COMMISSION OF THE EUROPEAN COMMUNITIES

nuclear science and technology

HANDBOOK OF MATERIALS TESTING REACTORS AND ANCILLARY HOT LABORATORIES IN THE EUROPEAN COMMUNITY

1977

EUR 5369 e

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INTRODUCTION

The purpose of this Handbook is to make available to those interested in "in-pile" irradiation experiments important data on Materials Testing Reactors in operation in the European Community. Only thermal reactors having a power output of more than 5 MW(th) are taken into consideration (see Table I).

In particular, detailed technical information is given on the experimental irradiation facilities of the reactors, their specialized irradiation devices (loops and instrumented capsules), and the associated hot cell facilities for post-irradiation examination of samples.

The information is presented in the form of eight information sheets for each reactor. These sheets have the following headings :

Sheet 1 : Main characteristics of the reactor
Sheet 2 : Experimental irradiation facilities of the reactor
Sheet 3 : Typical neutron spectra
Sheet 4 : Utilization and specialization of the reactor
Sheet 5 : Main characteristics of specialized irradiation devices
Sheet 6 : Main characteristics of facilities for post-irradiation examination
Sheet 7 : Equipment and techniques available for post-irradiation examinations
Sheet 8 : Utilization and specialization of the hot cell facility.

Nuclear engineers often need to refer to pertinent features of reactors, irradiation devices and hot laboratories, and to compare them easily. It is hoped that this Handbook will prove a useful source of reference in nuclear centres, governmental and industrial organizations, libraries, and so on.

If complete details are required by specialists, reference should be made to the specialized literature or to the reponsable officer of the facility (whose name and address is given on the first information sheet for each reactor).

This Handbook is the result of a co-operative effort between the staff of the European Communities and members of the Coordinating Committee on Materials Testing Reactors, instituted by the Council of Ministers of the European Communities. All data have been either provided or reviewed in March 1975 by national authorities or members of the Coordinating Committee.

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Table I

MATERIALS TESTING REACTORS IN THE EUROPEAN COMMUNITY COUNTRIES

Country	Name of reactor	Owner	Site	In operation since	Therm. power MW	Neutron fluxes x 10^{14} Thermal	Neutron fluxes x 10^{14} Fast	Hot lab
Belgium	BR 2	CEN	Mol	1961	80	9	7	LMA
Denmark	DR 3	Dan. AEC	Risø	1960	10	1,5	0,45	6 Hot cells
France	OSIRIS	CEA	Saclay	1966	70	3,4	4,5	LECI
	EL 3	CEA	Saclay	1957	18	2	0,3	LECI-CELIMENE
	SILOE	CEA	Grenoble	1963	30	3,4	4,0	LTHA
	MELUSINE	CEA	Grenoble	1958	8	1	0,7	LTHA
	PEGASE	CEA	Cadarache	1963	35	1	3	LECA
	TRITON	CEA	Fontenay R.	1959	6,5	0,7	0,6	35 Hot cells
Germany	FR 2	G.f.K.	Karlsruhe	1962	44	1	0,7	Hot cells
	FRJ 1	K.F.A.	Jülich	1962	10	1,1	5,4	Hot cells
	FRJ 2	K.F.A.	Jülich	1963	23	2	1	THTR - Lab
	FRG 2	GKSS	Geesthacht	1959	15 (21)	3	1,6	5 Hot cells
Italy	ESSOR	EURATOM	Ispra	1969	45	3	0,9	ADECO,ATFI,LMA
Netherlands	HFR	EURATOM	Petten	1961	45	2,4	3,1	LSO (RCN)
United Kingdom	DIDO	UKAEA	Harwell	1956	15	2,2		19 Hot cells
	PLUTO	UKAEA	Harwell	1959	23	2	1,7	19 Hot cells

INFORMATION SHEET No. 1
revu le 4. 12. 1974

MAIN CHARACTERISTICS OF THE BR2 REACTOR AT MOL

Name of reactor	BR2
Organization	CEN-EURATON
Site	C.E.N./S.C.K. MOL - Belgium
In operation since	1961
Power MW (th)	80 to 120
Moderator	H_2O+beryllium
Coolant	H_2O
Fluid and pressure (Kg/cm^2) in experimental channels	H_2O at 12 kg / cm^2 N.B. The head of a rig is exposed only to the static head due to the pool water i.e. 600 g/cm^2
Nominal operation days / year	220-250
Operating cycle (days)	
on power	21
shut down	7

	Responsable officers:	Address:
BR2	G. Stiennon	CEN/SCK
Hot Lab	A.G. Dewildt	Boeretang 200 B-2400 Mol

EXPERIMENTAL IRRADIATION FACILITIES OF THE BR2 REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	active length m/m	Diameter m/m	Typical neutron fluxes thermal	fast (>100 KeV)	γ-heating W/g Al	Remarks
In pressure vessel							
Fuel element channels	38*	760	17, 25, 34 or 43	1 – 4 x 10^{14}	2 – 7 x 10^{14}	5 – 17	All thermal fluxes expressed as unperturbed thermal flux $[n]_{0}^{0,5}$ at 2200 $m.s^{-1}$ measured at the axis.
Reflector channels	19* to 34	760	85	1 – 9 x 10^{14}	0,1 to 2 x 10^{14}	0.5 – 8	To obtain fast flux above 1 Mev multiply the >100 KeV value by 0,62
Peripheral channels	10	760	50			10	
Loop channels	up to 5	760	200	up to 9 x 10^{14}	4 x 10^{14}		
In reactor pool							
Pool tubes	4	various		5.10^{12} to 2.10^{13}	up to 10^{12}	$<0,5$	
Beam tubes	9	various		10^{7} to 5.10^{13}			

* Of these channels, 13 are "through-loops", extending completely through the reactor vessel from top to bottom

2) Reactivity available for experiments: ~ S 10 (7 % $\frac{\Delta k}{k}$)

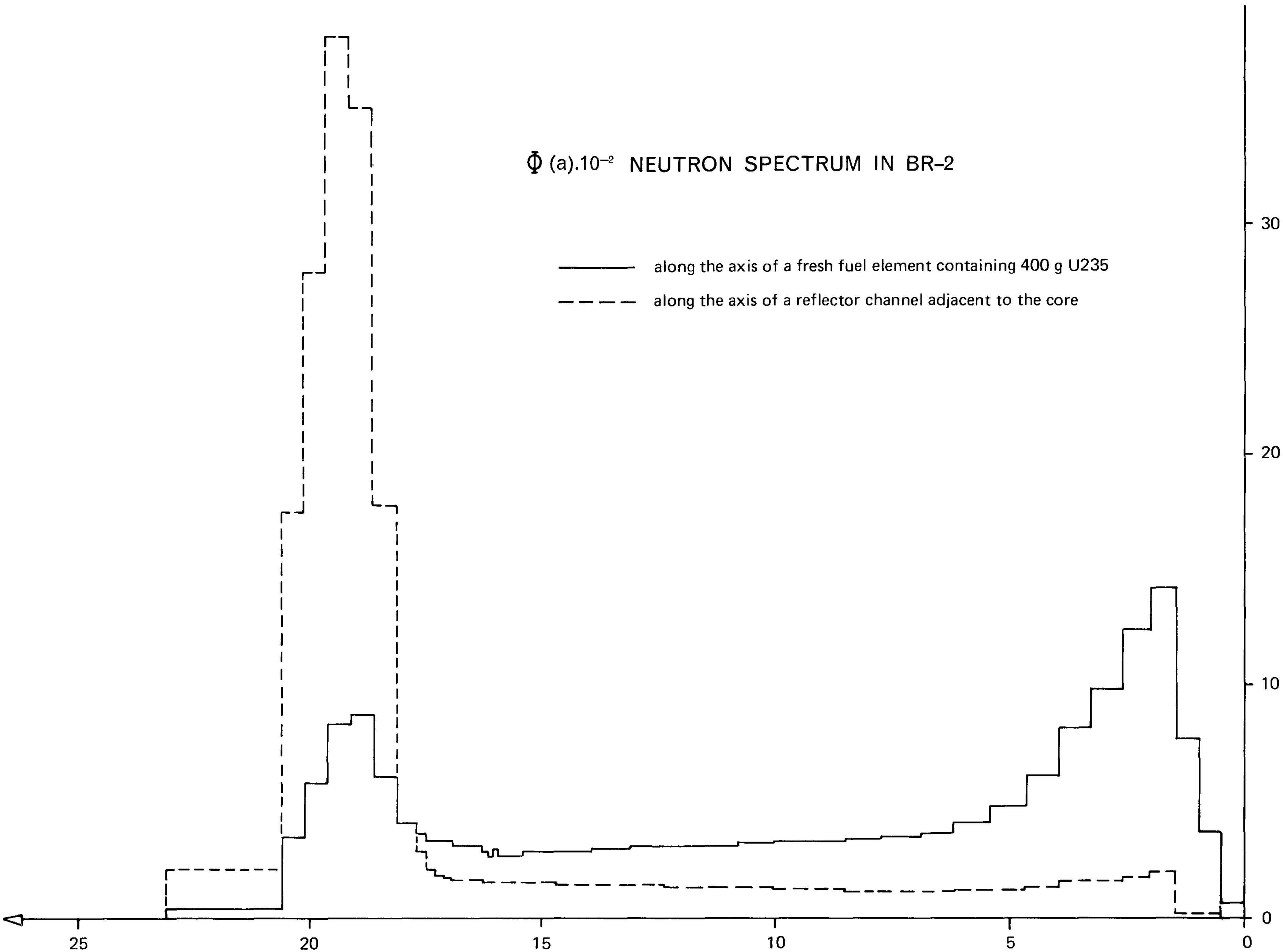
3) Typical neutron spectra available should be added on <u>sheet N° 3</u>

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) : Neutrography of active or inactive rigs
Underwater Television camera.

5) References of relevant publications: "Nuclear Engineering" Nov. 1967 Annual Progress Reports.
"Nuclear Engeneering" July 1961

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6)   See sheet N° 6

7) Are facilities available for irradiation on behalf of other organizations of the European Community ? : yes


Φ (a).10⁻² NEUTRON SPECTRUM IN BR-2
along the axis of a fresh fuel element containing 400 g U235
along the axis of a reflector channel adjacent to the core
30
20
10
0
25
20
15
10
5
0

INFORMATION SHEET No. 3

TYPICAL NEUTRON SPECTRA FOR THE BR2 REACTOR AT CEN, MOL.

n (upper limit)	(lower l.)	ϕ (n).10^{-2} Centre of fresh cermet elt. 400g U5	ϕ (n).10^{-2} Be reflector Channel 1e adj.
23,106	0,001 eV	0,434	2,132
20,580	0,0125	3,546	17,448
20,080	0,0206	5,782	27,968
19,580	0,340	8,312	38,182
19,080	0,0560	8,666	35,118
18,580	0,0924	6,082	17,850
18,080	0,152	4,145	6,055
17,679	0,227	3,665	2,911
17,476	0,278	3,388	2,129
17,275	0,340	3,284	1,898
17,078	0,414	3,291	1,847
16,889	0,50	3,091	1,708
16,250	0,9475	2,779	1,572
16,206	0,99	2,929	1,465
16,166	1,03	2,764	1,519
16,119	1,08	2,675	1,433
16,056	1,15	2,959	1,626
15,933	1,30	2,765	1,453
15,43	2,15	2,868	1,500
14,66	4,65	2,900	1,470
13,89	10	2,975	1,443
13,12	21,5	3,062	1,417
12,35	46,5	3,114	1,382
11,58	100	3,175	1,349
10,81	215	3,258	1,319
10,04	465 eV	3,288	1,279
9,27	1,00 keV	3,340	1,243
8,50	2,15	3,418	1,209
7,73	4,65	3,473	1,173
6,96	10	3,651	1,166
6,19	21,5	4,106	1,187
5,42	46,5	4,804	1,236
4,65	100	6,094	1,374
3,96	200	8,206	1,630
3,27	400	9,796	1,648
2,58	800 keV	12,405	1,791
2,01	1,40 MeV	14,137	1,998
1,44	2,50	7,694	1,342
0,96	4,00	3,717	0,271
0,48	6,50 MeV	0,696	0,058

UTILIZATION AND SPECIALIZATION OF THE BR2 REACTOR

1) What were the original purposes of the reactor ?

Materials testing	- in the core
Isotope production	- in the reflector
Fundamental physics research	- in beam tubes

2) What major modifications have subsequently been made and for which particular research programme ?
   The original alloy type fuel elements, containing 244 g ^{235}U, have been replaced by cermet elements, of identical geometry, containing 400 ^{235}U plus burnable poisons.
   The original design power of 50 MW has been uprated to 100 MW by provision of new heat exchangers and by changing the cooling tower packing.

3) For which major projects and programmes is the reactor currently being used ?
   Fast reactor development ~60%
   Various irradiation programmes ~25% (high temperature gas reactor, water reactors etc.)
   Radio-isotopes ~15%

4) What loops and irradiation devices have been specially developed for this reactor ?
   a) give name and purposes of the devices: see sheet N° 5
   b) main caracteristics of specialized irradiation devices are to be listed on separate sheet N° 5.

5) Major modifications planned: Steady increase in power level up to 130 MW over next 3 years.

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE BR2 REACTOR
(give also references of relevant publications)

- fuel-pin irradiation

  sodium loops with cadmium screen

  MFBS : up to 250 kW, up to 7 pins (oxide 600 W/cm, carbide 1200 W/cm)

  MOL 7B : up to 500 kW, 19 pins (oxide 600 W/cm) or 7 pins (carbide 1500 W/cm)

  MOL 7C (in design) : safety experiment (Na flow failure test)

  • helium loop with cadmium screen (in design)

    400 kW, 12 vented pins

  • rig (1 pin)

    - FAFNIR and FASOLD capsules (with Cd screen)

      oxide. 6 mm diameter, 350 to 600 W/cm or carbide, 8 mm diameter, 1000 to 1500 W/cm

      fission product pressure measurement, central temperature measurement, thermal cycling.

    - CIRCE and CEB (thermal flux)

      Continuous measurement of the power, possibility of detecting cladding rupture.

    - CFC

      Compatibility fuel canning test

    - THEBE

      Thermal conductivily measurement

    - P basket

      test of advanced type LWR fuel rod

- fissile material irradiation

  - CPUR and MOPS : swept loops for irradiation of coated particles.
  - POM : high burn-up (100.000 MWd/t) in short time (a few months) with continuous measurement of the power.
  - Mol 12 : creep experiment with in-pile measurement.
  - Mol 13 : hollow fuel pellet rig (oxide, 1000 W/cm).

∞

INFORMATION SHEET No. 5
(continued) (2)

- cladding material and structural material irradiation.

  MOL 1 : samples directly cooled by the reactor water (<100 °C)

  MOL 3 and DISP : in NaK or Na, 600 to 700 °C

  MOL 2 and 5 : creep experiment with in-pile measurement

  MGR : graphite irradiation, 150 to 1200 °C

  IPCTL : helium loop for graphite irradiation (carbon transfer experiment)

- radioisotopes production

  PACT : production of transplutonium elements.

  CSF : standard capsule

  Co and Ir capsules

  Actinium thimble (irradiation of Ra Co_3 with double containment)

  Hydraulic rabbit and self-service thimble.

INFORMATION SHEET No. 5
(Continued) (3)

References.

J. Planquart et al.
In-pile experimental equipment for BR2.
Third U.N. International conference on the peaceful uses of atomic energy. Geneva. 1964.

J. Planquart
Dispositifs d'irradiation pour BR2.
EAES Symposium on irradiation experiments. The Hague. 1965.

M. Soenen
Experience gained with the in-pile sodium loop for fast neutron irradiation after the first run in the BR2 reactor.
Symposium on alkali metal coolants corrosion studies and system operating experience. Vienna. 28 Novembre - 2 December 1966.

J.M. Baugnet
Boucles d'irradiation au réacteur BR2.
H.F.R. Information meeting. Petten. 7-8 December 1967.

P. von der Hardt
Development and in-pile performance of some BR2 irradiation rigs.
EUR 3626e. 1967.

W. Hebel
Production d'éléments lourds par irradiation d'américium 241 dans le réacteur BR2.
EUR 3560f. 1967.

M. Soenen
Experience gained with the 200 kW integrated in-pile sodium loop in the BR2 reactor.
International Conference on Fast Reactor Irradiation Testing.
Thurso, 14-17 April 1969.

G. Vanmassenhove
In-pile sodium loop 500 kW. Conceptional design.
International Conference on Fast Reactor Irradiation Testing.
Thurso, 14-17 April 1969.

P. von der Hardt
BR2 irradiation of fuel pins in liquid met 1 rigs.
International Conference on Fast Reactor Irradiation Testing.
Thurso, 14-17 April 1969.

A. Lhost
Thermal neutron fuel irradiation rig with continuous heat flux measurements.
International Conference on Fast Reactor Irradiation Testing.
Thurso, 14-17 April 1969.

J. Debrue, Ch. De Raedt, H. Lenders, F. Léonard, N. Maene, F. Motte, G. Stiennon
Utilization of the BR2materials testing thermal reactor for fast neutron irradiation.
A/CONF. 49/P/280
Fourth United Nations International Conference on the Peaceful Uses of Atomic Energy.
Geneva, 6-16 September 1971.

P. von der Hardt
Some BR2 Irradiation Devices for Fast Reactor Fuel and Fuel Elements.
EUR 4632e - 1971

P. von der Hardt
BR2 Irradiation Devices for HTGR Fuel.
EUR 4737e - 1971.

J.M. Baugnet et J.M. Gandolfo
Groupe d'exploitation du réacteur BR2 et de ses installations connexes - GEX.

Rapport d'activité 1971.

GBX/760/72 - June 1972.

C.E.N./S.C.K.

Hot Laboratories

INFORMATION SHEET N° 6

Main characteristics of Facilities for post-irradiation examinations at C.E.N./S.C.K. Center (MOL-Belgium)

Location, organization. Name of Lab.	Year of active operation	Scope: Active area	Scope: Number of working position	Gamma shielding (material, thickness, density)	Leak tightness	Special atmosphere	Manipulators no. and type (spare manipulators included)
MOL-Belgium Centre d'Etude de l'Energie Nucléaire. Studiecentrum voor Kernenergie							
A. Laboratory for Medium Activity (L.M.A.)	1965	~1200 m^2	26 + 8 under construction	lead 0,10 m 0,15 m 0,20 m concrete 0,80m d:3,4	most of facilities are αtight $\leq 0{,}51 m^{-3} h^{-1}$	One facility under Ar One facility under N2	12 - M 7 25 - MA 11 7 - BF 700 8 - M 8 3 - GM 150
B. Atelier très haute activité (A.T.H.A.)*	1965	~200 m^2	5	concrete 1,37 m d:3,4	not α	no special atm.	10 - M 8 4 - M 9 1 - GM 300

*Jointly operated by C.E.N. - S.C.K. and Euratom

C.E.N. / S.C.K. Information sheet n°7

Hot Laboratories

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATION

1) Owner or operator of the facility.
   A. L.M.A. building C.E.N./S.C.K. - Division of applied research.
   B. A.T.H.A. building GBX (C.E.N./S.C.K. - Euratom association).

2) A. L.M.A. not especially associated with a reactor.
   B. A.T.H.A. especially associated with BR2.

3) Details of equipment and techniques.

   A. L.M.A.

   a) Current metallographic examination facility including preparation of samples (vacuum impregnation apparatus, grinding and polishing machines, micro sampling apparatus, Leitz M M 5 R T microscope with Vickers micro-hardness tester).

   b) Metallographic examination facility under controlled atmosphere including preparation of samples (grinding and polishing machines, Reichert Telatom 61 microscope with Vickers micro-hardness tester and Leitz Aristophot micrograph).

   c) Microprobe analyser metallographic preparation facility (under construction).
   (Vacuum impregnation apparatus, grinding and polishing machines, ion bombardment apparatus, metallisation unit, ultra-sonic decontamination set ...).

   d) Mechanical test facility including tensile test

INFORMATION SHEET No. 7
(continued)

apparatus at high and low temperatures and fracture toughness, impact test apparatus at high and low temperatures, possibility of macroscopic examination of fractures, photography and metrology.

e) Metrology and profile projection facility.

f) Physical test facility including, thermal treatment (up to 1200 °C under vacuum or inert atmosphere), Vickers hardness measurements and swelling measurements by immersion density determination.

g) Workshop facilities (one under controlled atmosphere) equipped with several mechanical tools and machines, possibility of final dismantling of experimental samples, conditioning of samples, photography, punction and fission gas collection.

h) Burn-up determination preparation facility including dissolution of fuels, fission gas recuperation, sampling for gamma spectrometry and chemical analysis.

i) Hot thermobalance facility for several Kinetic studies.

j) Several multi-purpose cells for chemical or metallurgical work.

k) Several glove-boxes for low level preparation and measurement (plutonium boxes, decontamination boxes, tests on graphite, etc.).

B. A.T.H.A.

Dismantling and observation facilities including a variety of mechanical apparatus and tools, non destructive testing, metrology, gamma scanning and neutrography.

Information sheet n°8

UTILIZATION AND SPECIALISATION OF THE L.M.A. AND A.T.H.A.

1) Post irradiation examination of several materials.

   A. L.M.A. building - essentially destructive tests.

   B. A.T.H.A. building - essentially non destructive tests and dismantling operations.

2) Adaptations to new techniques and fuels for example carbide fuels and H.T.R. fuels.

3) - Fast breeder reactor fuel pin development programmes (oxides and carbides of U and Pu)
   - High temperature reactor fuels (coated particles).
   - Thermal and power reactor fuel pins.
   - Examination of structural materials (candidate cladding materials, structural elements of fuel assemblies, reactor vessel surveillance programmes).

4) A. L.M.A. - Extension of hot acilities for non destructive and destructive testing of fuel pins for power reactors (thermal and fast).

   B. A.T.H.A. - Extension of hot facilities for non destructive testing and dismantling of fuel assemblies for power reactors.

5) Yes.

INFORMATION SHEET N° 1

Jan. 1975

MAIN CHARACTERISTICS OF THE DR 3 REACTOR AT RISOE

Name of reactor	DR 3
Organization	Danish Atomic Energy Commission Research Establishment RISØ
Site	RISØ
In operation since	1960
Power MW(th)	10 MW
Moderator	D_2O
Coolant	D_2O
Fluid and pressure (kg/cm^2) in experimental channels	
Nominal operation days / year	305
Operating cycle (days)	28
on power	23.5
shut down	44.5

	Responsible officer	Address
DR 3 :	H. Floto	Reactor DR 3 Research Establishment Risø DK - 4000 Roskilde
Risø Hot Cell :	J.S. Quist	Risø Hot Cell Research Establishment Risø DK - 4000 Roskilde

INFORMATION SHEET No 2

IRRADIATION POSITION OF THE ...DR3... REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast(>100 KeV)	γ heating W/gr Al	Remarks
-fuel element central holes	26	610	50	1.5	0,45	1.5	
7 V holes	4	450	175	0.6	0.005	0.3	
4 V holes	4	150	100	0.3	0.001	0.2	
7 T holes	4	135	175	0.7	0.002	0.4	

2) Reactivity available for experiöents : ~8% dk/k

3) Typical neutron spectra available should be added on sheet No 3. Not measured, refer to PLUTO data

INFORMATION SHEET No 2
(contn'd)

4) Specialized equipment available for experimenters (e.g. neutrography, etc.) :

5) References of relevant publications :

6) If hot cell facilities are available on the reactor site give its name and the organization to which they belong (give details on sheet No 6)

7) Are facilities available for irradiations on behalf of other organizations of the European Community ? :

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

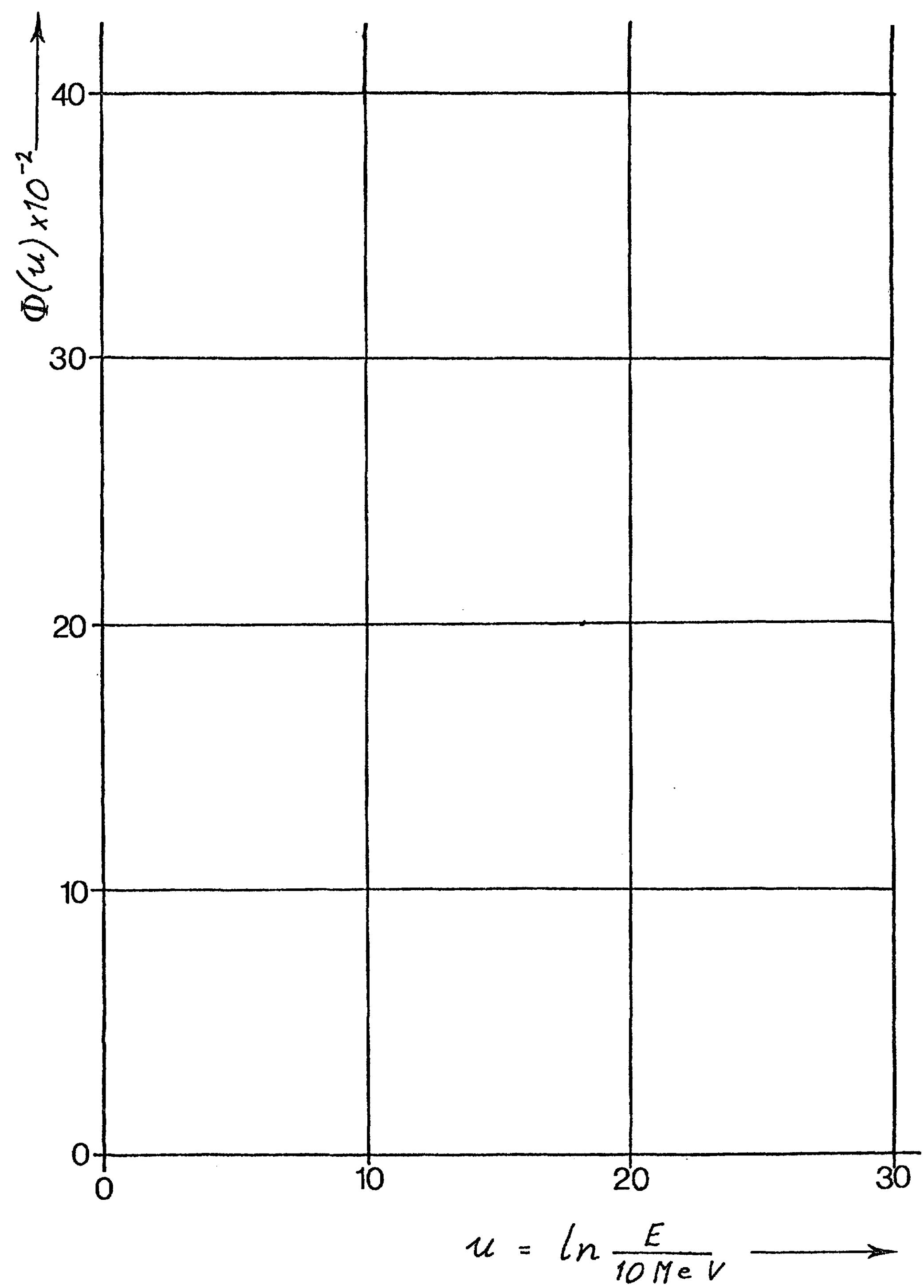
(histogram of flux per unit lethargy)

$\int \Phi(u)\, du = 1$

________ = typical core position

-------- = typical reflector position

.... =



INFORMATION SHEET N° 4

UTILIZATION AND SPECIALIZATION OF THE DR 3 REACTOR

1) What were the original purposes of the reactor ?

Materials testing and isotope production

2) What major modifications have subsequently been made and for which particular research programme?

Beam experiments for solid state physics research governed by DAEC have been installed at each end of the 4 horizontal, tangential experiment tubes (17.5 om ∅).

A cold neutron source is being installed in one of these tubes at the moment (1973/74)

3) For which major projects and programmes is the reactor presently being used ?

- Isotope production
- Dragon-project
- Fuel pin testing
- Basic research on solid state physics

4) What loops and irradiation devices have specially been developed for this reactor ?

a) give name and purposes of the devices :

- High pressure Rig HP 1 for fuel pin testing
- High pressure Rig HP 2 for fuel pin testing (also with thermal cycling)
- Corrosion Rig
- HTGR Rig for fuel irradiations up to 2000° C

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

INFORMATION SHEET N° 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE DR 3 REACTOR
(give also references of relevant publications)

fuel pin irradiations:

- High pressure Rig type HP 1(*): 1 pin, 200 W/cm^2, 9-15 mm., length 600 mm, 150 bars pressurized water failed fuel pins may be tested
- High pressure Rig type HP 2(*): 1 pin, 9-15 mm diam. length 400 mm, 80 bars pressurized water- thermal cycling tests may be performed
- Corrosion test facility : cladding samples 15 mm diam., 500 mm length, 80 bars 20 - 400° C water
- HTGR fuel irradiation rig : in fuel position, 700 - 2000° C
- Structural materials irradiation rig : reloadable, 40 - 500° C
- Thermal conductivity rig : for UO_2 up to 1900° C

*) H. Hagen, K. Hansen, J.A. Leth : Design and experience with rigs simulating LWR conditions in a research reactor
IAEA - SM - 165/8, 1972.

