ICS/D702

1/1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

FEB 13 1991

Mr. Carlton E. Thorne, Director
Office of Nuclear Export Control
Bureau of Oceans and International
Environmental and Scientific Affairs
U.S. Department of State
Washington, DC 20520

Dear Mr. Thorne:

Enclosed for your records is a legible copy of the Reactor Checklist for export license application XSNM02582. We apologize for the "fuzzy" copy of the earlier Reactor Checklist -- it was made from a faxed copy which was provided by the applicant when the original application was filed.

Sincerely,

Ronald Hauber

Ronald D. Hauber, Assistant Director
Exports, Security, and Safety Cooperation
International Programs
Office of Governmental and Public Affairs

Enclosure:
Reactor Checklist
(XSNM02582 - Belgium)

cc w/enclosure:
T. Hart, DOE
R. DeLaBarre, DOS
N. Martin, DOE
M. Rosenthal, ACDA
L. Burdick, DOD
G. Kuzmycz, DOC
J. Matos, ANL

STUDIECENTRUM VOOR KERNENERGIE
S.C.K./C.E.N.

CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE
C.E.N./S.C.K.

Boeretang 200 B-2400 MOL (Belgium)
TEL (014)31.68.71 - 31.18.01
TFX (014)31.50.21
TLX 31922
TLG Centratom Mol

EINGANG
02 JAN. 1991
GB Dienstleistung

To whom it may concern

END USE STATEMENT

The undersigned certifies that the following material, i.e. 32,1 kg of uranium (93.3 % U-235 enriched) in the form of METAL and containing 29,95 kg of U-235 that will be furnished to us under a short term fixed-commitment contract with US-DOE, will be used for BR2 reactor.

We authorize TRANSNUCLEAR Inc., two Skyline Drive Hawthorne, New-York to apply for the US export license.

Manufacturing of the fuel elements will be performed by CERCA, Romans, France.

P. GUBEL
Head of BR2 department

C. MALBRAIN
General Director

RECEIVED
'91 JAN 31 AM 10:30

Head office and Financial Services: Rue Ch. Lemairestraat 1, B-1160 Brussels (Belgium)
TEL (02)661.06.11 TFX (02)660.75.63 TLX 22.718 TLG Centratom Brussels

931 502

CHECKLIST FOR USE IN REVIEW OF REQUESTS FOR HEU TO DETERMINE TECHNICAL AND ECONOMIC JUSTIFICATION

BR2 REQUEST

1. Name of reactor and facility: BR2
2. Location: Belgian Nuclear Research Centre
   (C.E.N./S.C.K.)
   B-2400 MOL - BELGIUM
3. Quantity of uranium requested (kg U): 32.1 kg U_{tot}
4. Enrichment in the isotope U-235: 93.30 %
5. Quantity of uranium requested (kg U-235): 29.95 kg U-235
6. Type of fuel element and form of uranium:
   Assemblies of concentric cylindrical tubes, where the fuel is under the fuel is under the form of UAL_x powder ($x \cong 3$), 1.27 gU/cm^3, mixed with aluminium and burnable poisons added as powder.
7. Current reactor power level (MW th):
   Current reactor power: 60 to 100 MWth
   depending on the experimental loading.
   Maximal reactor power: 125 MWth
   Current maximal heat flux: 470 W/cm^2
   Maximal nominal heat flux: 600 W/cm^2
8. Duty factor: see appendix 1.
   Average burn-up: a) of a load, end of cycle
   if 6 to 7 $ of experiments. 37 %
   b) of elimin[illegible] fuel elements: 54 ± 4 %
9. a) Current core loading (kg U-2[illegible]):
   8 to 12 kg U-235, depending on the experimental loading
   b) Amount of fuel per element (kg U-235):
   400 g U-235 for a standard fuel element
   c) Number of elements in core:
   27 to 40, depending on the experimental load, routinely 31 fuelelements
   d) Average core life: One fuel element serves for 10 running weeks, i.e. 5 cycles of 2 weeks o[illegible] 4 cycles of 3 weeks

e) Active core and reflector dimensions:

height	914 mm
diameter	1100 mm
hexagonal lattice	96.4 mm pitch
fuel active height	726 mm

f) Neutron flux:

