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EUROPEAN
AMERICAN
COMMITTEE ON
REACTOR PHYSICS

LIST OF RESEARCH REACTORS AND CRITICAL FACILITIES

(WESTERN EUROPE AND CANADA)

O.E.C.D. EUROPEAN NUCLEAR ENERGY AGENCY
38, Boulevard Suchet - PARIS-16e

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SEPTEMBER 1964

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38, Boulevard Suchet - PARIS-16°

AUSTRIA

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
ASTRA	Seibersdorf	Austrian Atomic Energy Study Co.	Swimming pool	5,000 (12,000)	7.5×10^{13}	1.8×10^{14}	25/9/60	Research, materials testing, isotope production
AUSTRIA 100	Vienna	Atomic Institute of the Austrian Inst. of Technol.	TRIGA Mark II	100	4×10^{12}	5×10^{12}	21/3/62	Research and training
	Graz	Verein zur Förderung der Anwendung der Kernenergie	Argonaut	1	2×10^{10}	5×10^{9}	Under construction (1964)	Research and training

BELGIUM

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
BR 1	Mol	C.E.N.	Graphite, air-cooled	4,000	2.1×10^{12}	2.5×10^{12}	11/5/56	Physical research and radioisotope production
BR 02	Mol	C.E.N.	Swimming pool, U 235 Be-H_2O	100	10^{11}	4×10^{11}	14/1/60	BR 2 reactor physics
BR 2	Mol	C.E.N.	Tank, U 235 Be-H_2O	50,000	6.2×10^{14}	2.4×10^{15}	30/6/61	Materials testing
VENUS	Mol	C.E.N.	UO_2 enrich. H_2O + D_2O mixed in variable proportion	~ 0			3/5/64	Physics of VULCAIN reactor
SILOE	Ghent	I.I.S.N. + University	Swimming pool	15	1.5×10^{11}	8×10^{11}	Under construction (1965)	Research and training

CANADA

Name	Location	Operator	Type	Power kW(t)	Max.flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
ZEEP	Chalk River	A.E.C.L.	D_2O, various fuels	0.1	10^8		5/9/45	Heavy water lattice experiments
NRX	Chalk River	A.E.C.L.	D_2O-H_2O nat.UO_2 with enriched boosters	42,000	1.1×10^{14}	5×10^{13}	22/7/47	Neutron physics, isotope production, testing fuel elements and materials
NRU	Chalk River	A.E.C.L.	D_2O-D_2O enriched U	60,000	2.5×10^{14}	1.9×10^{14}	3/11/57	Research, fuel elements and materials testing, Pu and isotope production
PTR	Chalk River	A.E.C.L.	Swimming pool, U 235	Maximum power 10 Normal operating power 0.01	1.5×10^{11} 1.5×10^8	4.5×10^{11} 4.5×10^8	29/11/57	Reactivity measurements
MNR	Hamilton	McMaster University	Swimming pool, U 235	1,000	10^{13}	3×10^{13}	4/4/59	Research and training

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
ZED 2	Chalk River	A.E.C.L.	D_2O various fuels	0.1	$2x10^8$		6/9/60	Heavy water lattice experiments
WR 1	Whiteshell	A.E.C.L.	D_2O - Org.	40,000 (60,000)			Under construction (1965)	Materials and engineering testing for organic cooled, D_2O moderated power reactors

DENMARK

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
DR 1	Risø	Danish A.E.C.	Homogeneous uranyl-sulphate (L 55) U enr. 20%	2	6.3×10^{10}	1.2×10^{11}	15/8/57	Research and training
DR 2	Risø	Danish A.E.C.	Open tank, U enr. 90% H_2O	5,000	8×10^{13}	1.5×10^{14}	19/12/58	Neutron research, materials testing, isotope production
DR 3	Risø	Danish A.E.C.	D_2O-D_2O U 235 highly enr. U (PLUTO)	10,000	1.6×10^{14}	0.35×10^{14}	17/7/60	Neutron research, materials testing, isotope production

