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COMMISSION OF THE EUROPEAN COMMUNITIES

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PROJECTS OF EUROPEAN SIGNIFICANCE

(Interim Report from the Commission to the Council)

du Secrétariat
Général

COM 338

Commission of the European Communities
Joint Research Centre

PROJECTS OF EUROPEAN SIGNIFICANCE

Introduction

Three preliminary studies were begun in March 1983 following the Council meeting of the 10th of that month in which the Commission was requested to study projects suitable for siting at the JRC Ispra Establishment.

Terms of reference included examination of :

- opportunity and need at Community level;
- feasibility at Ispra;
- investment costs.

The subjects examined are :

- a Tritium Handling Laboratory;
- a Vibrating Table;
- Ignitor.

These subjects being of differing natures, different elements have had to be taken into account in each case and the rate of progress has not been uniform. As a result, it is not yet possible to come to any definite conclusion and statements must be regarded as being very preliminary observations to be confirmed as the studies progress.

1. Tritium Handling Laboratory

The need for a central European laboratory was particularly stressed by the Fusion Review Panel held in 1981, to serve the fusion reactor research programme. The facility, which would be placed at the disposal of all the fusion associations, would be multipurpose and be able to handle some 50 to 100 grams of Tritium.
Advantage could be taken of the existing protected area around the ESSOR installation which is already licensed to handle radioactive materials and has an 80 metres high ventillation stack. The reuse of existing building to house the laboratory is being evaluated. Investments would be expected to be of the order of 10 MioECUs (1983-value).

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2. Vibrating Table

Vibrating tables are fairly widely used to investigate the behaviour of structures under dynamic loading conditions. Installations in Member Countries range from 0,5 to 25 square metres area with static load capacities up to 25 tonnes.
A table of some 40 m^2 (6 m x 6 m) and 100 tonnes capacity would represent an important step forward in the testing of structures under realistic conditions and could thus be considered to be an important and significant European facility.
The installation of a table of this size at Ispra would not be expected to present problems concerning space, geological conditions or power supply. Since the evaluation of need in various applicational fields is still at an early stage the optimal characteristics of the plant are far from being established and a wide range of possibilities still exists; it follows that no real cost analysis can yet be made. However, it might be reasonably assumed that the investment for the machines outlined above would fall between 50 and 200 MioECUs.

3. Ignitor

No attempt has been made in the study to assess the need for such a machine. Indeed, it is accepted that such an opinion would properly come from the Fusion Associations and for the moment no such proposal is before them for consideration under the Fusion Programme.

The possibility, and the advantages of siting an Ignitor project at Ispra are analysed in the study, should such a project be proposed by a fusion association, and adopted. The results yielded so far seen to suggest siting at Ispra to be both feasible and advantageous.

Enclosed are the three interim reports submitted to the attention of the JRC Governing Board on June 14th, 1983.

1. TRITIUM HANDLING LABORATORY

1.1 The need of a European tritium laboratory (ETL)

Tritium problems are of paramount importance in the design and operation of fusion reactors and machines of the next generations. One of the key issues of the commercial fusion power reactors will be that of breeding the tritium which is consumed during operation, to recover it and refuel without the need of extra mural reprocessing. In the experimental reactors (NET/INTOR) possibly only a fraction of the burnt tritium will be compensated by the reactor production, the remaining part being supplied from outside. However such machines will be confronted with all the aspects of the tritium cycle, namely:

- plasma heating and fuelling;
- plasma exhaust reprocessing;
- tritium recovery from blanket;
- coolant detritiation;
- gaseous wastes and ventilation processing;
- handling of tritiated components from reactor and subassemblies.

Tritium has been utilized for many years already in the countries of the European Community in the field of biological, biochemical and chemical research and even for industrial and commercial applications. The confinement and conditioning of tritiated waste waters arising in nuclear fuel reprocessing have also been objectives of research efforts in the Community.

Tritium is produced in macroquantities in classified installations of the two nuclear weapon states France and Great Britain. These two countries have declared, in a statement at the Atomic Questions Group in December 1981, to be disposed to the release of know-how in tritium technology relevant to fusion. However it is now recognized that, although the know-how acquired in the military applications will be very useful to tackle the fusion reactor problems, the operational conditions typical of fusion for energy production require a complementary and specific effort on tritium problems in the next years in Europe. This point was stressed, among others, by the Fusion Review Panel held in 1981 and is confirmed by the fact that European Fusion Technology Programme 1982-1986 will include activities on tritium. The Fusion Review Panel supported the need of a central tritium laboratory in Europe mainly to demonstrate, in relation to licensing procedures, the safety of the tritium manipulation techniques for peaceful applications of fusion. It has to be noted that, also in USA and Japan, the need of constructing a tritium laboratory devoted to fusion problems has been recognized. The American facility (TSTA) is ready for operation in Los Alamos whereas the Japanese one is under construction at JAERI.