INFORMATION SHEET No 6

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT RISØ CENTRE

Location Organization Name of lab	Denmark Danish Atomic Energy Commission Research Establishment Risø Hot-Cell Facility
Year of active operation	1964
Scope of: Number of working positions	7
Scope of: Active area (m^2)	Caves and frogmens area : 432 m^2 (cave floor area: 62 m^2) Room for glove-boxes and shielded cells: 334 m^2 Other blue and red areas : 2,364 m^2 Total, classified areas : 3,130 m^2
Gamma shielding (material, thickness (m) and density g/cm^3)	CAVES Floor : Normal concrete, 0.8 m, 2.2 g/cm^3 Roof : Normal concrete, 1.0 m, 2.2 g/cm^3 Back and front wall: Normal concrete, 1.7-2.0m, 2.2 g/cm^3 Walls between caves: Magnetite concrete, 1.0m, 3.6 g/cm^3
Leak tightness	Yes - provided that all master-slave boots are intact.
Special atmosphere	Theoretically : Yes In practice : No
Manipulators number and type	7 pairs of master-slaves, Nuclear Equipment, heavy-duty, Harwell type α-seal. 1 power-operated manipulator, GEC Mk. 1. 1 power-operated cell hoist, GEC, capacity :1,5 t-
Remarks and references	

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE HOT CELL (FACILITY)

1) Owner or operator of the facility : Danish Atomic Energy Commission.

2) With which reactor is the facility associated? : DR2 and DR3 at Risø.

3) Give details of equipment and techniques available :

Maximum weight of transport containers is 25 t. Max. length of fuel elements to be received is 5 m. Max. activity is 10°Ci (1 MeV).

Dismantling: Cutting machines, milling machines, saws, lathe, drilling machines, tools etc. etc.

Visual inspection: Monoculars, binoculars, periscope, techniscope, epitechniscope, polaroid cameras.

Dimensional measurements: Profilometer (continuous diameter recording), length measuring bench. Max. length 2.1 m.

γ-scanning and γ-densitometry: Continuous recording of single isotopes and of relative density. Max. length 2.1 m. Use of multichannel analyzer and Ge-Li-detectors being considered.

Leak testing: Bubble-test used at present; SF_6-test being planned.

X-radiography: High energy X-radiography for water-reactor fuel rods; low energy X-radiography for coated-particle fuel.

Fission gas sampling: Pressure and amount of fission gases measured; gas analysis by mass-spectrometry.

Metallography: Impregnation of fuel rods if necessary; grinding, polishing, etching; Reichert Telatom microscope.

Miscellaneous: Surface replication, extraction, replication and analysis by X-ray-diffraction or chemical methods; burn-up-determination by Nd-method; H_2/D_2-determination by mass-spectrometry (Zr-alloys); autoradiography.

4) References of relevant publications :

Facilities at Research Establishment Risø for Post-Irradiation Examination of Dragon Project Experiments. Dragon Project Report No. 446, July 1966, F. Bundgaard Larsen and Arne Sørensen.

Post-Irradiation Services at Risø. Danish Atomic Energy Commission, Research Establishment Risø, July 1969.

UTILIZATION AND SPECIALIZATION OF THE RISØ (HOT CELL FACILITY)

1) What were the original purposes of the facility? : General purpose facility for examination of irradiated materials, for encapsulation of irradiation sources, and for repair work on contaminated/radioactive components.

2) What major modifications have subsequently been made and for which particular research programme? None.

3) For which major projects and programmes is the facility presently being used? The Danish programme for studies and development of water-reactor fuel. Post-irradiation examination on contract-basis for foreign institutions.

4) Major modifications planned : None - only development and improvement of equipment are foreseen.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community? Yes - during several years, more than 50% of the work has been carried out on contract-basis for foreign firms and institutions.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE FR2 REACTOR AT KARLSRUHE

Name of reactor	Forschungsreaktor (FR2)
Organization	Gesellschaft für Kernforschung
Site	Leopoldshafen bei Karlsruhe
In operation since	1961
Power MW(th)	44
Moderator	D_2O
Coolant	D_2O
Fluid and pressure (kg/cm^2) in experimental channel	3-1.2 kg/cm
Nominal operation days / year	280
Operating cycle (days)	
on power	38
shut down	11

	Responsible officer:	Address:
FR 2 :	Steiger	Ges. für Kernforschung D - 7500 Karlsruhe Postfach 3640
Hot Cells:		

EXPERIMENTAL IRRADIATION POSITIONS OF THE FR 2 REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	active length m/m	Diameter m/m	Typical unperturbed neutron fluxes: thermal	Typical unperturbed neutron fluxes: fast (>100 KeV)	γ-heating W/gr Al	Remarks
1. Isotope positions	41	2100	26	$5-9,5.10^{13}$	$2-6\ .10^{12}$	0.5	
2. Free fuel-element positions	40	2100	56	$4-9,5.10^{12}$	$2-6\ .10^{12}$	0.5	
3. Thermal columns -	6	1000	200x200 □	$0,3-2,2.10^{11}$	-		
	2	2000	100x100 □				
	1	2000	600x400 □				
	2	2000	200x200 □				
4. Radiation channels -	9	300	130x190	$3-5\ .10^{13}$	$1-2,5.10^{12}$	0,1	
	2	3000	55	$\leqq 9\ .10^{13}$	$\leqq 6\ .10^{12}$	≦0,5	
	1	2000	55	$\leqq 6\ .10^{13}$	$\leqq 4\ .10^{12}$	≦0,3	
5. Vertical channels	3	2100	130	$\leqq 9\ .10^{13}$	$\leqq 6\ .10^{12}$	≦0,5	

2) Reactivity available for experiments : ca. 5%

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g. neutrography, etc.) :
Neutron radiography, gamma scanning, gamma irradiation facility, hot cell in the reactor building, various transport casks, low-temperature transport cryostat, cold neutron source, facility for changing samples during operation, etc.

5) References of relevant publications :
1.) Kerntechnik 8 (1966) N°6, p. 253 "Utilization of the reactor FR-2 as a research facility, etc." H. Oehme, W. Marth
2.) KFK-Reports N° 688,742, 746, 1415
(annual operating reports)

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) Hot cells of the GFK

(Nuclear Research Institute)	Operated by RBT/HZ in the GFK
Transplutonium laboratory (TPL) of the GFK	

7) Are facilities available for irradiations on behalf of other organizations of the European Community? · Yes.

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

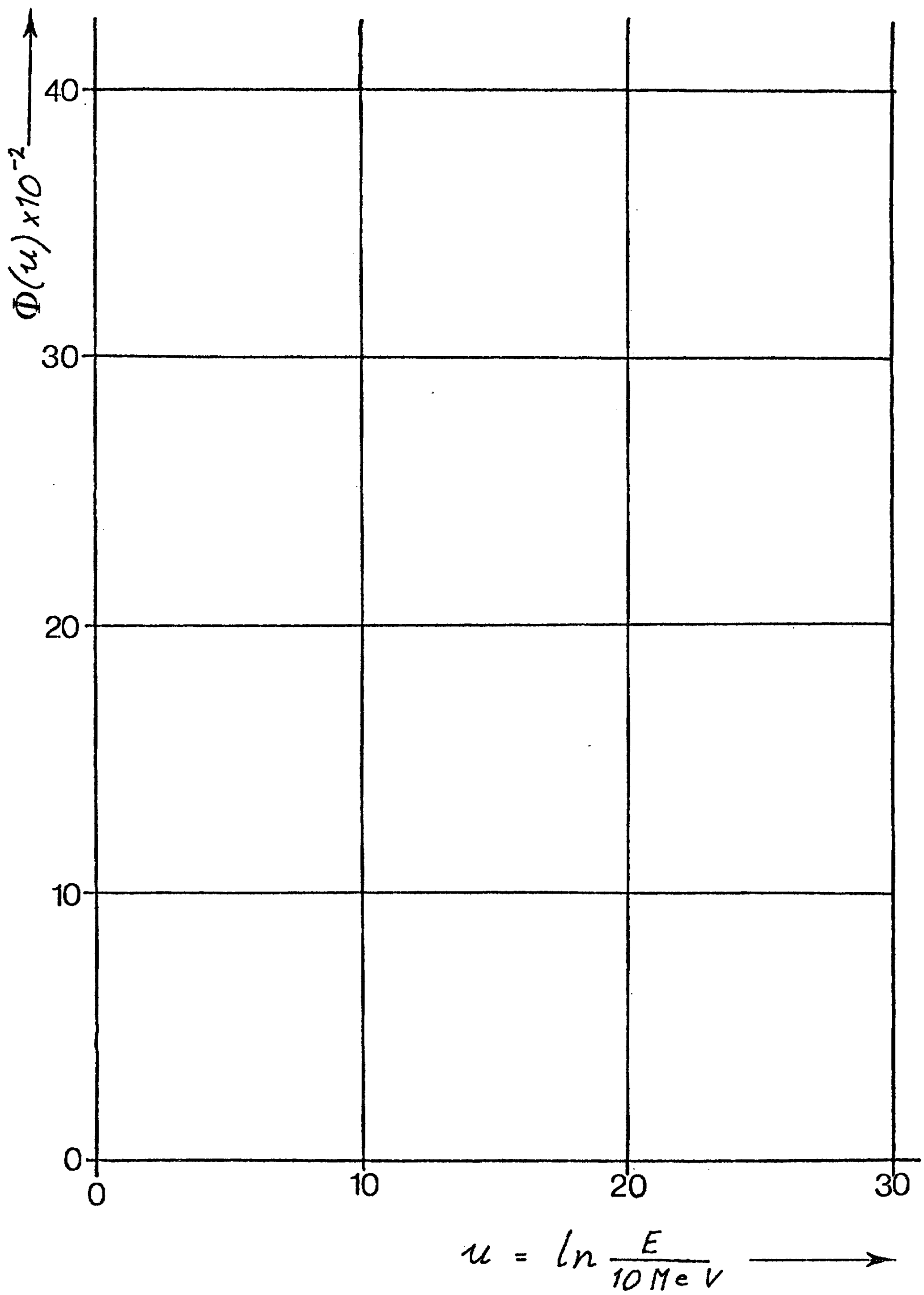
(histogram of flux per unit lethargy)

$\int \Phi(u)\,du = 1$

________ = typical core position

———— = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE FR 2 REACTOR

1) What were the original purposes of the reactor?

Pure research, solid-state physics, materials research, isotope production

2) What major modifications have subsequently been made and for which particular research programme ?

Reactor power increased from 12 MW to 44 MW
Neutron flux increased from $\phi_{th} = 3.10^{13}$ to 1.10^{14} cm^{-2} sec^{-1}

3) For which major projects and programmes is the reactor currently being used?

"Fast breeder" Project (PSB)
"Actinides" project (PACT)
Solid-state physics
Materials research
Isotope production

4) What loops and irradiation devices have been specially developed for this reactor?

a) give name and purposes of the devices : 1.) Low-temperature irradiation facility (solid-state physics); 2.) He loop (fuel element development); 3.) D_2O pressurized water circuit (fuel-element development); 4.) Superheated steam circuit (detection of cladding defects, filtering radioactive waste gases, decontamination, reactor safety); 5.) various capsule tests (fuel-element development); 6.) Pneumatic rabbit (isotope production); 7.) Thermionic converter (ITR development).

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned : None.

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE FR-2 REACTOR

(give also references of relevant publications)

1. Low-temperature irradiation facility

Medium: He in gaseous form; Expansion: reciprocating-piston device; $\emptyset_{th}$ (unperturbed): 8.10^{13} $\emptyset_f$ = $2.5.10^{12}$; Refrigerating capacity at 12°K = 500 W; Pressure experimental container: 2.5 atg; Lowest attainable irradiation-sample temperature: 10° - 20° K according to reactor power. Facility for cold transport in liquid He.

Publication: KFK Report N° 463.

2. He loop

Medium: He; Operating pressure: 30 atm; Gas throughput through the test section: maximum 350 kg/h; Maximum He temperature: 200° C; Maximum removable heat output ca. 30 kW; Specific test sample output: 1000 W/cm; cladding temperature: 600° C; Test sample change during reactor operation; Circuit is designed without stuffing boxes; H_3 and fission-gas clean-up section, iodine filter. Precise adjustment of the test-sample output by axial movement of the test sample; Gamma scanning device on removal.

Publications: 1. Kerntechnik 10 (1968) N° 6, P. 344

2. Kerntechnik 11 (1969) N° 7, P. 403

3. D_2O - Pressurized water circuit

Medium: D_2O in the bypass to the reactor coolant circuit; Operating pressure: 50 atm.; D_2O throughput

per test section: 1 - 6 m^3/h; Two test sections; Output dissipated per test segment: 150 kW; Maximum D_2O temperature: 150° C; Components without stuffing boxes; Mechanical filter; Cladding defect detectors.
Publications: Kerntechnik (submitted).

4. Superheated steam circuit

Medium: H_2O superheated steam; Operating pressure: 160 atm.; Maximum steam throughput: 140 kg/h; Maximum steam temperature: 550° C; Test sample output = 4 kW; Temperature of fuel cladding: ≦800° C; Circuit suitable for operation with cladding defects, and cladding defects up to 90 mm^2 have so far been brought in; Proof of cladding defects through gamma spectroscopy and delayed neutrons; various sample chambers in the circuit; H_2O sampling; Gas analysis; Iodine filter and inert gas delaying section.
Publications: KFK Report N° 1255

5. Various instrumented capsule experiments for fuel rod irradiation, of high-performance fuels, for measurement of fuel creep and swelling under various operating conditions.
Publications: Kerntechnik <u>10</u> (1968) N° 3, P. 136
Kerntechnik <u>12</u> (1970) N° 5/6
Kerntechnik <u>12</u> (1970) N°10, P. 454
Kerntechnik <u>14</u> (1972) N° 2, P. 12
Atomwirtschaft N° 2 (1973)

6. Pneumatic tube conveyor (rabbit)

Medium: Air under suction; Operating pressure in the irradiation channel: - 175 mm w.g.; Air throughput: 35 m^3/h; Velocity: 15 m/s; Irradiation time: between 10^{-1} and $3.6.10^5$ sec; $\phi_{th} = 9.10^{13}$; $\phi_f = 1.5.10^{12}$; Rapid discharge. In addition to the FR-2 building, the isotope laboratory and the radiation chemistry laboratory have each a dispatching and receiving unit.

7. Thermionic converter

Emitter temperature: ca. 1500° C; Collector temperature: ca. 700° C; Nuclear operating power: 1.7 kW; Efficiency: ca. 10%; Irradiation testpieces, with the exception of the auxiliary facilities, are not re-usable. Irradiation time attained so far: Maximum 8000 h.

Publications: Kerntechnik 11 (1969) N° 5
Kerntechnik 13 (1971) N° 1
1971 Meeting on reactors of one German Atomic Forum, Paper H.7-518
Int. Conf. on thermionic power Production, Jülich, 5 - 9 June 1972.

IRRADIATION FACILITIES

INFORMATION SHEET No. 5
(Continued) (3)

Types (e.g. isotope production holes, hydraulic rabbits, thermal columns, loops in core, loops in reflector, beam tubes, through holes, etc.)	No.	Useful dimensions	Nuclear Characteristics			Environmental Characteristics		
			Thermal Neutron flux	Fast Neutron flux	Gamma flux	Max. allowed temp.	Max allowed pressure	Surrounding medium
A) Facilities for Routine Irradiation								
1) Air-cooled Isotope Production Channels a) Standard Type	12	Standard sample (modified harwell can): dia: 2,6 cm, length: 6,8 cm (longer samples possible) 29 standard samples per channel				200°C	ambient	air
b) Special Type 1)	(12)	dia: 3,7 cm length: core height	5-9,5.10^13x)	2-6.10^12x)	1,6-8.10^13x)	200°C	ambient	air
2) Water-cooled Isotope Production Channel 2)	1	Dia: approx 2 to 4cm length: core height				100°C	approx 1.5 ata	D_2O
3) Instrumental Capsule Irradiation Rig 2)	1	dia: approx 3 cm length: approx. 30cm				approx. 500°C	ambient	He, Ne
4) Pneumatic Rabbit	1	dia: 3,5 cm length 10 cm	7,2-9,5.10^13 xx)	5,8-6.10^13 xx)	6-8.10^13 xx)	100°C	ambient	air
5) Thermal Column a) Vertical Holes 3)	6	20 x 20 x 100 cm 4)	0,3-2,2.10^11			approx. 100°C	ambient	air
B) Other Facilities								
5) Thermal Column b) Horizontal Holes 5)	1 2	60 x 40 x 200 cm 4) 10 x 10 x 200 cm 4) 20 x 20 x 200 cm 4) 20 x 20 x 190 cm 4)	0.3-2,2.10^11			approx 100°C	ambient	air

x) range of maximal flux in these facilities   xx) average and maximum flux in this facility

IRRADIATION FACILITIES

INFORMATION SHEET No. 5
(Continued) (4)

Types (e.g. isotope production holes, hydraulic rabbits, thermal columns, loops in core, loops in reflector, beam tubes, through holes, etc.)	No.	Useful dimensions	Nuclear Characteristics			Environmental Characteristics		
			Thermal neutron flux	Fast neutron flux	Gamma flux	Max. allowed temp.	Max allowed pressure	Sur-rounding medium
6) Horizontal Beam Holes 5) a) Thimbles	9	dia.in biol.shield: from 22 to 35 cm dia. in reflector: from 13 to 19 cm	$3-5.10^{13}$	$1-2.10^{12}$	$1-1,5.10^{13}$	approx. 100°C	ambient	air
b) Through Holes	2	dia. in biol. shield: from 22 to 35 cm dia in reflector and core: 5,5 cm	$3-6.10^{13}$	$1-2,5.10^{12}$	$1-2.10^{13}$			
7) Superheated-Steam Loop 6) (in core)	1	dia.: 2 cm length: 200 cm	$2-2,5.10^{13}$	$1,6-2.10^{12}$		550°C	160 ata	H_2O
8) Pressurized-Water Loop (in core)	2	dia: approx. 4 cm length: core height	$6-8.10^{13}$	10^{12}		140°C	55 ata	D_2O
9) He-Cooled Loop (in core)	1	dia.: 2,0 cm length: 60 cm	8.10^{13}	10^{12}		350°C	150 ata	He
10) Low-Temperature Irradiation Facility (in core)	1	dia.: 1 cm Length: 10 cm	$4-5.10^{13}$	$2,3.10^{12}$		from 216 to 73°C	4 ata	He

INFORMATION SHEET No 5
(Continued) (5)

Remarks

1) Sample geometry and sample holding device may be designed according to the pertinent cooling necessities within the given dimensions.

2) Presently in design phase.

3) Revolving sample holding device available for elimination of flux gradient.

4) Last number = axial dimensions within graphite block.

5) The horizontal beam holes and the horizontal holes of the Thermal Column are occupied by various experiments, preferably in the field of basic neutron physics research. Besides several neutron spectrometers, a cold neutron source is installed and provides a beam of neutrons with energies down to 5×10^{-3} eV.

6) The loop is designed for the operation of fuel samples with intentionally damaged cannings. The canning defect can be generated during operation.

7) Characteristics of coolant.

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT KARLSRUHE CENTRE

Location Organization Name of lab	Year of active operation	Scope Number of working positions	Scope Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators: number and type	Remarks and references
Dismantling cell FR 2	1961	2	7	concrete	no	no	Mod 8 GM 300 3 to.crane	Inspection & dismantling
Hot cells Bldg 32	1965	7	60	concrete	yes	possible	HWM - AZ ooG	Testing of irradiated fuel
		4	24	concrete	yes	possible	EM 50	
Hot Chemistry cells Bldg 32a	1965	4	27	concrete	no	possible	HWM A 100 GM300	Testing of irradiated fuel & reprocessing
		3	13	concrete	no			

INFORMATION SHEET N° 6

(Continued)

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT GfK CENTRE

Location : Organization Name of lab	Year of : active operation	Scope		: Gamma shielding (material, thickness (m) and density g/cm^3)	: Leak tightness :	Special: atmosphere	Manipulators: number and type	Remarks and references
		Number of: working positions:	Active area (m^2):					
Gesellschaft für Kernforschung	9	11	84	Concrete 90 cm 4,5 and 3,5	0,5 Vol% per h	N_2	22 Wälischmiller	
Karlsruhe Hot cells Building 701	0	29	60	Lead 20 cm		N_2	58 Wälischmiller	

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE GfK HOT CELLS FACILITY

1. Owner or operator of the facility : Gesellschaft für Kernforschung mbH, Karlsruhe, Post box 3640, Reactor operation and technology section, hot cells

2. With which reactor is the facility associated? : FR-2

3. Give details of equipment and techniques available :

   Dismantling cell, X-ray examination, Dimension measurements, Gamma spectrometry, Gas metering plant, Sample manufacturing, Metallography, radioautography, Tensile testing, Creep-rupture testing, Internal tube pressure testing, Charpy impact testing, Hardness testing, X-ray microstructure testing, Calorimetry, Electron microscopy, Micro sensing, Micro-weighing, Welding plant.

4. References of relevant publications :

   "Reports from the hot cells"

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE HOT CELLS

1. What were the original purposes of the facility? :

   Post-irradiation investigations for the "fast breeder" project

2. What major modifications have subsequently been made and for which particular research programme?

   Expansion of metallography and structural materials testing for the "fast breeder" project.

3. For which major projects and programmes is the facility presently being used?

   "Fast breeder" project

4. Major modifications planned :

   --

5. Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

   No, currently working at full capacity

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE MERLIN REACTOR AT Jülich

Name of reactor	FRJ-1 MERLIN
Organization	KFA-Jülich GmbH
Site	Jülich
In operation since	1962
Power MW(th)	10
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	Connected to ventilation system air with -0,01 kg/cm^2 respectively coolant water of the primary circuit for vertical channels
Nominal operation days/ year	290
Operating cycle (days)	
on power	26
shut down	5

	Responsible officer:	Address:
FRJ 1 :	Dr. Friedewold	Kernforschungsanlage GmbH
Hot cells	Dr. H. Müller	D - 517 Jülich
		Postfach 1913

IRRADIATION POSITIONS OF THE MERLIN REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	active length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
Randposionen	24	600	76,1x76,1	$0,4 - 1.10^{14}$	$1,5.10^{13}$	4,0	vertical tubes on lattice
Incore positions	5	600		$1,1.10^{14}$	$5,4.10^{13}$	6,4	
D3, E5, F6	3	1000	153 ∅	7.10^{12}	5.10^{11}		horizontal beam tubes
A1	1	1000	300 ∅				
TH I 1,2,3,4) TH II 1,3,4)		1500	101x101 x1750	2.10^{10}	2.10^{8}		2 thermal columns with 7 channels
TV2.1, TV2.2) TV1.1, TV1.2)	4	600	80x80	3.10^{12}	$0,2.10^{12}$		vertical graphite irradiations channels
V1, V2	2	200	150 ∅	2.10^{12}			vertical channels
Rabbits BE1)			40	5.10^{13}	7.10^{12}		irradiation facilities
BE22/1)	5	ca.400	65	1.10^{14}	$1.5.10^{13}$	4,0	
BE22/3)							
BE 25)	1	ca.100	40	5.10^{13}	1.10^{13}		
BE 26)	1	ca. 10	10	4.10^{13}	1.10^{13}		

2) Reactivity available for experiments : $\Delta k/_k$ 2,5% to 9,5% dependent on burn-up of fuel

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g. neutrography, etc.) :

storage block and radiation protection flasks for handling long and short, experiments facility, for neutro-radiography planned

5) References of relevant publications : 1. Sicherheitsbericht des Reaktors FRJ-1 (MERLIN) vom 26. April 1961
2. Sicherheitsbericht zu 1. vom 5. August 1963
3. Sicherheitsbericht für den Betrieb d. Forschungsreaktors FRJ-1 (MERLIN) mit einer therm. Leistung von 10 MW

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) Institut für Reaktorwerkstoffe, IRW - Heisse Zellen, KFA Jülich,
Institut für chemische Technologie

7) Are facilities available for irradiations on behalf or other organizations of the European Community? :

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

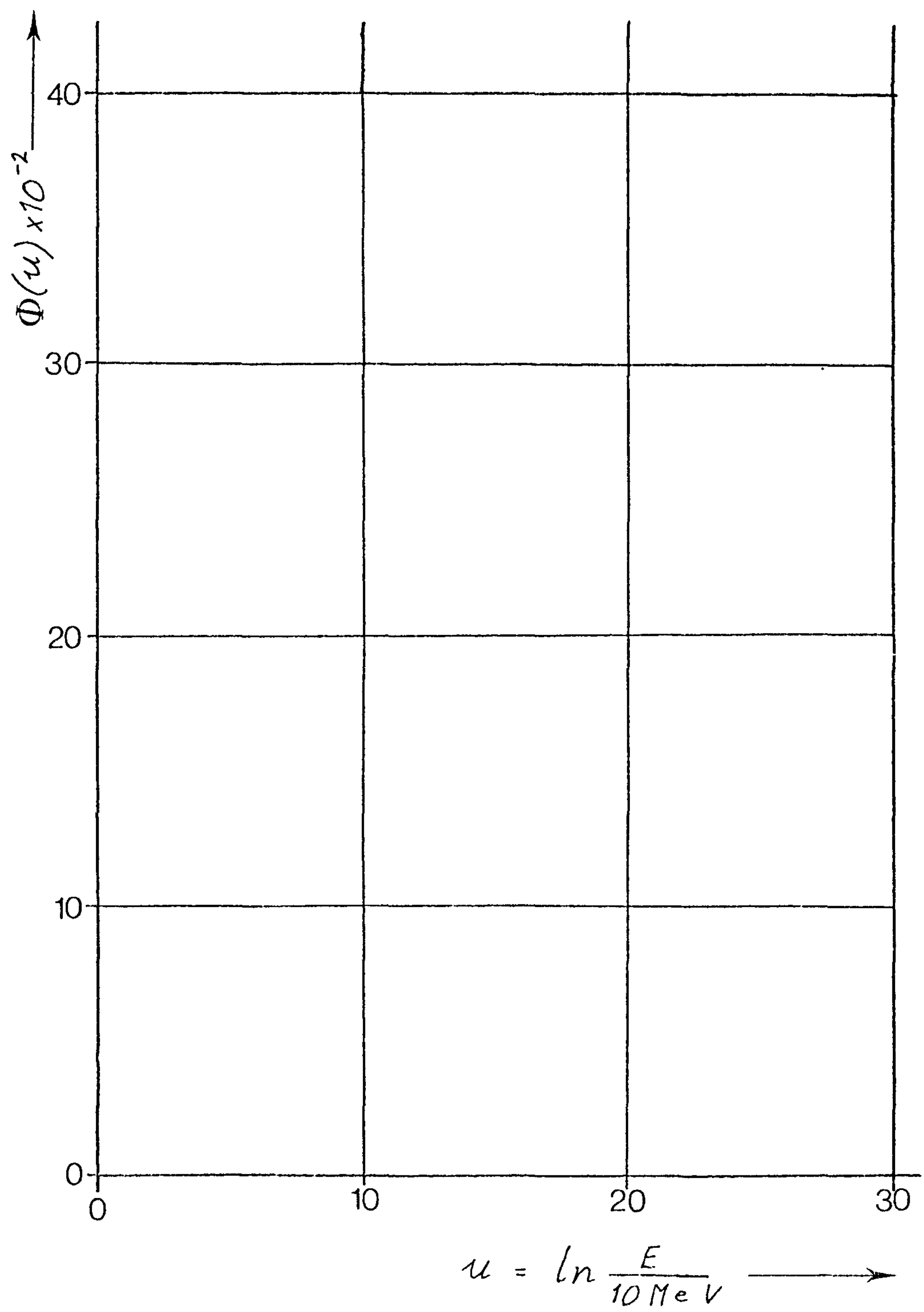
(histogram of flux per unit lethargy)

$\int \Phi (u)\, du = 1$

_________ = typical core position

————— = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE MERLIN REACTOR

1) What were the original purposes of the reactor?

Research in neutron physics, physics, chemistry, medicine, biology, fuel testing, education and training

2) What major modifications have subsequently been made and for which particular research programme?

Substantial modification 1967 to improve accessibility to reactor core and to run reactor longer operation cycles on power (up to 5 weeks)
Power increase from 5 MW to 10 MW in 1971 to short irradiation time

3) For which major projects and programmes is the reactor presently being used?

Fuel irradiation for graphite moderated high temperature reactors (especially for testing new reprocessing procedures). Small sample-irradiations for medicine, biology and chemistry

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :
1) Several simple irradiation facilities in Incore- and "Rand"-Positions to allow irradiations with selected neutron fluxes of a broad scale of material (e.g. organic substances) at a temperature level of 50° C.
2) Fast pneumatic rabbit facility (time for shooting out lower than 1 sec.)

3) Multi purpose irradiation rigs for fuel samples cooled by gas, water or liquid sodium

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

New facility for solid state physics in the Al beam tube.