FRANCE

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
EL 1 (ZOE)	Fontenay-aux-Roses	C.E.A.	D_2O-D_2O	150	10^{12}	$3x10^{10}$	15/12/48	Basic research and shielding studies with NAIADE I
EL 2 (P 2)	Saclay	C.E.A.	D_2O-CO_2	2,500	10^{13}	$2x10^{11}$	21/10/52	Research and isotope production
AQUILON I	Saclay	C.E.A.	D_2O	0.01	10^{7}	$3x10^{6}$	11/8/56-1960 (modified to AQUILON II)	Heavy water lattice studies
AQUILON II	Saclay	C.E.A.	D_2O	$\sim$0			8/1960	Lattice studies of large D_2O or D_2O organic systems
EL 3	Saclay	C.E.A.	D_2O-D_2O Enrich.U^2 1.6% and 4%	17,500	10^{14}	$4x10^{13}$	4/7/57	Research, materials testing and isotope production

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
RUBEOLE I then RUBEOLE II	Saclay	C.E.A.	U/UO_2-BeO	~0	10^8		1/2/57, dismantled 1/63	BeO lattice studies
PROSERPINE	Saclay	C.E.A.	Homogeneous Pu sulphate or enriched uranyl sulphate, BeO	~0	$5x10^7$		17/3/58	Criticality studies with Pu and U 235 fuel
MELUSINE	Grenoble	C.E.A. University	Swimming pool	2,000	$1.7x10^{13}$	$8.5x10^{13}$	1/7/58	Research
ALIZE I	Saclay	C.E.A.	Swimming pool	0,05	$5x10^7$	10^8	18/6/59 -7/60 modified to ALIZE II	Lattice studies (H_2O, slightly enrich. U)
ALIZE II	Saclay	C.E.A.	Swimming pool	~0			9/2/61	Lattice studies (H_2O, highly enrich. U)

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of *criticality*	Use
					thermal	fast		
TRITON I	Fontenay-aux-Roses	C.E.A.	Swimming pool	2,000	$2x10^{13}$	$8x10^{13}$	30/6/59	Shielding and irradiation studies
MINERVE	Fontenay-aux-Roses	C.E.A.	Swimming pool	0.1	$2x10^{7}$	$5x10^{7}$	29/9/59	Reactivity oscillation studies for materials purity analysis
PEG	Saclay	C.E.A.	Swimming pool	~0.0001	$5x10^{6}$	10^{7}	1959-60 (dismantled)	Research for PEGGY and *PEGASE*
MARIUS	Marcoule then Cadarache	C.E.A.	U-graphite $-CO_2$	0.1	10^{8}		7/1/60	U-graphite lattice studies
TRITON II	Fontenay-aux-Roses	C.E.A.	Swimming pool	1,000	10^{13}	$4x10^{13}$	9/1960	Shielding studies with NAIADE II

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
PEGGY	Saclay, then Cadarache	C.E.A.	Swimming pool	0.1	5×10^9	10^{10}	Saclay, 2/2/61 Cadarache, 7/12/61	Model for PEGASE studies
RACHEL	-	C.E.A.	Homogeneous Pu metal	~ 0			8/3/61	Fast reactor physics
ULYSSE	Saclay	I.N.S.T.N.	Argonaut	100	1.4×10^{12}	5×10^{11}	23/7/61	Training
ALECTO I then ALECTO II	Saclay	C.E.A.	Homogeneous Pu nitrate or enriched uranyl nitrate	~ 0	10^8		8/11/61 28/12/62	Criticality of cylinders with H_2O reflector
AZUR	Cadarache	C.E.A.	Swimming pool	~ 0			9/4/62	Reactor physics for highly enriched U water lattices (land-based prototype for submarines)