In the last few years, the assessments carried out in the frame of the NET/INTOR project to evaluate the fuel cycle processes, have made clear the necessity of disposing also in Europe of a laboratory where the components related to these processes can be tested in conditions similar to those of fusion power reactor in order to optimize their performance. This laboratory must be flexible enough to accommodate alternative components and systems as they will be proposed and developed in Europe in the frame of the fusion technology activity. The free accessibility of the laboratory to the European research staff and industry represents a very important aspect to ensure the usefulness of it. JRC-Ispra appears adapted to host and operate such a laboratory for the following reasons:

- it has achieved experience on fusion technology problems and, in particular, on those related to the NET/INTOR conceptual design;
- it is largely devoted to nuclear safety problems;
- it is capable to host the European teams which will have to work at the facility, even for long periods (European school and other facilities).

1.2 Overview on activities on tritium technology in the European Community

At the KFA Jülich the problem has been approached of separating hydrogen (and tritium) from gas streams (by catalytic devices) and of limiting tritium permeation by protective layers in heat exchangers of HTGR cooling systems. Both KFA Jülich and KFK Karlsruhe have examined various techniques of tritium enrichment in waste waters. At the Max Planck Institute for Plasma Physics at Garching, experimental studies have been performed specifically in relation to the fusion technology concerning the preparative separation of the hydrogen isotopes by gas chromatography and the clean-up of atmospheres of (secondary) containment systems.

The CEN Mol has been actively involved in the field of tritium recovery from waste streams arising in nuclear (fission) fuel reprocessing.

All the above mentioned activities have been performed either on the basis of simulation with hydrogen and/or deuterium or, at the most, at tracer levels of tritium. At both the Garching and the Mol centres, pilot installations are being prepared for the experimentation of the processes with more representative levels of tritium (up to 1000 Ci).

TABLE 1 - **European fusion technology programme 1982-1986**

First round accepted contracts on tritium

Task	Country	Accepted ceiling MECU	Time schedule	Technical description
T.1	D	1.10	82 - 84	fuel clean-up
	F	0.37	83 - 84	system
T.2	F	1.20	83 - 86	tritium recovery from waste streams
T.3	UK	0.15	83 - 85	tritium detector
T.4	B, F, UK	1.5 (max)	83 - 86	electrolytic cell
T.5	D	1.70	83 - 86	air decontamination
	F	1.60	83 - 86	system
T.6	D	2.85	83 - 86	industrial development
	F		83 - 86	of large components

TABLE 2 - **Research contracts on tritium bearing waste from reprocessing**

Programme period	Contractor	CEC contribution KECU	Title
75/79	CEN Mol	371	Separation of T from aqu. effluents
80/82	CEN Mol	393	Separation of T from aqu. effluents
83/84	CEN Mol	291	Separation of T from aqu. effluents
75/79	KFK Karlsruhe TU Karlsruhe	83	T-enrichment .. on hydrophobic catal.
75/79	USAEA Harwell	25	T immobilisation
75/79	UKAEA Harwell	30	T immobilisation by incorporation in inorganic solids
80/84	KFK Karlsruhe	58	Characterisation of conditioned cladding material (T release)

CEA and UKAEA have conceived, in the frame of a contract with JET, a tritium handling system, specifically taylor-made for the (rather limited) requirements of this installation. In the frame of the INTOR workshop, France has contributed in the conceptual studies of the main tritium systems, namely the spent plasma reprocessing line, the blanket processing line, the waste processing lines, and the neutral beam line.

Among the non-classified experiences it must be mentioned the recovery of tritium from heavy water at the Von Laue-Langevin Institute at Grenoble with a yearly through-put of up to 10^6 Ci.

Part of the basic studies on physico-chemical parameters of materials (e. g. permeation) performed in the French military programme hasbeen published (Montrouge).

In UK, Harwell is claiming to dispose of relevant experience in (tritium) radiation damage on materials.

On the Commission's level, Table 1 gives an overview on the tasks identified for tritium in occasion of the "First Round Projects" launched in the frame of the 1982-86 research programme. The fundings attributed to each task and country are also indicated.

For comparison Table 2 gives an overview of the activities shared by the Commission's indirect action programme on tritium bearing waste from reprocessing of nuclear (fission) fuel in the frame of the "Management and Storage of Radioactive Waste" programme (DG XII).

1.3 Summary of past and ongoing JRC activities related to tritium technology

Up to now the activities performed in this field pertain to conceptual design studies. The experimental work was limited to simulation studies with hydrogen and deuterium.

