

区分変更	
変更箇所	==
決行年月日	平成 13 年 11 月 30 日

# 被覆材照射試験

(ラブソディー PNC-9)

## 試験計画

昭和53年9月

技術資料コード	
開示区分	レポートNo.
S	N 241 78-31
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 高速増殖炉開発本部

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## 概 要

本報告はラブソディー炉における被覆材照射（ラブソディー PNC-9 契約番号 503C012）に関するものであり、供試材の諸特性、照射条件、照射計画等を含んでいる。

本試験の主たる目的は、原型炉炉心燃料被覆管および被覆管内に装荷された Modified 316 鋼のスエリング特性をもとめることである。また、微小引張試験片の照射後試験により、機械的性質におよぼす化学成分および冷間加工度の影響を解明する。

主な調査項目は次のとおりである。

- (1) 原型炉用被覆管（S. 50 K. S 材，S. 51 K 材）のスエリング挙動調査。
- (2) SUS 316 鋼のスエリングにおよぼす B. P の影響の系統的調査。
- (3) SUS 316 鋼のスエリングおよび機械的性質におよぼす C. N. B. P. Nb. Ti および冷間加工度の影響調査。

高速増殖炉開発本部

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## 1. 緒 言

高速増殖炉の炉心材料は $10^{23}$  n/cm<sup>2</sup>のオーダーの高速中性子照射をうける。このため、燃料被覆管においては高温強度とともに、ポイドスエリング、照射クリープなどが重要な設計要因となっている。

本試験計画では、原型炉用試作燃料被覆管（50年度S材50，51年度K材）をキャプセルとして、その中に化学成分、冷間加工度を種々かえた被覆管用試験材（Modified 316鋼）を入れ、ラブソディ炉で照射し、照射後にスエリング測定、引張試験等を行う。

キャプセル内の試験片，A～Dは，Ni イオン照射（BMI）<sup>(1)(2)</sup> C<sup>+</sup>イオン照射（東芝）<sup>(3)(4)</sup> サイクロトロン照射（原研，He注入クリープ試験）<sup>(5)</sup> HVEM照射（原研）<sup>(5)</sup> に供された試料と同じものである。また，ボロン量，燐量を系統的に変えた試験片E～NはC<sup>+</sup>イオン照射（東芝）<sup>(6)</sup> に供されたものと同じものである。

## 2. 実験の方法

### 2.1 供 試 材

キャプセル用被覆管，端栓材および試験片は全てPNCで用意され，試験片入りキャプセルの状態でCEAへ送付された。

供試材の詳細を以下に示す。

#### 2.1.1 被覆管および端栓材

被覆管は50年度試作原型炉炉心燃料被覆管2種（K，S），51年度試作原型炉炉心燃料被覆管1種<sup>(K)</sup>であり，端栓材は48年度試作原型炉炉心燃料用端栓材（住電）である

被覆管および端栓材の試験検査成績書を付録①に示す。

#### (イ) 被覆管の諸特性

キャプセル用被覆管の化学成分および機械的性質等を表-1に示す。これらの被覆管は照射クリープ試験（PNC-8）<sup>(8)</sup>に供されたものと同じものである。

#### (ロ) 試 験 片

キャプセル内に装荷されている試験片は，引張試験片，TEM用Foil①，②および密度試験片で，これらの詳細を図-1に示す。

供試鋼の化学成分は表-2.3.4に示すとおりで、E~NはPとBを系統的に変化させたものであり、A1~A9、B1~B7、C1~C9、D1~D5は化学成分、熱処理条件および冷間加工度を変化させたものである。

### 2.1.2 試験片装荷方法

キャプセル内の試験片配列状況を図-2に示す。また、それぞれのキャプセルの中の試験片は表-5.6のように装荷されている。これらの中、表-6のものはスペアキャプセルである。

## 2.2 照射条件

### 2.2.1 照射Rigへの組込み

キャプセルのマーキングは図-3のようになされており、Bottom側に径変化測定のためのCross markが付されている。

照射Rig内のキャプセルの配列は表-7に示すとおりである。

### 2.2.2 照射条件

照射炉：Rapsodie

照射位置：03-02型照射孔

照射全日数：613日

中間検査：240日毎に2回

目標ピーク全フルエンス： $1.29 \times 10^{22} \text{ n/cm}^2$  (全フラックス： $2.46 \times 10^{15} \text{ n/cm}^2 \cdot \text{sec}$ )

表-8参照)

封入ガス：He(大気圧)

照射温度：400℃~740℃(詳細は表-9参照)

### 2.2.3 照射実験

照射実験計画を表-10に示す。

仏国へ発送前のキャプセルの状況は付録-②のPacking Listに示されている。これにはPNC側で測定したキャプセルの諸元がリストアップされている。

一方、CEA側で測定されたキャプセルの諸元は付録-③に示されている。

照射実験の詳細は付録④の原契約書および付録⑤のAmendment No.1に記されている。

なお、全照射日数は454日+159日であるが、この159日はPNC-3の

failureに対する compensation に当るものである。

### 3. 文 献

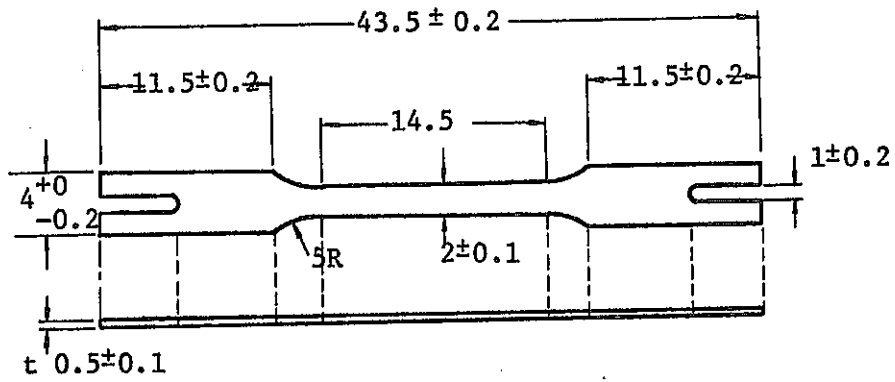
- (1) Battelle Research Report, "Program to assess the simulation with heavy ion bombardment to the effects of neutron irradiation on structure and density of stainless steel", 212B01043, PNC SA013.
- (2) Battelle Research Report (Final Report) "An investigation into the swelling resistance of PNC models, composed of modified 316 stainless steel LMFBR cladding alloys, when subjected to nickel ion bombardment," 2312002214 Rev. 1, PNC SA 305.
- (3) 鈴木和久他 "200KV炭素イオン照射による各種ステンレス鋼のスエリング測定" SN941 76-124, 1976.11.
- (4) M. Terarawa et al., "The influence of metallurgical variables on void swelling in Type 316 steel", Radiation Effects in Breeder Reactor Structural Materials, AIME 1977, PP687.
- (5) 長崎隆吉編, "高速炉用ステンレス鋼の照射特性の模擬試験(N)", SJ250 78-10, 1978.4.
- (6) 寺沢倫孝他 "高速炉燃料被覆管の炭素イオン照射試験(Ⅲ)", SJ201 78-29, 1978.4.
- (7) 石田, 岩永, 照射クリープ試験(その2), (ラブソディール-PNC-8) SN241 78-27, 昭和53年8月
- (8) 高速増殖炉開発のための燃料材料照射計画進捗状況(1978年度版), FBR本部 N241 78-09

表 - 1 Chemical compositions et al

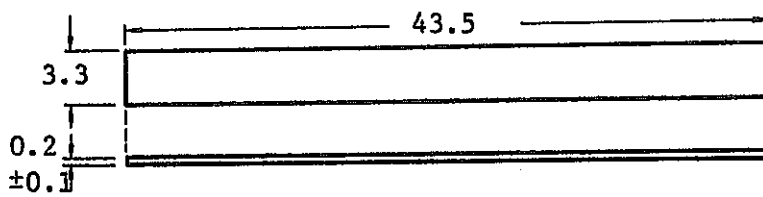
		Material S0	Material K0	Material K1	
Lot No.		5001	502	511	
Heat treatment		1,020°C x 1min.	1,075°C x 0.6min.	1,055°C x 0.6min.	
Elaboration		As drawn, 21% CW	As drawn, 20% CW	As drawn, 20% CW	
Chemical composition (wt%)	C	0.058	0.052	0.052	
	Si	0.53	0.42	0.36	
	Mn	1.94	1.69	1.88	
	P	0.029	0.027	0.028	
	S	0.010	0.005	0.005	
	Ni	13.05	13.85	13.74	
	Cr	17.50	17.76	17.50	
	Mo	2.40	2.30	2.15	
	Co	0.01	0.07	0.03	
	B	0.0012	0.0020	0.0026	
	N	0.0073	0.0071	0.0060	
	Al	0.022	0.048	0.032	
	As	0.002	0.003	0.003	
	Cu	0.14	0.02	0.02	
	Nb + Ta	0.002	<0.005	<0.005	
	Ti	0.003	0.003	0.004	
	V	0.002	0.04	0.04	
O	0.0033	0.0013	0.0028		
Mech. proper- ties	R.T.	$\sigma_B$ (kg/mm <sup>2</sup> )	83.3	86.2	87.6
		$\sigma_{0.2}$ (kg/mm <sup>2</sup> )	71.2	80.7	80.2
		$\epsilon$ (%)	20	16	16
	650°C	$\sigma_B$ (kg/mm <sup>2</sup> )	49.9	54.8	53.9
		$\sigma_{0.2}$ (kg/mm <sup>2</sup> )	43.4	49.6	47.6
		$\epsilon$ (%)	15	10	12
Grain size No.		8.0	8.5	8.7	
Hardness (Hv)		284	267	275	



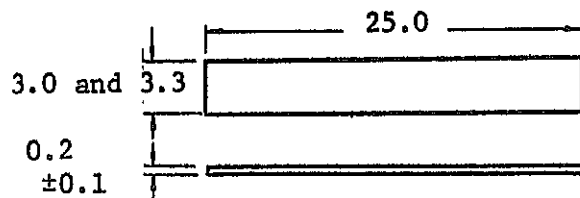
(1) Tensile test specimen



(2) Foil specimen ① for transmission electron microscope



(3) Foil specimen ② for transmission electron microscope



(4) Density specimen

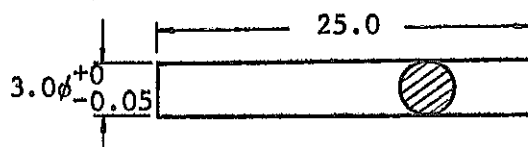


图-1 試驗片形状

表 - 2 Chemical composition of materials (Tensile, TEM Foil, Density)

Steel	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Al	B	As	Co	Ti	V	Nb	O	N		
																		total	sol.	insol
E	0.057	0.51	1.67	0.006	0.003	<0.05	13.32	17.34	2.56	0.022	0.0002	<0.001	0.096	<0.02	<0.005	<0.02	0.0042	0.0065	0.0065	tr.
F	0.061	0.50	1.69	0.024	0.006	<0.05	13.56	17.66	2.44	0.026	0.0002	<0.001	0.10	<0.02	<0.005	<0.02	0.0030	0.0061	0.0055	0.0006
G	0.067	0.50	1.72	0.047	0.002	0.04	13.46	17.40	2.52	0.030	0.0002	<0.001	0.10	<0.02	<0.005	<0.02	0.0049	0.0042	0.0039	0.0003
H	0.057	0.47	1.71	0.002	0.011	0.05	13.55	17.63	2.49	0.029	0.0019	0.003	<0.1	<0.01	<0.01	<0.03	0.0065	0.0070	0.0061	0.0009
I	0.060	0.48	1.74	0.028	0.009	<0.05	13.30	17.58	2.43	0.027	0.0012	0.002	<0.1	<0.01	<0.01	<0.03	0.0055	0.0106	0.0095	0.0011
K	0.058	0.49	1.71	0.051	0.010	0.05	13.54	17.59	2.51	0.026	0.0018	0.001	<0.1	<0.01	<0.01	<0.03	0.0063	0.0089	0.0083	0.0006
L	0.055	0.49	1.68	0.002	0.010	0.05	13.66	17.76	2.49	0.025	0.0040	0.002	<0.1	<0.01	<0.01	<0.03	0.0064	0.0066	0.0060	0.0006
M	0.054	0.48	1.74	0.027	0.010	0.05	13.42	17.70	2.50	0.024	0.0042	0.002	<0.1	<0.01	<0.01	<0.03	0.0039	0.0079	0.0068	0.0011
N	0.055	0.50	1.74	0.052	0.009	0.05	13.64	17.62	2.49	0.027	0.0047	0.002	<0.1	<0.01	<0.01	<0.03	0.0050	0.0123	0.0117	0.0006

表 - 3 CHEMICAL COMPOSITION AND TREATMENT OF TEST SPECIMENS (TEM Foil)

SPECIMEN	MATERIAL	CHEMICAL COMPOSITION													TREATMENT	
		C	Si	Mn	P	S	Ni	Cr	Mo	Co	B	N	Ti	Nb		O
A1	STD 316	0.06	0.65	1.64	0.028	-	12.66	16.53	2.34	-	0.0001	0.002	-	-	0.0104	1015°Cx10MIN → 20% C.W
A2	316+0.002C	0.002	0.55	1.61	0.032	0.011	13.09	16.53	2.54	0.002	0.0003	0.0029	-	-	0.0058	" "
A3	316+0.03N	0.056	0.55	1.56	0.032	0.012	13.18	16.62	2.52	0.002	0.0004	0.0255	-	-	0.0032	" "
A4	316+0.002B	0.070	0.76	1.58	0.022	0.007	13.22	16.32	2.53	0.001	0.0024	0.0028	-	-	0.0049	" "
A5	316 (LOW P)	0.057	0.63	1.62	0.004	0.010	13.20	16.89	2.51	0.002	0.0004	0.0033	-	-	0.0058	" "
A6	316+0.5Nb	0.06	0.66	1.69	0.026	-	13.02	17.19	2.38	-	0.0001	0.002	-	0.51	-	1200°Cx10MIN
A7	"	"	"	"	"	-	"	"	"	-	"	"	-	"	-	1200°Cx10MIN → 10% C.W.
A8	"	"	"	"	"	-	"	"	"	-	"	"	-	"	-	1200°Cx10MIN → 20% C.W.
A9	"	"	"	"	"	-	"	"	"	-	"	"	-	"	-	1200°Cx10MIN → 20% C.W. → 900°C x 4HR
B1	316+0.2Nb	0.05	0.64	1.69	0.027	-	13.27	16.90	2.41	-	0.0001	0.002	-	0.21	-	1200°Cx10MIN → 20% C.W.
B2	316+0.8Nb	0.05	0.65	1.64	0.028	-	13.32	16.78	2.32	-	0.002	0.002	-	0.83	-	" "
B3	316+0.02C	0.022	0.52	1.58	0.031	0.013	13.18	16.69	2.50	0.001	0.0006	0.0038	-	-	0.0047	1015°Cx10MIN → 20% C.W.
B4	316+0.25Ti	0.07	0.63	1.70	0.028	-	13.04	16.90	2.41	-	0.0001	0.002	0.26	-	0.0095	1200°Cx10MIN
B5	"	"	"	"	"	-	"	"	"	-	"	"	"	-	"	1200°Cx10MIN → 10% C.W.
B6	"	"	"	"	"	-	"	"	"	-	"	"	"	-	"	1200°Cx10MIN → 20% C.W.
B7	"	"	"	"	"	-	"	"	"	-	"	"	"	-	"	1200°Cx10MIN → 30% C.W.

表-4 CHEMICAL COMPOSITION AND TREATMENT OF TEST SPECIMENS (TEM Foil)

SPECIMEN	MATERIAL	CHEMICAL COMPOSITION														TREATMENT
		C	Si	Mn	P	S	Ni	Cr	Mo	Co	B	N	Ti	Nb	O	
C1	316+0.015N	0.055	0.56	1.62	0.029	0.005	13.12	16.88	2.55	0.001	0.0005	0.0173	-	-	0.0070	1015°Cx10MIN → 20% C.W.
C2	316+0.25Ti	0.07	0.63	1.70	0.028	-	13.04	16.90	2.41	-	0.0001	0.002	0.26	-	0.009	1200°Cx10MIN → 20% C.W. → 950°Cx6HR W.Q.
C3	316+0.4Ti	0.05	0.64	1.69	0.029	-	12.93	16.86	2.43	-	0.0001	0.002	0.45	-	0.0086	1200°Cx10MIN → 20% C.W.
C4	316+0.1C +0.07Ti+0.14Nb	0.11	0.68	1.69	0.027	-	13.37	16.81	2.41	-	0.0001	0.002	0.07	0.14	0.0062	" "
C5	STD 316	0.06	0.65	1.64	0.028	-	12.66	16.53	2.34	-	0.0001	0.002	-	-	0.0104	1015°Cx10MIN
C6	"	"	"	"	"	-	"	"	"	-	"	"	-	-	"	" → 10% C.W.
C7	"	"	"	"	"	-	"	"	"	-	"	"	-	-	"	1010°Cx10MIN → 20% C.W. → 650°Cx20HR → 950°Cx30MIN W.Q.
C8	"	"	"	"	"	-	"	"	"	-	"	"	-	-	"	1015°Cx10MIN → 30% C.W.
C9	"	"	"	"	"	-	"	"	"	-	"	"	-	-	"	950°Cx10MIN
D1	316+0.1C	0.11	0.55	1.60	0.030	0.006	13.17	17.01	2.53	0.001	0.0004	0.0031	-	-	0.0072	1015°Cx10MIN → 20% C.W.
D2	316+0.001B	0.065	0.55	1.63	0.029	0.005	13.14	17.01	2.54	0.001	0.0012	0.0022	-	-	0.0045	" "
D3	316+0.1Ti	0.05	0.64	1.62	0.028	-	13.04	16.26	2.39	-	0.0001	0.002	0.11	-	0.0098	1200°Cx10MIN → 20% C.W.
D4	321	0.080	0.61	1.63	0.025	0.006	11.98	17.28	-	0.001	0.0003	0.0026	0.39	-	0.0048	" "
D5	347	0.087	0.55	1.66	0.020	0.006	12.15	17.66	-	0.003	0.0002	0.0035	-	0.74	0.0037	" "

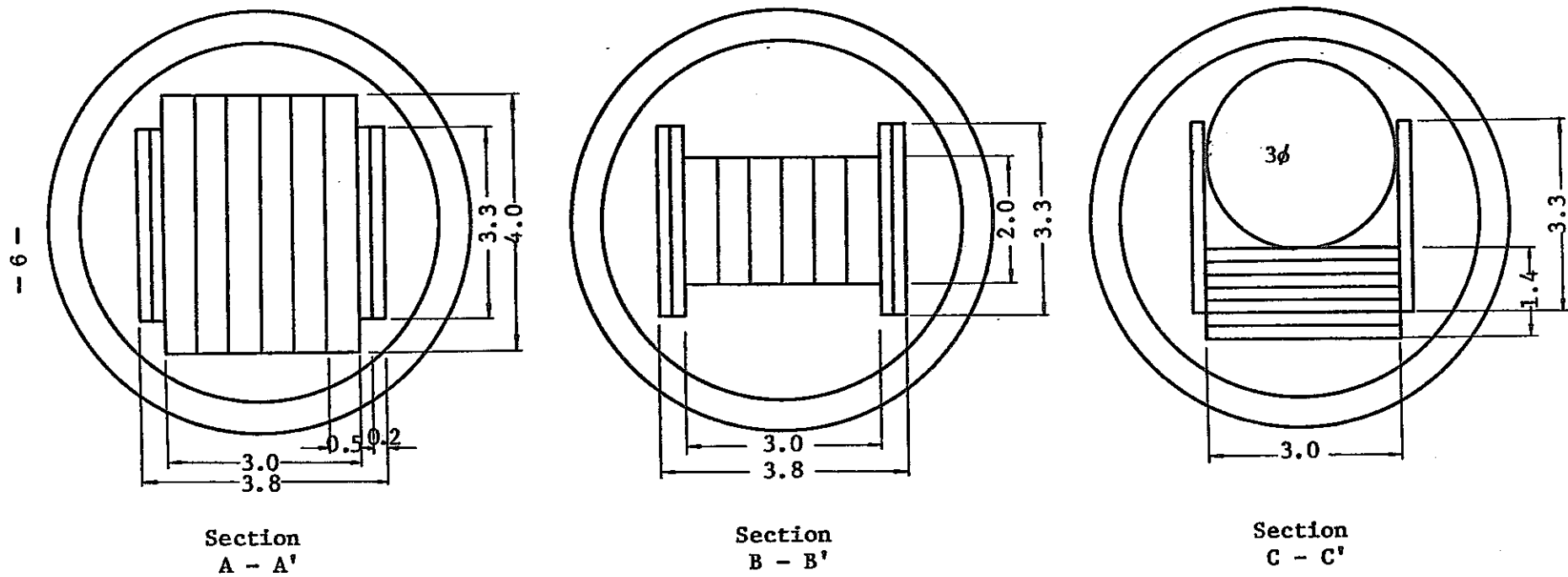
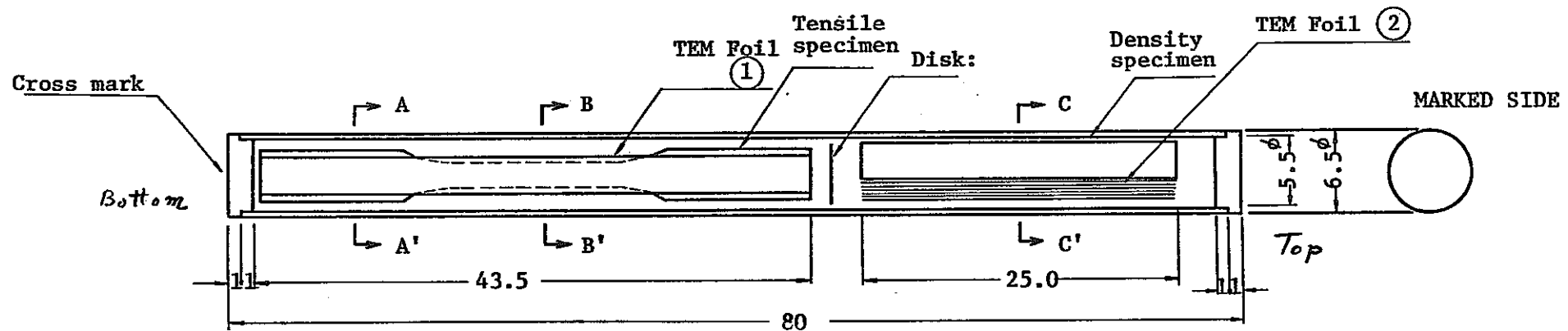


图 - 2 ARRANGEMENT OF TEST SPECIMENS IN CAPSULE

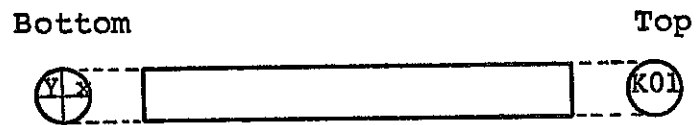
表-5 - Specimens contained in capsules

Capsule	Test specimens																			
	Tensile						TEM Foil (1)				Density	TEM Foil (2)								
K01	E1	E2	E3	G1	G2	G3	E1	E2	G1	G2	E1	E11	G11	A1-5	A2-5	A3-5	A4-5	A7-5	B1-12	B2-5
K11	H1	H2	H3	I1	I2	I3	H1	H2	I1	I2	G1	H11	I11	A5-5	A8-5	B6-5	C4-5	B3-5	B5-5	B7-5
S01	K1	K2	K3	L1	L2	L3	K1	K2	L1	L2	L1	K11	L11	C5-5	C6-5	C7-5	A6-5	C3-5	C8-5	C9-5
S06	M1	M2	M3	N1	N2	N3	M1	M2	N1	N2	N1	M11	N11	A9-5	B4-5	C2-5	C1-5	D1-5	D2-5	D3-5
K02	E4	E5	E6	G4	G5	G6	E3	E4	G3	G4	E2	E12	G12	A1-4	A2-4	A3-4	A4-4	A7-4	B1-11	B2-4
K12	H4	H5	H6	I4	I5	I6	H3	H4	I3	I4	G2	H12	I12	A5-4	A8-4	B6-4	C4-4	B3-4	B5-4	B7-4
S02	K4	K5	K6	L4	L5	L6	K3	K4	L3	L4	L2	K12	L12	C5-4	C6-4	C7-4	A6-4	C3-4	C8-4	C9-8
S07	M4	M5	M6	N4	N5	N6	M3	M4	N3	N4	N2	M12	N12	A9-4	B4-4	C2-4	C1-4	D1-4	D4-4	D5-4
K03	E7	E8	E9	G7	G8	G9	E5	E6	G5	G6	E3	E13	G13	A1-3	A2-3	A3-3	A4-3	A7-3	B1-10	B2-3
K13	H7	H8	H9	I7	I8	I9	H5	H6	I5	I6	G3	H13	I13	A5-3	A8-3	B6-3	C4-3	B3-3	B5-3	B7-3
S03	K7	K8	K9	L7	L8	L9	K5	K6	L5	L6	L3	K13	L13	C5-3	C6-3	C7-3	A6-3	C3-3	C8-3	C9-3
S08	M7	M8	M9	N7	N8	N9	M5	M6	N5	N6	N3	M13	N13	A9-3	B4-3	C2-3	C1-3	D1-3	D2-3	D3-3
K04	E10	E11	E12	G10	G11	G12	E7	E8	G7	G8	E4	E14	G14	A1-2	A2-2	A3-2	A4-2	A7-2	B1-9	B2-2
K14	H10	H11	H12	I10	I11	I12	H7	H8	I7	I8	G4	H14	I14	A5-2	A8-2	A6-2	C4-2	B3-2	B5-2	B7-2
S04	K10	K11	K12	L10	L11	L12	K7	K8	L7	L8	L4	K14	L14	C5-2	C6-2	C7-2	A6-2	C3-2	C8-2	C9-2
S09	M10	M11	M12	N10	N11	N12	M7	M8	N7	N8	N4	M14	N14	A9-2	B4-2	C2-2	C1-2	D3-2	D4-2	D5-2
K05	E13	E14	E15	G13	G14	G15	E9	E10	G9	G10	E5	E15	G15	A1-1	A2-1	A3-1	A4-1	A7-1	B1-8	B2-1
K15	H13	H14	H15	I13	I14	I15	H9	H10	I9	I10	G5	H15	I15	A5-1	A8-1	B6-1	C4-1	B3-1	B5-1	B7-1
S05	K13	K14	K15	L13	L14	L15	K9	K10	L9	L10	L5	K15	L15	C5-1	C6-1	C7-1	A6-1	C3-1	C8-1	C9-1
SOA	M13	M14	M15	N13	N14	N15	M9	M10	N9	N10	N5	M15	N15	A9-1	B4-1	C2-1	C1-1	D1-1	D2-1	D3-1

表-6 Specimens contained in spare capsules

Capsule	Test specimens													
	Tensile	TEM Foil ①	Density	TEM Foil ②										
K06	ES1 ES2 ES3 GS1 GS2 GS3	ES1 ES2 GS1 GS2	ES1	ES3 GS3 A1-16 A2-16 A3-16 A4-16 A5-18 A6-18 A8-18										
K07	HS1 HS2 HS3 IS1 IS2 IS3	HS1 HS2 IS1 IS2	GS1	HS3 IS3 A5-16 A8-16 B6-16 C4-16 B4-29 C5-18 C6-18										
K08	KS1 KS2 KS3 LS1 LS2 LS3	KS1 KS2 LS1 LS2	LS1	KS3 LS3 C5-16 C6-16 C7-16 A6-16 A1-32 A2-19 A3-19										
K09	MS1 MS2 MS3 NS1 NS2 NS3	MS1 MS2 NS1 NS2	NS1	MS3 NS3 A9-16 B4-16 C2-16 C1-11 A4-19 A5-19 A8-19										
K0A	FS1 FS2 FS3 FS4 FS5 FS6	FS1 FS2 FS3 FS4	FS1	FS5 FS6 A1-17 A2-17 A3-17 A4-17 B6-19 C4-19 C5-19										
K0B	F1 F2 F3 F4 F5 F6	F1 F2 F3 F4	F1	F5 F6 A5-17 A8-17 B6-17 C4-17 A1-33 A2-20 A3-20										

Each capsule has such as following marks on end plug.



Cross mark for diameter measurement

Specimen mark

☒ - 3 marking of capsule

表-7 Arrangement of capsules

Stage in rig	1 Bottom	2	3	4	5 Top
Material K0	K01	K02	K03	K04	K05
Material K1	K11	K12	K13	K14	K15
Material S0	S01	S02	S03	S04	S05
	S06	S07	S08	S09	S0A

K06 ~ K09, K0A, K0B: 6 spare capsules



表-8-①

GROUP NUMBER	ENERGY MEV - KEV			LETARGY
1	14.5	-	3.68 Mev	1.35
2	3.68	-	2.23 Mev	0.5
3	2.23	-	1.35 Mev	0.5
4	1.35	-	0.821 Mev	0.5
5	0.821	-	0.498 Mev	0.5
6	0.498	-	0.302 Mev	0.5
7	0.302	-	0.183 Mev	0.5
8	0.183	-	0.111 Mev	0.5
9	0.111	-	0.0674 Mev	0.5
10	67.4	-	40.9 Kev	0.5
11	40.9	-	24.8 Kev	0.5
12	24.8	-	15.0 Kev	0.5
13	15.0	-	9.12 Kev	0.5
14	9.12	-	5.23 Kev	0.5
15	5.53	-	3.36 Kev	0.5
16	3.36	-	2.04 Kev	0.5
17	2.04	-	1.23 Kev	0.5
18	1.23	-	0.748 Kev	0.5
19	0.748	-	0.454 Kev	0.5
20	0.454	-	0.275 Kev	0.5
21	0.275	-	0.101 Kev	1.0
22	0.101	-	0.0226 Kev	1.5
23	0.0226	-	0.00306 Kev	2.0
24	0.00306	-	0.000414 Kev	2.0
25	thermal			-

"Cote" means height expressed in millimeters - zero is core mid plane.

"Flux rapide" means flux of neutrons of energies higher than 0.111 KEV (eight first energy groups).

Unit for fluxes is  $n/cm^2.s$  and values are for characteristic conditions.

POSITION C302 FLUX A 25 GROUPES

表-8-②

CODE	GRUPE 1	GRUPE 2	GRUPE 3	GRUPE 4	GRUPE 5	GRUPE 6	GRUPE 7	GRUPE 8	GRUPE 9	GRUPE 10
-350	0.2452E+13	0.7591E+13	0.1814E+14	0.2955E+14	0.5890E+14	0.7316E+14	0.9329E+14	0.8447E+14	0.7426E+14	0.6822E+14
-315	0.3953E+13	0.1190E+14	0.2891E+14	0.4660E+14	0.8198E+14	0.1055E+15	0.1200E+15	0.1038E+15	0.8840E+14	0.7890E+14
-280	0.7330E+13	0.2014E+14	0.4350E+14	0.6550E+14	0.1079E+15	0.1350E+15	0.1449E+15	0.1213E+15	0.1007E+15	0.8745E+14
-245	0.1098E+14	0.2927E+14	0.5807E+14	0.8217E+14	0.1332E+15	0.1588E+15	0.1637E+15	0.1348E+15	0.1101E+15	0.9355E+14
-210	0.1724E+14	0.4373E+14	0.7822E+14	0.1026E+15	0.1629E+15	0.1813E+15	0.1827E+15	0.1475E+15	0.1180E+15	0.9767E+14
-175	0.3008E+14	0.7104E+14	0.1132E+15	0.1364E+15	0.2057E+15	0.2086E+15	0.2109E+15	0.1637E+15	0.1265E+15	0.1003E+15
-140	0.4749E+14	0.1074E+15	0.1588E+15	0.1800E+15	0.2581E+15	0.2402E+15	0.2463E+15	0.1828E+15	0.1356E+15	0.1020E+15
-105	0.6167E+14	0.1382E+15	0.1996E+15	0.2211E+15	0.3077E+15	0.2757E+15	0.2826E+15	0.2033E+15	0.1462E+15	0.1058E+15
-70	0.7065E+14	0.1582E+15	0.2265E+15	0.2489E+15	0.3447E+15	0.3020E+15	0.3084E+15	0.2188E+15	0.1547E+15	0.1092E+15
-35	0.7535E+14	0.1687E+15	0.2409E+15	0.2640E+15	0.3658E+15	0.3164E+15	0.3226E+15	0.2275E+15	0.1594E+15	0.1110E+15
0	0.7621E+14	0.1706E+15	0.2437E+15	0.2670E+15	0.3701E+15	0.3186E+15	0.3248E+15	0.2288E+15	0.1597E+15	0.1106E+15
35	0.7360E+14	0.1651E+15	0.2360E+15	0.2590E+15	0.3596E+15	0.3102E+15	0.3147E+15	0.2228E+15	0.1555E+15	0.1074E+15
70	0.6699E+14	0.1507E+15	0.2167E+15	0.2391E+15	0.3333E+15	0.2888E+15	0.2936E+15	0.2090E+15	0.1462E+15	0.1015E+15
105	0.5621E+14	0.1271E+15	0.1852E+15	0.2068E+15	0.2915E+15	0.2562E+15	0.2612E+15	0.1879E+15	0.1324E+15	0.9312E+14
140	0.3897E+14	0.8954E+14	0.1339E+15	0.1534E+15	0.2262E+15	0.2084E+15	0.2101E+15	0.1563E+15	0.1129E+15	0.8155E+14
175	0.2521E+14	0.6015E+14	0.9668E+14	0.1170E+15	0.1760E+15	0.1768E+15	0.1740E+15	0.1334E+15	0.9794E+14	0.7183E+14
210	0.1648E+14	0.4111E+14	0.7219E+14	0.9293E+14	0.1392E+15	0.1533E+15	0.1480E+15	0.1160E+15	0.8597E+14	0.6346E+14
245	0.1135E+14	0.2914E+14	0.5466E+14	0.7413E+14	0.1102E+15	0.1313E+15	0.1259E+15	0.1005E+15	0.7504E+14	0.5567E+14
280	0.7205E+13	0.1934E+14	0.3976E+14	0.5763E+14	0.8518E+14	0.1104E+15	0.1054E+15	0.8582E+14	0.6453E+14	0.4817E+14
315	0.4056E+13	0.1172E+14	0.2750E+14	0.4342E+14	0.6405E+14	0.9068E+14	0.8639E+14	0.7189E+14	0.5444E+14	0.4096E+14
350	0.1897E+13	0.6287E+13	0.1787E+14	0.3151E+14	0.4683E+14	0.7208E+14	0.6893E+14	0.5875E+14	0.4477E+14	0.3403E+14

0302

表-8-③

COTE	GROUPE 11	GROUPE 12	GROUPE 13	GROUPE 14	GROUPE 15	GROUPE 16	GROUPE 17	GROUPE 18	GROUPE 19	GROUPE 20
-350	0.5707E+14	0.4456E+14	0.2913E+14	0.1756E+14	0.1065E+14	0.1215E+14	0.1643E+14	0.1440E+14	0.1065E+14	0.7944E+13
-315	0.6244E+14	0.5098E+14	0.3181E+14	0.1858E+14	0.1157E+14	0.1424E+14	0.2157E+14	0.1629E+14	0.1200E+14	0.8897E+13
-280	0.6643E+14	0.5503E+14	0.3329E+14	0.1910E+14	0.1210E+14	0.1551E+14	0.2320E+14	0.1703E+14	0.1238E+14	0.9109E+13
-245	0.6863E+14	0.5679E+14	0.3370E+14	0.1916E+14	0.1218E+14	0.1616E+14	0.2367E+14	0.1690E+14	0.1199E+14	0.8681E+13
-210	0.6964E+14	0.5614E+14	0.3285E+14	0.1867E+14	0.1191E+14	0.1569E+14	0.2247E+14	0.1551E+14	0.1054E+14	0.7466E+13
-175	0.7020E+14	0.5262E+14	0.3023E+14	0.1738E+14	0.1131E+14	0.1399E+14	0.1847E+14	0.1199E+14	0.7376E+13	0.5061E+13
-140	0.7051E+14	0.4721E+14	0.2642E+14	0.1562E+14	0.1059E+14	0.1120E+14	0.1283E+14	0.7265E+13	0.3301E+13	0.2041E+13
-105	0.7159E+14	0.4412E+14	0.2376E+14	0.1482E+14	0.1075E+14	0.1061E+14	0.1051E+14	0.5257E+13	0.1811E+13	0.9478E+12
-70	0.7296E+14	0.4275E+14	0.2239E+14	0.1455E+14	0.1103E+14	0.1098E+14	0.9832E+13	0.4536E+13	0.1282E+13	0.5638E+12
-35	0.7360E+14	0.4192E+14	0.2159E+14	0.1437E+14	0.1118E+14	0.1116E+14	0.9681E+13	0.4314E+13	0.1127E+13	0.4554E+12
0	0.7295E+14	0.4106E+14	0.2096E+14	0.1407E+14	0.1109E+14	0.1112E+14	0.9530E+13	0.4206E+13	0.1073E+13	0.4230E+12
35	0.7071E+14	0.4005E+14	0.2023E+14	0.1355E+14	0.1076E+14	0.1078E+14	0.9160E+13	0.4035E+13	0.1026E+13	0.4092E+12
70	0.6660E+14	0.3819E+14	0.1921E+14	0.1264E+14	0.1013E+14	0.1006E+14	0.8415E+13	0.3706E+13	0.9320E+12	0.3313E+12
105	0.6079E+14	0.3564E+14	0.1794E+14	0.1138E+14	0.9074E+13	0.8977E+13	0.7491E+13	0.3352E+13	0.8935E+12	0.2996E+12
140	0.5298E+14	0.3264E+14	0.1665E+14	0.9923E+13	0.7414E+13	0.7553E+13	0.6755E+13	0.3295E+13	0.1141E+13	0.5648E+12
175	0.4564E+14	0.2948E+14	0.1463E+14	0.7910E+13	0.5246E+13	0.5626E+13	0.5566E+13	0.2759E+13	0.1177E+13	0.5912E+12
210	0.3939E+14	0.2655E+14	0.1267E+14	0.6277E+13	0.3719E+13	0.4146E+13	0.4496E+13	0.2222E+13	0.1067E+13	0.5158E+12
245	0.3407E+14	0.2389E+14	0.1111E+14	0.5268E+13	0.3027E+13	0.3338E+13	0.3763E+13	0.1898E+13	0.9210E+12	0.4520E+12
280	0.2907E+14	0.2125E+14	0.9662E+13	0.4389E+13	0.2467E+13	0.2688E+13	0.3134E+13	0.1619E+13	0.8008E+12	0.4036E+12
315	0.2438E+14	0.1861E+14	0.8334E+13	0.3640E+13	0.2039E+13	0.2193E+13	0.2608E+13	0.1386E+13	0.7067E+12	0.3706E+12
350	0.2000E+14	0.1598E+14	0.7125E+13	0.3021E+13	0.1742E+13	0.1856E+13	0.2187E+13	0.1199E+13	0.6387E+12	0.3529E+12

表-8-④

0302

COTE	GROUPE 21	GROUPE 22	GROUPE 23	GROUPE 24	GROUPE 25	GROUPE
-350	0.9952E+13	0.7744E+13	0.1848E+13	0.5698E+12	0.3261E+10	
-315	0.1178E+14	0.9045E+13	0.2570E+13	0.6353E+12	0.3140E+10	
-280	0.1239E+14	0.9411E+13	0.2902E+13	0.6335E+12	0.3057E+10	
-245	0.1197E+14	0.8960E+13	0.2833E+13	0.5491E+12	0.3639E+10	
-210	0.1025E+14	0.7519E+13	0.2457E+13	0.4042E+12	0.3971E+10	
-175	0.6523E+13	0.4569E+13	0.1439E+13	0.2103E+12	0.2503E+10	
-140	0.1800E+13	0.9219E+12	0.1444E+12	0.2764E+11	0.5431E+07	
-105	0.6511E+12	0.2963E+12	0.3486E+11	0.5830E+10	0.8859E+06	
-70	0.3042E+12	0.1047E+12	0.6433E+10	0.6481E+09	0.9884E+05	
-35	0.2317E+12	0.6744E+11	0.3807E+10	0.4469E+09	0.6778E+05	
0	0.2060E+12	0.6095E+11	0.3699E+10	0.4252E+09	0.6475E+05	
35	0.1926E+12	0.5643E+11	0.3681E+10	0.4285E+09	0.5833E+05	
70	0.1547E+12	0.3414E+11	0.3868E+10	0.4490E+09	0.580E+05	
105	0.1773E+12	0.5021E+11	0.4332E+10	0.4811E+09	0.701E+05	
140	0.4970E+12	0.2882E+12	0.4972E+10	0.5108E+09	0.4280E+07	
175	0.4547E+12	0.1612E+12	0.6515E+10	0.5828E+09	0.6777E+07	
210	0.3467E+12	0.3849E+11	0.9345E+10	0.6567E+09	0.7450E+07	
245	0.3297E+12	0.6572E+11	0.1338E+11	0.7319E+09	0.7347E+07	
280	0.3229E+12	0.9109E+11	0.1821E+11	0.8427E+09	0.7477E+07	
315	0.3263E+12	0.1146E+12	0.2386E+11	0.9890E+09	0.7839E+07	
350	0.3399E+12	0.1362E+12	0.3031E+11	0.1171E+10	0.8434E+07	

表-8-⑤

0302

COTE	FLUX RAPIDE
-350	0.3676E+15
-315	0.5026E+15
-280	0.6455E+15
-245	0.7711E+15
-210	0.9161E+15
-175	0.1140E+16
-140	0.1421E+16
-105	0.1690E+16
-70	0.1878E+16
-35	0.1981E+16
0	0.2000E+16
35	0.1941E+16
70	0.1798E+16
105	0.1572E+16
140	0.1217E+16
175	0.9592E+15
210	0.7793E+15
245	0.6373E+15
280	0.5108E+15
315	0.3997E+15
350	0.3041E+15

COMMISSARIAT A L'ÉNERGIE ATOMIQUE  
CENTRE D'ÉTUDES NUCLÉAIRES DE CADARACHE  
DEPARTEMENT D'EXPLOITATION DES REACTEURS

ADRESSE

BOITE POSTALE N° 1  
13 - SAINT-PAUL-LEZ-DURANCE

TÉLÉPHONE

88-90-00 CADARACHE

Service d'Exploitation et  
d'Expérimentation  
de RAPSODIE

M. Y. ISHIDA  
FBR Project  
PNC  
1-Chome Akasaka  
MINATO-KU  
TOKYO  
JAPAN

LE 19 avril 1978

SIER/78-179  
FM/RM - Clt-3076

Dear Mr. ISHIDA,

We have received your letter giving yours agreement on PNC 8-4 drawings and yours new temperature requirements for PNC 9 experiment. We have designed the PNC 9 irradiation rig in order to have the requested temperature on the capsule-tubes. So as you do not want to drill holes in the capsules to fill them with sodium, you will notice that the specimens, inside the capsules, will reach higher temperatures. For instance, the specimen of the third stage will achieved a temperature of 740°C, although the temperature of the capsules is 600°C.

Can you give your agreement on the data listed below ?

表 - 9 照射温度

Stage	1	2	3	4	5
Capsule temperature (°C)	Inn. 450 out. 400	500 409	600 437	550 472	550 495
Specimen temperature (°C)	485	600	740	635	580

Yours sincerely,



J.P. PAGES

Chef de la S.I.E.R.

# RAPSDIE

表-10

## PROVISIONS FOR IRRADIATION RUNS

DATE	1978						1979						1980							
	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
RUNS	48° RUN		49° RUN		50° RUN		51° RUN		52° RUN		53° RUN		MAINTENANCE WORKS		54° RUN					
	8	23			7	22			6	21			8	23			8	23		
																			15	30
																				16
																				31
EXPERIMENTS																				
PNC 5-2					IRR.				INT. INSPECTION				SCHEDULE TO BE DEFINED							
PNC 8-4					IRR.				INT. INSPECTION		IRR.		FINA. INSPECTION							
PNC 9									IRR.				INT. INSPECTION						IRR.	
PNC 10									IRR.				SCHEDULE TO BE DEFINED							
PNC 6									IRR.				SCHEDULE							
PNC 7											IRR.		SCHEDULE							

POWER CYCLES  
55°, 56°, 57° RUNS

- 19 -

動燃・東海  
検査開発課 殿

( 契約番号 \_\_\_\_\_ )

( もんじゆ )

「ラプソディー・PNC-9 照射試験」用

支給材の試験・検査成績書

昭和52年10月12日

茨城県那珂郡東海村村松  
動力炉・核燃料開発事業団  
東海事業所技術部

検査業務課

課長	係	



## 支給部材の数量および試験・検査成績書

部材名	材質	製造者	ロット 番号	数量 (本)	番号	寸法 (mm)	試験・検査成績書	ページ
(R & D) 高速 原型炉 もんじゆ 炉心用 被覆管 (3本)	SUS 316	住金	5001 (H.B) (H.P)	1	S 6146	外径 6.500±0.030 内径 5.600±0.025 肉厚 0.450±0.030	製造者 住友金属・鋼管製造所 № MS-RD-0009	P 2-P 3
		(50-1A213)					動燃・受入検査結果	P 4-P 5
		神鋼	502 (H.B) (H.P)	1	K 5666	長さ 3000±10  反No側端面仕上材 { 直角度 90°±15 面取り ≤ 0.030 アラサ ≤ 6.5	製造者 神戸製鋼・長府北工場 № S-77-5	P 6-P 7
		(50-1A213)					動燃・受入検査結果	P 4-P 5
神鋼	511 (H.B) (H.P)	1	K 6415		製造者 神戸製鋼・長府北工場 № S-77-8	P 8-P 9		
(51-1A13)					動燃・受入(立会)検査結果	P 4-P 5		
(R & D) 高速原型炉 もんじゆ 炉心用 端栓材	SUS 316	住電	1	1	TM 0974	外径 8.0±0.2 長さ 1000±10	製造者 住友電工・伊丹製作所 特殊線事業部 № 74-008	P 10
		(48-1A282)						

50-1A213

52.3.8 入荷

シシートNo. MS-RD-0009

発行年月日 52年3月2日

## 動力炉核燃料開発事業団殿

## 試験検査成績書

品名		高速増殖炉原型炉もんじゅ用炉心管
公称寸法		$6,500^{\text{φ}} \times 5,600^{\text{φ}} \times 0,450^{\text{Z}} \times 3,000^{\text{L}}$
契約	番号	50-1A-213
	数量	1200本
仕様書	PNC殿No.	
	住金No.	A-NO.689.
立会検査受検日		昭和52年3月2~4日
納入	顧客名	動力炉核燃料開発事業団 東海事業所殿
	数量	1200本 (S-6101~S-7308)
	予定日	昭和52年3月10日.
試験検査結果		別紙のとおり 全この項目について 仕様規格内であることを保証します。
備考		昭和50年度介. 製造No. TTJ-9013. Lot.No. 5001~5011.

住友金属工業株式会社

鋼管製造所

品質保証課長



# DATA SHEET (1)

ミルシート P MS-RD-0009

取 元 LOT No. S5001	SEQ 01	区分コード 部材コード: C.L.S.M 炉名: C.R.D 1: 本番 2: 炉心 3: 追加修正	製造年月日 年: 52 月: 03 日: 02	製造コード 製造No.: T.T.J.9.0.13 ヒートNo.: 6.8.0.5.4.8	仕様No. 製造元仕様No.: AN.0.6.8.9 PNC仕様No.:
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SEQ 02	数量 0.1.0.0	製品(リール) No.		加工条件		試料 No. - 1					試料 No. - 2			
		開始 No.	終了 No.	温度	時間	加工度	(1)	(2)	(3)	(4)	(5)	(6)	インゴット No.	套管 No.
		6.1.0.1	6.2.0.0	1.0.2.0	0.1.2.1	6.1.1.1	6.1.6.5						6.8.0.5.4.8	SE.U.9.5.7.0

SEQ 03 04 05	(目標 0.025) 化学成分 %																	
	C	Si	Mn	P	S	Ni	Cr	Mo	Co	N	Al	As	Cu	Nb	Ti	V		
	0.035-0.064	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.01	12.00-14.00	17.00-18.00	2.00-3.00	≤ 0.10	≥ 0.0005	≤ 0.010	≤ 0.05	≤ 0.03	≤ 0.20	≤ 0.05	≤ 0.1	≤ 0.02	TOP
	0.035-0.064	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.01	12.00-14.00	17.00-18.00	2.00-3.00	≤ 0.10	≥ 0.0005	≤ 0.010	≤ 0.05	≤ 0.03	≤ 0.20	≤ 0.05	≤ 0.1	≤ 0.02	取端
	0:061	0:5.5	1:9.0	0:0.28	0:0.09	1:3:1.5	1:7:4.0	2:4.8	0:0.1	0:0.019	0:0.086	0:0.20	0:0.02	0:1.5	0:0.02	0:0.02	0:0.02	製品
	0:056	0:5.5	1:8.9	0:0.27	0:0.08	1:3:0.5	1:7:4.5	2:5.1	0:0.1	0:0.018	0:0.072	0:0.20	0:0.02	0:1.4	0:0.02	0:0.02	製品	
	0:058	0:5.3	1:9.4	0:0.29	0:0.10	1:3:0.5	1:7:5.0	2:4.0	0:0.1	0:0.012	0:0.073	0:0.22	0:0.02	0:1.4	0:0.02	0:0.02	製品	

非金属材料															
製品				製品				製品				製品			
A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H
				1:5	0:0	1:0	0:0	0:0	0:0	1:5	0:0	2:0	0:0	1:0	0:0

SEQ 06	企相 (1) (2) 1/1 合格 2/2 不合格	粒界腐食 (1) (2) 1/1 合格 2/2 不合格	酸腐食 55.5 g/m <sup>2</sup> 1/2	結晶粒度 (NO 6より細粒) 1. 2. A:周 B:軸 A:周 B:軸 8:0 8:0	硬さ Hv 内部0.5(1→4) 1. 2. 平均値 (1-2) (3-4) 平均値 (1-2) (3-4) 2.87 2.78 2.96 2.81 2.83 2.77 2.98 2.76	表面浸透 (1) (2) 1/1 合格 2/2 不合格	(原管)扁平 (1) (2) 1/1 合格 2/2 不合格	押出し (1) (2) 1/1 合格 2/2 不合格	欠付 (1) (2) 1/1 合格 2/2 不合格	粗さ Rmax ≤ 3.25 内面 1.5
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SEQ 08	常温引張試験											
	①						②					
	多数採取 8%/Lot						A-軸 2%/Lot					
	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び
	≥75%	≥60%	≥10%	≥75%	≥60%	≥10%	8.3:6	7.1:4	20 A	8.3:0	7.1:2	20 A

内圧破壊試験					
①			②		
破断力	0.2%耐力	伸び	破断力	0.2%耐力	伸び
≤670%	≤500%	—	≤670%	≤500%	—
≤480%	≤300%	—	≤480%	≤300%	—

SEQ 09	高温引張試験 (650°C)											
	①						②					
	多数採取 8%/Lot						A-軸 2%/Lot					
	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び	抗張力	0.2%耐力	伸び
	≥40%	≥30%	≥7%	≥40%	≥30%	≥7%	51:4	4.3:3	13 A	48:4	4.3:4	16 A

高温引張試験					
①			②		
破断力	0.2%耐力	伸び	破断力	0.2%耐力	伸び
—	—	—	—	—	—



R & D

高速原型炉(もんじゅ) 炉心用 燃料被覆管( ) 製 ) 受入検査結果  
ラプソディー PNC-9 照射試験用

昭和 年 月 日

動燃。東海。検査業務課  
検査別異課

No側からの距離(ピット)

管No.	外観検査								判定	表面 アラサ (内・外)
	No.101	0	500	1000	500	2000	500	3000		
住金		50-1A213	ロット	№	5001					
S 6146									合	<3S
神鋼		50-1A213	ロット	№	502					
K 5666		118/20 3/3 P P P							合	<3S
神鋼		51-1A13	ロット	№	511					
K 6415		4301 押込							合	<3S

品質検査報告書

項目	内容
納入先名	動力部 長府製鋼所 長府北工場
品名	モーター心用材料 板鋼
材質	SUS 316
製品寸法	65 <sup>OD</sup> x 5.6 <sup>ID</sup> x 0.45 <sup>t</sup> x 3000 <sup>L</sup> (mm)
工場製作番号	S 50340102
ロット番号	L1631 , L1704 , L1704
納入数量	501 : 175本 , 502 : 477本 , 503 : 96本 (合計 748本)
立会検査年月日	昭和 52 年 4 月 26.27 日
工場検査年月日	昭和 52 年 4 月 27 日
納入残量	0
検査番号	501-A-213
検査種別	76-D 002 改 1
検査項目	1200 本
その他	Lot 501 及び Lot 502 は同じ契約での前納分(452本) Mill Sheet No S-77-3 と同一 Lot であるので DATA SHEET (1) に記入してある材料データは、S-77-3 と同一のデータを報告してあります。

尚、試験・検査結果は別紙をご参照下さい。

上記の通り相違ありません

昭和 52 年 4 月 26 日

株式会社 神戸製鋼所 長府北工場

品質保証課長



# DATA SHEET (1)

シールシート No. S-77-5

LOT No. K502	SEQ 01	区分コード 部材 検査 コード 名称 K R.D. 3	1 素材 F 識別 2 炉心 区分 3 炉心 区分	製造年月日 52 4 26	製造コード S50340 0Z	仕様 No. L170476D00Z改1	製造元仕様 No. PNC 仕様 No.
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SEQ 02	C	製造 (リール) No. 425556259861075	加工条件 20.1	試験 No. - 1 5Z60836134 X=0.6分 Y=0.8分	試験料 No. - 2	インゴット No.	薬管 No.
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化学成分 %														
C	Si	Mn	P	S	Ni	Cr	Mo	Co	B	N	As	Cu	Nb+Ta	V
0.05-0.65	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.010	13.0-14.0	17.0-18.0	2.0-3.0	≤ 0.10	≥ 0.0005	≤ 0.010	≤ 0.05	≤ 0.03	≤ 0.20	≤ 0.05
0.05-0.65	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.010	15.0-16.0	17.0-18.0	2.0-3.0	≤ 0.10	—	—	—	—	—	—
0.052	0.041	1.60	0.026	0.008	13.78	17.92	2.32	0.07	0.0018	0.0066	0.046	0.003	0.03	0.001以下
0.053	0.039	1.75	0.025	0.005	13.84	17.86	2.32	0.07	0.0016	0.0057	0.046	0.004	0.03	0.001以下
0.052	0.042	1.69	0.027	0.005	13.85	17.76	2.30	0.07	0.0020	0.0071	0.048	0.003	0.02	0.005以下

非金属介在物															
管				製品				製品				製品			
A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H
0.0 0.0 0.5 0.0 0.0 0.0 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.5 0.0															

0	7
—	≤ 0.1
0.0 0.1 3	0.0 0.5
0.0 0.1 5	0.0 0.2
0.0 0.1 3	0.0 0.3

8	10	14	22	40
1 1 合格	1 1 合格	1 2	1 8.5 / 1 8.5	2 8.2 2 8.8 2 7.7 2 8.0 2 8.7 2 7.1

42	44	46	48
1 1 合格	2 2 合格	1 1 合格	1 1 合格
2 2 不合格	2 2 不合格	2 2 不合格	2 2 不合格

常温引張試験											
(1)						(2)					
A・種		B・種		C		A・種		B・種		C	
抗張力	0.2%耐力	伸び	耐力	抗張力	0.2%耐力	伸び	耐力	抗張力	0.2%耐力	伸び	耐力
≥ 75 MPa	≥ 21 MPa	≤ 10%	—	—	—	—	—	—	—	—	—
55-80	≤ 21	≤ 45	—	55	≤ 21	≤ 45	—	55	≤ 21	≤ 45	—
55	≤ 21	≤ 45	—	55	≤ 21	≤ 45	—	55	≤ 21	≤ 45	—
85.9 8.1 0.156 A						86.4 8.0 0.159 A					

内圧破壊試験			
(1)		(2)	
抗張力	0.2%耐力	伸び	耐力
—	—	—	—
—	—	—	—
—	—	—	—

高温引張試験											
(1)						(2)					
A・種		B・種		A・種		B・種		A・種		B・種	
抗張力	0.2%耐力	伸び	耐力	抗張力	0.2%耐力	伸び	耐力	抗張力	0.2%耐力	伸び	耐力
≥ 40 MPa	≥ 21 MPa	≤ 7%	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
54.7 4.9 5.9 8 A						54.9 4.9 7.9 7 A					

高温引張試験			
(1)		(2)	
抗張力	0.2%耐力	伸び	耐力
—	—	—	—
—	—	—	—

52.7.20 入荷

## 製品検査報告書

項目	内容
御注文先名	動力炉・核燃料開発事業団
品名	もんじゅ炉心管
材質	SUS316
製品寸法	6.5 <sup>00</sup> x 0.45 <sup>±</sup> x 3000 <sup>±</sup> (mm)
工場製作番号	S50240102
チャージ番号	L1888
ロット番号	511, 512, 513
納入数量	405本, 300本, 295本 (合計1000本)
立会試験年月日	昭和52年7月13日～15日
工場出荷年月日	昭和52年7月18日
納入残量	0
契約番号	511-A-13
神鋼仕様番号	76-D-009 改1
受注数量	1000本
その他	

尚、試験・検査結果は別紙をご参照下さい。

上記の通り相違ありません。

昭和52年7月13日

株式会社 神戸製鋼所 長府北工場

品質保証課長





# DATA SHEET (1)

ミルシート肥 S-77-8

製造元 LOT No.  
K1511

SEQ  
0.1

区分コード			
部材コード	検査元	炉名	炉心
K	0	R <sub>0</sub> D	3
1	2	3	①
素材	区分	識別	
A	2	追加修正	

製造年月日			製造コード		仕様 No.		
年	月	日	製造 No.	ヒート No.	製造元仕様 No.	PNC 仕様 No.	
5	2	07	12	S.5.0.2.4.0.1.0.2	L18.8.8	7.6.0.0.9	改1

SEQ  
0.2

数量	製品 (リール) No.		加工条件		試料 No. - 1						試料 No. - 2		
	開始 No.	終了 No.	温度	時間	加工度	(1)	(2)	(3)	(4)	(5)	(6)	インゴット No.	炭管 No.
4.05	6401	6801	1055		20.0								

SEQ  
0.3

化学成分 %															
C	Si	Mn	P	S	Ni	Cr	Mo	Co	B	N	Al	As	Cu	Nb+Ta	V
0.05-0.07	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.010	13.0-14.0	17.0-18.0	2.0-3.0	≤ 0.10	≥ 0.0005	≤ 0.010	≤ 0.05	≤ 0.03	≤ 0.20	≤ 0.05	≤ 0.2
0.05-0.07	≤ 0.75	1.50-2.00	≥ 0.015	≤ 0.010	13.0-14.0	17.0-18.0	2.0-3.0	≤ 0.10							
0.048	0.35	1.73	0.028	0.006	13.50	17.50	2.24	0.04	0.0029	0.0051	0.031	0.004	0.02	0.011	0.04
0.046	0.34	1.91	0.026	0.006	13.52	17.34	2.17	0.04	0.0028	0.0048	0.031	0.004	0.02	0.010	0.04
0.052	0.36	1.88	0.028	0.005	13.74	17.50	2.15	0.03	0.0026	0.0060	0.032	0.003	0.02	0.005以下	0.04