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
MELUSINE II then SILOETTE	Grenoble	C.E.A. + University	Swimming pool	~ 0 100			23/5/62 5/5/64	Reactor physics for SILOE
SILOE	Grenoble	C.E.A. + University	Swimming pool	15,000	$1.5x10^{14}$	$1.5x10^{14}$	19/3/63	Research
PEGASE	Cadarache	C.E.A.	Tank, H_2O-CO_2 cooled	30,000	$1.5x10^{14}$		4/4/63	Fuel element testing for gas-cooled reactors
CABRI	Cadarache	C.E.A.	Swimming pool	excursion			21/12/63	Dynamic and safety studies of light water moderator reactor
INSTALLATION B	Valduc	C.E.A.	Homogeneous U/Pu systems	~ 0			4/63	Criticality studies for industrial applications

Name	Location	Operator	Type	Power kW(t)	Max. flux (n/cm^2s)		Date of criticality	Use
					thermal	*fast*		
PAT	Cadarache	C.E.A.	Pressurized water reactor with highly enriched U				14/8/64	Land-based prototype for submarine reactor
INSTALLATION C	Valduc	C.E.A.	UF_6	$\sim$ 0			Under construction	Criticality studies for industrial applications
CESAR	Cadarache	C.E.A.	U-graphite CO_2 heated (500° C)	0,1			Under construction (Summer 1964)	Hot critical assembly
HARMONIE	Cadarache	C.E.A.-Euratom	Fast source reactor	2		10^{12}	Project (1965)	Fast reactor physics
RAPSODIE	Cadarache	C.E.A. - Euratom	Fast breeder U-Pu-Na	20,000		$2x10^{15}$	Under construction (1966)	Breeder studies, fast neutron irradiation

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
MASURCA	Cadarache	C.E.A.-Euratom	Large fast critical assembly (U or Pu)	~0			Project (1966)	Fast reactor physics
-	Strasbourg	University	Argonaut (ULYSSE)	100	10^{12}	$4x10^{11}$	Project	Training
OSIRIS	Saclay	C.E.A.	Swimming pool	50,000	$3-4x10^{14}$	$3-4x10^{14}$	Under construction (1966)	Materials testing reactor
EOLE	Cadarache	C.E.A.	D_2O	~0	$>10^7$		Project (1966)	Heavy water lattice studies

GERMANY (F.R.)

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
FRM	Munich (Garching)	Inst. of Technol.	Swimming pool	1,000 (2,000)	$2.5x10^{13}$	$5x10^{13}$	31/10/57	Research and isotope production
FRF	Frankfurt /Main	Univ. of Frankfurt	Homogeneous uranyl-sulphate (L 54)	50	$\sim 10^{12}$	$2x10^{12}$	10/1/58	Research and isotope production
BER	West Berlin (Wannsee)	Hahn-Meitner Inst. für Kernforschung	Homogeneous uranyl-sulphate (L 54)	50	$\sim 10^{12}$	$2x10^{12}$	24/7/58	Research, chemistry of radionuclides
FRG 1	Geesthacht	Ges. für Kern-energieverwertung in Schiffbau und Schiffahrt	Swimming pool	5,000	10^{14}	$2x10^{14}$	23/10/58	Research and marine propulsion reactor problems
SAR 1	Munich (Garching)	Siemens-Schuckert	Argonaut	10	$1.4x10^{11}$	$5x10^{10}$	23/6/59	Lattice studies

Name	Location	Operator	Type	Power kW(t)	Max. flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
AEG Prüf-reaktor	Grosz-Welzheim	AEG	Argonaut	1	$2x10^{10}$	$5x10^{9}$	27/1/61	Lattice studies
FR 2	Karlsruhe (Leopolds-hafen)	Kernforschungs-zentrum	D_2O-D_2O	12,000	$4x10^{13}$	$2x10^{13}$	7/3/61	Research, fuel elements, isotope production
FRJ 1 (MERLIN)	Jülich (Stetternich)	Kernforschungs-anlage	Swimming pool (MERLIN)	5,000	$8x10^{13}$	$2x10^{14}$	23/2/1962	Research, materials testing, isotope production
SUR 100	Munich (Garching)	Siemens-Schuckert	Solid homogeneous	0.0001	$5x10^{6}$		28/2/62	Research and training
FRJ 2 (DIDO)	Jülich (Stetternich)	Kernforschungs-anlage	D_2O-D_2O U 235	10,000	$1.4x10^{14}$	$0.35x10^{14}$	14/11/62	Materials testing and isotope production