	$v_0\int_0^{0,5\,eV} n(E).dE$	$\int_{0,1\,MeV}^{\infty} \phi(E).dE$
Central Be plug	$9\ 10^{14}$ n/cm²s	$1.4\ 10^{14}$ n/cm²s
Standard fuel element	≤ 3.[illegible] 10^{14} n/cm²s	≤ $7\ 10^{14}$ n/cm²s
Driver fuel element (ø 200 mm)		$7\ 10^{14}$ n/cm²s

10. Annual fuel usage (kg U-235):
    Routinely, 75 fuel elements type VIn, or 30 kg U-235.
    In case of development of the safety programme for fast reactor:
    1 fuel element ø 200 mm or ~ 2 kg U-235.
    In case of starting of the fusion programme:
    20 fuel elements type Vn or 7,2 kg U-235.
11. Annual spare fuel requirement (kg U-235): 30 kg U-235 minimum in the form of METAL.
12. Plans to increase, decrease reactor power level:
    We continuously optimize the reactor performances: specific and total power, energy produced, number of fresh fuel elements to be used for an imposed cycle length, taking into account the experimental loading. The present trend is to increase the available fast flux and consequently the specific power, maintaining the maximum thermohydraulic characteristics of the reactor.
13. Estimated annual supply of current fuel request: 30 kg U-235 minimum.
14. Required manufacture's working stock, if any, included in this request: The manufacture's working stocks are not included in this request. For a normal order of <u>100</u> standard fuel elements, the manufacturer <u>requires</u> the availability of 27 kg U-235 above the quantity necessary for the production:
    [(100 x 0.4 Kg) + losses + 27 ≈ 68 kg U-235]
15. Fabrication loss, if any, included in this request (kg U-235): 2 %

included in this request.

16. Names of convertor: US-DOE Oak-Ridge Tennessee USA.
COGEMA BP-4 F-78141 Vélizy France.

17. Fabrication of fuel: CERCA Romans-sur-Isère, France.

18. Inventory on October 26, 1990.
The complete inventory is given at appendix 2. Find hereafter the detailed items of this inventory concerning usable fuel for the reactor BR2.

stock fresh fuel	n fuel el	U-tot [kg]	U-235 [kg]	HEU	Remark
COGEMA		11.662	10.854	0,9307	a)not available at present time
CERCA					
Scraps		7.100	6.530	0,9197	c)to be recovered
fabrication & scraps		76.967	70.369	0,9143	c)partially available
last supply		25.226	23.574	0,9345	c)shipped on October 23,1990
DOE (U.S.A.)		0.000	0.000		
BR2-BR02 (Mol-Belgium)					
standard fresh fuel	36	15.447	14.363	0,9298	b)only 5451 MWd
for experiments	9	3.534	3.285	0,9296	b)not usable
special type	21	5.321	4.784	0,8991	b)not usable *)
usable spent fuel	172	55.557	47.400	0,8532	d)only 10484 MWd

Remarks: a) scraps and UF6 to be recovered.
b) fabricated unirradiated stored fuel.
c) unirradiated non-fabricated and fabricated fuel.
d) spent fuel stored until residual 200 g U-235 /fuel el.
*) to restart the reactor after a prolongated shut-down (^{3}He-poisoning).