SEQ  
0.4  
0.5

非金属介在物															
炭管								製品							
A		B		C		D		A		B		C		D	
T	H	T	H	T	H	T	H	T	H	T	H	T	H	T	H
								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ti	
0	≤ 0.1
0.0007	0.007
0.0008	0.006
0.0028	0.004

SEQ  
0.6

金相	晶界腐食	硫酸腐食	結晶粒度 (NO.6~9)
(1) 合格	(1) 合格	≤ 5.5 g/m <sup>2</sup> /h	1. 平行 2. 垂直
(2) 不合格	(2) 不合格		A・周 B・軸

硬さ Hv (平均値) ≤ 290					
1. 平行 横断面			2. 垂直 横断面		
平均値	MAX	MIN	平均値	MAX	MIN
26.9	28.9	24.8	28.1	29.1	26.9

蛍光浸透	(原管) 扁平	押捻付	巻付
(1) 合格	(1) 合格	(1) 合格	(1) 合格
(2) 不合格	(2) 不合格	(2) 不合格	(2) 不合格

SEQ  
0.7

常温引張試験											
(1) A・軸						(2) B・周					
抗張力	0.2%耐力	伸び	位置	抗張力	0.2%耐力	伸び	位置	抗張力	0.2%耐力	伸び	位置
≥ 75% <sub>引</sub>	≥ 60% <sub>引</sub>	≥ 10%	—	≥ 75% <sub>引</sub>	≥ 60% <sub>引</sub>	≥ 10%	—	≥ 75% <sub>引</sub>	≥ 60% <sub>引</sub>	≥ 10%	—
≤ 52	≤ 21	≤ 45	—	≤ 52	≤ 21	≤ 45	—	≤ 52	≤ 21	≤ 45	—
55~80	≤ 30	—	—	55~80	≤ 30	—	—	55~80	≤ 30	—	—
≤ 55	≤ 35	≤ 18	—	≤ 55	≤ 35	≤ 18	—	≤ 55	≤ 35	≤ 18	—
8.8:1	8.1:6	16.1:A		8.7:0	7.8:7	16.4:A					

内圧破壊試験				
(1)			(2)	
破裂圧力	0.2%耐力	伸び	破裂圧力	0.2%耐力
≥ 670% <sub>引</sub>	≥ 500% <sub>引</sub>	—	≥ 670% <sub>引</sub>	≥ 500% <sub>引</sub>
≤ 480% <sub>引</sub>	≤ 360% <sub>引</sub>	—	≤ 480% <sub>引</sub>	≤ 360% <sub>引</sub>

SEQ  
0.8

高温引張試験											
(1) A・軸						(2) B・周					
抗張力	0.2%耐力	伸び	位置	抗張力	0.2%耐力	伸び	位置	抗張力	0.2%耐力	伸び	位置
≥ 47% <sub>引</sub>	≥ 30% <sub>引</sub>	≥ 7%	—	≥ 47% <sub>引</sub>	≥ 30% <sub>引</sub>	≥ 7%	—	≥ 47% <sub>引</sub>	≥ 30% <sub>引</sub>	≥ 7%	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
5.4:1	4.7:9	12.2:A		5.3:6	4.7:2	11.8:A					

高温引張試験				
(1)			(2)	
破裂圧力	0.2%耐力	伸び	破裂圧力	0.2%耐力
—	—	—	—	—
—	—	—	—	—

SEQ  
0.9

神戸製鋼

動力炉核燃料開発事業団殿

資料整理 NO. MN-7404

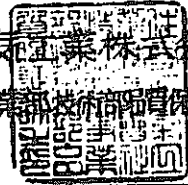
提出 No. 74-008

発行年月日 74年4月22日

試験. 検査成績表

高速原型炉炉心燃料要素用(文珠)  
端栓材 (8.0 mm)

住友電気工業株式会社  
特殊線事業部技術開発保証課



発注番号	A-282
契約数量	500本
仕様書	御契約仕様
製作番号	XS 4535
納入数量	500本

項目	No	項目	No
製造者	T	溶鋼番号	Gr 259
製造年月日	74.4.20	ロット番号	1
製造番号	XS 4535	製品番号	TM0501-TM1000
製造元仕様書	MN 74001	本数	500本
動燃仕様書			

化学成分	項目	C	Si	Mn	P	S	Ni	Cr	Mo	Co	B	N	Cu	Ti	V	Nb	As	Al	O	Fe	
	規格	0.035 ~0.064	0.75 以下	1.50 ~2.00	0.03 以下	0.02 以下	12.00 ~14.00	16.00 ~18.00	2.00 ~3.00	0.10 以下	0.0005 以下		0.20 以下	-	-	-	-	-	-	-	Bal.
	ロット	0.060	0.47	1.62	0.003	0.008	13.09	16.99	2.44	0.02	0.0005	0.028	0.01	Tr	0.003	Tr	0.001	0.004	-	Bal.	
	製品No	0510	0.055	0.52	1.76	0.001	0.010	13.16	16.92	2.44	0.01	0.0003	0.026	0.01	<0.01	<0.01	<0.01	0.002	0.007	66 <sup>5</sup> ppm	Bal.
	0950	0.056	0.51	1.73	0.001	0.010	13.15	16.95	2.44	0.01	0.0003	0.024	0.01	<0.01	<0.01	<0.01	0.002	0.005	65 <sup>5</sup> ppm	Bal.	
介在物試験	製品No	0510		0950		結晶粒度試験		規格 製品No		ASTM No.5 より細粒のこと		硫酸・硫酸銅腐食試験		規格 製品No		粒界腐食によるわれのなきこと					
	A系	0		0		0		0510		No.7		0510		良好							
	B系	0		0		0		0950		No.7		0950		良好							
	C系	0.0083		0.0123		0.0166															
	合計	0.0083		0.0123		0.0166															
機械的性質	引張試験	項目 規格 条件 (常温)	直径 (mm)	引張強さ (kg/mm <sup>2</sup> )	破断位置	伸び (%)	絞り (%)	0.2%耐力 (kg/mm <sup>2</sup> )	かたさ試験	項目	Hy (500g)										
		製品No	±0.2	75 ~105	-	-	-	-		製品No											
		0510	8.100	76.5	A	14.0	70.7	64.7		0510		288									
0950	8.103	80.2	A	16.0	70.1	66.2	0950	287													
健全性検査	浸透試験	規格 製品No	肉眼により深さ70μ以上の割れと判断される異常を認めないこと			表面仕上げ試験	規格 製品No	遊離化物、深さ70μ以上の穴や疵が認められないこと			超音波探傷	規格 製品No	製品棒の中心に存在する0.5mmφ相当の標準人工欠陥の信号と対比しての信号の検出								
		全数	良好				全数	良好				全数	良好								
寸法検査	外径測定	規格 製品No	±0.2 mm			真直度測定	規格 製品No	曲り30mm以下			長さ試験	規格 製品No	1.000 <sup>+10</sup> -0 mm								
		全数	良好				全数	良好				全数	良好								

付録-②

PACKING LIST AND SHIPPING NOTICE

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORP.

FUEL & MATERIAL ASSESSMENT SECTION TOKAI WORKS

TOKAI-MURA, IBARAKI-KEN JAPAN

DATE. Dec, 1, 1977

SHIPPED TO

M. ALAIN BEL

Chef de la section d'irradiation et d'experimentation  
de Rapsodie

CENTER D'ETUDES NUCLEAIRES DE CADARACHE

Boite Postale n°1

(13) SAINT PAUL LEZ DURANCE

FRANCE

QUANTITY

Sample Capsules and Temperature Monitor for PNC-9 Experiment

26pcs. 80mmLong, 6.5mmO.D. AISI Type 316, Capsule

Material KO: K01, K02, K03, K04, K05, K06,  
K07, K08, K09, KOA, KOB

Material K1: K11, K12, K13, K14, K15

Material S0: S01, S02, S03, S04, S05, S06,  
S07, S08, S09, SOA

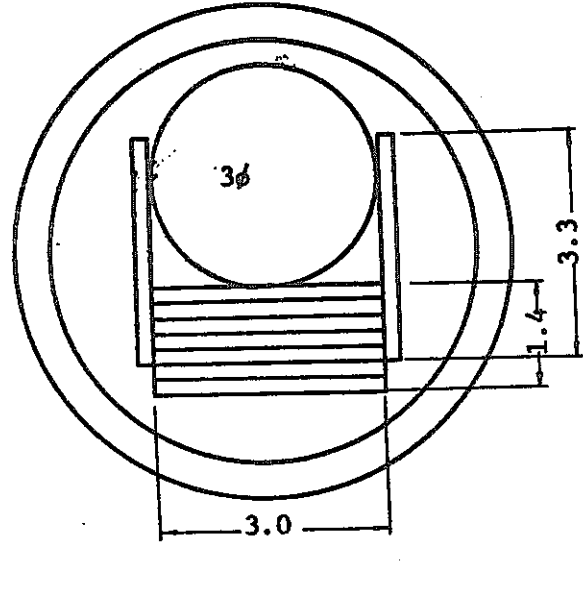
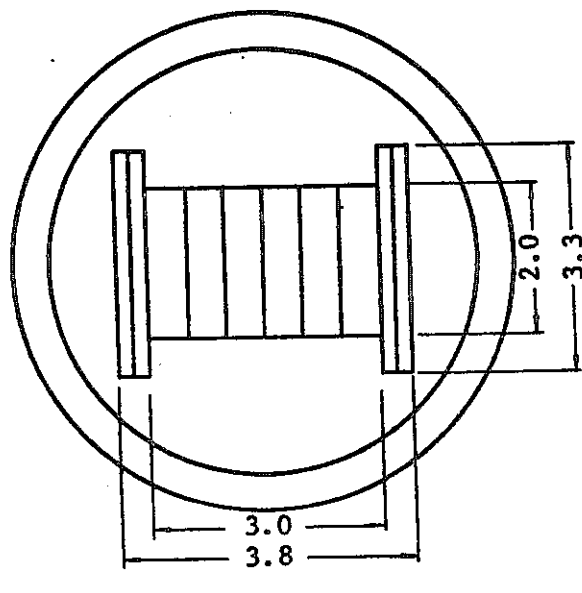
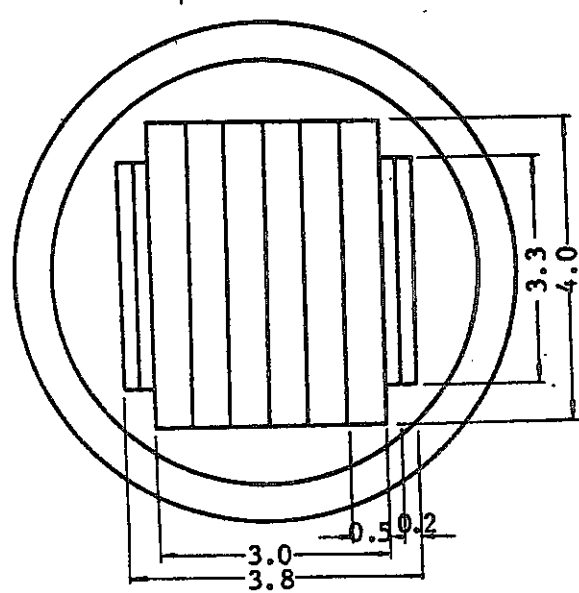
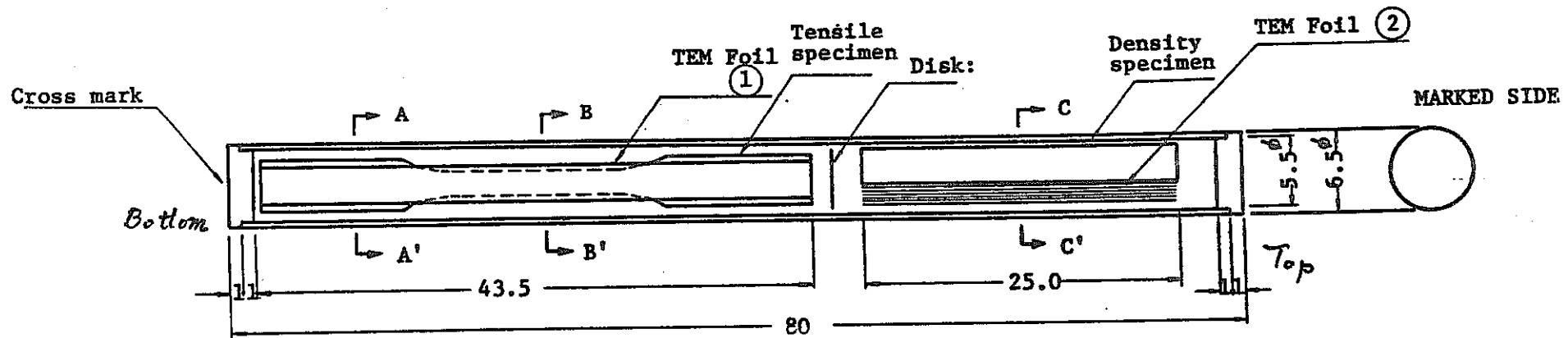
20pcs. 15mmLong, 2.1mmO.D., SiC Temperature Monitor

CHECKED BY

*A. Tanaka*

APPROVED BY

*M. Miwa*



Section  
A - A'

Section  
B - B'

Section  
C - C'

FIG. 1. ARRANGEMENT OF TEST SPECIMENS IN CAPSULE

Table 1.

Material		Capsule No.		Outer Dia. (mm)										Wall Thickness (mm)								Length (mm)	Weight (gr)
				(1)					(2)					Cross Mark Side				Specimen Mark Side					
				X-X'	Y-Y'	X-X'	Y-Y'	X-X'	Y-Y'	X-X'	Y-Y'	X-X'	Y-Y'	X	X'	Y	Y'	X	X'	Y	Y'		
														(1) (2) (3) (4) (5) ← 10 ← 15 ← 15 ← 15 ← 15 ← 10 → (mm)									
KO	K01	6.493	6.494	6.494	6.492	6.493	6.494	6.491	6.495	6.494	6.494	0.450	0.450	0.446	0.444	0.445	0.452	0.450	0.442	79.60	12.6818		
	K02	6.493	6.493	6.492	6.494	6.495	6.493	6.492	6.494	6.494	6.493	0.455	0.446	0.440	0.440	0.438	0.449	0.450	0.447	79.55	12.6656		
	K03	6.493	6.492	6.494	6.494	6.495	6.494	6.494	6.493	6.493	6.492	0.444	0.452	0.448	0.451	0.450	0.445	0.447	0.449	79.65	12.7042		
	K04	6.495	6.493	6.493	6.493	6.492	6.493	6.493	6.492	6.495	6.493	0.455	0.452	0.450	0.438	0.446	0.440	0.450	0.451	79.60	12.5877		
	K05	6.492	6.494	6.493	6.491	6.493	6.494	6.495	6.492	6.492	6.494	0.446	0.455	0.451	0.447	0.441	0.451	0.452	0.445	79.70	12.6557		
	K06	6.490	6.494	6.492	6.494	6.494	6.495	6.493	6.494	6.491	6.495	0.443	0.450	0.450	0.452	0.446	0.448	0.450	0.451	79.70	12.6358		
	K07	6.492	6.492	6.494	6.493	6.493	6.493	6.495	6.491	6.492	6.493	0.455	0.450	0.440	0.440	0.451	0.449	0.442	0.439	79.60	12.5137		
	K08	6.493	6.494	6.493	6.492	6.494	6.494	6.494	6.495	6.493	6.492	0.450	0.451	0.442	0.444	0.451	0.448	0.446	0.451	79.55	12.6208		
	K09	6.494	6.492	6.493	6.494	6.495	6.494	6.493	6.495	6.492	6.494	0.442	0.450	0.452	0.454	0.450	0.448	0.449	0.452	79.50	12.6130		
	K0A	6.492	6.495	6.490	6.494	6.492	6.493	6.494	6.491	6.493	6.492	0.440	0.440	0.448	0.450	0.452	0.450	0.441	0.439	79.55	12.6180		
	K0B	6.495	6.490	6.494	6.492	6.494	6.493	6.494	6.492	6.493	6.495	0.455	0.456	0.448	0.442	0.449	0.451	0.440	0.445	79.60	12.6298		
K1	K11	6.490	6.487	6.489	6.490	6.489	6.492	6.490	6.490	6.491	6.489	0.438	0.436	0.450	0.452	0.450	0.449	0.440	0.442	79.55	12.4934		
	K12	6.489	6.488	6.491	6.488	6.490	6.490	6.487	6.493	6.486	6.494	0.451	0.450	0.447	0.441	0.442	0.445	0.450	0.448	79.70	12.4510		
	K13	6.487	6.494	6.488	6.491	6.489	6.489	6.489	6.490	6.485	6.489	0.436	0.440	0.450	0.452	0.440	0.440	0.449	0.451	79.70	12.5450		
	K14	6.493	6.485	6.490	6.488	6.490	6.489	6.489	6.490	6.485	6.494	0.456	0.455	0.443	0.438	0.453	0.450	0.441	0.444	79.70	12.5110		
	K15	6.492	6.487	6.490	6.488	6.489	6.489	6.487	6.491	6.490	6.489	0.448	0.440	0.442	0.445	0.446	0.450	0.444	0.448	79.60	12.5054		
SO	S01	6.492	6.489	6.491	6.491	6.490	6.491	6.493	6.490	6.491	6.492	0.452	0.452	0.450	0.446	0.445	0.450	0.452	0.442	79.70	12.6565		
	S02	6.490	6.488	6.492	6.491	6.493	6.490	6.493	6.489	6.495	6.490	0.450	0.450	0.452	0.450	0.448	0.450	0.452	0.450	79.80	12.6020		
	S03	6.492	6.493	6.490	6.490	6.491	6.492	6.493	6.492	6.490	6.491	0.450	0.453	0.452	0.452	0.450	0.448	0.454	0.452	79.65	12.7002		
	S04	6.492	6.490	6.491	6.491	6.490	6.492	6.492	6.492	6.489	6.494	0.448	0.450	0.450	0.448	0.446	0.450	0.452	0.450	79.65	12.6762		
	S05	6.490	6.492	6.491	6.492	6.491	6.493	6.492	6.494	6.491	6.492	0.449	0.448	0.450	0.450	0.451	0.448	0.452	0.450	79.60	12.7036		
	S06	6.492	6.490	6.493	6.490	6.492	6.491	6.493	6.492	6.492	6.494	0.446	0.448	0.451	0.450	0.450	0.452	0.447	0.450	79.70	12.6612		
	S07	6.494	6.493	6.492	6.492	6.490	6.493	6.490	6.492	6.491	6.493	0.447	0.449	0.450	0.448	0.452	0.450	0.446	0.448	79.70	12.7106		
	S08	6.492	6.493	6.492	6.491	6.490	6.491	6.490	6.494	6.489	6.491	0.443	0.446	0.450	0.452	0.445	0.451	0.444	0.450	79.70	12.5674		
	S09	6.492	6.491	6.490	6.493	6.491	6.490	6.492	6.492	6.494	6.491	0.448	0.450	0.450	0.452	0.446	0.445	0.450	0.445	79.70	12.6546		
	S0A	6.490	6.491	6.491	6.491	6.491	6.492	6.494	6.491	6.494	6.489	0.442	0.440	0.450	0.448	0.441	0.445	0.451	0.448	79.75	12.6032		

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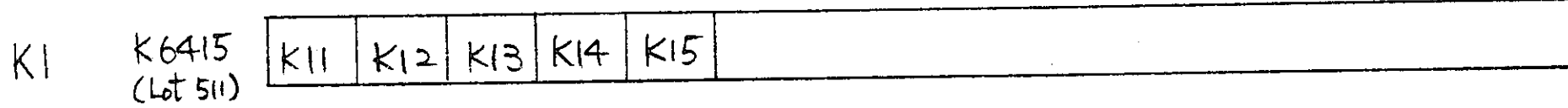
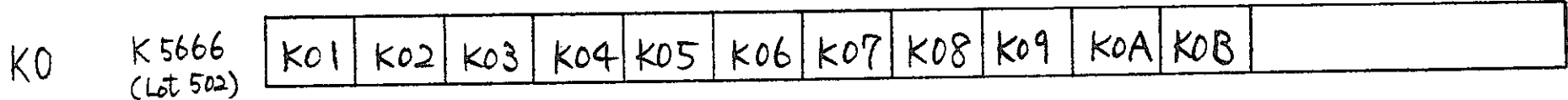
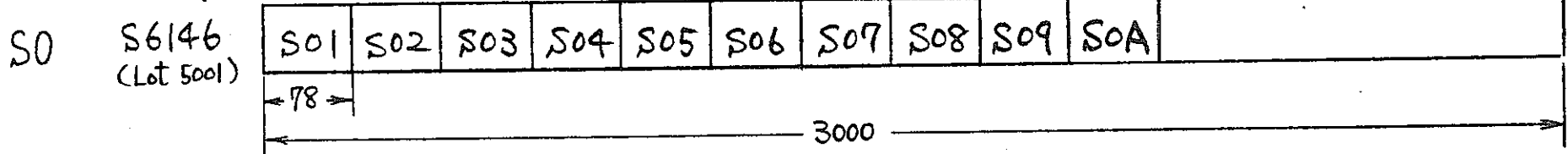
Fig. 2

Arrangement of Cladding Tubes and End Plug for Capsule.