Name	Location	Operator	Type	Power kW(t)	Max. flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
SAR 2 (Argonaut Karlsruhe) then STARK	Karlsruhe (Leopoldshafen)	Kernforschungszentrum	Argonaut then fast thermal Argonaut	0.01	1.5×10^8	5×10^7	11/1/63 Dismantled, re-erected 24/6/64	Reactor physics studies then fast reactor studies
FRG 2	Geesthacht	Ges. für Kernenergieverwertung in Schiffbau und Schiffahrt	Swimming pool	200			15/3/63	Research
SUR 100 BE	Berlin	Technische Universität	Solid homogeneous	0.0001	5×10^6		17/7/63	Research and training
	Darmstadt	Inst. Technol.	Solid homogeneous (SUR 100)	0.0001	5×10^6		23/9/63	Research and training
	Geesthacht	Ges. für Kernenergieverwertung in Schiffbau und Schiffahrt	Zr H moderated, enr. UO_2, split table	~ 0			8/5/64	Critical assembly for KNK reactor

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
FRMZ	Mainz	University	TRIGA Mark II (Pulsed)	30	1.2×10^{12}	2×10^{12}	Under construction (1964)	Research, training, isotope production
PTB-MESS-REAKTOR	Brunswick	Physikalisch-Technische Bundesanstalt	Swimming pool	1,000	6×10^{12}	1.5×10^{13}	Under construction (1964)	Research and training
	Karlsruhe	Siemens-Schuckert	D_2O	~0	-	-	14/11/63 Dismantled 6/9/64	Reactor physics of Karlsruhe MZFR pressure tank reactor
	Stuttgart	Inst. Technol.	Solid homogeneous (SUR 100)	2.0001	5×10^{6}		Under construction (1964)	Research and training
	Hambourg	Technical College	Solid homogeneous (SUR 100)	0.0001	10^{6}		Under construction (1964)	Training

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
	Ulm	Technical College	Solid homogeneous (SUR 100)	0.0001	10^6		Under construction (1964)	Training
	Aachen	Technical Academy	Solid homogeneous (SUR 100)	0.0001	10^6		Under construction (1964)	Training
SNEAK	Karlsruhe	Kernforschungs-zentrum	Fast seed Pu/U	~0	-	-	Under construction (1965)	Investigation of physics of fast and coupled reactors
	Bremen	Technical College	Solid homogeneous (SUR 100)	0.0001	10^6		Project (1967)	Training

GREECE

Name	Location	Operator	Type	Power kW(t)	Max.flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
DEMOCRITUS	Athens (Aghia Paraskevi)	Hellenic A.E.C.	Swimming pool	1,000	1.8×10^{13}	2×10^{13}	27/7/61	Research and training

ITALY

Name	Location	Operator	Type	Power kW(t)	Max. flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
ISPRA 1	Ispra	Euratom	D_2O-D_2O Enrich. U (CP-5)	5,000	10^{14}	1.6×10^{14}	24/3/59	Research, training, isotope production
Avogadro RS 1	Saluggia	S.O.R.I.N.	Swimming pool	2,000 (5,000)	3.6×10^{13}	4×10^{13}	10/9/59	Research
	Milan	Polytechn. Inst., Enrico Fermi Nuclear Centre	Homogeneous uranyl sulphate (L 54)	50	10^{12}	2×10^{12}	11/11/59	Research and training
COSTANZA	Palermo	University	Solid homogeneous (AGN 201-P-110)	0.0001	4.5×10^{6}		12/2/60	Research and training
RC 1	Rome (Casaccia)	C.N.E.N.	TRIGA Mark II	100	4×10^{12}	5×10^{12}	10/6/60	Research and training