INFORMATION SHEET N° 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE FRJ - 1 (MERLIN)

Type	Number	Useful dimension (mm)	Nuclear Characteristics			Environmental Characteristics	
			Thermal neutron flux $(n/cm^2 s)$	Fast neutron flux $(n/cm^2 s)$	Gamma flux r/h	Capsule Temp. ° C	Surrounding medium
FRJ-1 Insertion procedure (BE 3) (in-core - Pos.)	1	Dia. 50x110 (4 off)	$1 \cdot 10^{14}$	$4 \cdot 10^{13}$	10^{9}	50	H_2O
FRJ-1 Insertion procedure (BE 3) (outside of Core)	5	Dia. 50x110 (4 off)	$7 \cdot 10^{13}$	$1 \cdot 10^{13}$	$2 \cdot 10^{8}$	50	H_2O
FRJ-1 Tube insertion procedure (BE 22)	1	Dia. 50x110 (3 off)	$1 \cdot 10^{14}$	$4 \cdot 10^{13}$	10^{9}	50	H_2O
FRJ-1 Tube insertion procedure (BE 22)	1	Dia. 50x110 (3 off)	$8 \cdot 10^{13}$	$1 \cdot 10^{13}$	$2 \cdot 10^{8}$	50	H_2O
FRJ-1 Tube insertion procedure (BE 22)	1	Dia. 50x110 (3 off)	$7 \cdot 10^{13}$	$8 \cdot 10^{12}$	$2 \cdot 10^{8}$	50	H_2O
FRJ-1 Tube insertion procedure (BE 22)	1	Dia. 50x110 (3 off)	$6 \cdot 10^{13}$	$8 \cdot 10^{12}$	$2 \cdot 10^{8}$	50	H_2O
FRJ-1 Pneumatic-Rabbit (BE 1) (tube 3)	1	Dia. 23 x 80	$5 \cdot 10^{13}$	$1 \cdot 10^{13}$	$2 \cdot 10^{8}$	110	CO_2
FRJ-1 Pneumatic-Rabbit (BE 1) (tube 2)	1	Dia. 23 x 80	$5 \cdot 10^{12}$	$3 \cdot 10^{11}$	10^{8}	100	CO_2
FRJ-1 Pneumatic-Rabbit (BE 1) (tube 4)	1	Dia. 23 x 80	$3{,}5 \cdot 10^{12}$	$1{,}5 \cdot 10^{11}$	10^{8}	100	CO_2
FRJ-1 Fast Rabbit (BE 25)	1	Dia. 10 x 30	$6 \cdot 10^{13}$	$8 \cdot 10^{12}$	10^{8}	110	CO_2
FRJ-1 Testrig (LV 16)	1	Dia. 13 x 90	$8 \cdot 10^{13}$	$8 \cdot 10^{12}$	$2 \cdot 10^{8}$	40 - 300	H_2O/CO_2

<u>INFORMATION SHEET N° 5</u>
(cont'ed)

type	Number	Useful dimension (mm)	Nuclear Characteristics: Thermal neutron flux $(n/cm^2.s)$	Fast neutron flux $(n/cm^2.s)$	Gamma flux r/h	Environmental Characteristics: Capsule Temp. ° C	Surrounding medium
FRJ-1 Capsule rotating facility (BE 26)	1	17x15x 4 (10 off)	$3 . 10^{13}$	$2 . 10^{12}$	10^{8}	50	H_2O
FRJ-1 Cage facility (BE 15) (Thermal Column)	1	65 x 55 x 15	$2 . 10^{9}$	10^{7}	$2 . 10^{2}$	40	Air
FRJ-1 Low Temperature Irradiation (BE 14) (Thermal Column)	1	200 x 60 x 60	$1. 10^{10}$	10^{8}	$6 . 10^{3}$	down to 0	Air/CO_2

Publications

Bestrahlungstechnik an Forschungsreaktoren	W. Marth	Thiemig - Verlag München
Z I R - Ergebnisse und Möglichkeiten	M. Pollermann	K F A - Bericht (JÜL - 796 - RX)
The facilities for reactor irradiation	M. Pollermann	Sonderdruck K F A Jülich (1964)
Die Bestrahlungseinrichtungen an den Reaktoren	M. Pollermann	Atompraxis 10 (1964)
Rigbestrahlung von Stahlproben	D. Pachur	Kerntechnik 6 (1964)
Hydraulische Rohrpost	H. Stechemesser and K. Sachse	Kerntechnik 12 (1970)

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE DIDO REACTOR AT Jülich

Name of reactor	FRJ-2
Organization	KFA-Jülich GmbH
Site	Jülich
In operation since	1962
Power MW(th)	23
Moderator	D_2O
Coolant	D_2O
Fluid and pressure (kg/cm^2) in experimental channels	Connected to ventilation system air with $-0,01\ kg/cm^2$
Nominal operation days/year	240
Operating cycle (days)	
on power	23
shut down	5

	Responsible officer:	Address :
FRJ 2 :	Dr. Friedewold	Kernforschungsanlage GmbH
Hot cells :	Dr. H. Müller	D - 517 Jülich
		Postfach 1913

IRRADIATION POSITIONS OF THE DIDO REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
Fuel element	25	610	51	2.10^{14}	1.10^{14}	2,5	vertical
2V, 4V, 6V	7/4/4	610	51/102/ 153	$2\text{-}0,5.10^{14}$	1.10^{13}	0,3	vertical in D_2O
4VGR, 6VGR, 10VGR	2/6/2	610	102/153 254	1.10^{13}	1.10^{10}	0,005	vertical in graphite
4H, 6H, 10H	6/1/1	\1500	108/152/ 253	1.10^{14}	1.10^{11}	0,7 - 1,5	horizontal in D_2O
6 HGR	10	1100	152	2.10^{13}	2.10^{10}	0,025	horizontal in graphite
4 HTC	9	1100	101	7.10^{10}	10^9	1,15	horizontal thermal column
2 TAN	1	2000	21,5/85	2.10^{14}	1.10^{13}	1,15	below the core in D_2O

2) Reactivity available for experiments : 8% $\Delta k/k$ (about 10 irradiation facilities in fuel elements and V-channels)

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) :

Cold source (liquid hydrogen)

5) References of relevant publications : Safety report on research reactor FRJ-2 (DIDO), February 1962
Safety report on the operation of FRJ-2 at 15 MW, May 1967
Safety report on the operation of FRJ-2 up to a maximum of 25 MW, October 1970

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6)

7) Are facilities available for irradiations on behalf of other organizations of the European Community? :

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

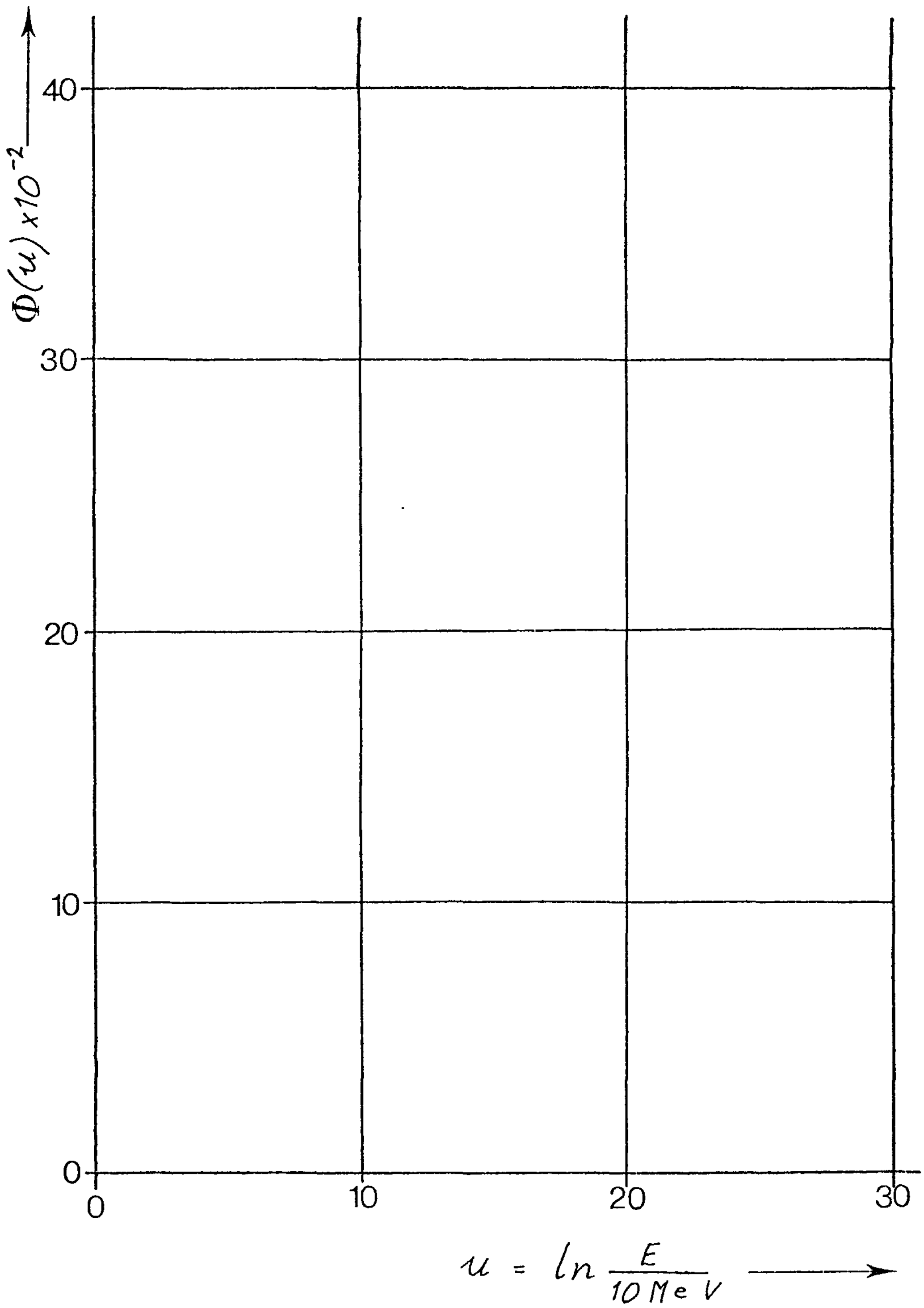
(histogram of flux per unit lethargy)

$\int \Phi\ (u)\ du = 1$

________ = typical core position

———— = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE DIDO REACTOR

1) What were the original purposes of the reactor?

Materials testing at 10 MW thermal power

2) What major modifications have subsequently been made and for which particular research programme?

Power increase to 15 MW (1967)) Power increase to 23 MW (1972)) Cold water cooling circuit for experiments) Better working conditions)	generally for all experiments

3) For which major projects and programmes is the reactor currently being used?

Beam experiments for solid state physics
Beam experiments for neutron physics
Irradiation experiments for HTR- and BWR-fuels
Irradiation of steel samples

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :

Liquid hydrogen loops for low energy neutrons
Boiling water loop facility for testing canned fuel rods under irradiation conditions (4 loops at the same time)

Irradiation rigs for coated particles in connection with sampling facility to measure release of fission products
4 flight spectrometers, one of them with backscattering devices

b) main characteristics of specialized irradiations devices are to be listed on separate sheet N° 5

5) Major modifications planned :

New experimental facilities for solid state physics

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE (DIDO) REACTOR

Type		Number	Useful dimension (mm)	Nuclear Characteristics: Thermal neutron flux ($n/cm^2 s$)	Fast neutron flux ($n/cm^2 s$)	Gamma flux r/h	Environmental Characteristics: Capsule Temp. ° C	Surrounding medium
FRJ-2 Rig	(BE 9)	6	10x10x55(24 off)	$1,5.10^{14}$	$4 . 10^{13}$	$1,4.10^{9}$	250-700	He/N
FRJ-2 Rig	(BE 21)	2	Dia. 45x20(2 off)	$1,5.10^{14}$	$4 . 10^{13}$	$1,4.10^{9}$	70	D_2O
FRJ-2 Hydraulic Rabbit	(BE 20)	1	Dia. 23x80	$1,4.10^{14}$	$1 . 10^{13}$	$1 . 10^{8}$	4	H_2O
FRJ-2 Standard Rabbit	(BE 12)	1	Dia. 23x80(2 off)	$3,5.10^{13}$	$1,5.10^{10}$	$5 . 10^{7}$	100	CO_2
FRJ-2 Fast Rabbit	(BE 11)	1	Dia. 4x25	$6 . 10^{13}$	$5 . 10^{10}$	$1 . 10^{8}$	200	CO_2
FRJ-2 Isotope Unit		1	Dia. 23x70(70 off)	$10^{10}-10^{13}$	$10^{7}-3.10^{9}$	$10^{5}-10^{7}$	50-300	CO_2
FRJ-2 Fuel Irradiation Loops in Core Automatic Analysing System for Fission Cares				$1,4.10^{14}$	$4 . 10^{13}$	$1,4.10^{9}$		

Publications

Irradiation techniques in research reactors, W. Marth, Thiemig Verlag, Munich

ZIR - results and possibilities, M. Pollermann, KFA report (Jül - 796 - Rx)

The facilities for reactor irradiation, M. Pollermann, reprint KFA Jülich (1964)

The irradiation facilities in reactors, M. Pollermann, Atompraxis 10 (1964)

Rig irradiation of steel test samples, D. Pachur, Kerntechnik 6 (1964)

Hydraulic rabbit, H. Stechemesser and K. Sachse, Kerntechnik 12 (1970).

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT KFA CENTRE

Location: Organisation Name of lab	Year of: active operation	scope		Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
		Number of working positions	Active area (m^2)					
Jülich KFA								
HZ 1	1969	11	70m^2 Cell 95 m^2	110 cm, 85 cm barytic concrete 3.5 gcm^{-3}	alpha-gamma-tight	N_2	8 Drath & Schrader ELMA 50-1000-2 24 HWM 100 1 HWM 200	H.O.Witte, H.Müller; Proc.17.Conf. Remote Syst. Technol.1969 S. 87-98 H.Müller K.Stradal H.Witte atomwirtschaft XIII, 8-9 (1968) S.444-448
HZ 2	1970	15	52 m^2	85 cm barytic concrete 3,5 gcm^{-3}	alpha-gamma-tight	N_2	2 Drath & Schrader ELMA 50-1000-2 30 HWM 100	as above

INFORMATION SHEET N° 6
(cont'ed)

Location: Organization Name of lab	Year of: active operation	Scope	:	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
		Number of working positions	Active area (m^2)					
HZ 3	-	-	-	-	-	-	-	-
BZ I	1965	10	11m^2	Lead 25 cm 15 cm 10 cm	Beta-gamma-tight	-	2 CRL 7 17 (rod grabs	
BZ II	1966	7	15,5m^2	Cast Iron 46 cm 7,0 g cm^{-3}	alpha-gamma-tight; boxes		12 HWM 100 1 CRL	
BZ III	1967	5	17 m^2	Concrete 140 cm 2,3 and 2,8 g cm^{-3}	alpha-gamma-tight; boxes		9 HWM 100 1 HWM 200	G.Pott, F.Stockschläder; Proc. 14. Conf. on Remote Syst. Techn. 1966 S. 11-20

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE HOT CELLS FACILITY

1) Owner or operator of the facility: K F A Jülich

2) With which reactor is the facility associated? : FRJ-1, FRJ-2, AVR (communication only by means of motor vehicles)

3) Give details of equipment and techniques available: B Z I

Inward and outward transfer, dismantling, sample removal, repacking, thread cutting. Determination of the crystalline proportion in notched-bar impact test samples, photography. Grinding notched-bar impact test samples for hardness testing. Notched-bar impact tests, hardness test. Length marking, length measurement, weighing.
Preparation of metallographic sections, periscope photography,
Leaching of surfaces to determine contamination level,
Leaching of particles in a leach apparatus,
Tensile test, small-load hardness test.

4) References of relevant publications:

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE HOT CELLS FACILITY

1) Owner or operator of the facility :	K F A Jülich
2) With which reactor is the facility associated? :	FRJ 1, FRJ 2, AVR (Communication only by motor vehicles)
3) Give details of equipment and techniques available:	B Z II Dismantling of reactor modules, longitudinal and transversal sectioning, removal of test samples, repacking, periscope photography, length measurement. Gamma scanning up to a length of 0.6 m, gamma spectrometry, Diameter and generatrix measurements (0.6 m long, 50 mm in diameter), optical inspection and periscope photography (magnification x 30), puncturing and removal of fission gas, void determination. Dismantling of fuel rods, removal of test samples, repacking, capsule dismantling, test-sample impregnation, measurements of spherical-element burn-up (Cs determination)

4) References of relevant publications :

Studies of irradiated high-temperature reactor fuels, Atomwirtschaft XIII , N° 8-9 (Aug-Sept 1968) PP 449 - 452, E. Groos, G. Pott, F. Stockschläder, B. Thiele.

INFORMATION SHEET N° 7

(Continued) (3)

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE HOT CELLS FACILITY

1) Owner or operator of the facility : K F A Jülich

2) With which reactor is the facility associated? : FRJ-1, FRJ-2, AVR (Communication only by means of motor vehicles)

3) Give details of equipment and techniques available :

B Z III

Test sample removal, repacking, periscope photography, leach testing, electrolytic disintegration.

Baking-out testing of spherical elements and coated particles.
Gamma spectrometry and gamma scanning up to a length of 0.5 m.

Test sample removal, optical inspection and periscope photography, dimension measurements, weighing, oxidation test, drop test, crush test, particle crushing experiment.

4) References of relevant publications :

1. Studies of irradiated high-temperature reactor fuels, Atomwirtschaft XIII, N° 8-9 (Aug.-Sept. 1968) pp. 449-452, E; Groos, G. Pott, E. Stockschläder, B. Thiele.

2. Apparatus for measuring the release of fission gases and other fission products resulting from baking out, KFA report Jül-707-RW, 1970, K.A. Stradal

3. Removal and handling of small test samples from HTR fuel elements, Paper presented at the 12th meeting of the Euratom Committee for Hot Laboratories, Cadarache, 25-26 May 1970.

4. Sampling from fuelled spheres and irradiated graphite pieces; Post-Irradiation Examination Techniques, Conference Reading/England, March 22-23, 1972. London: The Inst. of Civil Engineers, Vol.C.,p.35-38 M.Herren

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE HOT CELLS FACILITY

1) Owner or operator of the facility : K F A Jülich

2) With which reactor is the facility associated? : FRJ-1, FRJ-2, AVR (Communication only by means of motor vehicles)

3) Give details of equipment and techniques available: H Z 1 (+HZ 3, outside the cells)

Inward transfer of reactor modules, (horizontal and vertical up to 400 mm diameter, dismantling, leak testing.

Turning, milling, abrasive cutting, capsule opening, repacking, gamma spectrometry and gamma scanning of spherical elements.

Baking-out testing of coated particles, drop testing of spherical elements, crush testing of spherical elements and compacts (force/displacement diagram), weighing.

Dimension measurements (length, diameter, bowing up to a length of 4 m and a diameter of 200 mm).

Test sample storage

Metallographs and micrographs of ceramics, removal of microspecimens, microscopy.

Up to circa 1980, 60 000 AVR spherical fuel elements will be stored in the cooling pond of the HZ 1.

HZ 3 :

Electron scan microscopy of small, and also radioactive, bodies, such as coated particles, powders, etc. (outside the cells).

4) References of relevant publications :

1. Work programme and equipment of hot cells 1 and 2 in Jülich, Atomwirtschaft XIII, N° 8-9 (Aug.-Sept. 1968) pp. 444-448, H. Müller, K. Stradal, H. Witte.

2. Disassembling machine for in-core thermionic diodes
Post-Irradiation Examination Techniques, Conference Reading/England, March 22-23, 1972. London: The Inst. of Civil Engineers Vol.C, p.43-44 K.-A. Stradal

INFORMATION SHEET N° 7

(Continued) (7)

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST IRRADIATION EXAMINATIONS AT THE HOT CELLS FACILITY

1) Owner or operator of the facility : K F A Jülich

2) With which reactor is the facility associated? : FRJ-1, FRJ-2, AVR (Communication only by means of motor vehicles)

3) Give details of equipment and techniques available: H Z 2

The laboratory is currently being cleared out and decontaminated.

A reprocessing plant on a semi-works scale (graphite combustion, dissolution of the fuel) for spherical THTR fuel elements will then be installed. The laboratory will be thus occupied until about 1980.

4) References of relevant publications : Planning a semi-works scale experimental plant for the reprocessing of HTGR fuel elements, paper presented at the meeting on reactors of the German Atom Forum, Bonn 30 March - 2 April 1971, G. Kaiser, P. Sckuhr, H. Witte.

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE KFA JULICH (HOT CELL FACILITY)

1) What were the original purposes of the facility? :

BZ I	Steel studies
BZ II	Test fuel-rod studies
BZ III	Studies of THTR fuel elements (spheres)
HZ 1	General materials testing of large components
HZ 2	Physical and chemical studies of all kinds
HZ 3	Area prepared for setting up of lead cells

2) What major modifications have subsequently been made and for which particular research programme?

BZ I	
BZ II	
BZ III	
HZ 3	
HZ 1	Conversion to PADIRAC airlock system
HZ 2	Conversion of the area to the maintenance of alpha-tight boxes
	Changeover of the airlock system

These conversions were carried out, without any particular programme in mind, simply to keep pace with the latest developments in technology.

3) For which major projects and programmes is the facility presently being used?

see item 1)

4) Major modifications planned :

HZ 3 Two lead cells are to be installed here for steel studies (electron beam welding and tensile testing machine K_{IC})

HZ 1 A facility for gamma scanning objects 4 m in length will be installed here

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

All the hot laboratories mentioned above are in a position to accept projects that fall within the scope and capacity of their equipment, provided their work schedule permits it = (HZ 2 is occupied until 1980).

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS

AT KFA CENTRE

Location Organization Name of lab	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks
Kernforschungs - anlage Jülich "Chemiezellen"	1973	15 Hot cell boxes	51	Barytic concrete 0,85; $3,5 g/cm^3$	α-tight	none	40 Master-slave manipulators of the Wälischmiller A-100 type	
		2 Transfer stations	4	Lead, 0,25m and 0,20m				
		1 Technological box with variable shielding	35	Lead, variable				

INFORMATION SHEET N° 7'

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATION AT THE CHEMIEZELLEN FACILITY

I) Owner or operator of the facility : Operator of the "Chemiezellen" is the Institute for Chemical Technology

2) With which reactor is the facility associated? : FRJ-1 (MERLIN), AVR - Jülich

3) Give details of equipment and techniques available : The gastight boxes in non-gastight cells of barytic concrete and lead are interchangeable. Each experiment is assembled inside a box and cold-tested in the mock-up room, and the fully-equiped box is then moved into the charging zone of the concrete cells. The fully-equipped connection module for the electrical supply and control of the experiment is inserted into the appropriate console situated in the service area so that no further electrical connections need be made at the site of the experiment. In the charging zone the box is taken over by the manipulator, the shielding door of the charging zone is closed, and the box is placed by remote control on two forks which are attached to the plug-door. When the plug-door is closed, the box is moved to a position above the specially designed stand, and on being lowered into this stand is automatically coupled to all the supply connections. When a box is being removed, the plug-door performs the reverse function of uncoupling the box from the supply connections and returning it to the charging zone. All the boxes in both cell banks are gastightly connected to an underlying conveyor tunnel in which a dolly runs and from which they are sealed off by a cover inside the boxes. All transport of materials and radioactive substances from the transfer station to the individual boxes is effected via this tunnel. Besides commonly used transport systems, the PADIRAC and the CENDRILLON systems will be used for the transport of radioactive solids and radioactive liquids, respectively.

4) References of relevant publications :

1. J. M. Davis, B. Javary, A. Tarbe de St. Hardouin and L. Schlösser: Proc. 13th Conf. Rem. Syst. Techn. (1965) p. 69

2. H. Müller, F. Stockschlaeder, H. Witte: Radiation Safety in Hot Facilities; pp. 193-200 IAEA, Vienna 1970

3. H. Müller, F. Stockschlaeder, H. Witte: Radiation Safety in Hot Facilities; pp. 461-472 IAEA, Vienna 1970

4. H.J. Riedel, W. Utecht: Report JUL-777-CT, July 1971

INFORMATION SHEET N° 8'

UTILIZATION AND SPECIALIZATION OF THE CHEMIEZELLEN (HOT CELL FACILITY)

1) What were the original purposes of the facility? : The facility was planned for chemical work on hot radioactive materials.

2) What major modifications have subsequently been made and for which particular research programme? None.

3) For which major projects and programmes is the facility presently being used? The facility will be used in the reprocessing programme which is the main project of the Institute for Chemical Technology. The work includes experiments for waste treatment, refabrication of fuel particles, testing of experimental components under hot conditions and all the hot analytical work in connection with JUPITER (JUelicher PIlot-Anlage für Thorium-Element Reprocessing).

4) Major modifications planned : None.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

Not yet; there is no free capacity at the present.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE FRG 2 REACTOR AT GEESTHACHT

Name of reactor	FRG-2
Organization	Ges. für Kernenergie-Verwertung in Schiffbau und Schiffahrt m.b.H.
Site	GEESTHACHT (near Hamburg)
In operation since	1958
Power MW(th)	21 MW
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	
Nominal operation days/year	
Operating cycle (days)	
on power	28 days
shut down	7 days

	Responsible officer :	Address:
FRG 2 :	Dr. Röbert	Kernenergie Zentralabt. Forschungsreaktoren D-2054 Geesthacht Tesperhude
Hot cells :	Dr. Spalthoff	

IRRADIATION POSITIONS OF THE FRG 2 REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes x 10^{14} thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
In - core positions	3	600	75	4	2.3		
Peripheral positions	20	600	75	1.3	0.8		

2) Reactivity available for experiments :

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g; neutrography, etc.) : neutronography

5) References of relevant publications : The research reactors and irradiation facilities at the Research Centre Geesthacht of the G.K.S.S. , by J. Ahlf and G.A. Röbert (72,I,12) EAES - Sympos. at Petten, 16 - 17 May 1972

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6)

7) Are facilities available for irradiations on behalf of other organizations of the European Community? :

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

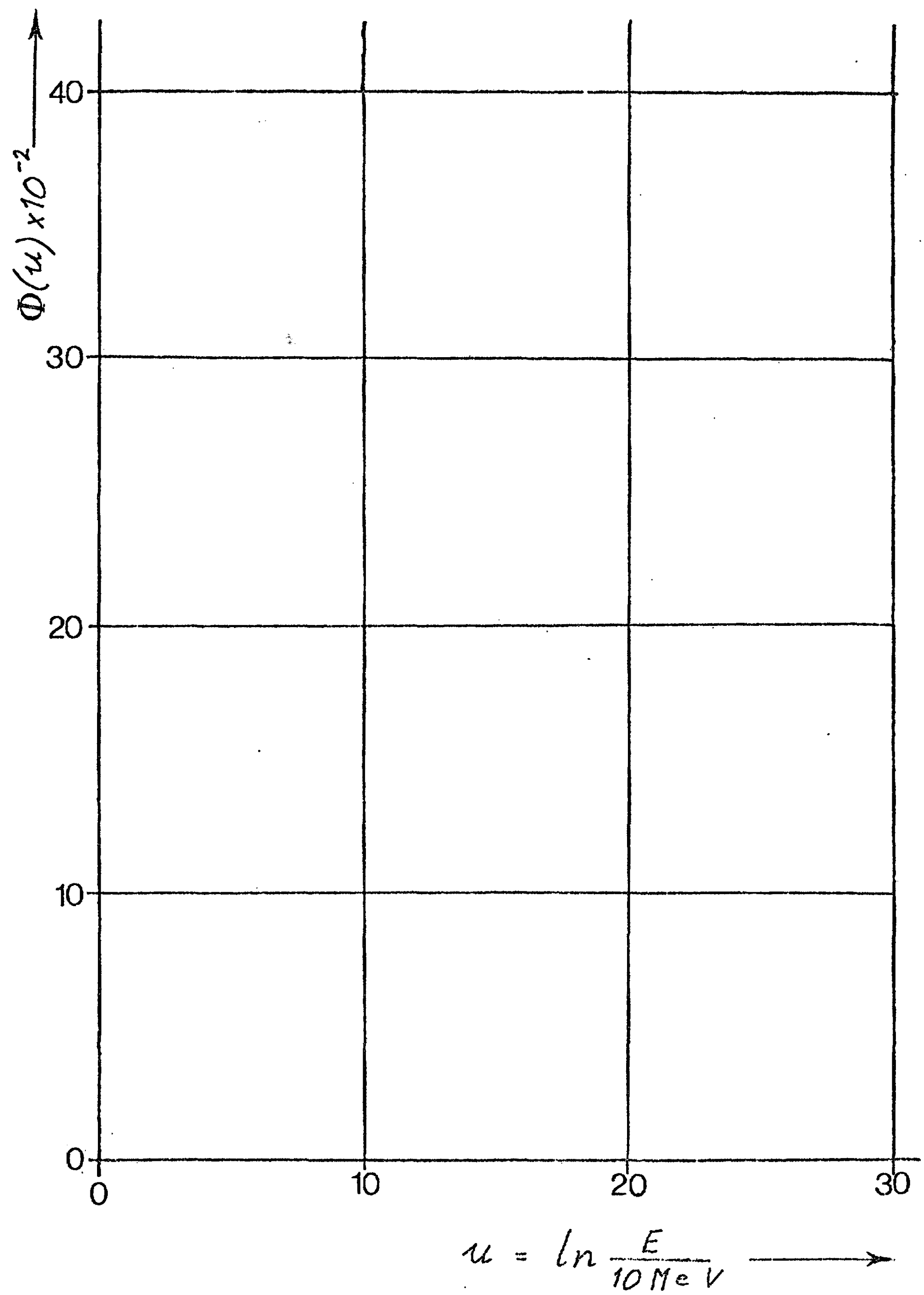
(histogram of flux per unit lethargy)

$\int \Phi(u)\, du = 1$

________ = typical core position

———— = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE FRG 2 REACTOR

1) What were the original purposes of the reactor?