19. Date at which the available and usable inventory will be expended: February 1993.
Date at which current inventory, including a, b, c (usable), will be expended: October 1993.
20. Date current requested fuel will be needed at reactor: February 1992, while the working stock is maintained at 27 kg U-235 in CERCA.
21. Date current requested fuel will be needed by fabricator: October 1991.
22. Time taken for shipment from USA to convertor/fabricator:
a) lead time for ordering in USA: six months.
b) shipment in and from USA: six months.
c) conversion UF6 -> U-metal: twelve months.
23. Date at which current requested fuel will be expended i.e., when a further HEU supply will be needed at reactor: February 1993. The current date sheduled for the replacement of the Beryllium matrix is mid-1995, which will cause nine months approximately a one year shutdown.
24. Dates at which reactor could be converted to 45 % fuel; to 20 % fuel, including time required for licensing procedure:
No date is fixed yet for BR2; in routine, it will not be before several years, as for other high flux reactors: ATR, HFIR, HFR in Grenoble ... From what we know, tests of fuel plates U_3Si_2-Al ($\leqq$ 4.8 g U/cm^3) are satisfying and the industrialization of the process is in under way. For the future (at a time still to be defined), it would be possible, if requested, to use MEU (45 % enrichment) at the BR2 reactor. The time required for licensing procedure is equal to a successful irradiation campaign and post-irradiation examination of prototype fuel elements, increased by six months for reports, when the reprocessing of this fuel has been demonstrated feasible technically and economically. The use of LEU in BR2 demands the availability of fuel plates containing U_3Si_1-Al ($\geq$ 7.1 g U/cm^3). No prevision can be given concerning the reliability of this fuel, which is required in order to attain the density level of LEU required for the BR2-reactor.

25. History and dates of previous HEU supplies by the U.S.:
Continuously, since June 08 1959, has U.S. supplied HEU for the reactors BR2, BR02 and third parties. The last delivery of 25 kg HEU for which the licence XSNM-02495 was issued on July 16, 1990, has been shipped from USA to Europe on October 23, 1990. The BR2 reactor has reduced its stock of available U-235, reducing the stock of partially burnt fuel element at minimum and recovering all scraps considering the increase of the number of planned experiments, an annual supply greater than 30 kg U-235 is foreseen after the year 1991. The appendix 3a and 3b give the details concerning respectively the deliveries of U-235, transfer of fuel for hot reprocessing and supply to third parties. The figure 3c gives the burnup spectrum of usable standard fuel elements at BR2.

26. Amount of fuel of U.S.-origin previously consumed during operation of reactor:
The total amount of uranium received up to October 23, 1990 is:

1332,774 kg U-235.

The total amount of uranium burnt to October 26, 1990 is:

1.24 g U-235/MWd x 361,557 MWd x 0.97 = 434,881 kg U-235.

The appendix 3d gives the total balance of highly enriched uranium received at BR2.

27. Status of cooperation between reactor operator and Argonne National Laboratory in reduced enrichment program (RERTR):
We have maintained the contact with the ANL representatives, for collaboration in the RERTR program, although there is some delay in the testing of very high density fuel plates. We cooperate also closely with the fuel fabricators mainly on the performances of our fuel elements (fission products release, corrosion, cladding, behaviour, ...).

28. Status of agreement between reactor operator and ANL to reduce enrichment:
Agreements and commitments for a joint study between the Belgian Nuclear Research Centre and the Argonne National Laboratory (RERTR program) on the utilization of LEU fuel elements in the BR2 reactor are effective: contract signed January 22, 1985. The first phase of the program has demonstrated the theoretical feasibility for irradiation of a LEU fuel element test in the BR2 core and has been terminated with the first approval by the Safety Authorities, by the presentation of the Safety Analysis Report at 8th March 1988. The research on technical feasibility is in progress. The analysis of this test will assess the modification in the performances and in the safety, with corresponding economic implications. The schedule for BR2 test elements is given at appendix 4.
29. Status of cooperation between reactor operator and IAEA reduced program: The Belgian Nuclear Research Centre as reactor operator participates regularly at the consultant's meeting organized by the IAEA for the reduced enrichment program.