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
ISPRA 2 then RANA	Ispra, then Rome (Casaccia)	C.N.E.N.	Swimming pool	10 100	$2x10^{11}$	$3.5x10^{11}$	15/12/61 to 2/1963 (1964)	Measure of resonance integral and neutron spectra
RB_1 then RB_3	Bologna (Monte Cuccolino)	University	Graphite-enrich. U (PCTR)	10	10^{11}	$4x10^{10}$	30/7/62 then (1965)	Study of graphite moderated lattices and after modification of coupled thermal fast systems
RTS 1	Pisa (San Piero a Grado)	CAMEN, Univ. of Pisa, Naval Academy of Livorno	Swimming pool	5,000	$3x10^{13}$	$6x10^{13}$	5/1963	Research and marine propulsion reactor problems
RB_2	Bologna (Monte Cuccolino)	AGIP Nucleare	Argonaut	10	10^{11}	$4x10^{10}$	28/5/63	Research and training
ROSPO	Rome (Casaccia)	C.N.E.N.	Organic UO_2 enrich. Th	$\sim$0			10/6/63	Reactor physics for PRO (up to 350°C)

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
ECO	Ispra	Euratom	D_2O	1			(1964)	Reactor physics for ORGEL
	Pavia	University	TRIGA Mark II	250	10^{13}		(1964)	Research and training
RTM	Rome (Casaccia)	C.N.E.N.	Four APTR reactors (pressurized swimming pool)	4x7,500	$1.4x10^{14}$		Under construction (1965)	Technological and materials studies
	Bologna	C.N.E.N.	Fast pulsed reactor	~0			Project (1965)	Measurement of cross-sections in the energy region below 10 keV
ESSOR	Ispra	Euratom	D_2O - org. nat. and enrich.U	25,000	10^{14}		Under construction (1966)	Materials testing for ORGEL

Name	Location	Operator	Type	Power kW(t)	Max.flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	*fast*		
	Casaccia	C.N.E.N.	*Fast* reactor	~ 0			Project (1966)	Fast source
	Rome (Casaccia)	C.N.E.N.	U - H_2O	~ 0			Project	Reactor physics of pressurized water systems
SORA	Ispra	Euratom	*Fast* pulsed	400	0.7×10^{15} at 100 c/s		Project	Research

THE NETHERLANDS

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
LFR	Petten	R.C.N.	Argonaut	10	$1.5x10^{11}$	$5x10^{10}$	28/9/60	Research and training
HFR	Petten	R.C.N.	Tank, U 235, H_2O	20,000	$2.5x10^{14}$	$7.8x10^{14}$	9/11/61	Research and materials testing
HOR	Amsterdam, then Delft	Inst. of Technol.	Swimming pool	10 100	$1.1x10^{12}$	$3.6x10^{12}$	21/5/57 4/1963	Research and training
KRITO	Petten	R.C.N.	Tank, low enrich.U H_2O	~0			29/3/63	Lattice studies (H_2O)
BARN	Wageningen	I.T.A.L.	Swimming pool	100	$1.2x10^{12}$	$4x10^{12}$	9/4/63	Irradiation of plants

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
KSTR	Arnhem	K.E.M.A.	Homogeneous suspension, ThO_2,235 UO_2 in H_2O	250	$\sim 10^{13}$	5×10^{13}	Under construction (1964)	Research on suspensions under reactor circumstances
ATHENE	Eindhoven	Technical University	Argonaut				Project	Reactor physics and dynamics

NORWAY

Name	Location	Operator	Type	Power kW(t)	Max. flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
JEEP 1	Kjeller	I.F.A.	D_2O-D_2O	450	1.8×10^{12}	10^{11}	6/1951	Neutron physics and isotope production
NORA	Kjeller	I.F.A.	D_2O/H_2O	$\sim$ 0	5×10^{8}		9/6/61	Heavy water lattice studies
JEEP 2	Kjeller	I.F.A.	D_2O-D_2O Enrich. UO_2	2,000	1.8×10^{13}	1.8×10^{13}	Under construction (1965)	Experimental neutron physics, shielding, isotope production

