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# CERTIFICATE AND RECORDS OF PNC FUEL PINS FOR RAPSODIE-6,7 IRRADIATION PROGRAM

February 1979

Tokai Works

Power Reactor & Nuclear Fuel Development Corporation.

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Tokai Works.  
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Certificate and Records of PNC Fuel Pins for  
RAPSODIE-6,7 Irradiation Program.

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1. General Remarks

Rap - 6, 7 irradiation tests planned as the pre-irradiation of Monju type fuel pins to be used for transient tests in GETR.

The 24 fuel pins (12 of upper and lower pins each) fabricated from two sintering lots of pellet. The fuel composition is 30% PuO<sub>2</sub> - 60% EUO<sub>2</sub>, and nominal pellet density is 85% TD.

The fuel pins contains fuel pellets, insulator pellets, spring, tagging gas container, plenum sleeve and sic container.

2. Fabrication process of the fuel

- 2 - 1 Pellet fabrication flow sheet and sampling position Fig. 2-1
- 2 - 2 Fabrication flow sheet of cladding Fig. 2-2
- 2 - 3 Fabrication process of fuel pin Fig. 2-3

3. Fabrication records of fuel pellets and pin components.

3 - 1 Fuel pellets

3 - 1 - 1 Sampling

(1) Lot size and lot number

Lot size of PuO <sub>2</sub> -EUO <sub>2</sub> powder mixing process	400g
Lot size of sintering	400g
Number of sintering lot	2

(2) Powder samples were taken out from materials for the isotopic composition analysis

a) Pu isotope analysis	1 Sample
b) U-235 analysis	3 "

(3) Pellets were taken out at random from each sintering lot for the following examinations.

a) Plutonium content	3 Pellets
b) Impurity (spectroscopy)	3 "
c) Impurity (chemical analysis)	6 "
d) Amount of released gas (includ moisture) <sub>2</sub>	"
e) O/M ratio	1 Pellet
f) Ceramography, α-autoradiography and X-ray diffraction	1 "

3 - 1 - 2 Analysis and other inspection methods.

The methods which are in the routine work at PNC were applied to the above analysis and inspections.

3 - 1 - 3 Inspection results

(1) Isotopic composition of plutonium and uranium are shown in Table 3-1.

(2) Chemical analysis

The results of analysis of plutonium content, impurities and O/M ratio in the mixed oxide fuel peller are shown in Table 3-2.

(3) Amount of released gas

The amount of released gas extracted at 1700°C for 30 minuts are shown in Table 3-2.

(4) X-ray diffraction test.

The X-ray diffraction charts with lattice constant are shown in Fig. 3-10.

(5) Macrography

The ceramographies and alpha-autoradiographies of fuel pellets are shown in photo 3-103-12.

(6) Dimension and density

The diameter, height and weight of all pellets were measured for determination of geometrical densities. Measured values and calculated densities are listed in Table 4-1-1 to Table 4-1-4.

3 - 2 Insulator pellets

3 - 2 - 1 Inspection results

The same methods which applied to the inspection of fuels were used for the determination of following items,

a) Dimension and density

Measured values and calculated densities are shown in Table 3-3.

b) Chemical analysis

The results of chemical analysis are shown in Table 3-4.

c) O/U ratio

The result of O/U ratio measured by ignition method is 2.01.

d) Amount of released gas

The result of analysis is <30µl/g.

3 - 3 Cladding

3 - 3 - 1 Inspection results

- a) Chemical composition  
Results of chemical analysis of cladding which were made by manufacturer are shown in Table. 3-5.
- b) Mechanical property  
Mechanical properties which were measured by manufacturer are shown in Table 3-6.
- c) Metallography  
Metallurgical tests such as grain size and inclusion were performed by PNC. The result of grain size measurements is listed in Table 3-6 with mechanical properties. Typical micrographs of cladding are shown in Photo 3-13.
- d) Dimension  
The results of dimensional measurement made by manufacturer are listed in Table 3-7.
- e) Non destructive test  
Non destructive tests of surface roughness and visual inspection were performed by PNC.  
The results are shown in Table 3-8.

3 - 4 End plug

3 - 4 - 1 Chemical composition

Chemical analysis of end plug material was made by manufacture. The results are shown in Table 3-9.

3 - 4 - 2 Mechanical properties

The results of mechanical properties measurement are shown in Table 3-10.

3 - 5 Spring

3 - 5 - 1 Chemical composition

The results of chemical analysis are shown in Table 3-11.

3 - 5 - 2 Spring constant and dimensions.

5 samples taken out from fabrication lot, and measured spring constant and dimensions. The results are shown in Table 3-12.

3 - 6 Sic capsule, tagging-gas capsule and sleeve

3 - 6 - 1 Chemical composition

Capsules and sleeve are made from same material.

The chemical composition is shown in Table 3-13.

End plugs of these capsules were made from same material



to the fuel pin end plug.

4. Fabrication and inspection records of fuel pins.

4 - 1 Pellets data of each pin

Dimensions, weight and density of pellets, and its location in pins are shown in Table 4-1-1 to 4-1-4.

4 - 2 Components of fuel pin

Weight and length of fuel pin components, total length and weight of fuel pellets and insulator pellets were measured. The results are shown in Table 4-2-1 to 4-2-2.

4 - 3 Pin diameter and total length

Pin diameters were measured at welded parts and at 50 mm intervals with a blade micrometer. Total length of the pins were measured with vernier calipers. Pin lengths are shown in Table 4-2-1 and 4-2-2. Pin diameters are shown in Table 4-3.

4 - 4 Helium leak test

The results were below enough than allowable leak rate of  $1.0 \times 10^{-8}$  atm cc/sec. The results are shown in Table 4-4.

4 - 5 X-ray radiography

The welded sections and components of fuel pins were inspected by x-ray radiography. Any harmful defects or abnormalities were not observed.

The results are shown in Table 4-4. X-ray films of each fuel pin will be sent together with this certificate.

4 - 6 Surface contamination

Loose and fixed contamination of fuel pins were checked and the results are shown in Table 4-4 together with other inspection results.

5. Combination of lower and upper pin.

It is desirable to combine same number of lower and upper pins to secure pin straightness.

Straightness when lower and upper pin connected, are shown in Table 4-4 also.

6. Fuel materials

Details of fuel materials of fuel pins are listed in Table 5-1.

