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PROPOSAL FOR A COUNCIL DECISION

adopting a research and training programme (1982 to 1986)
in the field of controlled thermonuclear fusion

(submitted by the Commission to the Council)

PROPOSAL

FOR A

RESEARCH AND TRAINING PROGRAMME (1982-86)

FOR THE EUROPEAN ATOMIC ENERGY COMMUNITY

IN THE FIELD OF CONTROLLED THERMONUCLEAR FUSION

(presented to the Council by the Commission)

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Chapter A) I - INTRODUCTION

1.1 ENERGY FROM THERMONUCLEAR FUSION

In several Decisions concerning the Fusion Programme, the Council of the European Community has recognized that "controlled thermonuclear fusion could be of benefit to the Community, particularly in the wider context of the security of the long-term energy supply".

In full consideration of the foreseeable long-term energy situation, it is very important to promote the development of the few conceivable major potential energy sources for the future, in particular in order to secure enough diversification in energy supply.

Fusion is one of these few major potential energy sources. It is at an early stage of development, but in principle has potential advantages which could be particularly valuable for Europe: the primary fusion fuels (D, Li) are abundant, widespread and cheap (1 g natural lithium could produce 15 MWh); both those fuels and helium, the final product of the reactions, are stable; a fusion reactor could be made very safe from the nuclear point of view; the doubling time for breeding new fuel could in principle be very short, etc. These potential advantages are balanced by certain drawbacks: the high construction cost of a reactor, neutron activation of the reactor structure, large tritium and lithium inventories, etc.

It is impossible today to make a credible estimate of the economic and social cost of fusion energy; the advantages and drawbacks of fusion should be continuously reassessed.

I.2 THE COMMUNITY FUSION PROGRAMME

Since its creation, Euratom has contributed funds and manpower to promote activities in the Fusion Laboratories in the member States and their integration in a common programme through contracts of Association. More recently, the JET Joint Undertaking (the focal point of the European programme), and

that part of the Joint Research Centre having responsibility for Fusion Technology, have been added to the system of Associations; moreover, two third countries (Sweden and Switzerland) are now fully associated with the Community Fusion programme. The Commission and the programme's coordinating bodies have therefore increasing responsibilities for the management and coordination of the expanding Community fusion programme which, following a Council Decision:

- is part of a long-term cooperative project embracing all work carried out in the member States and in certain third countries in the field of controlled thermonuclear fusion;
- aims, in the long term, at the attainment of a single common goal;
- presents itself as a single body in its relations with other fusion programmes in the world.

The successive Community research programmes in the field of Fusion are adopted by the Council for periods not exceeding five years. Every three years a new programme proposal is submitted by the Commission to the Council, so that successive five year programmes overlap for periods of two years. This "sliding programme" concept allows to take into account the evolution of the scientific and technical situation.

I.3 MOTIVATION FOR THE PRESENT PROGRAMME PROPOSAL

When adopting the 1979-83 Fusion Programme of the Community[1], the Council decided that "the Commission shall submit to the Council, not later than 1 July 1981, a review proposal designed to replace the present programme by a new five-year programme with effect from 1 January 1982".

Moreover, the rapid progress made recently in Tokamak physics and plasma heating techniques, the successful implementation of the construction of JET (which will become operational early in 1983) and the assessement of the problems (both in physics and in technology) to be solved before undertaking the construction of a device of the post-JET generation, make a revision of the 1979-83 programme technically very appropriate at this time.

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(1) O.J. N° L72 of 18.3.1980

The Commission, facing the needs of re-orienting and possibly increasing its activities in the field of thermonuclear fusion, presently in a phase of transition from basic research to technological development, felt it opportune to set up a Fusion Review Panel. This ad-hoc group of 11 prominent scientific personalities, whose responsibilities and interests extend well beyond the field of fusion research, had the following terms of reference:(2)

"Review, taking into account current international developments:

- the present status and progress of fusion R & D work in the Community fusion programme,
- the prospects for the further development of fusion as an energy source for the Community,
- future plans for the Community fusion programme, with particular emphasis on the next major step,

and formulate recommendations on future policy and action".

The Community Fusion Programme Review Panel has concluded its work in June 1981 and its final report is submitted to the Consultative Committee of the Fusion Programme, the Commission, the Council and the Parliament.

The programme proposal 1982-86 takes due account of the recommendations of the Community Fusion Review Panel.

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(2) Decision of the Commission, 26.11.1980, document E/1504/80

Chapter A) II - PRESENT SITUATION OF THERMONUCLEAR FUSION RESEARCH

II.1 CONTENTS OF THE PRESENT COMMUNITY PROGRAMME

II.1.1 Present situation

During the last decade, the basic trend of the European Programme (employing about 1000 professional staff) has been to concentrate on the most promising line, the Tokamak. This concentration has now largely been achieved and Europe has proved to be fully competitive in this field: the highest n T product has been reached in Frascati, and JET will be in the coming decade the largest fusion facility in the world. Within the Tokamak line, a strong effort has been applied to the provision of plasma heating, where Europe has been particularly successful.

Of the present Community activity only about 10% is now devoted to a few well chosen alternative lines which, within the toroidal magnetic confinement family, will be both alternative and contributory to Tokamaks. Work on mirrors has been totally discontinued. Less than 2% of the present budget is committed to laser development and studies in light-matter interaction.

The technology part of the fusion programme (about 7% of the overall budget) is almost entirely devoted to the Tokamak and is mainly oriented towards the needs of post-JET devices; international collaboration (with extra-European countries) has led to concrete results in some fields of technology and in system studies (INTOR).

II.1.2 Main Tokamaks

First operation	Device	Main objective (present or future)	Plasma current (KA)	Pulse duration (sec.)
1973	TFR (Fontenay)	Plasma heating, physics	400/600	1
1976	DITE (Culham)	Divertor, heating, physics	250/350	0.5
1977	FT (Frascati)	Scaling laws, RF-heating	1000	1
1980	ASDEX (Garching)	Divertor, heating, refuelling	500	5
1981	TEXTOR (Jülich)	Plasma-wall interaction	500/600	3
1983	JET	Scaling laws, heating plasma-wall interaction, α-particles	3800/4800	5/13
.... ?	TORE SUPRA (Cadarache)	Superconductor, long pulse, heating	1700	30
.... ?	FTU (Frascati)	Scaling laws, heating	1600	1
.... ?	ASDEX UPGRADE (Garching)	Divertor, cold mantle	....	...

- JET: The programme for the construction of the basic JET device is currently maintaining its planned schedule, which foresees the start of operation in April 1983. As a result of the completion and hand-over of all the non-specific buildings put at the disposal of JET by the Host organization, the whole JET team is now working on the JET site. The construction of the specific buildings is also advanced. The manufacture of components of the device is progressing well: a number have already been delivered on site, and others are being tested at the factory. Generally, progress with industrial contracts is reassuring, with only a few production problems of any significance, and about 75% of the contracts for equipment procurement have now been placed. (At the end of 1980, the commitment on industrial contracts amounted to about 125 MioECU, distributed over about 70 major contractors). On 30 April 1981, the JET team numbered 230 (including 113 professionals) of which 120 were Euratom staff.

- Possible new devices: three large specialized Tokamaks (TORE SUPRA, FTU, ASDEX-UPGRADE) are now at various stages of design in the Associations (see IV.2.1).

II.1.3 Supporting activities

- Heating: A successful development of neutral injection systems (hydrogen and deuterium) is proceeding at Culham and Fontenay, for their own needs, for JET and for devices in other Associations. Jülich is also involved in N.I. development. Preliminary work on neutral beams produced via negative ions is underway through collaboration between the EUR-CEA and EUR-Sweden Associations. Recent developments on Ion Cyclotron and Lower Hybrid Resonance Heating, particularly in the EUR-CEA Association, have led to large scale applications on JET and other large devices. Radio-frequency heating studies are performed on some of the main devices, as well as on most of the small specialized Tokamaks of the European programme. These small machines are essentially used to produce and confine plasmas appropriate for such studies; some of these machines are coming close to the end of their active life. A list is given below:

Device	Site	Main objectives	I (kA)	T (sec.)
PETULA	Grenoble	RF heating (lower hybrid)	100	0.1
ERASMUS	Brussels	RF heating (ion cyclotron)	50	0.015
TCA	Lausanne	RF heating (Alfven waves)	130	0.1
WEGA	Grenoble	RF heating (lower hybrid)	100	0.1
TORTURE	Jutphaas	Turbulent heating	100	0.005
THOR	Milan	RF heating (electron cyclotron)	55	0.01
RINGBOOG	Jutphaas	Cold mantle between plasma and wall	70	0.1
DANTE	Risø	Pellet ablation for refuelling	20	0.05
TOSCA	Culham	High beta, RF heating (electron cyclotron)	25	0.005
SPICA	Jutphaas	High beta	1000	0.001

- Diagnostics: the understanding of plasma behaviour implies the simultaneous measurement of a large number of parameters (density, local magnetic and electric fields, electron and ion energy distributions impurity content, etc...) with good spatial and temporal resolution and using methods which do not perturb the plasma. For thermonuclear plasmas this requires the development of sophisticated diagnostic

methods and the use of powerful computing facilities for data processing. A large fraction of the staff in the Associations is involved in diagnostic work both for their own use and for JET, and a high level of expertise now exists in all fields, with the exception of operation in a radioactive environment. The collaboration of all Associations in the preparation of JET diagnostics has started well but will require special attention, particularly when JET becomes operational.

- Cold Plasma mantle studies. The role of a cold mantle of plasma is being investigated in small devices at Stockholm and at Jutphaas, and the interaction between the hot plasma and the wall in general will form one of the main research topics for the TEXTOR machine at Jülich, and possibly for the ASDEX-UPGRADE at Garching.

II.1.4 Technology

Following reactor and post-JET studies, 6 main areas of R and D have been identified:

- Superconducting magnets. A substantial effort is being made on toroidal field coils: construction at Karlsruhe of one out of 6 large coils for the international LARGE COIL Project, development of toroidal field coils cooled by superfluid helium for TORE SUPRA at Fontenay-aux-Roses, and development of high-field coils using A15 conductors by the Dutch, Italian and Swiss Associations within the cooperative SULTAN project and also by KfK (Karlsruhe).

- Tritium technology. Political problems have strongly interfered with technical planning, leading to an extremely weak position of the European Programme in this field. Apart from the design of the tritium system for JET by CEA and UKAEA, under JET-contract, there are only incipient activities related to the Next Step machine, mainly at Jülich. Work in this field needs a vigorous start, since the handling and containment of large quantities of gaseous tritium is a vital part of the fusion fuel cycle.

- Blanket technology. Blanket design studies have a 10 years old tradition in Europe, but very little experimental work has been done. At present, an exploratory study has been started cooperatively by 5 Associations and the JRC Ispra with the aim of defining key problems and establishing an engineering programme.

- Materials. Radiation damage phenomena in steels, nickel alloys and refractory alloys are being studied in 6 associated laboratories and at the JRC Ispra, using accelerators as radiation sources. An effort has been started to concentrate this work on a few reference alloys and to focus strongly on stainless steel, the main candidate for the Next Step.

- Remote Handling. No systematic effort has yet been undertaken, except for JET. The equipment developed for JET, however, covers only partly the needs emerging from Next Step studies.

- Safety and Environment. Only a small effort has been started in this important field, mainly as contributions to the INTOR study by JRC Ispra in cooperation with the Danish, Dutch and Swedish Associations.

II.1.5 Theory and Computing

About 15% of the professional staff is involved in theoretical work and computational physics. Europe has played a full part in the general development of the theory of high temperature plasmas.

II.1.6 NET-INTOR

NET. It was early recognized that the preparation for and development of a post-JET machine, which would bring about a significant advancement of the Tokamak line, was likely to take more than 10 years and require a considerable, steadily increasing effort. Therefore, a Next European Tokamak Group was set up in November 1978, consisting of a small number of physicists and engineers. However, before a serious effort on conceptual design could start, the IAEA launched the international INTOR study. Priority was given to INTOR, to which the effort was diverted, understanding that the work for INTOR was, at the same time, a good preparation for NET.

INTOR. The INTOR study was started under the auspices of the IAEA, at the end of 1978, as a collective effort by Europe, Japan, the US and the Soviet Union, to define an international Next Step project following the JET-TFTR-JT60 generation of Tokamaks (see II.4.2). Virtually all Associations and the JRC have been giving support to

the study under the guidance of the European INTOR delegation. After conclusion of the data base assessment phase in 1979, the conceptual design was started (with a report due in July 1981). It has been agreed to continue the conceptual design study for one more year after the report; a decision will have to be taken whether or not the project should continue being supported by Europe in the engineering design phase, planned to start after July 1982.

II.1.7 Alternative Lines in Toroidal Confinement

- Reverse Field Pinch. After the pioneering work with ZETA (Harwell), research work on the RFP continued mainly at Culham, Padua and Los Alamos with relatively small devices. These three laboratories now plan to collaborate in the building and operation of a large machine, RFX (plasma current 2 MA). Compared with the Tokamak development, the RFP is at least one generation behind and its physics less well understood. In particular, there is little information on scaling laws and a larger apparatus is necessary to make progress. The design of RFX, to be located at Culham, is essentially complete.

- Stellarator. There is only one Stellarator operating in Europe (WENDELSTEIN VII-A at Garching) in which it has been shown that net current-free operation can be achieved by neutral injection (1.2 MW); this leads to confinement properties that are noticeably improved with respect to those of Tokamaks. Theoretical studies on further optimizing the Stellarator configuration give hopeful results: in particular, it appears possible to use a modular coil system replacing both the toroidal field coils and the helical winding. Experimental verification requires upgrading the WENDELSTEIN VII-A experiment.

- Other toroidal configurations. Some systems with special properties, such as possibly a high β , are being investigated on a small scale in Stockholm (INTRAP, EXTRAP).

II.1.8 Inertial Confinement

The Council Decision, stating that the fusion programme of the Community is a long term collaborative project embracing all work carried out on fusion, has been difficult to implement in the field of inertial confinement, because of political problems linked to possible military

implications. It should also be admitted that on present evidence inertial confinement does not appear to be the preferred route to a fusion reactor. As a consequence, the situation in Europe is the following:

In the framework of the Associations, research is limited both in volume and in objectives and is at present conducted at four sites:

- At Frascati, where pioneering work on laser fusion was done in the sixties, a new laser group has been recently set up to study the hydrodynamic stability of ablation-driven implosions using laser pulses of a few hundreds joules.
- At Garching, a high power (1 TW) iodine laser is being developed, and basic studies on light-plasma interaction are in progress.
- Theoretical work is carried out both at Göteborg and Brussels (Université Libre).