PORTUGAL

Name	Location	Operator	Type	Power kW(t)	Max.flux ($n/cm^2 s$)		Date of criticality	Use
					thermal	fast		
R.P.I.	Lisbon (Sacavem)	J.E.N.	Swimming pool	1,000	1.8×10^{13}	2×10^{13}	25/4/61	Research and training

SPAIN

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
JEN 1	Moncloa	J.E.N.	Swimming pool	3,000	3.5×10^{13}	1×10^{14}	10/1958	Research and isotope production
ARGOS	Moncloa, then Barcelona	Inst.of Techn.	Argonaut	10	10^{11}	4×10^{10}	7/1961 11/6/62	Research and training
ARBI	Moncloa, then Bilbao	Inst.of Techn.	Argonaut	10	10^{11}	4×10^{10}	4/1/62 3/7/62	Research and training

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2)s		Date of criticality	Use
					thermal	fast		
R 1	Stockholm	AB Atomenergi	D_2O-D_2O	1,000	3.7×10^{12}	3.7×10^{11}	13/7/54	Research
R 0	Studsvik	AB Atomenergi	D_2O	<0.01	$<2 \times 10^{8}$		9/1959	Heavy water lattice studies
R 2	Studsvik	AB Atomenergi	Tank, U 235, H_2O	30,000	3.1×10^{14}	9.1×10^{14}	4/5/60	Materials testing, research, isotope production
R 2-0	Studsvik	AB Atomenergi	Swimming pool	100 (1000 for short periods)	10^{12}	3×10^{12}	20/6/60	Criticality and shielding experiments
FR 0	Studsvik	AB Atomenergi	Enrich.U(20%) in various configurations, Cu reflector	0.1			11/2/64	Fast reactor physics

SWITZERLAND

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
SAPHIR	Geneva, then Würenlingen	Federal Inst. for Reactor Research	Swimming pool	1,000	10^{13}	$4.5x10^{13}$	8/1955, 4/1957	Materials testing and research
	Geneva	University	Solid, homogeneous (AGN-201-P-111)	0.02	10^{9}		9/1958	Research and training
	Basle	University	Swimming pool	2	$3x10^{10}$	10^{11}	4/1959	Research and training
DIORIT	Würenlingen	Federal Inst. for Reactor Research	D_2O-D_2O	20,000 (30,000)	$3.5x10^{13}$	$2.8x10^{13}$	15/8/60	Materials testing and isotope production

TURKEY

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
CEKMECE TR 1	Istanbul (Küçüçekmece)	Turkish A.E.C.	Swimming pool	1,000	1.8×10^{13}	2×10^{13}	6/1/62	Research and training

UNITED KINGDOM

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
GLEEP	Harwell	U.K.A.E.A.	Graphite-air	4.5	1.5×10^9		15/8/47	Testing of reactor materials purity
BEPO	Harwell	U.K.A.E.A.	Graphite-air	6,000	2×10^{12}	10^{11} (but 3×10^{11} is available)	5/7/48	Isotope production and general radiation source
ERIC	Aldermaston	U.K.A.E.A.	Small critical assembly machine	~0			1952	Criticality studies
ATLAS	Aldermaston	U.K.A.E.A.	Large critical assembly machine	~0			1952	Criticality studies
ZETR-0	Harwell	U.K.A.E.A.	Pu nitrate solution	~0	10^4		10/1952-1953 (dismantled)	Criticality studies