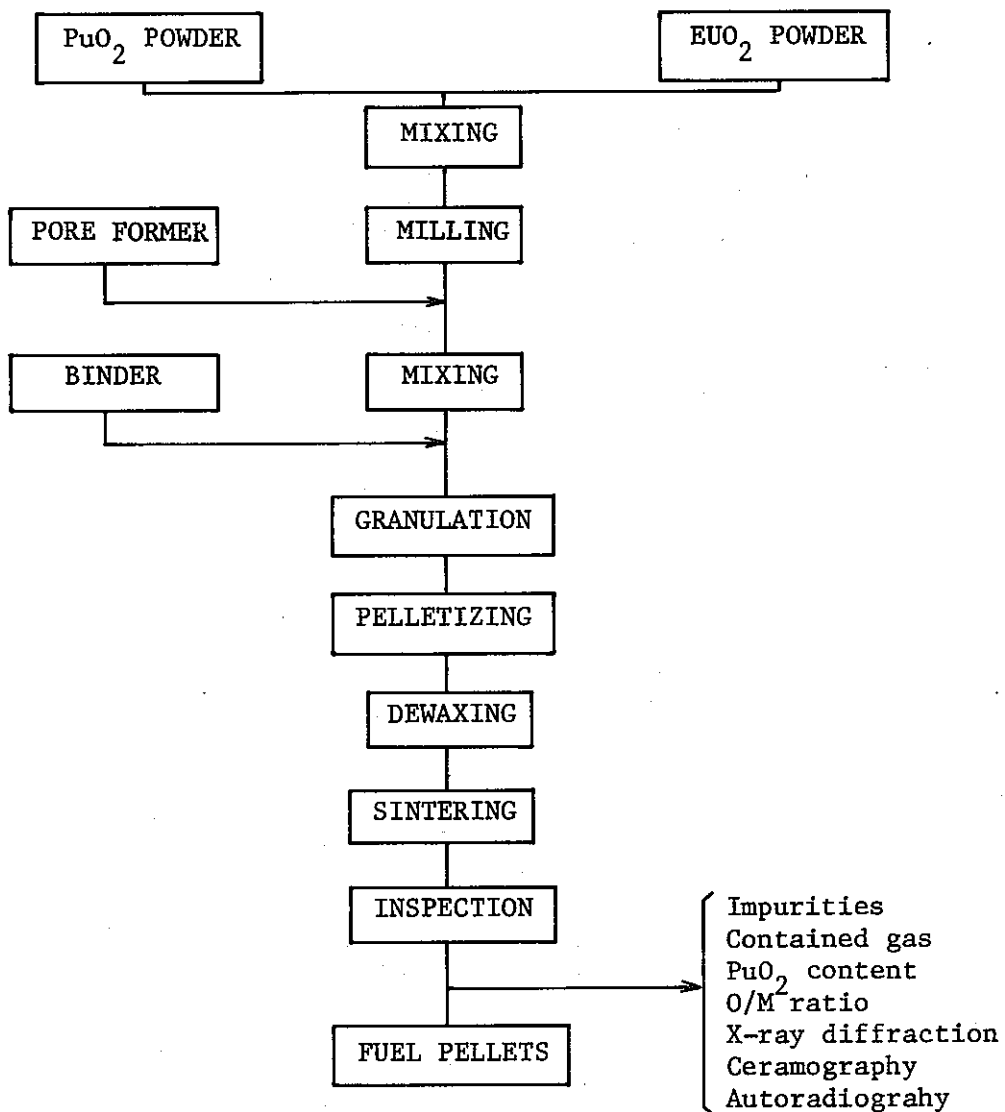


Fig. 2-1 Pellets fabrication process and sampling position

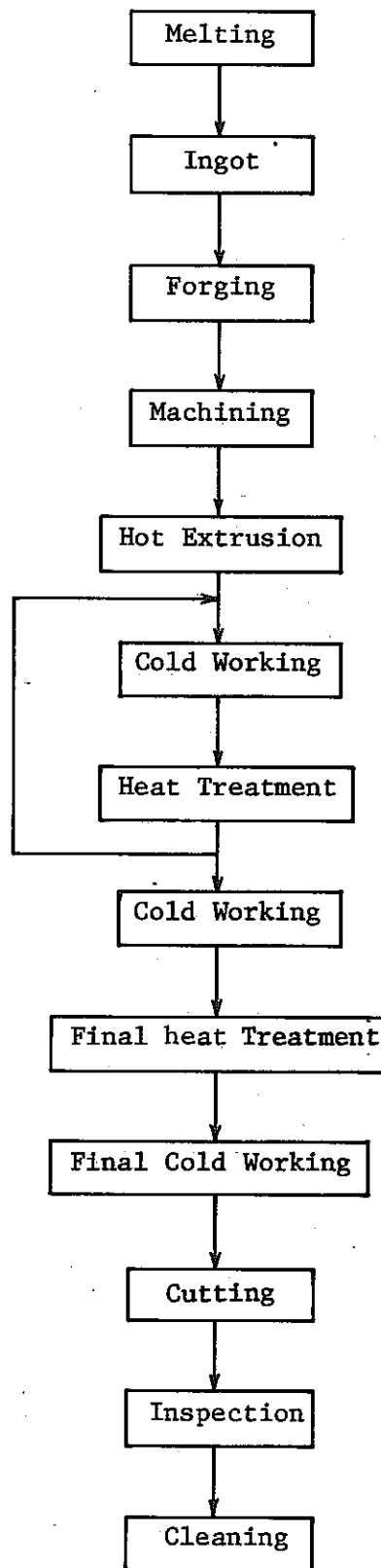


Fig. 2-2 Fabrication flow sheet of cladding

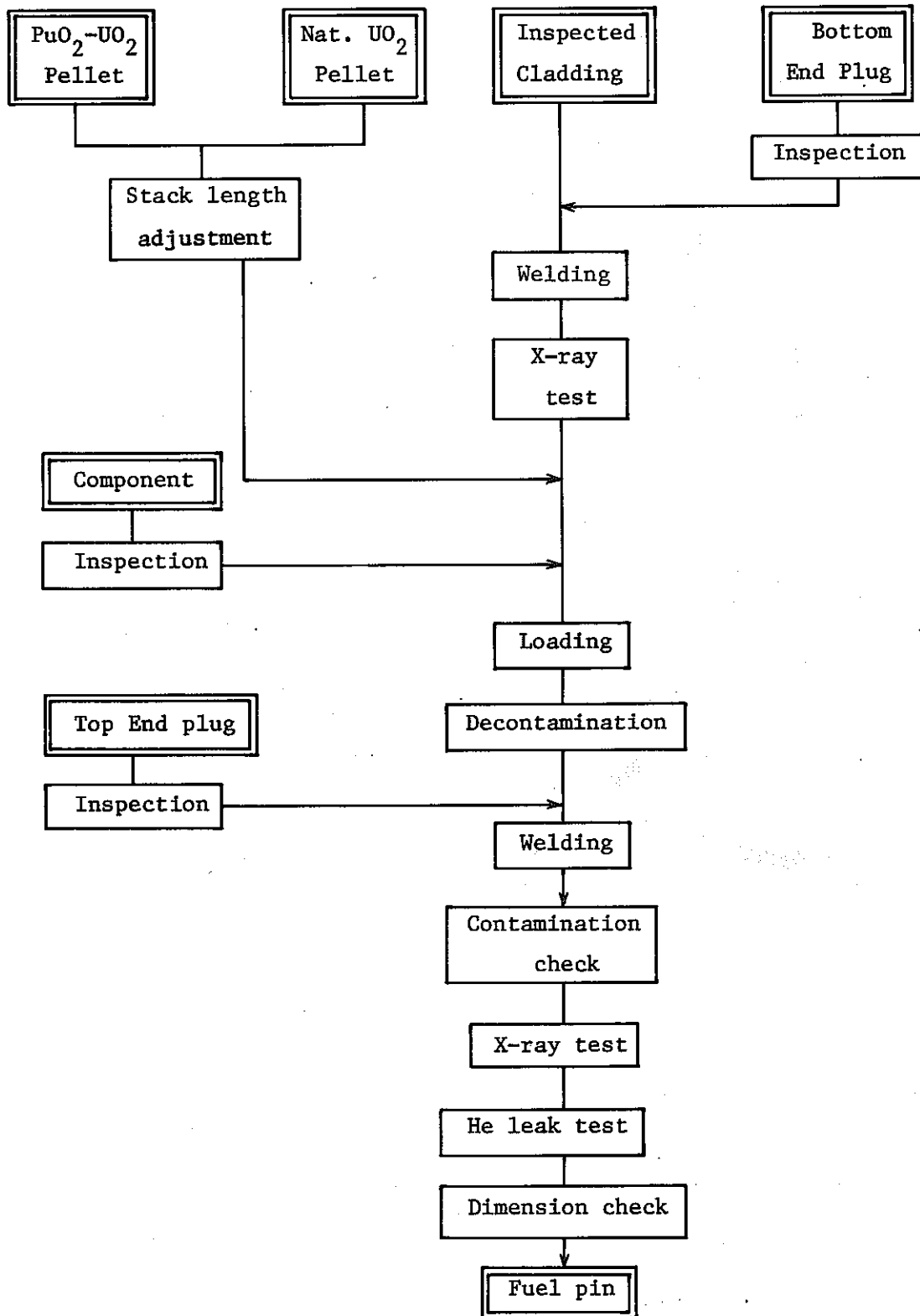
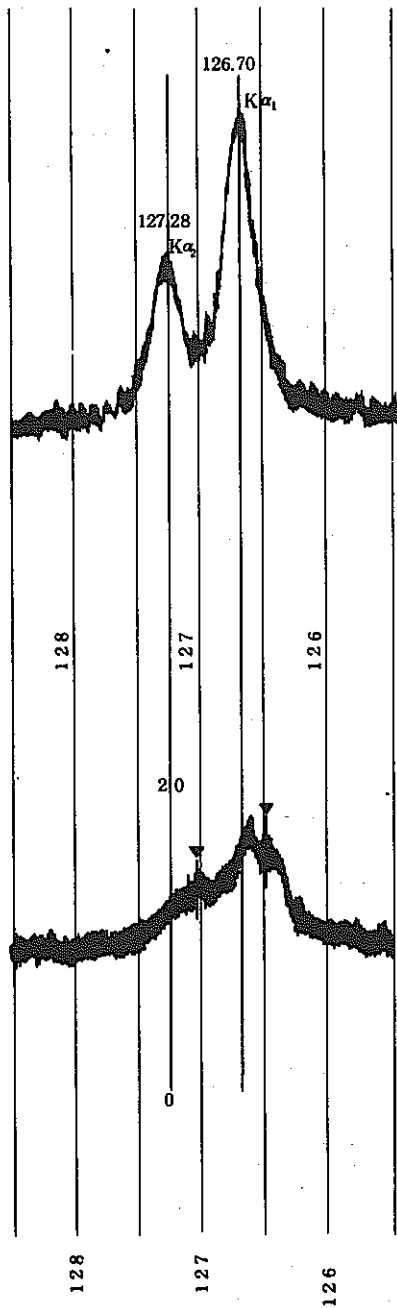


Fig. 2-3 Fabrication process of fuel pin



1) PN - 41

Lattice constant:  $5.44966 \pm 0.00025$

O/M ratio ; 1.993

Solid homogeneity; 100%

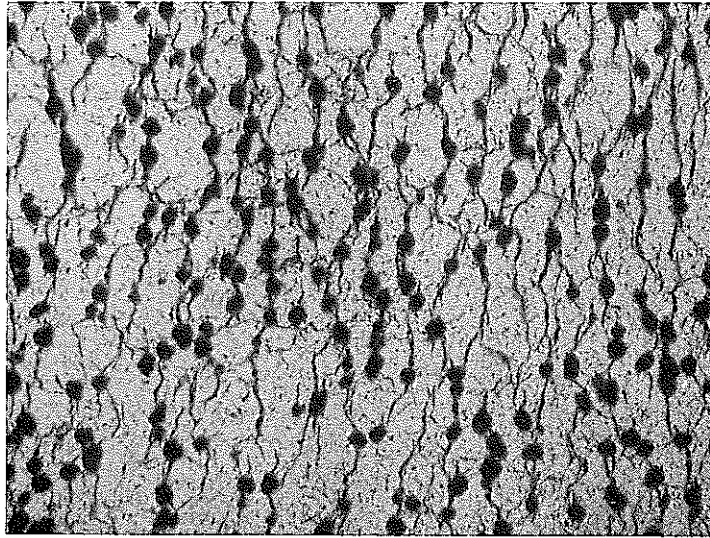
2) PN - 61

Lattice constant;  $5.45402 \pm 0.00076$

O/N ratio ; 1.977

Solid homogeneity: 100%

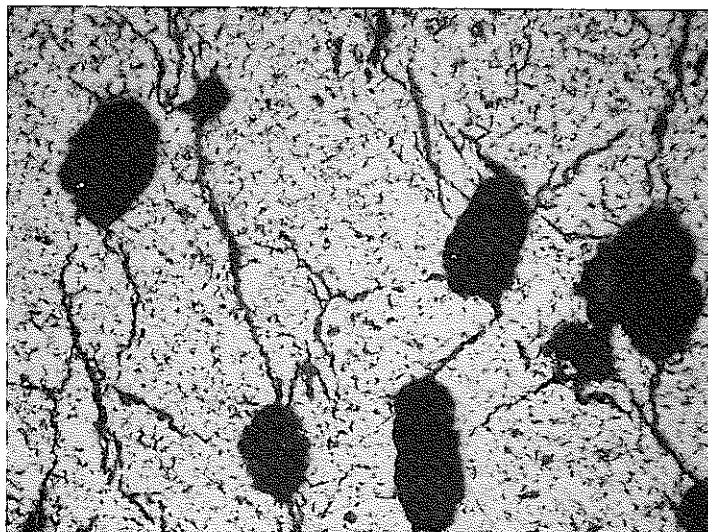
Fig. 3-1 X-ray diffraction result



MACRO

1mm

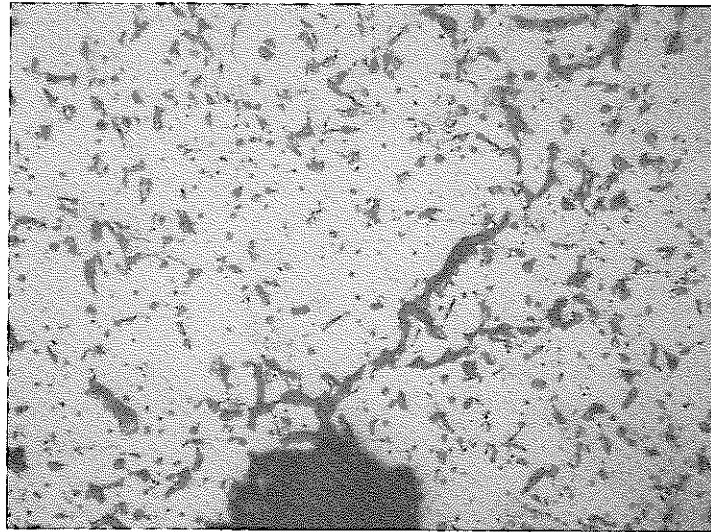
Photo 3-1 Ceramography of PN-41 fuel pellet (As polished)



MICRO

100μ

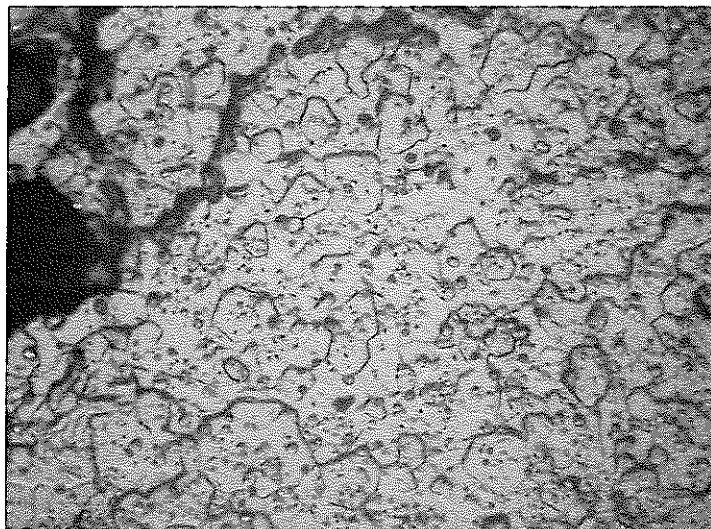
Photo 3-2 Ceramography of PN-41 fuel pellet (As polished)



MICRO

25μ

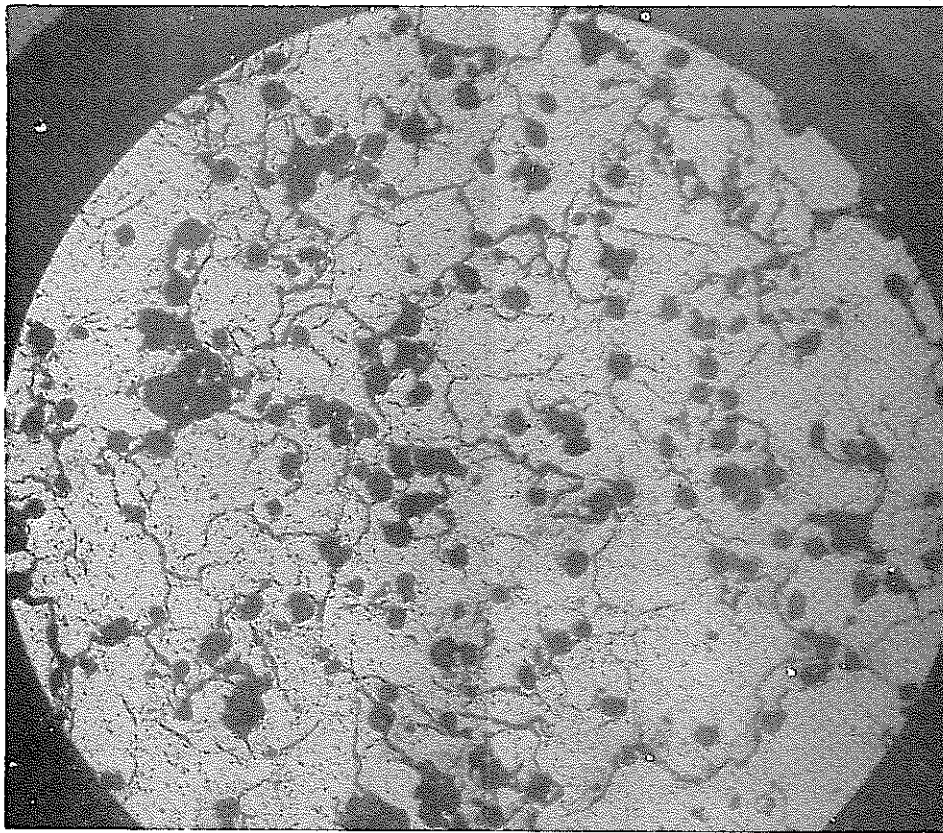
Photo 3-3 Ceramography of PN-41 fuel pellet (As polished)



MICRO

25μ

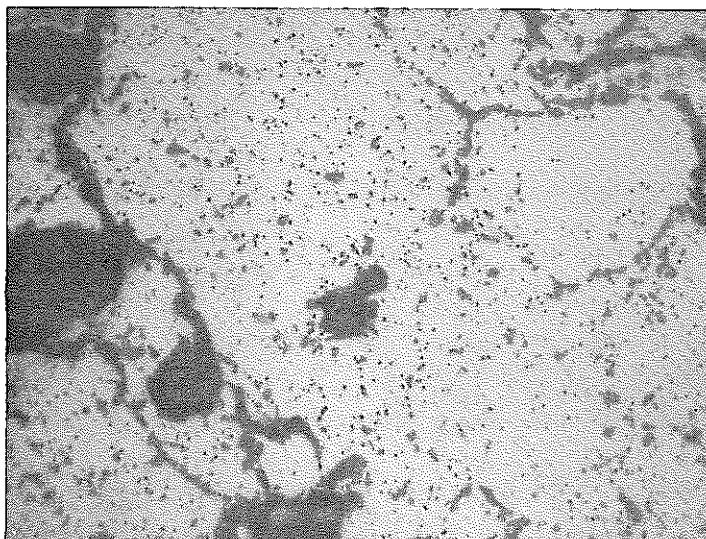
Photo 3-4 Ceramography of PN-41 fuel pellet (Etched)



MACRO

500μ

Photo 3-5 Ceramography of PN-61 fuel pellet (As polished)

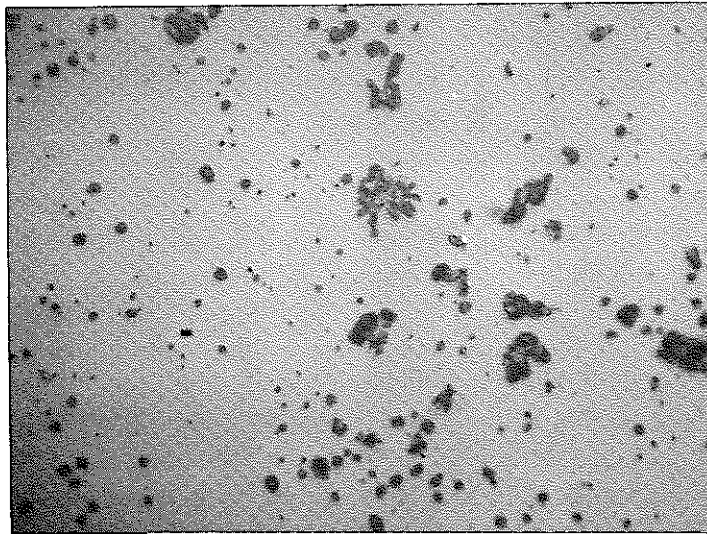


MICRO

100μ

Photo 3-6 Ceramography of PN-61 fuel pellet (As polished)