Moreover, independent laser programmes are followed by other laboratories outside the Associations, both civilian (Rutherford, Polytechnique, Frascati, ...) or military (Limeil, Aldermaston,...) but these are not directly aimed at the production of controlled thermonuclear fusion energy. The only activity on light ion beam fusion was recently started by a new small group at the Kernforschungszentrum, Karlsruhe. In heavy ion fusion, there is only one organized effort in Germany (Darmstadt), but some conceptual work is going on at the Rutherford Laboratory.

It is significant that in the field of inertial confinement where little coordination is exercised at the European level, the Community is playing only a very modest role on the world scene.

II.2 ORGANIZATION OF THE COMMUNITY PROGRAMME

The Community research programme in the field of controlled thermonuclear fusion is adopted by the Council of Ministers for periods not exceeding five years. The programme is part of a long term cooperative project embracing all the work carried out in the member States in the field of controlled thermonuclear fusion. It is designed to lead in due course to the joint construction of prototype reactors with a view to their industrial production and marketing.

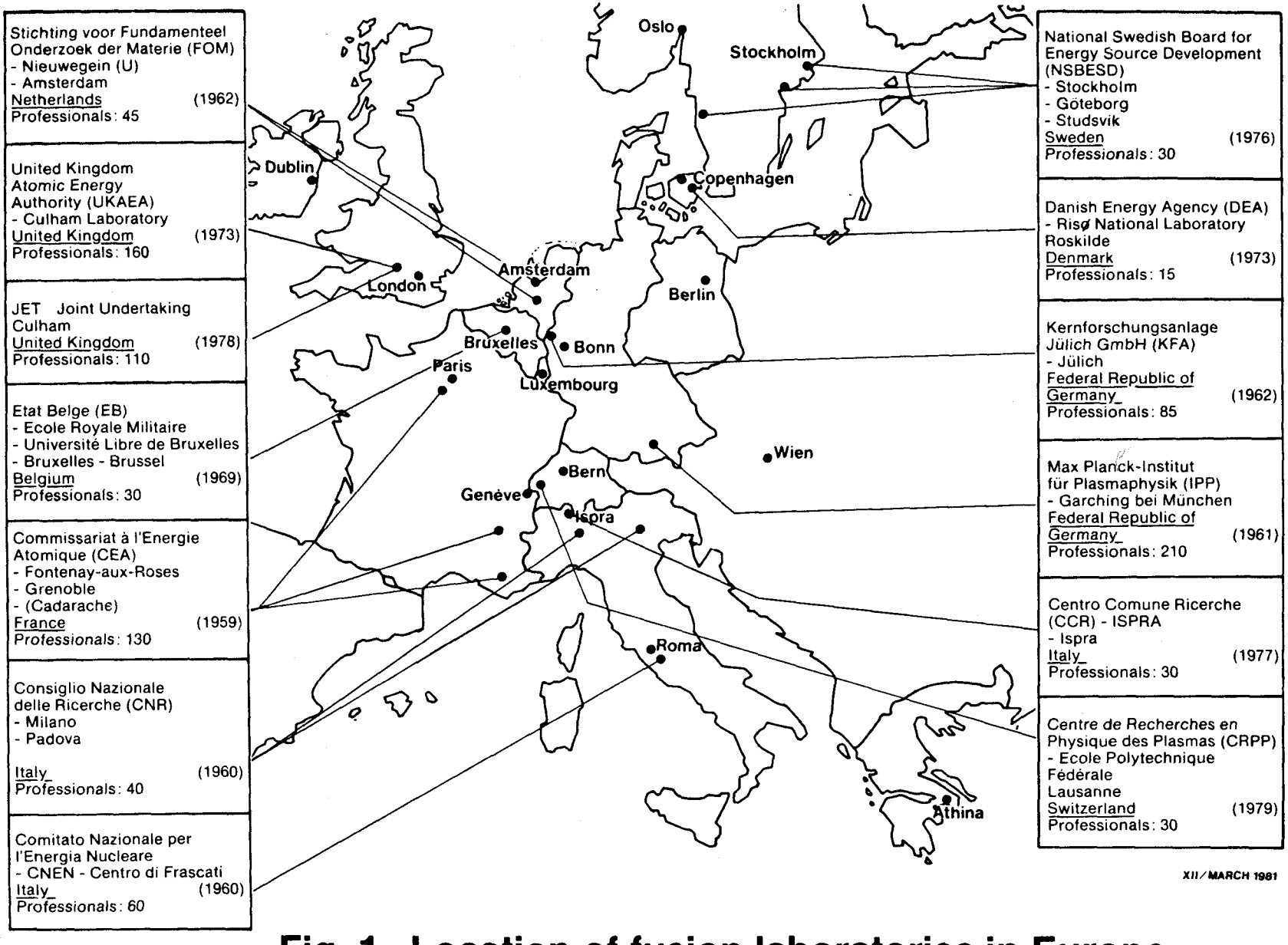

Fig. 1. Location of fusion laboratories in Europe

After three years of implementation of each five year programme, a new five year plan is adopted, which therefore overlaps with the last two years of the preceding period.
The programme is implemented by means of Contracts of Association between Euratom and the organizations within the Member States which are active in the field, and by the JET Joint Undertaking. A small part of the programme of the Joint Research Centre at Ispra is also dedicated to the fusion field. Several Association Contracts cover R & D work executed in other laboratories by means of subcontracts or other arrangements.

II.2.1 Associations

The location of the associated laboratories is shown in Fig. 1. Sweden and Switzerland joined the Community Fusion programme in 1976 and 1979 respectively.

Each contract provides for the financial participation of Euratom in the general running of the laboratories (operation, personnel, administration, etc.) to a uniform level of about 25%. Moreover, Euratom can contribute to a level of about 45% ("preferential support") in the capital investments necessary to build large experimental devices which, according to the Consultative bodies, have a scientific value of interest to the whole Community Programme.

Each Association is managed by a Steering Committee, made up of representatives of Euratom and of the associated institution. For the programme as a whole, there is a consultative and coordinating structure described in II.2.4.

II.2.2 Joint European Torus

For this project, a Joint Undertaking was set up in May 1978. The members of the JET Joint Undertaking are: Euratom, all its associated partners in the frame of the fusion programme and Ireland and Luxembourg (which have no Contracts of Association). The responsibilities for the Project are vested in the JET Council and the Director of the Project. Each member of the Undertaking has two representatives on the JET Council which steers the Joint Undertaking. The JET Council is assisted by the JET Executive Committee and may seek the advice of a JET Scientific Council.

The expenditure of the Joint Undertaking is borne by Euratom at 80% and the United Kingdom Atomic Energy Authority (UKAEA) at 10%. The remaining 10% is shared between all Members having Contracts of Association with Euratom.

The Project Team is formed in part by personnel put at the disposal of the Undertaking by the associated institutions (other than UKAEA) or from other organizations, and temporarily recruited by Euratom, and in part by staff made available by the UKAEA (host organization).

II.2.3 Joint Research Centre

The Ispra Laboratory of the Euratom Joint Research Centre (JRC) is conducting research in some specific domains of fusion technology: system studies, blanket materials, safety and environment. This work is financed at 100% by Euratom. From the scientific and technical point of view, it is coordinated with the other fusion activities of the Community by the Commission's Directorate for the Fusion Programme, and in the frame of the consultative system outlined below.

II.2.4 Management and consultative structure

The Fusion Directorate in Brussels (10 professionals) is responsible among other things for:

- preparing the 5-year programmes;
- negotiating the association contracts;
- participating in the steering of the associations;
- participating in the management structure of JET;
- attributing preferential support;
- concerting with the JRC fusion technology activity of this center, within the frame of the overall fusion programme;
- international relations, in the frame of the IEA (where the Commission has a leading role for fusion), of the IAEA, and on a bilateral basis.

The consultative structure of the fusion programme has been reduced, since December 1980, to one single committee: the Consultative Committee of the Fusion Programme (CCFP). Without prejudice to the Commission's responsibility for the implementation of the Fusion Programme, the CCFP has the task of contributing in its advisory capacity to the best possible implementation of the programme, in particular:

(a) to watch over the ongoing activities;

(b) to ensure that selectivity criteria are applied in the definition and management of the programme;

(c) to ensure harmony between the activities of the Associations, the JRC and the JET Project;

(d) to evaluate the results obtained;

(e) to collaborate in the preparation of programme proposals;

(f) to ensure proper relations between the Community Fusion Programme and other fusion programmes;

(g) to define priority actions with a view to the allocation of preferential support.

The CCFP acts also as "Advisory Committee on Programme Management" for the fusion activities of the JRC (direct action). It can create subcommittees: the "Programme Committee" assists the CCFP on all the points listed above, with the exception of point (f).

II.3 ROLE OF INDUSTRY

European industry hitherto has participated in the fusion programme as a supplier of components and equipment. Recent market inquiries indicate that it constitutes an adequate supply base for several technologically advanced pieces of equipment. But the long range character of fusion development, its high cost and its uncertainties have not induced industry to become a driving force for the programme. A closer involvement of industry will become essential as the programme moves from the scientific to the technological stage.

II.4 INTERNATIONAL COOPERATION

Fusion research has been "open", internationally, ever since it was freed from security restrictions in 1958. The results of the research, wherever carried out in the world, are published and discussed in international meetings and conferences. Only inertial confinement and tritium handling have military security restrictions causing some problems in the generally free exchange of information. The stage when commercial restrictions might become operative is still in the future. The collaboration between the European Community and the other world programmes is implemented as follows:

II.4.1 International Energy Agency

In the frame of the IEA (Paris), Euratom is the "leading organization" for cooperation in the field of fusion, which is the task of the Fusion Power Coordinating Committee (FPCC). The implementing Agreements concluded in this framework are signed by Euratom for itself and on behalf of its associates in the Community Fusion Programme. There are at present three such Agreements, in which the US is Euratom's main partner.

The subject of the first Agreement, concluded in 1977, is the study of plasma-wall interaction in the TEXTOR device, whose construction is now being completed in Jülich. This project is conducted and financed by the EUR-KFA association, with 45% Euratom support. The agreement provides for a participation of experts, mainly from the US and Japan, in the construction and in the operation of the device.

The second Agreement, concerning the development of superconducting magnets for fusion, was also concluded in 1977. It provides for the assembly in Oak Ridge (US) of a toroidal array of six superconducting coils of large dimensions. Three of these coils are being built in the USA, two in Europe (one at Karlsruhe with Euratom preferential support, the other in Switzerland) and one in Japan. Each partner undertakes the expenses for the coil he supplies and will participate in the tests on the toroidal assembly. The cost of one coil is of the order of 6 million dollars. The tests should start at Oak Ridge in 1984/85.

The third Agreement was concluded in 1980 and deals with the studies of radiation damage in fusion materials. It provides in particular for the participation of European specialists in the construction at Hanford (US) of the Fusion Materials Irradiation Test (FMIT) facility. The cost for the construction of this facility, which could be operational by 1984, but which could also be delayed by budget cuts, is of the order of 100 million dollars and is financed by the USA. Moreover in the framework of this agreement a broad radiation damage programme should be implemented. The agreement has been signed by Canada, Euratom (also on behalf of Sweden), Switzerland and the USA; Japan is expected to join in the near future.

The Commission has been requested by the IEA-FPCC to prepare, in collaboration with two European partners (UKAEA and CNR) and in contact with the other partners, an agreement covering the common construction and operation of RFX. The participation of the USA in RFX would be very valuable from the scientific and technical points of view and could also be important financially (hardware amounting to about 15% of the cost would be contributed by the USA).

Under the auspices of the IEA, regular exchanges of information and workshops on the large projects (JET, TFTR and JT 60) have taken place over the last five years.

II.4.2 International Atomic Energy Agency

In the frame of the IAEA (Vienna), the International Fusion Research Council (IFRC) is the advisory body to the Director General of the Agency. The IAEA organizes the biennal International conference on Plasma Physics and Controlled Nuclear Fusion, edits the review "Nuclear Fusion" and promotes other initiatives such as an annual conference on large Tokamaks.

In 1978, following a proposal by the Soviet delegation at the IAEA the Director General of IAEA asked governments sponsoring fusion research whether they would participate in international studies of the next major step INTOR (a post-JET Tokamak). After a unanimously favourable answer, the INTOR study was undertaken, under the auspices of the IAEA. According to the initial recommendation of the IFRC, the INTOR project should proceed in five phases: data base assessment,

definition, engineering design, construction and operation, each phase being followed by a decision whether to start the next one. For the first two phases, a series of "workshops" has been organized in Vienna, starting at the end of 1978, in which each of the four large fusion programmes takes part with a delegation formed by a small number of experts. The data-base assessment phase was concluded at the end of 1979 with the publication of a detailed report. The definition phase is now in progress and will end in Summer 1981 with the publication of an INTOR conceptual design. An interim phase (mid 81 - mid 82) has been recently agreed upon, during which the consistency of the conceptual design will be re-assessed using the same system of workshops. The further developments of this venture are uncertain.

II.4.3 Bilateral contacts

It has been agreed between Euratom and the US Department of Energy to establish a systematic exchange of information and possibly of staff in the field of alternative lines, where the two programmes are complementary. The development of neutral injection lines has been also the subject of an exchange of information and some cooperative initiatives in this field are envisaged.

II.5 FINANCIAL VOLUME OF THE 1979-83 COMMUNITY PROGRAMME

- The expenses which can be funded, following the Council Decision of 13 March 1980 amended by Council Decision of 19 May 1981, are:

TABLE I

	Total Volume MioECU	Euratom %	Participation MioECU
General expenses of the Associations (1)	496	25	124
Investments covered by preferential support (2)	130	45	58.5
JET (3)	243.1	80	195
Staff mobility, management and administration	8	100	8
TOTAL	877.1		385.5

(1) Including Technology (which is partly implemented through sub-contracts of the Associations) but excluding the Swedish and Swiss Associations.

(2) Including support to JET (Article 14 contracts) and NET.

(3) These figures do not include the funds necessary for the preparation of JET for its extended performance, neither for its operation during the year 1983.