In the past (1978) a feasibility study of a process similar to the

TSTA (Tritium System Test Assembly) of Los Alamos Laboratory has been commissioned to SNIA TECHINT, Rome. The aim has been to simplify the process and in particular the isotopic separation system (ISS) by cryogenic distillation of the hydrogen isotopes and helium. A preliminary project of such a facility together with a cost evaluation has been prepared by the contractor.

In the meantime the concept of new processes was settled at the JRC Ispra mainly based on the handling of tritiated water with the purpose to reduce the plant dimensions and consequently its investment and operational costs (especially for the secondary containment). SNIA TECHINT again made a feasibility study of these processes and a comparative cost evaluation with the first study (1979) confirming the above assumptions.
On the other hand the tritium inventory assumed high values in some processing units (distillation column and electrolytic cell).

Experimental work (1980) was started in order to demonstrate:

- the validity of some separation factors between hydrogen isotopes reported in the literature;
- the possibility of realizing an electrolytic cell with low liquid inventory.

A new electrolytic cell has been successfully tested which operates at high current density (50 A/dm^2) with the liquid inventory maintained at low values by soaking only the separator with the electrolyte. Moreover, with the same electrolytic cell, values of the separation factor between protium and deuterium higher than 10 have been obtained by using iron electrodes confirming the best values reported in the literature. These studies are progressing in order to refine the performance of this new cell type.

Presently, in the light of some results obtained at Garching on the separation of (relatively) large volumes (400 cm^3) of elementary hydrogen isotopes by gas chromatography a version of the JRC process schemes including this technique is being investigated more deeply.
A collaboration with IPP Garching on this process is envisaged.

A comparative analysis of the safety implications of alternative processes has been started.

Experimental studies on hydrogen-metal interactions have been started at JRC Ispra during the last few years. In the experiments solution, diffusion, permeation, absorption and desorption of protium and deuterium in various first wall candidate materials have been investigated.

The implications of tritium losses into helium as primary cooling fluid and its separation have been assessed. It was assumed that tritium will be present as tritiated water, due to the interaction with the steam in the secondary heat exchanger. A suitable absorber has been studied in order to keep the tritium level below those required by safety considerations.

Evaluation of the INTOR tritium losses through the piping of the cooling systems has been performed using a code developed at Ispra. Several deuterium permeation flux measurements through stainless steel membranes have been performed at different temperatures using an ultra high vacuum installation. Some measurements have been performed on oxidized membranes putting in evidence the complexity of the problem of protective barriers.

Theoretical and experimental studies to investigate the best method to recover tritium from the liquid breeder $Li_{17}Pb_{83}$ are in progress at JRC-Ispra since some years. Measurements of hydrogen isotopes solubility on $Li_{17}Pb_{83}$ at various breeder temperatures and gas pressures have been carried out first, in collaboration with the University of Cagliari. Meantime the design of a facility to demonstrate the validity of a process layout based on tritium extraction by a helium stream in countercurrent to the low-velocity breeder flow, has been set-up. The construction of this facility, which will first operate with hydrogen, is scheduled by the second part of 1983.

1.4 Objectives of ETL

There are common objectives to be achieved for the fuel cycle systems, to which the laboratory will be devoted:

- acquire experience on handling tritium in complex systems in connection with the safety of operators during routine operation (general and individual protective means) as well as with the protection of the environment (waste treatment, emergency clean-up, monitoring);
- provide the conditions to experience procedures for handling tritiated parts of the reactor and to optimize process components in relation to their operational safety and tritium inventory. In particular:
  a) execute experiments on tritium loaded mock-ups reproducing renewable parts of the NET reactor, aimed at decontamination and/or further treatment and conditioning (boots, seals, weldings);
  b) test new concepts and components developed in the European laboratories, like gas chromatography, electrolyzers and

catalyzers, tritium recovery systems from blanket in adverse operating conditions and for remote handling;

c) check the validity of the extrapolation of H/D physico-chemical data to the tritium case. This experimental control will be performed with tritium at the temperature and pressure conditions of fusion reactor applications, if these data will be not available as declassified information.

To cope with these requirements, a multipurpose installation is required rather than a facility devoted to a specific problem such as for example TSTA (Los Alamos).

1.5 Laboratory layout

ETL should consist of a hall (see Appendix 1) acting as tertiary containment for tritium with attached all necessary ancillary areas. Experimentation of process units and systems (primary containment) are performed in dry boxes or caissons, placed inside the hall. They represent the secondary containment, equipped with a proper clean-up system for on-line detritiation and recirculation of its atmosphere in a closed circuit. For particular research items requiring expensive and sophisticated instruments and equipment on one side and relatively small amounts of tritium on the other side, a few individual laboratories might be foreseen aside the hall.