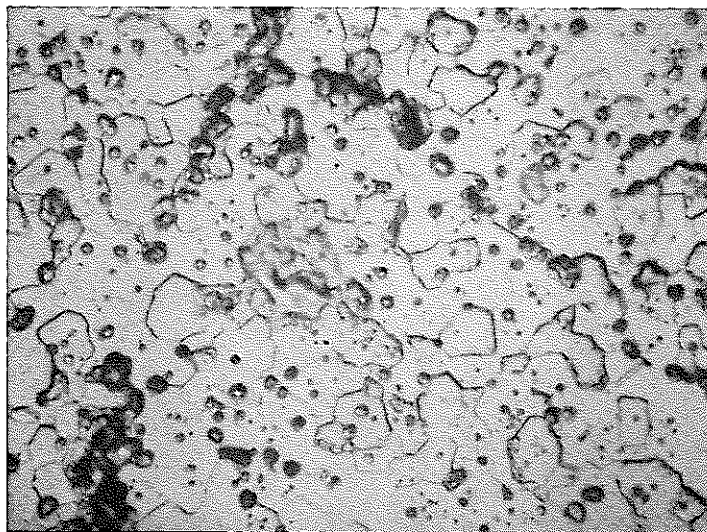




MICRO

25 $\mu$

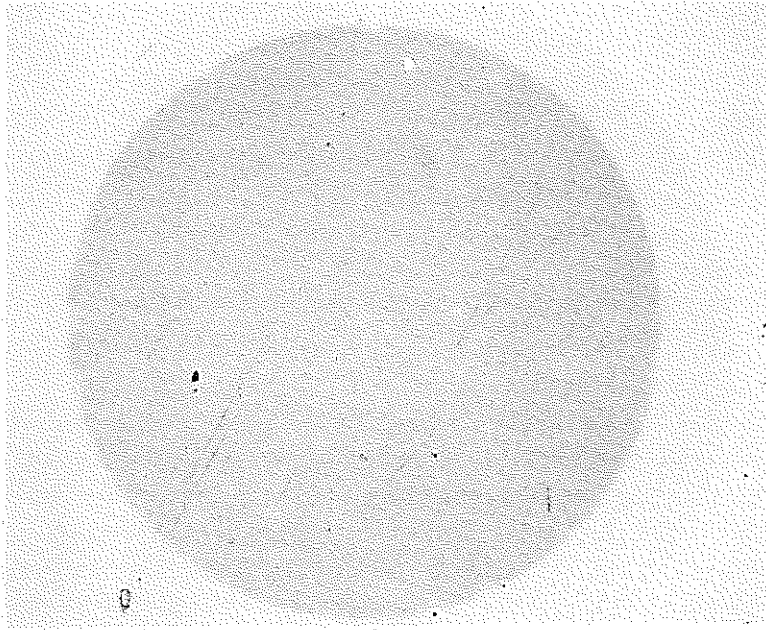
Photo 3-7 Ceramography of PN-61 fuel Pellet (As polished)



MICRO

25 $\mu$

Photo 3-8 Ceramography of PN-61 fuel Pellet (Etched)



MACRO

2mm

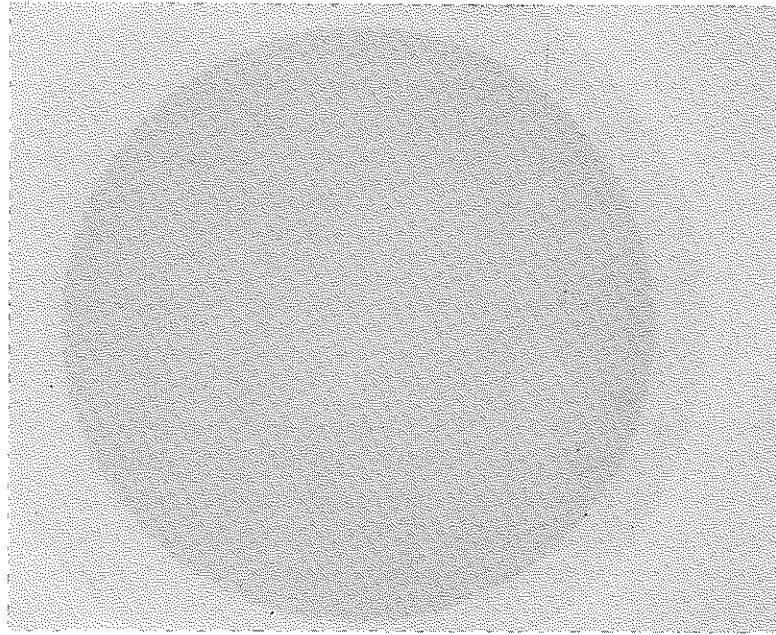
Photo 3-9  $\alpha$ -autoradiography of PN-41 fuel pellet



MICRO

100 $\mu$

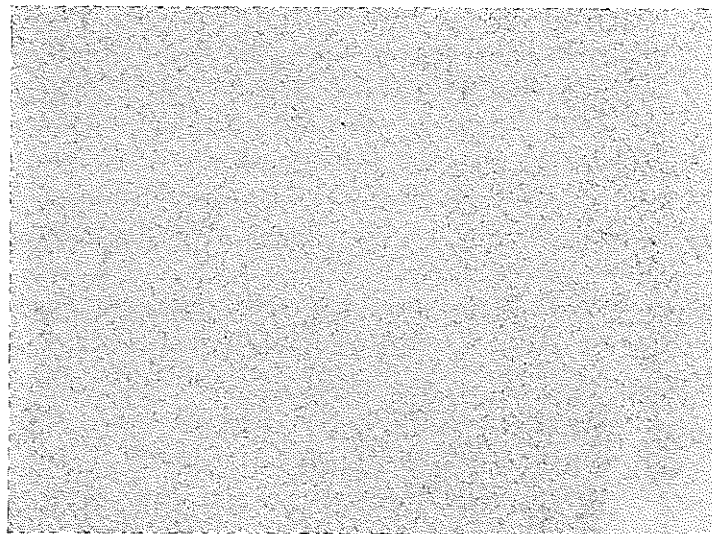
Photo 3-10  $\alpha$ -autoradiography of PN-41 fuel pellet



MACRO

2mm

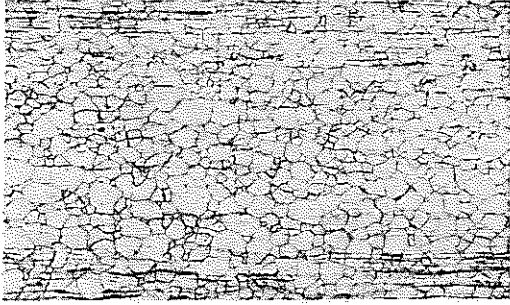
Photo 3-11  $\alpha$ -autoradiography of PN-61 fuel pellet



MICRO

100 $\mu$

Photo 3-12  $\alpha$ -autoradiography of PN-61 fuel pellet



× 100



× 400

(Lot No. 3, cladding No. S-5189)

Photo 3-13 Micrography of cladding

Table 3-1 Isotopic composition of plutonium and Uranium

	specification (%)	Isotopic composition (%)			
		Sample-1	Sample-2	Sample-3	Average
Pu - 238	0.1	0.10	/	/	0.10 *
- 239	76.0	77.26			77.26
- 240	19.8	19.25			19.25
- 241	3.5	2.83			2.83
- 242	0.6	0.56			0.56
U - 235	60 ± 1	59.78	59.89	59.92	59.86

\* Date of analysis; May. 22, 1976.

Table 3-2 Results of chemical analysis of fuel pellet

	Specification	PN - 41	PN - 61
PuO <sub>2</sub>	30±1 (W/O)	30.23	30.17
O/M	1.98±0.02	1.98	1.97
Al	< 200 (ppm)	60	220
B	< 10 "	< 1	< 1
Cd	< 10 "	< 5	< 5
Cr	< 200 "	40	50
Fe	< 500 "	140	180
Mg	< 25 "	10	< 10
Ni	< 200 "	25	55
V	< 100 "	< 5	65
Cu + Zn + Si	< 600 "	< 175	< 165
Ag+Mn+Mo+Pb+Sn	< 200 "	< 71	< 71
C	< 150 "	70	45
Cl	< 25 "	< 25	< 25
F	< 25 "	< 10	< 10
N	< 100 "	< 50	< 50
Released Gas (include moisture)	< 150 (μl/g)	< 10	< 10

Table 3-3 Dimension and density of insulator UO<sub>2</sub> pellet

	Diameter	Height	Weight	Density
Specification	5.3 <sub>+0.05</sub> mm	10 <sub>+0.2</sub> mm	-	93 <sub>+2</sub> % T.D.
Max	5.34	10.03	2.3	94.8
Min	5.31	9.95	2.3	94.1
Ave	5.32	10.0	2.3	94.5

Table 3-4 The result of chemical analysis of insulator pellet

Item	Specification	Result of analysis
Al (ppm)	<200 (ppm)	<14 (ppm)
B	<10	0.2
C	<150	17
Ca	<25	<10
Cd	<20	<0.3
Cl	<25	<10
Cr	<200	<8
F	<25	<10
Fe	<200	70
H	<5	5
Mg	<25	6
N	<150	23
Na	<200	5
Ni	<200	10
V	<200	<3
Cu+Zn+Si+Ti	<600	83
Ag+Mn+Mo+Pb+Sn	<200	9

Table 3-5 The result of chemical analysis of cladding

	Specification %	Results of analysis
C	0.035 ~ 0.064	0.046
Mn	1.50 ~ 2.00	1.57
P	≤ 0.03	0.018
S	≤ 0.01	0.008
Si	≤ 0.75	0.56
Ni	12.00 ~ 14.00	13.07
Cr	17.00 ~ 18.00	17.55
Mo	2.00 ~ 3.00	2.47
Co	≤ 0.10	0.01
B	0.0005 ~ 0.0015	0.0010
N	≤ 0.01	0.0074
Fe	Balance	Balance
Reference	-	Mill sheet No. MS-RD-0007

Table 3-6 Mechanical properties of cladding

	Specification	Results
Tensile strength (kg/mm <sup>2</sup> ) at room temperature	ASTM, A-370 ≥ 75	81.0
	at 650°C ≥ 40	45.9
0.2% offset strength (kg/mm <sup>2</sup> ) at room temperature	ASTM, A-450 ≥ 60	69.3
	at 650°C ≥ 30	41.5
Elongation (%) at room temperature	ASTM, E-21 ≥ 10	21.5
	at 650°C ≥ 7	17.0
Hydrostatic strength (kg/cm <sup>2</sup> ) Rupture pressure	ASTM, A-450 ≥ 1000	/
Yield pressure	≥ 900	
Grain size	ASTM, E-112 Plate-III ≥ No.6	7.5
Hardness	-	267

Table 3-7 Dimension of claddings

Pin No.	Spec. Tube No.	Outer dia.		Inner dia		Thickness		Straightness
		6.500 $\pm$ 0.030mm		5.600 $\pm$ 0.025mm		0.450 $\pm$ 0.030mm		0.50mm/ Total Length
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.		
U - 01	S.5223 - 2	6.506	6.490	5.595	5.590	0.456	0.444	<0.5
02	5236 - 1	6.506	6.491	5.599	5.592	0.458	0.444	"
03	5236 - 1	6.506	6.491	5.599	5.592	0.458	0.444	"
04	5260 - 1	6.507	6.494	5.599	5.592	0.463	0.441	"
05	5260 - 1	6.507	6.494	5.599	5.592	0.463	0.441	"
06	5260 - 2	6.507	6.494	5.599	5.592	0.463	0.441	"
07	5261 - 1	6.508	6.494	5.599	5.592	0.461	0.440	"
08	5263 - 1	6.507	6.492	5.600	5.593	0.458	0.443	"
09	5263 - 1	6.507	6.492	5.600	5.593	0.458	0.443	"
10	5264 - 1	6.508	6.493	5.601	5.593	0.463	0.440	"
11	5196 - 1	6.505	6.488	5.598	5.592	0.457	0.443	"
12	5196 - 2	6.505	6.488	5.598	5.592	0.457	0.443	"
L - 01	S.5242 - 1	6.508	6.494	5.595	5.589	0.460	0.447	<0.5
02	5264 - 1	6.508	6.493	5.601	5.593	0.463	0.440	"
03	5258 - 1	6.513	6.500	5.604	5.597	0.460	0.443	"
04	5196 - 2	6.505	6.488	5.598	5.592	0.457	0.443	"
05	5196 - 1	6.505	6.488	5.598	5.592	0.457	0.443	"
06	5236 - 2	6.506	6.491	5.599	5.592	0.458	0.444	"
07	5240 - 2	6.507	6.490	5.599	5.591	0.457	0.443	"
08	5263 - 2	6.507	6.492	5.600	5.593	0.458	0.443	"
09	5240 - 1	6.507	6.490	5.599	5.591	0.457	0.443	"
10	5236 - 2	6.506	6.491	5.599	5.592	0.458	0.444	"
11	5260 - 2	6.507	6.494	5.599	5.592	0.463	0.441	"
12	5261 - 2	6.508	6.494	5.599	5.592	0.461	0.440	"



Table 3-8 Non-destructive test of claddings

Item	Spec.	Result
Surface roughness	3 S	< 3 S
Ultrasonic inspection	<32 $\mu$	go
Visual inspection	Free of all scale and oxide	go

Table 3-9 Chemical composition of end plug material

Elements	Specification (%)	Results (%)
C	0.035 ~ 0.064	0.06
Si	$\leq$ 0.75	0.53
Mn	1.50 ~ 2.00	1.54
P	$\leq$ 0.03	0.02
S	$\leq$ 0.02	0.01
Ni	12.0 ~ 14.0	12.9
Cr	16.0 ~ 18.0	16.4
Co	$\leq$ 0.10	0.04
Mo	2.00 ~ 3.00	2.3
B	$\leq$ 0.0005	0.0003
N	$\leq$ 0.035	0.022

Table 3-10 Mechanical properties of end plug

Mechanical properties	Specification	Results
Tensile strength ( $\text{kg}/\text{mm}^2$ ) at room temperature	$\geq$ 60	(58.9)
0.2% offset strength ( $\text{kg}/\text{mm}^2$ ) at room temperature	$\geq$ 40	(33.2)
Elongation (%)	$\geq$ 25	(54)