   Nuclear research

2) What major modifications have subsequently been made and for which particular research programme?

   Materials research

3) For which major projects and programmes is the reactor presently being used?

   - Fortschrittlicher Druckwasser Reaktor (FDR) for ship propulsion
   - HGTR fuel irradiation in collaboration with K.F.A.

4) What loops and irradiation devices have specially been developed for this reactor?

   a) give name and purposes of the devices:

      Magazinkapsel for structural materials
      Creep capsule
      Water corrosion capsule
      HT1 capsule for HTGR fuel samples

   b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

INFORMATION SHEET N° 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE FRG 2 REACTOR
(give also references of relevant publications)

1) Magazine Rig A5 : for non fissile materials, 200 - 1000°C
electric heating 3 KW, up to 15 bar He, Ne, N_2 mixtures, 100 W/cm^2

2) Magazine Rig C1 : for Charpy specimens, 200 - 400°C

3) Magazine Rig F1 : inert gas mixture 5 bars for temperature control
specimen diam. 20 mm, length 240 to 480 mm, 500 W/cm

4) Creep Rig K1 : 5 tubular specimens 350 - 450°C, in He-Ne gas mixture, maximum force 4000 N

5) Water corrosion Rig W3 : for Zircaloy cans at full PWR conditions, at 350°C and 150 bars

6) Test fuel elements for burn up studies : solid burnable poison containing FDR fuel rods assembled in a basket 350 W/cm

7) Device for HTGR fuel irradiation HT 1 : 600 - 1400°C, on line fission gas analysis.

INFORMATION SHEET No. 6
Dec. 1974

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATION AT . . . . GEESTHACHT. . . . . .CENTRE

Location Organization Name of lab.	Year of active operation	Scope Number of working positions	Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators Number and type	Remarks and references
GKSS old hot cell region	1963	1	20	concrete 1,2m; 3,3g/cm^3	none	none	2 Mod. 8 (Central Research)	1 crane 2 to
new hot cell region (concrete cells	1969	2 2	18 18	concrete 1,1m; 3,6g/m^3 concrete 1,1m;3,0g/cm^3	$\frac{\Delta V}{V}$ =1%/h (Δp=50 mm WS	none none	8 A 100 (Wälischmiller)	1 heavy duty manipulator 1to (Draht & Schrade)
technological cells	1969	3	7	lead 10 cm	none	none	2 mod. 7 (Hobson) several tongs	impact, hardness and tensile test
metallography cells	1972	4	10	lead 17,5 cm	$\frac{\Delta V}{V}$=1%h	none	7 A 200 (Wälischmiller)	opt. microscope
chemical cells	1973	3	5	lead 17,5 cm	$\frac{\Delta V}{V}$=1%h	none	4 A 200	

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE GKSS
Hot Cells (FACILITY)

1) Owner or operator of the facility : Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt mbH. (GKSS), 2054 Geesthacht-Tesperhude

2) With which reactor is the facility associated? : swimming-pool reactors FRG-1 (5 MW th) and FRG-2 (21 MW th)

3) Give details of equipment and techniques available :

a) Examination of LWR fuel rods (gamma scan; burn-up determination; dimensional measurements; neutron radiography; cladding inspection by periscope, eddy current techniques and helium leak test; fission gas analysis).

b) Examination of oxide fuel and canning material (metallography; chemical analysis; electron microprobe; stereoscan; mechanical tests).

c) Examination of pressure vessel steels (notch impact test; drop weight test; tensile test;

K_{Ic}-measurement).

d) Handling of irradiation rigs.

4) References of relevant publications : Das Heisse Labor der Reaktorstation Geesthacht: F. Borchers, W. Spalthoff and D. Wittstock GKSS 71/E/5. (vorgelegt auf der 13. Sitzung des EURATOM-Kommitees für Heisse Laboratorien am 24./25. Juni 1971 in Jülich)

UTILIZATION AND SPECIALIZATION OF THE GKSS-HOT-CELLS (HOT CELL FACILITY)

1) What were the original purposes of the facility ?

Materials research for ship reactors (LWR-type).

2) What major modifications have subsequently been made and for which particular research programme ?

--//--

3) For which major projects and programmes is the facility presently being used ?

see 1)

4) Major modifications planned :

--//--

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community ?

Examination of fuel elements and pressure vessel steel specimens from landbased reactors.

INFORMATION SHEET No 1

MAIN CHARACTERISTICS OF THE OSIRIS REACTOR AT SACLAY

Name of reactor	OSIRIS
Organization	C.E.A.
Site	SACLAY (C.E.N./S)
In operation since	1966 (September)
Power MW (th)	70 MW
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	H_2O
Nominal operation days/year	230
Operating cycle (days)	
on power	21
shut down	7

	Responsable officer:	Address :
Coordinateur des piles experimentales: (Coordinator of experimental piles)	A. Deville	CEN - Cadarache B.P. nO 1 F - 13 St. Paul-lez-Durance
OSIRIS :	J.J.Graf	CEN- Saclay B.P. no 2 F-91190 Gif-sur-Yvette

IRRADIATION POSITIONS IN THE OSIRIS REACTOR

I) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
in-core location							
34	4	600	37		$4{,}18.10^{14}$	14	four positions can be grouped to obtain an 84,4 mm square section
42	4	600	37		4,85	14	
46	4	600	37		3,74	14	
54	4	600	37		5,72	14	
62	4	600	37		5,72	14	
66	4	600	37		4,85	14	
core grid location							
21	4	600	37	$1{,}7\ 10^{14}$	$1{,}1\ 10^{14}$		
22-24-25 in Be	3	600	32	2,6 to $3{,}1\ 10^{14}$	$1{,}75\ 10^{14}$		
11 to 17	7	600	84,4	1,4 to $2{,}8\ 10^{14}$			
Ext grid location	25	600	82,4	1 to $3{,}71o^{14}$		3	

2) Reactivity available for experiments :

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) :

- neutrography ; gammascanning
- fission product analysis in line
- hydraulic rabbits for activation analysis and isotope production
- neutron model Isis (800 kW)

5) References of relevant publications :

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) : two hot cells for dismantling and L.E.C.I. for post irradiation examination

7) Are facilities available for irradiation on behalf of other organization in the European Community ? : Yes

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

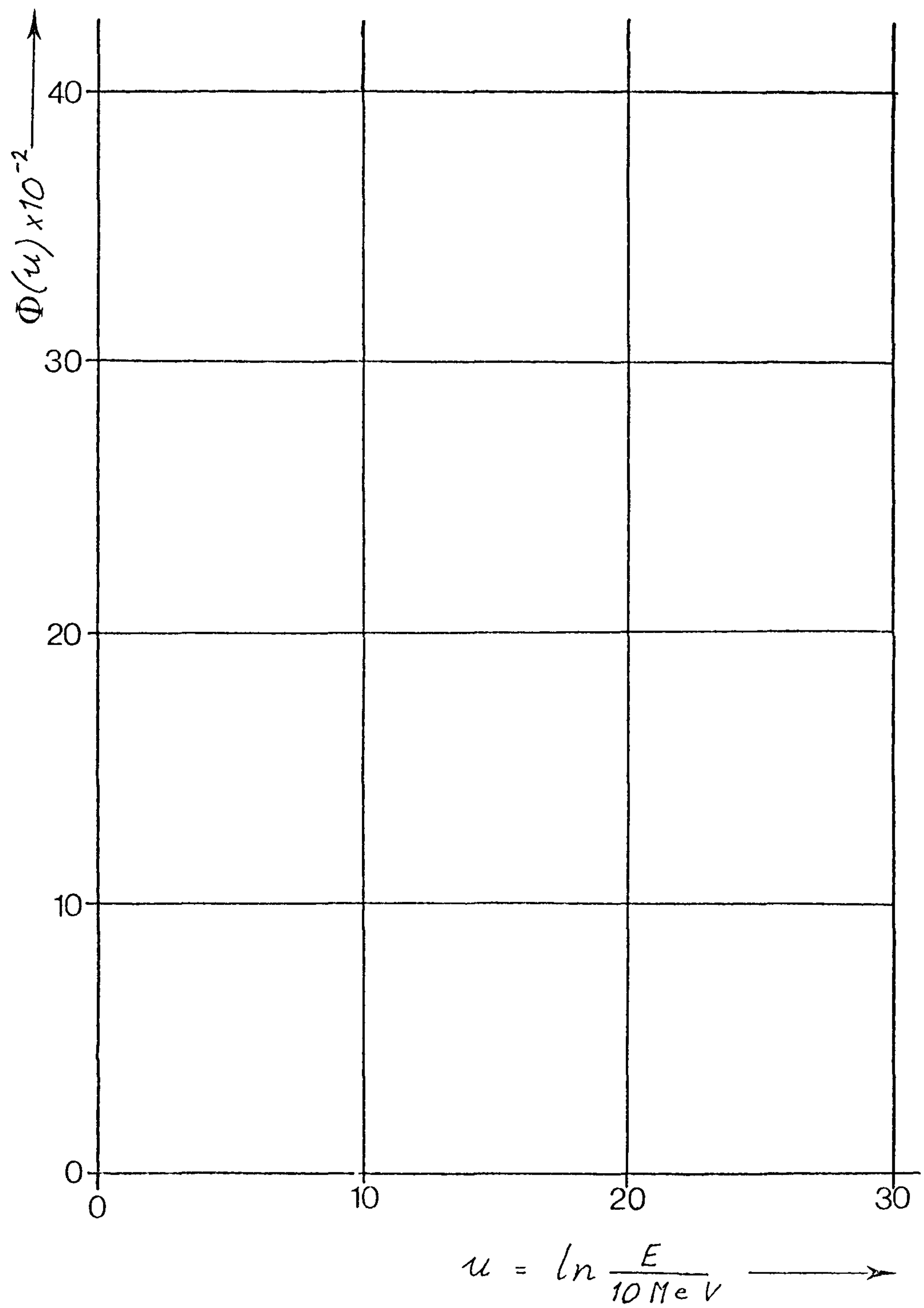
(histogram of flux per unit lethargy)

$\int \Phi(u)\,du = 1$

________ = typical core position

———— = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE OSIRIS REACTOR

1) What were the original purposes of the reactor ?

Materials testing and isotope production

2) What major modifications have subsequently been made and for which particular research programme ?

In december 1968 the original design power of 50 MW was uprated to 70 MW.

3) For which major projects and programmes is the reactor currently being used ?

- fast reactor development
- light water reactor development
- high temperature reactor development
- safety studies
- radio isotope production

4) What loops and irradiation devices have specially been developed for this reactor ?

a) give names and purposes of the devices :

see sheet No 5

b) main characteristics of specialized irradiation devices are to be listed on separate sheet No 5

5) Major modifications planned :

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE OSIRIS REACTOR

(give also references of relevant publications)

High temperature irradiation

- Colibri	:	in gas up to 1 500 °C, fissile materials and structured materials with separate compartments and independently controlled atmosphere fission product analysis.
- Cythère	:	for Wigner effect measurements up to 1 150 °C - 0,01 mm accuracy
- Othello	:	Helium loop 900 °C - 60 bars - 33 g/s - 45 kW for HTR fuel rods
- Spitfire	:	Helium loop 800 °C - 60 bars - 160 g/s - 75 kW for HTR fuel rods
- Aida 4	:	Helium loop 1 000 °C - 60 bars - 300 g/s for HTR fuel rods (Ø 120 mm)

Fast reactors

-Banjo	:	Sodium loop - 650 °C - 280 g/s - 2 000 W/cm - 70 kW for fast reactor
-Médina	:	Rig for measurement of fuel can variations (~ 5 μm) in liquid metal

Light water reactors

-Marina	:	boiling water rig - 325 °C - 165 bars for power cycling and safety studies

- Elsa : NaK filled rig - 325 °C for fuel pin power cycling - 750 - 500 W/cm by He 3
- Irène : water loop - 300 °C - 155 bars - 6 m/s - 140 kW - 700 W/cm for power cycling of 4 or 8 UO_2 rods reloadable with fission products analysis in line
- Colibri : in H_2O - 170 bars for dynamic corrosion studies.

INFORMATION SHEET No 6

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT SACLAY CENTRE

Location Organization Name of lab	Year of active operation	Scope		Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special tmosphere	Manipulators number and type	Remarks and references
		Number of working positions	Active area (cm^2)					
Cellules Osiris	1966	2	15	1,2o m heavy concrete (d= 3,5)			In each cell 2 light CRL remote handling devices 1 heavy ERTN remote handling device 1 micro-bridge	

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATION AT THE OSIRIS HOT CELLS (FACILITY)

Owner or operator of the facility : Service des Piles de Saclay

With which reactor is the facility associated? : OSIRIS reactor, Saclay

Give details of equipment and techniques available :

These two cells are for the post-irradiation handling of samples used mainly in experiments in the OSIRIS reactor i.e., the recovery of the testpieces and integrators for shipment to the specialist examination laboratories (and above all LECI) and the disposal of active waste.

There are in each cell : - 2 light-duty handling devices
- 1 heavy-duty handling device
and adequate shearing machines

One of the cells enables the Na or NaK produced by the irradiation equipment to be neutralized.

References of relevant publications : OSIRIS reactor - Descriptive report dated May 1969.

INFORMATION SHEET No 8

UTILIZATION AND SPECIALIZATION OF THE SACLAY CENTRE (HOT CELL FACILITY)

1) What were the original purposes of the facility ? :

At the Saclay Centre there is a hot-laboratory complex (LECI) which is very important for the post-irradiation stripping and examination of fuels and testpieces.

Full information is available from Mr Roussel , Head of Laboratory

2) What major modifications have subsequently been made and for which particular research programme ?

3) For which major projects and programmes is the facility presently being used ?

4) Major modifications planned :

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community ?

INFORMATION SHEET No 1

MAIN CHARACTERISTICS OF THE EL3 REACTOR AT SACLAY

Name of reactor	EL3
Organizetion	C.E.A.
Site	SACLAY
In operation since	1957
Power MW(th)	18
Moderator	D_2O
Coolant	D_2O
Fluid and pressure (Kg/cm^2) in experimental channels	D_2O 2 bars
Nomimal operation days/year	260 - 270
Operating cycle (days)	105
On power	90
shut down	15

	Responsable officer :	Address :
(Coordinator of experimental reactors)	A. DEVILLE	CEN - Gadarache B.P. no 1 F-13 ST.Paul-les-Durance
EL3 :	J.J. GRAF	CEN - Saclay B.P. No 2 F-91190 GIF-sur-Yvette

IRRADIATION POSITIONS OF THE EL3 REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes x 10^{14}: thermal	fast (>180 KeV)	-heating: W/gr Al	Remarks
Cells	9	1 000	43	1,2-2,75			in the core
Independent cell	1	1 000	43	2,2-2,75			in the core
Cells	25	1 000	43	0,9-1,5			in the moderator
Radial Channels	10	1 200	140	0,5-0,9			in the moderator
Radial Channels	2	1 200	240	o,5-0,9			in the moderator
Tangential channels	4	1 800 along the pile axis	180 x 180				in the reflector

2) Reactivity available for experiments :

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) :

X-ray examinations. for vertical devices
Stripping cell

5) References of relevant publications :

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) : CELIMENE hot cell belongs to Services des Piles, Saclay

7) Are facilities available for irradiations on behalf of other organizations of the European Community? : Yes

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

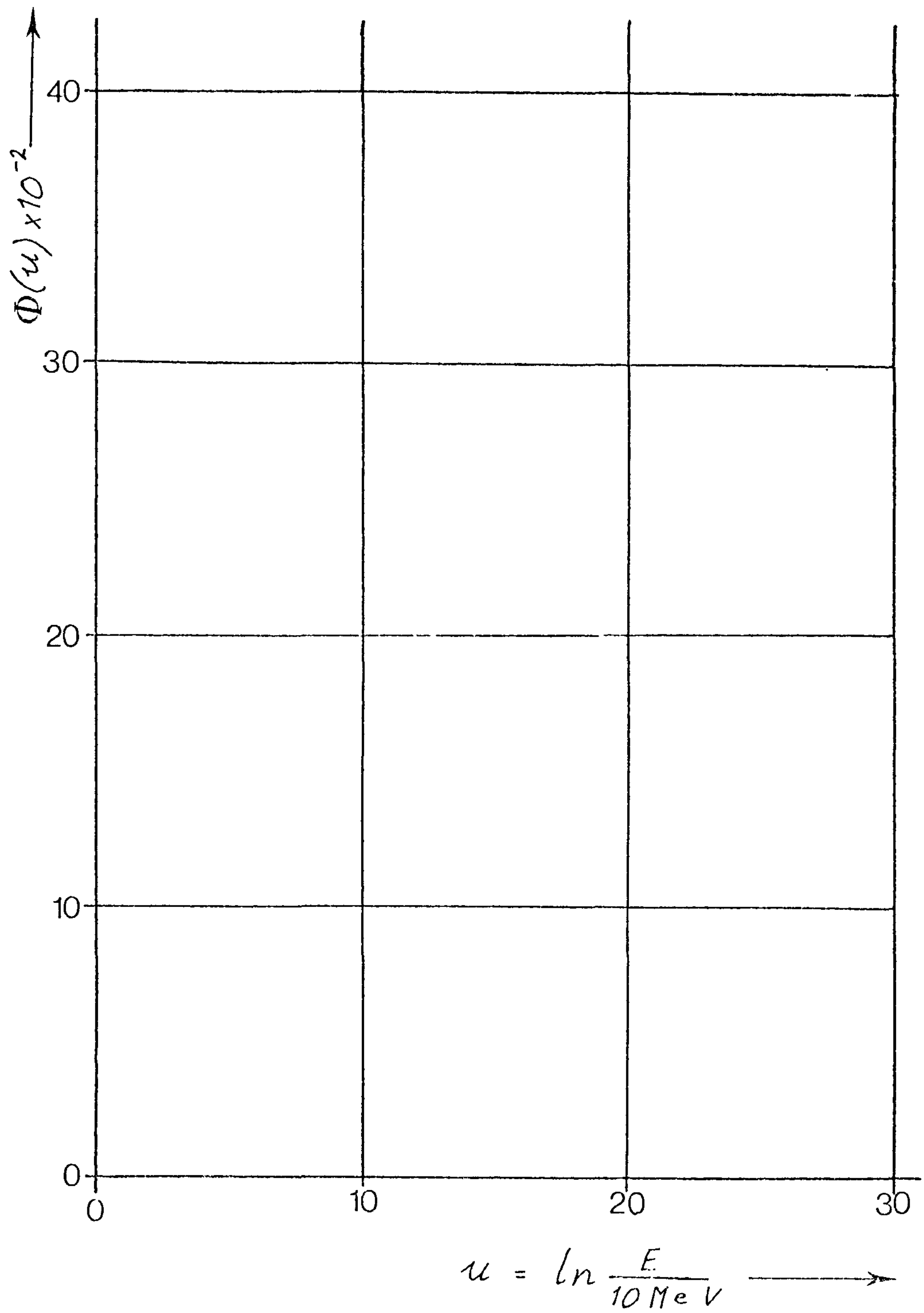
(histogram of flux per unit lethargy)

$\int \Phi\ (u)\ du = 1$

________ = typical core position

-------- = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE EL3 REACTOR

1) What were the original purposes of the reactor?

- Pure research
- Technological research
- Radioactive elements
- Irradiation for analysis
  for biological studies

2) What major modifications have subsequently been made and for which particular research programme?

In 1971 - Replacement of UO_2 fuel by a sandwich fuel

3) For which major projects and programmes is the reactor currently being used?

Physical research : Spectrometry
Neutron guides cooled by hydrogen loops

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

INFORMATION SHEET No. 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE ....EL3..... REACTOR
(give also references of relevant publications)

EXPERIMENTS ON THERMAL NEUTRONS IN THE FIELD OF NUCLEAR FUEL IRRADIATION

Many types of instrumented irradiation devices were investigated, several units of each of them having been used.
They are: LAG, SOPHIE, DANIELLE, CECILE, AGNES, OLGA.

<table>
<tr><th colspan="2">DEVICES</th><th>Extracted power W/cm</th><th>Cladding maximum temperature °C</th><th>Burnup MWd/T</th><th>Cooling mode of fuel specimen</th><th>Temperature control</th><th>Special features</th></tr>
<tr><td rowspan="4">EL3 REACTOR</td><td>DANIELLE</td><td>650</td><td>650</td><td>> 30 000</td><td rowspan="4">Sodium static bonding</td><td></td><td>Simplicity, low development cost</td></tr>
<tr><td>CECILE</td><td>650</td><td>650</td><td>> 20 000</td><td rowspan="2">Gas sheet with fixed thermal resistance</td><td>Electric heating up of sodium</td></tr>
<tr><td>AGNES</td><td>650</td><td>650</td><td>> 20 000</td><td>Measurement of reactor core temperature</td></tr>
<tr><td>OLGA</td><td>650</td><td>630</td><td>> 100 000</td><td></td><td></td></tr>
</table>

INFORMATION SHEET No 5
(Continued)

HORIZONTAL CHANNELS	EXPERIMENTS	REMARKS
H 1	Hydrogen loop linked with two spectrometers.	
H 2	Polarized-neutron spectrometer	
H 4	Spectrometer, study of inelastic scattering of slow neutrons by solid bodies.	Triple-axis spectrometer
H 5	Hydrogen loop linked with two extreme-length neutron guides.	
H 7	γ capture spectometer	
H 9	Two spectrometers : - 1 polarized-neutron (horizontal plane) - 1 conventional, intended for study of crystalline structures (vertical plane).	
H 10	Crystal spectrometer for study of neutron diffraction by solid and liquid bodies (horizontal plane).	
H 11	Crystal spectrometer for study of textures of samples of uranium for fuel-element fabrication purposes , and other types.	
H 12	Double crystal spectrometer for study of neutron diffraction by solid bodies.	
T 3	Alice loop - Study of BSD components.	

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT SACLAY CENTRE

Location: Organization Name of lab	Year of active operation	Number of working positions	Scope Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators: number and type	Remarks and references
Celimène	1 965	two	18 m^2	barytic concrete density 3.4 thickness 1 m	β, γ	no	4 light-duty manipulators CRL type E 2 heavy-duty OTER	

INFORMATION SHEET No 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE .CELIMENE..(FACILITY)

1) Owner or operator of the facility : Centre d'Etudes Nucléaires de Saclay - Services des Piles de Saclay

2) With which reactor is the facility associated ? : EL3 reactor

3) Give details of equipment and techniques available :

4) References of relevant publications :

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE CELIMENE (HOT CELL FACILITY)

1) What were the original purposes of the facility? :

Stripping of experimental devices irradiated in the research reactors - removal or recharging of irradiated samples, metrology, visual inspection.

2) What major modifications have subsequently been made and for which particular research programme?

Addition of sodium-potassium or sodium eutectic neutralizers (breeder research)

3) For which major projects and programmes is the facility presently being used?

Long-term shutdown

4) Major modifications planned :

Under way, modification for stopping of actual PWR or BWR fuel elements and examination of needles in Laboratoire d'Etudes des Combustibles Irradiés (Irradiated Fuel Study Lab.)

5) Are facilities available for post irradiation examinations on behalf of other organizations

within the European Community? :

The cell is available in every way to whoever applies through the Laboratoire d'Etudes des Combustibles Irradiés.

INFORMATION SHEET No 1

MAIN CHARACTERISTICS OF THE MELUSINE REACTOR AT GRENOBLE

Name of reactor	MELUSINE
Organization	C.E.A.
Site	CEN - Grenoble
In operation since	1958
Power MW (th)	8
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	
Nominal operation days / year	230 days in a next future
Operating cycle (days)	
on power	5) now and then; 25) in a next future
shut down	2) now and then; 3) in a next future

	Responsable officer :	Address :
Coordinator of experimental piles	A. DEVILLE	CEN - Cadarache B.P. no 1 F-13 St.Paul-lez-Durance
MELUSINE	MILLIES	CEN - Grenoble Cédex no 85 F-38041 Grenoble

IRRADIATION POSITIONS OF THE MELUSINE REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes $n/cm^2.s$ thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
- in-core positions	4	600	32	7×10^{13}	1×10^{14}	3	
- peripheric positions	30	600	77	6×10^{13}	5×10^{13}	1,5	
- beam tubes	5			$3{,}5 \times 10^{8}$*			* At the outer end of a standard collimater. Thermal flux at the neutron source surface of the beam tube is $6 \times 10^{13} n/cm^2.s$

2) Reactivity available for experiments : 2 per cent.

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g. neutrography, etc.) :

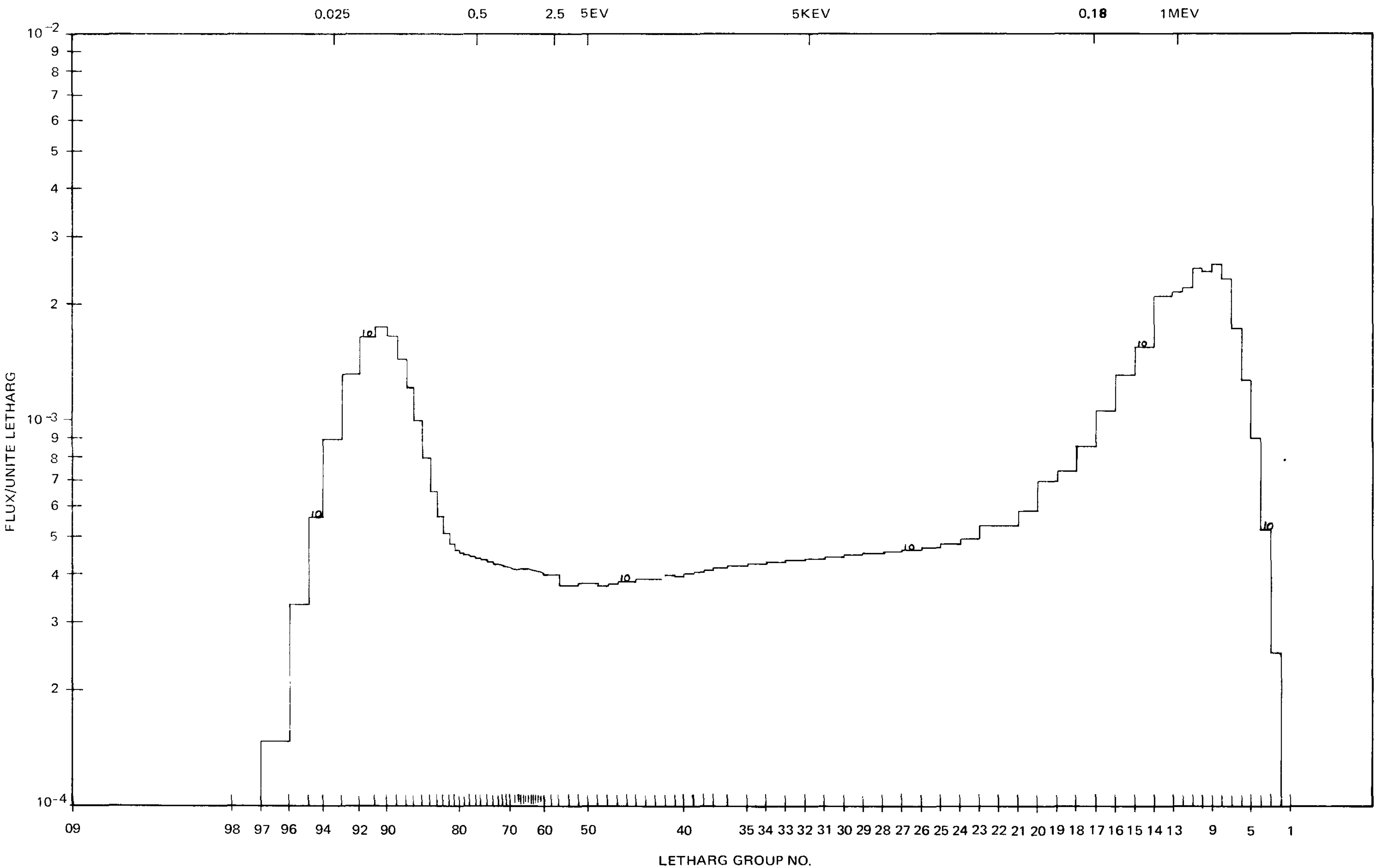
- Neutrography
- Hot Cell
- Automatic data logging
- Cold loops (liquid Nitrogen, liquid Neon, liquid Helium)
- 3 pneumatic rabbits (1 in D_2O, 1 in H_2O, 1 fast rabbit)
- D_2O tank with various irradiations positions
- Sampling and analysis of gaseous fission products

5) References of relevant publications : - CEA/B.I.S.T. n° 156 (Feb. 1971)
   - CEA/B.I.S.T. n° 153 and 154 (Nov. - Dec. 1970)

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on <u>sheet N° 6</u>) dismantling cell in the reactor hall
   LAMA - Service des Piles

7) Are facilities available for irradiations on behalf of other organizations of the European Community? : CNEN, CISE, Instituto Galileo Ferrario (Italia)

TYPICAL NEUTRON SPECTRA FOR THE MELUSINE REACTOR AT GRENOBLE



INFORMATION SHEET No 4

UTILIZATION AND SPECIALIZATION OF THE MELUSINE REACTOR

1) What were the original purposes of the reactor ?