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
WATERFALL	Aldermaston	U.K.A.E.A.	Critical assembly machine	~ 0			1954	Criticality studies (systems reflected by oil or water)
ZEPHYR	Harwell	U.K.A.E.A.	Fast reactor Pu/U	~ 0		8×10^8	5/2/54-6/1958 (dismantled)	Fast reactor physics
DIMPLE	Harwell, then Winfrith	U.K.A.E.A.	H_2O, D_2O or organic moderator and Pu or U fuel	< 0.1	3×10^8		8/54-12/60, re-erection 18/6/62	Testing a wide range of lattices at uniform temperature (up to 80°C)
ZEUS	Harwell	U.K.A.E.A.	Fast reactor U 235 (45%)	0.1		5×10^9	12/1955-9/57 (dismantled)	Fast reactor physics
ZETR Ia	Harwell	U.K.A.E.A.	UO_2F_2 (U 235, 45% enrich. and U 233) solution	~ 0	10^5		12/1955-56 (dismantled)	Criticality studies

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
LIDO	Harwell	U.K.A.E.A.	Swimming pool, U 235/Al	100	10^{12}	$3x10^{12}$	21/9/56	Thermal reactor physics including shielding
DIDO	Harwell	U.K.A.E.A.	D_2O-D_2O U 235/Al	15,000	$1.9x10^{14}$	$5x10^{14}$	7/11/56	Materials testing, isotope production, research
NEPTUNE	Harwell then Derby	Admiralty then Rolls Royce	Swimming pool	~0.1	$\sim10^8$		7/1/57-6/1959 then 26/2/63	Naval propulsion studies, then development of long life coils for submarines
NERO	Harwell, then Winfrith	U.K.A.E.A.	Graphite, enrich. U	~0.1	$3x10^8$		23/2/57-9/1959, re-erected, 11/1960 dismantled 1964	Studies of nuclear properties by oscillation methods and investigations for advanced graphite moderated reactors
ZETR Ib/c (modification of ZETR Ia)	Dounreay	U.K.A.E.A.	Enrich.U solution	~0	10^6		14/8/57-8/1960 (dismantled)	Criticality studies of uranium solutions

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
PLUTO	Harwell	U.K.A.E.A.	D_2O-D_2O U 235 80%	15,000	1.8×10^{14}	5×10^{13}	25/10/57	Neutron defraction loop, materials testing, isotope production, research
HAZEL (ZETR II)	Harwell	U.K.A.E.A.	UO_2F_2 (45% enrich.) solution, D_2O	~0	$\sim10^6$		4/58-9/58 (dismantled)	Criticality studies
EMTR	Dounreay	U.K.A.E.A.	D_2O - D_2O U 235	10,000	1.2×10^{14}	0.5×10^{14}	24/5/58	Materials testing
HORACE	Aldermaston	U.K.A.E.A.	Swimming pool, U 235	0.01	$\sim10^8$		5/1958	Nuclear information on HERALD core
MERLIN	Aldermaston	A.E.I. Ltd.	Swimming pool, U 235	5,000	7×10^{13}	2×10^{14}	16/7/59-1962 (ceased operation)	Research, testing, training

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
JASON	Slough, then Greenwich	Hawker-Siddeley, then Royal Naval College	Argonaut	10	$1.5x10^{11}$	$5x10^{10}$	30/9/59 - 1961, re-erection, 6/11/62	Research and training
DFR	Dounreay	U.K.A.E.A.	U/Pu fast reactor	60,000		$3x10^{15}$	11/1959	Development of fast reactor technology
TESSIE	Dounreay	U.K.A.E.A.	Solid mixtures of low enrichment UF_4 and paraffin wax	5	10^8		11/1959	Nuclear safety of slightly enriched U sludges and precipitates
ZENITH	Winfrith	U.K.A.E.A.	Graphite, heated N_2, Pu/Al alloy fuel	0.1	$2x10^8$		19/12/59	Reactor physics of high temperature gas-cooled reactors
HERALD	Aldermaston	U.K.A.E.A.	Swimming pool, U 235	5,000	$3x10^{13}$	$1.2x10^{14}$	29/2/60	General research and radiation damage studies