Table 3-11 Chemical composition of spring

Elements	Spec. (%)	Results (%)	Refernce
C	< 0.08	0.033	Inconel-X
Si	< 0.50	0.04	
S	< 0.015	< 0.005	
Cr	14.0 ~ 17.0	15.14	
Ni + Co	> 70.0	73.28	
Ti	2.0 ~ 2.75	2.51	
Al	0.4 ~ 1.0	0.8	
Fe	5.0 ~ 9.0	7.19	
Cd + Ta	0.7 ~ 1.2	0.95	

Table 3-12 Spring constant and spring dimensions

Item	Spring constant	Free length	Outer Diameter	Wire Diameter
Sample Spec.	0.089 kg/mm	48 ± 1 mm	5.2 ± 0.4 mm	0.6 mm
Sample - 1	0.10	48.2	5.1	0.6
" - 2	0.10	48.4	"	"
" - 3	0.09	48.4	"	"
" - 4	0.10	48.0	"	"
" - 5	0.09	48.2	"	"
Average	0.096	48.2	5.1	0.6

Table 3-13 Chemical composition of container and sleeve

Elements	Specification %	Results %
C	0.04 ~ 0.08	0.058
Si	≤ 0.075	0.52
Mn	≤ 2.00	1.74
P	≤ 0.03	0.003
S	≤ 0.03	0.007
Cr	16.00 ~ 18.00	17.20
Ni	11.00 ~ 14.00	12.92
Mo	2.00 ~ 3.00	2.50
Co	≤ 0.10	0.06
B	≤ 0.001	0.0001
N	≤ 0.035	0.006

Table 4-1-1 Pellet line up of upper pins (U-01 ~ U-06)

N841-79-30

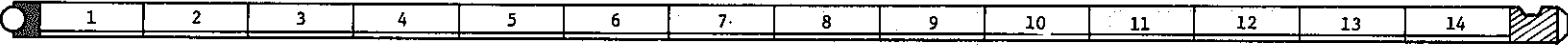

		Connecting e.p. 														upper e.p. 
		Insulator p. Fuel p.							Fuel p. Insulator p.							
U-01	Pellet No	5	26	27	28	30	31	33	37	38	39	40	42	48	6	fuel Pellet lot PN-41
	Dia. (mm)	5.31	5.413	5.425	5.453	5.425	5.430	5.413	5.425	5.420	5.405	5.418	5.405	5.413	5.43	
	Hei. (mm)	10.02	10.245	10.005	9.775	10.375	10.175	10.225	9.770	10.270	10.375	10.175	10.225	9.725	10.00	
	T.D. (%)	93.79	83.92	83.43	86.24	83.44	83.19	83.24	86.92	82.53	83.83	84.11	83.55	84.24	93.63	
	Wt. (g)	2.28	2.184	2.130	2.173	2.209	2.164	2.162	2.167	2.159	2.203	2.178	2.164	2.084	2.28	
U-02	Pellet No.	7	49	50	51	52	54	55	56	58	59	60	61	62	8	" PN-41
	Dia.	5.32	5.430	5.425	5.415	5.405	5.418	5.410	5.405	5.413	5.413	5.405	5.425	5.413	5.32	
	Hei.	10.02	10.220	10.185	10.110	10.040	10.110	9.855	10.005	10.345	10.065	10.290	10.055	10.145	10.00	
	T.D.	93.45	83.47	82.95	83.34	84.34	83.68	84.29	84.53	84.10	84.25	84.40	82.90	84.17	93.63	
	Wt.	2.28	2.181	2.156	2.168	2.145	2.153	2.108	2.153	2.210	2.156	2.200	2.127	2.169	2.28	
U-03	Pellet No.	15	99	100	101	102	103	104	105	106	107	108	109	110	16	" PN-41
	Dia.	5.32	5.425	5.428	5.423	5.413	5.418	5.413	5.420	5.413	5.410	5.415	5.410	5.405	5.32	
	Hei.	10.00	10.195	10.185	10.185	10.195	9.980	9.985	10.210	10.045	9.885	10.105	10.015	10.125	10.00	
	T.D.	92.81	83.64	83.41	83.57	84.18	83.67	84.03	83.98	84.18	84.27	84.23	84.63	84.41	92.81	
	Wt.	2.26	2.176	2.170	2.170	2.180	2.125	2.110	2.184	2.148	2.114	2.164	2.151	2.164	2.26	
U-04	Pellet No.	9	63	64	65	66	67	68	69	70	71	72	73	74	10	" PN-41
	Dia.	5.32	5.405	5.420	5.423	5.413	5.433	5.408	5.418	5.423	5.415	5.423	5.413	5.408	5.31	
	Hei.	9.98	9.945	10.160	10.175	10.155	10.245	10.005	10.160	10.095	10.170	9.660	10.060	10.035	10.00	
	T.D.	94.23	84.16	83.66	83.92	84.20	83.27	84.52	83.81	83.03	84.03	83.77	84.06	84.31	93.99	
	Wt.	2.29	2.120	2.165	2.177	2.172	2.183	2.144	2.165	2.137	2.173	2.063	2.148	2.145	2.28	
U-05	Pellet No.	13	87	88	89	90	91	92	93	94	95	96	97	98	14	" PN-41
	Dis.	5.31	5.433	5.435	5.428	5.428	5.428	5.420	5.418	5.418	5.425	5.415	5.418	5.435	5.32	
	Hei.	10.03	9.915	10.185	10.365	10.275	10.165	9.875	10.170	10.020	10.285	10.070	10.205	10.155	10.03	
	T.D.	93.7	83.12	83.49	83.48	83.60	83.46	84.01	84.04	84.40	83.82	84.25	84.14	82.62	14.17	
	Wt.	2.28	2.109	2.178	2.210	2.194	2.167	2.113	2.175	2.152	2.200	2.157	2.182	2.149	2.30	
U-06	Pellet No.	25	160	161	162	163	164	165	166	167	168	169	170	171	26	" PN-41
	Dis.	5.32	5.438	5.423	5.425	5.418	5.425	5.418	5.418	5.415	5.443	5.420	5.425	5.440	5.32	
	Hei.	10.01	10.055	9.955	10.035	10.225	10.305	10.035	10.110	9.865	10.145	10.055	10.030	10.350	10.01	
	T.D.	93.54	83.71	83.69	83.57	84.16	83.55	84.00	84.31	84.29	83.05	84.14	83.81	82.57	93.54	
	Wt.	2.28	2.150	2.124	2.140	2.190	2.197	2.145	2.169	2.114	2.165	2.155	2.145	2.193	2.28	

Table 4-1-2 Pellet line up of upper pins (U-07 ~ U-12)

N841-79-30

		Connecting e.p.													Upper e.p.		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		
		Insulator p. Fuel p.													Fuel p. Insulator p.		
U-07	Pellet No	21	135	136	137	138	139	140	141	142	126	144	145	146	22	Fuel pellet	
	Dia. (mm)	5.31	5.413	5.415	5.413	5.413	5.408	5.408	5.413	5.418	5.428	5.415	5.418	5.433	5.31	Lot	
	Hei. (mm)	9.95	10.040	10.050	10.185	10.255	10.085	10.125	10.025	10.015	10.305	9.975	10.165	9.975	9.96	PN-41	
	T.D. (%)	94.52	83.60	84.10	84.65	84.77	84.04	83.38	84.74	84.28	83.58	84.38	83.85	83.53	94.78		
	Wt. (g)	2.29	2.132	2.149	2.182	2.200	2.149	2.166	2.148	2.148	2.20	2.140	2.169	2.132	2.29		
U-08	Pellet No.	23	148	149	150	151	152	153	154	155	156	157	158	159	24	"	
	Dia.	5.32	5.413	5.428	5.425	5.438	5.423	5.410	5.425	5.430	5.415	5.423	5.418	5.408	5.31	PN-41	
	Hei.	10.00	9.785	10.365	10.015	10.235	10.045	10.005	10.200	10.330	9.925	10.095	10.245	10.075	10.01		
	T.D.	93.63	84.33	83.36	83.27	83.35	83.45	84.09	85.75	83.11	84.21	83.65	83.73	84.25	93.89		
	Wt.	2.28	2.096	2.207	2.128	2.187	2.153	2.135	2.232	2.195	2.125	2.153	2.183	2.153	2.28		
U-09	Pellet No.	11	75	76	77	78	79	80	81	82	83	84	85	86	12	"	
	Dia.	5.34	5.415	5.420	5.413	5.408	5.413	5.415	5.425	5.423	5.438	5.423	5.418	5.433	5.32	PN-41	
	Hei.	10.03	10.205	10.375	10.335	10.165	10.185	10.185	9.995	10.175	10.075	10.395	10.045	10.145	10.02		
	T.D.	93.47	84.37	83.74	84.34	84.12	84.03	84.15	83.90	83.07	82.93	82.94	84.15	83.71	93.04		
	Wt.	2.30	2.189	2.213	2.214	2.168	2.174	2.179	2.140	2.155	2.142	2.198	2.151	2.173	2.27		
U-10	Pellet No.	19	123	124	125	143	127	128	129	130	131	132	133	134	20	"	
	Dia.	5.31	5.408	5.405	5.418	5.425	5.415	5.425	5.415	5.415	5.425	5.428	5.428	5.428	5.32	PN-41	
	Hei.	9.98	10.255	10.190	10.025	9.970	10.280	10.150	10.230	10.225	10.295	10.295	10.285	10.075	9.97		
	T.D.	94.17	84.42	84.18	84.24	83.72	83.60	83.93	84.09	84.05	83.74	83.44	83.21	83.86	93.92		
	Wt.	2.28	2.195	2.174	2.149	2.130	2.185	2.174	2.187	2.185	2.200	2.194	2.186	2.150	2.28		
U-11	Pellet No.	1	1	2	4	5	6	7	8	9	10	11	12	13	2	"	
	Dia.	5.32	5.428	5.430	5.425	5.433	5.413	5.425	5.415	5.428	5.430	5.418	5.433	5.443	5.32	PN-41	
	Hei.	9.98	10.120	9.990	10.255	10.080	10.060	10.040	10.075	10.220	10.375	10.275	10.250	10.295	10.02		
	T.D.	93.82	85.26	84.29	85.97	83.47	84.13	83.72	84.09	83.74	83.05	83.52	83.69	83.13	93.45		
	Wt.	2.28	2.205	2.153	2.256	2.153	2.150	2.145	2.154	2.186	2.203	2.184	2.195	2.198	2.28		
U-12	Pellet No.	3	14	15	16	17	18	19	20	21	22	23	24	25	4	"	
	Dia.	5.32	5.425	5.408	5.445	5.443	5.423	5.433	5.423	5.415	5.423	5.415	5.425	5.420	5.32	PN-41	
	Hei.	9.99	10.190	9.720	10.240	10.285	10.055	10.125	10.025	10.070	10.100	10.060	10.150	9.850	10.00		
	T.D.	93.73	83.64	84.77	82.93	83.55	83.37	83.37	84.04	83.98	83.53	83.53	83.74	83.90	93.63		
	Wt.	2.28	2.175	2.089	2.183	2.207	2.153	2.160	2.148	2.150	2.151	2.107	2.169	2.105	2.28		

Table 4-1-3 Pellet Line up of lower pins (L-01 ~ L-06)

Lower e.p.		Connecting e.p.															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		
		Insulator p.							Fuel p.							Insulator p.	
L-01	Pellet No.	33	22	63	9	80	57	52	51	30	21	101	92	87	34	Fuel pellet	
	Dia. (mm)	5.32	5.425	5.440	5.433	5.418	5.425	5.433	5.425	5.425	5.425	5.433	5.408	5.423	5.31	Lot	
	Hei. (mm)	10.02	9.755	9.875	10.380	10.360	10.335	10.330	10.315	10.305	10.290	10.280	10.155	10.235	10.00	PN-61	
	T.D. (%)	94.27	84.74	84.51	85.65	85.44	84.48	84.51	84.60	84.84	85.00	84.98	86.36	85.86	94.81		
	Wt. (g)	2.30	2.109	2.141	2.275	2.252	2.228	2.234	2.227	2.231	2.232	2.235	2.223	2.240	2.30		
L-02	Pellet No.	39	69	74	107	79	32	78	43	58	12	91	86	46	40	"	
	Dia.	5.31	5.433	5.413	5.423	5.428	5.410	5.443	5.420	5.438	5.428	5.418	5.428	5.430	5.31	PN-61	
	Hei.	10.00	9.740	9.720	10.375	10.370	10.355	10.330	10.310	10.305	10.285	10.285	10.255	10.255	10.01		
	T.D.	94.81	86.28	84.40	85.19	85.48	85.45	85.95	85.56	84.49	85.42	85.25	85.62	84.79	94.40		
	Wt.	2.30	2.134	2.095	2.261	2.260	2.249	2.251	2.253	2.234	2.248	2.237	2.236	2.219			
L-03	Pellet No.	35	66	41	62	18	104	37	16	26	17	103	61	55	36	"	
	Dia.	5.32	5.413	5.328	5.433	5.423	5.420	5.408	5.428	5.440	5.433	5.425	5.420	5.425	5.31	PN-61	
	Hei.	10.00	9.740	9.720	10.375	10.370	10.335	10.330	10.310	10.305	10.285	10.285	10.255	10.255	10.01		
	T.D.	94.81	86.28	84.40	85.19	85.48	85.45	85.95	85.56	84.49	85.42	85.25	85.62	84.79	94.40		
	Wt.	2.30	2.134	2.095	2.261	2.260	2.249	2.251	2.253	2.234	2.248	2.237	2.236	2.219	2.29		
L-04	Pellet No.	31	75	77	42	24	111	39	40	108	84	67	13	114	32	"	
	Dia.	5.32	5.435	5.433	5.425	5.423	5.405	5.405	5.423	5.435	5.420	5.408	5.410	5.413	5.31	PN-61	
	Hei.	10.02	9.770	9.675	10.385	10.360	10.350	10.320	10.320	10.300	10.295	10.280	10.260	10.195	9.98		
	T.D.	94.27	84.54	84.56	84.37	85.22	86.26	86.28	84.87	85.04	85.90	86.54	85.88	86.29	94.17		
	Wt.	2.30	2.115	2.093	2.236	2.251	2.261	2.255	2.233	2.243	2.252	2.255	2.236	2.234	2.28		
L-05	Pellet No.	29	184	185	186	187	188	189	190	33	44	19	35	110	30	"	
	Dia.	5.31	5.433	5.420	5.423	5.413	5.415	5.428	5.423	5.423	5.405	5.423	5.410	5.413	5.31	Pellet No184	
	Hei.	10.02	10.270	10.215	9.970	10.030	10.135	10.105	10.085	10.225	10.420	10.225	10.225	10.190	10.03	~190; PN-41	
	T.D.	93.80	83.60	84.17	83.99	84.12	84.21	83.73	84.05	85.01	86.38	85.58	86.13	86.18	93.71	44~110; PN-61	
	Wt.	2.28	2.197	2.190	2.135	2.147	2.170	2.161	2.161	2.216	2.280	2.231	2.235	2.230	2.28		
L-06	Pellet No.	41	85	82	5	6	116	106	29	49	100	10	76	59	42	"	
	Dia.	5.31	5.430	5.420	5.455	5.433	5.405	5.410	5.425	5.410	5.410	5.413	5.413	5.418	5.32	PN-61	
	Hei.	10.02	10.885	10.400	9.510	9.925	10.050	10.180	10.150	10.280	10.270	10.345	10.100	9.840	9.99		
	T.D.	94.21	85.91	86.13	83.16	84.34	86.01	86.15	84.71	85.40	86.54	86.16	86.12	84.38	94.14		
	Wt.	2.29	2.390	2.281	2.040	2.142	2.189	2.225	2.194	2.228	2.255	2.264	2.209	2.113	2.29		