- Testing of structural materials and fuel samples in instrumented capsules
- Solid state physics at very low temperature and under magnetic field
- Nuclear physics on beam tubes (neutron diffraction, Mössbauer effect application, short period fission products...)
- Radio activation analysis

2) What major modifications have subsequently been made and for which particular research programme ?

- Modifications

The power was uprated several times; in 1971 a power of 8 MW was reached.

- Programme

Applied and fundamental research

3) For which major projects and programmes is the reactor presently being used ?

- Reactor materials devlopment, for high temperature reactors, light water reactors, thermo-electronic conversion, CIRENE Project.
- Solid state physics for university
- Radio isotopes production

4) What loops and irradiation devices have specially been developed for this reactor ?

a) give name and purposes of the devices :

- CHOUCA - rigs for structural or fissile materials, 200 - 900° C
- HEBE - rigs for structural materials, 350 - 1 400° C
- CYRANO - rigs for fissile materials in NaK at 900° C
- High Frequency Furnace (2000° C)
- Cold loops - liquid He - Liquid Neon - Liquid Nitrogen

b) main characteristics of specialized irradiation devices are to be listed on separate sheet no 5

5) Major modifications planned :

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE MELUSINE REACTOR

(give also references of relevant publications)

See irradiation devices listed for SILOE-reactor

Reference : CEA/B.I.S.T. n° 153 and 154 : Nov. - Dec. 1970

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT MELUSINE REACTOR

Location Organization Name of lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators: number and type	Remarks and references
Melusine Hot Cell	1 960	1	4	Heavy concrete Th = 1 m d = 3,2 g/cm^3		Negative pressure	1 manipulator PYE	

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE MELUSINE ... (FACILITY)

1) Owner or operator of the facility :

2) With which reactor is the facility associated? :

3) Give details of equipment and techniques available :

4) References of relevant publications :

INFORMATION SHEET No 8

UTILIZATION AND SPECIALIZATION OF THE .MELUSINE....... (HOT CELL FACILITY)

1) What are the original purposes of the facility ? :

2) What major modifications have subsequently been made and for which particular research programme ?

3) For which major projects and programmes is the facility presently being used ?

4) Major modifications planned :

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community ?

INFORMATION SHEET No 1

MAIN CHARACTERISTICS OF THE SILOE REACTOR AT GRENOBLE

Name of reactor	SILOE	
Organization	C.E.A.	
Site	C.E.N. - Grenoble	
In operation since	1963	
Power MW (th)	35	
Moderator	H_2O	
Coolant	H_2O	
Fluid and pressure (kg/cm^2) in experimental channels		
Nominal operation days / year	235 days on nominal power	
Operating cycle (days)	28 days	
on power	21 days	
shut down	7 days	
	Responsable officer :	Address :
Coordinator of experimental piles	A. DEVILLE	CEN - Cadarache B.P. no 1 F-13 St.Paul-lez-Durance
SILOE	MILLIES	C E N -Grenoble Cédex no 85 F-38041 Grenoble

IRRADIATION POSITIONS OF THE SILOE REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
core positions	12	600	36 mm	6×10^{14}	$4,2 \times 10^{14}$	12	
peripherical positions	40	600	80x76 mm	5×10^{14}	2×10^{14}	7	
beam tubes	2			3×10^{8} xx 8×10^{8}			xx at the outer end of a standard collimator.
pneumatic rabbits	2			4.10^{13}			

2) Reactivity available for experiments : 2 to 2,5 per cent.

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) :

- Neutrography, on line computers, in-pile gamma spectrometry, gaseous fission product sampling and analysis during irradiation dismantling hot cells.

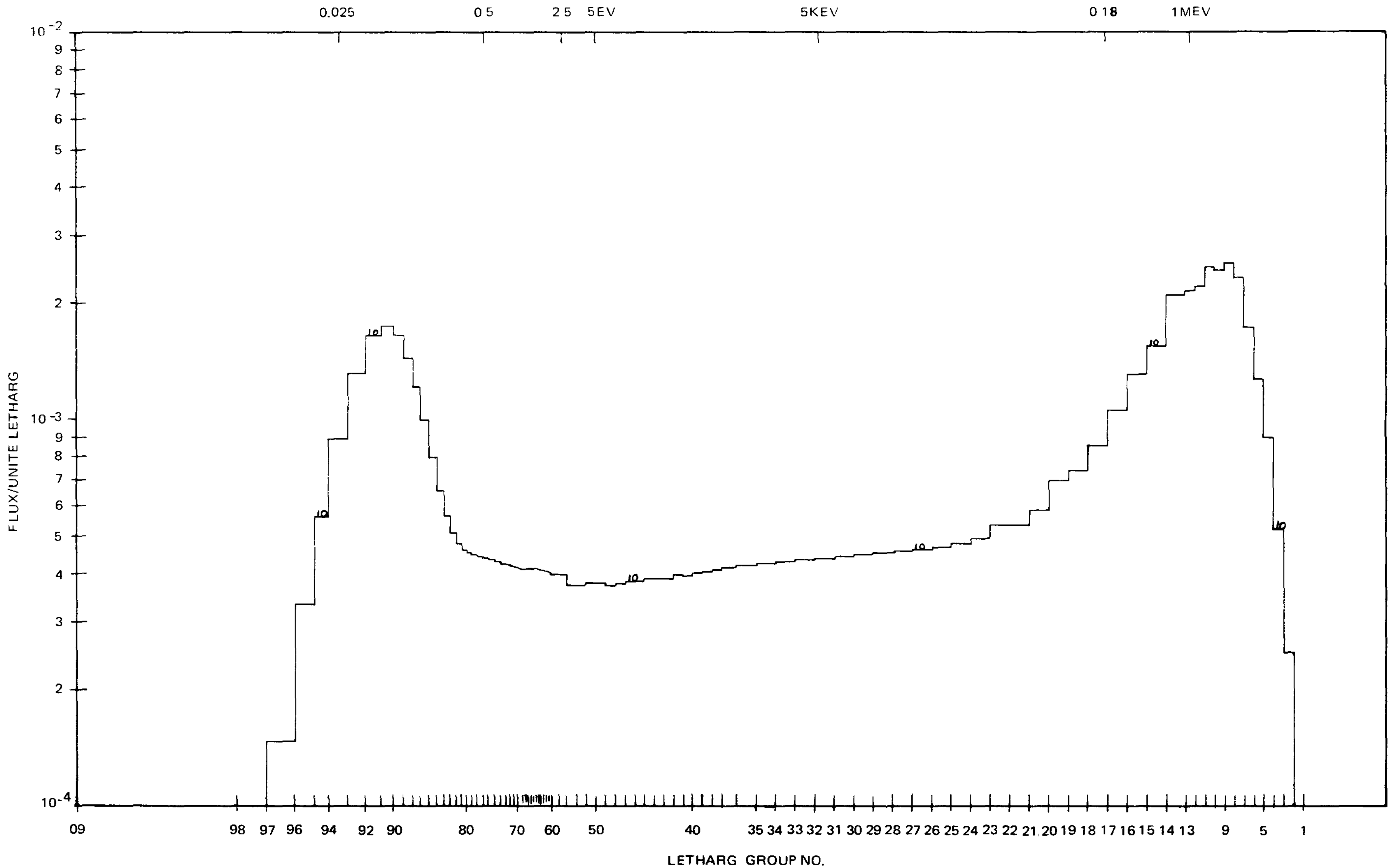
5) References of relevant publications :

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) Dismantling HOT CELL in the reactor hall
LAMA - Service des Piles

7) Are facilities available for irradiation on behalf of other organizations of the European Community ? :

CHEN (Italy) GfK Karlsruhe and KFA Jülich (Germany), UKAEA and CEGB (Great Britain)

TYPICAL NEUTRON SPECTRA FOR THE SILOE REACTOR AT GRENOBLE



UTILIZATION AND SPECIALIZATION OF THE SILOE REACTOR

1) What were the original purposes of the reactor?

Materials testing, basic research with neutron beams

2) What major modifications have subsequently been made and for which particular research programme?

In 1968 the original design power of 15 MW was uprated to 30 MW

In 1972 the nominal power level was uprated to 35 MW.

3) For which major projects and programmes is the reactor currently being used?

- Fast reactor development
- High temperature reactor development
- Light water reactor development (Pressurised and boiling water)
- Gas -cooled reactor development
- Neutron diffraction

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices : see sheet 5

The irradiation devices are standardized
Adaptation to other testing reactors has been made when necessary

b) main characteristics of specialised irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE SILOE REACTOR

CHOUCA : rig for structural and fissile material irradiation, 200 - 900° C, with 5 different types of sample holders for graphite, dispersed fuel, creep, swelling, growth and corrosion studies. Rechargeable capsule.

HEBE : rig for structural material irradiation, 350 - 1 400° C, 60 bars.

CYRANO : rig for fuel pin irradiation (in Na or NaK, 300 - 800° C, from 1 to 155 bars) with continuous measurement of the fuel sample nuclear power. Sample diameter : 4 - 35 mm. That rig was used for fission product studies (release, pressure, diffusion) and for dimensional measurements (length and diameter).

HF 3 and HF 5 : High Frequency Furnaces for small fissile material samples up to 2 000° C (High burn up irradiation).

Thermopump sodium loop for experimental irradiation of fuel pins (up to 3), 70 KW, 2 - 6 m/s flow rate, temperature regulation. Cladding failure studies through fission products release and by gamma scanning during irradiation.

Thermosiphon-boiler : rig for irradiating fuels of the light water reactor family with possibility of water sampling (water chemistry, fission product recuperation, gamma spectrometry) and studying cladding failure evolution.

Gas loops : 2 loops, previously used to study graphite corrosion under irradiation, are going to be adapted to high temperature fuel irradiation (fission product migration and plating, continuous in-pile gamma spectometry).

TUMULT : rig with separate internal divisions for irradiation of high temperature fuel, 800 - 1 500° C. Possibility of thermal cycling. Measurement of the fission product release rate. Gamma spectometry.

Resonant cavity : methods of accurate in-pile measurement of dimensional changes can be adapted to HEBE, CHOUCA, HF furnace, Thermopump.

INFORMATION SHEET N° 6

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT Grenoble CENTRE

Location: Organization Name of Lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special Atmosphere	Manipulators number and type	Remarks and references
Siloé reactor Hot Cell	1963	1	9 m^2	e = 1 000 mm of heavy concrete (d = 3,5)		Negative atmospheric pressure inside	2 PYE CD 3 985	Equipped with various special tools used for dismantling, loading and reloading of rigs capsules, etc.
Laboratory for the analysis and measurement of high-level Radioactivity CEA-CEN/ Grenoble Service des Piles	1961	3	14	barytic concrete - 1 m d = 3,5 g/cm^3			6 PYE modèl 8	Machining
	1962	9	10	lead - 0,15 m d = 10,5 g/cm^3			14 Hobson model 7	Metallographic tests
	1965	3	19	barytic concrete - 1 m d = 3,5 g/cm^3	air exchange	nil	6 PYE model 8	sectioning X-ray test
	1966	5	8	lead - 0,20 m	10-50 times/h		10 CRL model 9	Non-destructive tests
	1966	12	17	lead - 0,15 m	15 mm WG negative pressure		swivel-jointed tongs	Strength of materials

Location: Organization Name of Lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special Atmosphere	Manipulators number and type	Remarks and references
	1970	6	7	lead - 0,15 m	15 mm WG negative pressure		10 Hobson model 7	HTR-specific tests
	1973	5	6	lead - 0,15m	"		10 Hobson model 7	Metallographic tests

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE LAMA (FACILITY)

1) Owner or operator of the facility : CEN.G - USSTC

2) With which reactor is the facility associated? : Mélusine - Siloé and if required with other CEA reactors.

3) Give details of equipment and techniques available :

- Stripping of all testpieces irradiated in research pile-various machining operations (sectioning, unselting, removal of samples and testpieces by spark erosion).
- Non-destructive testing: observation, viewing through periscopes and macroscopes - X-ray photography high-accuracy metrology (diameters, eccentricity, camber, length), density measurements, γ spectrometry and γ scanning.
- Destructive testing: taking of gaseous fission product samples, testing of material strength: hardness, tensile strength, toughness (Charpy, Pellini tests, etc.).
- Metallography: sample preparation and examination by optical microscopy - preparation of samples for examination by election microscopy of microprobes.

4) References of relevant publications:

UTILIZATION AND SPECIALIZATION OF THE LAMA (HOT CELL FACILITY)

The Laboratory for the Analysis and Measurement of high-level Activity (LAMA) was conceived in 1958 to meet the needs of arising out of the commissioning of the Mélusine research reactor. The building was extended during 1964-65 in order to fulfil the new requirements linked with the criticality of SILOE. This Laboratory has never had a specific task relating to a clearly defined research programme: on the contrary the highly diverse nature of its equipment enables it to adapt easily to the wide range of testpieces irradiated in the piles at Grenoble.

The additional capacity installed in the LAMA since 1965 meets two requirements, namely:

- for specific studies concerning new families of reactors (e.g., installation of cells for HTR particles)
- for an increase in the LAMA's potential in a field already exploited (metallographic testing, for example).

The non-specialist nature of the Laboratory therefore enables it to offer its services for post-irradiation tests in connection with all reactor families and for all public or private bodies in the European Community. In addition this potential has already been exploited by several European organizations.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE TRITON REACTOR AT FONTENAY-AUX-ROSES

Name of reactor	TRITON
Organization	Experimental Reactor
Site	Fontenay-aux-Roses
In operation since	1959
Power MW (th)	6,5 MW since 1965
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	
Nominal operation days / year	335 days for year
Operating cycle (days)	
on power	32
shut down	2,5

	Responsible officer :	Address:
Coordinator of experimental piles:	A. DEVILLE	CEN - Cadarache B.P. n°1 F-13 St.Paul-lez-Durance

INFORMATION SHEET N° 1
(cont'ed)

	Responsible officer:	Address:
TRITON:	FRANZETTI	CEN- Fontenay-aus-Roses B.P. n° 6 F - 92 Fontenay-aux-Roses

IRRADIATION POSITIONS IN THE TRITON REACTOR

Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	Heating W/gr Al	Remarks
in core 25	1	600	$\leqslant 70$	$\leqslant 4,2.10^{13}$	$\leqslant 3,5.10^{13}$	$\leqslant 1,7$	**Five positions in first**
44	1	600	$\leqslant 70$	$\leqslant 4,2.10^{13}$	$\leqslant 3,5.10^{13}$	$\leqslant 1,7$	**periphery with lead shield.**
First periphery	17	600	$\leqslant 70$	$2.10^{13} \leqslant 0 \leqslant 6.10^{13}$	$3.10^{12} \leqslant 0 \leqslant 10^{13}$	$0,2 \leqslant x \leqslant 1$	**Five beam out reactor**
Second periphery	22	600	$\leqslant 70$	$2.10^{12} \leqslant 3.10^{13}$		$0,1 \leqslant x \leqslant 0,45$	**two tangential**
Third periphery	10	600	$\leqslant 70$	$6.10^{11} \leqslant 3.10^{12}$		$0,1 \leqslant x \leqslant 0,3$	**one radial axial**
Fourth periphery	10	600	$\leqslant 70$	$1,5.10^{11} \leqslant 7.10^{11}$			**two radial lateral**
Stool (3)	45	600	$\leqslant 70$	$10.^{7} \leqslant 10^{11}$			**neutron flux $\leqslant 10^{9}$**

Typical Neutron Spectra for the TRITON Reactor at FONTENAY-aux-ROSES

The histogram of flux per unit of lethargy for the TRITON reactor is the same as that supplied for the SILOE and MELUSINE reactors, which are tankless pool reactors.

INFORMATION SHEET N° 4

UTILIZATION AND SPECIALIZATION OF THE TRITON REACTOR

1) What were the original purposes of the reactor ?

Since it was mainly intended for studies on protection against radiation the reactor core could be moved for irradiation purposes in various parts of the pool. Operation was with natural or forced draught for a given setup, with a maximum power of 1.2 MW.

2) What major modifications have subsequently been made and for which particular research programme ?

As a result the pile was completely modified for the purpose of specializing in irradiation in fixed positions and of increasing the number of irradiation positions. Following this modification the operating power of Triton increased to 6.5 MW. In view of this new potential, experimental vues have been directed towards the irradiation of fuel, graphite, cladding and structural materials, protective devices, radioactive-element fabrication, pure research.

3) For which major projects and programmes is the reactor currently being used ?

Currently the reactor is being used:

- for an extensive programme covering the irradiation of low gamma heat-up reactor vessel steels.

- to complete the thermoelectronic studies.

- to supply radioactive elements at all times, thanks to a reactor availability in exceeding 8000 hours/year.

This availability also permits the further development of Industrial Neutrography in high-efficiency plant which is unique in France and even in Europe.

Finally, the reactor is used for pure research basically on low-temperature studies and on the study of metal dispersion.

INFORMATION SHEET N° 4
(cont'ed)

4) What loops and irradiation devices have specially been developed for this reactor ?

a) give name and purposes of the devices

A type of loop developed for this reactor has since been used with other CEA reactors, namely low-temperature loops incorporating a cryogenerator.

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

Mention should be made of the high-performance "FRUIT"-type irradiation devices and also of conventional devices: Furnaces, CHOUCA, HEBE; COLIBRI, NICOBRA. These simple inexpensive devices have been developed for the irradiation of protective materials (concretes) and vessel steels. They are "BETSY" and "SIAT".

5) Major modifications planned

No major modifications are currently envisaged but potential experiments in the pool and on extracted fuel clusters are constantly being improved.

INFORMATION SHEET N°5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE TRITON REACTOR

1)- "Fruit" device for continuous creep studies

This device was designed for studies of the creep in reactors of uranium samples subjected to tensile stress(1). Its range of use devices from its initial intended purpose i.e.,

- the medium in which the testpiece is submerged consists of a mixture of sodium and potassium:
- the temperature may be set at a predetermined value between 300°C and 600°C and can be maintained during reactor shutdowns;
- a tensile force of up to 10 kg can be applied.

The deformation rates which one can reasonably expect to study via testpieces having a measuring base about 50 mm long are not less than 10^{-6}/h. The total deformation which can be studied is 20 mm.

The deformation is measured in accordance with an original procedure for which a patent application has been made(2).

Under this procedure the core of a transducer having two windings (the coefficients of self induction of which vary inversely in accordance with the position of the core) which is rigidly attached to the movable head of the testpiece by a short rod made of molybdenum, a metal having a low coefficient of thermal expansion.

The displacement of the movable head in relation to the fixed head is measured by a micrometer gauge, of which the essential components, which are submerged in the reactor water, are made of Invar. A 4 mm micrometer screw is actuated by a 20 stepping motor capable of operating at 1/4356 rev.

At any given point in time the position of the movable head can be determined from the position of the motor, which corresponds to a given ratio between the values for the coefficients of self induction of the transducer windings connected to the micrometer screw via the Invar chamber.

The extension of the testpiece is therefore measured by converting variations in the differences in length between the testpiece core support rod assembly and the components of the micrometer into the angle of rotation of the micrometer screw.

It can be seen from the above description that in this device the dimensions of the micrometer components are little affected by variations in heating due to nuclear radiation, so that there is little drift.

Literature

(1) C. Thomas de Montpreville - Dispositif "FRUIT" pour l'étude en continu du fluage de l'uranium, Note C.E.A. N-1426

(2) Demande de brevet N° EN 70 33976.

2)- Systems for Irradiation at low Temperatures

With the appearance on the international market of cryogenerators adapted for the recondensation of cryogenic fluid vapours, it has become possible to modify considerably the design of irradiation systems in swimming-pool reactors. Because of their small size they are easy to install, while their flexibility and the fact that they operate in closed nitrogen, hydrogen or neon circuits ensures a high degree of safety, excellent reliability and economic operation in irradiation experiments. The Fontenay-aux-Roses systems (Vinka loops), which operate at 20 °K, are liquid hydrogen cryostats with nitrogen heat insulation mounted - with their cryogenerators - on a carriage by means of which the bottom of the loop can be moved close to the core, thereby making possible

INFORMATION SHEET N° 5
(cont'ed) (2)

investigations at fluxes of up to 2.2 x 10^{12} $n_f.cm^{-2}.s^{-1}$. Through pressure regulation it is possible to stabilize the temperature to within ± 0.05 degK over a temperature range from 20 to 300°K. With these systems, which operate automatically, a total irradiation experience of over 15000 hours * has been accumulated with continuous cycles of as long as 2500 hours. Many different types of experiment can be performed (in situ measurements of length, resistivity, traction, etc.), with the possibility of post-irradiation annealing and removal of samples while cold. All the measuring is done remotely through a data acquisition circuit.

3)- Industrial Neutrography

This very-high performance installation, which is mounted on a cluster removed from the Triton reactor (axial channel) is partly automated and used 90% to cater for French and foreign industrial needs.

The principal characteristics of this monitoring unit are as follows:

- Collimation ratio 1/200
- Useful range, formats used 18 x 24 cm
- Total flux density................$10^7 n.cm^2 s^{-1}$ 24 x 30 cm
- Thermal fux density......
  ..... energies ⩽0.5 eV ...... $6,3.10^6$ $n.cm^2.s$
- Gamma dose rate: γA 17 ⩽ A ⩽ 27 rad/h
- Max. dimensions of (test) pieces 0,50 x 0,50 x 0,50 m
- Length of traverse ⩽ 4 m
- Weight of testpieces ⩽ 100 kg
- Exposure range 1'-20'
- Films currently used from Industrex A to Industrex R single coated or equivalent

* (start-up of the first loop (20 °K) in 1966)

INFORMATION SHEET N° 5
(cont'ed)(3)

REFERENCES OF RELEVANT PUBLICATIONS FOR SYSTEMS OF IRRADIATIONS AT LOW TEMPERATURE

(1) Les irradiations neutroniques à basses températures dans Mélusine et Siloé, Irradiations à 20 K dans le réacteur Triton, Bull. Infs scient. techn. CEA n° 153-154 (nov.-déc.1970) 60 et 66.

(2) DEPIERRE, Y., VERDIER, J., Dispositif d'irradiation à basse tempe- rature, Brevet français P.V. 8525 du 9 avril 1965.

(3) CONTE, R.R., Irradiations aux basses températures, Rapport CEA-R-3910 (1969).

(4) CONTE, R.R., Dispositif d'irradiation en pile à 20 K , Cryogenic Engineering Conf., Comm. I, Annexe 1966-5, Boulder (Institut International du froid, Paris).

(5) CONTE, R.R., 20 K in pile irradiation facility, Adv. cryogen. Engng 12 (1967) 673.

(6) CONTE, R.R., Dispositif d'irradiation aux neutrons à 20 K, Rev. Phys. appl. 2 (1967).

(7) WEINBERG, C., CONTE, R.R., DURAL, J., Dispositif de mesures simultanées de longueur et de résistivité sous irradiation à basses températures, Note CEA-N-1315 (1970).

(8) WEINBERG, C., Croissance de l'uranium sous irradiation à basses températures, Rapport CEA-R-4315 (1972).

(9) CONTE, R.R., von STEBUT, J., Micromachine de traction fonctionnant aux températures, Rev. Phys. appl. 4 (1969) 70.

(10) von STEBUT, J., Elastoresistivity, A property especially sensitive to stage I radiation defects in copper, Phys. Status Solidi (a) 9 (1972) K 145.

(11) PONSOYE, J., Irradiation de tungstène sous contrainte uniaxiale à basse température, Radiat. Eff. 8 (1971) 13.

(12) LESUEUR, D., Amorphysation of Pd-Si alloy by irradiation with fission products, Fizika (Italy) 2, suppl. 2 (1970) 13.

(13) LETEURTRE, J., POUCHON, J.L., ZUPPIROLI, L., FRANCOIS, A., HOUSSEAU, N., DURAL, J., Croissance induite dans le tungstène irradié sous contrainte à 20 K, Phys. Lett. 38A 6 (1972) 411.

INFORMATION SHEET N° 5
(cont'ed)(5)

REFERENCES OF RELEVANT PUBLICATIONS FOR INDUSTRIAL NEUTRON RADIOGRAPHY

- La Neutrographie Industrielle auprès du réacteur TRITON

  par A. LAPORTE - CEA.

  Colloque sur les Applications Modernes de la Pyrotechnie

  TOULON - 19/22 June 1973.

- Industrial Applications of Neutrons Radiography in France

  by A. LAPORTE - CEA.

  Conference on Radiography with Neutrons

  BIRMINGHAM - 10th September 1973

- Two Examples of Quantitative Neutron Radiography

  by A. LAPORTE & J. MARS - CEA.

  Conference on Radiography with Neutrons

  BIRMINGHAM - 10th September 1973

- Neutrographie Qualitative et Neutrographie Quantitative

  par J.P. BOULOUMIE - CNES

  A. LAPORTE - CEA.

  3ème Colloque International sur les Méthodes de Contrôles non Destructifs

  TOULOUSE - May 1974

- Industrial Neutron Radiography for Nuclear Uses

  by G. FARNY & A. LAPORTE - CEA.

  Euratom Working Group on Irradiation Devices

  HARWELL meeting - 2 and 3 July 1974.

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT FONTENAY CENTRE

Location: Organization Name of lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special Atmosphere	Manipulators name and type	Remarks
TRITON Cell	1962	2	12 m^2	1.03 m heavy concrete, density 3.5	-	-	4 manipulators light-duty CRL E remote-control handling devices. 1 heavy-duty ERTN E 600 handling device.	

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS IN THE TRITON CELL (FACILITY)

1) Owner or operator of the facility :

Section d'Exploitation TRITON.

2) With which reactor is the facility associated ?

With the Triton reactor, Fontenay aux Roses.

3) Give details of equipment and techniques available :

This cell is used solely for stripping of material irradiated in the Triton reactor i.e., the recovery of testpieces and integrates for shipping to the specialist CEN laboratories at Saclay, and the disposal of radioactive waste.

This cell's equipment comprises :

- 1 stripping miller
- 1 cutting machine for use under a controlled atmosphere
- 1 ac electric saw
- 1 set of hydraulic shears
- 1 pneumatic vice, plus pneumatic tools.

4) References of relevant publications :

- PILE TRITON - Rapport descriptif, Septembre 1967 (CEA N° 840)
- Demantèlement "COLIBRI T" en tronçonneuse étanche pour mesures de pression et analyse des produits de corrosion MICHEL FAURE - DPE/SET N° 169/70.

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE HOT CELL AT FONTENAY-AUX-ROSES

There is at the CEN, Fontenay-aux-Roses a very large hot laboratory complex specializing basically in the examination of Pu pins (RM2 system).

Detailed information is obtainable either from the Head of Department at Fontenay, Mr. Dieumegard, or more simply from the Euratom Hot Lab. Committee, which is due to meet next in October 1974.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE PEGASE REACTOR AT Cadarache

Name of reactor	PEGASE
Organization	C.E.A.
Site	C.E.N.-Cadarache
In operation since	1963
Power MW (th)	35
Moderator	H_2O
Coolant	H_2O
Fluid and pressure (kg/cm^2) in experimental channels	Gas (He or CO_2) up to 60 kg/cm^2 or Na and (N_2, He)
Nominal operation days / year	300
Operating cycle (days)	
on power	120
shut down	7

	Responsible officer:	Address :
Coordinateur des piles expérimentales :	A. DEVILLE	CEN - Cadarache B.P. n° 1 F - 13 St.Paul-lez-Durance
PEGASE :	ECKERT	

IRRADIATION POSITIONS OF THE PEGASE REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ heating W/gr Al	Remarks
8 positions around the reactor core	8	914	114 up to 229	$2\ 10^{14}$	$0,5\ 10^{14}$	0.5	Distance between loops and reactor core can be adjusted separately for each one.