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
PHOENIX (HAZEL II)	Dounreay	U.K.A.E.A.	UO_2F_2 (30% and 93% enrich.) solution	0.1	10^7		7/1960 (dismantled)	Nuclear safety of U solutions in large process vessels
PUMA	Dounreay	U.K.A.E.A.	Solid mixtures of PuO_2 and polythene moderator	$\sim$ 0.01	10^7		11/1960	Study of under-moderated Pu/H systems
VERA	Aldermaston	U.K.A.E.A.	Fast reactor U or Pu	0.1		10^9	22/2/61	Physics of small fast reactor systems
NESTOR	Winfrith	U.K.A.E.A.	Argonaut	10	10^{11}	4×10^{10}	13/3/61	Source of neutrons for subcritical assemblies giving thermal fluxes of 10^8 n/cm^2s in the assemblies
SIRIUS	Dounreay	U.K.A.E.A.	UO_2F_2 (30% and 93% enrich.) solution	0.1	10^7		8/1961	Neutron shielding studies

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
TOAD (ZETR III)	Dounreay	U.K.A.E.A.	UO_2F_2 (30% enrich.) solution	0.01	10^8		1961	Nuclear safety of U solutions in small process vessels
HERO	Windscale	U.K.A.E.A.	Graphite, heated gas, enrich. UO_2	3	10^9		5/2/62	AGR physics up to 500°C
DAPHNE	Harwell	U.K.A.E.A.	D_2O/D_2O U 235/Al	0.1	$2x10^9$	$5x10^8$	20/2/62	Reactor physics of DIDO and PLUTO type reactors
ZEBRA	Winfrith	U.K.A.E.A.	Fast reactor U/Pu	0.1		$5x10^9$	19/12/62	Dilute fast reactor physics
PANTHER	Dounreay	U.K.A.E.A.	Pu nitrate solution	0.01	10^8		31/1/63	Nuclear safety of Pu solutions

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
QUAGGR	Dounreay	U.K.A.E.A.	Fast Pu/C assemblies	0.01			1/63	Dilute fast reactor physics
HECTOR	Winfrith	U.K.A.E.A.	U 235/Al alloy; graphite, heated CO_2 driver with various fuels in the inner region	0.1	$3x10^8$		10/3/63	Reactivity measurements at high temperatures (up to 450°C) by oscillator methods
	Glasgow (East Kilbride)	Scottish Universities	Argonaut	100	$2x10^{12}$	$5x10^{11}$	24/6/63	Research and training
JUNO	Winfrith		H_2O/D_2O mixtures				28/4/64	Reactor physics of H_2O/D_2O reactor systems
	Risley	Northern Universities	Swimming pool	1,000			1/7/64	Research

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
	London (Silwood Park)	London University (Imperial College)	Consort II (Argonaut)	100	2×10^{12}	4×10^{12}	Under construction (1964)	Research and training
	London	London University (Queen Mary College)		~0			Under construction (June 1964)	Research with critical assembly
-	Dounreay						(1964)	Land based prototype of submarine

OECD JOINT UNDERTAKINGS

Name	Location	Operator	Type	Power kW(t)	Max.flux (n/cm^2s)		Date of criticality	Use
					thermal	fast		
HBWR	Halden, Norway	International	Boiling D_2O	20,000	5.4×10^{13}	-	29/6/59	Boiling heavy water reactor development
DRAGON	Winfrith, United Kingdom	International	Graphite-Helium	20,000	4.5×10^{13}	-	23/8/64	High temperature gas-cooled reactor development

DESCRIPTIONS OF RESEARCH REACTORS AND CRITICAL FACILITIES IN WESTERN EUROPE AND CANADA

1. The following list gives references to papers describing research reactors and critical facilities mentioned in this document and arranged in alphabetical order. When the reactor has no name it is referred to under that of the place where it is located.

2. This list, which does not claim to be exhaustive, has been drawn up on the basis of information at present available in the ENEA Secretariat. Suggestions for amendments or more appropriate references would be welcomed and included in further editions.

3. Reactors described in the "Directory of Nuclear Reactors", Vol. II and III, I.A.E.A., Vienna, are indicated by a +; those described in "Nuclear Reactor Plant Data, Research and Test Reactors" Vol. II, A.S.M.E. and McGraw-Hill, New York, 1959, by an *.

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