ETL can be located inside the protected ESSOR area, in the vicinity of the already existing stack (80 m height). The hall where the power supply for SSTP was foreseen can be utilized to install part of the ETL facilities.

Within August 1983 a feasibility study with a preliminary cost evaluation will be performed including an estimation of the possible gain from the utilisation of the existing building with respect to a completely new realisation of the laboratory.

1.6 Tritium inventory

Among the purposes of ETL,the supply of tritium to European fusion machines is not included. In an experimental reactor such as NET/ INTOR, the expected tritium inventory will be of the order of several kilograms. As an example, in Table 3 is given the breakdown of the tritium inventory presented in the INTOR-Phase II-a European report. However, it appears that the major part of this inventory will be present as hold-up in intermediate storage or at a stationary state in the blanket. In TSTA the expected tritium inventory is 150 g. In this facility, which is devoted to a specific process, a significant part of the inventory is taken by the cryodistillation column. Given the objectives of ETL, tritium inventories even lower, of the order of 50-100 g, should be sufficient for a significant operation. These values correspond to dose committments, in case of accidental total release through the stack in the form of tritiated water (which is very hypothetical), much below the value taken as a reference in the existing External Emergency Plan of ESSOR.

TABLE 3 - Break-down of the INTOR-IIa tritium inventory

Plasma exhaust and neutral injectors	370 g
Breeding tritium	737 g
Primary coolant detritiation	65 g
Wastes	not estimated
Atmosphere	1 g
Neutral injectors and torus feed	245 g
	1369 g
Storage	2300 g
Breeding blanket	500-1000 g
Total	~ 4220-4720 g

1.7 ETL in the frame of the European activity on tritium

As mentioned in the frame of the European Fusion Technology Programme 1982-86, some activities are to be started dealing with:

- feasibility studies of tritium recovery from fuel as well as from waste streams including the air decontamination systems;
- orientative studies on some components like electrolytic cells and tritium detection systems;
- definition of the actions for industrial development of large components.

In the detailed definition of the tasks and the design of the JRC laboratory, a straight coordination and continuous exchange of information will be ensured with the other European laboratories in order to exploit and to integrate the results of these studies and to complement them. In particular the various proposed schemes and systems could be verified with accent on the operational conditions and safety (environmental requirements for example). For the laboratory construction, full utilization will be made of course of the parallel industrial development of components (typically the case of tritium compatible vacuum pumps and valves) foreseen in Europe.

1.8 Preliminary evaluation of time schedule and resources

Starting from a possible Council decision, the following planning can be envisaged for the design and construction of ETL:

- 15 months for the detailed design of the basic laboratory (hall, ancillary equipment, secondary containment systems);

- 36 months for the construction and mounting of basic omponents;
- 6 months for commissioning tests and operation start.

The extension of the laboratory equipment to specific systems to test processes and for mock-up operations should start two years after the beginning of the ETL design.

This time schedule appears to be in line with the needs of NET engineering design.

The staff foreseen for the operation of ETL (beginning in all cases in the multiannual plan after 1987) is estimated to be 25 research-men, including 7 professionals. During the design and construction phase, the required JRC-staff will be about 8 research-Men/a for the 1984-87 programme.

It is considered strongly recommendable to send, starting in 1984, JRC personnel to follow the TSTA facility operation in USA (Los Alamos) for operation training.

The cost of ETL is estimated to be 10-12 MECU (1983-value), 6-8 MECU of which will be for investments and contracts outside and 4 for staff and services. The rate of investments is:

- 20% at the beginning of the study;
- 60% after 15 months;
- 20% during the following 36 months period.

1.9 Next steps of the assessment

The actions for the following period (up to end August 1983) are:

- design and cost evaluation of the following parts of the facility:
  - a) technological hall including glove boxes, hot cells and other secondary containment caissons;
  - b) specialized laboratories;
  - c) auxiliary services (emergency clean-up system, glove box clean-up systems, hot ventilation, waste treatments and storage area);

- optimization of the emergency and glove-box clean-up systems as a function of the programmed type of the facility operation.

APPENDIX 1 - Preliminary layout of the ETL facility

ETL is subdivided into two sectors: the Hot and Cold Areas. The Hot Area is formed by a technological hall ($\cong 200\ m^2$; $h \cong 10\ m$), 5 laboratories ($\sim 20\ m^2$ each; $h \cong 4\ m$) and a service area ($\cong 160\ m^2$) where the ventilation, clean-up and safety systems are located.

The Cold Area includes offices and general services.

The technological hall contains hot cells where tritiated (and eventually activated) components can be remotely handled.

