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*CERTIFICATE AND RECORDS OF  
HALDEN IFA-554/555 TEST FUEL  
RODS IN PNC IRRADIATION PROGRAM*

*SEPTEMBER 1985*

*Tokai Works  
Power Reactor & Nuclear Fuel Development Corporation*

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**CERTIFICATE AND RECORDS OF HALDEN IFA-554/555  
TEST FUEL RODS IN PNC IRRADIATION PROGRAM**

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ATTACHMENT

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1. General remarks

Halden IFA-554/555 irradiation test is planned to examine the fuel behavior of ATR type fuel under load follow reactor operation.

Eight fuel rods for this irradiation test were fabricated in Plutonium Fuel Div. in Tokai Works PNC.

These fuel rods install instruments for the measurement of fuel column elongation, cladding elongation, plenum pressure and fuel center temperature.

The fuel pellets were made from one type of PuO<sub>2</sub> raw materials. It was obtained by precipitation direct denitration process.

The fuel composition is 4.4 % PuO<sub>2</sub>-UO<sub>2</sub> (natural), and the pellet nominal dimension is 12.40 mm diameter and 13 mm height.

2. Fabrication process of the fuel

2-1 Fabrication process of the fuel pellets ----- Fig. 2-1

2-2 Fabrication process of the fuel rods ----- Fig. 2-2

3. Fabrication records of the fuel pellets and the rod components

3-1 Fuel pellets

3-1-1 Pellet fabrication lots and sampling

- 1) Fabrication lot numbers and pellet types are shown in Table 3-1.
- 2) Samples were taken out at random from each sintering lot are performed following items.
- 3) Inspection
  - a) Plutonium content
  - b) Impurities (spectroscopy)
  - c) Impurities (chemical analysis)
  - d) Contained gas
  - e) O/M ratio
  - f) Ceramography and  $\alpha$ -autoradiography

- g) Isotopic composition
- h) Dimension and density

### 3-1-2 Methods of inspection

The examination and analysis listed above, were performed by methods which are in the routine work at PNC.

### 3-1-3 Inspection results

- 1) Isotopic composition of plutonium is shown in Table 3-2.

- 2) Chemical analysis

Plutonium content, impurities, contained gas and O/M ratio in the mixed oxide fuels are shown in Table 3-3.

- 3) PuO<sub>2</sub> spot

Uniformity of PuO<sub>2</sub> in the fuel pellets was inspected by  $\alpha$ -autoradiograph. There was no harmful PuO<sub>2</sub> spot in fabricated lot. The  $\alpha$ -autoradiographs are shown in Photo-1.

- 4) Dimensions and density of pellets

The diameter, height, and weight of all pellets were measured for determination of geometrical density. Hollow dish and chamfer sizes were measured on a few pellet by vernier calipers.

These values were taken into density calculations. The measured average values of dimensions are shown in Table 3-4.

The average dimensions and density of pellets are shown in Table 3-5-1 to 3-5-8.

- 5) Ceramography

The ceramography are shown in Photo-2.

## 3-2 Insulator pellets

### 3-2-1 Inspection results

The same methods which applied to the inspection of fuel pellets were used for determination of following items.

- 1) Chemical analysis

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

2) Dimension and density

Measured values of dimensions, weight and calculated densities are shown in Table 3-5-1 to 3-5-8.

3-3 Cladding

Material

- a) Zry-2
- b) Zry-2 with Zr-liner

3-3-1 Inspection results

1) Chemical composition

Results of chemical analysis of cladding which were reported by manufacturer are shown in Table 3-6, 3-7.

2) Mechanical properties

Mechanical properties which were measured by manufacturer are shown in Table 3-8, 3-9.

3) Metallography

Metallographic tests such as grain size and hydride orientation were performed by manufacturer. The results are shown Table 3-8, 3-9 and Photo 3, 4.

4) Dimension, defect, surface and straightness

Dimensional measurements, ultrasonic defects detection, visual observation and straightness inspection were done by PNC.

The results are shown in Table 3-10.

3-4 End plug

Instrument end plugs were fabricated at Holden site and air transported to PNC.

3-5 Spring

- Material : AISI 304-WPB
- Spring constant :  $\bar{X} = 0.0643$  kg/mm (without plate)  
 $\bar{X} = 0.0668$  kg/mm (plate)



Weight and free length: Shown in Table 3-5-1 to 3-5-8 for each fuel rod.

3-6 Disc

Material : Zry-2

Weight and thickness : Shown in Table 3-5-1 to 3-5-8.

4. Records of fabrication and inspection for fuel rods

4-1 Instrument of fuel rod

The Combination of instrument end plugs and each rod are shown in Table 4-1.

4-2 Weight and length of fuel stacks and fuel rods

Fuel stack length and weight were measured by a vernier caliper on a balance.

These values are shown in Table 4-1.

4-3 Nondestructive inspection

The results of He leak test, X-ray inspection, contamination inspection insulation resistance and conduction are summarized in Table 4-2.

5. Fuel Material

Weight of fuel material contained in the eight fuel rods are listed in Table 5-1.