Cladding Tube

Material Cladding No.

No. Side



End Plug

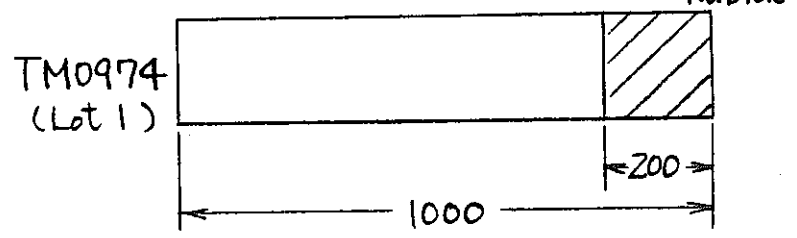


Table 2-1

Dimension and Weight of Specimens contained in Capsules.			Density Specimen No. Side					
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	L1	2.962	2.960	2.960	25.012	1.3807	8.02
		K1				43.59		
	TEM Foil	K2				43.58		
	①	L1				43.60		
		L2				43.58		
S01		K11				25.47		
		L11				25.48		
		C5-5				25.39		
		TEM Foil	C6-5			25.23		
		②	C7-5			25.52		
			A6-5			25.45		
			C3-5			25.07		
			C8-5			25.08		
			C9-5			25.17		
		Density	L2	2.964	2.960	2.958	25.012	1.3795
		K3				43.56		
	TEM Foil	K4				43.58		
	①	L3				43.56		
		L4				43.61		
S02		K12				25.22		
		L12				25.25		
			C5-4			25.22		
		TEM Foil	C6-4			25.26		
		②	C7-4			25.13		
			A6-4			25.26		
			C3-4			24.95		
			C8-4			25.01		
		C9-4			25.39			

Table 2-2

Dimension and Weight of Specimens contained in Capsules.			Density Specimen No. side					
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	L3	2.958	2.957	2.958	25.027	1.3763	8.01
		K5				43.62		
	TEM Foil	K6				43.63		
	①	L5				43.61		
		L6				43.61		
S03		K13				25.54		
		L13				25.51		
		C5-3				25.53		
		TEM Foil	C6-3			25.54		
		②	C7-3			25.47		
			A6-3			25.60		
			C3-3			24.97		
			C8-3			25.11		
			C9-3			25.16		
		Density	L4	2.964	2.956	2.958	25.022	1.3767
		K7				43.64		
	TEM Foil	K8				43.63		
	①	L7				43.58		
		L8				43.57		
S04		K14				25.14		
		L14				25.19		
			C5-2			25.13		
		TEM Foil	C6-2			25.15		
		②	C7-2			25.05		
			A6-2			25.15		
			C3-2			24.98		
			C8-2			25.08		
		C9-2			25.15			



Table 2-3

Dimension and Weight of Specimens contained in Capsules.						Density Specimen No. side		
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	L5	2,970	2,960	2,960	24,996	1,3780	8.00
		K9				43.63		
	TEM Foil	K10				43.65		
	①	L9				43.63		
		L10				43.59		
		K15				24,96		
S05		L15				25,02		
		C5-1				24,86		
	TEM Foil	C6-1				24,87		
	②	C7-1				24,80		
		A6-1				24,91		
		C3-1				25,05		
		C8-1				25,01		
		C9-1				25,14		
	Density	N1	2,965	2,960	2,958	25,004	1,3773	8.00
		M1				43.59		
	TEM Foil	M2				43.59		
	①	N1				43.59		
		N2				43.61		
		M11				25,27		
S06		N11				25,28		
		A9-5				25,44		
	TEM Foil	B4-5				25,39		
	②	C2-5				25,31		
		C1-5				25,26		
		D1-5				24,97		
		D2-5				25,20		
		D3-5				24,99		

Table 2-4

Dimension and Weight of Specimens contained in Capsules.			Density Specimen No. side			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	N2	2.957	2.960	2.960	25.008	1.3788	8.02
		M3				43.59		
	TEM Foil	M4				43.63		
	①	N3				43.61		
		N4				43.62		
S07		M12				25.49		
		N12				25.46		
		A9-4				25.40		
	TEM Foil	B9-4				25.33		
	②	C2-4				25.37		
		C1-4				25.46		
		D1-4				24.95		
		D4-4				25.03		
		D5-4				25.01		
		Density	N3	2.956	2.958	2.959	25.030	1.3778
		M5				43.60		
	TEM Foil	M6				43.59		
	①	N5				43.60		
		N6				43.62		
S08		M13				25.08		
		N13				25.02		
		A9-3				25.01		
	TEM Foil	B9-3				24.96		
	②	C2-3				25.10		
		C1-3				24.99		
		D1-3				24.96		
		D2-3				25.14		
		D3-3				25.09		

Table 2-5

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	N4	2.958	2.958	2.958	25.000	1.3770	8.02
		M7				43.59		
	TEM Foil	M8				43.60		
	①	N7				43.61		
		N8				43.60		
S09		M14				25.19		
		N14				25.15		
		A9-2				25.09		
	TEM Foil	B4-2				25.03		
	②	C2-2				25.00		
		C1-2				25.08		
		D3-2				25.10		
		D4-2				25.01		
		D5-2				25.00		
		Density	N5	2.960	2.956	2.956	25.005	1.3676
		M9				43.58		
	TEM Foil	M10				43.58		
	①	N9				43.65		
		N10				43.62		
S0A		M15				25.08		
		N15				25.05		
		A9-1				24.96		
	TEM Foil	B4-1				25.00		
	②	C2-1				25.03		
		C1-1				25.11		
		D1-1				24.95		
		D2-1				25.18		
		D3-1				24.93		

Table 2-6

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	E1	2,960	2,956	2,956	24.990	1.3754	8.02
		E1				43.61		
	TEM Foil	E2				43.60		
	①	G1				43.60		
		G2				43.62		
K01		E11				25.20		
		G11				25.18		
		A1-5				25.02		
		TEM Foil	A2-5			25.17		
		②	A3-5			25.21		
			A4-5			25.18		
			A7-5			24.63		
			B1-12			25.04		
			B2-5			25.09		
		Density	E2	2,960	2,957	2,959	25.020	1.3792
		E3				43.60		
	TEM Foil	E4				43.61		
	①	G3				43.61		
		G4				43.61		
K02		E12				25.20		
		G12				25.22		
		A1-4				25.17		
		TEM Foil	A2-4			25.19		
		②	A3-4			25.18		
			A4-4			25.22		
			A7-4			24.58		
			B1-11			25.17		
		B2-4			25.12			

Table 2-7

Dimension and Weight of Specimens contained in Capsules.						Density Specimen No. Side		
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	E3	2.956	2.956	2.958	24.994	1.3768	8.03
		E5				43.61		
	TEM Foil	E6				43.62		
	①	G5				43.61		
		G6				43.59		
K03		E13				25.13		
		G13				25.13		
		A1-3				25.02		
	TEM Foil	A2-3				25.06		
	②	A3-3				25.02		
		A4-3				25.04		
		A7-3				24.60		
		B1-10				25.13		
		B2-3				25.09		
		Density	E4	2.957	2.957	2.958	24.980	1.3760
		E7				43.63		
	TEM Foil	E8				43.62		
	①	G7				43.59		
		G8				43.61		
K04		E14				25.15		
		G14				25.16		
		A1-2				25.07		
	TEM Foil	A2-2				25.06		
	②	A3-2				25.08		
		A4-2				25.00		
		A7-2				24.59		
		B1-9				25.16		
	B2-2				25.13			

Table 2-8

Dimension and Weight of Specimens contained in Capsules.		Density Specimen No. side			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )	
		(1)	(2)	(3)				
K05	Density	E5	2,960	2,956	2,956	24.970	1.3748	8.02
	TEM Foil ①	E9				43.61		
		E10				43.61		
		G9				43.61		
		G10				43.60		
	TEM Foil ②	E15				25.01		
		G15				25.03		
		A1-1				24.86		
		A2-1				24.95		
		A3-1				24.86		
		A4-1				24.90		
		A7-1				24.68		
		B1-8				25.17		
	B2-1				25.09			
	K06	Density	ES1	2,960	2,960	2,960	25.020	1.3806
TEM Foil ①		ES1				43.62		
		ES2				43.64		
		GS1				43.60		
		GS2				43.61		
TEM Foil ②		ES3				24.95		
		GS3				25.09		
		A1-16				25.01		
		A2-16				25.01		
		A3-16				25.06		
		A4-16				25.02		
		A5-18				25.19		
	A6-18				24.96			
A8-18				25.09				

Table 2-9

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. Side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	GS1	2.956	2.950	2.950	25.027	1.3724	8.02
		HS1				43.63		
	TEM Foil	HS2				43.60		
	①	IS1				43.59		
		IS2				43.59		
K07		HS3				25.05		
		IS3				25.06		
		A5-16				24.96		
	TEM Foil	A8-16				24.95		
	②	B6-16				24.96		
		C4-16				24.83		
		B4-29				25.03		
		C5-18				25.24		
		C6-18				24.91		
		Density	LS1	2.961	2.963	2.963	24.998	1.3800
		KS1				43.60		
	TEM Foil	KS2				43.59		
	①	LS1				43.58		
		LS2				43.56		
K08		KS3				25.26		
		LS3				25.23		
		C5-16				25.28		
	TEM Foil	C6-16				25.17		
	②	C7-16				25.33		
		A6-16				25.25		
		A1-32				24.56		
		A2-19				25.06		
		A3-19				25.07		

Table 2-10

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. Side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	NS1	2.958	2.959	2.960	25.009	1.3780	8.02
		MS1				43.59		
	TEM Foil	MS2				43.59		
	①	NS1				43.60		
		NS2				43.61		
		MS3				25.19		
K09		NS3				25.25		
		A9-16				25.21		
	TEM Foil	B4-16				25.16		
	②	C2-16				25.21		
		C1-11				25.19		
		A4-19				25.15		
		A5-19				25.19		
		A8-19				25.09		
	Density	FS1	2.957	2.955	2.955	25.021	1.3760	8.02
		FS1				43.60		
	TEM Foil	FS2				43.63		
	①	FS3				43.62		
		FS4				43.61		
		FS5				24.87		
K0A		FS6				24.89		
		A1-17				24.93		
	TEM Foil	A2-17				24.94		
	②	A3-17				24.89		
		A4-17				24.97		
		B6-19				25.02		
		C4-19				25.01		
		C5-19				25.11		



Table 2-11

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. Side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	F1	2.958	2.958	2.957	25.014	1.3790	8.03
		F1				43.58		
	TEM Foil	F2				43.58		
	①	F3				43.60		
		F4				43.60		
		F5				24.99		
KOB		F6				24.99		
		A5-17				24.98		
	TEM Foil	A8-17				25.05		
	②	B6-17				24.87		
		C4-17				25.02		
		A1-33				24.67		
		A2-20				25.10		
		A3-20				25.06		
	Density	G1	2.942	2.940	2.941	25.058	1.3630	8.01
		H11				43.60		
	TEM Foil	H2				43.60		
	①	I1				43.61		
		I2				43.62		
		H11				25.29		
K11		I11				25.28		
		A5-5				25.19		
	TEM Foil	A8-5				25.22		
	②	B6-5				25.13		
		C4-5				25.28		
		B3-5				24.98		
		B5-5				24.95		
		B7-5				25.10		

Table 2-12

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	G2	2,954	2,951	2,951	25,030	1,3728	8.02
		H3				43.60		
	TEM Foil	H4				43.61		
	①	I3				43.59		
		I4				43.59		
K12		H12				25.29		
		I12				25.28		
		A5-4				25.33		
	TEM Foil	A8-4				25.37		
	②	B6-4				25.42		
		C4-4				25.11		
		B3-4				24.96		
		B5-4				25.00		
		B7-4				25.04		
		Density	G3	2,946	2,950	2,949	25,016	1,3712
		H5				43.60		
	TEM Foil	H6				43.60		
	①	I5				43.57		
		I6				43.58		
K13		H13				24.89		
		I13				24.96		
		A5-3				25.00		
	TEM Foil	A8-3				24.90		
	②	B6-3				25.01		
		C4-3				24.75		
		B3-3				25.00		
		B5-3				25.07		
		B7-3				25.03		

Table 2-13

Dimension and Weight of Specimens contained in Capsules.							Density Specimen No. side	
Capsule No.	Test Specimens	Specimen No.	Outer Dia. (mm)			Length (mm)	Weight (gr)	Density (g/cm <sup>3</sup> )
			(1)	(2)	(3)			
	Density	G4	2.954	2.952	2.952	25.020	1.3728	8.01
		H7				43.60		
	TEM Foil	H8				43.60		
	①	I7				43.59		
		I8				43.59		
K14		H14				24.84		
		I14				24.84		
		A5-2				25.00		
	TEM Foil	A8-2				24.85		
	②	B6-2				24.90		
		C4-2				24.84		
		B3-2				25.02		
		B5-2				25.09		
		B7-2				25.04		
	Density	G5	2.954	2.952	2.952	25.038	1.3752	8.03
		H9				43.62		
	TEM Foil	H10				43.58		
	①	I9				43.59		
		I10				43.59		
K15		H15				24.80		
		I15				24.75		
		A5-1				24.85		
	TEM Foil	A8-1				24.85		
	②	B6-1				24.86		
		C4-1				24.70		
		B3-1				25.01		
		B5-1				25.06		
		B7-1				25.04		

Table 3. Helium Leak Test Result of Capsules.

P.N.C.

Technical Service Division

Fuel and Material Assessment section

Specimen No.	leak rate of Standard specimen $4.3 \times 10^{-9}$ atm cc/sec $3.26 \times 10^{-8}$ atm cc/sec		F o.p.	F B.G	L (atm cc/sec)	Reference
	ST <sub>o.p.</sub> - ST <sub>B.G.</sub>	ST <sub>o.p.</sub> - ST <sub>B.G.</sub>				
KOA, KOB } K01 ~ K09 } K11 ~ K15 } total SOA } S01 ~ S09 } 26	38 x 1 - 20 x 1	32 x 5 - 18 x 1	20 x 1	20 x 1	0	(No leak)

\* Helium gas (1 atm) is packed in these fuel pins.

$$L = \frac{ST}{ST_{o.p.} - ST_{B.G.}} \times (F_{o.p.} - F_{B.G.})$$

L : leak rate of test piece (atm cc/sec)

ST : leak rate of Standard Specimen (atm cc/sec)

ST<sub>o.p.</sub> : the increase in out put signal of detector

(When standard specimens attached to detector)

ST<sub>B.G.</sub> : Back Ground (After Standard Specimens are measured)

F<sub>o.p.</sub> : the increase in out put signal of detector

(When test piece are placed in an enclosure)

F<sub>B.G.</sub> : Back Ground (After test piece are measured).

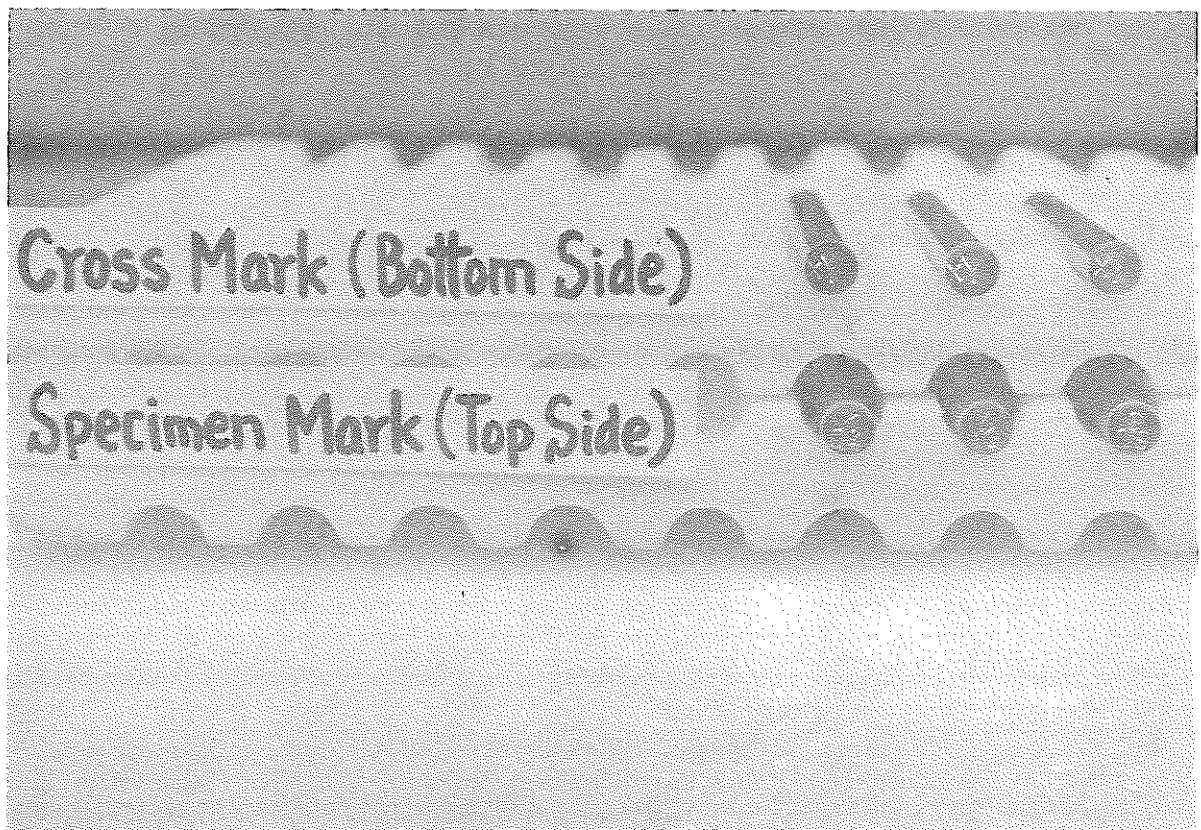


Photo. 1 Marking of Capsule

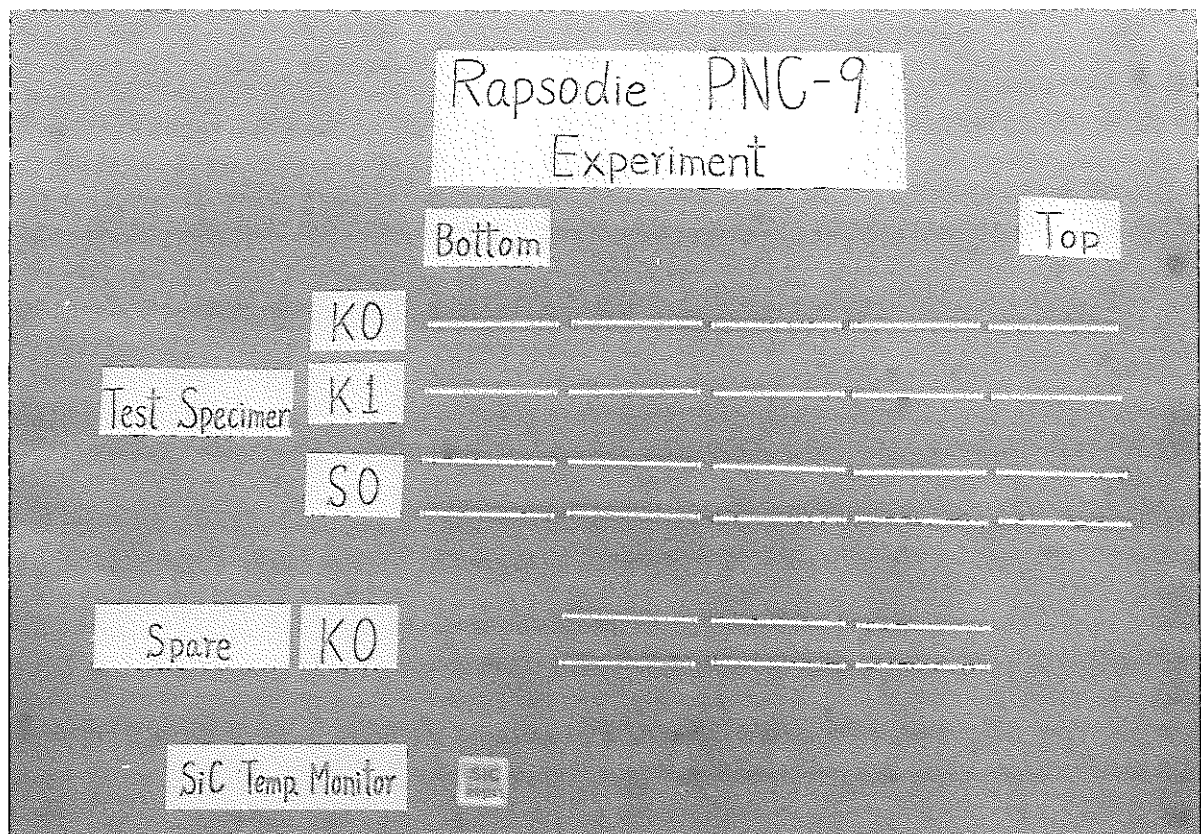


Photo. 2 Arrangement of Capsules in the Rig.