Appendix 1.
§ 8 Actual and foreseen duty factor

	Actual			foreseen		
	1988	1989	1990	1990	1991	1992
Date of begin	16 Dec 87	15 Dec 88	13 Dec 89	03 Oct 90	9 cycles of	10 cycles
Date of end	15 Dec 88	13 Dec 89	02 Oct 90	02 Jan 90	21 days	21 days
end of cycle	13/88A	13/89A	10/90A			
time of the year [day]	365.3	363.0	292.7	90	365	365
operation (1) [day]	167.6	181.2	146.8	2 x 21	189	210
duty factor	0.46 (2)	0.50	0.49 (3)		0.52	0.57 (4)
energy produced	10.958	11.504	9924 + 2 x1300		~12.000	~13.000
number of fresh fuel elements loaded	68	78	56 + 2 x 6		~75	~81
mass of fresh U-235 [kg]	26.9	31.2	22.4 + 4.8		~30	~33

Remarks:

1. The operating time is defined to be the time when the reactor has a power > [illegible] %. Nominal power for normal cycle and > 1 % nominal power for special campaign.
2. At the end of year 1988 the available stock of fresh fuel elements was zero and the number of reactive (B and Sm burnt) partially burnt fuel elements (10 < ß < 25 %) was minimum.
3. From cycle 9/90, the radioisotopes production has been adapted for cycle length of 21 days, permitting installation of the CALLISTO loop equipment and heavier electromechanical maintenance in the BR2 complex, anticipating the renewal of the reactor at the end of the year 1995.
   Because the ^{3}He rising rate increases with the cumulated energy produced with the Be matrix, the duty factor <u>must</u> increase above 50 %.
4. The CALLISTO loop programme will begin irradiation in October 1991; the duty factor should be higher than 0,55.

Appendix 2.
§ 18 Inventory on October 26, 1990

	U tot [kg]	U-235 [kg]	Enrichment [%]	Remark
Cogema (France)				not available
Scraps	7.022	6.533	93.04	a)to be recovered
Euratom UF6	4.640	4.321	93.12	b)to be converted
CERCA (France)				available
fabrication and scraps	84.067	76.899	91.47	c)partially usable
last supply	25.226	23.574	93.45	c)shipped from DOE on October 1990.
DOE (USA)	0	0	-	
CEN-SCK (MOL-BELGIUM)				
BR1:				
Physics department	0.243	0.222	91.35	a)for experiment at BR1
BR02:				
41 fuel elements	13.241	11.897	89.85	c) to be recovered
BR2:				
2 fresh fuel el type G VIn from BR02	0.891	0.804	90.17	b) usable
34 fresh fuel el type G VIn standard	14.555	13.559	93.15	b) usable
9 fresh fuel el type G Vn	3.534	3.285	92.96	b) for experiments
21 fresh fuel el type A	5.321	4.784	89.90	b) not usable *
172 partially burnt fuel el ø 84 mm	55.567	47.400	85.31	b) usable **
2 partially burnt fuel el ø 200 mm	2.197	1.902	85.56	d) usable
566 spent fuel el ø 84 mm	143.154	107.609	75.17	d) not usable
11 spent fuel el ø 200 mm	16.000	12.961	81.00	d) not usable

Remarks:

a : scraps
b : fabricated unirradiated stored fuel
c : unirradiated non fabricated fuel
d : spent fuel stored
* : only usable to restart the reactor after prolongated shut-down
**: permitting to produce 10484 MWd.