2) Reactivity available for experiments : 8500 p cm

3) Typical neutron spectra available should be added on <u>sheet N° 3</u>

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) : PEGGY nuclear model

- X ray, facility (loop radiography)
- Special Lab. for physico thermal measurements (several gas chromatographs)
- Several Ge-Li γ spectrometers on line
- Neutron radiography facilities in Pegase and in Peggy
- Neutron radiography facility for loop examination

5) References of relevant publications : See attached sheet

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6)

Pegase hot cell for dismantling, packaging, transfer and transportation to hot laboratories of Cadarache (LECA) and ADAC

7) Are facilities available for irradiations on behalf of other organizations of the European Community? :

yes (examples : KFA, Dragon, General Atomic)

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

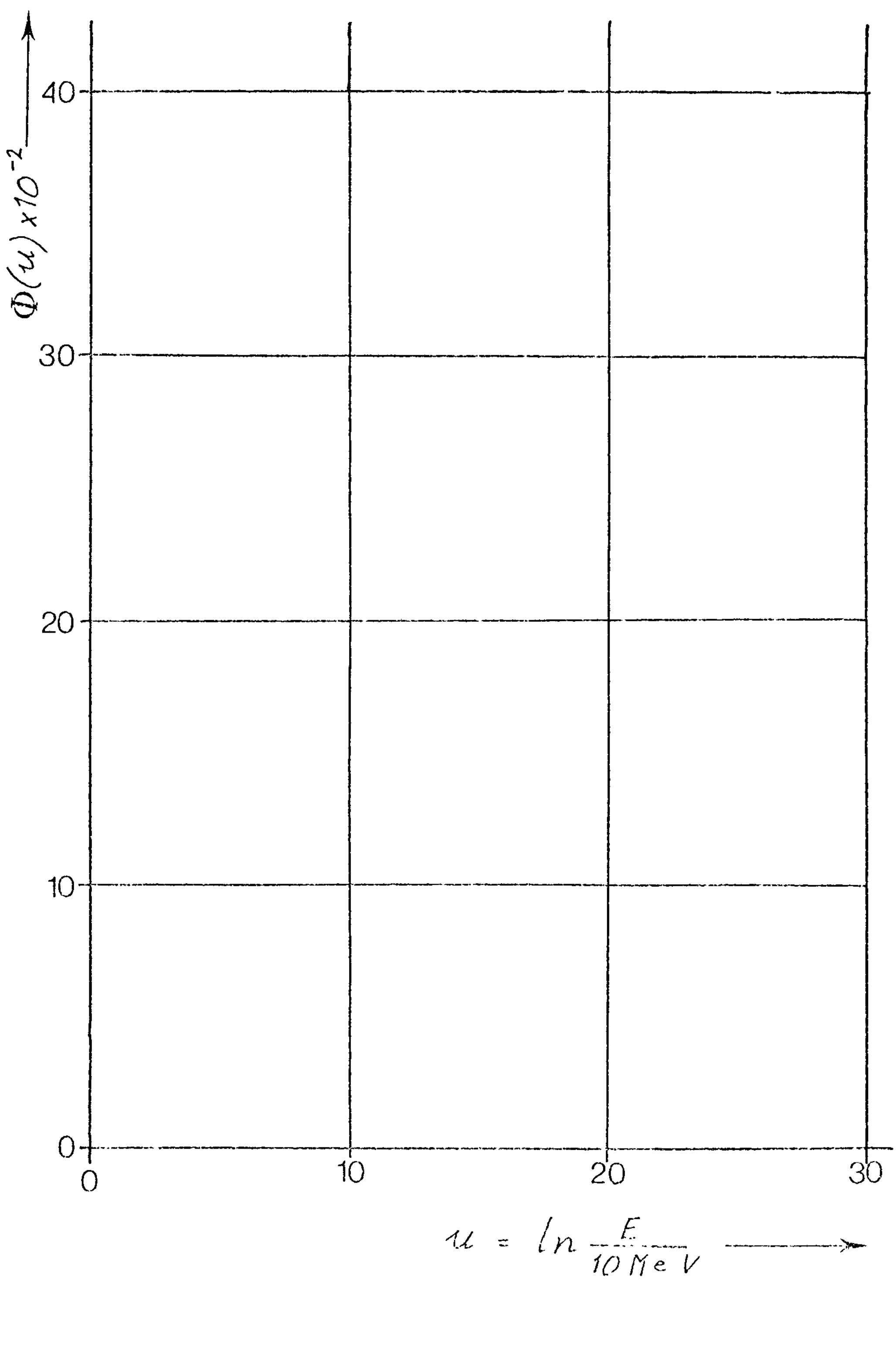
(histogram of flux per unit lethargy)

$\int \Phi (u) \, du = 1$

________ = typical core position

-------- = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE PEGASE REACTOR

1) What were the original purposes of the reactor ?

Specialized for EDF and EL 4 full size fuel element testing.

2) What major modifications have subsequently been made and for which particular research programme ?

1 - improvement of the reactor fuel, with burnable poison, to avoid flux perturbation on experimental rigs.

2 - out of pile circuits of the different loops to have a permanent checking of the experiments, and a maximum of versatility (HTR, and fast breeder programmes ...).

3) For which major projects and programmes is the reactor presently being used ?

- High temperature reactor fuel element testing.
- Fast breeder fuel element testing.

4) What loops and irradiation devices have specially been developed for this reactor ?

a) give name and purposes of the devices : * loop - ** devices

* - EDF loops for gas graphite reactor
* - EL 4 loops for heavy water reactor

* - INCA
** - PIRATE for fast breeder fuel failure in pile testing
** - SAPHIR for Fission Products plate out experiments
** - CPL for Fission Products studies, release, trap, plate out, etc ...
** - CYCLAMEN for high temperature and cycling experiments
** - IDYLLE Fission product release experiments (to serve as a reference)

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

INFORMATION SHEET NO. 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE PEGASE REACTOR

(give also references of relevant publications) (1)

- for HTR - fuel irradiations

  - HERMES general device charged in the loop :

    cooling gas temperature 900°C, flow <200 g/s, pressure 60 bars, fuel power <400 KW, test section 130 mm Φ and 900 mm length for safety experiments with irradiated fuel Fission products release and plate out studies, the HERMES device can be modified and designed for special purpose (for instance IDYLLE and CPL) and for power cycling.

  - HELIOS special device charged in the loop :

    cooling gas temperature 1200°C, flow 400 g/s, pressure 60 bars, fuel power 300 KW, test section 125 mm Φ, action length 900 mm for safety experiments with faulty fuel elements and for power cycling experiments.

- for fast reactor fuel elements

  - PIRATE special device charged in the loop :

    fuel pins formerly irradiated in Rapsodie are reloaded into Pirate to study

    a) the interaction of Na with UO_2 PuO_2,

    b) the emission of fission products through the can and

c) the evolution of can failures

- Publications

- Les boucles du réacteur Pégase	CEA R 3564
- La sûreté des combustibles nucléaires. Essais effectués dans la Pile Pégase	A/Conf 49/P./580
- Compte rendu des essais fusion Magnox	DPE/SPP 70/252
- Boucle d'irradiation Hélios "HTR et applications calogènes"	UTC/SPP/GEF 70/014
- Essai en conditions de fonctionnement anormales	UTC/SPP/GEF 73/198
- Essai dans une boucle de Pégase d'un dispositif à trompe pour obtenir les hautes températures d'Hélium	CEA R 4143
- Pegase loop experiment BIP 01	SPP 73/104
- Compte rendu de l'essai Cyclamen	SPP 73/054

(1) publications and technical notes available upon request

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT CADARACHE CENTRE

Location: Organization Name of lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
CEN/ Cadarache LECA	information not available							
CEN/ Cadarache ADAC	7	4	40 m^2	concrete : 1,20 m d = 3,5 lead glass :90 cm d = 4,5	X	(Air or N_2 possible	14 CRL A 8 2 CRL 5 stretchable 5 NEL 150	

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE LECA (FACILITY)

(Information not available)

INFORMATION SHEET N° 7
(Continued)

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE ADAC (FACILITY)

1) Owner or operator of the facility :

Commissariat à l'Energie Atomique
C.E.N./Cadarache

2) With which reactor is the facility associated? :

Rapsodie

3) Give details of equipment and techniques available :

Equipments allows the wasning of fuel assemblies, continuous X Ray Radiography and metrology. Quality inspection and measurements are accurate within 1μ over the diameter and 10^{-2} for length, weight and bend.
XRay and Neutron radiography - Gas pressure measurements inside the fuel by drilling (destructive testing), clad permeability, cracks detection by Eddy current method. Reassembling of clusters by welding with manipulator.

4) References of relevant publications :

BIST - Nov. 1972

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE LECA (HOT CELL FACILITY)

(Information not available)

UTILIZATION AND SPECIALIZATION OF THE ADAC (HOT CELL FACILITY)

1) What were the original purposes of the facility? :

Dismantling and non destructive testing of fuel assemblies from Rapsodie.

2) What major modifications have subsequently been made and for which particular research programme?

- Setting up of a pulsed reactor in cell for neutron radiography purpose.
- Pressure measurements of gaseous fission Products.
- Reconstruction of assemblies including fresh and irradiated pins in order to have a new irradiation after check up.

3) For which major projects and programmes is the facility presently being used?

- Supervision of standard fuel elements.
- Inspection of irradiated structure materials.
- Inspection of Foreign experimental assemblies.

4) Major modifications planned :

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

Yes.

INFORMATION SHEET N° 1

(November 1974)

MAIN CHARACTERISTICS OF THE ESSOR REACTOR AT ISPRA

Name of reactor	ESSOR
Organization	CEE EURATOM JRC ISPRA
Site	JRC ISPRA - VARESE ITALY
In operation since	DEC. 1968
Power MW(th)	- 25/33 in driver zone - up to 18 MW in experimental zone
Moderator	D_2O at 99,74%
Coolant	- D_2O in driver zone - H_2O, D_2O organic in experimental zone
Fluid and pressure (kg/cm^2) in experimental channels	see sheet n°5
Nominal operation days/year	~200

Operating cycle (days)	typical	long	short
on power		42	18
shut down		8	4

	Responsible officer:	Address :
ESSOR :	T.DOYLE	Centro EURATOM Division ESSOR I - 21020 Ispra (Varese)
ADECO :		
ATFI :		

INFORMATION SHEET N° 1
(Continued)

Main features of ESSOR

Care

Active dimensions:	diameter 118 cm height 154 cm
Sub-assemblies:	16 feeder fuel elements of 5 concentric plates containing 465 or 650 grammes of uranium-235 each
	12 experimental zone positions, maximum diameter 17 cm
	4 peripheral zone positions, maximum diameter 7.5 cm
Moderator	12 000 kg D_2O at 50°C and atmospheric pressure

Control

Safety rods:	4 mechanical type, B_4C (3% negative reactivity in 2 seconds)
	6 liquid poison type, Li_3BO_3 (7% negative reactivity in 0.2 seconds)
Shim rods:	10 mechanical type, Cd (15% negative reactivity at 0.007%/sec.)
Control rods:	2 mechanical type, stainless steel (0.8% negative reactivity at 0.04%/sec.)

Pressure vessel

AISI 304 L stainless steel

height 423 cm
diameter 238 cm

Design pressure: 8 kg/cm^2

Handling

Feeder zone machine: Maximum capacity:
diameter 14 cm
height 573 cm

Experimental zone machine:
Maximum capacity:
diameter 29 cm
height 935 cm

INFORMATION SHEET N° 1 (bis)
(cont'ed) (2)

Reactor operation

Long cycle:	Total duration of cycle:	50 days
	Duration of shutdown:	8 days
Short cycle:	Total duration of cycle:	22 days
	Duration of shutdown:	4 days

IRRADIATION POSITIONS OF THE ESSOR REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
				$\times 10^{14}$ n cm^{-2} sec^{-1}			
Experimental channel	12	2200	170	3-4	0,05	unknown	
Driver zone channel	16	1540	32	1,5	1,1	"	
Reflector zone channel	4	2200	75	1,5	0,01	"	

2) Reactivity available for experiments : 12000 pcm

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g. neutrography, etc.) : clean workshop, analytical chemistry laboratory, Hot Laboratories for dismantling and post-irradiation examination of experiments

5) References of relevant publications : see Sheet n° 5

6) If hot cell facilities are available on the reactor site, give its name and organization to which they belong (give details on sheet N° 6)

7) Are facilities available for irradiations on behalf of other organizations of the European Community ? :

Yes.

INFORMATION SHEET No. 2a

(Continued) (2)

MAIN CHARACTERISTICS OF THE EXPERIMENTAL LOOPS IN ESSOR

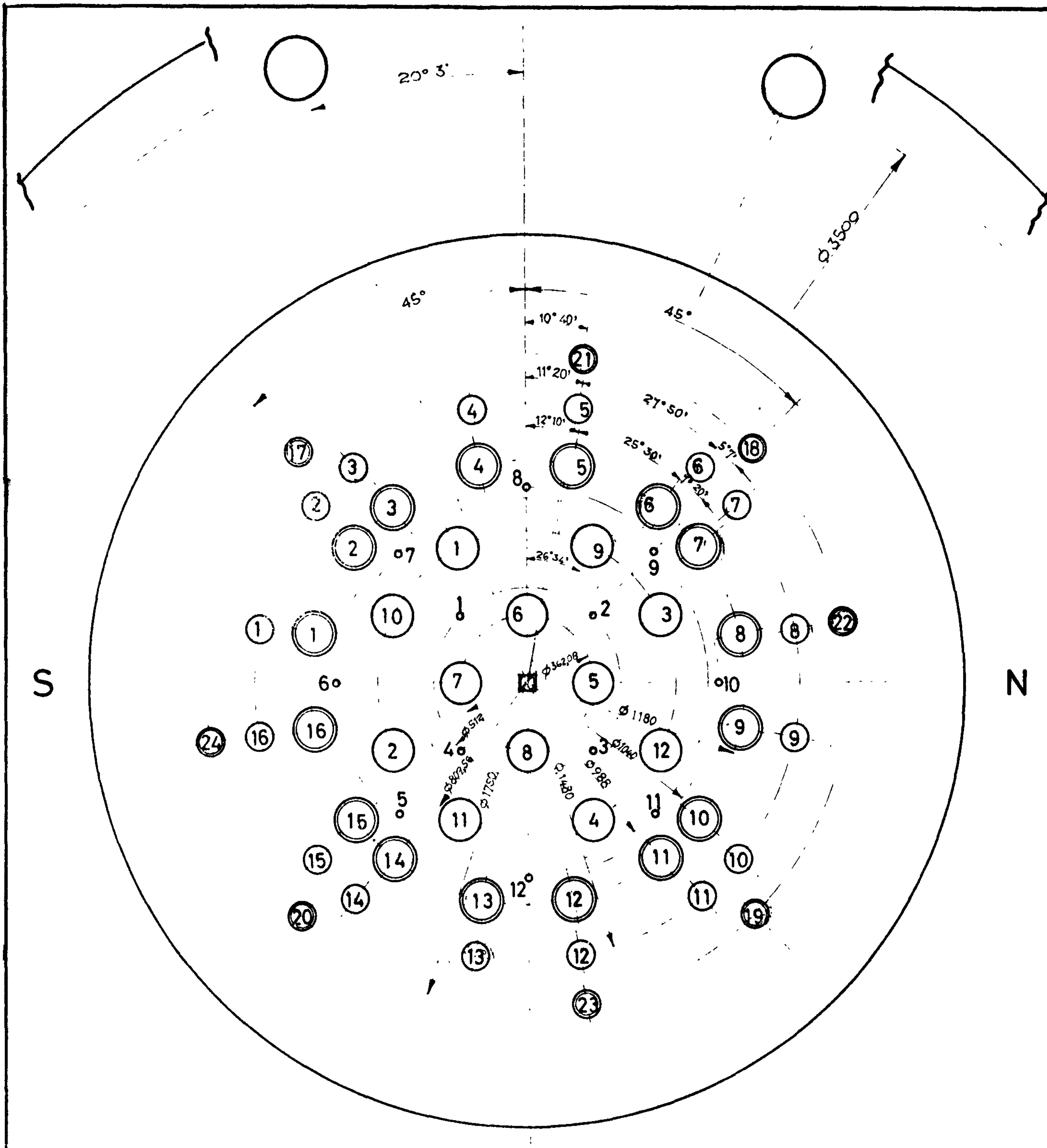
Name of the loop	Dimensions		Unperturbed neutron flux		Axial form factor	Max. power MW	Coolant					
	Diameter cm	Length cm	Thermal $x10^4$	Fast $x10^4$			Nature	Pressure max at als	Loss of pressure at als	Flow Kg/sec	Inlet temp. ^oC	Outlet temp. max. ^oC
CART I & II	10,6	220	3	0,05	0,65	1,5	fog	50	1,5	10	250	264
CLEOPATRA	10,9	220	3	0,05	0,5	3,15	H_2Opres	180	5,5	10,7/ 28,6	320	335
CABIRIA	12,4	220	3	0,05	0,5	3,15	H_2Oboil	70/90	6	4,5/18	-	284,5/302
IRA	5,6	150	3	0.05	0,80	0,300	H_2O	180	-	1,5	300	350
SARA	5,6	150	3	0,05	0,80	0,450	H_2O	180	-	3,3	-	350
MK 5 (3 channels)	9,2	160	3	0,05	0,75	1,8 each channel	Thermip	15	-	23,6	-	450

INFORMATION SHEET No. 2

(Continued) (3)

MAIN CHARACTERISTICS OF THE EXPERIMENTAL DEVICES IN ESSOR

Devices	Dimensions		Unperturbed neutron flux		Axial form factor	Max. power MW	Coolant					
	Diameter cm	Length cm	Thermal $x10^4$	Fast $x10^4$			Nature	Pressure Max. kg.	Loss of pressure atm abs	Flow m^3/h	Inlet temp. ^oC	Outlet temp. max. ^oC
ZENON (Cirene)	3,07	160	1,5	1,1	0,75	0,1	D_2O	8	3	89	45	60
ZENON(Colibri)	3,07	4x14	1,5	1,1	0,80	0,1	D_2O	8	3	89	45	60
MODESTE 4	17	220	3-4	0,05	0,65	0,25	D_2O	1,2	1,2	16	45	80
MODESTE Gioconda	5,8	1,50	3,5	0,05	0,80	0,06	D_2O	1,2	1,2	6	45	47
Rabbit Radioelem	2,6	7x11,5	3	0,05	0,9	-	D_2O	~3	-	5	45	80
Fuel	2	4x7	3	0,05	0,9	0,035	D_2O	3	-	3	45	80
Super Zenon	3,6	160	1	1,2	0,75	0,1	D_2O	8	3	89	45	60
Commode	161	120	0,8	0,33	0,85	2,5	D_2O	8	-	90	45	80
Zircon	5,0	1,500	0,8	2,5	0,75	-	CO_2	50	-	-	-	-



ESSOR CORE CONFIGURATION

Experimental channels, dia. 167-130 (Nos 1-12)

Feeder zone channels, inside dia. 112 (Nos 1-16)

Control and safety rods, inside dia. 65 (Nos 1-16)

Reflector zone channels, inside dia. 65 (Nos 17-24)

Channels for ionization chamber, dia. 290

Central flux-measurement channel, dia. 44 mm

Flux-measurement channels, dia. 6,75 mm, (Nos 1-12)

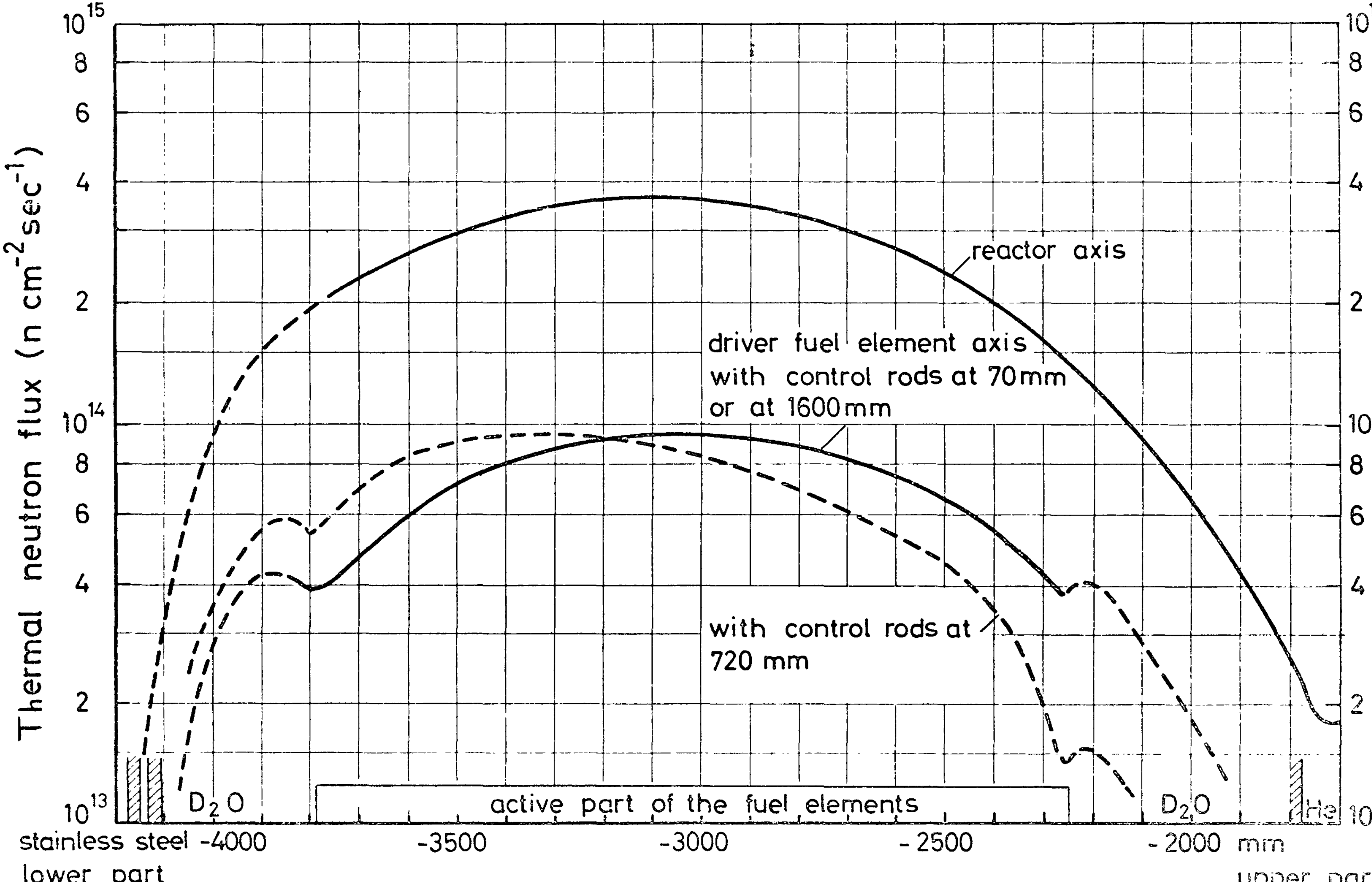


Fig. 2 - AXIAL DISTRIBUTION

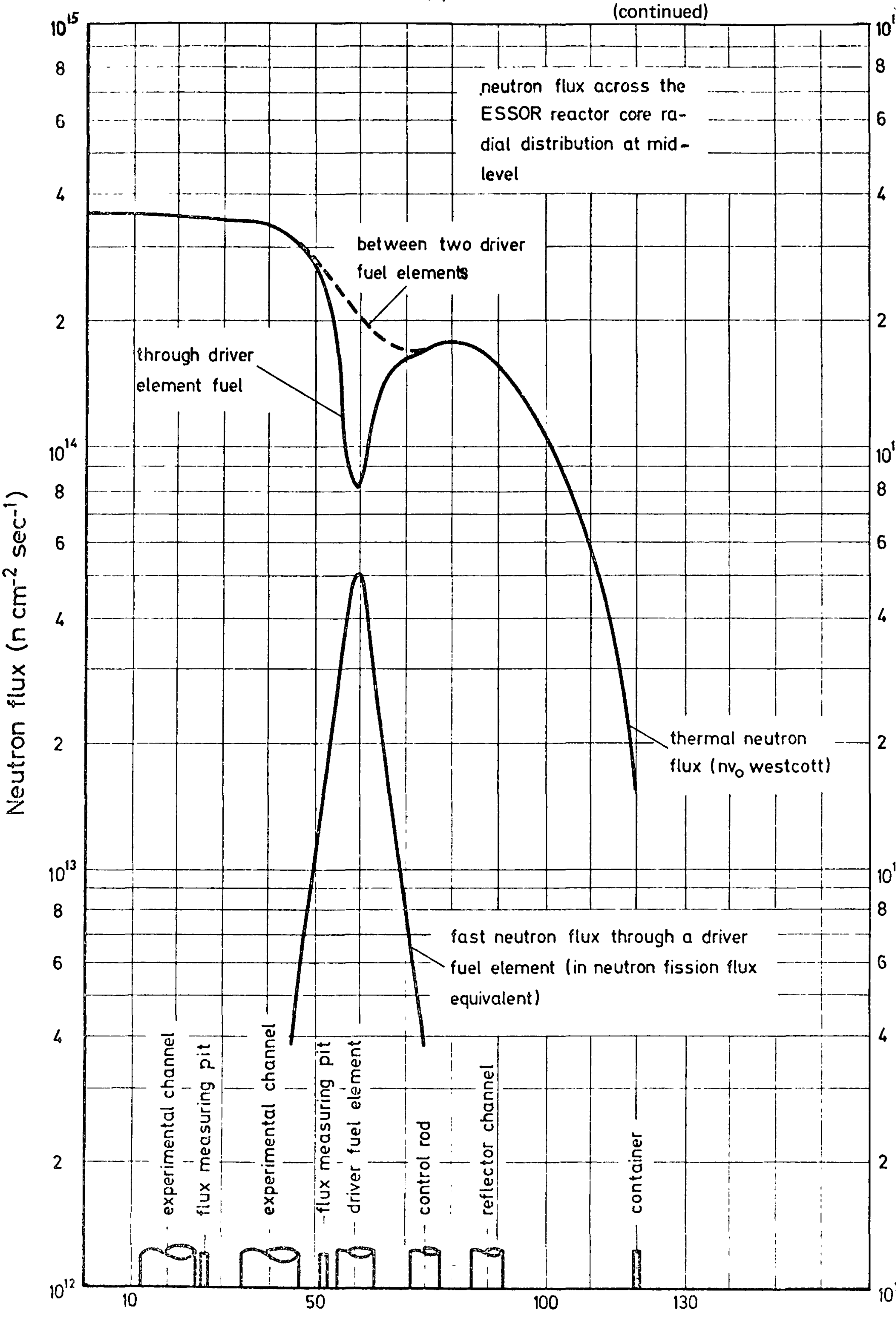


Fig. 3-RADIAL DISTRIBUTION

TYPICAL NEUTRON SPECTRA FOR THE .... REACTOR AT ....

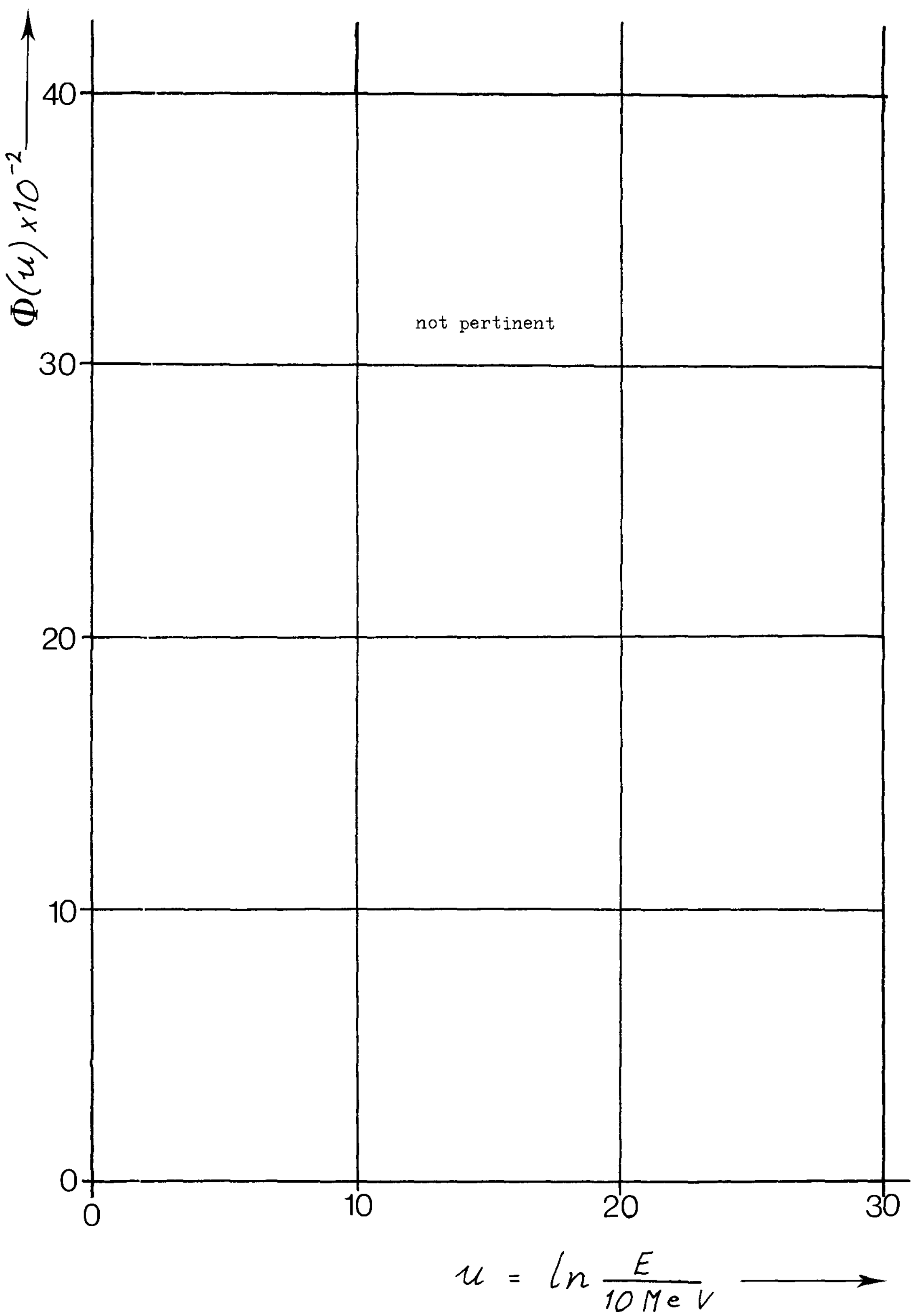
(histogram of flux per unit lethargy)

$\int \Phi(u)\,du = 1$

——— = typical core position

-------- = typical reflector position

.... =



UTILIZATION AND SPECIALIZATION OF THE ESSOR REACTOR

1) What were the original purposes of the reactor? Technological study of Orgel type reactor:
   Study of organic coolant, pressure and calandary tube, S.A.P. cladding material
   U.C. fuel elements
   Development of CIRENE type fuel

2) What major modifications have subsequently been made and for which particular research programme?
   - Some organic loops were dismantled and substituted by LW loops
   - Some specific dispositifs have been added
     (other indications in successive sheets).