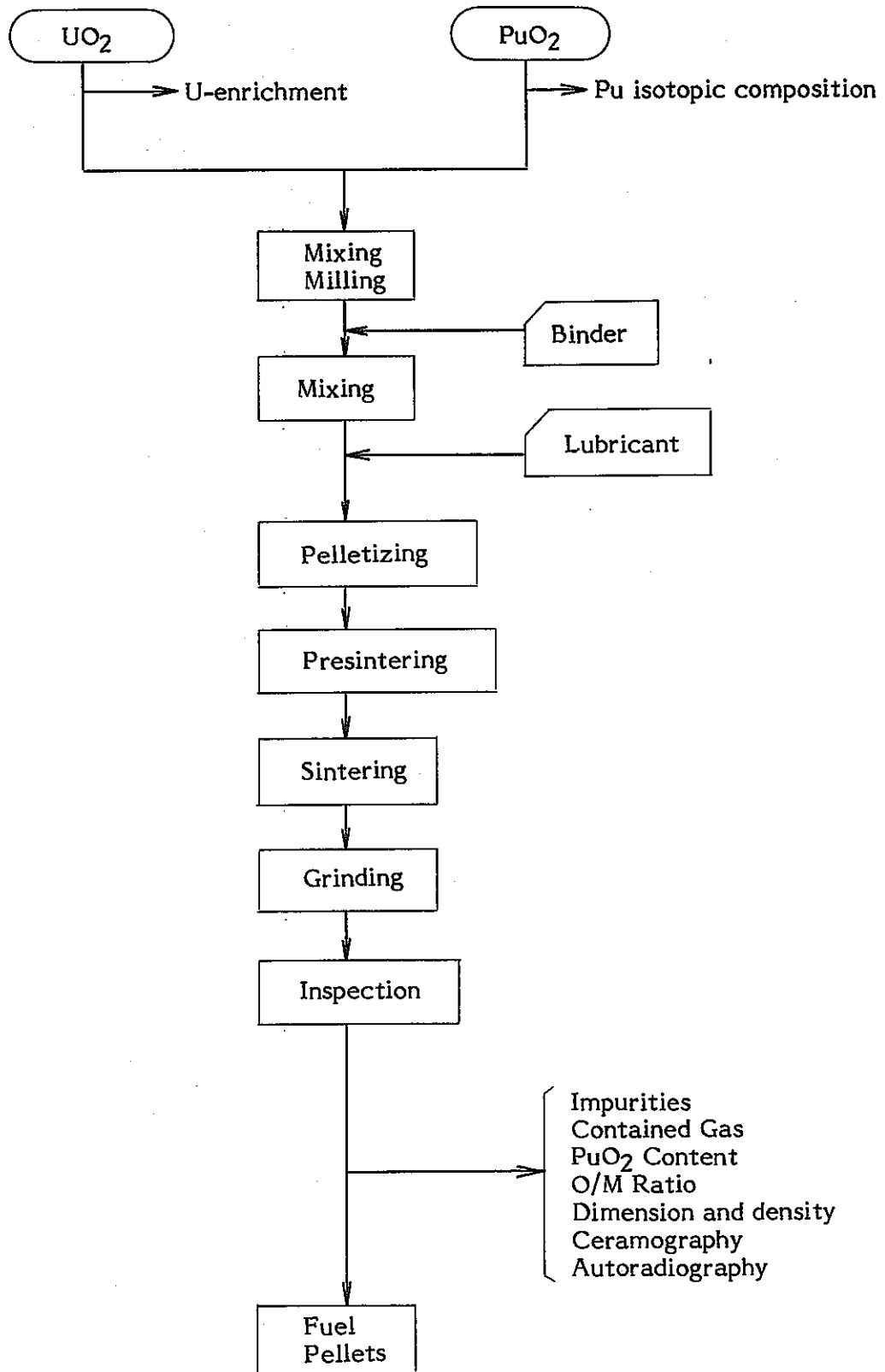


Fig. 2-1 Flow Diagram of Pellets Fabrication Process

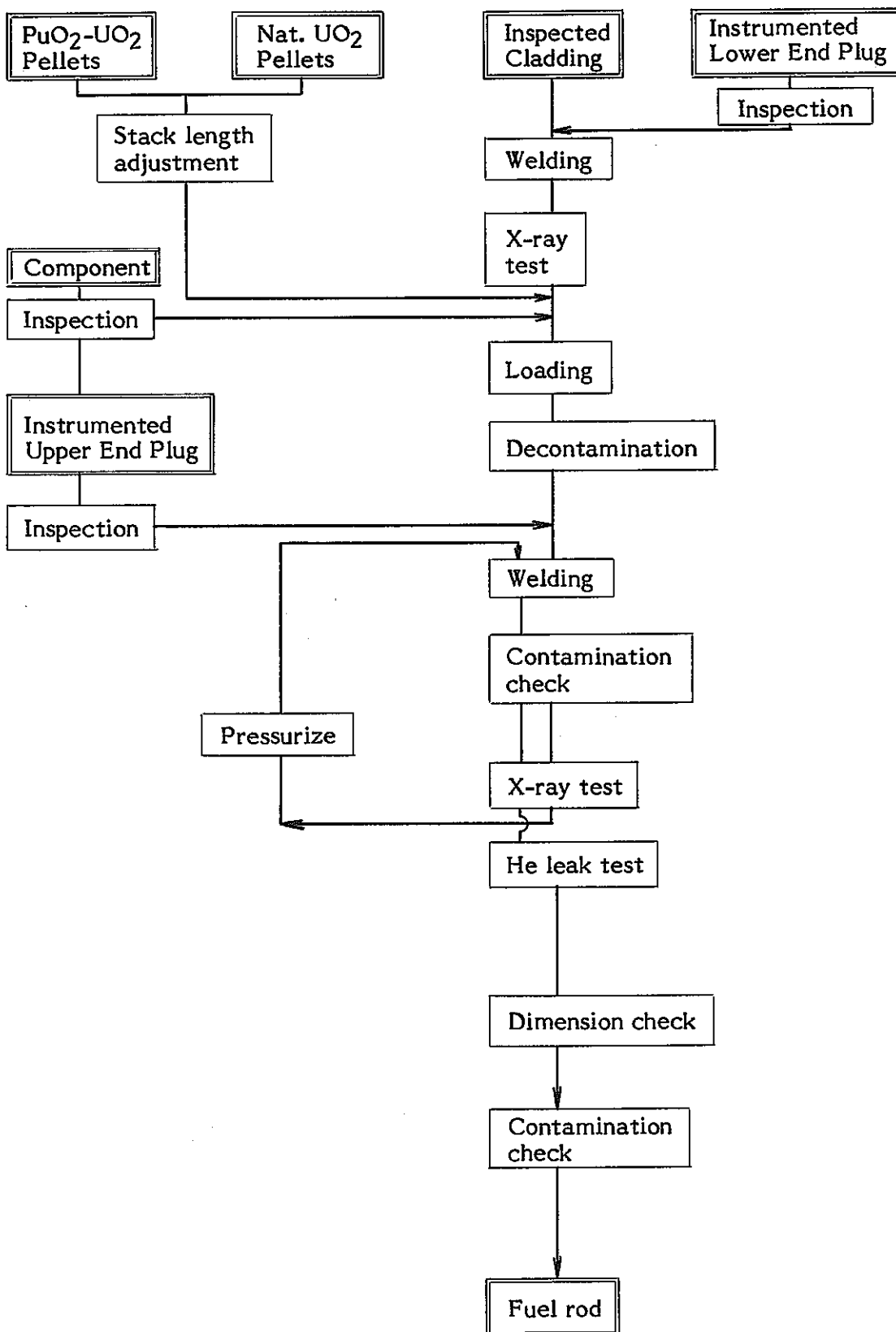


Fig. 2-2 Flow Diagram of Fuel rod Fabrication Process

Table 3-1 Fabrication Lot Numbers and Pellet Types

Lot No.	Pellet Types						Material
	Dish-chamfer standard stack adj		Hollow (large) - chamfer standard stack adj		Hollow (small) - chamfer standard stack adj		
HAL-01	○						
HAL-02			○				
HAL-03					○		MOX
HAL-04		○					
HAL-05				○			
HAT-02	○						
HAL-IP-1	○						NUO <sub>2</sub>
HAL-IP-2					○		

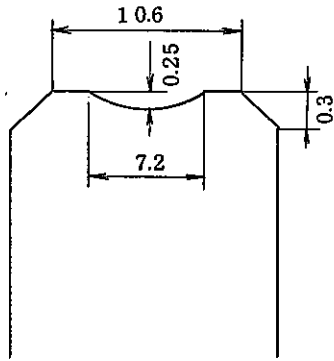
Table 3-2 Results of Chemical Analysis of Fuel Pellet

Isotope	Isotopic Composition (Analysis date)
Pu-238	0.16 (w/o)
Pu-239	73.03
Pu-240	22.13
Pu-241	3.84
Pu-242	0.84
Am-241	0.14 (October, 24, 1980)
U	0.71 (Natural)

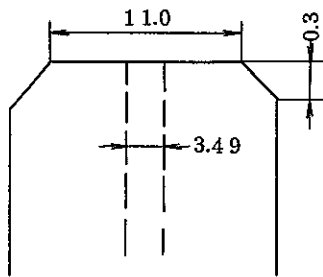
Table 3-3 Results of Chemical Analysis of MOX Fuel Pellet and Insulator Pellet

Item	Specification	MOX Pellet	Insulator Pellet
O/M Ratio	(1.97 ~ 2.02) 2.00 ~ 2.03 (insulator)	1.98	2.00
Contained Gases	< 60 $\mu$ l/g	< 30	< 30
Moisture	< 10 $\mu$ l/g	< 5	< 5
Plutonium content	3.40 $\pm$ 0.14 fission w/o	3.44	
Pu+U/M.O	$\geq$ 87.3 w/o	0.8825	
Pu Spot	< 400 $\mu$ m	77	
Impurities			
Ag	$\leq$ 10 (ppm)	< 0.2	< 0.2
Al	$\leq$ 200	< 10	< 10
B	$\leq$ 1.0	< 0.3	< 0.3
Ca	$\leq$ 200	< 10	< 10
Cd	$\leq$ 1.0	< 1.0	< 1.0
Cr	$\leq$ 200	< 10	< 10
Cu	$\leq$ 50	< 1	< 1
Fe	$\leq$ 500	< 10	< 10
Mg	$\leq$ 100	< 2	< 2
Mn			< 6
Mo	$\leq$ 300	< 10	< 10
Ni	$\leq$ 300	< 10	< 10
Pb	$\leq$ 100	< 10	< 10
Si	$\leq$ 400	< 10	< 10
Sn	$\leq$ 20	< 10	< 10
C	$\leq$ 200	< 30	< 30
F	$\leq$ 25	< 10	< 10
Cl	$\leq$ 25	< 10	< 10
N	$\leq$ 200	120	95
Zn			< 50
Dy+Eu+Gd+Sn	$\leq$ 1.2	< 1.0	< 1.0

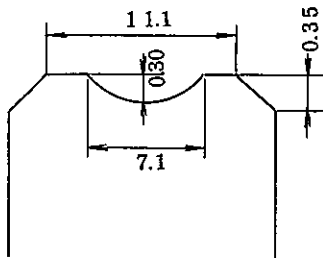
Table 3-4 Measured Average Values of Dimensions



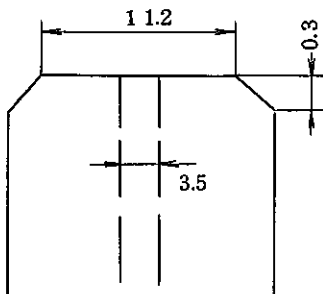
FPA HAL-04



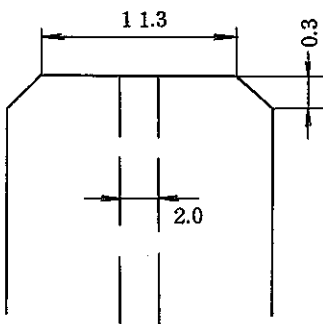
FPB HAL-05



FPA HAL-01

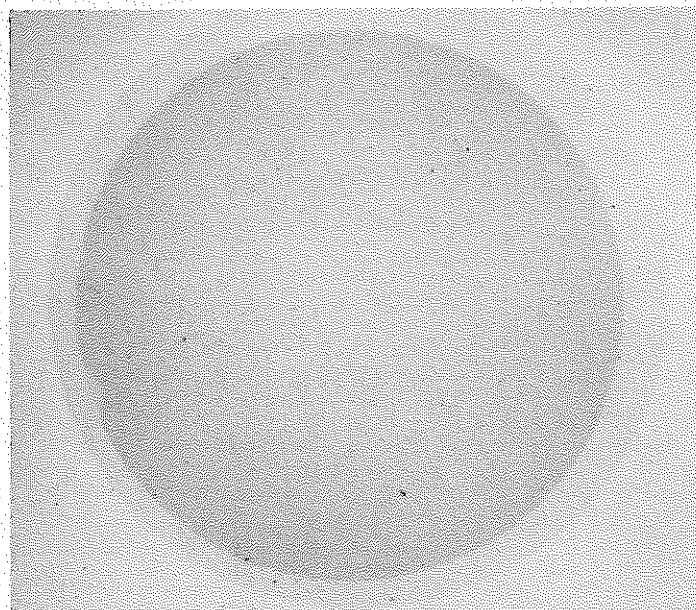


FPB HAL-02

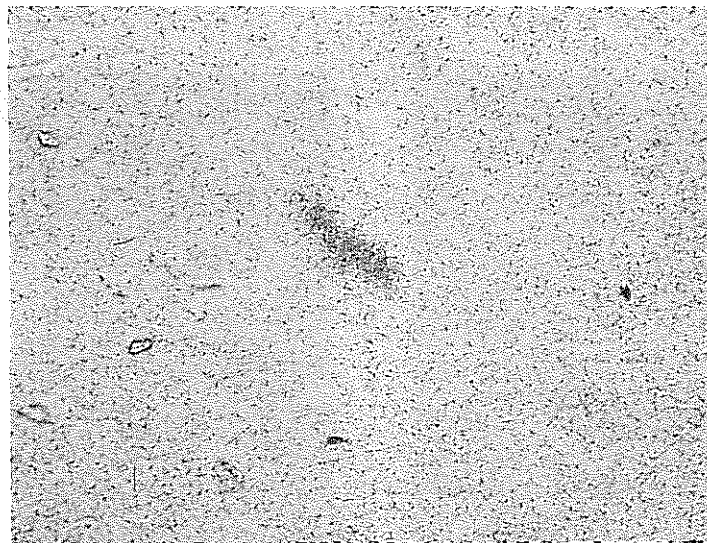


FPC HAL-03

[mm]



2 mm

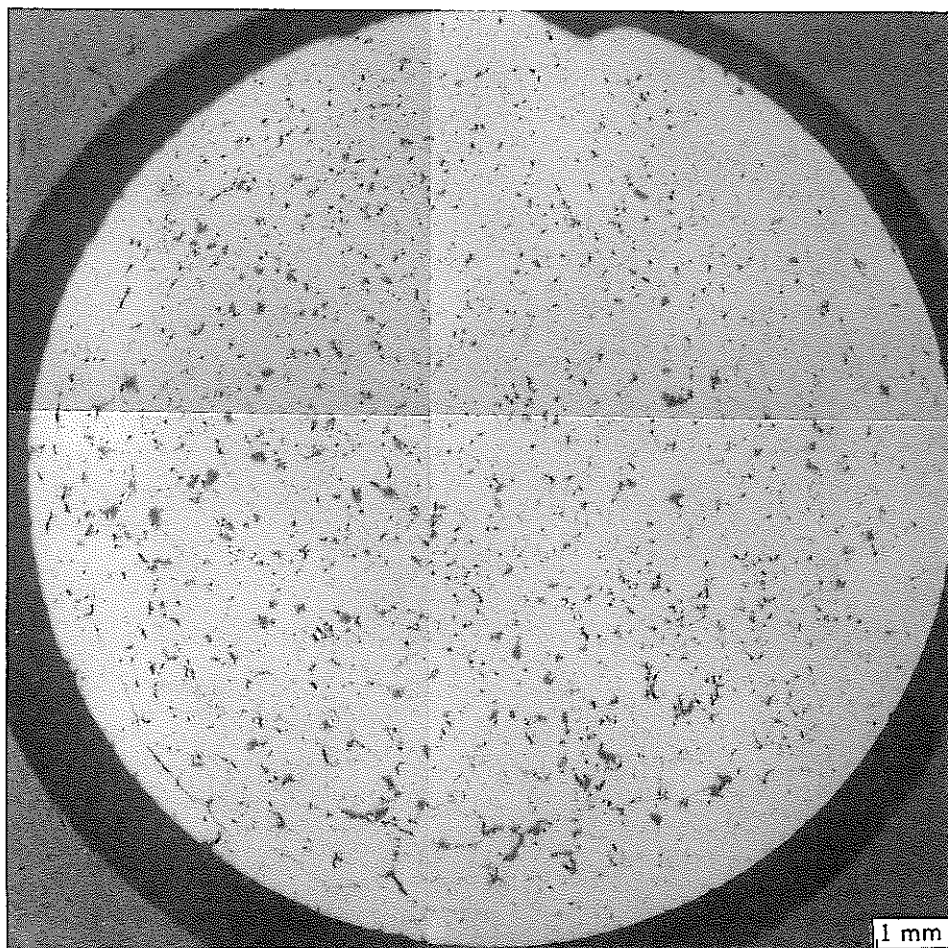


200  $\mu$ m

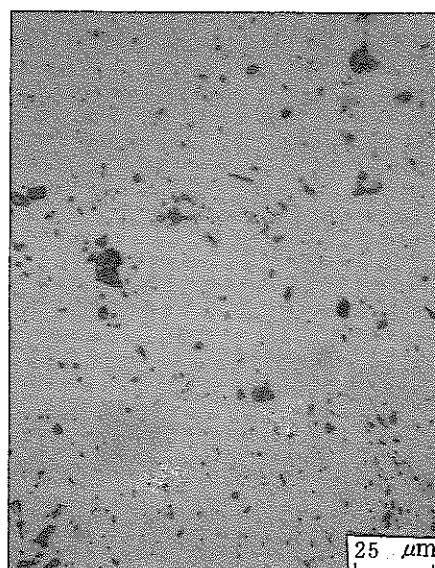
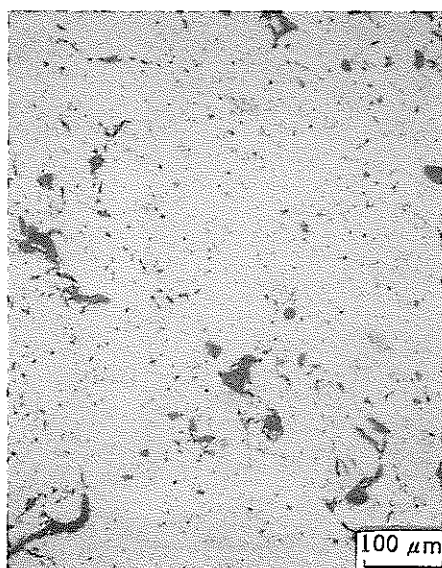
Photo-1  $\alpha$ -autoradiographs