To the total in Table I should also be added the expenses of the Associations in the third States (Sweden and Switzerland) which are estimated, for the period 1979-83, to be around 35 MioECU.

Finally, in the frame of the programme of the Joint Research Centre for the four years 1980-83, about 26 MioECU will be devoted to activities in the area of fusion technology.

The yearly evolution of the expenditure of the Associations (Sweden and Switzerland excluded), of JET, and for management and mobility, is shown in Table II, in round figures. (The figures concerning the years 1980 and 1981 are indicative estimates).

TABLE II

(payments, MioECU)

Activity	1979	1980	1981	Total
JET	30.7	50.5	76.3	157.5
Associations (total expenditure)	112.7	132.6	148.8	394.1
- out of which financed at preferential rate (1)	(9.0)	(17.5)	(25.5)	(52.0)
Management + Mobility	1.5	1.7	1.9	5.1
TOTAL	144.9	184.8	227.0	556.7

(1) Including priority actions, support to JET and NET.

- The rate of increase of the overall financial volume of the Associations programme has been 17.5% from 1979 to 1980, and will probably be 12.5% from 1980 to 1981; whereas the corresponding rates of inflation in the Community have been 13.8% and 12.6% respectively. Apart from a real increase between 1979 and 1980 due essentially to the inclusion in the programme of technology activities, the Associations have been working at a constant level of spending during the last three years.

- The Community contribution to the Fusion programme excluding JET for the period 1979-81 can be evaluated from Table II at about 114 MioECU. In the Council minutes (1) related to the March 1980 Programme Decision, the following statement of the Commission is found : "it will implement the 1979-1983 programme exclusive of JET in such a way that at least 40% of the appropriations authorized are available for financing activities to be carried out during the last two years of the programme." The appropriation for 1979-83 being 190.5 MioECU, it means that a maximum of 190.5 x 0.6 = 114.3 MioECU was available for the Fusion Programme exclusive of JET during 1979-81. The corresponding Community contribution (estimated at 114 MioECU) is within the prescribed limits.

II.6 CONTENTS OF THE OTHER WORLD PROGRAMMES

Over the world the Tokamak line is by far the most advanced and receives the largest support, even if all other world programmes have a broader spectrum than the European one. A schematic view of the major world Tokamaks is given in Fig. 2.

II.6.1 U.S.A.

The USA fusion programme is the largest in the world.

. Tokamaks represent the main activity (1/3 of the overall budget, not including heating and technology). A large device, TFTR, is due to start operating in 1982; subsequent operation with tritium is foreseen. A machine of the post-JET generation (FED) is in the definition phase,

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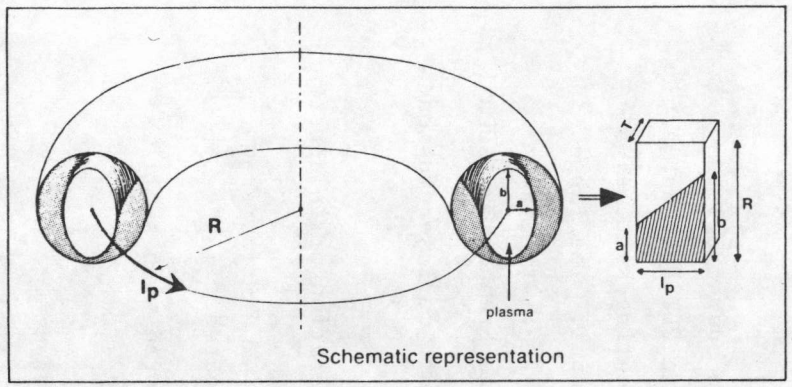
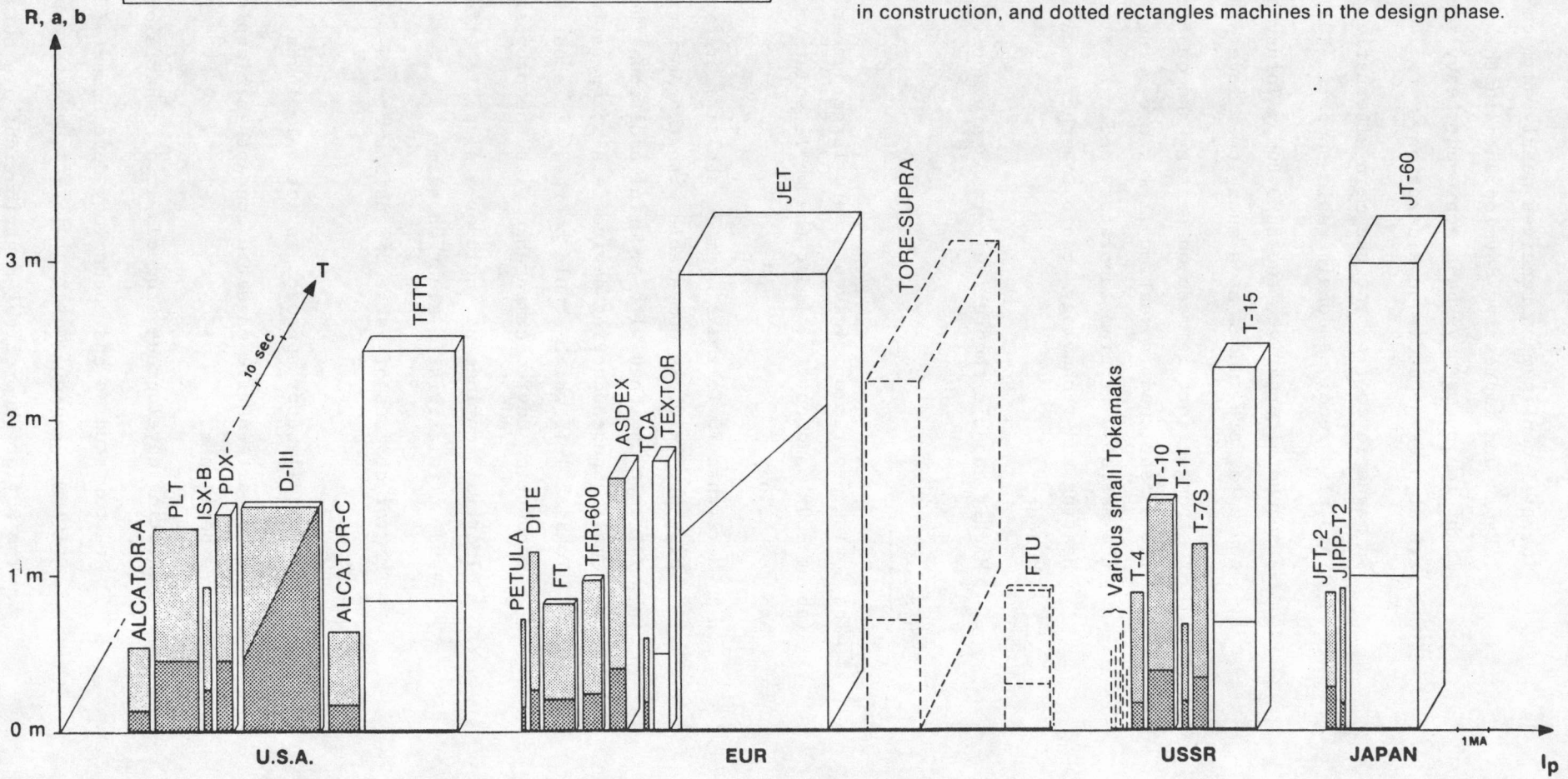
(1) ATO 32, 4 March 1980.

Fig. 2. Major Tokamaks in the World (Target values)



- Each machine is represented by a parallelepiped whose:
  - width is proportional to the planned maximum plasma current Ip,
  - height is proportional to the major radius (R) of the device,
  - thickness is proportional to planned maximum plasma duration T.
- The intermediate line (horizontal for a circular plasma cross-section, tilted for an elongated cross-section) represents the minor radius (a) and the height (b) of the plasma cross-section.
- Shaded rectangles are machines in operation, white rectangles machines in construction, and dotted rectangles machines in the design phase.



- Inertial confinement receives nearly as much funding as the Tokamak and impressive developments in the field of lasers and light ion beams have been achieved; heavy ion beam experiments are at present under consideration.
- In magnetic confinement the main alternative is the tandem mirror. This also receives considerable support (20%).
- A second alternative, the ELMO Bumpy Torus, and some new alternative concepts, are funded at a much lower level than the mirror.
- A strong effort is made on heating and on technology, where all items mentioned in section II.1.4 are being pursued, including the use of a tritium laboratory and extensive work on System Studies. Heating and technology absorb together about 12% of the overall budget.
- Highly capable theoretical groups are active in several centres.

II.6.2 U.S.S.R.

The Soviet programme involves a very large number of professionals (about 3000) and covers almost the whole spectrum of fusion science and technology.

- More than 10 Tokamaks of moderate size are in operation; the biggest, T-10, is comparable with the American PLT, but has not yet been equipped with powerful additional heating systems; a small superconducting device is also operational. The large Tokamak T-15 which should be ready in about 1984 is a superconducting device comparable with the proposed French TORE SUPRA.
- Inertial confinement includes a sizeable effort on laser fusion and on relativistic electron beams.
- Mirror devices of large dimensions are in operation or in construction.
- The Stellarator approach is actively investigated.
- Other alternative magnetic concepts are explored with small experiments.
- Heating development proceeds at a rather slow pace.
- Reactor studies and technology development (Superconductivity tritium, blanket, materials) form an active part of the programme.
- The Soviet theoretical contributions are outstanding.

II.6.3 Japan

The fusion reactor development programme is being carried out in Japan as one of the national projects. It started late (in the early seventies) but has been characterized by an extremely fast growth, a strong involvement of industry, and a concrete and important collaboration with the U.S.A. It involves:

- "Reactor core plasma development", where special emphasis is put on JAERI's Tokamak programme. The major device is JT-60, a large Tokamak of the JET generation which is planned to become operational in 1984; tritium operation is not foreseen. Japan has also been participating substantially in the construction and exploitation of the rather large American DOUBLET III Tokamak. The programme is supplemented by strong university programmes, among which the Heliotron stellarator and open systems with tandem mirrors have priority. Inertial confinement (lasers, electron beams, light-ion beams) has less priority but is studied in a special "Institute of Laser Engineering" at Osaka University. A significant effort on basic research exists also, but no sizeable "exotic" alternative magnetic confinement lines are studied.
- "Fusion reactor technology development": all the usual problems are studied.

II.6.4. China

The fusion effort in China started at about the same time as in Europe. Up to now, its scientific achievement is not well known, but it is unlikely to be qualitatively comparable with that of the above-mentioned programmes. At present, the Chinese effort seems to involve about 700 professionals working in 4 centres. It is diversified: Tokamaks, mirrors, pinches, plasma focus, laser fusion, reactor conceptual studies, fusion technology, heating techniques. The largest device, the Tokamak HL-1, is a machine similar to the French TFR, and is scheduled to go into operation in 1981.

II.7 FUNDING LEVELS OF THE WORLD PROGRAMMES

Information is given in Fig. 3 for U.S.A., Japan and the European Community. Note that the USA figures do not include inertial confinement, whose budget is about half that of magnetic confinement.

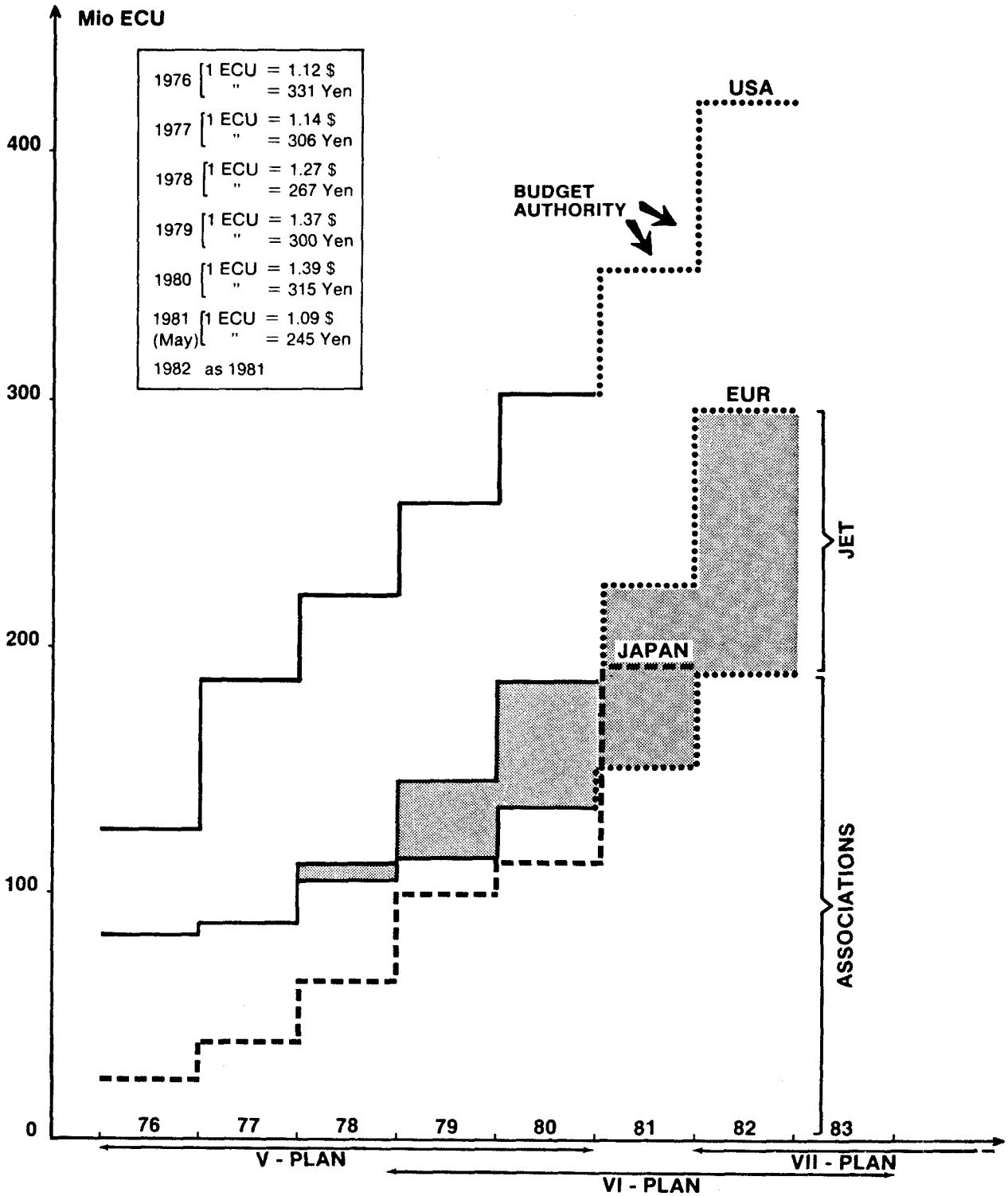


Fig. 3: Evolution of yearly expenditure (payments) devoted to fusion in Mio ECU:
USA: magnetic confinement programme (excluding inertial, including mirrors).
JAPAN: overall programme (including inertial).
EUR: overall programme (excluding Sweden, Switzerland and JRC).