Table 4-1-4 Peelet line up of lower pins (L-07 ~ L-12)

N841-79-30

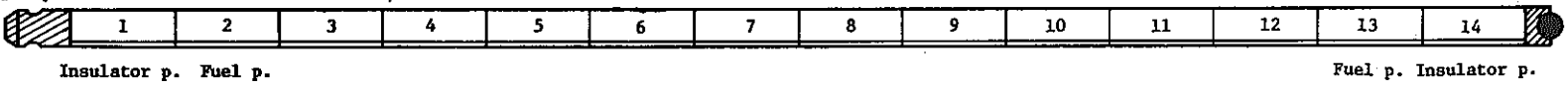
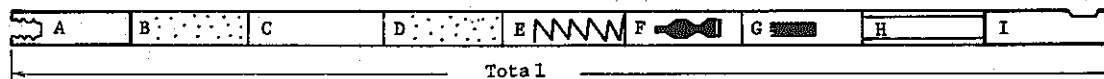
		Lower e.p.  Connecting e.p.															
		Insulator p.							Fuel p.							Insulator p.	
L-07	Pellet No.	27	172	173	174	175	176	177	178	179	180	181	182	183	28	Fuel pellet	
	Dia. (mm)	5.31	5.425	5.420	5.423	5.415	5.418	5.425	5.410	5.435	5.408	5.430	5.433	5.420	5.32	Lot	
	Hei. (mm)	10.01	10.185	10.030	9.815	10.230	10.365	10.215	9.905	9.705	10.025	10.065	10.235	9.825	9.98	PN-41	
	T.D. (%)	93.89	83.61	84.04	83.96	84.51	83.86	83.55	84.46	83.40	84.19	83.87	83.69	84.07	93.82		
	Wt. (g)	2.28	2.173	2.147	2.101	2.198	2.213	2.178	2.123	2.073	2.140	2.158	2.192	2.104	2.28		
L-08	Pellet No.	37	15	89	94	34	83	3	23	115	105	54	96	2	38	"	
	Dia.	5.31	5.443	5.438	5.420	5.408	5.438	5.423	5.438	5.408	5.425	5.428	5.410	5.418	5.32	PN-41	
	Hei.	10.01	10.560	9.980	9.985	10.195	10.294	10.410	10.150	10.250	10.145	10.260	9.970	9.840	9.99		
	T.D.	94.30	84.69	84.45	85.50	85.60	84.74	85.48	84.93	86.83	85.50	84.94	86.46	85.10	94.14		
	Wt.	2.29	2.297	2.160	2.174	2.212	2.236	2.268	2.210	2.256	2.213	2.226	2.187	2.219	2.29		
L-09	Pellet No.	17	111	112	113	114	115	116	117	118	119	120	121	122	18	"	
	Dia.	5.31	5.443	5.420	5.425	5.420	5.430	5.408	5.425	5.428	5.415	5.433	5.438	5.418	5.32	PN-41	
	Hei.	9.99	10.125	10.055	10.320	10.135	10.195	10.035	10.155	9.955	10.155	10.045	10.205	10.115	10.03		
	T.D.	93.26	82.60	83.67	83.31	83.86	83.87	84.11	84.24	82.94	84.16	83.57	82.72	84.11	93.35		
	Wt.	2.26	2.140	2.143	2.194	2.165	2.178	2.140	2.183	2.109	2.173	2.148	2.164	2.165	2.28		
L-10	Pellet No.	43	71	53	64	47	88	117	73	95	97	36	68	90	44	"	
	Dia.	5.32	5.438	5.423	5.428	5.415	5.418	5.423	5.423	5.428	5.455	5.418	5.418	5.405	5.32	PN-41	
	Hei.	10.02	10.615	10.055	9.800	9.825	10.080	10.070	10.480	10.475	10.230	10.345	10.205	9.810	9.99		
	T.D.	93.86	84.65	84.02	84.56	85.07	86.18	85.48	85.58	85.76	83.37	85.62	86.04	86.34	93.73		
	Wt.	2.29	2.303	2.154	2.116	2.125	2.210	2.194	2.286	2.294	2.200	2.254	2.234	2.145	2.28		
L-11	Pellet No.	47	81	98	45	27	28	93	4	7	1	112	48	31	48	"	
	Dia.	5.31	5.420	5.405	5.413	5.440	5.415	5.423	5.408	5.435	5.408	5.405	5.408	5.418	5.32	PN-41	
	Hei.	10.01	10.170	10.165	10.175	10.185	10.190	10.180	10.180	10.165	10.140	10.165	10.150	10.185	10.01		
	T.D.	94.30	85.57	86.67	85.97	84.56	85.84	85.86	86.92	85.42	86.64	86.59	86.01	84.96	93.95		
	Wt.	2.29	2.216	2.231	2.222	2.210	2.224	2.220	2.243	2.224	2.227	2.229	2.213	2.202	2.29		
L-12	Pellet No.	45	70	50	8	65	56	72	60	99	11	102	14	25	46	"	
	Dia.	5.32	5.435	5.410	5.425	5.418	5.413	5.415	5.443	5.415	5.423	5.423	5.418	5.425	5.31	PN-41	
	Hei.	10.01	10.405	10.280	10.025	10.020	10.280	10.170	10.110	10.110	10.125	10.130	10.125	10.150	10.00		
	T.D.	93.95	84.19	85.90	84.61	85.83	85.82	85.88	83.96	85.10	85.73	85.13	85.11	84.86	94.40		
	Wt.	2.29	2.256	2.241	2.164	2.188	2.245	2.220	2.180	2.187	2.213	2.219	2.193	2.198	2.29		

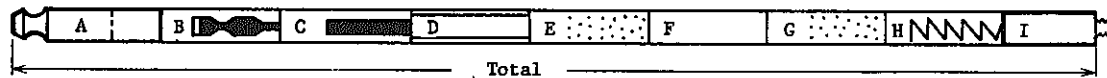
Table 4-2-1 Dimension and Weight of fuel pins and components (upper pins)



Pin No.	Cladding No.		A	B	C	D	E	F	G	H	I	Cladding	Total
			Connect- ing e.p. (Lower)	Insulator pellet	Fuel pellet	Insulator pellet	spring	Tagging gas capsule	No SiC Capsule	Sleeve	Upper end plug		
U 01	S-5223-2	(a)	25.05	10.02	121.50	10.00	Free Length 48.2 mm (Av.) Weight 0.56 g (Av.)	70.16	39.91	89.95	45.00	390.00	460.00
		(b)	6.44	2.28	25.98	2.28		4.51	27 2.49	3.47	11.99	26.85	86.72
U 02	S-5236-1	(a)	25.02	10.02	121.30	10.00		70.20	39.89	89.95	45.01	389.98	459.80
		(b)	6.44	2.28	25.93	2.28		4.56	23 2.51	3.68	11.99	26.70	86.87
U 03	S-5236-1	(a)	24.92	10.00	120.85	10.00		70.05	39.92	89.95	44.99	390.00	459.94
		(b)	6.44	2.26	25.86	2.26		4.56	8 2.44	3.68	11.99	26.77	86.80
U 04	S-5260-1	(a)	24.99	9.98	120.75	10.00		70.26	39.93	89.85	44.95	389.94	459.50
		(b)	6.44	2.29	25.79	2.28		4.52	14 2.52	3.47	11.99	26.77	86.57
U 05	S-5260-1	(a)	25.01	10.03	121.60	10.03		70.28	39.94	89.95	45.00	389.92	459.72
		(b)	6.44	2.28	25.99	2.30		4.51	10 2.51	3.47	11.99	26.76	86.85
U 06	S-5260-2	(a)	25.00	10.01	121.00	10.01		70.19	39.93	89.80	45.06	390.00	459.76
		(b)	6.44	2.28	25.89	2.28		4.52	11 2.45	3.47	11.99	26.78	86.63
U 07	S-5261-1	(a)	25.05	9.95	121.05	9.96	70.06	39.95	89.70	45.06	389.92	459.80	
		(b)	6.44	2.29	25.92	2.29	4.53	12 2.44	3.47	11.99	26.75	86.62	
U 08	S-5263-1	(a)	24.99	10.00	121.25	10.01	70.20	39.93	90.00	45.04	390.00	459.68	
		(b)	6.44	2.28	25.95	2.28	4.53	16 2.51	3.68	11.99	26.72	86.97	
U 09	S-5263-1	(a)	25.03	10.03	122.35	10.02	70.22	39.75	90.00	44.99	390.06	459.76	
		(b)	6.44	2.30	26.10	2.27	4.53	22 2.43	3.48	11.99	26.72	86.80	
U 10	S-5264-1	(a)	25.03	9.98	122.20	9.97	70.27	39.93	89.90	44.98	190.08	459.72	
		(b)	6.44	2.28	26.11	2.28	4.51	30 2.10	3.48	11.99	26.74	86.89	
U 11	S-5196-1	(a)	25.03	9.99	121.70	10.02	70.24	39.94	89.95	45.05	390.00	459.90	
		(b)	6.44	2.28	26.18	2.28	4.52	29 2.50	3.47	11.99	26.66	86.74	
U 12	S-5196-2	(a)	25.03	9.99	120.75	10.00	70.28	39.95	89.95	45.01	390.02	459.90	
		(b)	6.44	2.28	25.80	2.28	4.56	17 2.51	3.47	11.99	26.67	86.55	

\* a; length (mm)  
b; weight (g)

Table 4-2-2 Dimension and weight of fuel pins and components (lower pins)



Pin No.	Cladding No.		A Lower end plug	B Tagging gas capsule	C SiC capsule	D Sleeve	E Insulator pellet	F Fuel pellet	G Insulator pellet	H Spring	I Connect- ing e.p. (Upper)	Cladding	Total
L 01	S-5242-1	(a)	89.68	70.23	39.91	90.00	10.02	121.85	10.00	Free Length : 48.2 mm (Av.) Weight : 0.56 g (Av.)	14.87	389.98	494.45
		(b)	23.08	4.48	2.52	3.48	2.30	26.63	2.30		5.70	26.88	97.84
L 02	S-5264-1	(a)	89.85	70.19	39.98	90.00	10.00	121.95	10.02		14.91	390.00	494.70
		(b)	23.08	4.52	2.45	3.47	2.29	26.60	2.29		5.70	26.73	97.84
L 03	S-5258-1	(a)	89.82	70.60	40.01	89.97	10.00	122.35	10.01		14.97	390.06	494.85
		(b)	23.14	4.56	2.45	3.48	2.30	26.68	2.29		5.70	26.89	97.98
L 04	S-5196-2	(a)	90.01	70.09	39.95	90.00	10.02	122.20	9.98		14.97	389.96	494.75
		(b)	23.14	4.56	2.52	3.48	2.30	26.66	2.28		5.70	26.65	97.85
L 05	S-5196-1	(a)	90.02	70.24	39.99	89.95	10.02	121.75	10.03		14.98	390.00	494.85
		(b)	23.14	4.51	2.43	3.47	2.28	26.35	2.28		5.70	26.72	97.44
L 06	S-5236-2	(a)	90.05	70.21	39.95	89.90	10.02	121.60	9.99		14.94	390.02	494.55
		(b)	23.04	4.53	2.51	3.47	2.29	26.53	2.29		5.70	26.71	97.65
L 07	S-5240-2	(a)	89.74	70.10	39.98	89.95	10.01	120.50	9.98	14.97	390.00	494.60	
		(b)	23.13	4.57	2.54	3.67	2.28	25.80	2.29	5.70	26.73	97.26	
L 08	S-5263-2	(a)	89.95	70.12	39.98	89.90	10.01	121.75	9.99	14.91	389.98	494.65	
		(b)	23.13	4.53	2.44	3.48	2.29	26.57	2.29	5.70	26.68	97.69	
L 09	S-5240-1	(a)	89.72	70.16	39.94	89.95	9.99	121.35	10.03	15.01	390.00	494.85	
		(b)	23.20	4.51	2.53	3.47	2.26	25.90	2.28	5.70	26.70	97.15	
L 10	S-5236-2	(a)	89.96	70.24	39.94	89.95	10.02	121.65	9.99	14.97	390.10	495.00	
		(b)	23.17	4.51	2.50	3.48	2.29	26.52	2.28	5.70	26.68	97.75	
L 11	S-5260-2	(a)	90.07	70.25	39.97	89.90	10.01	121.80	10.01	14.83	390.00	494.75	
		(b)	23.13	4.54	2.51	3.48	2.29	26.66	2.29	5.70	26.77	97.94	
L 12	S-5261-2	(a)	89.80	70.19	39.89	90.00	10.01	121.85	10.00	14.98	389.98	494.60	
		(b)	23.12	4.51	2.52	3.48	2.29	26.48	2.29	5.70	26.75	97.77	

\* a; length (mm)  
b; weight (g)