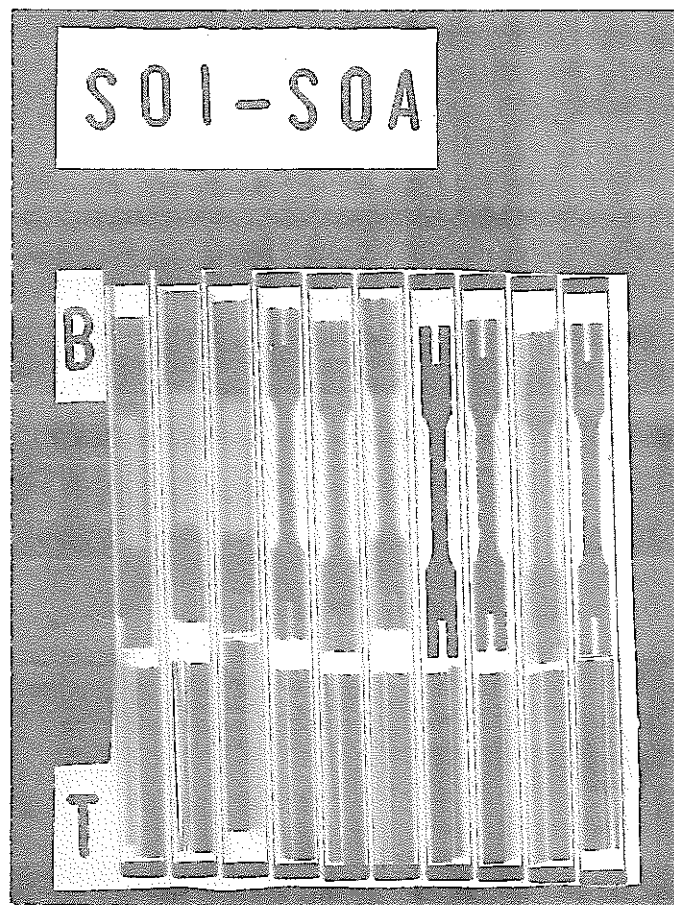
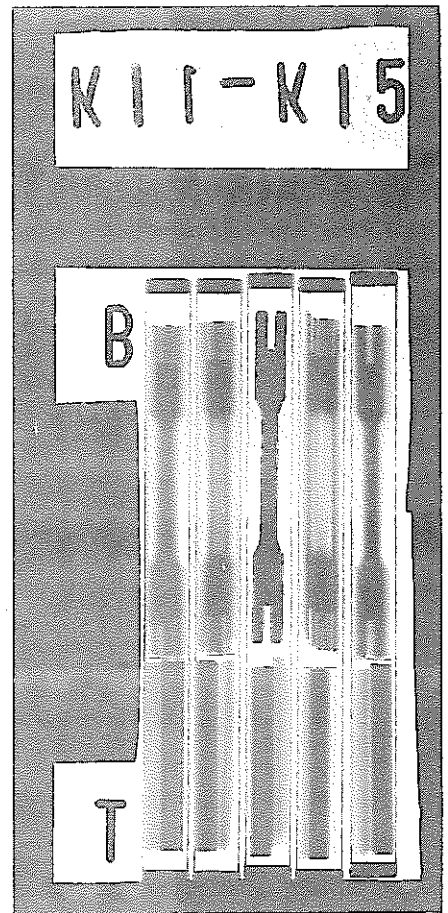
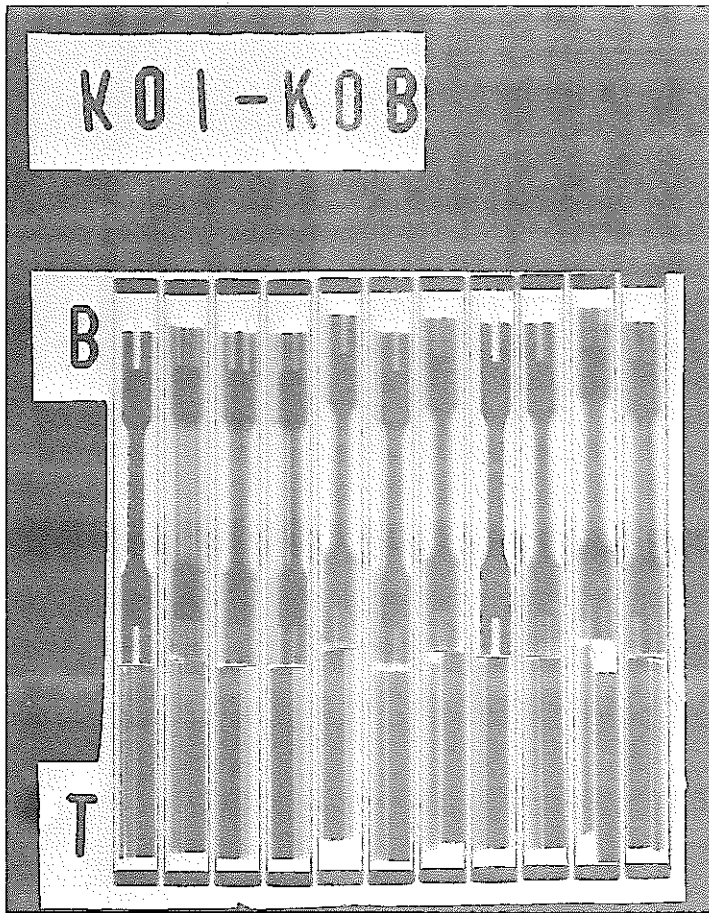


Photo. 3 X-ray Photograph of Capsules.

付録-③

RÉPUBLIQUE FRANÇAISE

COMMISSARIAT A L'ÉNERGIE ATOMIQUE  
CENTRE D'ÉTUDES NUCLÉAIRES DE CADARACHE  
DEPARTEMENT D'EXPLOITATION DES REACTEURS

ADRESSE

BOITE POSTALE N° 1  
13 - SAINT-PAUL-LEZ-DURANCE

TÉLÉPHONE

28-90-00 CADARACHE

Service d'Exploitation et  
d'Expérimentation  
de RAPSODIE

M. Y. ISHIDA  
FBR Project  
PNC  
1 CHOME AKASAKA  
MINATO KU  
TOKYO  
JAPAN

LE 12 mai 1978

SEER/SIER -78/229  
Cit 3076 - FM/RM

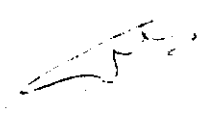
OBJECT : PNC 9 EXPERIMENT

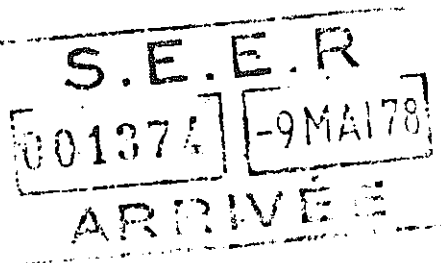
We have the pleasure to send you the following documents :

- 6 copies of technical notice GET 78/086 giving the metrology (length, diameter and weight measurements) of the capsules.
- A pocket containing the negatives of the 6 photographs corresponding to figures 1, 2 and 3 of the preceding notice.

Yours sincerely,

Le Chef de la S.I.E.R.

  
J.P. PAGES



## CHARACTERISTICS of SPECIMEN CONTAINERS

"P.N.C.9"

## 1. METROLOGY :

## 1.1 - Length measurements.

These have been made by means of a "PALMER" having a range of 75 to 100mm with a precision of 1/100th of a mm.

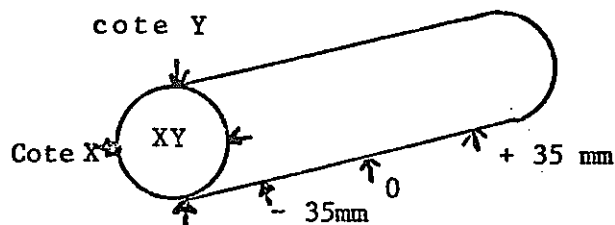
Results are given in Table I, in several cases, non parallelism of end surfaces was observed.

In this case the indicated value is the minimum one.

## 1.2 - Diameter measurements.

The diameters have been measured by means of a PALMER having a capacity of 0 to 25mm with a precision of 1/100th of a mm.

Following schematic shows the measurements which were made.



2 measurements made in perpendicular directions xy, were repeated in 3 positions (- 35mm, 0, + 35mm). Table II shows the list of the obtained values.

## 2. WEIGHT MEASUREMENTS :

They were made on a "METTLER" precision balance with a milligram precision. The weights observed are indicated on Table III.

## 3. EXTERNAL ASPECT :

Photographs of each series of specimen were made. Figures 1, 2 and 3 give the aspect before irradiation of the containers.

A set of negatives is also delivered separately.



TABLE I

LENGHT of SAMPLES.

Markings		mm	Observations
KO	0A	79,64	
	0B	79,66	
	01	79,68	
	02	79,64	
	03	79,71	(mini) face non//
	04	79,64	face non//
	05	79,73	
	06	79,76	face non//
	07	79,69	
	08	79,62	
K1	09	79,50	
	11	79,67	
	12	79,74	
	13	79,75	
	14	79,78	
SO	15	79,63	
	0A	79,77	
	01	79,78	
	02	79,82	
	03	79,73	
	04	79,70	
	05	79,75	
	06	79,76	Face non//
	07	79,76	
	08	79,75	
09	79,74		

T A B L E II

DIAMETER of SAMPLES

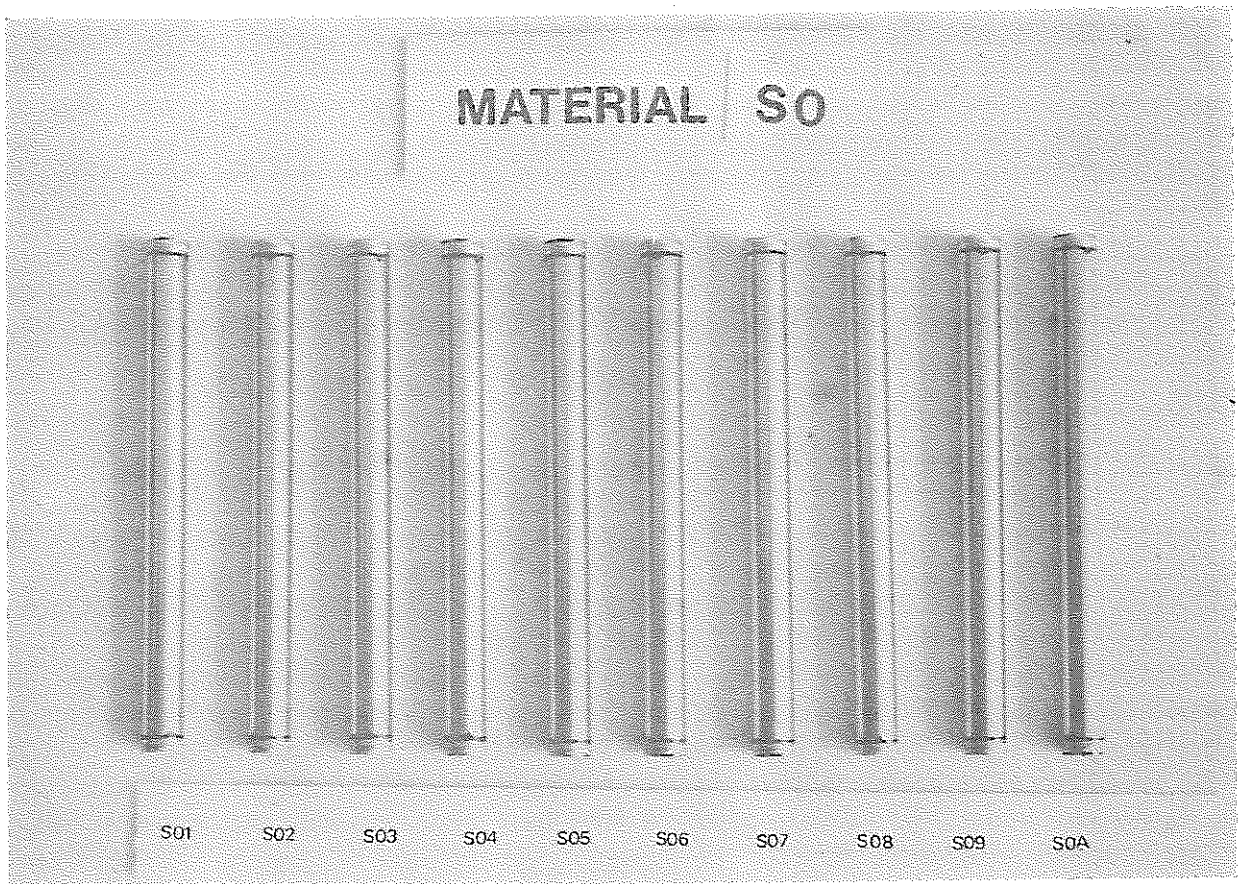
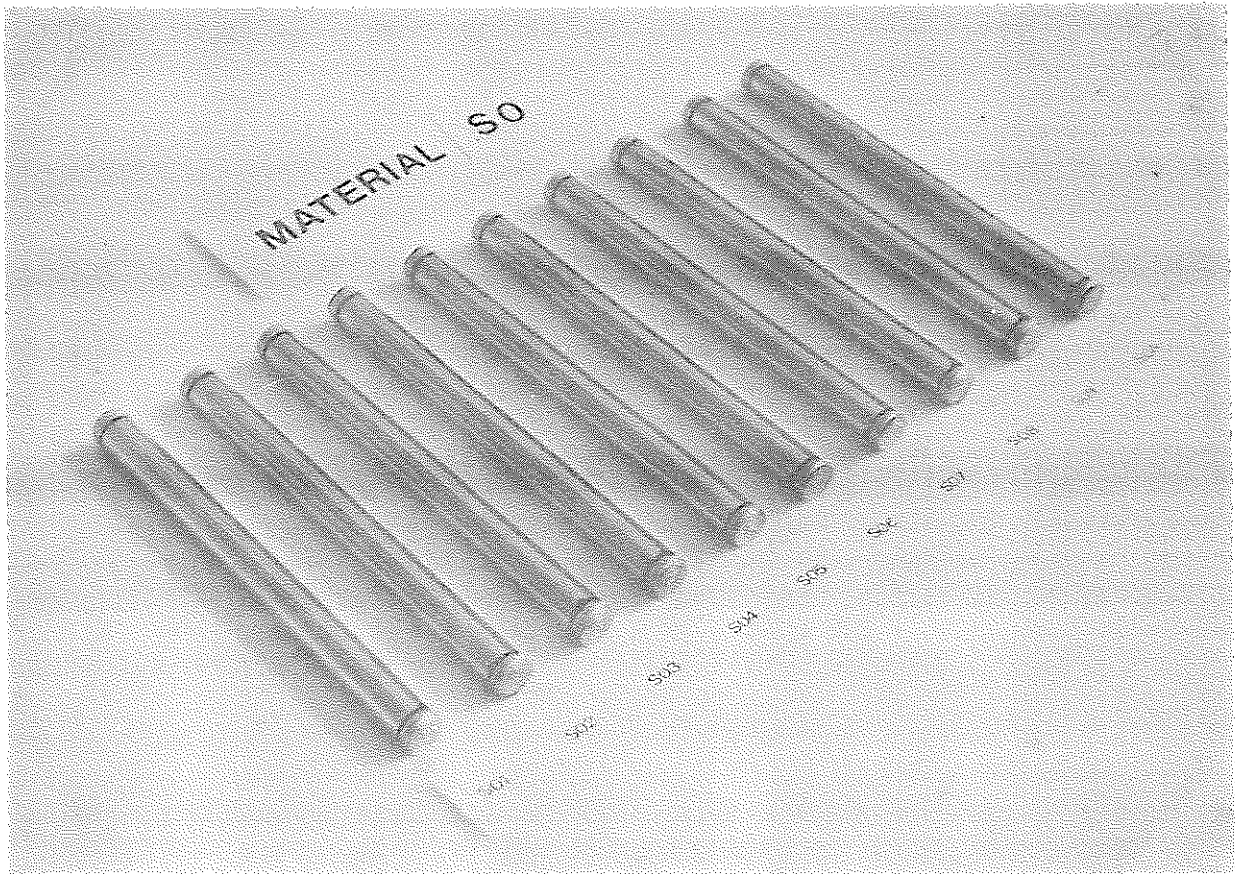
Markings		Dimensions (mm)			
		- 35	0	+ 35	
KO	OA	x y	6.495	6.493	6.495
			6.492	6.493	6.496
	OB		6.493	6.493	6.490
			6.495	6.493	6.496
	01		6.498	6.494	6.498
			6.491	6.493	6.491
	02		6.492	6.492	6.491
			6.495	6.493	6.495
	03		6.489	6.494	6.496
			6.496	6.494	6.492
	04		6.491	6.492	6.492
			6.495	6.493	6.495
	05		6.495	6.494	6.491
			6.492	6.492	6.496
	06		6.495	6.495	6.495
			6.494	6.493	6.491
	07		6.493	6.493	6.491
			6.493	6.491	6.497
	08		6.491	6.494	6.491
			6.494	6.493	6.497
	09		6.494	6.494	6.493
			6.493	6.494	6.495