Most of the laboratories contain relatively small amount of tritium (<10 Ci each) to perform basic studies, e.g. permeation tests, thermo-chemical and kinetic properties. The other laboratories will contain larger amounts of tritium (>1000 Ci) to study typical processing steps such as electrolysis, chromatography.

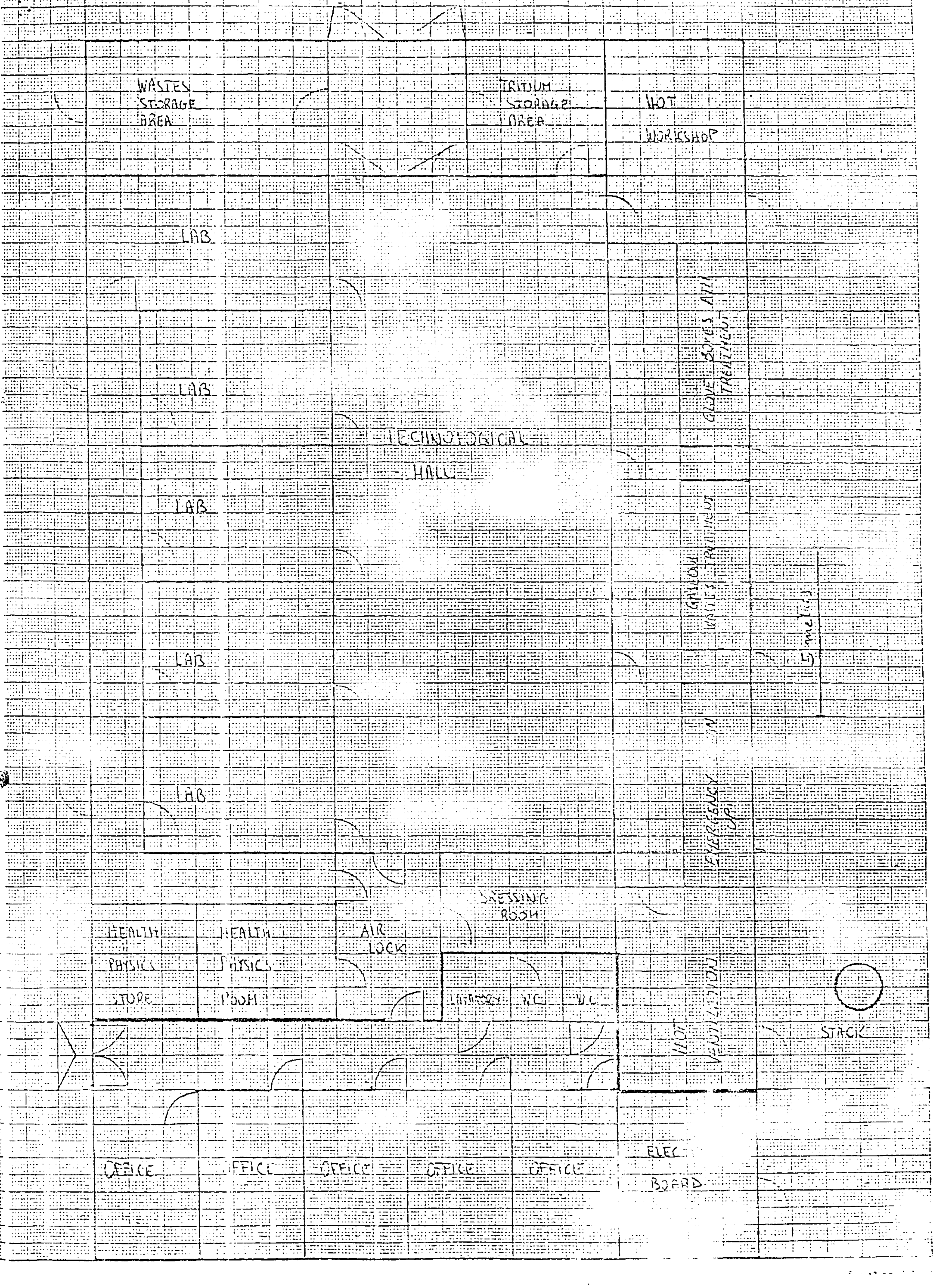
The service area ($200\ m^2$) contains the normal and emergency clean-up systems serving the technological hall and the laboratory and the waste processing system.

A preliminary layout is shown in the annexed drawing. The total surface of ETL is expected to be about $800\ m^2$.

As already stated, the area related to the technological hall is ~ 10 m high. The other areas have heights around 4 m.

E.T.L.

ANNEX 2 to the 4th Meeting on Tritium Handling Laboratory



2. VIBRATING TABLE

2.1. Utilization of Vibrating Tables

Today, there is an increasing concern about the possible effects of seismic events, or similar dynamic phenomena (e.g., airplane crashes, explosive accidents, etc.) on both nuclear and non nuclear, but potentially dangerous, industrial plants, as well as on civil engineering structures.

The need for safety assessments and improved design concepts in the above engineering fields has motivated the development of a wide spectrum of experimental and analytical research activities all over the world.

In this context, vibrating tables represent useful and widely used experimental devices for investigating the behaviour of structures, components, or equipments when submitted to dynamic loading. Their range of capabilities extends from in-depth testing of models (e.g. to validate calculation methods), to qualification tests, including verification of conformance to prescribed standards. One may therefore distinguish between two fundamental aspects in the use of vibrating tables:

- testing for qualification purposes
- testing for research and development purposes.

The latter aspect includes a wide variety of possible applications, such as

- study of damping characteristics and frequency response functions in the linear and nonlinear range,
- study of coupled problems, such as soil-structure and fluid-structure interactions,
- assessment of dynamic behaviour and extreme load evaluation of reinforced concrete structures,
- assistance in the development of antiseismic design concepts.

2.2. Review of the existing vibrating tables

A large number of vibrating tables is currently in operation throughout the world. In Table I we have reported the main characteristics of some of the largest tables existing, or under construction in the Community. For comparison purposes , we have also included in Table I the performances of a Japanese table which is by far the largest presently under operation.

From Table I it appears that the size of the tables presently in operation within the Member Countries is in the range of 0.5-25 m^2 with a maximum tested equipment weight of 5 to 25 metric tons. On the other hand the largest facility in the world is a 15x15m table in Japan which is capable to test equipments weighting up to 1000 metric tons.

In addition to the parameters mentioned in Table I, vibrating tables are also characterized by their range of accurate frequency response, the number of independent loading directions, and their capability of simulating complex loading conditions with an adequate software.

As far as the cost of vibrating tables is concerned, it appears to be difficult to give precise figures. Tentatively one might say that the cost of the medium-size vibrating tables presently in operation in the Community is in the range 1-5 MECU, while, the large Japanese table could have a cost of 300-400 MECU. The time schedule for the design and construction of vibrating tables is estimated to be in between of 3 to 6 years.

2.3. Scope of the JRC assessment

The JRC is currently trying to ascertain whether a vibrating table of intermediate size between the largest presently in operation in the Community and the huge Japanese table may respond to the research and qualification needs of the Member Countries.

TABLE I : Shaking Table Performances (1)

ORGANIZATIONS	Table Name	Degrees of Freedom	Size m x m	Force rating (kN)	Max Tested Eqmt. weight (Metric Tons)	Max-acceleration (g)	Max-actuator stroke (mm)
CEA, Saclay, France	VESUVE	1 H	3.1x3.1	350	20	1.8g at 15t	± 100
CEA, Saclay, France	TOURNESOL	2 H V	2 x 2	H 100 V 2x100	10	0.9g at 10t	H ± 125 V ± 100
Ansaldo Impianti Genova, Italy	PERSEUS	2 H V	3.5x3.5	H 220 V 208	10	1.7g at 2.5t	H ± 70 V ± 70
Hochtemperatur Reaktorbau, Jülich, FRG	SAMSON	3 Hx Hy V	5 x 5	H 510 V 850	25	1.5g at 25t 2.0g at 15t 3.0g at 5t	± 200
National Eng. Lab. Glasgow UK		2 H V	3 x 3	H 500 V 3x250	20		H ± 125 V ± 75
National Eng. Lab. Glasgow UK		2 H V	3 x 3	H 150 V 3x50	5		H ± 125 V ± 125
ISMES, Bergamo Italy	T 1 T 2 T 3	2 1 1	2.5 x 4 0.62x0.62 2 x 2	60 15 50			± 35 ± 75 ± 125
Technical Univ. Athens, Greece	under construction	3 Hx Hy V	4 x 4		10	Hx:1.5g Hy:1.5g at 10t V:2.9g	± 100
Tadotsu Eng. Lab. Japan		2 H V	15 x 15	H 30000 V 33000	1000	H 2.7g at 500t V 1.4g	H ± 200 V ± 100

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(1) A few typical tables are reported

Apparently, the construction of a vibrating table with increased dimensions could offer advantages such as:

- reduction of the problems arising from the impossibility to completely satisfy the laws of similitude in a scale model,
- possibility to appraise the response characteristics (damping, frequency) at full excitation level and to analyse the effects of nonlinearities induced by the material behaviour and by design features such as gaps, restraints, etc.,
- possibility to include in a more realistic fashion the coupling of the tested component to its environment,
- possibility to qualify cumbersone equipments(mechanical or electrical)for which numerical modelling is particularly difficult.

However, it must be kept in mind that the construction of a large vibrating tabel represents an operation of considerable technical and economical relevance and that its cost/benefit ratio must therefore be appraised in the necessary detail.

Another aspect to be kept in mind is the very rapid development of powerful numerical methods for the simulation of complex dynamic problems and the increasing availability of very large and fast computers. These developments in software and hardware might well give the analysis a much more important role than heretofore and consequently reduce the needs for testing, especially with costly large-scale models.

The JRC is shall analyze further possible community needs for a vibrating table. If such needs are identified the characteristics of a suitable table will be determined.

2.4. Status of the assessment and further steps

The JRC is establishing a number of contacts with organizations (e.g. industries, licensing bodies, possibly insurance companies) in the Community potentially interested in the development of a project on a large vibrating table to be installed at Ispra. The JRC also intends to confront the results of its assessment with those of similar studies presently in progress in some Member Countries.

Another aspect to be considered in our evaluation is the adequacy of the Ispra site to host a large vibrating table. Here, preliminary indications based on previous experiences are that there should be no major problems as far as availability of space, soil conditions and power supply are concerned.

The possible problems for transport of very large components which cannot be assembled or built on site will be investigated.

If preliminary positive indications are obtained from the above contacts, the JRC intends to perform under contract more detailed enquiries and evaluations before presenting its findings on the effective needs for such a project and the results of the feasibility study.
The outcome of this study could be made avalaible at the end of 1984 at the earliest. At that time the detailed elaboration of a programme, in collaboration with the identified interested partners could start and lead to a final proposal about 18 months later.

In formulating such a programme the JRC should concentrate on activities relevant to Reactor Safety and Industrial Risk. Although the JRC is presently not involved in seismic analysis, competences exist in the areas of dynamic testing, instrumentation, data acquisition and numerical methods which could be used for the actions to be proposed.

3. INCREASE OF JRC ACTIVITY ON POST-JET PROJECTS

3.1 Introduction

Following the request of the Council, two main projects have been considered:

- NET (Next European Torus), an experimental reactor project which is included in the 1982-86 European Fusion Programme for which a study team has been already set-up in Garching;
- IGNITOR, a high magnetic field Tokamak project which should prove the plasma ignition, the feasibility study of which has been done by an Italian team and evaluated by an ad hoc Panel set-up by the Commission.

3.1.1. NET

In the current programme, JRC-Ispra is already involved in the studies of NET, as the main laboratory in support to the design team set-up at Garching. The participation to these studies will be increased in the next JRC programme (1984-87) namely:

- by a contribution to the conceptual design studies in the areas of mechanical configuration and plant-layout, first wall and blanket components, safety and environmental analysis;
- by the execution of a number of experiments in support to NET, related to materials investigation (first wall and breeder), major accidental conditions and remote handling. In the present phase of the NET studies this contribution covers the design requests.

As far as the problem of eventually hosting NET at Ispra is concerned, it appears premature because, according to the European plan, the engineering design of this machine could not start before 1988.

3.1.2. IGNITOR

As it is well known, for the time being this project is not included among those submitted by the Fusion Associations and has not been discussed by the Consultative Committee on Fusion Programmes. In these conditions it is premature for the JRC to elaborate on this project. What can be done is the evaluation of the feasibility of hosting such a project in Ispra and collateral impacts.

3.1.2.1. Summary of the characteristics of the IGNITOR project

IGNITOR is a Tokamak proposed by Prof. Coppi (MIT and Scuola Normale Superiore di Pisa) in order to achieve ignition conditions. IGNITOR has evolved from a line of high-field devices such as the Alcator A and C and the Frascati Torus. In 1980 a contract for a feasibility study was given by CNEN to Scuola Normale Superiore, this institute acting as main contractor on behalf of a study group including Tecnomasio Brown Boveri, CNR Istituto dei Plasmi di Milano, NIRA, Stone and Webster, SNIA Techint, etc. In May 1981 the Feasibility Study was completed. At the end of 1982 an Ad Hoc Review Panel appointed by the Commission of the European Communities examined the summary of the Feasibility Study and gave an advice.

The main parameters of the machine are reported in Table 1. These parameters are not definitely settled.

The experimental system is composed of five main items: the machine core (4x4x4 m), the auxiliary heating system (RF), the electrical supply system, the tritium system, the cryogenic system and other auxiliaries. The first three items cost each about 1/4 of the total. The machine requires a biological shield about 2 m thick and a remote handling system.