Appendix 3a

SUPPLY of HIGHLY ENRICHED URANIUM for BR2 REACTOR

	contract	date	U-tot [kg]	U-235 [kg]	HEU
1	S-BE-7	080659	4.091	3.675	0.8983
2	BE/ML/4	301059-261062	40.208	36.129	0.8985
3	EU/ML/3-2	231263-250664	44.267	39.777	0.8986
4	EU/ML/3-[illegible]	260864-300964	21.259	19.105	0.8987
5	EU/ML/3-22	261163	22.239	19.975	0.8982
6	EU/ML/3/16	230564-260964	10.871	9.773	0.8990
7	EU/ML/3-21A	010168-010769	13.755	12.375	0.8997
8	EU/ML/3-18	040964	9.444	8.509	0.9010
9	EU/ML/3-44	040965	45.500	40.917	0.8993
10	EU/ML/3-45	310565-090965	14.692	13.209	0.8990
11	EU/ML/3-51	230366-130466	52.000	46.767	0.8994
12	EU/ML/3-63	060267-130367	8.996	8.069	0.8970
	" " "	-1302[illegible]	15.097	13.540	0.8969
13	EU/ML/3-78	070767	22.185	19.927	0.8982
14	EU/ML/3-94	240[illegible]68	9.696	8.707	0.8980
15	EU/ML/3-116	[illegible]0269	56.475	50.551	0.8951
16	EU/ML/3-131	0[illegible]0769	13.984	12.580	0.8996
17	EU/ML/3-134	020769	6.984	6.279	0.8991
18	EU/ML/3-101	110969	4.600	4.132	0.8985
19	EU/ML/9-1	311269	41.997	37.823	0.9006
20	EU/ML/3-218	010172	3.845	3.459	0.8996
21	EU/ML/9-25	020871	50.100	45.125	0.9007
22	UES/EU-17	120970	55.493	49.949	0.9001
23	UES/EU-35	260572	166.574	149.869	0.8997
24	EU/ML/9-11	010173	4.042	3.640	0.9005
25	EU/ML/3-21	010773	14.283	12.850	0.8997
26	UES/EU/7	201273	97.086	90.410	0.9312
27	UES/EU/105	191274	97.650	90.961	0.9315
28	UES/EU/144	150777	76.123	70.951	0.9321
29		231080 AG1418	113.080	105.270	0.9309
30	UES/EU/151	280286 AG2041	55.054	51.322	0.9322
31		061088 AG2218	42.792	39.861	0.9315
32	Spain U+Ni	140389 AG2325	26.694	23.976	0.8982
33	XSNM-02444				
	EURATOM M	021089 AG	41.752	38.723	0.9275
	EURATOM UF6	021089 AG	4.640	4.321	0.9313
34	XSNM-02495	160790	25.226	23.574	0.9345
	total [kg]		1332.774	1216.079	0.9124

Appendix 3b

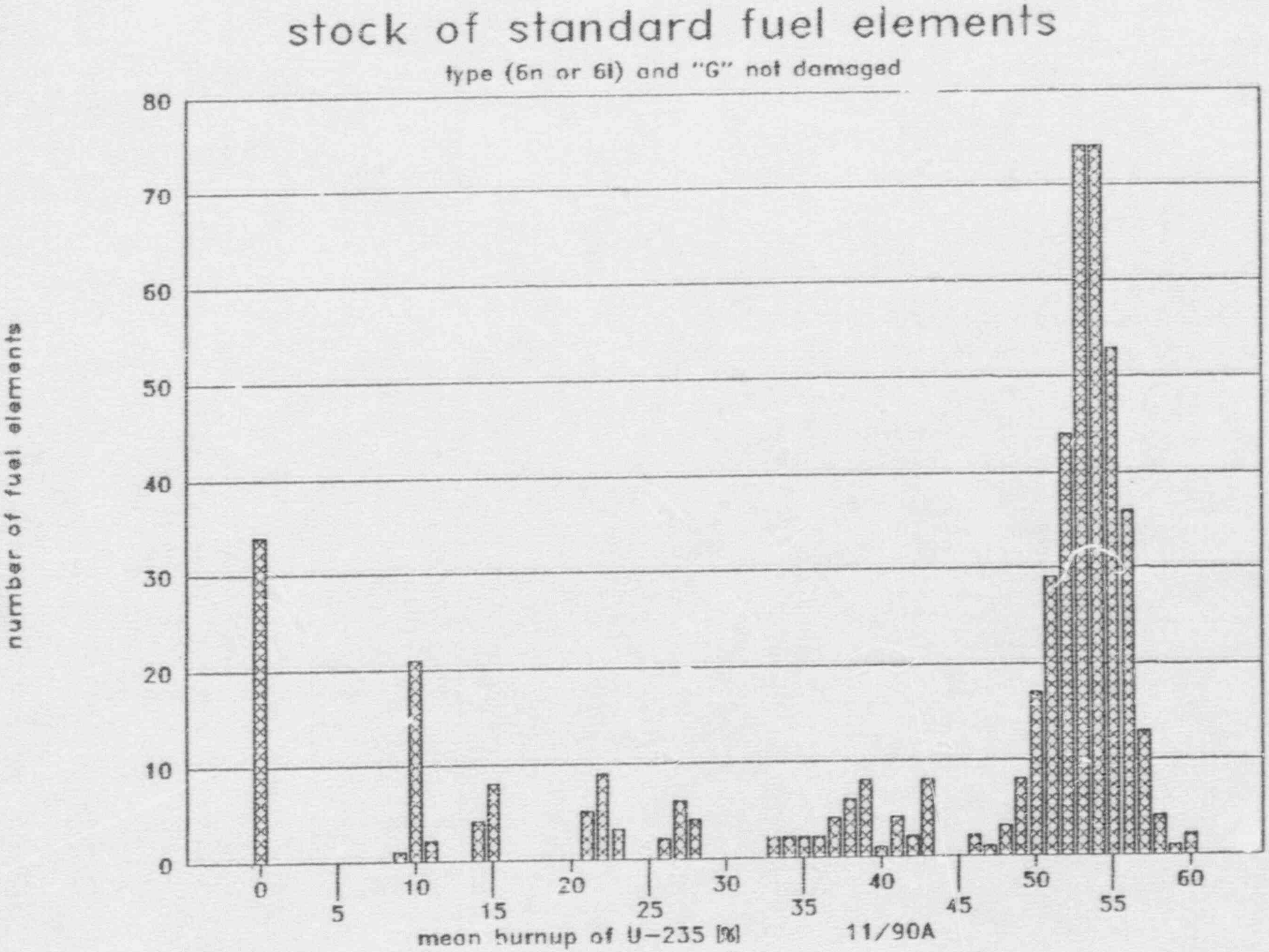
SUPPLY of HIGHLY ENRICHED URANIUM to THIRD PARTIES