3) For which major projects and programmes is the reactor presently being used?
   Testing of fuel elements for both BWR and PWR types
   Testing of fuel elements for CIRENE type reactor
   Testing and experiments of structural materials
   Special testing on UO_2 and PUO_2 fuel and kernel particles
   Testing of liquid safety rods.

4) What loops and irradiation devices have specially been developed for this reactor?

   a) give name and purposes of the devices :

      see sheet n° 4 bis

   b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned : Super Zenon, Commode and Zircon devices in development

INFORMATION SHEET N° 4
(Continued)

Development of point 4 of sheet n° 4

Name and purposes of main devices:

1. CABIRIA and CLEOPATRA respectively BW loop (3,15 MW, 90 ata) and PW loop (3,15 MW 180 ata)
   - Studies of fuel bundle under irradiation in advanced routine conditions, including simulation of the load - following operation of a power station.

2. CART I and CART II loop: light water fog cooled loops for testing CIRENE fuel assemblies.

3. IRA loop (300 KW, 180 ata) irradiation of LW reactor fuel pins in normal conditions for the study of densification and interaction between cladding and fuel.

4. SARA Loop (450 KW, 180 ata) irradiation of LW reactor fuel pins in critical conditions for safety assessment.

5. Zenon devices: irradiation at low temperature into the inner cavity of the driver fuel elements.

6. MODESTE devices: simultaneous irradiation of four capsules or instrumented fuel-pins in the experimental zone.

7. RABBIT: irradiation of non instrumented capsules or fuel pellets in the experimental zone with the possibility to remove the experiment at any time.

8. Liquid safety rods: testing under irradiation of various components of the system.

9. MK 5: multiple organic cooled loop connected to 1-3 experimental channels each 1,8 MW power.

INFORMATION SHEET N° 5

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE ESSOR REACTOR

(give also references of relevant publications)

see sheet 2a and 2b

Publications

1. A future for the ESSOR plant? P. Bonnaure and coll. - Energia Nucleare; Vol. 19 n° 4 April 72
Published jointly in Nuclear Engineering International and in french in Industries Atomiques et Spatiales.

2. Notiziario del CNEN - Anno 20 n° 8 - 9 agosto-settembre 1974. Il programma italiano per il reattore ESSOR

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT ISPRA CENTRE

Location Organization Name of Lab.	Year of: active operation	Scope: Number of working positions:	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and: density g/cm^3)	Leak: tightness	Special: atmosphere	Manipulators number and type:	Remarks and references
ADECO	1970	7	$70m^2$	Heavy concrete 1,10 m d = 3,5	alfa tight	none	12 M.S. Extended reach - central research L 1 HD electromechanical type OTER 2300	Associated with large pool 8 m water height protection
ATFI	1971	5	$80m^2$	Normal concrete 1,10 m d= 2,3	none	none	8 MS HD extended reach central research L manipulator	
LMA	1969	3 - 17		Heavy concrete 1 m d = 3,4 and 15 cm lead brick	alfa tight	none	6 HD MS manipulator, Model 19 1 HD electromechanical ERTN 100 KN teleman. M7 MS manipula	

INFORMATION SHEET N° 6

(Continued)

MAIN CHARACTERISTICS OF THE ESSOR HOT FACILITIES

Table I - Water Pool and ADECO

• Name and dimensions of the facility • Shielding	General equipment	Specific equipment
Water Pool - 7.64 x 3.70 m - 8 m of water height	- Crane, 2 trolleys on the same bridge weight 40 T and 6 T - Cantilever crane for underwater disposal of fuel elements	- 39 Supports for driver fuel elements - 48 Supports for experimental fuels and devices
Dismantling pool - 7.15 x 3.70 m - 8 m water height		- Dismantling device for PWR fuel elements model - Cutting device for MTR fuel elements max. diameter 120 mm max. length 5.300 mm
Access	- to the reactor: d = 250 mm L = 5500 mm	- Air-lock equipped with a swinging arm - Air-lock equipped with a rotating arm and lift Several supports

TABLE I (continued)

ADECO Working Cell 4411 Length: 10.40 m Width: 3.20 m Height 7.10	- 3 working stations, every one equipped with a) 1 shielded glass window b) 2 heavy duty, extended reach, master-slave manipulators c) 1 periscope - 1 travelling crane weight 20 kN	- 8 dry storage pits: internal diameter 280 mm length 5300 mm - 1 washing pit : internal diameter 120 mm length 5470 mm - 1 visual and photographic examination pit equipped with a vertical presentation bench. Diameter capacity of 110 mm for bundle and of 4 to 25 mm for pin - 4500 mm max length - cladding failures detection device, bubble type 110 mm max diameter 2 m max length - pucture test, vertical system with mechanical drilling device -capacity: a) fuel pin diameter 4 to 22 mm b) max length 5300 mm - dismantling rig equipped with a) longitudinal milling, 1,70m max length b) transversal cutting, 120 mm max diameter c) extremity milling - fuel pin cutting device equipped with diamond setting disc

TABLE I (continued)

Working cell 4411 (continued)		
Access to evacuation zone	70 mm internal diameter 1670 mm max. length	LMA 20 cm lead shielding container equipped with a "Ragueneau" shell
	105 mm internal diameter 645 mm internal diameter	"La Calhene" type door shielded and tight door equipped with an horizontal trolley
	600 mm internal diameter and 3 m max. length	Vertical access by the roof of the cell with a shielded plug and a tight plate
the neutrography device	240 x 240 mm square shape	Aluminium finger tube equipped with a trolley
testing cell	355 mm internal diameter 505 mm internal diameter	Shielded plug Shielded plug
Neutrography cell 4303		
L = 2.60 m W = 3.20 m h = 3.70 m heavy concrete: 1.10 m thick: $3.5\ g/cm^3$ and: 55 cm of iron		- electrostatic accelerator with titan-tritium target 2.10^{11} n/sec/4π of 14.5 meV - moderated and collimated neutron beam of $5.\ 10^{5}$ n cm^{-2} sec^{-1} - tin aluminium window, 100 x 100 mm square shape

TABLE I (continued)

Neutrography cell 4303 (continued)		
External Access	Iron door 70 x 200 cm	Iron door on trolley
Non-destructive testing cell 4304 L = 8.00 m W = 3.20 m h = 3.60 m heavy concrete: 1.10 m thick, 3.5g/cm^3 alpha tight	- 2 working stations equipped with a) a shielded glass window b) 2 HD extended reach. Master-slave tele-manipulators c) 1 periscope hole - a travelling crane: weight 20 KN 3 m height under the hook	- gamma spectrometry device a) vertical bench for fuel pins, diameter 4 to 25 mm; max. length 3.80 m b) several windows 20 x 0.2-0.5-1-2mm c) Ge-Li detector d) A.D.C. 16, 384 channels analyser associated with a minicomputer 20 K bytes memory capacity e) results - on magnetic tape IBM compatibility - on paper A4 format X Y plotter - teletype listing f) micro-programmation to obtain - automatik peak identification - energy calibration - calculation of peak full width at half max. - peak area with or without back ground - cross and selective gamma scanning

TABLE I (continued)

Non-destructive testing cell 4304 (continued)		- metrological bench for bundle and fuel pin - cladding failures detection for fuel pins only 50 ata He pressurization 500 mm max length 22 mm max diameter 270°C detection temperature
Access to 4305 cell	- 200 mm max diameter - 800 mm max length	air lock equipped with a shell and shielded door
In the roof of the cell	- Solid wastes: 230 mm diameter and 170 mm max length : 410 mm diameter and 700 mm max length	shielded plugs with adaptation for a 200 mm lead container
4305 cell L = 3.60 m W = 3.20 m h = 3.60 m heavy concrete 1.10m thick, 3.5 g/cm^3	1 shielded glass window 2 HD extended reach Master-slave telemanipulators 1.10 KN travelling crane 1 periscope hole	bench-scale vitrification installation

TABLE I (continued)

Access to		
cell 4304	see cell 4304 access	
cell 4306	- 200 mm max diameter - 800 mm max length	air lock equipped with a shell and 2 shielded doors
Rear zone	- 105 mm/270 mm diameter concentric tight doors with 250 mm lead shielded	"PADIRAC" system; 20 cm lead
In the roof	- identical to 4304 roof access	see 4304
4306 cell		
L = 7 m W = 3.20 m h = 3.60 m	2 shielded glass windows 4 HD extended reach master-slave tele-manipulators 1 10 KN travelling crane 2 periscope holes	non equipped
4307 cell L = 3 m W = 3.20 h = 3.60 heavy concrete	non equipped	non equipped

MAIN CHARACTERISTICS OF ESSOR HOT FACILITIES

TABLE II - A.T.F.I.

. Name and dimensions of the facility	General equipment	Special equipment
Storage and examination cell 3102 length 3.2 m width 4.8 m height 11.7 m	- a 20 KN crane and a 10 KN electromechanical manipulator every one equipped with a TV camera travelling on the same railway (covered the 3 cells)	- 1 through the wall periscope - a Rabbit **TV** camera - several supports
Dismantling cell length 3 m width 4.8m height 11.7m	- a standard working station in the dism. cell - 3 standard working stations in the testing cell every one equipped with - 1 shielded glass window - 2 HD extended reach master-slave manipulator - 1 periscope hole	- disk cutting machine moving on vertical bench max.diam.capacity 200 mm; max.length 7000 mm
Testing cell length 10.2 m width 4.8 m height 4.7 m	- shielding 1.10 m thick normal concrete	1 burst test device 1 helium test bench 1 electro erosion cutting machine 1 reciprocating saw 1 500 KN hydraulic shears

TABLE II (continued)

Access to reactor building	- 250 mm diameter - 11,000 mm length	- air-lock and several supports
wastes in the basement	- 2 holes Ø250 mm diameter	1 shielded plug non equipped 1 shielded plug equipped with alpha transfer system
wastes in the roof	- 230 mm diameter and 1700 mm max. length - 410 mm diameter and 700 mm max. length	shielded plugs with adaptation for a 200 mm lead shielded container
rear door	- 1100 mm width 2000 mm height	concrete shielded door on trolley

INFORMATION SHEET N° 7

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE ADECO FACILITY

1) Owner or operator of the facility : CEE Euratom - JRC ISPRA - ESSOR Division

2) With which reactor is the facility associated? : ESSOR

3) Give details of equipment and techniques available :

- Under water dismantling device for PWR-type fuel assembly
- Dismantling rig equipped with longitudinal, transversal cutting, extremity milling
- 8 dry storage and 1 washing pits.
- Visual and photografic examination, presentation bench
- Punter test and fission-gas sampling
- Fuel pin cutting device
- Neutroradiography examination device
- Gamma spectrometry vertical bench with GeLi detector and computer program
- Cladding fealure detection device, bubble test system in oil at 270°C.

4) References of relevant publications:

- Dismantling workshop for Orgel fuel elements - J. Biteau, C. Garric, A. Wilhelen - AIEA International Symposium on Working methods in High Activity Hot Laboratories, June 1965 - Paper n° 44.
- Facilities at the CCR Ispra for manipulation and post-irradiation examination of fuel elements for

Power reactors. 15th meeting of Euratom Hot Laboratories Committee Geesthacht - June 1973

- Post-irradiation analysis of TRINO Vercelles Reactor fuel elements - EUR 4909e 1972.

UTILIZATION AND SPECIALIZATION OF THE ADECO HOT CELL FACILITY

1) What were the original purposes of the facility? :

Dismantling and non destructive examination of Orgel fuel elements

2) What major modifications have subsequently been made and for which particular research programme?

The devices were adapted for Cirene fuel elements type and for dismantling of specific rigs
Improvement of the devices for LWR assemblies examination.

3) For which major projects and programmes is the facility presently being used?

Cirene fuel elements post-irradiation examination
Help to the Power LW reactor technology

4) Major modifications planned :

Equipment of one cell with other non destructive testing device as Eddy current test and macrophotographic devices for cladding examination.
Cutting of cladding by laser techniques.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

Yes.

INFORMATION SHEET N° 6

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT CASACCIA CENTRE

Location: Organization Name of lab.	Year of active operation	Scope Number of working positions	Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
Casaccia (Roma)								
C N E N								
OPEC 1	12	5	24	Concrete 0,75 m 3,5 g/ml	only gamma	NO	10 MOD 8 1 NEL 100	
OPEC 2	will start in 1975	10	60	Concrete 1 m 3,6 g/ml or 0,65 m 3,6 g/ml	$\alpha - \gamma$	Provision for inert atmosph.	10 MOD 8 (HD) 2 ABC (Heavy mechanic arms) 10 MOD G	

OPEC Hot Lab

Responsible officer:

Dr. C. CESARANO

Address :

CNEN
CSN della Casaccia
C.P. 2400 - I - 00100 Roma

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE OPEC FACILITY

1) Owner or operator of the facility : C N E N - Italy

2) With which reactor is the facility associated? : None

3) Give details of equipment and techniques available :

Non destructive tests: visual - gamma scan-gamma densitometry - metrology - X ray radiography

Piercing for fission gas collection and analysis

Dismantling of fuel and capsules

Macro and Microscopy

Radial sampling- and radiochemical analysis

Annealing - HD Determination O/Me determination

4) References of relevant publications :

1. Cacciari, Cesarano, Lepscky, Nepi : Hot facilities of CNRN
Proc. 8th Conference Hot Laboratory and Equipment 167 (1960)

2. Cesarano, Cudia, Evangelisti, Lauro, Vescia : The Alpha-Gamma Radiometallurgy Laboratory at Casaccia Nuclear Center - Design and Construction
Proc. 19th Conference on Remote Systems Technology 145 (1971)

UTILIZATION AND SPECIALIZATION OF THE OPEC 1 HOT CELL FACILITY

1) What were the original purposes of the facility? :

Any kind of experiment
Requiring hot facilities

2) What major modifications have subsequently been made and for which particular research programme?

- Enlarging the office and low activity laboratory
  Space in order to afford a comprehensive program of post-irradiation analysis of ceramic nuclear fuels
- Building a new wing (OPEC 2) for $\alpha - \gamma$ post-irradiation work on Pu Fuels

3) For which major projects and programmes is the facility currently being used?

1) CIRENE project
2) Basic research and development
3) Miscellaneous requirement of other programs

4) Major modifications planned :

No one (see 2b)

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community? :

Not at the moment.

INFORMATION SHEET N° 1
(September 1974)

MAIN CHARACTERISTICS OF THE HFR REACTOR AT PETTEN

Name of reactor	High Flux Reactor
Organization	EURATOM
Site	CCR - Petton
In operation since	1961
Power MW(th)	45 MWth
Moderator	H_2O, Be
Coolant	
Fluid and pressure (kg/cm^2) in experimental channels	H_2O 3,6 abs.
Nominal operation days/year	265 days/year
Operating cycle (days)	
on power	2 x 19 } Total cycle = 1 + 19 + 3 + 19 = 42 days
shut down	1, 3 }

	Responsible officer :	Address :
HFR :	P. von der HARDT	EURATOM - J.R.E. Westerduinweg NL - Petten (Noord-Holland)
LSO - Hot Lab	H.J. WERVERS	Reactor Centrum Nederland Westerduinweg NL - Petten (Noord-Holland)

IRRADIATION POSITIONS OF THE HFR REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes $10^{14} n/cm^2 s$ thermal	fast (>100 KeV)	max. γ-heating W/gr Al	Remarks
In-core positions	6	600	72 max. (in-core and reflector positions)	2,9	5,3	14	
Reflector positions	9	600		1,1	2,1	5	
Poolside facility (PSF)	14	500	50	3,0	1,0	4	Number of PSF positions available for test irradiations: 10

2) Reactivity available for experiments :

3) Typical neutron spectra available should be added on sheet N° 3   see sheet N°3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.) :

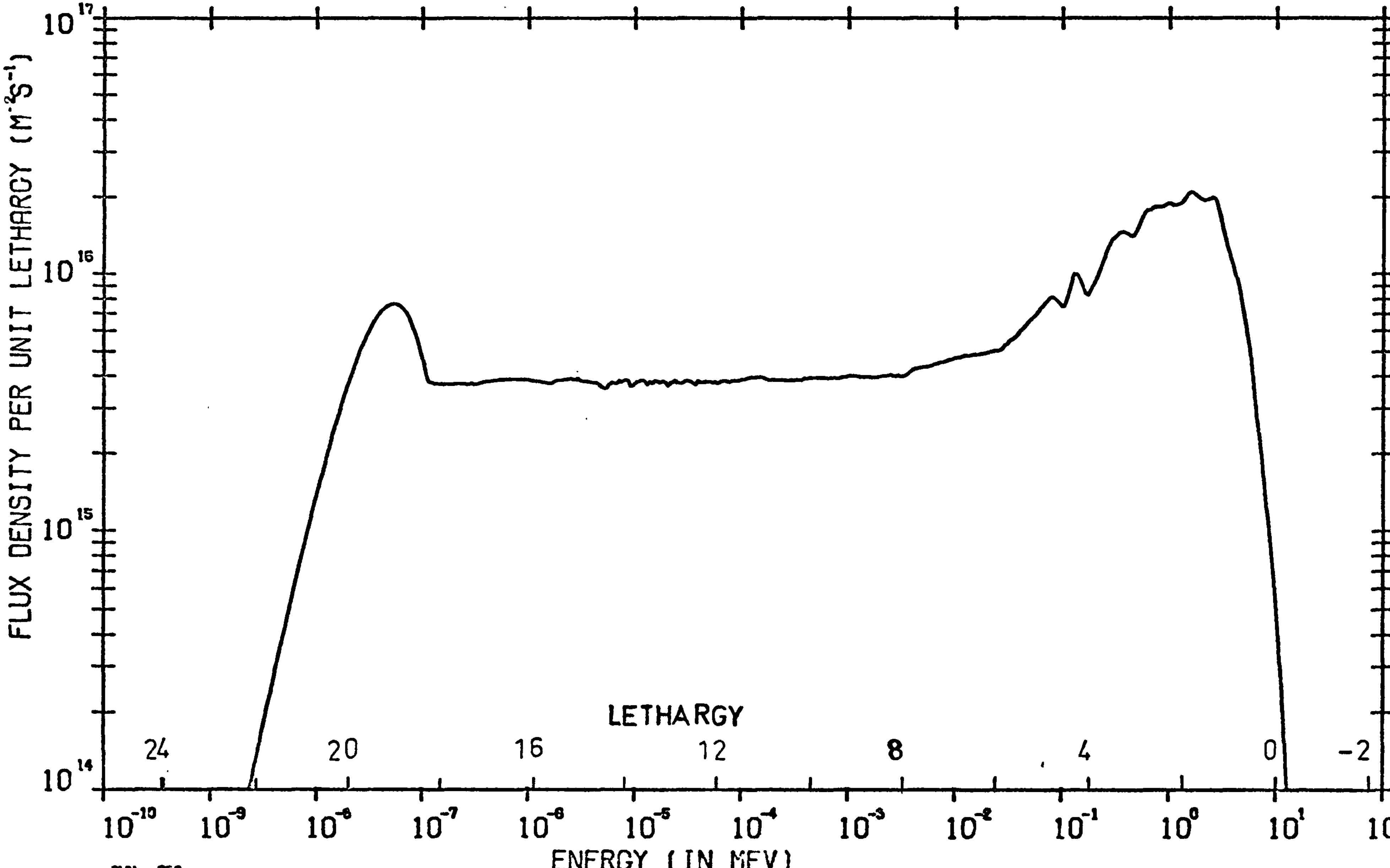
Neutrography, digital data acquisition, centralized gas control systems
centralised in-pile heater control system

5) References of relevant publications :

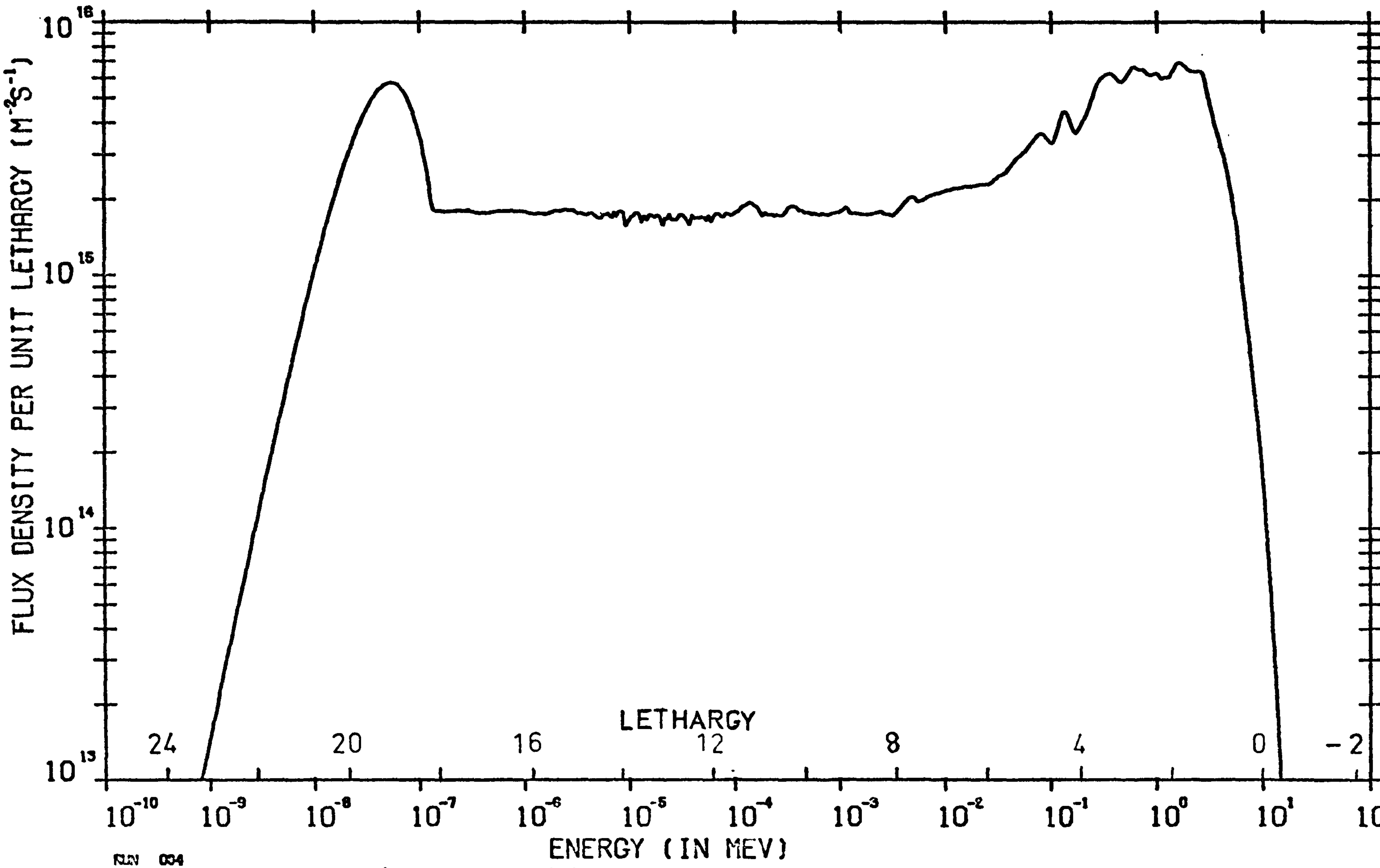
Annual Report 1973 (to be edited)

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6)   see sheet N° 6

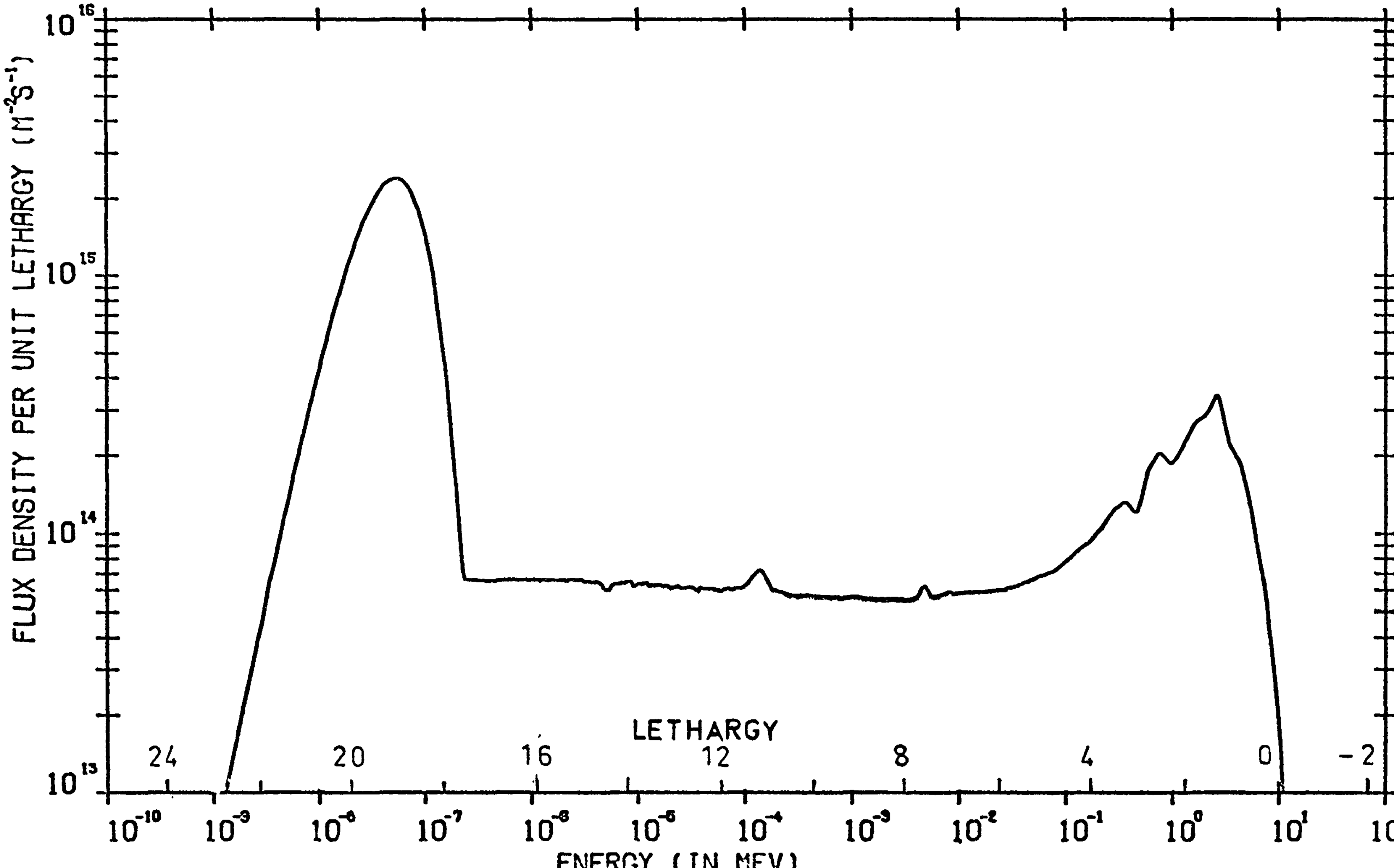
7) Are facilities available for irradiations on behalf of other organizations of the European Community? :



Neutron spectrum in HFR core position E5, representative for a mid-core experiment position.



Neutron spectrum in HFR core position G2, representative for a near-reflector experiment position.



Neutron spectrum in HFR poolside facility at a distance of 128 mm from the core box wall.

INFORMATION SHEET N° 4

(September 1974)

UTILIZATION AND SPECIALIZATION OF THE HFR REACTOR

1) What were the original purposes of the reactor?

Materials testing, isotope production and beam hole experiments (solid state and nuclear physics)

2) What major modifications have subsequently been made and for which particular research programme?