Table 4-3 The results of pin diameter and welded part diameter measurements

N841-79-30

Direction *	Diameter of welded part (spec ; <6.65mm)				Pin diameter (spec ; 6.500±0.030mm)													
	Upper end plug		Lower end plug		Distance from lower end plug welded part (mm)													
	X	Y	X	Y	50		100		150		200		250		300		350	
Pin no.	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
U - 01	6.55	6.54	6.58	6.60	6.503	6.503	6.503	6.503	6.503	6.503	6.504	6.503	6.504	6.504	6.502	6.504	6.505	6.504
- 02	6.57	6.53	6.62	6.58	6.503	6.503	6.503	6.503	6.503	6.502	6.505	6.502	6.505	6.504	6.502	6.503	6.504	6.503
- 03	6.54	6.55	6.61	6.59	6.504	6.503	6.503	6.503	6.503	6.502	6.504	6.503	6.502	6.503	6.504	6.503	6.504	6.503
- 04	6.54	6.55	6.62	6.58	6.503	6.503	6.503	6.502	6.503	6.503	6.503	6.503	6.503	6.503	6.503	6.503	6.503	6.503
- 05	6.59	6.55	6.59	6.60	6.504	6.503	6.506	6.505	6.504	6.603	6.504	6.504	6.504	6.503	6.504	6.503	6.504	6.504
- 06	6.62	6.59	6.59	6.59	6.505	6.505	6.505	6.506	6.506	6.505	6.505	6.506	6.505	6.506	6.505	6.506	6.505	6.506
- 07	6.59	6.59	6.60	6.61	6.502	6.502	6.503	6.502	6.504	6.504	6.503	6.503	6.503	6.502	6.502	6.502	6.502	6.502
- 08	6.57	6.58	6.60	6.58	6.504	6.503	6.504	6.504	6.503	6.504	6.504	6.504	6.504	6.504	6.502	6.504	6.504	6.504
- 09	6.58	6.55	6.61	6.60	6.502	6.502	6.503	6.502	6.502	6.502	6.503	6.502	6.503	6.502	6.503	6.503	6.503	6.502
- 10	6.56	6.57	6.60	6.62	6.503	6.503	6.505	6.506	6.502	6.502	6.503	6.503	6.502	6.502	6.502	6.502	6.502	6.502
- 11	6.59	6.56	6.60	6.59	6.501	6.501	6.503	6.503	6.502	6.502	6.501	6.501	6.502	6.501	6.501	6.501	6.501	6.502
- 12	6.58	6.55	6.62	6.60	6.502	6.502	6.502	6.501	6.502	6.501	6.503	6.502	6.503	6.501	6.503	6.501	6.503	6.501
L - 01	6.58	6.55	6.59	6.61	6.505	6.506	6.505	6.506	6.505	6.506	6.505	6.505	6.506	6.505	6.506	6.506	6.506	6.505
- 02	6.57	6.54	6.59	6.60	6.502	6.501	6.502	6.501	6.502	6.501	6.502	6.501	6.502	6.502	6.502	6.502	6.501	6.501
- 03	6.55	6.58	6.59	6.63	6.511	6.510	6.510	6.510	6.513	6.510	6.510	6.511	6.510	6.510	6.510	6.510	6.511	6.511
- 04	6.57	6.55	6.60	6.59	6.503	6.501	6.500	6.501	6.502	6.501	6.503	6.503	6.502	6.502	6.502	6.503	6.502	6.501
- 05	6.55	6.55	6.58	6.61	6.503	6.502	6.502	6.502	6.504	6.504	6.503	6.502	6.503	6.503	6.502	6.502	6.502	6.502
- 06	6.57	6.55	6.60	6.62	6.503	6.503	6.503	6.503	6.503	6.502	6.505	6.503	6.503	6.503	6.503	6.502	6.502	6.503
- 07	6.56	6.56	6.59	6.58	6.502	6.504	6.503	6.503	6.502	6.503	6.502	6.503	6.502	6.502	6.502	6.502	6.502	6.502
- 08	6.58	6.55	6.60	6.60	6.504	6.503	6.503	6.503	6.505	6.503	6.504	6.502	6.503	6.502	6.503	6.502	6.503	6.503
- 09	6.58	6.55	6.63	6.60	6.502	6.502	6.501	6.502	6.503	6.503	6.501	6.501	6.501	6.501	6.501	6.500	6.500	6.501
- 10	6.55	6.58	6.59	6.63	6.506	6.504	6.504	6.504	6.505	6.504	6.504	6.504	6.504	6.504	6.504	6.504	6.505	6.505
- 11	6.55	6.55	6.59	6.61	6.505	6.505	6.505	6.505	6.505	6.505	6.505	6.505	6.505	6.504	6.505	6.505	6.505	6.505
- 12	6.55	6.57	6.61	6.62	6.503	6.502	6.503	6.504	6.502	6.502	6.503	6.501	6.503	6.502	6.502	6.502	6.502	6.501

\* ; A dot is marked on the lower end plug. This dot shows X-direction, and Y-direction is 90° from this point.

Table 4-4 Results of non destructive inspection of fuel pins

Item	X-ray radiography		He-LookTest	Surface contamination		Straightness*
Spec.	No harmful defects		(atm.cc/ s)	Loose	Fixed	<2mm
Pin NO.	Welding point	Struc- ture of pin	$1 \times 10^{-8}$	<10dpm	<1000 dpm	
U - 01	Go	Go	0.036	< 5	8	Go
- 02	Go	Go	"	< 5	40	Go
- 03	Go	Go	"	< 5	16	Go
- 04	Go	Go	"	< 5	12	Go
- 05	Go	Go	"	< 5	52	Go
- 06	Go	Go	"	< 5	24	Go
- 07	Go	Go	"	< 5	< 5	Go
- 08	Go	Go	"	< 5	8	Go
- 09	Go	Go	"	< 5	32	Go
- 10	Go	Go	"	< 5	8	Go
- 11	Go	Go	"	< 5	48	Go
- 12	Go	Go	"	< 5	< 5	Go
L - 01	Go	Go	0.036	< 5	< 5	Go
- 02	Go	Go	"	< 5	12	Go
- 03	Go	Go	"	< 5	< 5	Go
- 04	Go	Go	"	< 5	< 5	Go
- 05	Go	Go	"	< 5	24	Go
- 06	Go	Go	"	< 5	8	Go
- 07	Go	Go	"	< 5	20	Go
- 08	Go	Go	"	< 5	76	Go
- 09	Go	Go	"	< 5	8	Go
- 10	Go	Go	"	< 5	8	Go
- 11	Go	Go	"	< 5	< 5	Go
- 12	Go	Go	"	< 5	< 5	Go

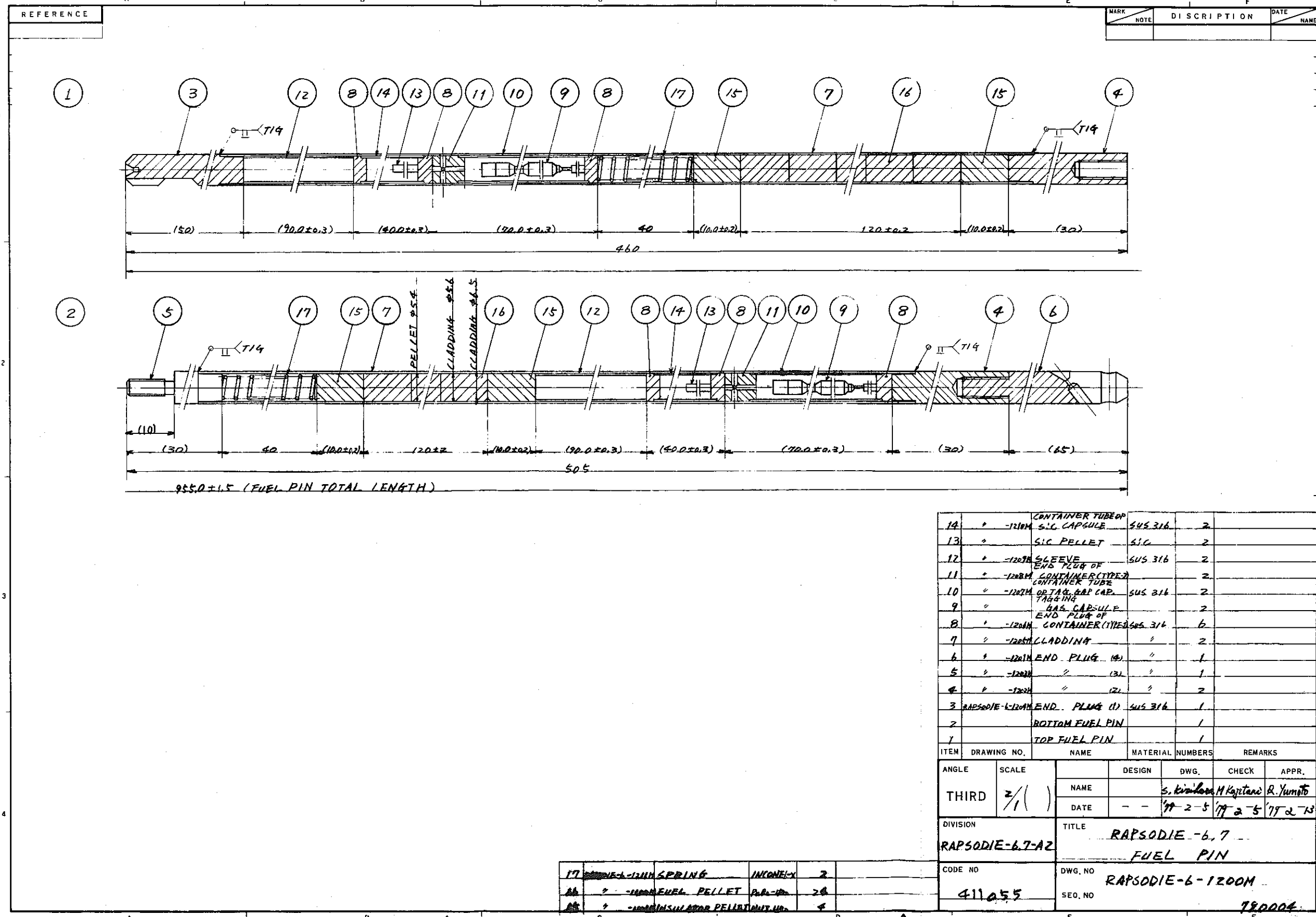
\* Straightness was checked after upper and lower pin connected.

Table 5-1 Weight of fuel materials

PIN NO.	CORE PELLETS							INSULATOR PELLETS	
	M.O (g)	PLUTONIUM			E.URANIUM			N.URANIUM	
		PuO <sub>2</sub> (g)	Pu (g)	Pu fissionable (g)	E.UO <sub>2</sub> (g)	E.U. (g)	U <sup>235</sup> (g)	N.UO <sub>2</sub> (g)	N.U. (g)
Lower-01	26.63	8.04	7.09	5.68	18.59	16.38	9.80	4.60	4.05
02	26.60	8.03	7.09	5.67	18.57	16.36	9.79	4.58	4.03
03	26.68	8.06	7.11	5.69	18.62	16.41	9.82	4.59	4.04
04	26.66	8.05	7.10	5.68	18.61	16.39	9.81	4.58	4.03
05	26.35	7.96	7.02	5.62	18.39	16.20	9.70	4.56	4.02
06	26.53	8.01	7.07	5.65	18.52	16.31	9.77	4.58	4.03
07	25.80	7.79	6.87	5.50	18.01	15.87	9.50	4.56	4.02
08	26.57	8.02	7.08	5.66	18.55	16.34	9.78	4.58	4.03
09	25.90	7.82	6.90	5.52	18.08	15.93	9.53	4.54	4.00
10	26.52	8.01	7.06	5.65	18.51	16.31	9.76	4.57	4.03
11	26.66	8.05	7.10	5.68	18.61	16.39	9.81	4.58	4.03
12	26.48	8.00	7.05	5.64	18.48	16.28	9.75	4.58	4.03
Upper-01	25.98	7.85	6.92	5.54	18.13	15.98	9.56	4.56	4.02
02	25.93	7.83	6.91	5.53	18.10	15.95	9.54	4.56	4.02
03	25.86	7.81	6.89	5.51	18.05	15.90	9.52	4.52	3.98
04	25.79	7.79	6.87	5.50	18.00	15.86	9.49	4.57	4.03
05	25.99	7.85	6.92	5.54	18.14	15.98	9.57	4.58	4.03
06	25.89	7.82	6.90	5.52	18.07	15.92	9.53	4.56	4.02
07	25.92	7.83	6.90	5.52	18.09	15.94	9.54	4.58	4.03
08	25.95	7.84	6.91	5.53	18.11	15.96	9.55	4.56	4.02
09	26.10	7.88	6.95	5.56	18.22	16.05	9.61	4.57	4.03
10	26.11	7.89	6.95	5.57	18.22	16.06	9.61	4.56	4.02
11	26.18	7.91	6.97	5.58	18.27	16.10	9.64	4.56	4.02
12	25.80	7.79	6.87	5.50	18.01	15.87	9.50	4.56	4.02
Total	628.88	189.93	167.50	134.04	438.95	386.74	231.48	109.64	96.58