Chapter A) III - MEDIUM-TERM CONSIDERATIONS

III.1 MEDIUM-TERM OBJECTIVES AND STRATEGY

- Exploratory long term planning studies, conducted in the framework of the Community programme as well as in other parts of the world, and based on the quite reasonable assumption that a demonstration reactor (DEMO) would be of the Tokamak type, have indicated a choice of possible strategies to reach DEMO. These strategies lead to different time schedules and different total expenditures depending mainly upon the amount of risk they involve but they all have a common trunk: the major machine(s) to be built after JET (or its foreign equivalents) will be a deuterium-tritium burner(s) and should demonstrate the technical feasibility of DEMO. Thus, all world fusion programmes are now in a position to fix an intermediate aim for their medium-term efforts: the "Next Step(s)".

  A Next Step is a large Tokamak which should:

  . demonstrate long-pulse D-T burn;

  . demonstrate on a reactor scale the "intrinsic" technologies, i.e. tritium, superconducting magnets, and remote handling;

  . provide for engineering testing of the breeding blanket and for studies of the first wall, of structural alloys and other important reactor technologies.

  Confidence that the Next Step could reasonably have such objectives is based on the extrapolation of present knowledge in physics (the necessary experimental check of the scaling laws will be provided by machines of the JET generation) and on the assessment (which has been made in particular by the INTOR group) that the required technologies can be developed in due time. Estimates of the construction cost of the Next Step indicate a figure of the order of 1 to 2 BioECU.

- In Europe, the medium-term strategy is based on the following assumptions and objectives, in line with the recommendations of the Fusion Review Panel:

  . The most urgent task of the fusion programme is to establish the conditions for, and demonstration of, D-T ignition (or near-ignition)

in a toroidal magnetic confinement system; this task will be partially and perhaps even totally fulfilled by JET, whose programme should thus be conducted with vigour and determination by the whole European fusion community; the exploitation of Tokamaks of intermediate size is needed to provide additional knowledge, both in support of JET and to complement the JET results.

. The Community must immediately launch the definition and the conceptual design studies of the Next Step, a Tokamak which aims to establish the technical feasibility of DEMO; in parallel, the Community should actively develop the technologies required to build the Next Step.

. Fusion reactor system studies should be carried out in order continuously to assess the state of the art and keep the programme oriented towards its ultimate goal, the demonstration reactor.

. Both the remaining uncertainties in the detailed physics of toroidal confinement and our ignorance of the ways to arrive at economic net power production suggest that studies of alternative systems should be carried out with the aim of assessing their reactor potential.

. International collaboration will continue to be exploited, at a possibly increased level, both in the planning and execution of fusion research.

. A subsequent assessment of the results of JET and other similar devices will be needed before deciding whether to go ahead with the construction of the Next Step.

III.2 IMPLEMENTATION

The implementation of the strategy outlined above will be achieved by a programme having as main items NET, JET, other Tokamaks and auxiliary activities, technology, and alternative lines.

- NET (Next European Tokamak) is the prospective European Next Step following JET. The NET programme will consist of a study leading to the definition and conceptual outline of NET in sufficient detail to provide guidance to a NET-relevant technology programme. By developing a European concept for the Next Step, the European participation in possible international Next Step ventures, like INTOR, will be strengthened, preserving at the same time

the option of an independent European approach. The conceptual design of NET, together with the physics and technology results available by the end of 1984, will also provide an essential element for the next revision of the fusion programme.

- The full support of the JET programme, in particular the extended performance phase, is essential for the verification, at the earliest possible date, of existing Tokamak scaling laws to the regime of plasma parameters at or near ignition. Such verification is clearly required before embarking on any major expenditures for NET.

- The strong Tokamak programme in the Associations and the development of heating, diagnostics and other auxiliary equipment will be kept under constant review in order to meet the requirements of JET and, in due time, those of NET; this will also guarantee the compatibility of the various elements of the overall programme, as far as staff and budgets are concerned.

- The technology programme will be designed according to the needs of NET, as presently seen from the INTOR study. The main areas to be covered are tritium technology, remote handling, superconducting magnet technology, blanket technology, and materials (with the latter partly extending beyond the needs for the Next Step, towards the long-term application to DEMO). Again, a continuous reassessment of the programme following the findings of the NET study will be necessary, in order to guide the technological development. Specific attention will be devoted to the problems of providing the initial tritium inventory for NET (present estimate: ~ 2-5 Kg), and of ensuring at least partial breeding in the NET blanket.

- Alternative lines (magnetic or inertial confinement) are less advanced than Tokamaks. Because of limited resources, none of the large programmes of the world can adequately cover a comprehensive range of alternative systems. Therefore, there is a strong case for international cooperation in this field. For the European programme, it is proposed to invest most of the indigenous effort on the Reversed Field Pinch and on the Stellarator, to maintain a "wait-and-see" position concerning Mirrors, and to keep a small effort for some basic studies on Inertial Confinement, while strengthening international cooperation.

Chapter A) IV - PROPOSED PROGRAMME FOR THE PERIOD 1982-86

For clarity, the fusion programme is subdivided hereafter into four chapters, each chapter dealing with arguments which have specific funding or technical features:

- JET, which is a Joint Undertaking;
- the Associations (NET-Technology excluded);
- NET-Technology, which is partly handled by the Associations, and also by the JRC, but which constitutes a technical unity;
- Management and mobility.

Funding concerning Sweden and Switzerland (Associations with third countries) and JRC (Fusion Technology) is not included in the present programme proposal.

IV.1 JET

IV.1.1 Background to the present proposals

The proposed JET programme for 1982-86 represents a natural evolution of the programme which was envisaged when the JET Joint Undertaking was established in 1978.[1] At that time, the programme was conceived in two phases. The initial phase was the "construction of JET in its basic performance", for which a cost estimate of 184.6 MioECU was given at January 1977 prices. It was noted in the Minutes of the Council meeting concerned that this "amount does not include the cost of the investments required to enable the installation to reach its extended performance level". The second, operational phase was expected to "cover a period of five to seven years following on from the construction phase", and it was estimated that "The annual cost of the Project during this second period will approximate to that incurred during the first period". The programme now proposed is fully consistent with these statements. The proposed average annual expenditure during 1982-86 on the tasks which were originally described as the operational phase is slightly lower (in real terms) than the annual average expenditure on the construction phase during the years 1978-83. The overall

(1) O.J. No. L151 of 7.6.1978, p. 8-24.

duration of the programme remains 12 years, and the scientific and technical objectives remain essentially unaltered. The overall cost estimate for the construction phase has increased in real terms by 3.7%: however because of the ongoing effects of inflation, the cost at current prices has increased significantly, and has been the subject of two intervening Programme Decisions of the Council, at the level of 201.25 MioECU at January 1979 prices[2] and 263.75 MioECU at January 1981 prices[3] respectively (here and subsequently the expression "X MioECU at Y prices" means that X is the value at current prices if it is assumed that inflation ends at the date Y).

IV.1.2 Recent scientific and technical developments

During the last three years, experimental results from the world wide fusion programme have substantially narrowed the parameter range over which scaling laws have to be extrapolated, in order to forecast the performance of JET. Detailed calculation now confirm that there is a good prospect that the full objectives of JET may be achieved. Indeed, there is a possibility that the results may go beyond the stated objectives, and that thermonuclear ignition may be approached.

This is a major landmark in fusion research, and cannot be achieved in any other experiment currently under way within the world fusion programme. The recent calculations have also defined more closely the plasma heating power which JET will need to achieve its full objectives, and the JET Council has decided that 25 MW should be installed. There is no longer any doubt that this is technically feasible.

As a result of recent developments, there is now a greater awareness of the limited scope of the experimental programme which can be carried out with the basic performance configuration, and the JET Council is convinced that the extension to full performance should be pursued without delay.

IV.1.3 Objectives of JET during the 5-year programme 1982-86

The programme proposed in the present submission has three overlapping phases:

- the completion of the construction of the JET device in its basic

(2) O.J. No. L72 of 18.3.1980, p. 19
(3) O.J. No. L149 of 6.6.1981, p. 32

performance (June 1978 - April 1983);

- the extension of JET to full performance (Jan 1982 - June 1987);
- the operational phase, up to the end of 1986 (April 1983 - Dec. 1986).

Beyond the present submission, it is envisaged that after the full performance configuration becomes available (in June 1987) there will be about one year of operation at full power, before introducing tritium into the device, and then two years of radioactive operation with deuterium-tritium plasmas, with completion in mid-1990. The achievement of this timetable is conditional upon the achievement of the proposed rate of investment. This point is discussed more fully in the annexed Opinion of the JET Council.(4)

The technical content of the programme remains essentially as set out in EUR-JET R5, the design document cited in the JET Statutes. A few points have been clarified by Decisions of the JET Council:

(i) the basic performance configuration includes 5 MW of Neutral Injection heating, and the so-called 'List A' diagnostic equipment,

(ii) the extension to full performance requires the following additional items: a further 20 MW of heating equipment, the 'List B & C' diagnostics, power supply equipment to extend the pulse duration to 15 sec and maintain full plasma current, remote maintenance and tritium handling equipment.

(iii) The operational phase requires provision for staff costs, operating costs, electricity charges and equipment maintenance, modification and replacement costs, estimated at 5% (per year) of the value of the equipment installed. The total number of staff working on site will rise to 480.

The estimates agreed by the JET Council for the overall cost of the three phases, and for the costs falling within the years 1982-86, are shown in Tables III and IV. In accordance with Article 46 § 2(c) of the Euratom Treaty, the Council is requested to approve Tables III and IV, and to record their approval in the Minutes of the meeting at which the Decision is taken, with the understanding that the base date

(4) See part C).

(5)

TABLE III: JET Project Costs with future expenditure at January 1981 prices

		1977-81	1982-86	Later years	Total
Basic performance construction:	commitments	226.75	60.75	-	287.5
	payments	163.9	123.6	-	287.5
Extension to full performance:	commitments	-	137.4	0.9	138.3
	payments	-	123.1	15.2	138.3
Operational phase (to end of 1986):	commitments	-	160.0	-	160.0
	payments	-	153.3	6.7	160.0
Total	commitments	226.75	358.15	0.9	585.8
	payments	163.9	400.0	21.9	585.8

TABLE IV: JET Project Costs with future expenditure in 1982 prices

Basic performance construction:	commitments	226.75	85.45	-	312.2
	payments	163.9	148.3	-	312.2
Extension to full performance:	commitments	-	164.9	1.1	166.0
	payments	-	147.7	18.3	166.0
Operational phase (to end of 1986):	commitments	-	192.0	-	192.0
	payments	-	184.0	8.0	192.0
Total	commitments	226.75	442.35	1.1	670.2
	payments	163.9	480.0	26.3	670.2

for the cost estimates for future expenditure is January 1981, except in relation to the basic performance construction phase, for which these costs remain based upon the estimates prepared with the original base date of January 1977 (191.4 Mio ECU).

IV.1.4 Work to be performed by the Associations in support of JET

The JET Joint Undertaking was established, in the words of the Statutes, to "construct, operate and exploit JET as part of the Euratom fusion programme and for the benefit of the participants in this programme". It has therefore always been envisaged that the Associations would be fully involved in the JET Programme. This involvement takes three forms:

(i) The Associations will play a major part in the scientific exploitation of JET. Because of their long experience of Tokamak research, they are uniquely qualified to contribute, and it is foreseen that about half of the 80 professional scientists required to plan the experimental programme, perform measurements and to interpret the results will be association staff working alongside members of the JET team.

(ii) The Associations have a considerable expertise in the procurement of complex equipment for fusion research, especially in the areas of diagnostic and plasma heating equipment. The project has already used this expertise by placing procurement contracts with the Associations: they participate in the design, and either construct equipment themselves, or act as the prime contractor supervising industrial subcontractors. The estimated value of such contracts (fully paid by JET), to the end of 1981, is about 6 MioECU, and further contracts of this type, to a value of about 20 MioECU, are foreseen during 1982-86.

(iii) The Associations also assist the project by performing R & D work in these same areas, to help in the early stages of equipment design. This work is undertaken on the basis of contracts under Article 14 of the JET Statutes, which are financed at 45% by the Commission. The estimated value of such work to the end of 1981 is 13 MioECU, and it is expected to continue during 1982-86 at a level of 34 MioECU.

IV.2 THE ASSOCIATIONS

The activity in the Associations (NET-Technology excluded) will remain primarily concentrated on Tokamak physics and on supporting activities for Tokamaks, including an increase (specific developments and/or experiments) in the support of JET and NET. The effort will also include research on alternative lines and contributions to fusion technology. Work concerning NET and fusion technology is described in § IV.3.

IV.2.1 Main Tokamaks

- The five main devices at present in operation (TFR, DITE, FT, ASDEX) or near completion (TEXTOR) will continue to be exploited with improved diagnostics to widen the understanding of Tokamak physics and of the interaction between plasma and wall. They are all being systematically improved, mostly by the addition of auxiliary heating (neutral injection, ion cyclotron and lower hybrid) at a multimegawatt level. Some of these devices (TFR and FT, for instance) will be decommissioned during the period 1982-86 if the construction of larger devices (see below) is undertaken.

- In the 1979-83 programme proposal, allowance (50 MioECU) was made for the possible launching of two new Tokamaks: a superconducting device TORE SUPRA, and an ignition experiment (VHFT). It was mentioned that "the possibility of building each of the two new experiments outlined above has not yet been assessed. It is 'a fortiori' not certain that both will have to be built". Extensive definition and design work on these two devices has taken place since then, leading in both cases to a confirmation of the scientific and technical value of the projects but also to a large increase in cost, so large in fact in the case of ZEPHYR (ex-VHFT) that this project was phased out for budgetary reasons towards the end of 1980.

- At present, three specialized Tokamaks are at various stages of design in the Associations and are the subject of discussion by the Consultative bodies of the Fusion Programme:

  . TORE SUPRA is a large superconducting Tokamak (1.7 MA plasma current) which in addition to its intrinsic technological value should be used for the development of Radio-Frequency heating methods and Neutral Injection at the level of 10 MW, for studies

of the dynamic of impurities, and for investigating the physics of long pulses (30 sec). The engineering design is completed, and final approval is being sought from the CCFP.

. FTU is a high field Tokamak (8 Tesla - 1.6 MA) which should extend knowledge of the scaling laws governing the plasma confinement time, and which should produce deuterium plasmas of reactor relevant densities and temperatures. It would imply the use of high-power R.F. heating (8 MW, Lower Hybrid). The study of plasma-wall interaction in reactor relevant conditions would be possible with this device. The procedure for approval by the CCFP has been initiated for FTU.

. ASDEX-UPGRADE is a device incorporating a poloidal divertor with coils outside the toroidal field coils which would, under reactor relevant conditions, demonstrate the possibility of disruption control and permit the study of the plasma-wall interaction, of the properties of the cold plasma mantle, of the physics of long pulses and of the possibility of sustaining the plasma current without a transformer. It is in the definition phase.

Each of these projects aims at the solution of a different set of problems of fundamental importance for the assessment of the Tokamak as a reactor. The three projects are therefore complementary; they are also complementary to JET.

- Outside the framework of the Associations, preliminary studies concerning the feasibility of a very high field compact Tokamak aiming at ignition are being conducted on a modest scale without financial support by the Commission.

IV.2.2 Supporting activities for JET and other main Tomamaks

- Nine minor Tokamaks, at present in operation, will continue to be exploited for specific purposes (mostly studies on R.F. heating, high beta equilibrium and stability, cold mantle). Most of these devices will be decommissioned during the 1982-86 period, whereas one or two new small machines will be built (for instance COMPASS - a device intermediate between Tokamaks and Reverse Field Pinches to explore some of the remaining aspects of MHD optimisation in Tokamaks & Pinches).

- The development of high voltage (up to 160 kV) long pulse neutral injection systems (hydrogen and deuterium) at the multimegawatt level

required by JET and the other large devices will be pursued. Investigation of neutral injectors based on negative ions will continue on an exploratory level. The development of multimegawatt RF heating systems at the ion cyclotron and at the lower hybrid frequencies will be accelerated, for their application to JET and other devices. Other R.F. methods (Alfven waves, Electron Cyclotron Resonance) will continue to be investigated.

- Research and development concerning diagnostics, will remain one of the major activities of the Associations which have responsibility for preparing JET diagnostics. In due time, the Associations will second staff to participate in the exploitation of JET.

IV.2.3 Alternative lines

The present uncertainties on the potential of Tokamaks as future fusion reactors makes it necessary to pursue the development of alternative systems as back-up solutions. This part of the Programme is developing into an informal but effective world-wide collaboration in which the lines are divided amongst the major programmes, (for instance Mirrors in the United States, Reverse Field Pinches and Stellarators in Europe) with a proposed cross-participation of staff and hardware. The Commission will seek more formal Agreements, in particular with the United States, which would guarantee full mutual access to scientific knowledge and techniques on lines followed elsewhere. This could be part of a more general agreement with the USA on Fusion R & D. Between 10 and 15% of the overall European effort will be devoted to Reverse Field Pinch and Stellarators, together with some limited studies on other toroidal configurations and on Inertial Confinement.

- Reverse Field Pinch. Two small devices (HBTX 1A and ETA-BETA) are in operation but are likely to be discontinued before 1986. A large machine, RFX (2 MA), planned to be built in collaboration by Culham, Padua and Los Alamos, would be needed if progress is to be made. The essential objective of RFX would be to find out whether or not the RFP can provide good confinement of high temperature ($\sim$ 1 keV), high β (10-20%), ohmically heated plasmas. The essential motivation of building RFX is the hope that the RFP might lead to a less complex and cheaper reactor than the Tokamak. The design studies of RFX are essentially complete. The procedure of approval by the consultative bodies is at an intermediate stage.

- Stellarators. One device (Wendelstein VII-A) is in operation and will continue to be used to study plasma confinement and heating in net current free configurations. Further progress on the Stellarator line would imply the construction of "Advanced Stellarators" which hold theoretical promise of higher betas and better behaved plasmas (less turbulence, etc..) and in which the magnetic field configuration would be produced by modular coils. Two different steps are under consideration:

  . W VII-AS, which would be using most of the components of W VII-A; its design could start immediately;

  . W VII-X, a new system whose major radius would be about twice that of W VII-A and would aim at a beta of about 10%. This device, if successful, would get close to demonstrating the reactor potential of Stellarators.

  The possibility of US participation is being explored.

- Other toroidal configurations. A new class of devices, the "compact tori", is the object of intense exploratory research in the U.S.A. A small device of this type, EXTRAP, has been proposed by an Association, and is being examined by the CCFP.

- Research on Inertial Confinement will remain limited to a modest effort (less than 2% of overall effort) in the fields of drivers development and light-matter interaction.

IV.2.4 Overall expenditure of the Associated Laboratories (NET and Technology excluded).

For the sake of discussion, the overall budget of the Associations is hereafter divided into 3 items:

Continuation of present activity (NET-technology excluded);
Possible new large devices;
NET-technology (see § IV.3).

- Continuation of present activity:

  . The general expenses (support 25%) are estimated at 111.5 MioECU for 1981, including the salaries of Euratom staff seconded to the Associations. At the price level of 1st January 1982, this is uplifted to 122.6 MioECU taking a mean rate of inflation in the Community of 9.94%. It is proposed to maintain the yearly

running costs constant (122.6 MioECU) during the period 1982-86, leading to a global amount of 613 MioECU (= 122.6 x 5).

. The "normal" priority actions (support 45%) are defined as the actions covering the construction of small devices and the improvement of the existing devices (technology excluded): complementary heating, modifications, etc... They are estimated at 10.2 MioECU for 1981, which means 11.2 MioECU at 1st January 1982 prices level. A tentative estimate of the foreseen needs for the period 1982-86 shows that they correspond to the present rate of expenses (11.2 MioECU per year), leading to a global amount of 56 MioECU (= 11.2 x 5).

. The support to JET (Article 14 contracts) amounted to 7.9 MioECU in 1981. Estimates by the JET Project lead to a need of 34 MioECU during the period 1982-86 (see IV.1.4).

- Possible new large devices. None of these devices (TORE SUPRA, FTU, ASDEX-UPGRADE, RFX, Stellarators) has yet received final approval. The design of three of them (TORE SUPRA, FTU, RFX) is advanced enough for their full construction to be technically possible during the period 1982-86. If built, they would be priority actions (support 45%). Their approximate capital construction cost would be the following (at price level January 1982):

. TORE SUPRA, heating included: 82 MioECU (CEA estimates). The CCFP financial ad hoc group recommended to increase this amount by about 22 MioECU, mainly for contingencies;

. FTU, heating included: 23 MioECU (CNEN estimates);

. ASDEX UPGRADE: about 52 MioECU (IPP preliminary estimates);

. RFX: 42 MioECU (UKAEA and CNR estimates), including an expected contribution (hardware) of about 7 MioECU from the USA.

. Stellarators: about 9 MioECU for W VII-AS and about 26 MioECU for W VII-X (IPP preliminary estimates).

Under recommendation of the CCFP, a total volume of 156 MioECU (corresponding to an appropriation of the Commission of 70.2 MioECU at a support rate of 45%) is foreseen in the present programme proposal to cover the construction of these possible new large devices during the period 1982-86.

IV.3 NET AND TECHNOLOGY

As outlined in Chapter A) III, the Next European Tokamak (NET) is an important element in the strategy of fusion reactor development. Because the time lag from the definition to the operation of such a machine cannot be less than 10 years, the study of NET and the development of new technologies for NET should start now. Therefore, a substantial part of the proposed programme 1982-86 is devoted to these tasks. At this stage, most of the scientific-technical effort can be provided by fusion and fission research laboratories. But it is evident that industrial involvement will be increasingly important when approaching the construction of NET, and already in this initial phase industrial expertise is indispensable for the development of selected technical components.

IV.3.1 NET

A comprehensive study of NET will be undertaken during the years 1982-84, in order to define the basic objectives of this machine, outline its essential components, and determine the research and development needs for its later construction, particularly in the technology field. The principal aims of this activity are:

- to be the focal point and to provide guidance for the current fusion effort, particularly for the technology programme;
- to provide the technical elements for a decision at the end of 1984 on the future strategy and for the corresponding revision of the programme;
- to strengthen the European capability for international co-operation on the Next Step.

The NET group will also undertake such system studies as necessary for the precise definition of NET, e.g. those concerning the future demonstration reactor.
Given the importance of the NET study and its complexity calling for widespread expertise in physics, chemistry and engineering, a staff of about 50 people is foreseen. This will include from the beginning industrial staff, both in order to draw on industrial experience and to build up interest and specific fusion expertise in industry. In the later stages, the Commission will promote the constitution of industrial consortia which should play an essential role in the possible engineering design and construction of NET.

The INTOR study, undertaken in 1978 under IAEA auspices by EURATOM, Japan, USA and USSR (see II.4.2), provides an excellent base on which to start the NET study. The NET team will also produce the future European contributions to the INTOR conceptual design, as long as this is continued.

IV.3.2 Technology

Five major reactor technology R & D areas have been identified specifically for the Tokamak line and constitute the main elements of the technology programme: tritium technology, remote maintenance, superconducting magnet technology, blanket technology, and first-wall and structural alloys development. Safety and environmental impact studies are closely related to technology and hence are also included in the programme.

The proposed technology programme has been designed mainly to meet the needs for a conceivable Next Step in the European Tokamak development. Presently, the only useful reference to the objectives and design features of such a Next Step machine is the INTOR study.

The proposed programme accounts for R & D needs defined in INTOR, but at the moment is based on the assumption that the developments will be conducted in a self-contained indigenous European effort. However, efforts towards international cooperation on the design and construction of the Next Step will continue and the programme will be re-assessed as soon as such cooperation may materialize.

A European Next Step Tokamak (e.g. NET) may look different from INTOR. However, the required performance will be roughly the same: long-pulse burning DT plasma, handling and safe containment of tritium, use of superconducting magnets, presence of a breeding blanket and neutron shield, remote maintenance.

In the absence of any agreed time-scale for the Next Step, the proposed technology programme for 1982-86 is designed with the aim of developing the technological input for the engineering design of the Next Step by about the end of the programme period. It should be emphasized that only a continued intensive study of the Next Step will show whether or not the proposed technology programme covers all required subjects adequately and completely and whether it will lead to the required results at the right time. A critical revision of the technology programme

will be due when a firm concept for the Next Step is established.

The proposed programme includes the following activities:

- Tritium technology: experimental study of alternative deuterium-tritium fuel cleanup and isotopic enrichment systems, development of components of the personnel and environment protection system, development of tritium-compatible vacuum pumps, development of the general flow-sheet for the NET tritium systems and design of a test facility for these systems.

- Remote handling tools: assessment of needs for NET, specific tool design and system integration.

- Superconducting magnet technology: finalization of the construction and home test of the European coil, the experimental phase of the international Large Coil Project (under IEA Implementing Agreement); development of 12 Tesla toroidal field coil systems; development of poloidal field coils according to NET specifications.

- Blanket technology: conceptual design studies, completion of the data base for liquid lithium and solid lithium compound breeders; benchmark experiments on tritium breeding and on shielding of 14 MeV neutrons in blanket mock-ups; experimental study of tritium recovery from the blanket.

- Materials: in-pile study in fission reactors of fatigue, crack-growth, and creep of stainless steel under pulsed load; screening study of potential first wall and structural materials by neutron damage simulation in accelerators; development of helium doping techniques; radiation damage in insulators. For sample irradiations in intense high energy neutron sources, international cooperation will be sought, particularly with US. This could require some participation in the construction of the appropriate facilities.

- Safety and environmental studies: general safety and environmental study and accident analysis of DT-fusion devices; experimental study of selected safety items, like lithium fires, tritium atmospheric diffusion, cryogenic hazards, biological effects of magnetic fields.

Competence for some of the technical developments needed for the next Tokamak generation can be found in industry. Typical examples are, among

others, vacuum pumps, remote handling tools, and generators for radio-frequency heating of the plasma. Therefore, a number of industrial development contracts are foreseen in the frame of the NET-technology programme.

IV.3.3 Overall expenditure for NET and technology

The overall budget proposed for NET and technology amounts to 190 MioECU (at 1982 price level).

The activities in this part of the programme will be supported by the Commission at the levels 25%, 45% and 100%, see table V.

NET will be supported at the level of preferential support, i.e. at 45%.

A large fraction of the technology programme will consist of new activities, planned to cover the research and development needs for NET. The remaining part of the programme is a continuation of present activities, re-organized according to the needs for NET. The technology projects will involve new hardware and also existing installations which have been built for non-fusion purposes in fission laboratories and which will be used for conducting fusion technology research (e.g. fission research reactors). A substantial fraction of the programme will therefore qualify for a 45% level of support. The remaining technology activities will be supported at the level of 25%.

Finally, industrial contracts will be supported at 100% level.

TABLE V

NET and Technology Budget (at 1982 price level)

	Overall budget MioECU	Support level	Community contribution, MioECU
Technology (basic)	106	25%	26.5
Technology (preferential) and NET	77	45%	34.5
Industrial contracts	7	100%	7.0
Total	190	36%	68.0

IV.4 MANAGEMENT AND MOBILITY

- The "Mobility Contract" for the exchange of staff among the various laboratories engaged in or contributing to the implementation of the programme has been extensively used during the last five-year programme with good effects. This exchange has proved to be the best method for the transfer of scientific and technical know-how and an excellent means of improving the utilization of the available staff and expertise. It is proposed to extend the field of application of these mobility contracts also to staff coming from industrial firms. Moreover with the increase of exchanges foreseen, due in particular to the support to NET and JET, it is proposed to increase the maximum amount to be set aside for the mobility fund from 2 MioECU (1979-83) to 3 MioECU (1982-86). Spain has recently signed the "Agreement for the Promotion of Staff Mobility"[1] and will contribute to the mobility fund in proportion to the ratio of the Spanish G.N.P. to that of the Community.

- The existing management structure (see II.2.4) seems adequate to ensure a proper steering of the Fusion Programme in the next five years. The need for tighter steering of the more complex assembly of Community Fusion activities (NET, support to JET, new large machines) in any case calls for an increase of staff in the Fusion Directorate. Moreover, the expansion of the Programme, in particular in the field of technology, will result in an increase of expenditure for organizing meetings, workshops, etc. and for expert contracts. The appropriation of the Commission for management should consequently increase slightly faster than inflation, from 7 MioECU (1979-83) to 10 MioECU (1982-86).

- The appropriation of the Commission for "Management and Mobility" should then amount to 13 MioECU.

IV.5 STAFF

- The Commission proposes to fix the number of Euratom staff for the programme exclusive of JET at 110 and to raise it for JET progressively from 150 to 180 during the period 1982-86. This increase for JET has

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(1) O.J. N° L190 of 24.7.1980.

been recommended by the JET Council in order to enable the project to retain its Community character and to draw on the European pool of talent in such areas as radio-frequency heating technology, Tokamak physics, Computational physics and diagnostic instrument development. The bulk of Euratom staff working on the non-JET programme is seconded to the Associations. However, the smaller part working in Brussels at the Fusion Programme Directorate should be increased to ensure efficient steering of the expanding programme.
The proposed Euratom staff should be seen in the context of a total staff of 3500-4000 people working in the Fusion Programme, which includes about 1000 professionals (including part-time contributors).

- Since the recruitment of junior professionals has been extremely limited in the recent years, the average age of the staff is increasing at a rate which approaches one year per year. Moreover, the staff is very homogeneous in age, most being in the 45-50 range. For a programme which should last a few more decades this ageing of the staff is a dangerous phenomenon.

IV.6 APPROPRIATION OF THE COMMISSION FOR 1982-86

The overall cost estimate for the 1982-86 Fusion Programme (1504.3 MioECU), the corresponding Commission contribution (676.1 MioECU), the appropriation remaining from the current programme (about 101.8 MioECU) and the new tranche requested (about 574.3 MioECU) result from Table VI hereafter which sums up the financial information given in Chapter A) IV.

As the figures shown in the Proposal for a Council Decision are only indicative, the proposed total amounts of Community resources for the 1982-86 Fusion Programme have been rounded there as follows:

	MioECU
General programme	325
JET	355
Total	680

Foot-notes to Table VI

(1) Sweden, Switzerland and JRC excluded.

(2) Provisional figures, as the expenditure in 1981 is not yet known. Include 3.0 MioECU which constitute the provisional positive balance from third States contributions to the Fusion Programme (JET excluded) as from 1976 to 1981.

(3) Commitment budget of JET, as decided by the JET Council (see enclosed Opinion, part C)

(4) NET-Technology excluded. In order to obtain price level 1982, the 1981 expenditure for running costs of Associations and normal priority actions, as well as the 1981 estimates for the possible new large devices, have been raised by 9.94% which corresponds to the rise of consumer price index in the EC weighted according to the apportionment of expenditure for the Community Fusion Programme in the member States.

(5) Covers only work pursuant to Article 14 of the JET Statutes.

(6) Covers the activity of the NET group up to next programme revision only. The Community participation of about 36% to NET and Technology is a weighted average. (See Table V)

(7) G.P.: General programme, which means Associations (NET-Technology included) and Management and Mobility.

TABLE VI

Proposed 1982-1986 budget of the Fusion Programme[1], at price level 1982
(all figures in MioECU)

Activity	1981 Total expenditure (estimated)	1982/86 Total expenditure (forecast)	Rate of COM participation	COM contribution 1982/86	Unused appropriations from preceding programmes (2)	New tranche requested
JET (3)	76.7	442.3	80%	353.8	34.9	318.9
Associations, (4) running costs	111.5	613.0	25%	130.6*	19.9	110.7
Support of JET (5)	7.9	34.0	45%	15.3	4.0	11.3
Normal priority actions	10.2	56.0	45%	25.2	40.0	55.4
Possible new large devices						
TORE SUPRA	2.7	156.0	45%	70.2		
FTU	-					
ASDEX UPGRADE	-					
RFX	-					
STELLARATORS	-					
NET & Technology (6)	16.8	190.0	≃ 36%	68.0	0.0	68.0
Management & Mobility	1.9	13	100%	13	3.0	10
Total	227.7	1504.3	≃ 45%	676.1	101.8	574.3
				JET 353.8 G.P.(7) 322.3	JET 34.9 G.P. 66.9	JET 318.9 G.P. 255.4

* To the 130.6 MioECU should be added 22.6 MioECU (see part D, 5.1.2) already committed prior to 1982 within the programme 1979-83 for the years 1982 and 1983. Therefore the total Community contribution for 82-86 will be: 130.6 + 22.6 = 153.2 = 25% of 613.0.

B. PROPOSAL FOR A COUNCIL DECISION

of .....

adopting a research and training programme (1982 to 1986)

in the field of controlled thermonuclear fusion

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Atomic Energy Community, and in particular Article 7 thereof,

Having regard to the proposal from the Commission submitted after consultation with the Scientific and Technical Committee,

Having regard to the opinion of the European Parliament[1],

Having regard to the opinion of the Economic and Social Committee[2],

Whereas in its Decision 80/318/Euratom[3], as amended by Decision 81/380/Euratom[4], the Council adopted a research and training programme 1979 to 1983 in the field of controlled thermonuclear fusion; whereas Article 3 of that Decision provides that the Commission will submit to the Council, not later than 1 July 1981, a review proposal designed to replace the 1979 to 1983 programme with a new five-year programme (1982 to 1986) with 1982 and 1983 constituting years common to both programmes; whereas Decision 80/318 Euratom should therefore be repealed;

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(1) O.J. N°
(2) O.J. N°
(3) O.J. N° L 72, 18.3.1980, p. 18
(4) O.J. N° L 149, 6.6.1981, p. 32.

Whereas, in view of the considerable efforts needed to reach the application stage of controlled thermonuclear fusion, which could be of benefit to the Community, particularly in the wider context of the security of its long-term energy supplies, the various stages of development of the work hitherto undertaken in this field should continue on a joint basis;

Whereas the scientific progress achieved in this field in recent years in the Community and the rest of the world illustrates the need, particularly for Tokamak systems, to construct larger and more complex devices and to concentrate in particular on the development of plasma heating techniques;

Whereas it is necessary to complete the construction of JET in its basic performance, to extend the device to its full performance and to operate and exploit it;

Whereas the time has come to start the definition of the large device constituting the next step after JET and to launch, with the collaboration of the JRC, the technological developments required for its design and construction as well as those needed in the longer term for the fusion reactor;

Whereas the research proposed by the Commission constitutes an appropriate means of pursuing such actions and it is, consequently, in the common interest to adopt a multiannual programme in the field of controlled thermonuclear fusion, the existence of which is moreover a necessary condition for the Community participation in strengthening world cooperation in this field;

Whereas it is important that the Community should continue to encourage the construction of certain equipment concerned with projects accorded priority status, the support of JET by the Associations and certain developments in the field of fusion technology, by granting a preferential rate of participation in the expenditure for such actions;

Whereas, furthermore, the mobility of staff between organisations cooperating in the execution of the programme should be promoted;

HAS DECIDED AS FOLLOWS:

Article 1

A research and training programme in the field of controlled thermonuclear fusion as defined in the Annex is hereby adopted for a five-year period as from 1 January 1982.

Article 2

The total amount of resources necessary for the duration of the programme exclusive of JET are estimated at 325 MioECU, and the staff required is evaluated to be 110 employees.

The total amount of resources necessary for JET during the duration of the programme are estimated at 355 MioECU, and the staff required is evaluated to be 180 temporary employees within the meaning of Article 2(a) of the conditions of employment of other servants of the European Communities.

The ECU is defined according to the financial regulations in force. These figures are given merely by way of indication and can be adjusted within the annual budgetary procedure.

Article 3

The Commission shall submit to the Council, not later than 1 July 1984, a review proposal designed to replace the present programme with a new five-year programme with effect from 1 January 1985.

Article 4

Decision 80/318/Euratom hereby repealed with effect from 1 January 1982.

Done at Brussels.

For the Council,

The President

ANNEX

CONTROLLED THERMONUCLEAR FUSION

1. The subject matter of the programme to be executed shall be:

   (a) plasma physics in the sector concerned, in particular studies of a basic character relating to confinement with suitable devices and to methods for producing and heating plasma;

   (b) research into the confinement, in closed configurations, of plasma of widely varying density and temperature;

   (c) research into light-matter interactions and transport phenomena and the development of high-power lasers;

   (d) the development and application to confinement devices of sufficient powerful plasma heating methods;

   (e) improvement of diagnostic methods;

   (f) definition of the large device constituting the next step after JET and technological developments required for its design and construction as well as those needed in the longer term for the fusion reactor;

   (g) completion of the construction of the JET device in its basic performance; extension of JET to full performance ; operation and exploitation of JET.

   The work referred to in (a), (b), (c), (d), (e) and (f) shall be carried out by means of association or limited duration contracts designed to yield the results necessary for the implementation of the programme and which take into consideration the work carried out by the JRC, in particular in relation to the next step and technology referred to in (f).

   The implementation of the JET project referred to in (g) has been entrusted to the "Joint European Torus (JET), Joint Undertaking", established by Decision 78/471/Euratom[1].

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(1) O.J. N° L 151 of 7.6.1978, p. 10.

ANNEX

2. The programme set out in point 1 shall be part of a long-term cooperative project embracing all work carried out in the Member States in the field of controlled thermonuclear fusion. It is designed to lead in due course to the joint construction of prototypes with a view to their industrial production and marketing.

3. The global needs for the duration of the programme exclusive of JET are estimated at 325 MioECU and 110 Community employees. The amount of 325 MioECU can be broken down as follows:

(a) about 44% for the financing at a preferential rate of projects, as specified in paragraph 5;

(b) about 2% for industrial contracts in the field of fusion technology;

(c) about 4% for administration costs and for expenditure intended to ensure the mobility of staff to enable them to work in organizations cooperating in the implementation of the programme;

(d) the amount not set aside for the operations and expenditure referred to in (a), (b) and (c) shall be devoted to the financial participation by the Community in other expenditure incurred by the associations. This participation shall be at a uniform rate of about 25%.

4. Any positive balance from the contributions of associated third countries under the programme shall be devoted for expenditure referred to in point 3 (d) and to the financial participation by the Community in the execution of international cooperative projects.

5. After consulting the Consultative Committee of the Fusion Programme the Commission may finance at a uniform preferential rate of about 45% projects belonging to one of the following areas:

Tokamak systems and support for JET
Other toroidal machines
Heating and injection
Next Step and Fusion technology.

ANNEX

In return, all Associations shall have the right to take part in the experiments carried out with the equipments thus constructed.

6. The global needs for the JET Project during the programme period are estimated at 355 MioECU and 180 temporary staff. The amount in question is intended to finance the completion of the construction of the JET device in its basic performance, the extension of JET to full performance and the operation and exploitation of JET, with a participation rate of 80%.

C) DECISION OF THE JET COUNCIL ON THE JET PROGRAMME 1982-86

1. At its meeting on 19 March the JET Council decided to endorse the proposals of the JET Director concerning the JET Programme for the years 1982-86, and thereafter up to the planned completion of the scientific programme in mid-1990. This programme permits JET to operate at full performance in 1987, and also allows experiments with deuterium-tritium plasma to begin in mid-1988. From a technical point of view, the JET Council is satisfied that the programme can be executed as planned, and that it can achieve its objectives. There is a possibility that the results may go beyond these objectives and that thermonuclear ignition may be approached. This is a major landmark in fusion research, and cannot be achieved in any other experiment currently under way within the world fusion programme.

2. In reaching this decision, which was strongly endorsed by the JET Scientific Council and the JET Executive Committee, the JET Council was aware of the important position of JET within the European fusion programme. In many respects, JET is the only device which can provide essential information on the behaviour of high temperature plasma which is a prerequisite for any decision to launch the next major research device in fusion research (e.g. NET or INTOR). For this reason, any delay in the JET Programme would have far-reaching effects. The JET Council was also aware of the sensitivity of the proposed timetable, with its corresponding financial requirements, to what might normally appear to be small financial restrictions. Any decrease in the overall financial ceilings for the period 1982-86 below the proposed figure of 358 MEUA for commitments and 400 MEUA for payments (at January 1981 price levels) would seriously delay the programme. In particular, any decrease in the payments budgets for the years 1982 and 1983, below the proposed levels of 90 MEUA and 100 MEUA respectively (at January 1981 price levels) would prevent new commitments being undertaken in these years, and hence delay the programme correspondingly. The decision was however taken in full knowledge of the difficulties which all the Partners would have in meeting these payments budgets. The JET Council examined carefully a number of alternative programmes in which this difficulty was alleviated by slowing

down the Project, and concluded that the retardation was quite disproportionate to the savings made. It was also recognised that the proposed payments budget for 1982 was significantly higher than that for 1981 ; however, it had to be borne in mind that the unpaid commitments of the Project at the end of 1981 resulting from contracts already placed were foreseen to amount to about 62 MEUA.

3. The JET Council also considered the impact of future inflation on its proposals and decided to present the proposals for the 1982 budget and for the 1982-86 Programme in July 1982 economic conditions. The provisional inflation taken for this 18 months period (starting on 1 January 1981) was 20 % leading to a demand for 108 MEUA for a preliminary draft payments budget for 1982. The overall ceilings for commitments and payments for 1982-86 should be 442.3 MEUA and 480 MEUA respectively, in order that these figures should be consistent with the budget figures for 1982. Consequently, the JET Council recommends these figures to the Commission for inclusion in the Euratom Pluriannual Fusion Programme for 1982-86.

4. The JET Council emphasized the need for flexibility in planning the evolution of the research and development programme on JET, especially as regards the timetable for procurement of neutral injection and ion cyclotron resonance heating equipment. The JET Council believes that within the overall financial ceilings proposed, the flexibility needed would be ensured.