As Polished



MACRO

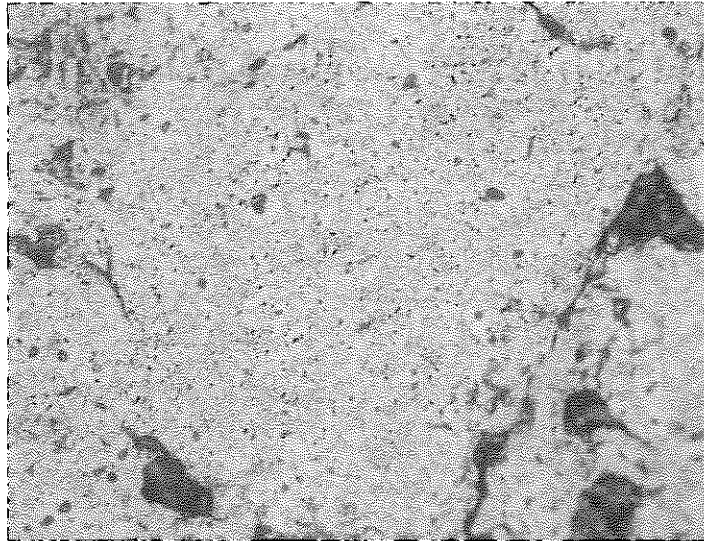


MICRO

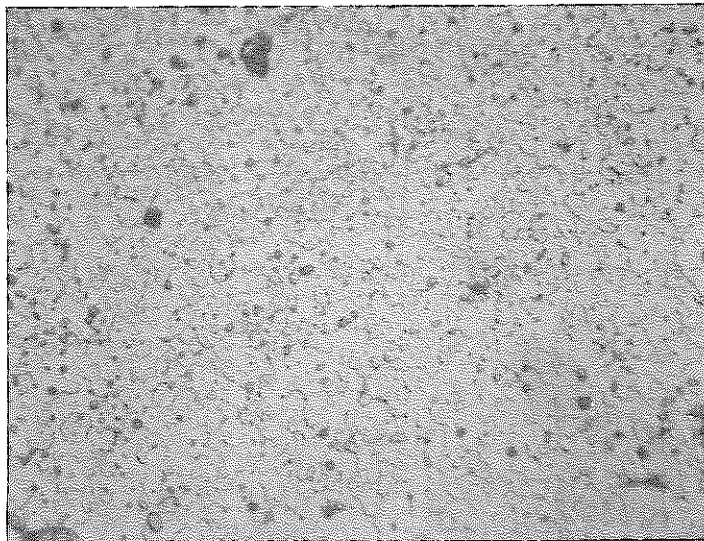
Photo-2-1 Ceramography

As Etched

MICRO



50 μ m



25 μ m

Photo-2-2 Ceramography

Table 3-5-1 ROD No. IFA-554-1 (Cladding No. S10845-1)

Pellet Lot No.		HAL-01		
Pellet O.D (mm)	Av.		12.408	
	S.D		0.006	
Density (%T.D)	Av.		93.59	
	S.D		0.317	
Height (mm)	Av.		12.88	
Cladding I.D (mm)	Av.	12.694		
	S.D	0.0068		
Length (mm)		573.02		
Weight (g)		140.82		

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.0	5.97	5.16	5.22	72.0	116.80
Weight (g)	-	3.87	6.32	6.40	2.74	-
Density (%)	-	-	95.37	95.34	-	-

Table 3-5-2 ROD No. IFA-554-2 (Cladding No. K26895-1)

Pellet Lot No.			HAL-01	HAL-04	
		Pellet O.D (mm) Av.		12.408	12.411
S.D		0.007			
Density (%T.D) Av.		93.63	94.28		
S.D		0.264			
Height (mm) Av.		12.98	4.12		
Cladding I.D (mm) Av.		12.706			
S.D		0.0058			
Length (mm)		572.99			
Weight (g)		139.88			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.0	6.02	5.02	5.30	71.90	116.80
Weight (g)	-	3.92	6.17	6.43	2.74	-
Density (%)	-	-	95.60	94.26	-	-

Table 3-5-3 ROD No. IFA-554-3 (Cladding No. S10845-2)

Pellet Lot No.			HAL-02	HAL-05	
		Pellet O.D (mm) Av.		12.409	12.407
	S.D		0.004		
Density (%T.D) Av.			93.53	93.45	
	S.D		0.263		
Height (mm) Av.			13.42	4.21	
Cladding I.D (mm) Av.		12.697			
	S.D	0.0037			
Length (mm)		572.99			
Weight (g)		141.27			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.0	6.02	5.22	5.00	72.0	116.80
Weight (g)	-	3.90	6.42	6.08	2.74	-
Density (%)	-	-	95.70	94.98	-	-

Table 3-5-4 ROD No. IFA-554-4 (Cladding No. S10845-3)

Pellet Lot No.			HAL-01	HAL-03	HAL-04
		Pellet O.D (mm) Av.		12.408	12.405
	S.D		0.007	0.002	
Density (%T.D) Av.			93.53	93.75	94.02
	S.D		0.355	0.224	
Height (mm) Av.			13.02	13.36	5.02
Cladding I.D (mm) Av.		12.706			
	S.D	0.0052			
Length (mm)		573.02			
Weight (g)		141.27			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	95.90	6.00	5.14	5.16	73.0	50.40
Weight (g)	-	3.81	6.27	6.32	4.02	-
Density (%)	-	-	95.30	95.41	-	-

Table 3-5-5 ROD No. IFA-554-5 (Cladding No. K26895-2)

Pellet Lot No.			HAL-01	HAL-03	HAT-02
Pellet O.D (mm)	Av.		12.408	12.406	12.386
	S.D		0.006	0.002	0.002
Density (%T.D)	Av.		93.58	94.28	95.35
	S.D		0.265	0.182	0.240
Height (mm)	Av.		12.874	13.340	12.655
Cladding I.D (mm)	Av.	12.710			
	S.D	0.0061			
Length (mm)		573.06			
Weight (g)		140.07			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	95.40	5.99	5.18	5.32	72.2	50.75
Weight (g)	-	3.81	6.31	6.52	4.02	-
Density (%)	-	-	95.13	95.31	-	-

Table 3-5-6 ROD No. IFA-554-6 (Cladding No. S10845-4)

Pellet Lot No.			HAL-02	HAL-05	
		Pellet O.D (mm) Av.		12.408	12.421
	S.D		0.003		
Density (%T.D) Av.			93.56	93.37	
	S.D		0.239		
Height (mm) Av.			13.121	4.18	
Cladding I.D (mm) Av.		12.703			
	S.D	0.0011			
Length (mm)		573.14			
Weight (g)		141.34			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.80	6.00	5.14	5.08	72.2	45.10
Weight (g)	-	3.84	6.077	6.25	4.03	-
Density (%)	-	-	94.87	94.99	-	-



Table 3-5-7 ROD No. IFA-555-1 (Cladding No. K26895-3)

Pellet Lot No.			HAL-01	HAL-04	
		Pellet O.D (mm) Av.		12.409	12.403
	S.D		0.006		
Density (%T.D) Av.			93.60	94.01	
	S.D		0.350		
Height (mm) Av.			13.153	4.18	
Cladding I.D (mm) Av.		12.712			
	S.D	0.0064			
Length (mm)		572.99			
Weight (g)		140.09			

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.0	5.97	5.25	5.22	72.8	92.10
Weight (g)	-	3.90	6.46	6.40	4.01	-
Density (%)	-	-	95.64	95.39	-	-

Table 3-5-8 ROD No. IFA-555-2 (Cladding No. K26895-4)

Pellet Lot No.			HAL-01	HAL-04	
		Pellet O.D (mm) Av.		12.408	12.409
S.D		0.006			
Density (%T.D) Av.		93.52	94.33		
S.D		0.321			
Height (mm) Av.		13.151	4.24		
Cladding I.D (mm) Av.	12.709				
S.D	0.004				
Length (mm)	573.01				
Weight (g)	140.14				

Parts	Lower End Plug	Disc	Insulator Pellet		Spring (Plenum)	Upper End plug
			(bottom)	(top)		
Length (mm)	105.0	6.00	5.15	5.19	72.6	92.20
Weight (g)	-	3.90	6.31	6.36	4.01	-
Density (%)	-	-	95.25	95.73	-	-

Table 3-6 Chemical Composition of Cladding

	Specification	Results	
		(1)	(2)
Ingot			
1. Composition	%		
Sn	1.20 ~ 1.70	1.48	1.48
Fe	0.07 ~ 0.20	0.15	0.15
Cr	0.05 ~ 0.15	0.10	0.10
Ni	0.03 ~ 0.08	0.05	0.05
Fe+Cr+Ni	0.18 ~ 0.38	0.30	0.30
Zn			
2. Impurities	PPM		
Al	≤ 75	62	61
B	≤ 0.5	< 0.2	< 0.2
Cd	≤ 0.5	< 0.2	< 0.2
C	≤ 270	160	160
Co	< 20	< 10	< 10
Cu	≤ 50	< 10	< 10
Hf	≤ 100	83	78
H	≤ 25	11	8
Mn	≤ 50	< 10	< 10
N	≤ 80	27	25
Ca	≤ 30	< 10	< 10
Si	≤ 120	78	81
Pb	≤ 130	3	3
Ti	≤ 50	14	14
Cl	≤ 20	< 10	< 10
W	≤ 100	< 10	< 10
Mg	≤ 20	< 2	< 2
U (TOTAL)	≤ 3.5	< 1	< 1
O	900 ~ 1500	1180	1200

Table 3-7 Chemical Composition of Cladding (Zr Liner tube)

Ingot	Specification	Results	
		(1)	(2)
1. Composition	%		
Sn	1.20 ~ 1.70	1.48	1.48
Fe	0.07 ~ 0.20	0.15	0.15
Cr	0.05 ~ 0.15	0.10	0.10
Ni	0.03 ~ 0.08	0.05	0.05
Fe+Cr+Ni	0.18 ~ 0.38	0.30	0.30
Zn			
2. Impurities	PPM		
Al	≤ 75	57	54
B	≤ 0.5	< 0.2	< 0.2
Cd	≤ 0.5	< 0.2	< 0.2
C	≤ 270	140	140
Co	< 20	< 5	< 5
Cu	≤ 50	< 10	< 10
Hf	≤ 100	< 50	< 50
H	≤ 25	9	10
Mn	≤ 50	11	< 10
N	≤ 80	31	31
Ca	-	< 10	< 10
Si	≤ 120	81	85
Pb	-	< 3	< 3
Ti	≤ 50	11	< 14
Cl	-	< 10	< 10
W	≤ 100	< 10	< 10
Mg	-	< 2	< 2
U (TOTAL)	≤ 3.5	< 1	< 1
O	900 ~ 1500	1130	1130

Table 3-8 Mechanical Properties of Cladding

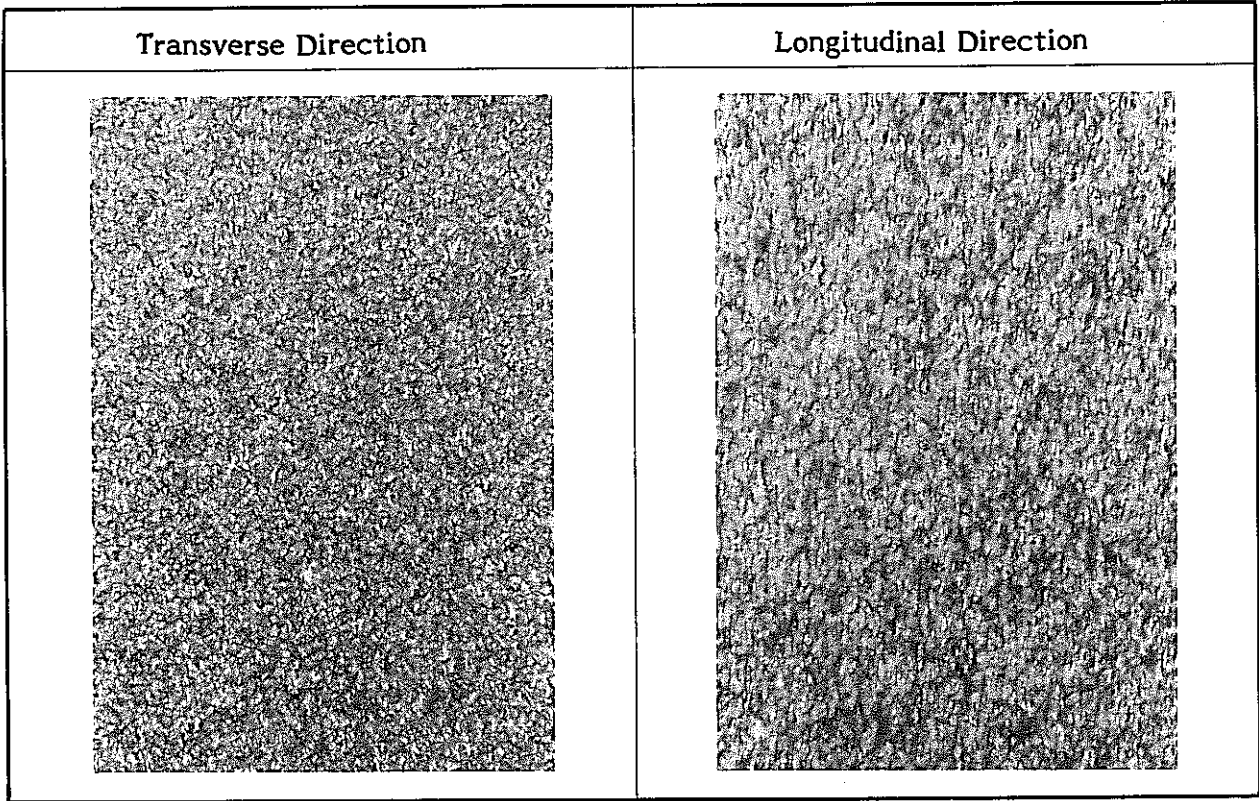
	Specification	Test Results
Burst Pressure (kg/cm <sup>2</sup> )	≥ 600	907
Cir. Elongation (%)	≥ 20	31.2
Yield Strength (kg/mm <sup>2</sup> )	≥ 49	67.3
U.T.S. (kg/mm <sup>2</sup> )	≥ 42	51.9
Elongation (%)	≥ 20	24.0
343°F Yield Strength (kg/mm <sup>2</sup> )	≥ 29	39.8
343°F U.T.S. (kg/mm <sup>2</sup> )	≥ 23	29.3
343°F Elongation (%)	≥ 20	29.0
Grain Size, (ASTM No.)	Finner than No. 9	12.5 , 12.0
Corrosion (mg/dm <sup>2</sup> )	≤ 22mg/dm <sup>2</sup> /72hrs. (ASTMB353-71)	16.9
Hydride Orientation (FN)	≤ 0.35	0.00
Flare (%)	≥ 15 of O.D.	52

Table 3-9 Mechanical Properties of Cladding (Zr Liner tube)

	Specification	Test Results
Burst Pressure (kg/cm <sup>2</sup> )	≥ 600	868
Cir. Elongation (%)	≥ 20	31.3
Yield Strength (kg/mm <sup>2</sup> )	≥ 49	67.8
U.T.S. (kg/mm <sup>2</sup> )	≥ 42	51.6
Elongation (%)	≥ 20	24.0
343°F Yield Strength (kg/mm <sup>2</sup> )	≥ 29	41.2
343°F U.T.S. (kg/mm <sup>2</sup> )	≥ 23	30.6
343°F Elongation (%)	≥ 20	30.0
Grain Size, (ASTM No.)	Finner than No. 9	13.5 , 13.0
Corrosion (mg/dm <sup>2</sup> )	≤ 22mg/dm <sup>2</sup> /72hrs. (ASTMB353-71)	16.6 , 16.0
Hydride Orientation (FN)	≤ 0.35	0.02 , 0.00, 0.23
Flare (%)	≥ 15 of O.D.	49

Micrograph of Grain Size

(x100)



Hydride Metallographic

(x100)

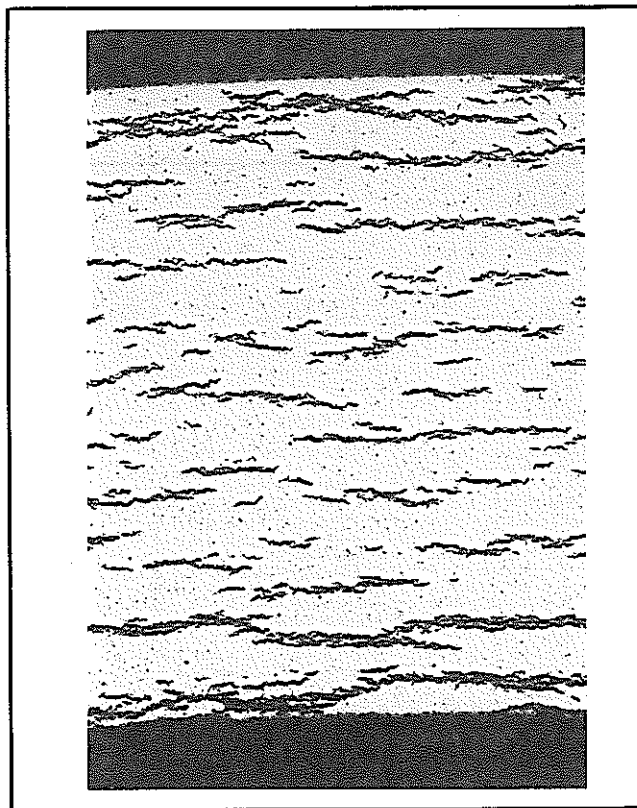
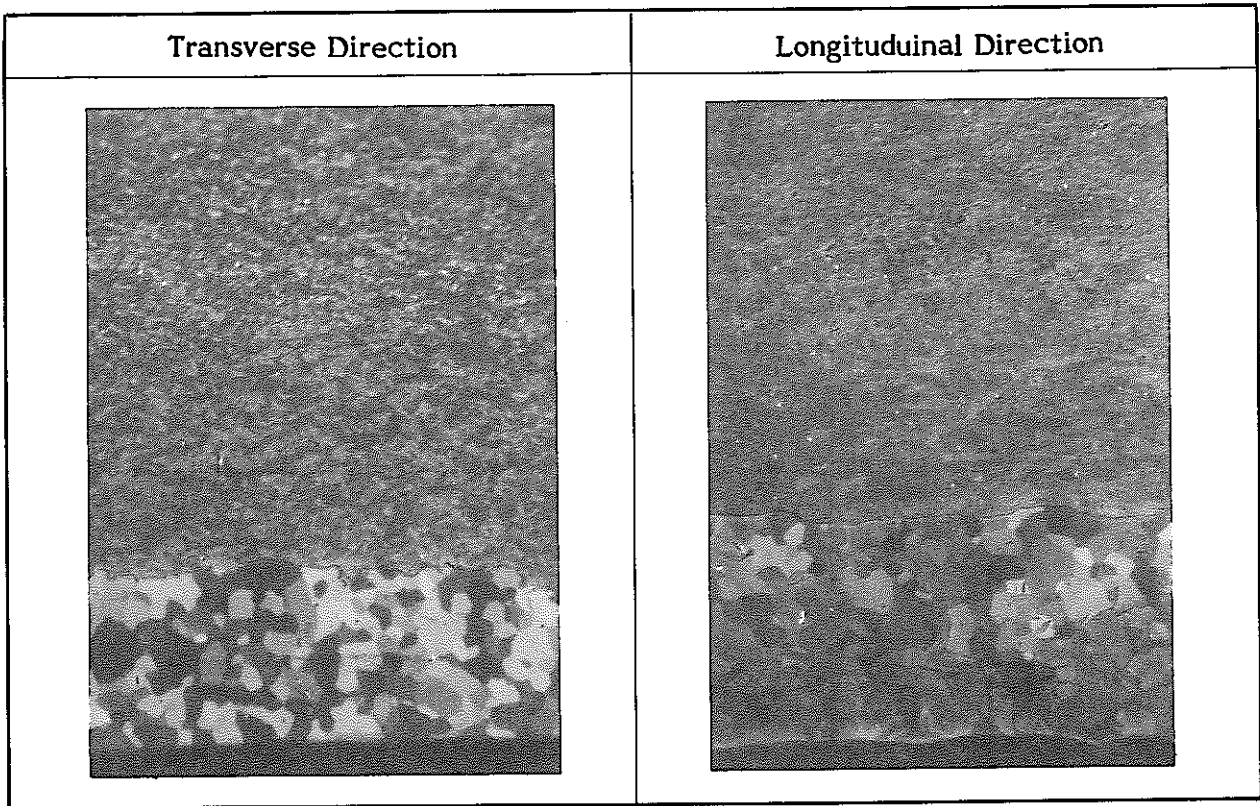


Photo-3 (Zry-2 tube)

Micrograph of Grain Size

(x400)



Hydride Metallographic

(x100)

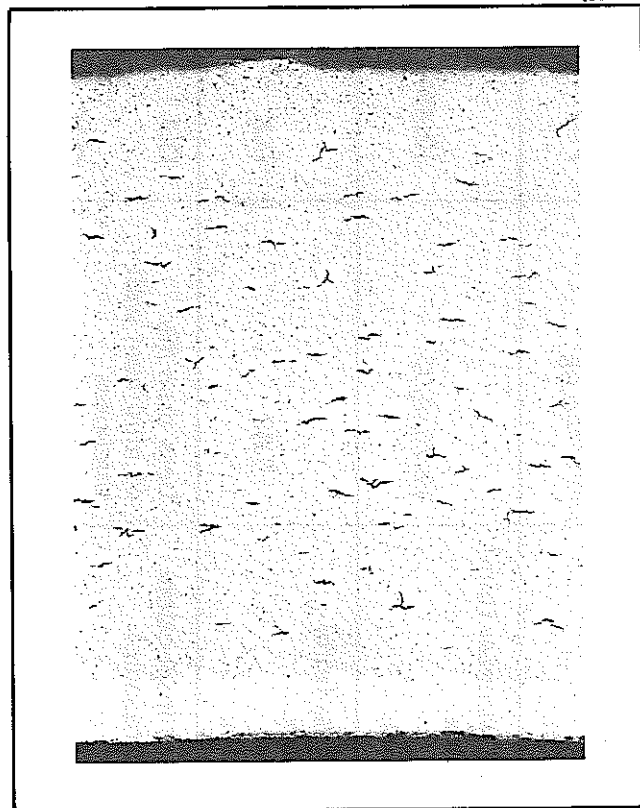


Photo-4 (Zr Lining tube)



Table 3-10 The Results of Cladding Inspection

Item \ Rod No.	Specification	554-1	554-2	554-3	554-4	554-5	554-6	555-1	555-2
Outer Diameter (mm) Max. Min.	$14.50^{+0}_{-0.08}$	14.462	14.450	14.457	14.456	14.453	14.462	14.452	14.450
Inner Diameter (mm) Max. Min.	$12.70^{+0.05}$	12.694	12.706	12.697	12.706	12.710	12.703	12.712	12.709
Thickness (mm) Max. Min.	$\geq 0.82$	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K
Defects inspection (by Ultrasonic)	Less than 5% of minimum wall thickness	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K
Axial Direction Circumferential Direction		O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K
Visual observation	not exist harmful scal and oxide. not exist more than $50 \mu\text{m}$ of pit, dint and hair seam	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K
Straightness	$< 0.4 \text{ mm}$	O.K	O.K	O.K	O.K	O.K	O.K	O.K	O.K
Reference	Cladding No.	S 10845-1	K 26895-1	S 10845-2	S 10845-3	K 26895-2	S 10845-4	K 26895-3	K 26895-4

Table 4-2 The Results of Non Destructive Inspection of Fuel Rods

Item Rod No.	Helium Leak Test Spec. $<1 \times 10^{-8}$ atm.cc/sec.	X-ray Inspection		Contamination		Insulation Resistance ( $\Omega$ )	Conduction $\infty$
		Lower E.P $< 0.5\text{mm}\phi$	Upper E.P $< 0.5\text{mm}\phi$	Loose $< 20\text{dpm}$	Fixed 1000dpm		
554-1	$6 \times 10^{-10}$	O.K	O.K	$< 3$	125	—	—
554-2	"	"	"	"	195		
554-3	"	"	"	"	155		
554-4	"	"	"	"	485	627, 371 611	O.K
554-5	"	"	"	"	350	523	O.K
554-6	"	"	"	"	225	519	O.K
555-1	"	"	"	"	285	—	—
555-2	"	"	"	"	325		

Table 5-1 Weights of Fuel Materials

Rod No.	Fuel Pellet						Insulator Pellet	
	M.O (g)	Plutonium			Nat. Uranium		Nat. Uranium	
		PuO <sub>2</sub> (g)	Pu (g)	Pu.fissile (g)	N.UO <sub>2</sub> (g)	N.U (g)	N.UO <sub>2</sub> (g)	N.U (g)
554-1	600.233	26.89	23.72	18.23	573.34	505.11	12.718	11.20
554-2	598.986	26.83	23.67	18.19	572.15	504.07	12.595	11.10
554-3	557.942	25.00	22.05	16.95	532.95	469.53	12.497	11.01
554-4	597.306	26.76	23.60	18.14	570.55	502.65	12.595	11.10
554-5	602.774	27.00	23.82	18.31	575.77	507.25	12.836	11.31
554-6	557.240	24.96	22.02	16.93	532.28	468.93	12.322	10.86
555-1	602.162	26.98	23.79	18.29	575.19	506.74	12.855	11.33
555-2	601.540	26.95	23.77	18.27	574.59	506.21	12.667	11.16
Total	4718.183	211.37	186.44	143.31	4506.82	3970.50	101.085	89

Table 4-1 Weight and Length of Fuel Stacks and Fuel Rods

Item Rod No.	End Plug		Fuel Stack			Fuel Rod		Reference
	Lower	Upper	Length (mm)	Length*1)	Weight (g)	Length*2) (mm)	Weight (g)	
554-1	PF	EF	489.2	499.6	612.95	580.5		Zr-Liner
554-2	PF	EF	488.3	498.6	611.58	580.5		
554-3	PF	EF	490.4	500.6	570.44	580.5		
554-4	TF	EC	489.0	499.3	609.90	581.0		Zr-Liner
554-5	TF	EC	490.9	501.4	615.61	580.5		
554-6	TF	EC	489.5	499.7	569.56	581.0		
555-1	PF	EC	491.1	501.5	615.02	580.5		Zr-Liner
555-2	PF	EC	490.4	500.8	614.21	581.0		Zr-Liner

Notes \*1) Include insulator pellets.

\*2) Rod length means the interval between "V" grooves.

Attachment

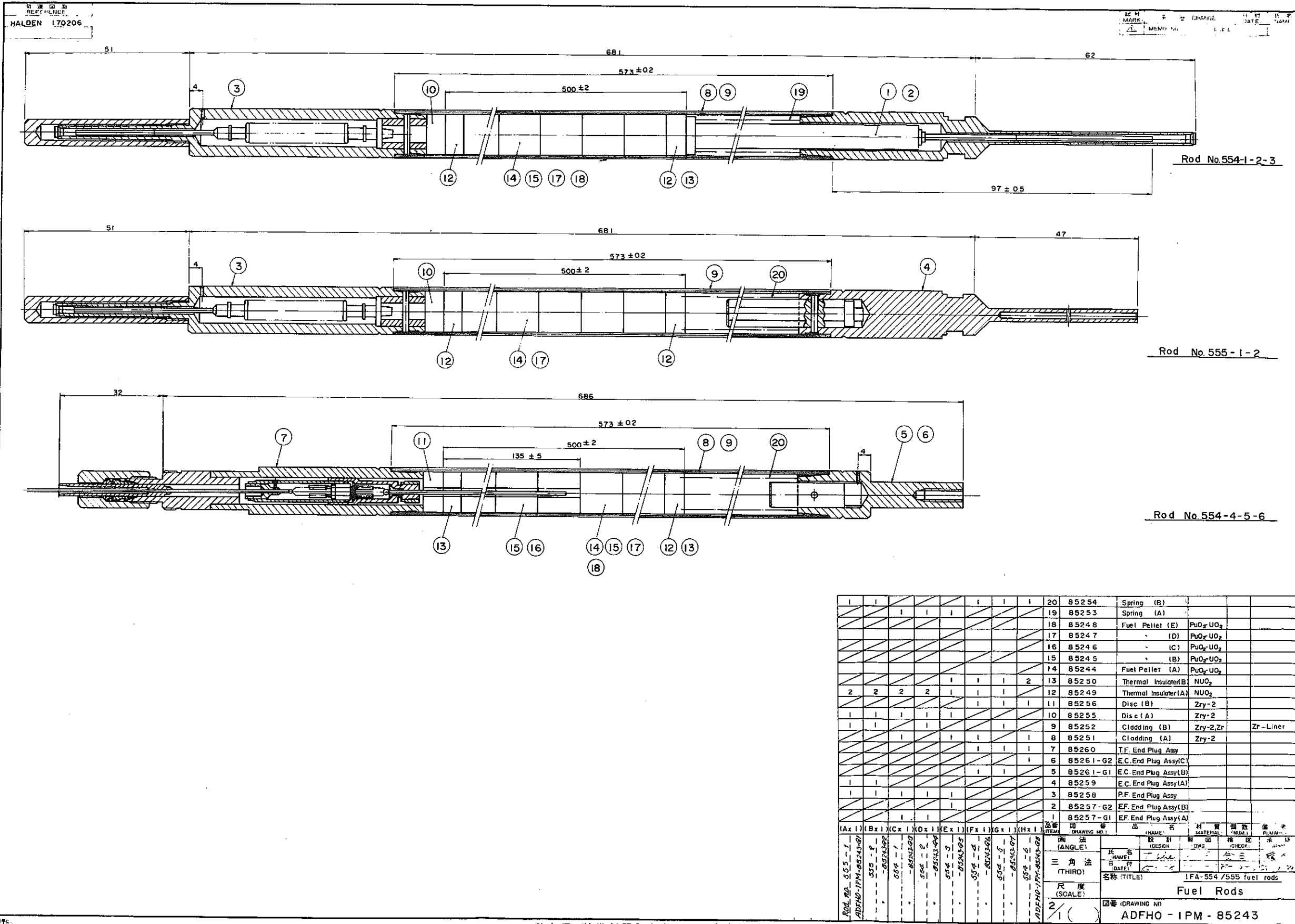
**Drawings of IFA-554/555 fuel rods**

## 図面一覧表 (DRAWING LIST)

プロジェクト名 (PROJECT NAME)		コードNo.	図面庫No.	図面リスト	複 写
IFA-554 / 555 fuel rods				①新リスト ②組替え+番機先	
No.	図番 (DRAWING NO.)	名称 (TITLE)	①連番 ②関連図面 ③	承認、および修正年月 APPROVAL & REVISION DATE	
1	ADFHO-1PM-85243	Fuel Rods	HALDEN 170206	85/10	
2	◇ -4PM-85244	Fuel Pellet (A)		85/10	
3	◇ -4PM-85245	Fuel Pellet (B)		85/10	
4	◇ -4PM-85246	Fuel Pellet (C)		85/10	
5	◇ -4PM-85247	Fuel Pellet (D)		85/10	
6	◇ -4PM-85248	Fuel Pellet (E)		85/10	
7	◇ -4PM-85249	Thermal Insulator (A)		85/10	
8	◇ -4PM-85250	Thermal Insulator (B)		85/10	
9	◇ -4PM-85251	Cladding (A)		85/10	
10	◇ -4PM-85252	Cladding (B)		85/10	
11	◇ -4PM-85253	Spring (A)		85/10	
12	◇ -4PM-85254	Spring (B)		85/10	
13	◇ -4PM-85255	Disc (A)	◇ 480395	85/10	
14	◇ -4PM-85256	Disc (B)	◇ 480410	85/10	
15	◇ -2PM-85257	E.F.End Plug Assy.(A),(B)	◇ 381058 381271,381272	85/10	
16	◇ -3PM-85258	P.F.End Plug Assy.	◇ 381040	85/10	
17	◇ -3PM-85259	E.C End Plug Assy.(A)	◇ 381273	85/10	
18	◇ -3PM-85260	T.F.End Plug Assy.	◇ 381041	85/10	
19	◇ -3PM-85261	E.C.End Plug Assy.(B),(C)	◇ 480575 480576	85/10	
			氏名 (NAME)	日付 (DATE)	図面の種類
			製図 (DWG.)	桐原 85-10-15	①基本設計図面(PRELIMINARY)
			検図 (CHA)	金田 85-10-16	②製作図面(MANUFACTURE)
			承認 (APPR.)	横内 85-10-28	③完成図面(FINAL)
			図番(DRAWING NO.)		
記号 (MARK)	来歴(CHANGE)	日付 (DATE)	氏名 (NAME)	ADFHO-4LM-85242	

整理No. < - >

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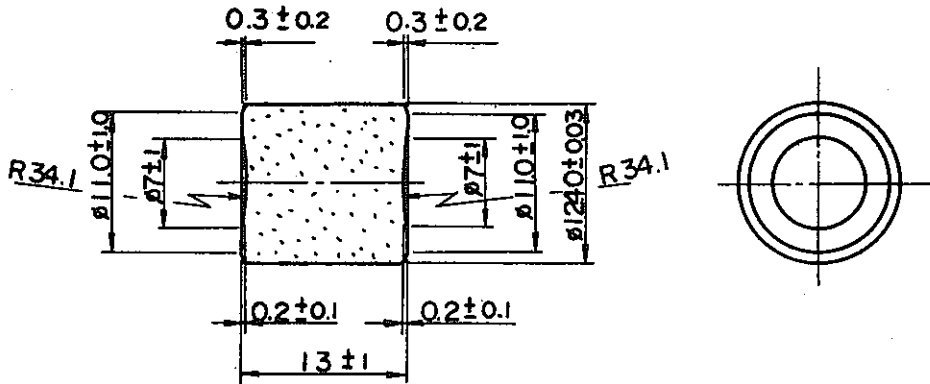
ITEM	QTY	DESCRIPTION	MATERIAL	UNIT
20	1	85254 Spring (B)		
19	1	85253 Spring (A)		
18	1	85248 Fuel Pellet (E)	PuO <sub>2</sub> -UO <sub>2</sub>	
17	1	85247 Fuel Pellet (D)	PuO <sub>2</sub> -UO <sub>2</sub>	
16	1	85246 Fuel Pellet (C)	PuO <sub>2</sub> -UO <sub>2</sub>	
15	1	85245 Fuel Pellet (B)	PuO <sub>2</sub> -UO <sub>2</sub>	
14	1	85244 Fuel Pellet (A)	PuO <sub>2</sub> -UO <sub>2</sub>	
13	2	85250 Thermal Insulator(B)	NUO <sub>2</sub>	
12	2	85249 Thermal Insulator(A)	NUO <sub>2</sub>	
11	1	85256 Disc (B)	Zry-2	
10	1	85255 Disc (A)	Zry-2	
9	1	85252 Cladding (B)	Zry-2,Zr	Zr-Liner
8	1	85251 Cladding (A)	Zry-2	
7	1	85260 T.F. End Plug Assy		
6	1	85261-G2 E.C. End Plug Assy(C)		
5	1	85261-G1 E.C. End Plug Assy(B)		
4	1	85259 E.C. End Plug Assy(A)		
3	1	85258 P.F. End Plug Assy		
2	1	85257-G2 E.F. End Plug Assy(B)		
1	1	85257-G1 E.F. End Plug Assy(A)		

ROD NO.	SCALE	DATE	DESIGNER	CHECKER	GROUP
ADFHO-1PM-85243	2/1				

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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	-- --	



Rod No.	Numbers
554 - 1	(38)
554 - 2	(38)
554 - 4	(28)
554 - 5	(28)
555 - 1	(38)
555 - 2	(38)

品番 (ITEM)	図番 (DRAWING NO.)	fuel pellet	FuO <sub>2</sub> - UO <sub>2</sub>	34%Pu fissile
		品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	圖法 (ANGLE)	名称 (TITLE)
製図 (DWG.)	桐原	85-3-8	三角法 (THIRD)	IFA-554/555 fuel rods
検図 (CHECK)	金田	85-10-15	尺度 (SCALE)	Fuel Pellet (A)
承認 (APPR.)	横内	85-10-16	2/1 ( )	図番 (DRAWING NO.)
		85-10-20		ADFHO - 4PM - 85244

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関連図面 (REFERENCE)		記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
		△	MEMO NO. による	- -	

Rod No.	Numbers
554 - 3	(38)
554 - 6	(38)

1		fuel pellet	PuO <sub>2</sub> -UO <sub>2</sub>	3.4 <sup>w</sup> % Pufissile
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	圖法 (ANGLE)	名稱 (TITLE)
	T. Ito	85-3-8	三角法 (THIRD)	IFA-554 / 555 fuel rods
製圖 (DWG.)	桐原	85-10-15	尺度 (SCALE)	Fuel Pellet (B)
檢圖 (CHECK)	金田	85-10-16	2 / 1 ( )	圖番 (DRAWING NO.)
承認 (APPR.)	横内	85-10-20		ADFHO - 4PM - 85245

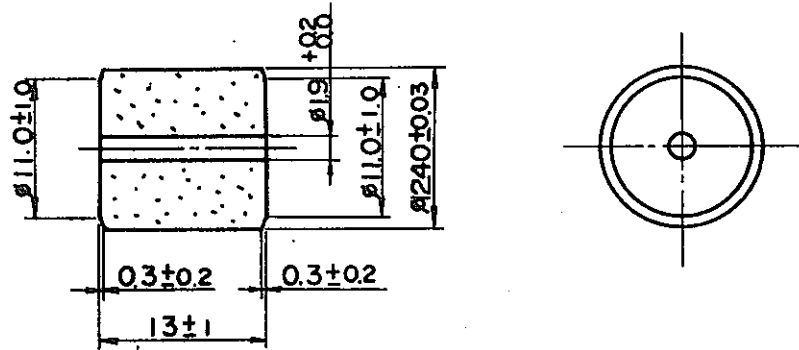
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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	



Rod No.	Numbers
554 - 4	(10)
554 - 5	(10)

1		fuel pellet	PuO <sub>2</sub> -UO <sub>2</sub>	34% Pu fissile
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)
製図 (DWG.)	J. Ahe	85-3-8	三角法 (THIRD)	1 FA-554/555 fuel rods
検図 (CHECK)	桐原	85-10-15	尺法 (SCALE)	Fuel Pellet (C)
承認 (APPR.)	金田	85-10-16	2 / 1 ( )	図番 (DRAWING NO.)
	橋内	85-10-20		ADFHO-4PM-85246

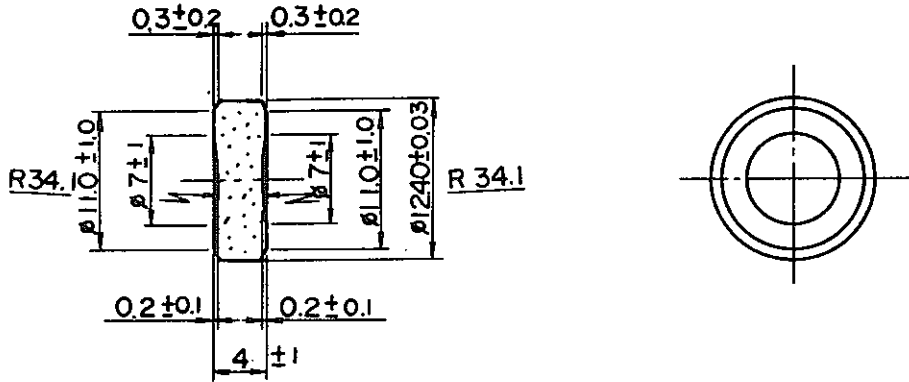
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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	-	

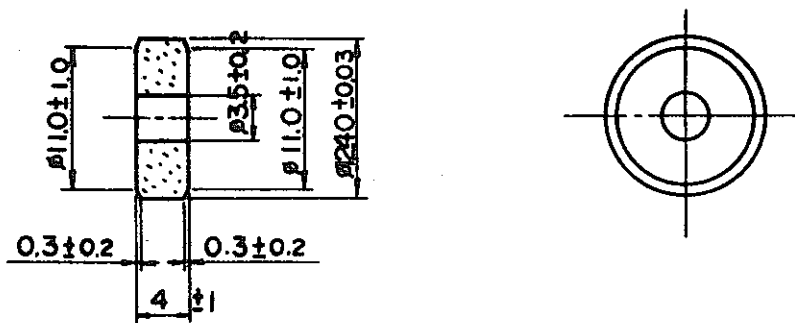


Rod No.	Numbers
554 - 1	2 (Max)
554 - 2	2 (Max)
554 - 4	2 (Max)
554 - 5	2 (Max)
555 - 1	2 (Max)
555 - 2	2 (Max)

1	fuel pellet		FuO <sub>2</sub> -UO <sub>2</sub>	3.4 <sup>w</sup> % Pufissile
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)
製図 (DWG)	T. Ake	85-3-3	三角法 (THIRD)	1 FA-554/555 fuel rods
検図 (CHECK)	桐原	85-10-15	尺度 (SCALE)	Fuel Pellet (D)
承認 (APPR.)	金田	85-10-16	2/1 ( )	図番 (DRAWING NO.)
	橋内	85-10-20		ADFHO-4PM-85247

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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	--	

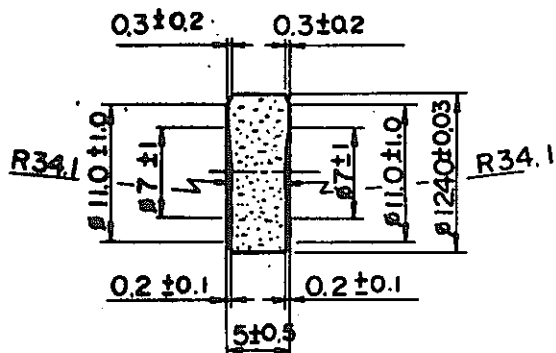


Rod No.	Numbers
554 - 3	2 (Max)
554 - 6	2 (Max)

1		fuel pellet	PuO <sub>2</sub> -UO <sub>2</sub>	3.4% <sup>w</sup> Pu fissile
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)
設計 (DESIGN)	T. Aibe	85-3-8	三角法 (THIRD)	IFA-554/555 fuel rods
製図 (DWG)	桐原	85-10-15	尺度 (SCALE)	Fuel Pellet (E)
検図 (CHECK)	金田	85-10-16	2/1 ( )	図番 (DRAWING NO.)
承認 (APPR)	横内	85-10-20		ADFHO-4PM-85248

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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	-

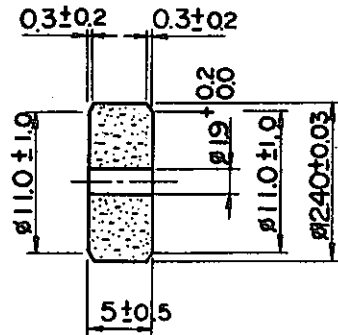


Rod No.	Numbers
554 - 1	2
554 - 2	2
554 - 3	1
554 - 4	1
554 - 5	1
555 - 1	2
555 - 2	2

品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
		Thermal Insulator	NUO <sub>2</sub>		
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)	IFA-554/555 fuel rods  Thermal Insulator (A) 図番 (DRAWING NO.) ADFHO-4PM-85249
製図 (DWG)	桐原	85-3-8	三角法 (THIRD)		
検図 (CHECK)	金田	85-10-14	尺度 (SCALE)		
承認 (APPR.)	橋内	85-10-16	2/1 ( )		
		85-10-20			

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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	