## APPENDIX

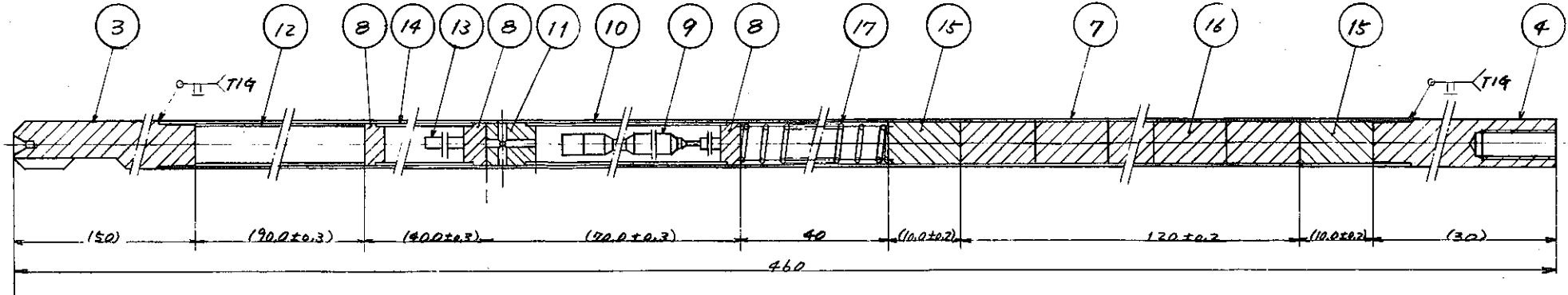
### DRAWINGS OF RAPSODIE-6,7 FUEL PINS



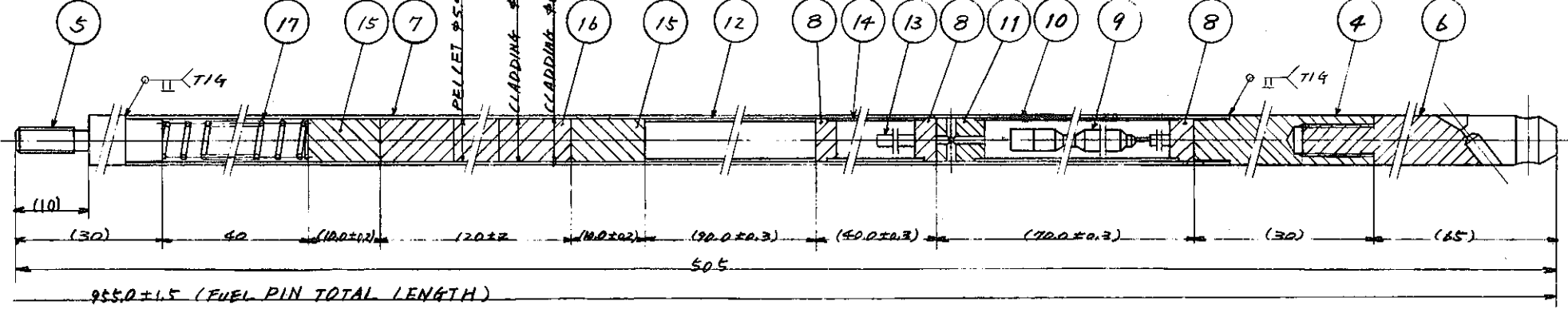
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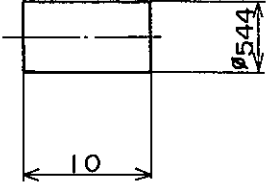
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14	CONTAINER TUBE OP	SUS 316	2
13	SIC CAPSULE	SIC	2
12	SLEEVE	SUS 316	2
11	END PLUG OF		2
10	CONTAINER (TYPE 2)	SUS 316	2
9	CONTAINER TUBE		2
8	OP TAG CAP CAP	SUS 316	2
7	GAS CAPSULE		2
6	END PLUG OF		2
5	CONTAINER (TYPE 1)	SUS 316	1
4	CLADDING		2
3	END PLUG (1)	SUS 316	1
2	BOTTOM FUEL PIN		1
1	TOP FUEL PIN		1

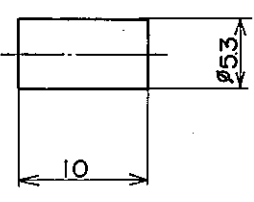
ANGLE	SCALE	DESIGN	DWG.	CHECK	APPR.
THIRD	2/1				
DIVISION		TITLE			
RAPSDIE-6,7-AZ		RAPSDIE-6,7 FUEL PIN			
CODE NO		DWG. NO		SEQ. NO	
411055		RAPSDIE-6-1200M		780004	

17	WELDED SPRING	INCONEL	2
16	FUEL PELLET	Pu-239	20
15	INSULATOR PELLET UNIT		4

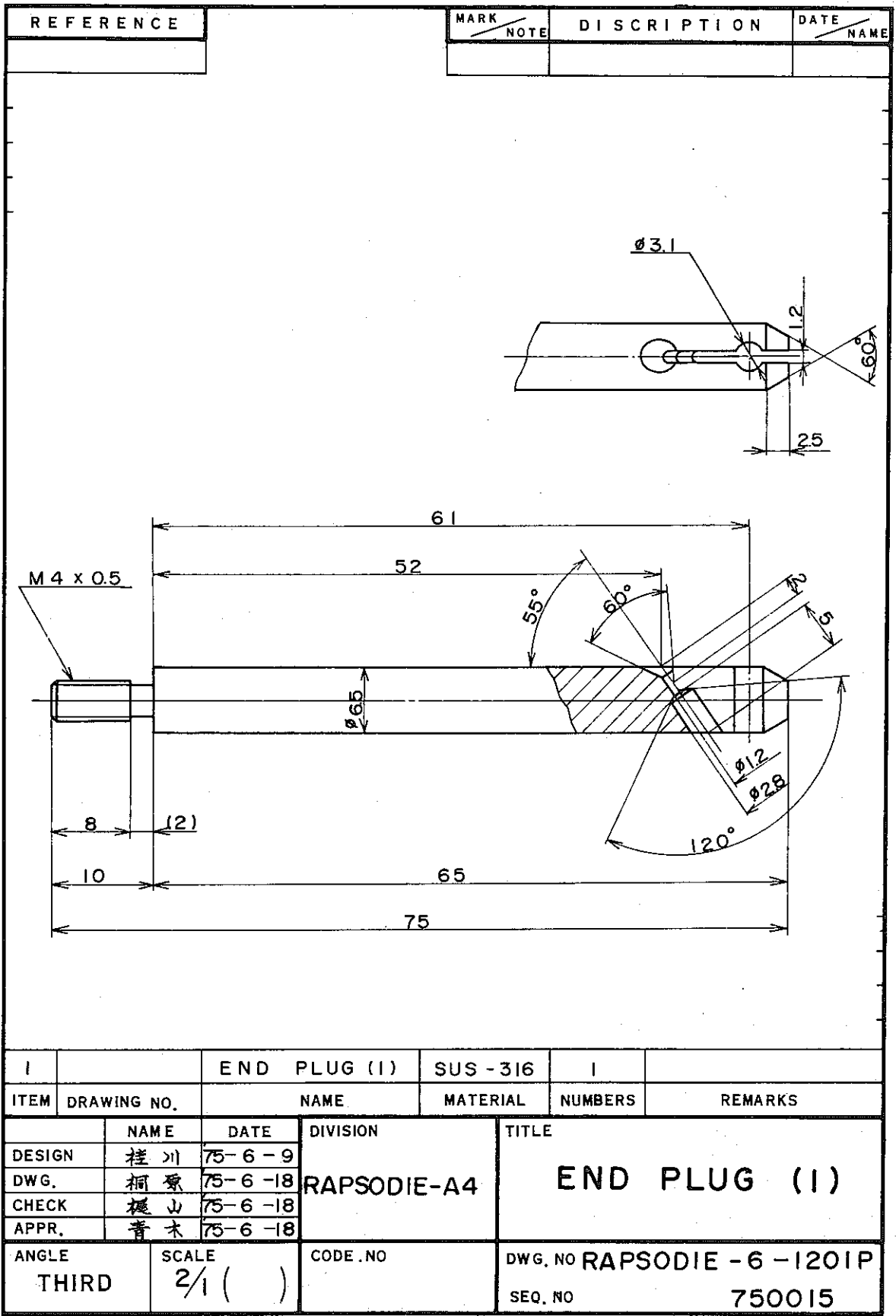
REFERENCE	MARK NOTE	DISCRIPTION	DATE NAME
			
1		FUEL PELLET	PuO <sub>2</sub> -UO <sub>2</sub> 24
ITEM	DRAWING NO.	NAME	MATERIAL      NUMBERS      REMARKS
	NAME	DATE	DIVISION      TITLE
DESIGN	桂 川	75-6-9	RAPSODIE-A4      FUEL PELLET
DWG.	桐 原	75-6-18	
CHECK	榎 山	75-6-18	
APPR.	青 木	75-6-18	
ANGLE THIRD	SCALE 2/1 ( )	CODE .NO	DWG. NO RAPSODIE-6-1100P SEQ. NO 750026

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

N841-79-30

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME		
					
1		AXIAL BLANKET PELLET	NAT. UO <sub>2</sub> 4		
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂川	75-6-9	RAPSODIE-A4	AXIAL BLANKET PELLET	
DWG.	桐原	75-6-18			
CHECK	樋山	75-6-18			
APPR.	青木	75-6-18			
ANGLE	SCALE	CODE NO	DWG. NO RAPSODIE-6-1101P		
THIRD	2/1 ( )		SEQ. NO 750025		

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI





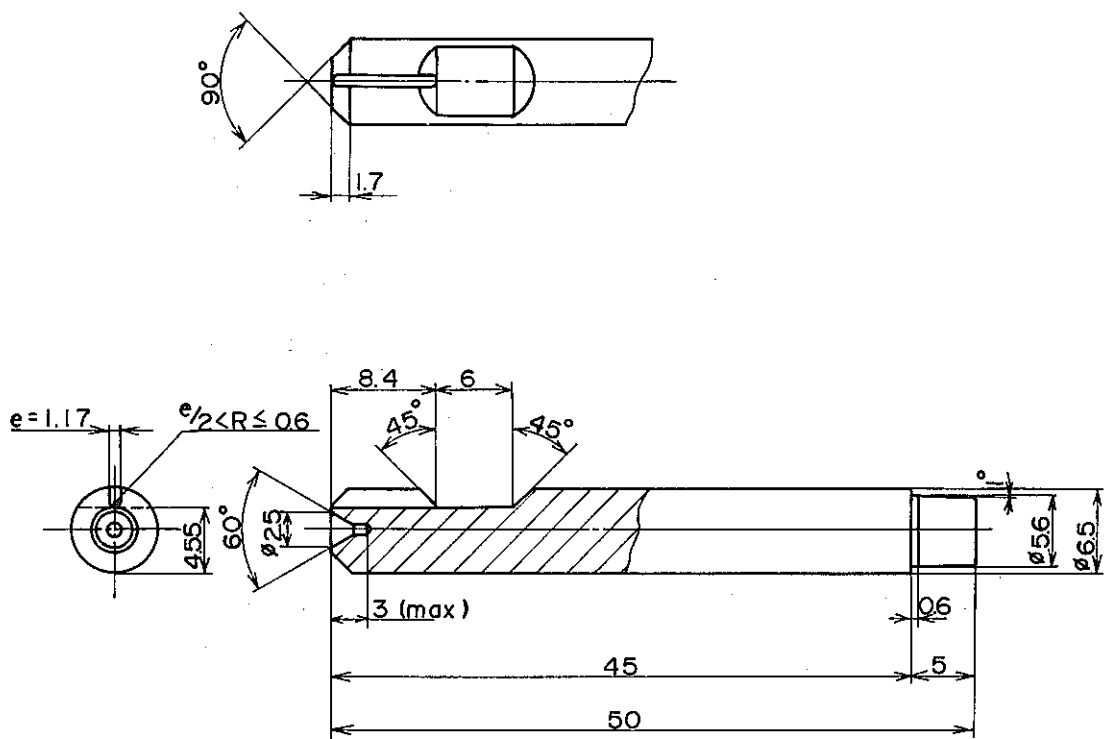
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1		END PLUG (2)	SUS - 316		
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂 川	75-6-9	RAPSDIE - A4	END PLUG (2)	
DWG.	桐 原	75-6-18			
CHECK	樺 山	75-6-18			
APPR.	青 木	75-6-18			
ANGLE	SCALE	CODE .NO	DWG. NO	RAPSDIE - 6 - 1202 P	
THIRD	2/1 ( )		SEQ. NO	750016	

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

REFERENCE	MARK NOTE	DISCRIPTION	DATE NAME
I		END PLUG (3)	SUS - 316
ITEM	DRAWING NO.	NAME	MATERIAL
	NAME	DATE	DIVISION
DESIGN	桂川	75-6-9	RAPSODIE - A4
DWG.	桐原	75-6-18	
CHECK	榎山	75-6-18	
APPR.	青木	75-6-18	
TITLE	END PLUG (3)		
ANGLE	SCALE	CODE .NO	DWG. NO
THIRD	2/1 ( )		RAPSODIE - 6 - 1203P
			SEQ. NO
			750017

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

REFERENCE	MARK	DISCRIPTION	DATE
	NOTE		NAME



I		END PLUG (4)	SUS - 316	I	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
DESIGN	桂川	75-6-9	RAPSODIE-A4	END PLUG (4)	
DWG.	桐原	75-6-18			
CHECK	堀山	75-6-18			
APPR.	青木	75-6-18			
ANGLE THIRD	SCALE 2/1 ( )	CODE .NO	DWG. NO	RAPSODIE-6-1204P	SEQ. NO
				750018	

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME

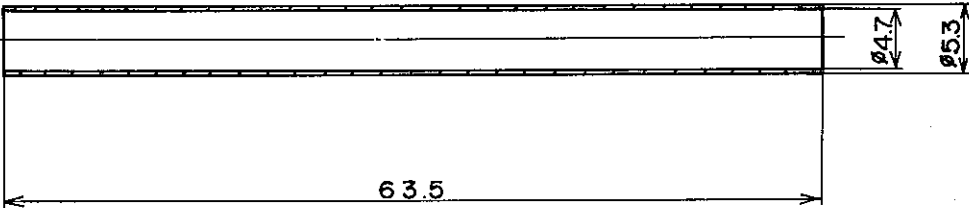
  

I		CLADDING	SUS -316	2	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂川	75-6-9	RAPSODIE-A4	CLADDING	
DWG.	桐原	75-6-18			
CHECK	榎山	75-6-18			
APPR.	青木	75-6-18			
ANGLE THIRD		SCALE 2/1 ( )	CODE .NO	DWG. NO	RAPSODIE-6-1205P
				SEQ. NO	750019

N841-79-30

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME
1		END PLUG OF CONTAINER	SUS - 316    6
ITEM	DRAWING NO.	NAME	MATERIAL    NUMBERS    REMARKS
	NAME	DATE	DIVISION    TITLE
DESIGN	桂川	75-6-9	RAPSODIE - A4    END PLUG OF CONTAINER (TYPE - 1)
DWG.	桐原	75-6-18	
CHECK	榎山	75-6-18	
APPR.	青木	75-6-18	
ANGLE	SCALE	CODE .NO	DWG. NO    RAPSODIE - 6 - 1206P
THIRD	5/1 ( )		SEQ. NO    750020