INTERIM OPINION OF THE CCFP ON THE DRAFT PROPOSAL FOR A RESEARCH AND TRAINING PROGRAMME (1982-86) FOR THE EUROPEAN ATOMIC ENERGY COMMUNITY IN THE FIELD OF CONTROLLED THERMO-NUCLEAR FUSION

26 JUNE 1981

The CCFP has devoted several meetings to discussions of the 5-year programme 1982-86. It has received very recently the Commission's final draft Proposal and has been informed today about the content of the Report of the Fusion Review Panel.

It is not in the position therefore to formulate today a detailed opinion on the Programme Proposal. It intends to provide detailed advice in July 1981.

However, on the basis of the discussions to date, the Committee is in the position to support the general objectives underlying the proposal, and considers that the financial volume and the proposed splitting between JET and the general programme are not unrealistic.

D) FINANCIAL RECORD SHEET

I. FUSION PROGRAMME (exclusive of JET)

1. RELEVANT BUDGET HEADING : 7341 (former item 3341)

2. TITLE OF BUDGET HEADING : Thermonuclear fusion.

3. LEGAL BASIS : Article 7 of the EAEC Treaty
Council Decision 80/318/Euratom (1) as amended by Decision 81/380/Euratom (2) and decision expected before January 1982.

4. DESCRIPTION, OBJECTIVE(S), JUSTIFICATION OF THE PROGRAMME :

4.1 Description

The programme is designed to continue research in the field of controlled thermonuclear fusion and covers all activities in the Member States in this field. Sweden and Switzerland are associated with the programme. It relates in particular to the study of magnetic confinement of plasma and of fusion technology.

4.2 Objectives

(a) The short term objectives of the programme are :

- to accumulate enough knowledge, both in physics and in technology, required for the definition, design and construction of the large device constituting the next step after JET.
- to assess up to what point magnetic confinement systems other than Tokamak systems (Stellarators, reversed field pinch) may be regarded as real alternatives to Tokamak ;
- to carry out a minimum programme on inertial confinement.

(b) the final aim of this programme is to determine whether energy can be produced at competitive prices from nuclear fusion reactions between light atomic nuclei and, if so, jointly to construct prototypes with a view to industrial-scale production and marketing.

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(1) O.J. N° L 72 of 18.3.1980

(2) O.J. N° L 149 of 6.6.1981

4.3 Justification

The problem of energy sources at world level in the long term is far from being solved. Thermonuclear fusion is one of the very few sources which might solve this problem or at least make a substantial contribution to its solution, in a way which would be particularly beneficial to Europe. The main reasons for conducting research in this field on a Community basis are as follows :

- the scale of the human and financial resources required, which suggests that such a development could hardly be carried out on a national basis ;
- the existence of a Community programme is a necessary condition for the Community participation in strengthening world cooperation in this field ;
- the existence of a collective need, common to all Member States ;
- the long time-scale of the effort (extending towards the end of the century) needed to arrive at the construction of the reactor ;
- in the event of success, the opening-up of a wide Community market for the European reactor.

5. OVERALL FINANCIAL IMPLICATIONS OF THE PROGRAMME FOR THE PERIOD 1982 TO 1986.

5.1 Implications in respect of expenditure

5.1.1 Costs incurred by :

- The budget of the Communities :	344,900,000 ECU (1)
- National administrations and other sectors at national level :	717,100,000 ECU
Total cost :	1,062,000,000 ECU

5.1.2 Multiannual timetables

To take into account the evolution of the preceding programmes, the timetables below relate to the period 1976 to 1986, covering the previous programme 1976-80, the current programme 1979-83 and the proposed programme 1982-86. The allocation for the period 1976-1986 totals 525.9 MioECU and has been calculated as follows :

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(1) The 344.9 MioECU include 22.6 MioECU committed prior to 1982 within the programme 1979-83 for the years 1982 and 1983. The proposed Community allocation for 1982 is therefore 344.9 MioECU - 22.6 = 322.3 rounded to 325 in the Proposal for a Council Decision.

	Tranche
Programme 1976-80 :	124.0 MioECU
Programme 1979-83 : 190.5 MioECU - 44.0 (unused appropriations from programme 1976-80) :	146.5 MioECU
Proposed programme 1982-86 : 322.3 MioECU - 66.9 (unused appropriations from programme 1979-83) :	255.4 MioECU
Total :	525.9 MioECU

Appropriations for commitment (UA 1976/77, EUA 1978/80, ECU 1981 onwards)

Category of expenditure	1976-1978 (final execution) (a)	1979 (final execution)	1980 (final execution)	1981 (budget including appropriations carried over from 1980)	1979-1981 (b)	1982	1983	1984	1985	1986	1982-1986 (c)	1976-1986 (d)=(a)+(b)+(c)
Staff	12,062,849	5,541,729	5,554,283	6,520,200	17,616,212	6,791,000	7,266,000	7,775,000	8,319,000	8,901,000	39,052,000	68,731,061
Administr. & techn. oper.	570,314	175,719	256,942	348,292	780,953	389,000	315,000	337.000	360,000	386,000	1,787,000	3,138,267
Contracts	95,701,341	1,732,803	54,855,423	17,280,733	73,868,959	102,820,000	97,419,000	70,888,000	6,321,000	4,012,372	281,460,372	454,030,672
					3,000,000 (1)							
Total	108,334,504	7,450,251	60,666,648	24,149,225	95,266,124	110,000,000	105,000,000	79,000,000	15,000,000	13,299,372	322,299,372 (2)	525,900,000

(1) The 3 MioECU correspond to the estimated positive balance of the associated third States contributions to the fusion programme (exclusive of JET) as from 1976 to 1981 (see point 5.3).

(2) As the figures shown in the Proposal for a Council Decision are indicative only the 322.3 MioECU have been rounded there to 325 MioECU.

62.

Appropriations for payment (UA 1976/77, EUA 1978/80, ECU 1981 onwards)

Category of expenditure	1976-1978 (final execution) (a)	1979 (final execution)	1980 (final execution)	1981 (budget including appropriations carried over from 1980)	1979-1981 (b)	1982	1983	1984	1985	1986 and later	1982-1986 and later (c)	1976-1986 and later (d)=(a)+(b)+(c)
Staff	12,062,849	5,541,729	5,546,248	6,528,235	17,616,212	6,791,000	7,266,000	7,775,000	8,319,000	8,901,000	39,052,000	68,731,061
Administr. & techn. operation	570,314	175,719	236,676	368,558	780,953	389,000	315,000	337,000	360,000	386,000	1,787,000	3,138,267
Contracts	48,030,856	19,051,810	27,074,721	25,691,081	71,817,612	43,320,000	62,719,000	66,888,000	73,321,000	84,934,204	331,182,204	454,030,672
					3,000,000 (1)							
Total	60,664,019	24,769,258	32,857,645	32,587,874	93,214,777	50,500,000	70,300,000	75,000,000	82,000,000	94,221,204	372,021,204 (2)	525,900,000

(1) The 3 MioECU correspond to the estimated positive balance of the associated third States contributions to the fusion programme (JET exclusive) as from 1976 to 1981.

(2) The 372.0 MioECU include 27.1 MioECU to be paid for work executed prior to 1982 as well as 22.6 MioECU to be paid for commitments incurred prior to 1982 for the years 1982 and 1983. The Community allocation for 1982 to 1986 is therefore 372.0 MioECU - 27.1 - 22.6 = 322.3, rounded in the Proposal for a Council Decision to 325 MioECU.

63.

5.2 Method of calculation

(a) Staff costs

The staff proposed for this programme consists of the following :

Year	A	B	C	Total
1981	75	35	3	113
1982-86	75	32	3	110

The calculations are based on the appropriations for staff expenditure entered in the budget 1981 and have been increased by 7 % per annum, taking into account the decrease of staff number from 113 to 110. The Community expenditure related to staff costs are included in heading (b) and (c) below.

(b) Administrative and technical operating expenditure and management

This covers the costs of travel, missions, experts and the organization of meetings together with the use of administrative and technical support. Inclusive of the cost of Commission staff working in the Fusion Directorate in Brussels the expenditure is estimated at 10 MioECU to be financed at 100 % by the Community budget.

(c) Contract expenditure

i) Association Contracts. For the period 1982-86 the cost of carrying out the fusion programme in the laboratories associated with the Community is estimated at 1042 MioECU, including NET and sub-contracted work on fusion technology as well as the Commission staff seconded to the associated laboratories. The Community would participate in the financing of this expenditure at a rate of about 25 %. This rate could be increased to about 45 % for actions accorded priority status by the CCFP and for the support of JET. The Community expenditure related to the participation in the financing of the Association expenditure is estimated at 302.3 MioECU. (1)

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(1) To 302.3 MioECU must be added 22.6 MioECU committed prior to 1982 for the years 1982 and 1983.

ii) Industrial contracts. A number of industrial development contracts are foreseen in the frame of the Fusion Technology Programme. The Community would finance such contracts at 100 % and about 7 MioECU are provided for that purpose.

iii) Costs involved in the mobility of staff other than Commission staff are estimated at 3 MioECU to be financed at 100 % by the Community budget.

5.3 Contributions of third States associated with the Fusion Programme (exclusive of JET).

i) The balance of contributions/expenditure during the period 1976 to 1981 is shown in the following table (MioECU) :

(a) Year	(b) Third States contributions	(c) Community expenditure related to the execution of the cooperation agreements	(d) = (b) - (c) Balance
1976	1.0	0.4	+ 0.6
1977	1.1	0.4	+ 0.7
1978	1.4	0.5	+ 0.9
1979	2.3	1.6	+ 0.7
1980	2.5	1.8	+ 0.7
1981	1.9	2.5	- 0.6
Total	10.2	7.2	+ 3.0

The positive balance of 3 MioECU is used for financial participation by the Community in the Association expenditure and has been taken into account in the calculation of the new tranche to be opened for the years 1982 to 1986 (see point 5.4 below).

ii) On the basis of the multiannual timetable for payment appropriations (see point 5.1.2) and assuming a constant average proportion between GNP (Sweden + Switzerland) GNP Community of 7.5 % the contributions of these two States to the proposed fusion programme 1982/86 (exclusive of JET) are estimated as follows (MioECU) :

1982	1983	1984	1985	1986	1982-86
3.79	5.27	5.63	6.15	7.07	27.91

The association contracts concluded with Sweden and Switzerland terminate on 31.12.1983. Therefore the expenditure related to the execution of the cooperation agreements during the period 1984 to 1986 are not yet known and the balance cannot be calculated at the time being.

The contributions of Spain are limited to the Mobility Contract and are estimated at 0.2 MioECU for the period 1982/86.

5.4 Calculation of new tranche to be opened for 1982 to 1986 taking into account unused appropriations from preceding programmes

(i) Tranches opened for preceding programmes :

	MioECU
programme 1976/80	124
programme 1979/83 : 190.5 - 44 =	146.5
balance of third States contributions 1976/81	3.0
Total of (i) :	273.5

(ii) Calculations of unused appropriations :

According to the Council Decisions and the recommendations of the CCF and CCFP the allocation of 273.5 MioECU has been broken down and used as follows (MioECU) :

	(a) allocation	(b) committed for 1976/81	(c) = (a) - (b) unused appropriations
General support to associations	186.5	166.6 (1)	19.9
Preferential support to associations	75	31	44
Management + Mobility	12	9	3
Total of (ii) :	273.5	206.6	66.9

These figures are provisional, as the final expenditure in 1981 is not yet known.

(iii) Tranche to be opened for 1982-86 :

	MioECU
Proposed Community allocation for 1982-86 (rounded)	325
less : unused appropriations from preceding programmes (total of (ii)), rounded	- 67
Total of (iii)	258

(1) Including 22.6 MioECU committed for 1982 and 1983.

Since the amount of the unused appropriations is based on a provisional calculation, the 258 MioECU have also to be considered as provisional.

5.5 Implications in respect of revenue

- Community taxes on the salaries of Commission staff
- Contribution of this staff to pension scheme.

6. FINANCING OF THE PROGRAMME

- Appropriations entered in the budgets of the European Communities for 1976 to 1981
- Appropriations to be entered in future budgets (1982 to 1987).

7. TYPE OF CONTROL TO BE APPLIED

Scientific control :
- Steering committees set up by association contracts concluded with the national laboratories.
- Consultative Committee for the Fusion Programme set up by Council Decision of 16.12.1980.

Administrative and Financial Control :
- Steering Committees
- DG of Financial Control with regard to the execution of the budget and the regularity and conformity of the expenditure and the Contracts Division of DG XII.

II) JET PROJECT

1. RELEVANT BUDGET HEADING CODE : 7342 (former item 3342)

2. TITLE OF BUDGET HEADING : Participation in the JET Joint Undertaking

3. LEGAL BASIS : Articles 45 to 51 of the EAEC Treaty and Article 9 of the JET Statutes, Council Decisions 78/470/Euratom of 30.5.1978 (O.J. L 151 of 7 June 1978, page 8), 30/318/Euratom of 13.3.1980, 81/380/Euratom of 19.5.1981 and Council Decision expected before January 1982.

4. DESCRIPTION, OBJECTIVES AND JUSTIFICATION OF THE PROJECT :

4.1 Description

Construction, operation and exploitation, as part of the Community fusion programme and for the benefit of the participants therein, of a large torus facility of the Tokamak type and its auxiliary facilities (Joint European Torus - JET) in order to extend the parameter range applicable to controlled thermonuclear fusion experiments up to conditions close to those needed in a thermonuclear reactor.

4.2 Objectives

To obtain and study a plasma in condition and dimensions approaching those needed in a thermonuclear reactor. Four main areas of work are required to achieve this aim :

(i) the scaling of plasma behaviour as parameters approach the reactor range ;

(ii) the plasma-wall interaction in these conditions ;

(iii) the study of plasma heating ;

(iv) the study of α-particle production and confinement and consequent resultant plasma heating.

4.3 Justification

The execution of the JET Project is an essential stage in the development of the Community's fusion programme. With regard to the final aim of this programme and its justification, please refer to Part I, Section 4.3 of the record sheet.