Rod No.	Numbers
5 5 4 - 3	1
5 5 4 - 4	1
5 5 4 - 5	1
5 5 4 - 6	2

1	Thermal Insulator		NUO 2		
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)	IFA-554/555 fuel rods
設計 (DESIGN)	T. Ahe	85-9-8	三角法 (THIRD)	Thermal Insulator (B)	
製図 (DWG.)	桐原	85-10-15	尺度 (SCALE)	図番 (DRAWING NO.)	
検図 (CHECK)	金田	85-10-16	2/1 ( )	ADFHO-4PM-85250	
承認 (APPR.)	種内	85-10-20			

整理No. < - >

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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	

1		Cladding	Zry - 2	4	554-1,-3-4-6
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	圖法 (ANGLE)	名称 (TITLE)	IFA-554/555 fuel rods  Cladding (A)
設計 (DESIGN)	T. Ahe	85-3-8	三角法 (THIRD)	圖番 (DRAWING NO.) ADFHO- 4PM- 85251	
製図 (DWG.)	桐原	85-10-15	尺度 (SCALE)		
検図 (CHECK)	金田	85-10-16	2/1 ( )		
承認 (APPR.)	横内	85-10-20			

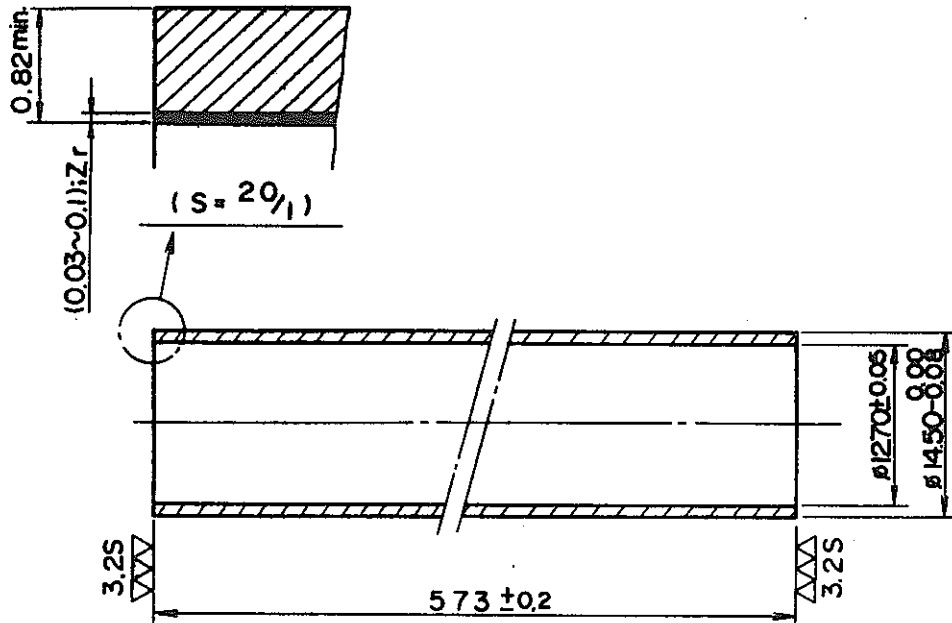
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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	



1		Cladding	Zry-2, Zr	4	Zr-Liner 554-2-5755-1-2
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)	I FA-554/555 fuel rods  Cladding (B)
製図 (DWG)	T. Ake	85-7-8	三角法 (THIRD)		
検図 (CHECK)	桐原	85-10-15	尺度 (SCALE)		
承認 (APPR.)	金田	85-10-16	2/1 (20/1)	図番 (DRAWING NO.) ADFHO-4PM-85252	
	横内	85-10-20			

整理No. < - >

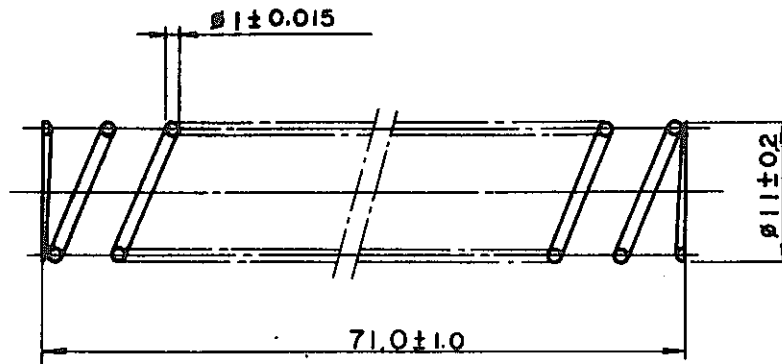
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関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO. による	- -	



### SPECIFICATION

MATERIAL	SUS 304 - WPB
WIRE DIAMETER	$\phi 1 \pm 0.015$
OVER DIAMETER	$\phi 11 \pm 0.2$
EFFECTIVE NUMBER TURNS	12
END TURNS	1
FREE LENGTH	$71.0 \pm 1.0$
SPRING CONSTANT	0.073 kg/mm

1	Spring		3	554-1,-2,-3
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
設計 (DESIGN)	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)
製図 (DWG)	T. Abe	85-3-8	三角法 (THIRD)	IFA-554/555 fuel rods
検図 (CHECK)	桐原	85-10-15	尺度 (SCALE)	Spring (A)
承認 (APPR.)	金田	85-10-16	2/1 ( )	図番 (DRAWING NO.)
	横内	85-10-20		ADFHO-4PM-85253

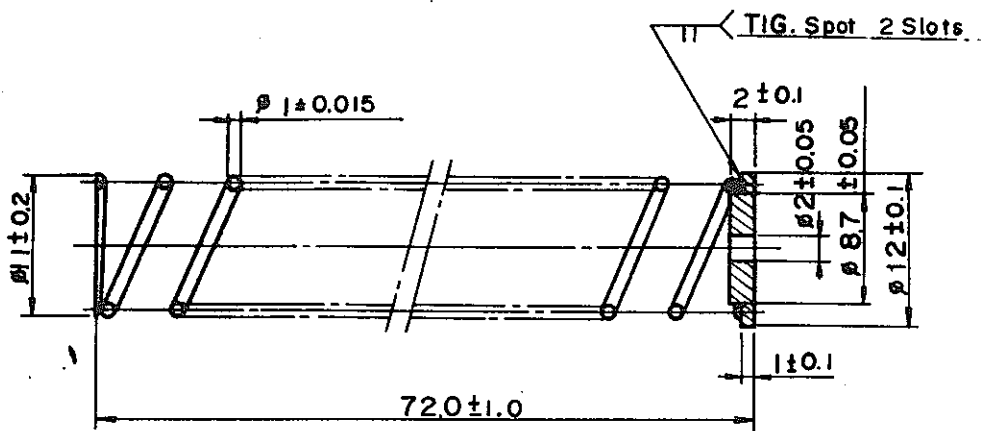
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動力炉・核燃料開発事業団

東海事業所

(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. TOKAI WORKS)

関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
	△	MEMO NO による	- -	



### SPECIFICATION

MATERIAL	SUS304-WPB
WIRE DIAMETER	$\phi 1 \pm 0.015$
OVER DIAMETER	$\phi 11 \pm 0.2$
EFFECTIVE NUMBER TURNS	12
END TURNS	1
FREE LENGTH	$71.0 \pm 1.0$
SPRING CONSTANT	0.073 kg/mm

2		Plate	SUS304	5	"
1		Spring		5	554-4-5-6 555-1-2
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)	IFA-554/555 fuel rods
設計 (DESIGN)	T. Aho	85-3-8	三角法 (THIRD)	Spring (B)	
製図 (DWG)	桐原	85-10-15	尺度 (SCALE)	図番 (DRAWING NO.)	
検図 (CHECK)	金田	85-10-16	2/1 ( )	ADFHO-4PM-85254	
承認 (APPR.)	横内	85-10-20			

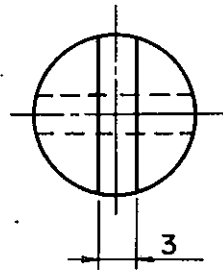
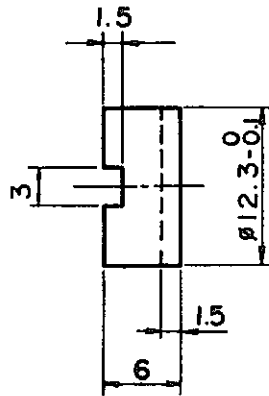
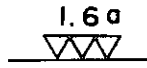
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(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS)

関連図面 (REFERENCE)	記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
HALDEN 480395	△	MEMO NO. による	- -	



1		Disc (A)	Zry - 2	2	554-1, -2, -3 555-1, -2
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)	備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	画法 (ANGLE)	名称 (TITLE)	IFA-554/555 fuel rods
設計 (DESIGN)	T. Arie	85-3-8	三角法 (THIRD)	Disc (A)	
製図 (DWG.)	桐原	85-10-15	尺度 (SCALE)		
検図 (CHECK)	金田	85-10-16	2/1 ( )	図番 (DRAWING NO.)	ADFHO-4PM-85255
承認 (APPR.)	横内	85-10-20			

整理No. < - >

動力炉・核燃料開発事業団

東海事業所

(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. TOKAI WORKS)

関連図面 (REFERENCE)		記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
HALDEN 480410		△	MEMO NO. による	- -	

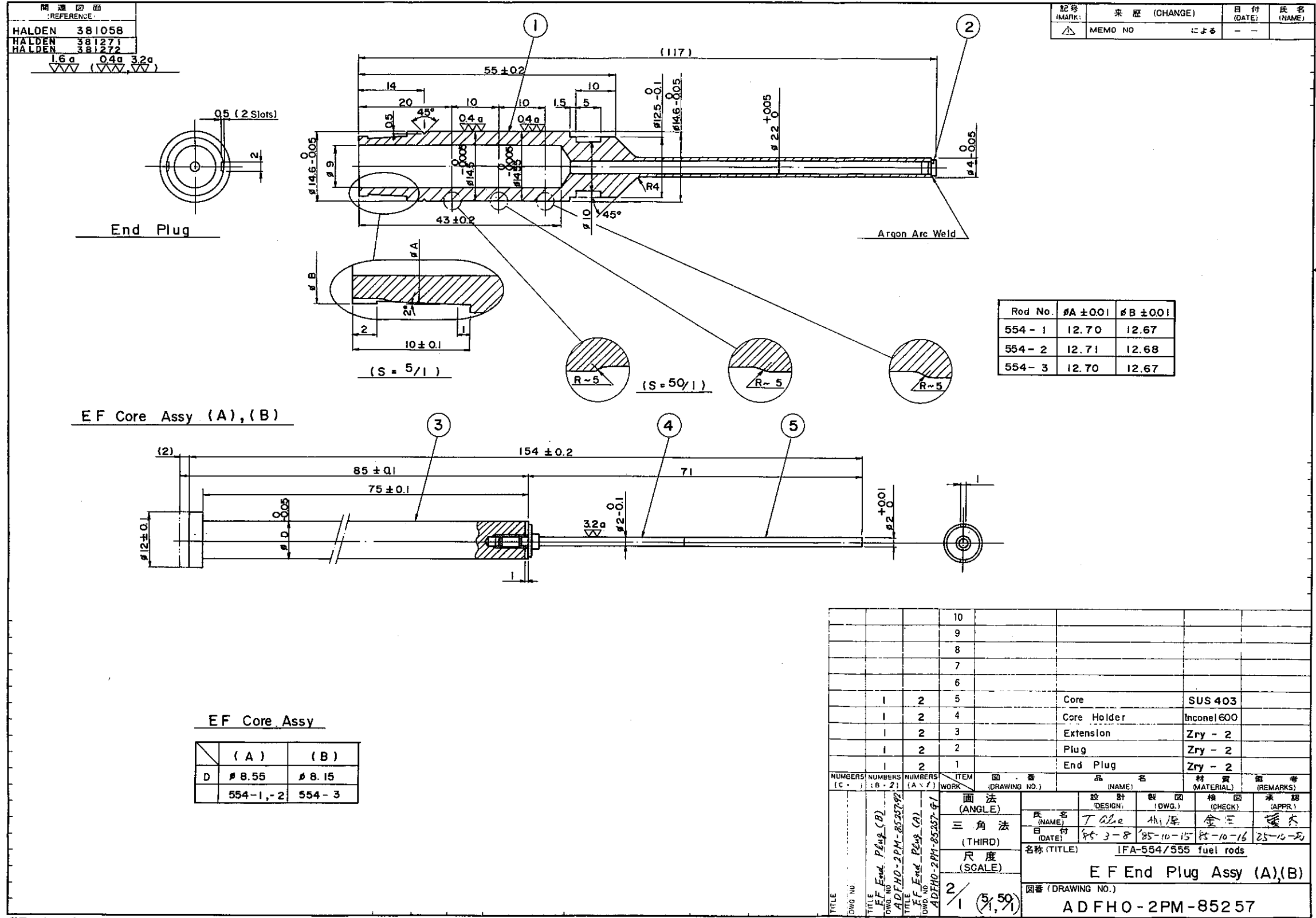
1	Disc (B)	Z ry-2	3	554-4,-5,-6
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUMBERS)
				備考 (REMARKS)
	氏名 (NAME)	日付 (DATE)	圖法 (ANGLE)	名称 (TITLE)
設計 (DESIGN)	T. Aho	85-9-8	三角法 (THIRD)	1FA-554/555 fuel rods
製図 (DWG.)	相原	85-10-15	R 度 (SCALE)	Disc (B)
検図 (CHECK)	金田	85-10-16	2 / 1 ( )	図番 (DRAWING NO.)
承認 (APPR.)	横内	85-10-20		<b>ADFHO-4PM-85256</b>