- Power increase 20-30-45MW, burnable poison fuel elements
- Poolside facility: electrical operation of trolleys for fast and programmed power transients
- Top plate modification for easier access and vibration-free rig fixation

3) For which major projects and programmes is the reactor currently being used?

Graphite, static and creep. Coated particle fuel
LWR and LMFBR transient fuel irradiations
Various metal radiation damage programmes
Isotope production and neutron physics

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :

High Pressure Water Loop
Various capsules for above-mentioned programmes

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5.
see sheet N° 5

5) Major modifications planned :--

INFORMATION SHEET N° 5
(September 1974)

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE HFR REACTOR

(give also references of relevant publications)

B - Irradiation devices for non fissile materials

- o REFA- Multipurpose reloadable facility, sample diam. 70 m/m, 200-2000°C, Extrapolated designs ("HTJ", "TRIO")
- o BERO- High Pressure Water Facility
- o NAST- Steel Irradiation in Sodium

C - Irradiation devices for in-pile measurements

- o Fuel creep assembly: for elongation measurement of fissile specimens under variable loading, and fission rate, temperature up to 1100°C.
- o Canning creep assembly: for tensile-creep measurements at 250 - 700°C.
- o Loss of cooling capsule study of a fuel pin, which looses its cooling under fast reactor conditions 600 W/cm, 525°C can temperature
- o Compact creep assembly: for tensile-creep measurements on compact samples under variable loading and temperature up to 1100°C.
- o Graphite creep assembly: for tensile-creep measurements on graphite samples under variable loading and temperature up to 1100°C.

- Information on HFR facilities, dec. 1971, EUR 4639/e (4 reports)

INFORMATION SHEET NO. 6

September 1974

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT . PETTEN . . . CENTRE

Location Organization Name of lab.	Year of active operation	Scope Number of working positions	Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
Petton RCN* LSO	1964	5 (5 cells)	37,5	1,20m concrete of 3,5 g/cm^3	dynamic	possible	5 pairs mod. 9 1 GEC MK 1	
HFR Petton Euratom DM Cell	1966	1	about 10	Cast iron 0,6m; locally: Pb and 2,8g/cm^3 concrete	dynamic	no	1 pair M9,PYE, Nr HD-LD 3985 1 OTER 2100	HFR Dismantling Cell on top of reactor pool side wing
LSO Petten Euratom)H Cell	1972	1	3,5	Pb 0,254 m	α-tight	possible	1 pair C.R.L.	Special equipment for fuel pin examinations
)G 5 Cell*	1974	1	1,8	Pb 0,178 m			1 pair BF 651	Special equipment for coated particle fuel

* 4 G-type universal Pb cells for chemical, metallurgical etc. work are available to RCN and Euratom, besides G5.

INFORMATION SHEET N° 6
(Continued)
UPDATED 1-11-1974.

MAIN CHARACTERISTICS OF FACILITIES FOR POST IRRADIATION EXAMINATIONS AT THE PETTEN CENTRE

Location Organization Name of lab.	Year of active operation	Scope: Number of working positions	Scope: Active area (m^2)	Gamma shielding (material, thickness (m) and density (g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
Petten L.S.O. R.C.N.	1964	high activity cells 4 in line, 5 working stations	37,5	barytes concrete 120 cm. 3,5 g/cm^3	dynamic	no unless special in-cell box installed	5 pairs master-slaves, heavy duty 1 powermanip. G.E.C. 1 powermanip. Draht & Schrader 1 hoist	cells AB, C, D,E general purpose use, dismantling gamma-scanning dynamic testing
L.S.O. R.C.N.	1965	metallographic cell line with head end cell, 10 working stations	9,6	lead: 11,4 g/cm^3 head end cell: 25 cm. remaining cells: 18 cm.	yes	nitrogen or other	tongs in ball-joints	F metallography
L.S.O. R.C.N.		medium activity cells, 2 cells, 1 working station each. additional cell will be available in 1975.	4,8	lead and steel 18 cm. lead aequivalent	yes	nitrogen or other	masterslaves 2 pairs, compact type, CRL model G	G2, G3 (G1) chemical operations
L.S.O. Euratom	1972	medium activity cell, 2 working stations	± 4	lead, 25 cm.	yes	nitrogen or other	masterslaves 2 pairs, compact type, CRL model G	H special equipmen fuel pin examination, micro X-ra micro sampling
L.S.O. Euratom	1974	medium activity cells, 1 working station each, 3 working stations	6,6	lead and steel, 18 cm. lead aequivalent	yes	nitrogen or other	masterslaves 1 pair CRL, model G 1 pair BF 651 1 pair Hobson	G4, G5, G6 special equipment coated particle fuel exam.
H.F.R. Euratom	1966	high activity cell 1 working station	~ 10	cast iron 60 cm.	dynamic	no	1 pair masterslaves Pye heavyduty 1 powermanip.Oter 2100 1 hoist	associated with high flux reactor dismantling of irrad. devices

INFORMATION SHEET N° 6
(Continued)
UPDATED 1-11-1974.

MAIN CHARACTERISTICS OF FACILITIES FOR POST IRRADIATION EXAMINATIONS AT THE PETTEN CENTRE

Location Organization Name of lab.	Year of active operation	Scope		Gamma shielding (material, thickness (m) and density (g/cm^3))	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
		Number of working positions	Active area (m^2)					
Petten L.S.O. R.C.N.	end of 1974	special facility for creep testing 10 machines one headend cell with one working station		lead, 18 cm.	none	none	one pair master-slaves CRL, Compact model G	creep testing only

INFORMATION SHEET N° 7
(updated 1. 11. 1974)

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE PETTEN FACILITY

1) Owner or operator of the facility:

R.C.N. and Euratom, as indicated on sheet nr. 5.

2) With which reactor is the facility associated?:

H.F.R. Petten.

3) Give details of equipment and techniques available:

The combined R.C.N.-Euratom facilities can supply all current post-irradiation examination techniques, e.g., dismantling, dimensional measurements, photography, visual inspection, gamma spectrometric scanning, fissiongas sampling and analysis, burn-up determination, ceramography X-ray techniques (macro and micro) neutrography, microsampling, mechanical testing comprising tensile (static and dynamic), creep, impact, hardness, electron microscopy, electron microscanning, weighing, density determinations;
in addition remote assembly of components handling of large radiation sources, chemical sparations, remote welding.

Limitations: shielded flasks → max. weight 25 tons
fuel assemblies → max. length appr. 2 metres
projection X-ray macro → 0-300 kV, 6 mA
micro X-ray → 5-60 kV, 3-60 mA
visual inspection → periscope 4-15x

Limitations (cont'ed) : dynamic testing and tensile → 20 tons

creep → 3 tons

INFORMÁTION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE PETTEN HOT-CELL FACILITIES

1) What were the original purposes of the facility?:

Post-irradiation examination of materials irradiated in the H.F.R., inclusive of dismantling of irradiation devices, support of H.F.R. operations and general purposes.

2) What major modifications have subsequently been made and for which particular research programme?:

None.

3) For which major projects and programmes is the facility presently being used?:

See irradiation programme (information sheet nr. 4).

4) Major modifications planned:

a) Modification of material routing system, adaptation of one or two cells and transfer systems to α-compatible standards to meet requirements set by Pu-enriched fuels.

b) Extension of building to accommodate additional medium-activity cells for mechanical testing of structural materials.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?:

Yes.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE DIDO REACTOR AT HARWELL

Name of reactor	DIDO
Organization	U.K.A.E.A.
Site	Atomic Energy Research Establishment, Harwell, Berkshire, England.
In operation since	1956
Power MW(th)	Current Operating Power: 22.5 MW
Moderator	D_2O
Coolant	D_2O - Primary; H_2O - secondary
Fluid and pressure (kg/cm^2) in experimental channels	Not applicable
Nominal operation days / year	310
Operation cycle (days)	
on power	24
shut down	4

	Responsible officer:	Address :
DIDO :	W.F. Wood	Research Reactors Division A.E.R.E. Harwell, Didcot, Oxfordshire OX11 ORA

IRRADIATION POSITIONS OF THE DIDO REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
Fuel Element							
(i) Mk 5/4	22	600	50	$1.8\ 10^{14}$	$0.6\ 10^{14}$	4	
(ii) S2	2	400	25	$1.1\ 10^{14}$	$1.6\ 10^{14}$	6	
Reflector							
2V	9	600	50	$2.0\ 10^{14}$	$5\ 10^{12}$	1	
4V	5	600	100	$0.6\ 10^{14}$	$4\ 10^{11}$	0.2	) Can be sub-divided to 50mm
6V	4	600	150	$2.0\ 10^{14}$	$2\ 10^{12}$	1	) or 25mm facilities if required.
4VGR	2	600	100	$8\ 10^{12}$	-	-	
6VGR	6	600	150	$8\ 10^{12}$	-	-	
10VGR	2	600	250	$8\ 10^{12}$	-	-	
4H	6	-	100	$1\ 10^{14}$	-	-	
6H	1	-	150	$1\ 10^{14}$	-	-	
10H	1	-	250	$1\ 10^{14}$	-	-	

INFORMATION SHEET N° 2
(cont'ed)

2) Reactivity available for experiments : 8.0%

3) Typical neutron spectra available should be added on sheet N° 3

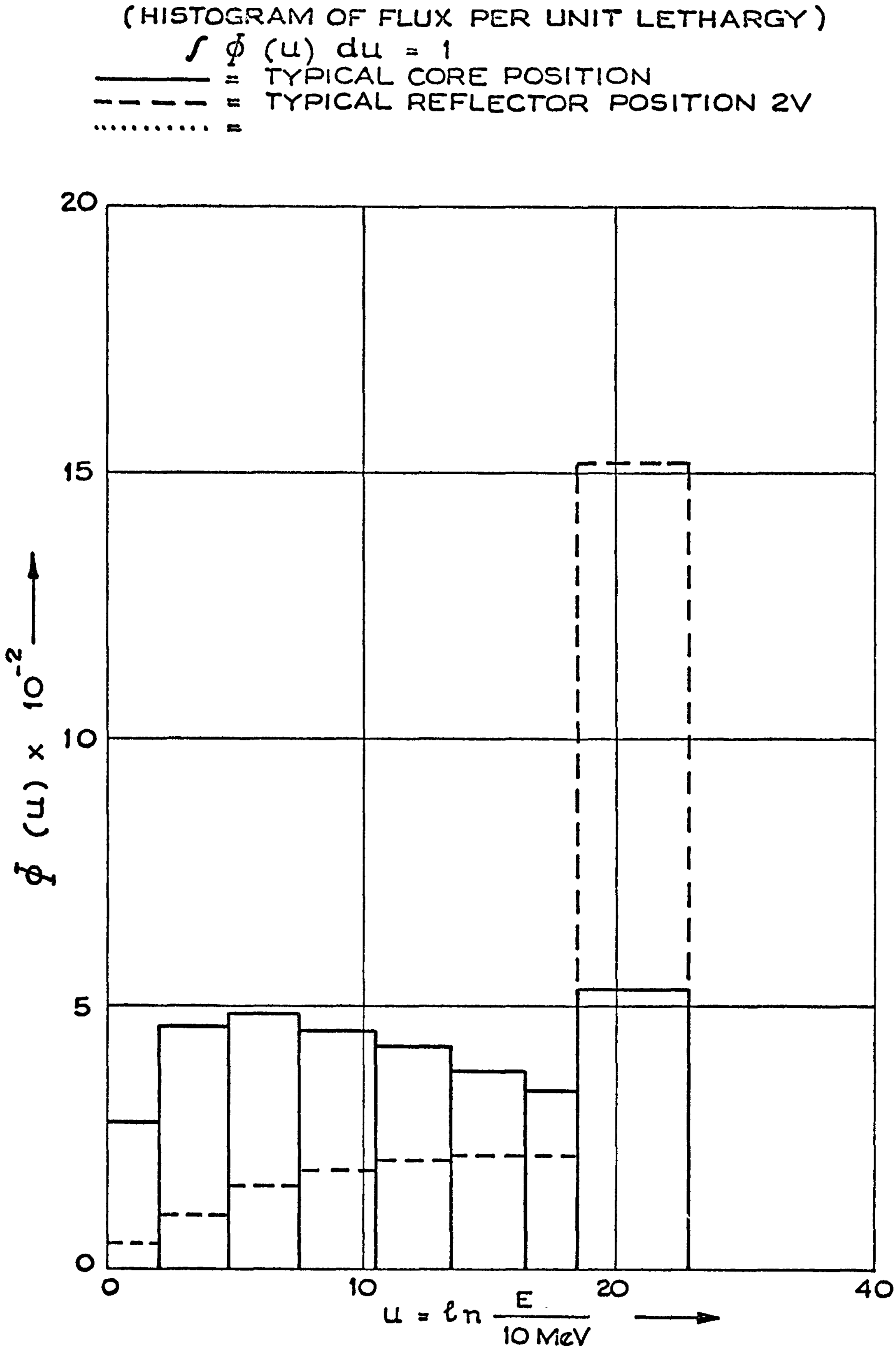
4) Specialized equipment available for experimenters (e.g., neutrography, etc.) : Various handling equipments, sample changing cells, data collection facilities etc.

5) References of relevant publications :

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6) Yes, Research Reactors Division, also other large hot cells operated by Engineering Division and P.I.E. facilities in Metallurgy Division.

7) Are facilities available for irradiations on behalf of other organizations of the European Community? :

Yes.



TYPICAL NEUTRON SPECTRA FOR THE DIDO REACTOR AT AERE HARWELL

UTILIZATION AND SPECIALIZATION OF THE DIDO REACTOR

1) What were the original purposes of the reactor?

Materials and fuels testing in support of civil power reactor programmes.

Neutron Beam experiments for fundamental physics research.

Isotope Production.

2) What major modifications have subsequently been made and for which particular research programme?

Progressive increases in power from 10 MW to 22.5 MW in support of all programmes.

Development of special fuel elements to provide more experiment facilities and harder flux spectrum.

3) For which major projects and programmes is the reactor presently being used?

Gas cooled thermal reactor programme.

Fast Reactor'programme.

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :

Various dynamic gas loops in support of gas-cooled reactor programmes for study of fuels, structure materials, cladding and coolant chemistry.

Irradiation rigs, some of which can be loaded and unloaded at power. Cold neutron beam source at liquid hydrogen temperature. High pressure water loops, used with various experiments in reactor core or reflector (see sheet 5)

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

Possible increase in reactor power and flux and changes to flux spectra.

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE DIDO REACTOR

(give also references of relevant publications)

High Pressure Water Loop

A loop constructed in mild steel for the irradiation of fissile specimens in water at the following nominal conditions:

Pressure: 17.2 MPa   Temperature: up to 300°C

Pump differential pressure: 1 MPa at flow rates up to 2.27 kg/s

Heat rejection capacity: Three loops at 150 kW, 50 kW, 50 kW.

Experiment volumes at high neutron flux: 600 mm long 78 mm dia.
600 mm long 38 mm dia. (two)

Shielding: 600 mm concrete

Neutron radiation facilities for radioactive and non-radioactive specimens and including post radiation examination and measurement of specimens within experimental rig assemblies.

INFORMATION SHEET No. 0

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT . HARWELL . . . CENTRE

Location Organization Name of lab.	Year of active operation	Number of working positions (Scope)	Active area (m^2)	Gamma shielding (material, thickness (m) and density g/cm^3)	Leak tightness	Special atmosphere	Manipulators number and type	Remarks and references
1. High activity handling building 459.	1958 1960	(a) 5 (b) 5	45 45	1.70 2.3 1.35 2.3	- -	- -	20 Master slave NEL model 9 1-General Mills Power Manipulation type 350. 1-GEC Power Manipulator.	General purpose facility Rig & fuel element dismantling. P.I.E of fuel and reactor components. Preparation of radio-isotope sources.
2. Post Irradiation Laboratory B.393.6	1959	(a) 3 (b) 9 interconnected lead cells. (c) 20 free-standing lead cells	20 14 20	1.000 3.2 0.250 11.4 various thickness 50mm to 250mm density 11.4	To maintain nitrogen atmos. of less than 2% O_2	Nitrogen	6 Master slave NEL model 9 180, Tong Manipulators Harwell type	Examination of advanced reactor fuels.
3. DIDO Handling cell	1957	3	16	1.37 2.3	-	-	6 type ARGONNE 8 and 9. 1 overhead electrically and hydraulically operated (Limbry & Heron Ltd)	Rig and fuel dismantling or repair.
4. Miscellaneous cells in the Metallurgical and Chemistry Building equipped for special purposes e.g. Gamma scanning, Chemical analysis etc.								
5. Miscellaneous cells in DIDO & PLUTO reactors for rig sample changing, absorber maintenance etc.			up to 1m^2	0.25 11.4	-	-	up to 4 long manipulators	

EQUIPMENT AND TECHNIQUES AVAILABLE FOR POST-IRRADIATION EXAMINATIONS AT THE AERE HARWELL (FACILITY)

1) Owner or operator of the facility :

(1) Owner, Engineering Division, Operator Engineering Division.

(2) Owner, Metallurgy Division, Operator Engineering Division.

2) With which reactor is the facility associated? :

Primarily, DIDO and PLUTO (Harwell), Dounreay Fast Reactor (Dounreay), DRAGON Reactor (Winfrith) but material is also received from reactors in other countries.

3) Give details of equipment and techniques available :

1. Equipment for dismantling of large irradiation rigs and experimental fuel assemblies.

2. Equipment for the detailed examination of fuels and components including

(a) Measurement of length and diameter changes utilising electrical transducers.

(b) Collection of fission product gases using laser piercing techniques.

(c) Preparation of materials for examination on optical; electron and stereo-scanning microscopes.

(d) Precision gamma scanning of fuels.

(e) Machining of irradiated materials in mechanical test pieces.

(f) Equipment for mechanical properties testing - tensile creep, fatigue etc.

(g) Re-encapsulation of irradiated material.

(h) Preparation and encapsulation of radio-isotopes, Cobalt, Caesium, Californium.

4) References of relevant publications :

See attached list.

INFORMATION SHEET N° 7
(cont'ed) (2)

References of Relevant Publications

1. Bown, J.E., et al., "The High-Activity Handling Building at A.E.R.E. Harwell". Proceedings of the 2nd United Nations Conference on the Peaceful Uses of Atomic Energy. Vol. 17, pp 631-644 (September 1958).

2. Bown, J.E., Ritchie, A.B., "Operations in the High Activity Handling Building B.459, A.E.R.E., Harwell. Proc. 8th Conf. Hot Labs.Equip., TID7599, 1, 50 USAEC Div.Tech. Info. (1960).

3. Venables, H.J., "Remote Handling of Irradiated Alpha-Active Materials in the Metallurgy Division, A.E.R.E., Harwell". Proc. 8th Conf. Hot Labs. Equip., TID7599 1, 78, USAEC Div. Tech. Info. (1960).

4. Ritchie, A.B., Serrels, G.A., "Dismantling and Machining Operations on High Activity Rigs at Harwell", Proc. Symp. High Activity Hot Lab. Working Methods, Grenoble 1, 329 (1965).

5. Ritchie, A.B., "Safety Experience and the Control of Hazards in Hot Cell Operations at Harwell". Proc. 15th Conf. Remote Systems Technology p.167 (1967).

6. Campbell, D., "Post Irradiation Examination Facilities and Techniques" Journal of the Inst. of Nuc. Engs. Vol. 11, N° 5 p 136 (1970)

7. Rich, J.B., et al., "Techniques employed in the examination of irradiated prototype fuel pins for high temperature gas-cooled reactors". Proc. Symp. Post-Irradiation Examination Techniques.

8. Brown, P.E., et al., "Lead-shielded Micro-handling Cell for coated fuel particles". A.E.R.E. R.6702

INFORMATION SHEET N° 8

UTILIZATION AND SPECIALIZATION OF THE HARWELL (HOT CELL FACILITY)

1) What were the original purposes of the facility? :

The two major post-irradiation examination facilities were designed in support of a materials-testing programme for the British Nuclear Power Programme. This is still the main purpose of the facility.

2) What major modifications have subsequently been made and for which particular research programme?

No major modifications have been made to the concrete cell facilities, but the equipment within is frequently changed dependent on the research programme. The most recent changes are in support of a High Temperature Reactor programme. In the lead cell facility a number of the cells were regrouped and linked together to achieve better productivity.

3) For which major projects and programmes is the facility currently being used?

(a) High temperature reactor project.
(b) Fast reactor project.
(c) Advanced gas-cooled reactor project.

4) Major modifications planned:

A progeamme to re-build several of the older lead cells, including the provision of a new optical-microscope is in progress.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community? :

Yes.

INFORMATION SHEET N° 1

MAIN CHARACTERISTICS OF THE PLUTO REACTOR AT HARWELL

Name of reactor	PLUTO
Organization	U.K.A.E.A.
Site	Atomic Energy Research Establishment Harwell, Berkshire, England.
In operation since	1957
Power MW (th)	Current Operating Power: 22.5 MW
Moderator	D_2O
Coolant	D_2O - Primary; H_2O - secondary
Fluid and pressure (kg/cm^2) in experimental channels	Not Applicable
Nominal operation days / year	310
Operation cycle (days)	
on power	24
shut down	4

	Responsible officer :	Address:
PLUTO :	W.F. Wood	Research Reactors Division A.E.R.E. Harwell, Didcot, Oxfordshire OX11 ORA

IRRADIATION POSITIONS OF THE PLUTO REACTOR

1) Irradiation positions (in core, reflector, others)

Name	Number	Active Length m/m	Diameter m/m	Typical unperturbed neutron fluxes thermal	fast (>100 KeV)	γ-heating W/gr Al	Remarks
Fuel Element							
(i) Mk 5/4	21	600	50	1.8×10^{14}	6×10^{13}	4	
(ii) S2	5	400	25	1.1×10^{14}	1.6×10^{14}	6	
Reflector							
C.C.A.	3	600		1.3×10^{14}	10^{12}	0.5	)
7V	4	500	175	10^{14}	5×10^{11}	0.3	) May be sub-divided to
4V	4	200	100	5×10^{13}	2×10^{11}	0.1	) 50 mm or 25 mm diameter facilities.
4VGR	4	200	600	8×10^{12}	7×10^{9}	Neg.	)

2) Reactivity available for experiments : 8.0%

3) Typical neutron spectra available should be added on sheet N° 3

4) Specialized equipment available for experimenters (e.g., neutrography, etc.): Various handling equip-

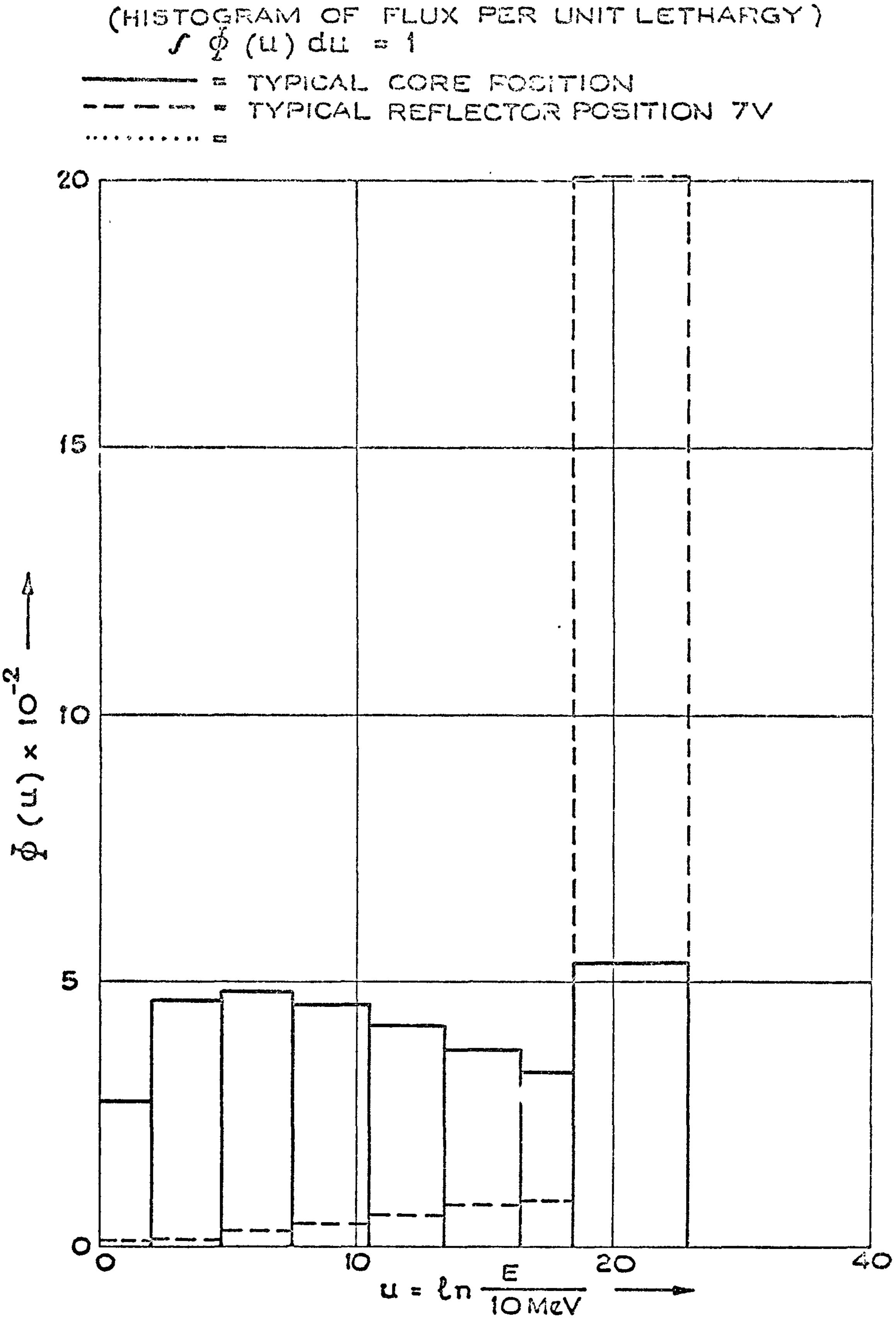
ments, sample changing cells, data collection facilities, etc.

5) References of relevant publications :

6) If hot cell facilities are available on the reactor site, give its name and the organization to which they belong (give details on sheet N° 6): Yes, Research Reactors Division, also other large hot cells operated by Engineering Division and P.I.E. facilities in Metallurgy Division.

7) Are facilities available for irradiations on behalf of other organizations of the European Community? :

Yes.



TYPICAL NEUTRON SPECTRA FOR THE PLUTO REACTOR AT A E R E HARWELL

UTILIZATION AND SPECIALIZATION OF THE PLUTO REACTOR

1) What were the original purposes of the reactor?

Materials and fuels testing in support of civil power reactor programmes.

Neutron Beam experiments for fundamental physics research.

Isotope Production.

2) What major modifications have subsequently been made and for which particular research programme?

Progressive increases in power from 10 MW to 22.5 MW in support of all programmes.

Development of special fuel elements to provide more experiment facilities and harder flux spectrum

3) For which major projects and programmes is the reactor presently being used?

Gas Cooled thermal reactor programme.

Fast Reactor programme.

4) What loops and irradiation devices have specially been developed for this reactor?

a) give name and purposes of the devices :

Various dynamic gas loops in support of gas-cooled reactor programmes for study of fuels, structure materials, cladding and coolant chemistry. Also effect of power cycling on fuels and cladding materials. Irradiation rigs, some of which can be loaded and unloaded at power.

b) main characteristics of specialized irradiation devices are to be listed on separate sheet N° 5

5) Major modifications planned :

Possible increase in reactor power and flux and changes to flux spectra.

MAIN CHARACTERISTICS OF SPECIALIZED IRRADIATION DEVICES IN THE PLUTO REACTOR

(give also references of relevant publications)

Gas Loops

A number of dynamic gas loops are in operation in which helium or other coolant gases at pressures up to 7 M Pa and gas temperatures up to 400°C are circulated over fissile fuel specimens. Fine control of coolant gases down to 1 v.p.m. total impurities is possible and controlled additions of moisture or other impurities is provided for. Automatic control of gas flow rates and specimen temperatures is provided. Neutron flux can be finely controlled using He^3 gas as an absorber and power cycling with varying ratios (up to approx. 5) with pre-determined ratio change characteristics are achieved using the same gas.

MAIN CHARACTERISTICS OF FACILITIES FOR POST-IRRADIATION EXAMINATIONS AT . HARWELL . . . . CENTRE

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(e) Machining of irradiated materials for mechanical test pieces.
(f) Equipment for mechanical properties testing - tensile creep, fatigue etc.
(g) Re-encapsulation of irradiated material.
(h) Preparation and encapsulation of radio-isotopes, Cobalt, Caesium, Californium etc.

4) References of relevant publications : See attached list.

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(cont'ed)

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(a) High temperature reactor project.
(b) Fast reactor project.
(c) Advanced gas-cooled reactor project.

4) Major modifications planned :

A programme to re-build several of the older lead cells, including the provision of a new optical microscope is in progress.

5) Are facilities available for post irradiation examinations on behalf of other organizations within the European Community?

Yes.

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