	contract	date	U-tot [kg]	U-235 [kg]	HEU	customer
1	EU/ML/9-1	240970.230271	0.200	0.180	0.9000	FRM EU/ML/3-123
2	UES/EU/7	070374.120874	0.322	0.300	0.9317	IRE
3	UES/EU/35	200374	0.234	0.211	0.9017	PTB Braunschweig
4	UES/EU/105	160975.050777	12.897	12.015	0.9316	IRE
	UES/EU/105	.150179				
5	UES/EU/7	061175.020476	1.883	1.752	0.9304	CEN/SCK metallurgie
6	UES/EU/7	090176.110276	0.419	0.377	0.8998	NUKEM
7	UES/EU/144	230379	3.000	2.790	0.9300	IRE
8	AG 1418	210182	11.085	10.309	0.9300	NUKEM (CEN/SCK BR3)
9	AG 2041	lent 1975	6.688	6.227	0.9311	KFK (MOL 7C)
	total [kg]		36.728	34.161	0.9301	

FUEL IN HOT REPROCESSING

	localisation	date	fuel el	U-tot fresh [kg]	U-235 fresh [kg]	HEU fresh	U-tot spent [kg]	U-235 spent [kg]	HEU spent	burnup mean
1	Eurochemic	1967	125	32.133	28.877	0.8987	24.999	20.332	0.8133	0.2959
2	Eurochemic	1968	144	38.372	34.500	0.8991	29.244	22.430	0.7942	0.3499
3	Eurochemic	1969	550	139.907	125.971	0.9004	104.580	84.265	0.8057	0.3311
4	Eurochemic	1970-71	300	77.173	69.530	0.9010	56.172	44.631	0.7945	0.3561
5	Eurochemic	01.07.72	150	32.367	29.071	0.8982	23.849	19.053	0.7989	0.3446
6	Eurochemic	13.10.72	100	26.253	23.559	0.8974	19.590	15.691	0.8010	0.3340
7	Eurochemic	28.06.73	150	43.208	38.845	0.8990	29.685	22.875	0.7706	0.4111
8	Eurochemic	05.02.74	150	55.375	49.805	0.8994	37.100	28.222	0.7607	0.4334
9	Marcoule	24.01.75	150	59.981	53.934	0.8992	38.560	28.637	0.7427	0.4690
10	Marcoule	31.12.75	75	31.139	27.995	0.8991	19.311	14.028	0.7264	0.4989
11	Savannah	1979	144	47.611	42.903	0.9011	30.260	22.412	0.7406	0.4776
12	Savannah	1979-80	144	61.930	56.412	0.9109	37.380	27.421	0.7336	0.5139
13	Savannah	1981-82	108	47.715	43.193	0.9052	28.341	20.313	0.7167	0.5297
14	Idaho	24.11.82	36	15.347	14.267	0.9296	9.531	7.255	0.7612	0.4915
15	Savannah	1989 pending								
	total [kg]		2326	708.511	638.863	0.9017	487.602	377.565	0.7743	0.4090