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

REFERENCE	MARK NOTE	DISCRIPTION	DATE NAME
			
1		CONTAINER TUBE OF TAG GAS CAPSULE	SUS-316      2
ITEM	DRAWING NO.	NAME	MATERIAL      NUMBERS      REMARKS
	NAME	DATE	DIVISION
DESIGN	桂川	75-6-9	RAPSODIE - A4
DWG.	桐原	75-6-18	
CHECK	板山	75-6-18	
APPR.	青木	75-6-18	
TITLE		CONTAINER TUBE OF TAGGING GAS CAPSULE	
ANGLE THIRD	SCALE 2/1 ( )	CODE .NO	DWG. NO RAPSODIE -6-1207P SEQ. NO 750021

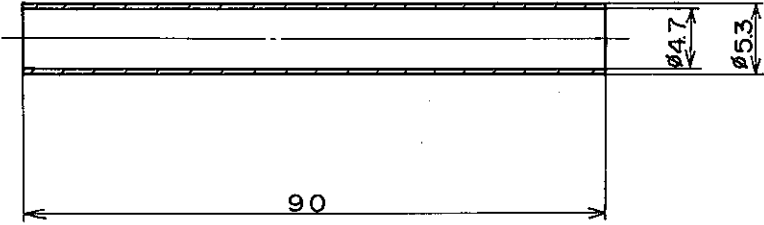
POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

N841-79-30

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME
1		END PLUG OF CONTAINER	SUS - 316      2
ITEM	DRAWING NO.	NAME	MATERIAL      NUMBERS      REMARKS
DESIGN	NAME	DATE	DIVISION
DWG.	挂川	75-6-9	RAPSODIE - A4
CHECK	桐原	75-6-18	
APPR.	榎山	75-6-18	
TITLE	青木	75-6-18	
ANGLE	SCALE	CODE . NO	DWG. NO
THIRD	5/1 ( )		RAPSODIE - 6 - 1208 P
			SEQ. NO
			750022

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

N841-79-30

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME
			

I		SLEEVE	SUS-316	2	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂川	75-6-9	RAPSODIE -A4	SLEEVE	
DWG.	桐原	75-6-18			
CHECK	榎山	75-6-18			
APPR.	青木	75-6-18			
ANGLE	SCALE	CODE .NO	DWG. NO	RAPSODIE-6-1209 P	
THIRD	2/1 ( )		SEQ. NO	750023	

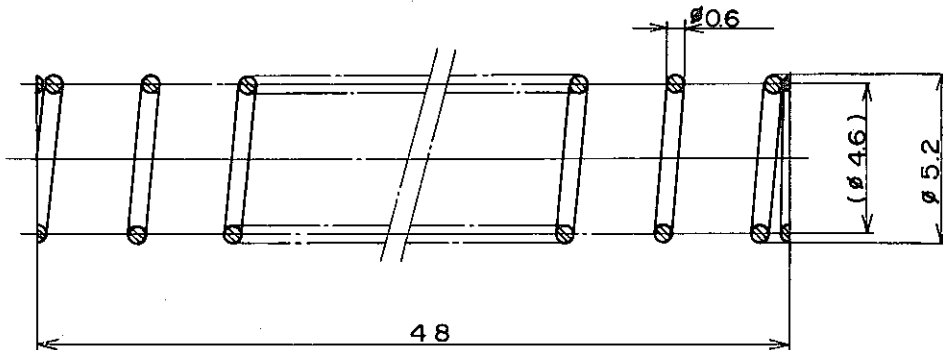
POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI



REFERENCE	MARK NOTE	DISCRIPTION	DATE NAME
1		CONTAINER TUBE OF SiC CAPSULE	SUS-316      2
ITEM	DRAWING NO.	NAME	MATERIAL      NUMBERS      REMARKS
	NAME	DATE	DIVISION
DESIGN	桂川	75-6-9	RAPSODIE-A4
DWG.	桐原	75-6-18	
CHECK	板山	75-6-18	
APPR.	青木	75-6-18	
ANGLE THIRD	SCALE 2/1 ( )	CODE .NO	TITLE CONTAINER TUBE OF SiC CAPSULE
		DWG. NO	RAPSODIE-6-1210 P
		SEQ. NO	750024

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

REFERENCE	MARK / NOTE	DISCRIPTION	DATE / NAME

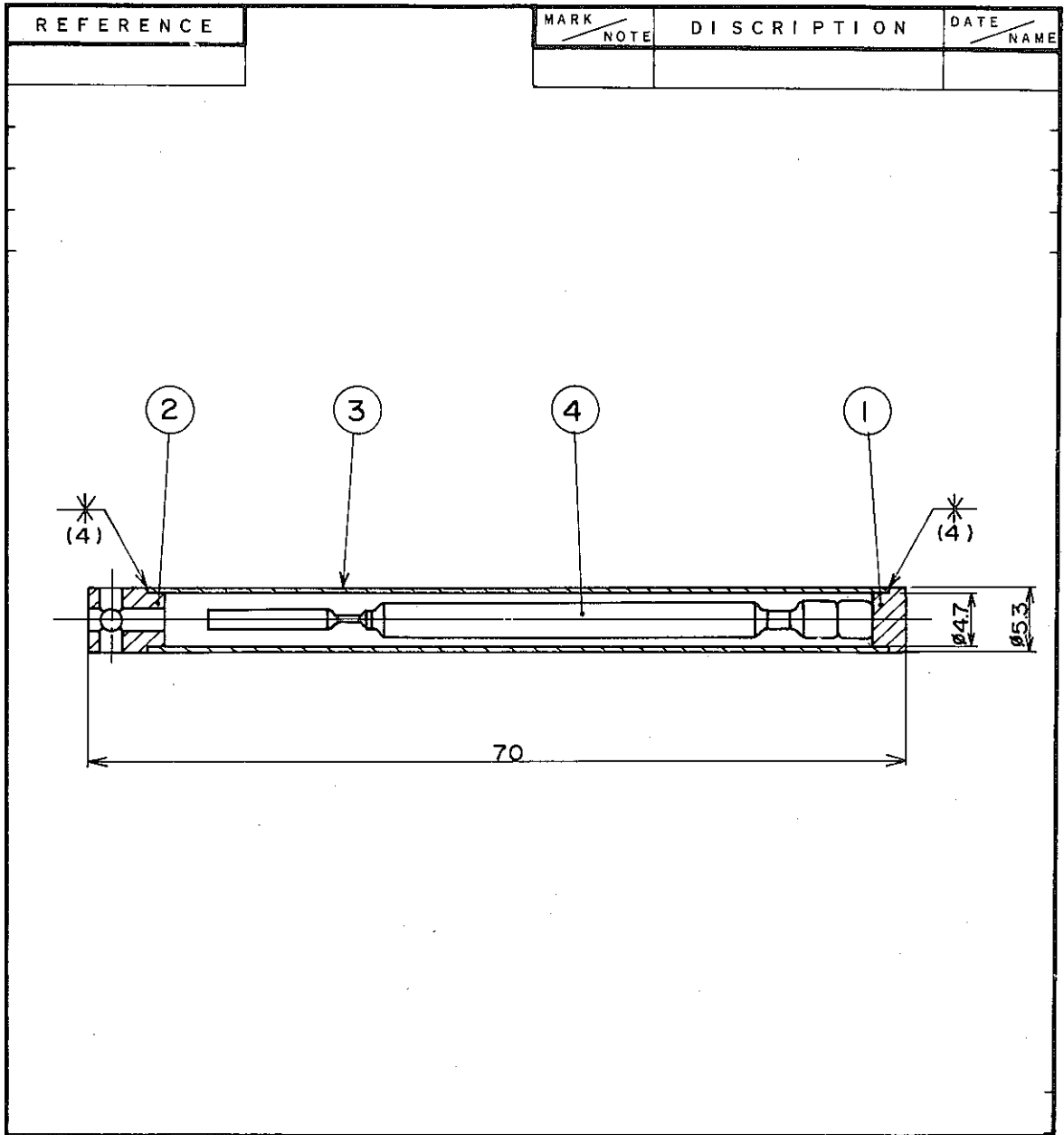


MATERIAL	SWPB
WIRE DIA	0.6
COIL OUTER DIA	5.2
TOTAL TURNS	17
END TURN	2
COIL DIRECTION	RIGHT
FREE LENGTH	48
SPRING CONSTANT	0089 <sup>kg</sup> / <sub>mm</sub>

I		SPRING	SWPB	2	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂川	75-6-9	RAPSODIE -A4	SPRING	
DWG.	桐原	75-6-18			
CHECK	榎山	75-6-18			
APPR.	青木	75-6-18			
ANGLE	SCALE	CODE .NO	DWG. NO	RAPSODIE -6-1211P	
THIRD	5/1 ( )		SEQ. NO	750027	

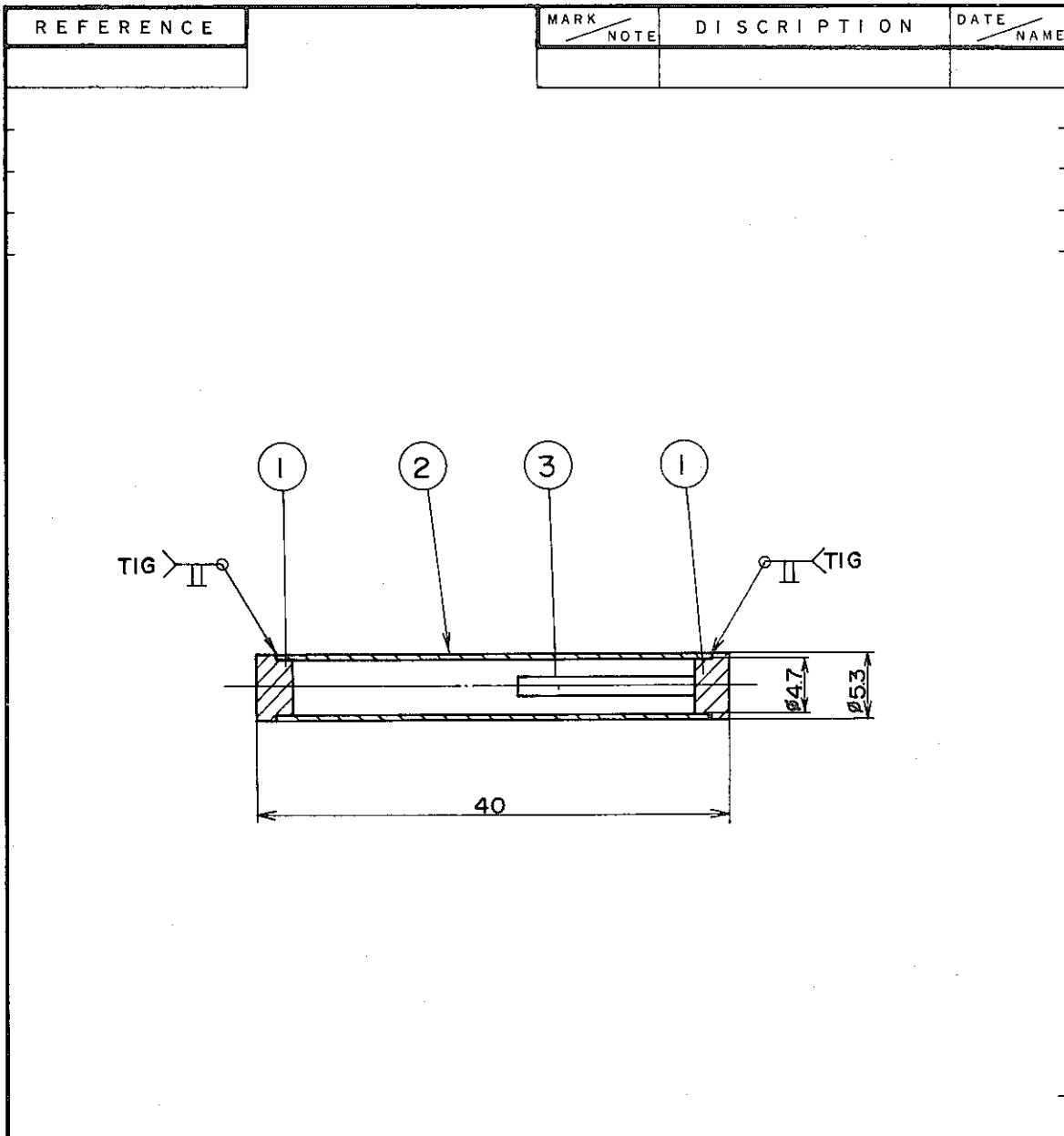
POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI

N841-79-30



4		TAGGING GAS CAPSULE		1	
3	RAPSODIE -6-1207P	CONTAINER TUBE OF TAG GAS CAP.	SUS-316	1	
2	-6-1208P	END PLUG OF CONTAINER (TYPE-2)	✓	1	
1	RAPSODIE -6-1206P	END PLUG OF CONTAINER (TYPE-1)	SUS-316	1	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION	TITLE	
DESIGN	桂川	75-6-9	RAPSODIE -A4	CONTAINER OF TAG. GAS CAPSULE	
DWG.	桐原	75-6-10			
CHECK	樺山	75-6-18			
APPR.	青木	75-6-18			
ANGLE	SCALE	CODE .NO	DWG. NO RAPSODIE -6 - 1212 P		
THIRD	2/1 ( )		SEQ. NO 750028		

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI



3		SIC PELLET	SIC	1	
2	RAPSODIE -6-1210P	CONTAINER TUBE OF SIC CAPSULE	SUS-316	1	
1	RAPSODIE -6-1206P	END PLUG OF CONTAINER (TYPE-1)	SUS-316	2	
ITEM	DRAWING NO.	NAME	MATERIAL	NUMBERS	REMARKS
	NAME	DATE	DIVISION		TITLE
DESIGN	桂川	75-6-9	RAPSODIE-A4		CONTAINER OF SiC
DWG.	桐原	75-6-18			
CHECK	提山	75-6-18			
APPR.	青木	75-6-18			
ANGLE THIRD	SCALE 2/1 ( )	CODE .NO	DWG. NO	RAPSODIE-6-1213 P	
			SEQ. NO	750029	

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI