a project of such scale is the rigorous control of costs over the long period of time considered for the joint implementation of ITER. Over the more than 20 years of existence of the JET Joint Undertaking, Europe has gained a unique and successful experience on the methods to be used. During negotiations, the EU will use this experience to ensure that this objective will be met. It has been agreed during the negotiations that the sharing of the construction costs would be calculated on the basis of the cost estimates, percentage wise, presented in the ITER-EDA Final Design Report. Once the detailed list of the supplies to be contributed by Europe will be known, a final validation by independent experts of the cost for Europe could be considered before a final decision is taken regarding ITER construction.