Appendix 3c


stock of standard fuel elements
type (6n or 6l) and "G" not damaged
number of fuel elements
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
30
35
40
45
50
55
60
mean burnup of U-235 [%]
11/90A

Appendix 3d

TOTAL INVENTORY of HIGHLY ENRICHED URANIUM at BR2 REACTOR
****

28/11/90

localisation date	fuel el	U-tot fresh [kg]	U-235 fresh [kg]	HEU fresh	U-tot rest [kg]	U-235 rest [kg]	HEU rest
TOTAL fresh supply		1332.774	1216.079	0.9124	1332.774	1216.079	0.9124
stock:							
at COGEMA		11.662	10.854	0.9307	11.662	10.854	0.9307
at CERCA		109.293	100.473	0.9193	109.293	100.473	0.9193
at BR02 and BR2 to recover	38	6.760	6.077	0.8990	6.760	6.077	0.8990
at BR02 only useable at BR02	48	13.241	11.897	0.8985	13.241	11.897	0.8985
at BR2 type G 6n fresh usable	36	15.447	14.363	0.9298	15.447	14.363	0.9298
at BR2 type G 5n not standard	9	3.534	3.285	0.9296	3.534	3.285	0.9296
at BR2 type A 6n,5n no poison	21	5.321	4.784	0.8991	5.321	4.784	0.8991
at BR2 type 6n,5n burnt usabl	172	72.474	67.302	0.9286	55.557	47.400	0.8532
at BR2 totally burnt (84mm)	566	240.070	221.628	0.9232	143.154	107.609	0.7517
at BR2 burnt fuel ATR (200mm)	104	24.94.	22.797	0.9141	18.197	14.863	0.8168
at BR1 for experiments		0.243	0.222	0.9136	0.243	0.222	0.9136
subtotal:	994	502.984	463.682	0.9219	382.407	321.827	0.8416
supply to third parties		36.728	34.161	0.9301	36.728	34.161	0.9301
reprocessed or dismantled	2478	772.926	698.507	0.9037	524.954	405.371	0.7722
1.24g/MWd * 0.97 * 361,557.39MWd						434.881	
fabrication losses until Dec 23, 1989			16.704			16.704	
TOTAL	3472		1213.054			1212.944	
difference			3.025			3.135	

that is lower than 2% of fabrication losses
and burden U-235 mass for the energy produced: 9.032

Appendix 4

§ 28. Approximate schedule for BR2 test elements at November 1989.

	Approximate time required (months)	Approximate completion date
1. First approval of Safety Report.		8th March 1988
2. Finalize detailed specification		26th April 1989
3. Fabrication feasibility reports from CERCA and 2nd approval of Safety Report.		December 1989
4. Fabricate test fuel elements.	12	December 1990 pending.
5. Reactivity and flux measurements in BR02 Critical Facility Third approval of Safety Report.	3	January 1991 March 1991
6. Irradiation in BR2	18	July 1992
7. Cool irradiated elements.	4	September 1992
8. Post-irradiation-examination	3	January 1993

The key uncertainties in this schedule are the dates for finalization of the specifications by CERCA and the dates by which CERCA will be able to deliver the finished elements to BR2.