5. OVERALL FINANCIAL IMPLICATIONS OF THE PROJECT FOR THE DURATION OF THE PROGRAMME 1982 TO 1986 (ECU)

5.1 Implications in respect of expenditure

5.1.1 Costs incurred by :

The budget of the European Communities (80 %)	355,000,000
National administrations and other sectors at national level (20 %)	87,300,000
Total cost :	442,300,000

5.1.2 Multiannual timetable

To take into account the evolution of the preceding programmes, the timetable below relates to the period 1978 (year of establishment of the JET Joint Undertaking) to 1986, covering the preceding programme 1976/80 and 1979/83 as well as the proposed programme 1982/86. The Community allocation for the period 1978 to 1986 totals to 529.9 MioECU and has been calculated as follows :

	Tranche
Programme 1976/80 :	182.4 MioECU
Programme 1979/83 : 195 - 86.4 (unused from programme 1976/80)	108.6 MioECU
Proposed programme 1982/86 : 353.8 - 34.9 (unused appropriations from programme 1979/83)	318.9 MioECU
	529.9

The following table shows the commitment and payment budget of JET and the corresponding 80 % contribution of the Community to the payment budget of JET :

	(a) 1978/81	1982	1983	1984	1985	1986	(b) 1982/86	(c) Later years (1)	Total = (a) + (b) + (c)
JET budget									
Commitments	226.7	137.6	91.4	68.6	80.3	64.4	442.3	-	669.0
Payments	163.9	108.0	120.0	102.0	84.0	66.0	480.0	25.1	669.0
Community contribution	125.8	83.2	99.2	81.6	67.2	52.8	384.0	20.1	529.9 (2)

(1) The column "later years" shows only the payments relating to commitments incurred during the period 1982/86. It does not show the appropriations to be committed during these later years (1987-90) nor the payments related to such commitments.

(2) The 529.9 MioECU include 176.1 MioECU paid or to be paid for commitments contracted by JET before 1982. Therefore 529.9 MioECU - 176.1 = 353.8, rounded to an indicative figure of 355 MioECU in the Proposal for a Council Decision.

5.2 Method of Calculation

At its meeting of 19/20 March 1981 the JET Council approved the Project Development Plan of JET for the period 1982 to 1986 in which the expenditure of JET during that period is estimated, at price level January 1981, at :

Commitments :	358.16 MioECU
Payments :	400.00 MioECU

At the same meeting, the JET Council recommended, taking into account the inflation trend at that moment, to raise the payments budget by 20 % in order to obtain an average price level of the year 1982, at which the programme proposal 1982-86 should be presented. This would lead to a payment budget of 400 x 1.20 = 480 MioECU at price level 1982, to which corresponds a commitment budget of 442.25 MioECU, 80 % of which = 353.8 MioECU has to be financed by the Community budget, rounded in the Proposal for a Council Decision to 355 MioECU.

5.3 Contributions of Sweden and Switzerland

i) The 125.8 MioECU paid by the Community to JET during the period 1976 to 1981 include 6.0 MioECU coming from the Swedish and Swiss contributions.

ii) On the basis of the multiannual timetable for payment appropriations of the Community (see point 5.1) and assuming a constant average proportion of GNP (Sweden + Switzerland) to GNP Community of 7.5 % the contributions of these two States are estimated during the period 1982/86 as follows (MioECU) :

1982	1983	1984	1985	1986	1982-86
6.24	7.44	6.12	5.04	3.96	28.8

These contributions shall be devoted to the financial participation by the Community in the execution of international cooperative projects, in particular of such projects which will be performed under implementing or similar agreements concluded after approval by the Council.

5.4 Calculation of new tranche to be opened for 1982-86 taking into account the unused Community appropriations from preceding programmes (MioECU)

(i) Tranches opened for preceding programmes :

	JET budget	COM participation of 80 %
Programme 1976-80	-	102.4
Programme 1979-83 : 195 - 86.4	-	108.6
Total of (i)	263.75	211.0
(ii) Commitments in 1976 to 1981		
Committed in 1976 to 1980	149.0	-
Commitment appropriations entered in JET budget 1981 or carried over from preceding years	+ 77.75	-
less : revenues of JET in 1978 to 1981	- 6.65	-
Total of (ii)	220.10	176.1
(iii) Unused Community appropriations		
Total of (iii) = Total (i) - Total (ii) =	-	34.9

5.5 Implications in respect of revenue

Community taxes on the salaries of temporary staff.

6. PROJECT FINANCED FROM :

Appropriations entered in the budgets of the European Communities for 1976 to 1981.

Appropriations to be entered in future budgets.

7. TYPE OF CONTROL TO BE APPLIED

(a) Scientific control : JET Council
Consultative Committee for Fusion Programme.

(b) Administrative and Financial Control : JET Council
Court of Auditors.

COMMISSION OF THE EUROPEAN COMMUNITIES

ADDENDUM

COM(81) 357 final/2

Brussels, 1982

PROPOSAL FOR A COUNCIL DECISION

adopting a research and training programme (1982 to 1986)
in the field of controlled thermonuclear fusion

(submitted by the Commission to the Council)

O P I N I O N

of the Consultative Committee for the Fusion Programme
on the Proposal for a five-year Programme 1982-1986
on controlled thermonuclear fusion
adopted at its meeting on 15 July 1981

The CCFP:

1. Supports the Commission statements that controlled nuclear fusion is potentially a major long-term source of energy for Western Europe and that the main application foreseen - central electricity generation by an inexhaustible fuel is of sufficient and common importance to justify a major Community R & D programme.

2. Agrees that the progress of research on the technical means of releasing this energy by the so-called magnetic confinement method holds out a real possibility of technical success.

3. Believes that the Euratom activities have maintained Europe in the forefront of international fusion research and fostered the ability of European industry to provide the advanced electrotechnology so far needed for the development of fusion.

4. Has assessed the Community programme in relation to the following factors:

   i) the potential of thermonuclear fusion as a major long-term energy source,
   ii) the prospect of success,
   iii) the desirability for European industry's capabilities not to lag behind that in other regions,
   iv) the forward plans of the component national research programmes,
   v) the need for orderly progress in order to create the possibility of a decision on the next step before the end of the decade.

5. Taking account of these factors, considers that expansion of research in vital areas, viz. JET extended performance and technology for the Next Step, is necessary, that the Commission has presented a balanced and coherent programme for 1982-86 which is consistent with the long term objectives of the programme, and views the envisaged financial envelope of 1500 MECU as reasonable.

6. Notes that the Commission's proposal is generally in line with the recommendations of the Fusion Review Panel.

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The CCFP:

7. Endorses the strategy of the programme, the priorities which it entails, and the relative funding of JET and the general programme. The CCFP emphasizes the importance of:

   i) enhanced participation of the Associations in the Scientific programme of JET,

   ii) expansion of the technology developments (including safety and environmental aspects) needed for the Next Step and reactors,

   iii) the basic Tokamak programme and the programme of research on alternate toroidal magnetic confinement systems. Support for new machines of the various types should be determined with a view to their relevance for reactors and to keeping a balance in financial effort between these approaches.

8. Recognizes that this deliberate decision to emphasize work on toroidal magnetic confinement, taken in order not to overtax European resources, presents some risks, but considers that these are acceptable in view of the broad basis of fusion research provided by international collaboration.

9. Accepts the objective of having no more than one major step between JET and a Tokamak reactor demonstrating the sustained generation of electricity; and endorses strongly the need to discipline technology developments to the needs of this objective. Great care will therefore be needed in the selection of the Next Step and in considering the extent of international collaboration in the Next Step.
   Endorses continued participation in the INTOR Workshop.
   Recognizes the need to develop a technology programme which renders Europe capable of tackling all major aspects of the Next Step, and for work on a conceptual design for NET to serve as a focus for this effort.
   Emphazises the desirability of stimulating the technical capability of European industry to contribute to the further development of fusion.

10. Notes that the activity of the Community's Joint Research Centre in fusion research is omitted from the Commission's proposed programme. That part of fusion work that is carried out at Ispra should be planned at the same time and with the same objectives as that of the Associations. The CCFP therefore requests an early submission by the Commission on the work that could be conducted in future by the JRC.

11. Is aware that the Commission did not find it possible to support directly the cost of Euratom staff seconded to the Associations. In view of the doubts on the benefits of the secondment procedure, the CCFP welcomes the recent reduction in number of Euratom staff and urges the Commission to review the procedure with a view to making further reductions.

12. Wants to stress the importance of a timely Council Decision. A delay would not only postpone operational decisions and create serious steering difficulties, in particular for JET, but would also jeopardize the advantages of the sliding programme concept and weaken the coordination of the Community programme and its capacity for international collaboration.

The CCFP notes the difficult situation of the two Third Countries participating in the Community Fusion Programme which do not participate in the annual budgetary procedure by which the amount of resources devoted to the Fusion Programme might be adjusted, and the request of these countries to be consulted by the Commission in such cases.

The Swedish delegation has drawn the attention of the CCFP to the fact that the financial volume of the proposed programme could make difficult the future Swedish participation to the Community Fusion Programme on the present basis.

OPINION OF THE SCIENTIFIC AND TECHNICAL COMMITTEE (STC) ON THE DRAFT PROPOSAL FOR A FIVE-YEAR PROGRAMME 1982-86 ON CONTROLLED THERMONUCLEAR FUSION

- THE STC HAS EXAMINED ON 13 JULY 1981 THE DRAFT PROPOSAL FOR A FIVE-YEAR PROGRAMME 1982-86 PRESENTED BY THE COMMISSION; IT HAD ALSO RECEIVED THE REPORT OF THE FUSION REVIEW PANEL.

- BECAUSE OF THE SHORT TIME AVAILABLE, THE COMMITTEE CONCENTRATED ITS DISCUSSION ON THE PRINCIPAL FEATURES OF THE COMMISSION'S PROPOSAL.

- THE COMMITTEE IS OF THE OPINION THAT, TAKING INTO ACCOUNT THE LONG TERM PERSPECTIVES OF FUSION AND ITS IMPORTANCE FOR THE COMMUNITY, RESEARCH ON FUSION SHOULD RECEIVE INCREASED SUPPORT. IT CONSIDERS AS FULLY JUSTIFIED THE OVERALL FINANCIAL VOLUME FORESEEN FOR THE PROGRAMME AS WELL AS THE WAY IN WHICH THIS IS DIVIDED AMONG THE DIFFERENT ACTIVITIES INDICATED IN THE PROPOSAL OF THE COMMISSION. IT REAFFIRMS THE ADVANTAGES OF THE SLIDING PROGRAMME CONCEPT BUT UNDERLINES THE FACT THAT THESE ADVANTAGES COULD BE LOST UNLESS THE DECISION CONCERNING PROGRAMME REVISION CAN BE TAKEN WITHOUT DELAY.

- THE COMMITTEE APPROVES THE STRATEGY PROPOSED BY THE COMMISSION WHICH IS TO MAINTAIN THE CONCENTRATED EFFORT ON THE TOKAMAK LINE AND SIZEABLE EFFORT ON TWO ALTERNATIVE LINES IN MAGNETIC CONFINEMENT, REVERSE FIELD PINCH AND STELLARATORS. THE STC RECOMMENDS A PERIODIC REASSESSMENT OF THE REACTOR RELEVANCE OF THESE LINES COMPARED WITH THAT OF THE TOKAMAK.

- THE COMMITTEE ACCEPTS THE LOGIC OF THE COMMISSION'S PROGRAMME IN WHICH NET IS CONCEIVED AS THE ONLY STEP BETWEEN JET AND DEMO, BUT STRESSES THE NECESSITY OF CONTINUALLY ASSESSING THE VALIDITY OF THIS WORKING ASSUMPTION. THE STC APPROVES THE IMMEDIATE LAUNCHING OF THE NET DEFINITION GROUP WHICH SHOULD ACT AS A FOCUS FOR THE DEVELOPMENT OF THE TECHNOLOGY PROGRAMME, THE PROPOSED INCREASE OF WHICH IS CONSIDERED AS A MINIMUM. THE JET PROGRAMME AND THE OTHER TOKAMAK PROGRAMMES OF THE COMMUNITY SHOULD BE DIRECTED TO ESTABLISH THE SCIENTIFIC AND TECHNOLOGICAL FEASIBILITY OF NET. IN VIEW OF THE TECHNOLOGICAL AND SCIENTIFIC PREREQUISITES THE STC UNDERSTANDS THAT DECISIONS CONCERNING SUBSTANTIAL INVESTMENTS RELATIVE TO THE ENGINEERING DESIGN OF NET WILL NOT BE NEEDED BEFORE NEXT PROGRAMME REVISION OF 1984, EXCEPT AS IT IS SAID BEFORE FOR THE TECHNOLOGY PROGRAMME AND RELATED NEW LARGE DEVICES.

- THE COMMITTEE RESERVES ITS POSITION ON THE PROPOSED TRITIUM LABORATORY, THE MISSION OF WHICH DOES NOT APPEAR PRESENTLY TO BE SUFFICIENTLY WELL DEFINED.

- AS FAR AS INERTIAL CONFINEMENT IS CONCERNED, THE MAJORITY OF THE COMMITTEE CONSIDERS THAT UNLESS THE COMMUNITY IS PREPARED TO MAKE A CONSIDERABLE ENLARGEMENT TO ITS FINANCIAL COMMITMENT, THE ACTIVITY MIGHT BE LIMITED TO A PERIODIC ASSESSMENT OF THE RESULTS OBTAINED ELSEWHERE IN THE WORLD. A MINORITY CONSIDERS IT OPPORTUNE IN THESE CIRCUMSTANCES TO MAKE, ON THE CONTRARY, A SLIGHT INCREASE IN THE LEVEL OF THE PRESENT EFFORT SO AS TO ALLOW THE COMMUNITY TO FOLLOW PROGRESS MADE ELSEWHERE RATHER THAN TRYING TO BE COMPETITIVE ON THE WORLD LEVEL.

- CONCERNING PERSONNEL, THE STC DRAWS THE ATTENTION OF THE MEMBER STATES TO THE APPRECIABLE AGEING OF THE RESEARCH STAFF, IT BEING PARTICULARLY NOTICEABLE IN THE ASSOCIATIONS. IT RECOMMENDS THAT ALL MEASURES SHOULD BE TAKEN TO COUNTERACT THIS, FOR INSTANCE BY INCREASING STAFF MOBILITY, ESPECIALLY FOR THE EURATOM STAFF WORKING IN THE ASSOCIATIONS. THE PRESENT SYSTEM OF CHARGING THE TOTAL PERSONNEL EXPENSES OF THIS EURATOM STAFF TO THE ASSOCIATIONS SHOULD THEREFORE BE RECONSIDERED.