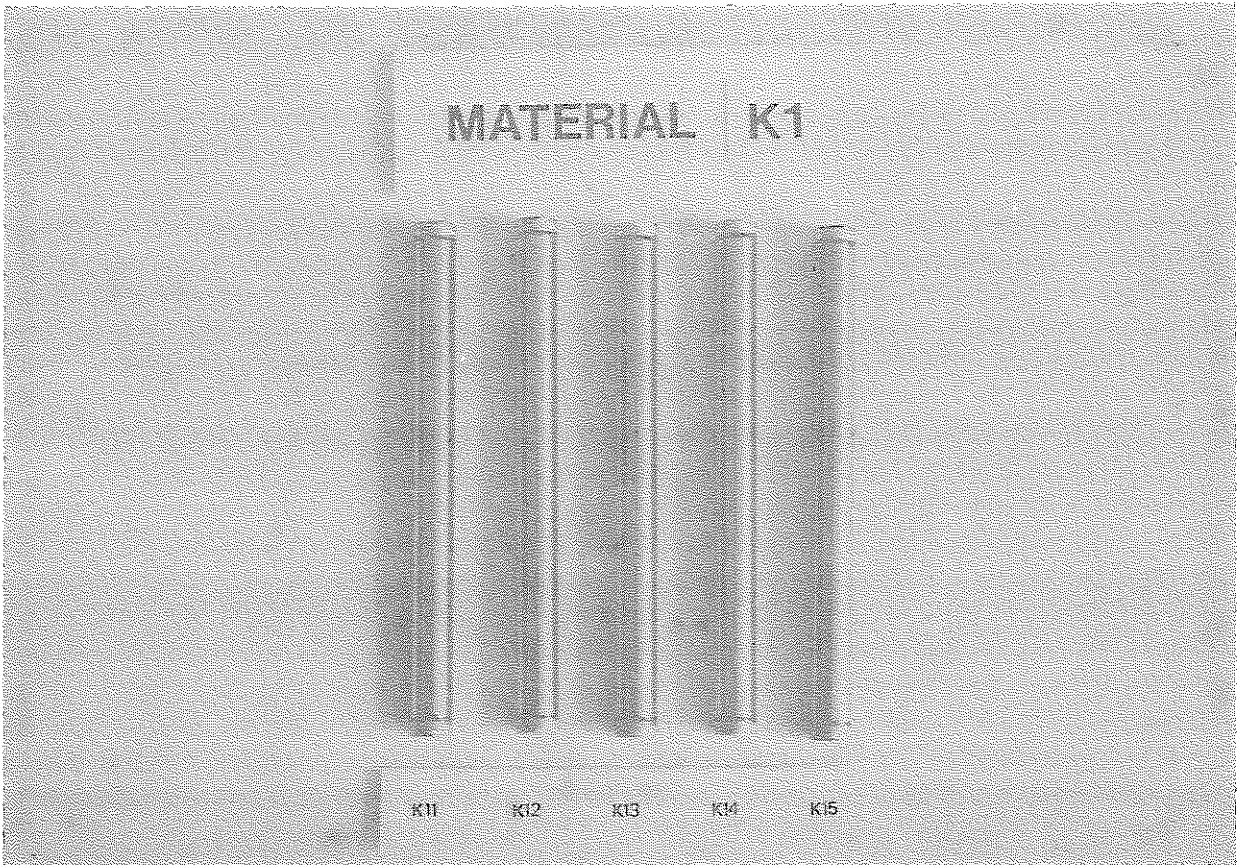
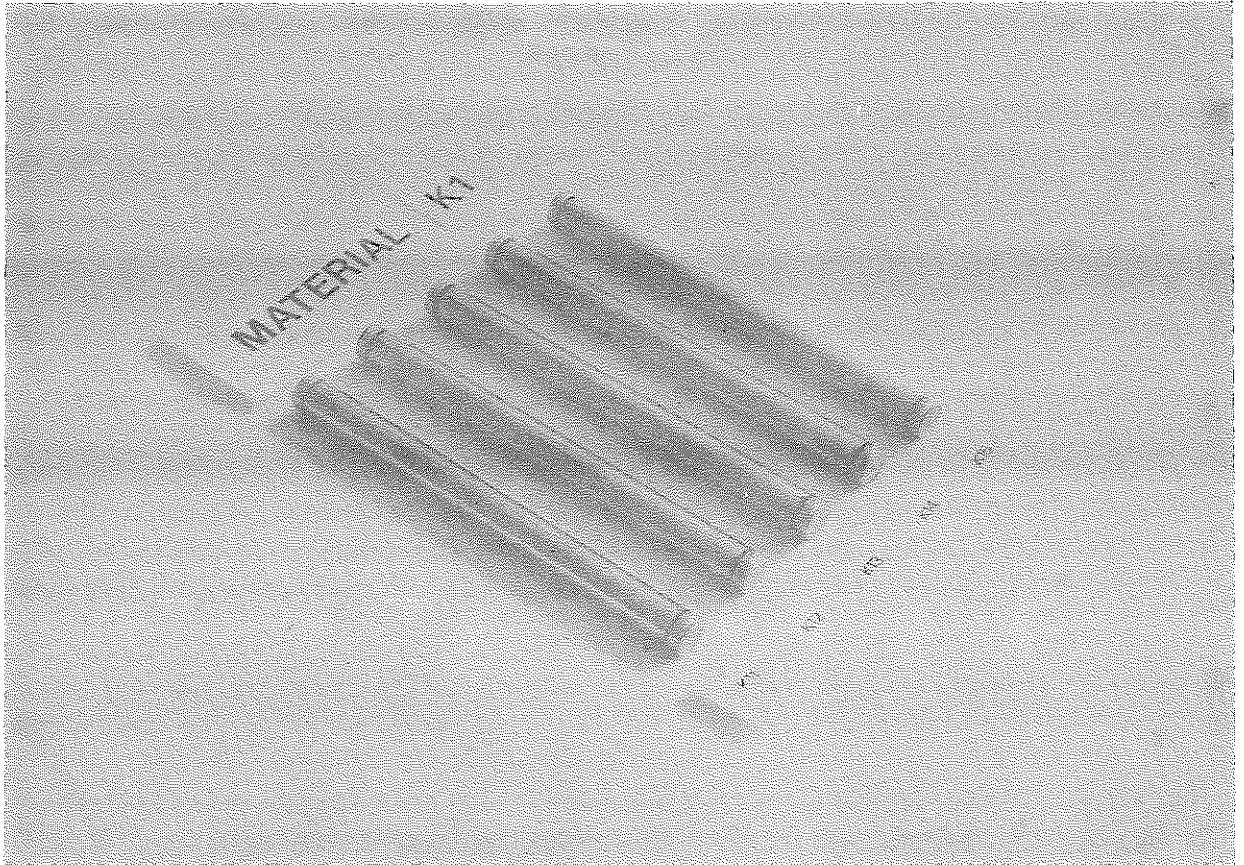
TABLE II (continued)

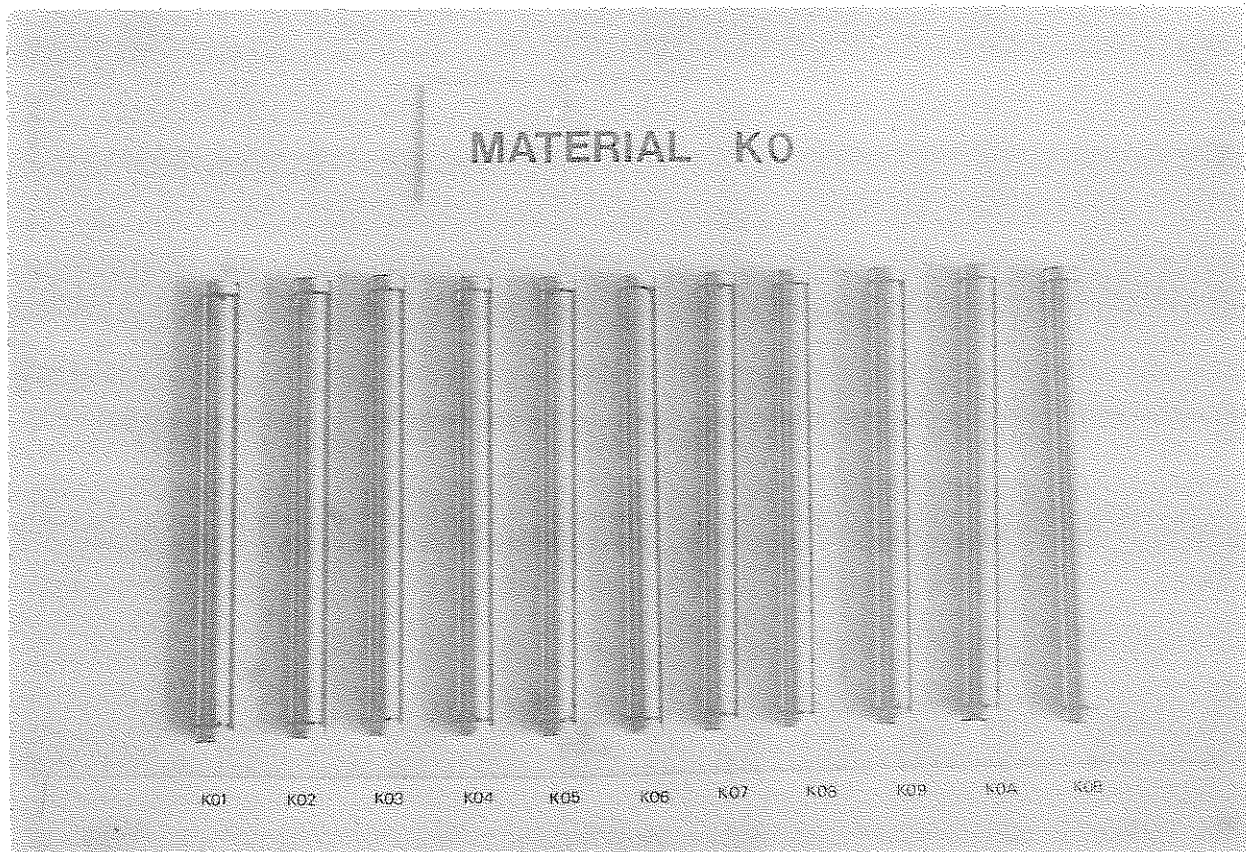
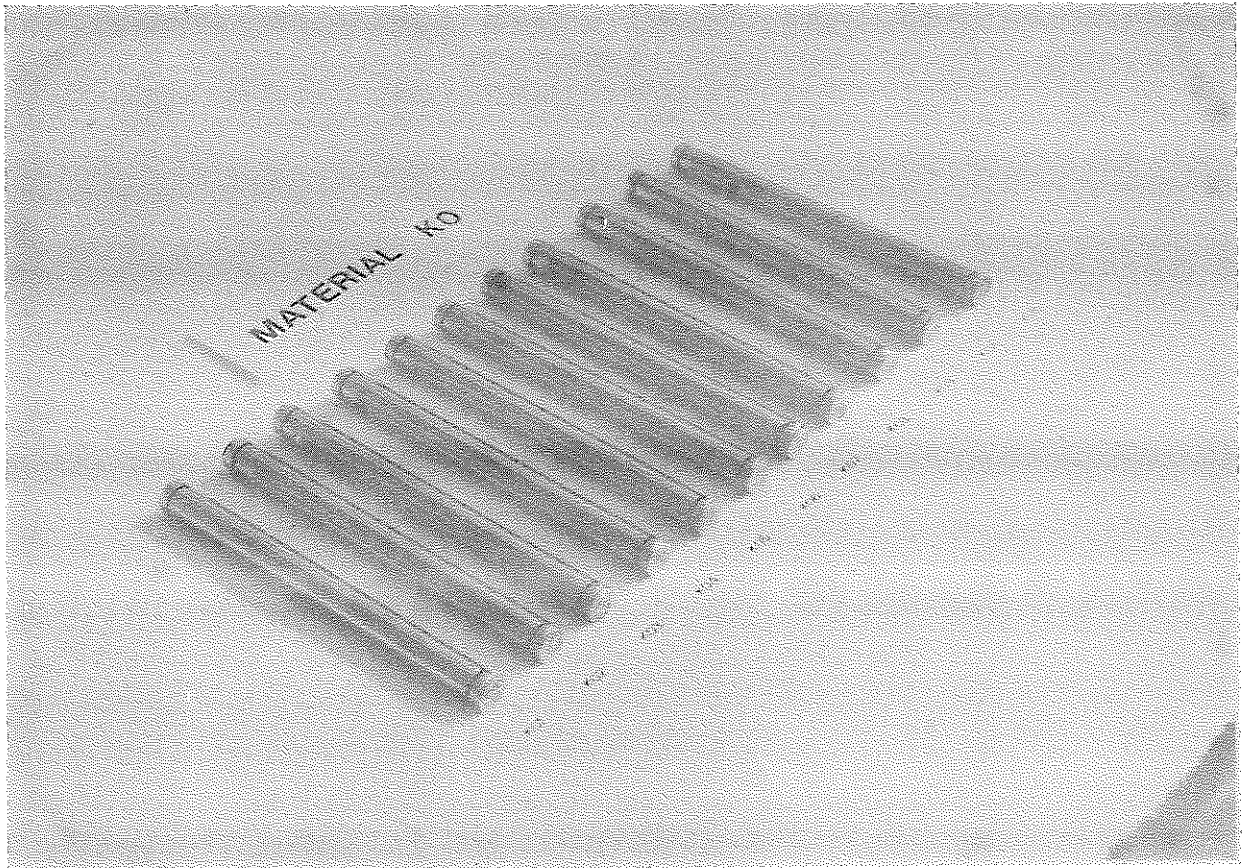
Markings			Dimensions (mm)			
			- 35	0	+ 35	
K1	11	x	6.486	6.491	6.493	
		y	6.491	6.488	6.488	
	12		6.487	6.489	6.493	
			6.494	6.490	6.486	
	13		6.493	6.489	6.492	
			6.488	6.490	6.485	
	14		6.485	6.489	6.493	
			6.493	6.490	6.485	
	15		6.488	6.488	6.488	
			6.491	6.489	6.491	
	S0	0A	x	6.496	6.491	6.493
			y	6.490	6.492	6.495
		01		6.490	6.491	6.491
				6.494	6.493	6.492
		02		6.487	6.492	6.493
			6.491	6.490	6.492	
03			6.491	6.490	6.490	
			6.491	6.491	6.493	
04			6.495	6.491	6.494	
			6.490	6.491	6.490	
05		6.493	6.492	6.492		
		6.491	6.490	6.491		
06		6.491	6.491	6.491		
		6.492	6.490	6.492		
07		6.494	6.492	6.494		
		6.492	6.492	6.494		
08		6.494	6.491	6.492		
		6.490	6.491	6.491		
09		6.492	6.493	6.494		
		6.491	6.493	6.492		

T A B L E III

<i>Markings</i>		<i>Weight (grammes)</i>
K0	0A	12.609
	0B	12.620
	01	12.6672
	02	12.657
	03	12.695
	04	12.578
	05	12.647
	06	12.626
	07	12.5045
	08	12.6115
K1	09	12.604
	11	12.485
	12	12.4415
	13	12.536
	14	12.502
S0	15	12.496
	0A	12.595
	01	12.6475
	02	12.593
	03	12.691
	04	12.667
	05	12.694
	06	12.652
	07	12.702
	08	12.558
	09	12.645







付録-④

50.10.29

契263譯子

AGREEMENT FOR PNC 9 RIG EXPERIMENT

CONTRACT VEN 0701

-----



Between

The POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION having their principal office at 9.13 1 CHOME, AKASAKA MINATO-KU, TOKYO (JAPAN) hereinafter called PNC.

of the one part,

And

COMMISSARIAT A L'ENERGIE ATOMIQUE (hereinafter called CEA) having their principal office at PARIS 15e, 29-33 rue de la Fédération FRANCE

of the other part,

IT IS HEREBY AGREED AS FOLLOWS:

## Article 1 UNDERTAKING

This contract has for object to irradiate in the RAPSODIE Reactor samples mounted in a rig (PNC IX) (tubes, plates and tensile specimens...), and to define between PNC and C.E.A. all the necessary works before, during and after the irradiation (calculations, tests, inspections, irradiation conditions, examinations).

## Article 2 DOCUMENTS, MATERIALS AND SERVICES PROVIDED BY PNC

- 2.1 PNC shall write a file of specifications which contains all the informations and calculation data listed in appendix I. This file shall be approved by C.E.A. who give their remarks.
- 2.2 PNC shall supply the samples and Sic monitors as listed in appendix II.
- 2.3 PNC shall supply the contro documents of samples manufacturing as listed in appendix III. PNC shall send to C.E.A. six copies of the English translation of these documents.
- 2.4 All these materials shall be sent to C.E.A. in accordance with the time schedule specified in appendix VIII, Centre d'Etudes Nucléaires de CADARACHE, Département des Réacteurs à Neutrons Rapides (A l'attention de M. BEL - Bâtiment 208) B.P. n° 1 - 13115 SAINT-PAUL-LEZ-DURANCE-FRANCE)
- 2.5 PNC shall arrange at their own expenses the transportation of the supplies from JAPAN to FRANCE and shall issue all the necessary orders for this service. PNC shall be responsible for the compliance with the relevant transport regulations and code of practice, and for obtaining, prior to the actual movements the requisite certification or other approval

from the competent authorities. PNC shall provide suitable containers for transportation of these materials.

### Article 3 SERVICES AND SUPPLIES PROVIDED BY C.E.A.

#### 3.1 Before irradiation:

3.1.1 C.E.A. shall examine the PNC file of specifications as provided in article 2.1.

3.1.2 C.E.A. shall make the calculations and drawings of rig according to PNC specifications as provided in article 2.1. These drawings shall be sent to PNC for agreement. After this approval they shall be the official drawings and the only one to be used for manufacturing.

3.1.3 C.E.A. shall fabricate two rigs for irradiation.

3.1.4 C.E.A. shall carry out in their laboratories all the examinations and in appendix V Paragraph 1.

3.1.5 C.E.A. shall conduct in their workshop the assembling of the two rigs.

#### 3.2 Irradiation:

After the satisfactory results of the examinations, inspections and tests provided, C.E.A. shall make the decision concerning the initiation of irradiation test in the RAP-SODIE Reactor. In this case, C.E.A. shall conduct the loading of the rig in the adequate position chosen by mutual agreement in accordance with the time schedule provided in appendix VIII. C.E.A. shall make best possible efforts to reach the irradiation conditions as agreed and described in appendix IV.

The rig shall stay in the reactor for whole period of irradiation campaigns, according to the program in anticipated nominal starting and finishing dates of forthcoming schedule

reactor campaigns and they shall inform PNC as soon as possible if a major change in the dates so advised appears likely to be necessary.

3.3 Intermediate examination :

C.E.A. shall perform one intermediate examination as provided in appendix IV and as described in appendix V paragraph II.

3.4 Final examination :

C.E.A. shall perform the final examination as provided in appendix IV and as described in appendix V paragraph III.

3.5 Reports :

C.E.A. shall supply to PNC all the reports provided in appendix VI. These reports shall be issued in six copies in English translation.

3.6 Return of remnants :

3.6.1 After irradiation C.E.A. shall prepare for the return of all remnants of parts supplied by PNC (Samples and SIC). C.E.A. shall store these remnants free of charges for four months since CEA shall inform PNC the dates when the remnants are ready for return. The storage by C.E.A. shall be free of charge during the four months following the advice date. Thereafter C.E.A. shall ask PNC to pay the storage charges at the rate of 500 F.F./day. C.E.A. shall inform PNC three months in advance when the remnants will be ready for return.

3.6.2 PNC and C.E.A. shall each appoint a representative who together shall be responsible for the coordination of transport arrangements.

3.6.3 All these remnants shall be sent to JAPAN at the following address :

PNC Laboratories  
Oarai Engineering Center  
Power Reactor and Nuclear Fuel Development Corporation  
Oarai, Ibaraki, Japan

Article 4 PNC's REPRESENTATIVES

- 4.1 PNC shall have the right to send two representatives as observers in CEA's facilities to be present during the services specified in Article 3.
- 4.2 The length of stays or visits of the representatives shall be limited to 10 men-days.
- 4.3 C.E.A. shall provide the representatives with the necessary services during their stays office and usual furniture, usual office equipments and stationary, telephone (except long distance calls) and cafeterias, medical or housing assistance and so on.
- 4.4 During their stay in CEA's facilities, the representatives shall observe the safety and disciplinary rules in force in CEA's facilities. In particular, to enter some of the facilities, they will be asked to observe the instructions given from CEA's responsible authority.