3.1.2.2. Assessment of the feasibility of siting IGNITOR at Ispra

The main problems to be considered are :

- electrical supply system
- main building and auxiliary systems
- licensing

and , in addition :

- fuel handling, decontamination and waste treatment systems
- ausxiliary systems
- generic infrastructure support.

Only the first three items of this list have been considered so far and the studies are proceeding.
As working hypothesis the following timing has been assumed : three years (83-86) for design and construction and five years (87-91) for the operation.

A) Electrical power supply

The requirements of IGNITOR in terms of power transients demand are still harder than those of JET (Table 1). Being the electrical supply a key issue for siting, highest priority has been given to its feasibility and cost assessment. Contracts have been established with ENEL-Compartimento di Milano, on the basis of a questionnaire similar to that set-up during the site enquiry for JET and on the basis of a preliminary design proposed by Tecnomasio Brown Boveri. These contacts have confirmed the feasibility of the supply directly from the ENEL 380 kV grid at the border of the Ispra Centre. In the next days ENEL should send a first detailed answer to the questionnaire including a preliminary cost for the line-up to the main transformer station on the Ispra site, and the contractual conditions for the supply in the period 1987-1991.
The transformer station should be installed in the Centre near to the ESSOR location. The time required for the realization of the connection and of the station is evaluated to be two years.

B. Building and auxiliary systems

The best location for IGNITOR would be inside the ESSOR protected area. An analysis of the possibility of installing the machine inside the main containment of ESSOR has shown that this would not be convenient both from economical and technical points of view.
An area for a new building inside the ESSOR fence that offers optimal conditions from the point of view of electrical connection, building foundations, nuclear infrastructure and general infrastructure has been identified.

C. Licensing

No major problems are expected for licensing. Indeed the tritium inventory in IGNITOR should not exceed 1 g (10,000 Ci).
The actual "release formula" for gaseous effluents from ESSOR reactor

gives annual release	2000 Ci
13 weeks period	1000 Ci
successive 24 h period	4 Ci

In case of absolute necessity these figures can be multiplied by a factor 5.
In the case that ESSOR reactor will be decommissioned, the Licensing Authority should be asked to confirm the existing release authorization.
For the construction licence, a procedure similar to that adopted for the Ispra MC 40 Cyclotron recently installed at Ispra in the frame of the execution of the Fusion Program, is required (art. 55 DPR 13.2.1964 n.185 and DM 4.1.1977). The licensing process is expected to take about two years.

D) Collateral aspects

Studies should be continued. One can anticipate that a number of requirements such a machine could find a proper environment within the JRC where appropriate skills and supports have been developped in the framework of the programme (reactor safety, waste disposal, fusion technology).

3.5. Further Steps of the Assessment

For the next step (September) the activity will be :

- Define from a technical and economical point of view the electrical supply system
- Define the overall layout of the buildings and auxiliaries and provide a preliminary cost evaluation
- Check with the help of Prof. Coppi on the most recent version of the design of the machine, further requirements of the site.
- Define and evaluate in detail the steps of the licensing procedure.

Table 1 - Power Supply Requirements

	IGNITOR	JET
Total energy consumption pulse (GJ) (Toroidal and Poloidal Field Coils)	0.4 - 0.006	5.3 - 1.0
Pulse duration:		
- raise time (sec)	2	13
- plateau time (sec)	1	20
Required pulse power:		
- active (MW)	600	575
- reactive (MVAR)	500	300
Pulse frequency (max)	3/d	6/h
Max number of pulses		
- max. power	5.000	
- low power	50.000	

APPENDIX I - IGNITOR Reference Specifications

Geometrical parameters	Symbol	Pre-compression	Post-compression
Major radius (cm)	R_0	109	72.5
Minor radii product (cm^2)	a,b	30.5 x 38	25 x 31
Plasma current (MA)	$I_{\parallel}$	2.6	4
Toroidal magnetic field at $R = R_0$ (kG)	B_T	80 for $q_\psi = 2$ 100 for $q_\psi = 2.5$	120 for $q_\psi = 2$ 150 for $q_\psi = 2.5$

Average beta $\langle\beta\rangle$	Below 1%
Primary plasma heating method	Ohmic and adiabatic compression
Auxiliary heating (L.H. or I.C.R.H.)	5 MW with 0.4 sec pulse length
Peak plasma density n_0	$\sim 10^{15}/cm^3$ in post-compression phase
Neutron wall loading	~ 1.6 MW/m^2
Maximum number of neutrons per discharge	$5 \times 10^{18} \rightarrow 14$ MJ of thermonuclear energy
Operational life span	5 years
Tritium injected (per discharge)	15 curie
Toroidal field pulse length (flat top)	1.5 sec at 120 kG 1 sec at 150 kG