Article 5 DELAY OR CANCELLATION OF THE EXPERIMENT

- 5.1 C.E.A. reserve the right to delay, to cancel or to terminate the irradiation in the Rapsodie Reactor at any time for safety reasons.
- 5.2 PNC shall have the right to cancel the irradiation experiment in case of the following reasons:
- 5.2.1 If C.E.A. estimate that the start of the irradiation will be delayed by six months or more from the tentative schedule specified in appendix VIII.
- 5.2.2 If C.E.A. estimate that the completion of the irradiation will be delayed by six months or more from the

tentative schedule specified in appendix VIII.

5.3 If the irradiation conditions, as specified in appendix IV, cannot be reached, PNC and CEA shall decide, by mutual agreement, cancellation or continuation of the irradiation.

In any case, Article 6 shall be applied.

5.4 In case when the situation as described in 5.2 and 5.3 arise, C.E.A. shall promptly notify PNC by registered mail of these situations. PNC shall, within thirty days after receipt of these notifications from C.E.A., notify C.E.A. of the decision as to continuation or cancellation of the irradiation.

5.5 In the event the irradiation is cancelled or terminated due to the reasons as described in 5.1, 5.2 and 5.3 above, C.E.A. shall reimburse PNC the amount received by the date of receipt of the letter of cancellation, less costs incurred prior to the receipt of the said notification.

5.6 In the event that PNC and C.E.A. agree to conduct the irradiation in spite of the reasons described in 5.2 and 5.3, the irradiation tentative schedule as specified in Appendix VIII shall be revised by mutual agreement.

Article 6 PRICES

6.1 PNC shall pay for the supplies and services provided in the article 3.1.

... PNC file examination and all works necessary to bring the irradiation to a successful issue (article 3.1.1 and 3.1.2).

.....	35,500 FF
..... Fabrication of two rigs	... 46,000 FF
TOTAL PRICE	..... 81,500 FF

5

6.2 PNC shall pay for the PNC IX irradiation as provided in article 3.2 for one equivalent full power day (EFPD) in a type 03-02 position ..... 5,750 FF/EFPD

6.3 PNC shall pay for one intermediate examination of PNC IX rig as provided in the article 3.3 the total lump sum of 152,000 FF.

6.4 PNC shall pay for the final examination of PNC IX rig as provided in article 3.4 the total lump sum of 107,000 FF.

6.5 The prices as provided in the Articles 6.1, 6.2, 6.3 and 6.4 are December 1974 prices; they will be steady and non revisable up to December 1975. After this date, they will be actualised by applying of the following escalation clause:

$$P = P_o \left( 0.20 + 0.20 \frac{PSdA}{PSdA_o} + 0.15 \frac{T}{T_o} + 0.45 \frac{S}{S_o} \right)$$

in which

P = Actualised price;

P<sub>o</sub> = Price as provided in the Articles 6.1, 6.2, 6.3 or 6.4;

PSdA<sub>o</sub> = December 1974 miscellaneous products and services index;

PSdA = Average value of the same index for the period of executing of the supplies or services provided;

T<sub>o</sub> = December 1974 stainless steel sheet index;

T = Average value of the same index for the period of executing of the supplies or services provided;

S<sub>o</sub> = December 1974 salary index;

S = Average value of the same index for the period of executing of the supplies or services provided.

All the indexes referred above are published in the monthly french magazine "BULLETIN MENSUEL DE STATISTIQUE" (I.N.S.E.E. - 29, Quai Branly - 75700 PARIS)

or in the periodical "BULLETIN OFFICIEL DES SERVICES DES PRIX" (26, rue Desaix 75732 PARIS CEDEX 15).

The revision of prices shall be calculated with the escalation formula provided above at the same time when the invoices for the services carried out are established. PNC shall be required to make the payment for the escalation charges after all payments are completed. However total sum of the escalation charges shall not exceed the sum of 439,885 FF.

#### Article 7 . PAYMENT

7.1 The prices as provided in the article 6.2 shall be paid by PNC as specified in appendix VII.

7.2 C.E.A. shall, within 30 days of the presentation of the reports on pre-irradiation work, at the end of each campaign of irradiation, at the date of the presentation of the reports, on each intermediate and final examinations, submit invoice to PNC in respect of the sums due at the time of submission of the invoices.

7.3 In the event of the premature interruption or termination of any scheduled experiment during irradiation, C.E.A. shall submit an invoice to PNC for payment in respect of the sum due for the irradiation up to the date calculated as provided in article 5.

If C.E.A. at the written PNC's request, agree to undertake work not foreseen in this contract, a particular quotation will be issued in due time by common agreement.

7.5 PNC shall make payment, within 40 days of the receipt of each invoice, to the BANQUE NATIONALE DE PARIS in AIX EN PROVENCE (FRANCE) for the account of C.E.A., free of all charges.



Article 8 GUARANTEE

All information supplied by one party to the other within the terms of this Agreement shall be considered as representing the best knowledge and conviction of the supplying party, but the supplying party does not give any guarantees as to the accuracy of the information and shall not be considered as being responsible for the possible consequences of any use of said information.

Article 9 CONFIDENTIALITY

All information required by C.E.A. regarding the material shall be treated by C.E.A. as confidential. C.E.A. shall not disclose it to any third party without prior written consent of PNC. All information acquired by PNC regarding the examination, performances and operation of the Rapsodie Reactor or any other equipment of C.E.A. shall be treated by PNC as confidential.

PNC shall not disclose it to any third party without prior written consent of C.E.A.

Article 10 RESPONSIBILITY

10.1 C.E.A. shall be solely responsible for damages resulting from a nuclear accident occurred in its facilities in the course of execution of this Agreement.

10.2 PNC shall be responsible for non nuclear damages that it or its representatives might cause to third parties or to CEA's facilities.

PNC shall be responsible for industrial injuries and professional diseases of its representatives, and for compensation of damages to its properties during their stays in CEA's facilities.

Article 11 INDUSTRIAL PROPERTY

The right in inventions arising from any scheduled experiment shall be dealt with as follows:

11.1 For any invention which is made by C.E.A. staff and which relates primarily to the fuel pins being irradiated and the spare pins, the rights throughout the world in said invention shall be assigned to PNC with an irrevocable royalty-free, non-exclusive licence to C.E.A. on any patents arising therefrom with right to sub-licence.

11.2 For any invention which is made by PNC staff and which relates primarily to RAPSODIE or other property belonging to C.E.A., the rights throughout the world in said invention shall be assigned to C.E.A. with an irrevocable, royalty-free, non exclusive licence to PNC on any patents arising therefrom with right to sub-licence.

11.3 In the event that one party, having the right to seek patent protection for an invention, chooses to forego that right then the other party shall be entitled to seek patent protection for that invention subject to the understanding that said former party shall be entitled on request to a royalty-free irrevocable licence with the right to sub-licence under any patents granted.

11.4 Without prejudice to the rights of the parties hereto to grant sub-licences under articles 11.1 and 11.2 the party proposing to grant any sub-licence shall, before so doing, consult the other party with a view to coordination of their licensing policies to such extent as can be agreed.

11.5 PNC shall hold CEA harmless and indemnified against all actions which may be brought and all claims or

demands which may be made in respect of any infringement of letters patent concerning any fuel pins and material specimens supplied by PNC.

Article 12 SCHEDULE

The present agreement shall be performed according to the schedule provided in appendix VIII. The contract shall be terminated no later than 30th of June 1978.

Article 13 FORCE MAJEURE

Neither party shall be liable for failure to perform its part of this agreement when such failure is due to any cause beyond the control of the parties.

Article 14 ARBITRATION

All disputes arising in connection with the present agreement shall be finally settled under the rules of conciliation and arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the rules. Any arbitration shall be held at Tokyo, Japan.

Article 15 LAW

This agreement is subject to French Law.

Article 16 NOTICE

Any communication or notice required to be given by one party to the other under this agreement may be transmitted by hand, air mail, telegraph or teleprinter to the following addresses:

- PNC : Director, Contract Division  
POWER REACTOR AND NUCLEAR  
FUEL DEVELOPMENT CORPORATION  
9-13, 1-chome Akasaka Minato-ku,  
Tokyo, JAPAN
- C.E.A. : CENTRE D'ETUDES NUCLEAIRES DE  
CADARACHE  
Groupement des Affaires Commerciales  
Boite Postale n° 1  
13115 SAINT-PAUL-LEZ-DURANCE  
FRANCE

Article 17 CANCELLATION OF PREVIOUS DOCUMENTS AND  
COMMUNICATIONS

17.1 This agreement shall constitute the entire agree-  
ment reached between C.E.A. and PNC and supersede all previous  
documents made on the same subjects between the parties to this  
agreement including any exchange of letters as well as all memo-  
randa, notes and data.

17.2 Modification or additions to the provisions of  
the agreement which might result in modification of price, schedule  
or responsibility shall be made only by additional clauses to this  
agreement.

Article 18 JAPANESE GOVERNMENT APPROVAL

The effective date of this agreement shall be  
the date of the requisite approval of the Government of Japan.

PNC shall inform C.E.A. immediately after  
such approval has been obtained and until such time as it is  
obtained neither party shall have any obligation whatsoever under  
this agreement.

In witness whereof, the parties have executed  
this agreement as of, 20<sup>th</sup> day of March, 1975.

POWER REACTOR AND NUCLEAR FUEL  
DEVELOPMENT CORPORATION,

by *Minoru Tanaka*

COMMISSARIAT A L'ENERGIE ATOMIQUE,

by

LE DIRECTEUR  
*A. Junca*  
A. JUNCA

## APPENDIX I

### SPECIFICATIONS FOR PNC IX EXPERIMENT

#### I - SPECIFICATION FILE

- I - 1 General description of the experiment
- I - 2 Specifications of all the samples
  - Material specifications
  - Dimensions
  - Heat treatments
  - Chemical composition
  - Elaboration
  - Mechanical properties in the range of 400 °C to 700 °C
- I - 3 Operating conditions
  - Temperature
  - Maximum fluency
  - Number of intermediate examination and corresponding fluencies.
- I - 4 Quality control and testing procedures on materials supplied by PNC (See appendix II)
- I - 5 Loading scheme of the specimens in the rig for each story with marks of specimens
- I - 6 General specifications for operations concerning the intermediate and final examination.

#### II - REFERENCE DOCUMENTS

Drawings prepared by C.E.A. and approved by PNC shall be the reference documents.

After mounting of the rig the assembly report and the drawings certified in conformity with fabrication shall be the only authoritative documents.

## APPENDIX II

### DELIVERY DISTRIBUTION FOR PNC IX

#### I - PNC SUPPLIES

PNC shall supply:

- 25 tubes, section 5.6 - 6.5 mm, (20 for irradiation, 5 for spares), length 80
- 20 Sic monitors (15 for irradiation, 5 for spares)
- All the samples necessary to put in the tubes according the PNC choice, plates, tensile specimens or other shapes. These samples shall be supplied in adequate number for the irradiation and for spares (At least 5 samples of each shape for spare).

#### II - C.E.A. SUPPLIES

C.E.A. shall supply

- two rigs for irradiation
- 15 SIC for monitoring the temperatures.

## APPENDIX III

### CONTROL DOCUMENTS

#### I - GENERAL DATA

##### I - 1 Elementary control operation

A document shall be issued after each elementary control operation in order to know all the characteristics of each sample in connection with the manufacturing references.

##### II - 2 General control document

The general control document shall gather all documents issued from elementary control operations. It shall include all the tests and inspection results mentioned hereunder.

#### II - CONTROLS TO BE ACHIEVED ON MATERIALS PROVIDED FOR PNC IX BY PNC

- Dimensional controls of each tube and of each sample
- Chemical analysis of different types of used materials
- Control of the markings
- Controls during the elaboration of materials
- Check of final metallurgical state of each material.



## APPENDIX IV

### IRRADIATION CONDITIONS

#### I - TARGET NOMINAL IRRADIATION CONDITIONS

I - 1 The rig shall be loaded in a type 03 - 02 position of RAPSODIE Reactor core in order to obtain:

- Temperatures in the range 400 °C ~ 700 °C
- A target fluency  $0.79 \times 10^{23} \text{ n/cm}^2 \pm 0.5 \times 10^{22} \text{ n/cm}^2$

#### REMARK

PNC IX irradiation shall be made at the beginning in alternation with PNC VIII in the same position (03 - 17) that is to say that PNC IX rig shall be loaded in this position during the two runs where PNC VIII rig will undergo the two intermediate examinations. After the end of PNC VIII irradiation, PNC IX shall stay in this position for all the irradiation time.

I - 2 Two intermediate examinations are provided:

- The first one after about 240 equivalent full power days (Fluency about  $5.10^{22} \text{ n/cm}^2$ )

I - 3 A final examination is provided after the completion of 240 irradiation equivalent full power days more.

#### II - NOMINAL REACTOR REFERENCE CONDITIONS

II - 1 Characteristic conditions

- The characteristic power is the power determined according to the reactor loading of each campaign, which corresponds to the characteristic flux at reactor center of  $3.2 \times 10^{15} \text{ n/cm}^2/\text{s}$  (Total flux)
- The characteristic sodium flow rate in RAPSODIE reactor corresponds to a pressure drop across the core of 2380 mb.
- The "E.F.P.D." equivalent full power day corresponds to a day during which the reactor has been operated continually at the characteristic power.

II - 3 Summary of nominal reactor reference conditions

- Total flux at reactor center:  $3.2 \times 10^{15} \text{ n/cm}^2/\text{s}$
- Sodium inlet temperature 400 °C
- Pressure drop across the core 2,380 bars

## APPENDIX IV

(Continuation)

II - 3 Duration of irradiation campaigns  
Nominal duration of campaigns is 48 days.

### III - IRRADIATION SCHEDULE

- Number of E.F.P.D. corresponding to a flux of  $0,79 \times 10^{23} \text{ n/cm}^2$  at the maximum flux level at the type 03 - 02 position is about 374 days.
- Time necessary to make an intermediate examination on rig and samples is 1 to 2 months.
- Time necessary to make the final examination is about 3 months.

## APPENDIX V

### EXAMINATIONS

#### I - PRE-IRRADIATION EXAMINATIONS

- Total length of each tube with accuracy  $\pm 0.05$  mm
- Weight of each sample with accuracy  $\pm 1$  mg

#### II - INTERMEDIATE EXAMINATIONS

- 1 - Visual examination and photography
- 2 - Dismantling of the rig and extraction of samples
- 3 - Exchange of temperature monitors and new measurements
- 4 - Reassembling of specimens in a new rig.

#### III - FINAL EXAMINATION

C.E.A. shall perform all the operations provided in appendix V, paragraphs II.1, II.2, II.3, and shall insert specimens in a suitable container ready to be placed in a cask for transportation.

#### IV - OTHER EXAMINATIONS

All the other examinations which should be asked by PNC, on the samples as measurements tests... and so on and which are not provided in this contract, will form the subject of an amendment a this contract.

## APPENDIX VI

### C.E.A. REPORTS

#### I - REPORTS ON WORK BEFORE IRRADIATION

- I - 1 On material supplied by PNC
  - Results of the various inspections
- I - 2 On the rig
  - Assembling report

#### II - IRRADIATION REPORTS

- II - 1 At the end of each irradiation campaign (Run)
  - Diagram of the sodium inlet temperature
  - Diagram of the total power
  - Diagram of the reactor sodium flow rate
  - Fluency on the specimens
- II - 2 At the end of each irradiation a complete report of the entire irradiation including:
  - A summary of each run
  - The results of the flux and temperature monitors

#### III - INTERMEDIATE AND POST-IRRADIATION REPORTS

Any work performed in hot cells (see appendix V paragraph II and III) shall be described in a report sent to PNC.

## APPENDIX VII

### COST OF IRRADIATION

#### I - NORMAL PRICE $P_o$

This is the daily price when the RAPSODIE reactor is operated at a power included between 90 % and 100 % of the characteristic power (as defined in appendix IV)

#### II - CALCULATED PRICE P

If the effective average daily power is smaller than 90 % of the characteristic power, the daily cost of irradiation will be given by:

$$- P (J) = P_o \frac{j}{J} \times \left( \frac{WE}{WC} \right)^2$$

-  $P_o$  : As defined above

-  $WC$  : Characteristic power

-  $WE$  : Effective average daily power

-  $\frac{j}{J}$  : Represents the fraction of day during which RAPSODIE reactor is operated at a power higher than 100 kW.

## APPENDIX VIII

### TIME SCHEDULE

- |              |   |   |
|--------------|---|---|
| To           | - | RECEPTION AT CADARACHE OF SPECIFICATION FILE                              |
| To + 1 MONTH | - | REMARKS OF C.E.A. ON SPECIFICATION FILE AND DESIGN OF THE RIG SENT TO PNC |
| To + 1.5 "   | - | AGREEMENT BETWEEN PNC AND C.E.A. ON CALCULATIONS AND DRAWINGS             |
| To + 2 "     | - | RECEPTION AT CADARACHE OF PNC SUPPLIES AS PROVIDED IN ARTICLE 2.2         |
| To + 3 "     | - | END OF MOUNTING OF ALL THE SAMPLES AND ASSEMBLING OF FIRST RIG            |
| To + 4 "     | - | LOADING OF FIRST RIG IN RAPSODIE REACTOR                                  |
| To + 12 "    | - | BEGINNING OF THE FIRST INTERMEDIATE EXAMINATION                           |
| To + 14 "    | - | LOADING OF SECOND RIG IN RAPSODIE REACTOR                                 |
| To + 22 "    | - | END OF THE IRRADIATION  |
| To + 23 "    | - | END OF FINAL EXAMINATION  |

付録-⑤

ORIGINAL

Amendment of the Agreement  
for PNC 9 Rig Experiment

Amendment No. 1

VEN 0701

503C012

This Amendment is made on 30th day of March, 1976 between The Power Reactor and Nuclear Fuel Development Corporation having their principal office at 9-13, 1-chome, Akasaka, Minato-ku, Tokyo, Japan (hereinafter called "PNC") of the one part and Commissariat a l'Energie Atomique having their principal office at Paris 15<sup>e</sup>, 29-33 rue de la Federation, France (hereinafter called "CEA") of the other part.

Whereas under the provision of the Agreement between PNC and CEA dated 20th March 1975 (VEN-0701) CEA are irradiating PNC 9 rig in the Rapsodie Fortissimo Reactor,

Whereas PNC have requested to continue irradiation in order to increase the total fluency,

Whereas CEA are willing to continue the irradiation as requested by PNC,

Now therefore it is hereby agreed as follows.

#### Article 1

The second sentence of Article 12 shall be modified as follows.

"The contract shall be terminated no later than 31st day of ~~March 1979~~ December 1980".



Article 2

The target fluency of " $0.79 \times 10^{23} \text{ n/cm}^2 \pm 0.5 \times 10^{22} \text{ n/cm}^2$ " specified in Appendix IV, I, I-1 shall be modified as " $0.97 \times 10^{23} \text{ n/cm}^2 \pm 0.5 \times 10^{22} \text{ n/cm}^2$ "

Article 3

The first sentence in Appendix IV, III shall be modified as follows.  
"-Number of E.F.P.D. corresponding to a flux of  $0.97 \times 10^{23} \text{ n/cm}^2$  at the maximum flux level at the type 03-02 position is about 454 days."

Article 4

The time schedule of "End of the irradiation" and "End of final examination" specified in Appendix VIII shall be modified as "To + 30" and "To + 35" respectively.

Article 5

All of the provisions of Agreement VEN0701 except those modified by this Amendment No.1 shall remain effective.

In witness whereof, the parties have executed this Amendment.

Power Reactor and Nuclear Fuel  
Development Corporation

*M. Janyukin*

MANAGER, CONTRACT DIVISION

Commissariat a  
l'Energie Atomique

LE DIRECTEUR

*[Signature]*  
A. JENCA