整理No. < - >

動力炉・核燃料開発事業団

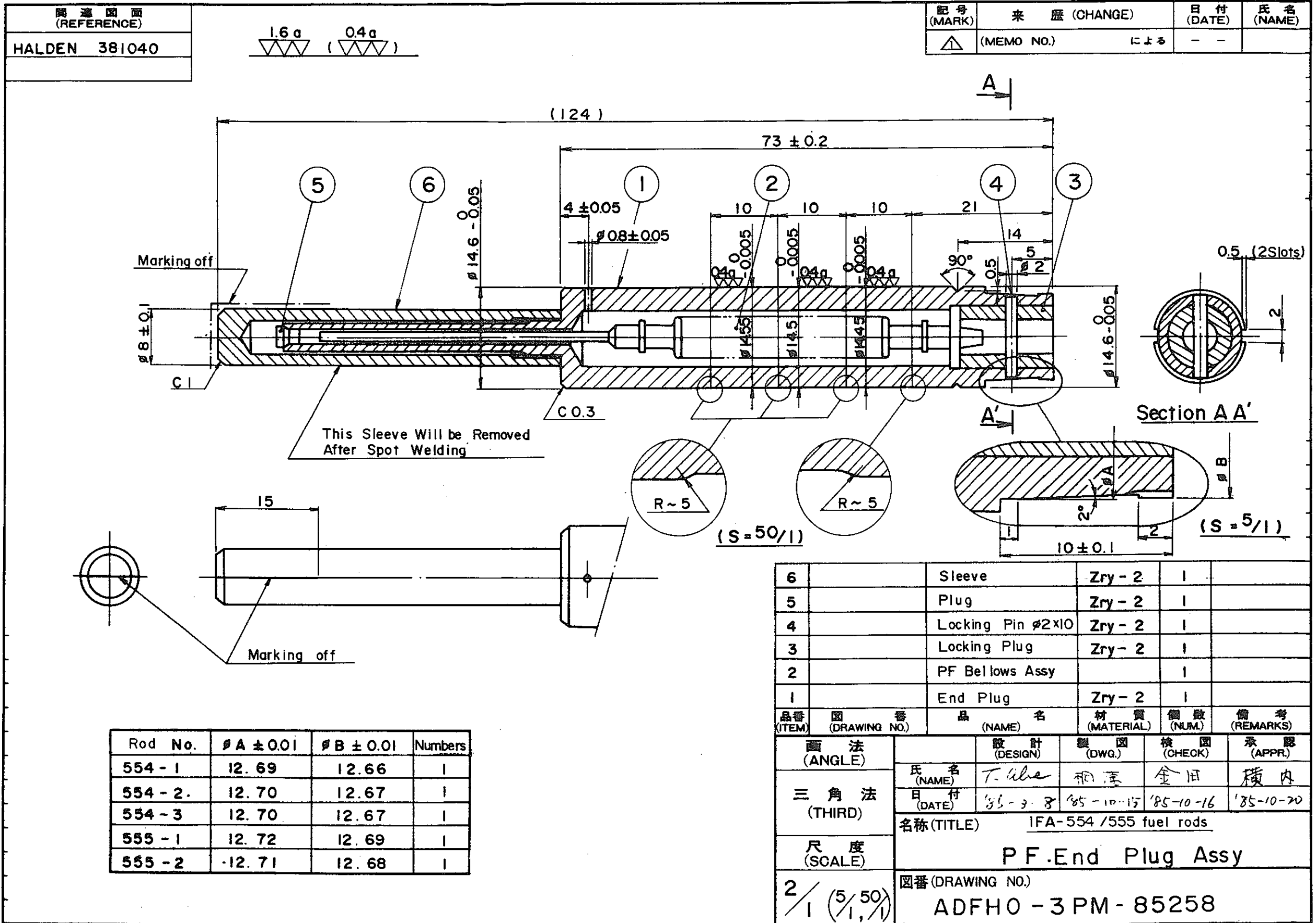
東海事業所

(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS)



整理No. < - >

動力炉・核燃料開発事業団 東海事業所  
(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS)



関連図面  
(REFERENCE)  
HALDEN 381040

記号 (MARK)	来 歴 (CHANGE)	日 付 (DATE)	氏 名 (NAME)
△	(MEMO NO.) による	- -	

Rod No.	φ A ± 0.01	φ B ± 0.01	Numbers
554 - 1	12.69	12.66	1
554 - 2	12.70	12.67	1
554 - 3	12.70	12.67	1
555 - 1	12.72	12.69	1
555 - 2	12.71	12.68	1

品番 (ITEM)	図 番 (DRAWING NO.)	品 名 (NAME)	材 質 (MATERIAL)	個 数 (NUM.)	備 考 (REMARKS)
6		Sleeve	Zry - 2	1	
5		Plug	Zry - 2	1	
4		Locking Pin φ2x10	Zry - 2	1	
3		Locking Plug	Zry - 2	1	
2		PF Bellows Assy		1	
1		End Plug	Zry - 2	1	

画 法 (ANGLE)	設 計 (DESIGN)	製 図 (DWG.)	検 査 (CHECK)	承 認 (APPR.)
三 角 法 (THIRD)	氏 名 (NAME)	日 付 (DATE)	氏 名 (NAME)	氏 名 (NAME)
尺 度 (SCALE)	名 称 (TITLE)			
2 / 1 (5 / 50)	P.F. End Plug Assy			
	図 番 (DRAWING NO.)			
	ADFHO - 3 PM - 85258			

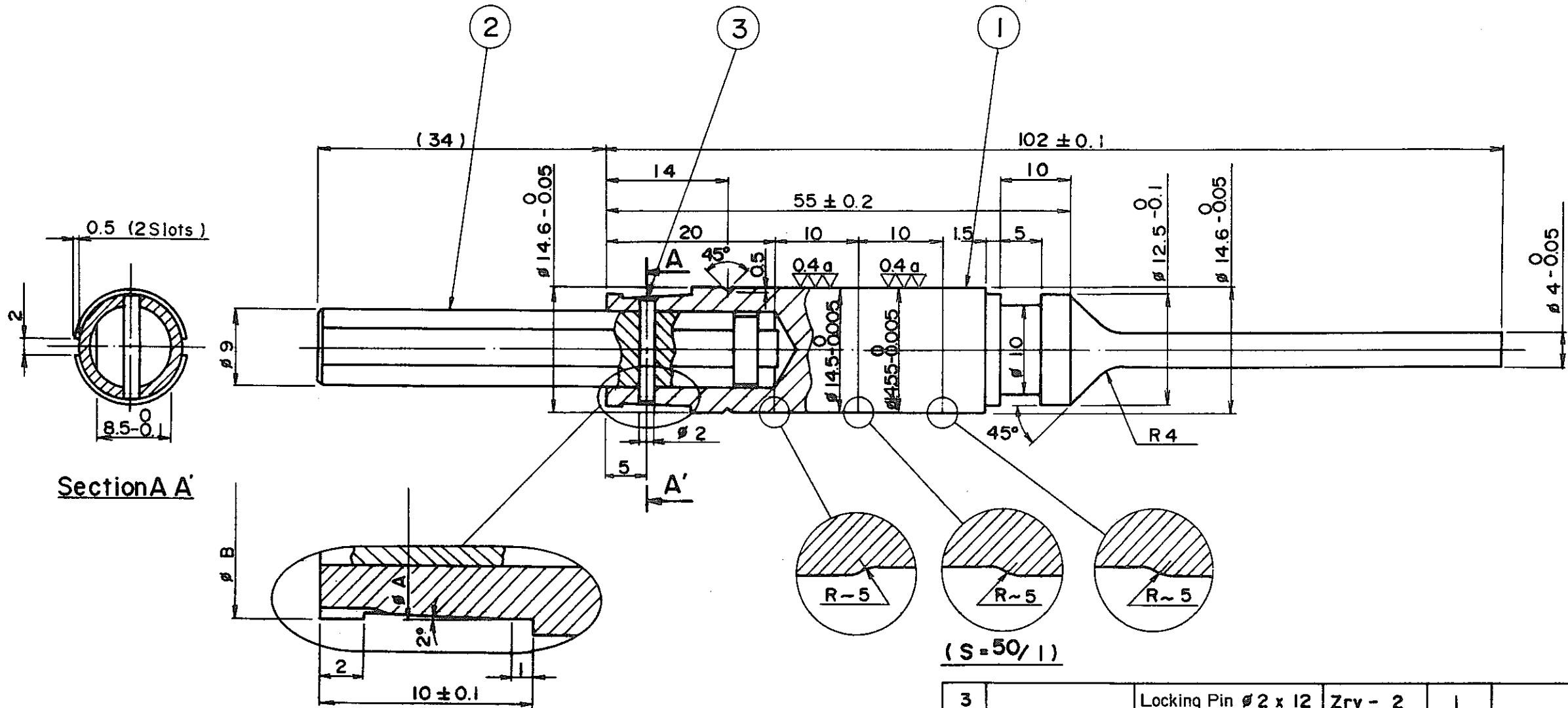
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(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS)

関連図面  
(REFERENCE)  
HALDEN 381273

1.6a (0.4a)

記号 (MARK)	来 歴 (CHANGE)	日 付 (DATE)	氏 名 (NAME)
△	(MEMO NO.) による	- -	



Section A A'

(S = 5 / 1)

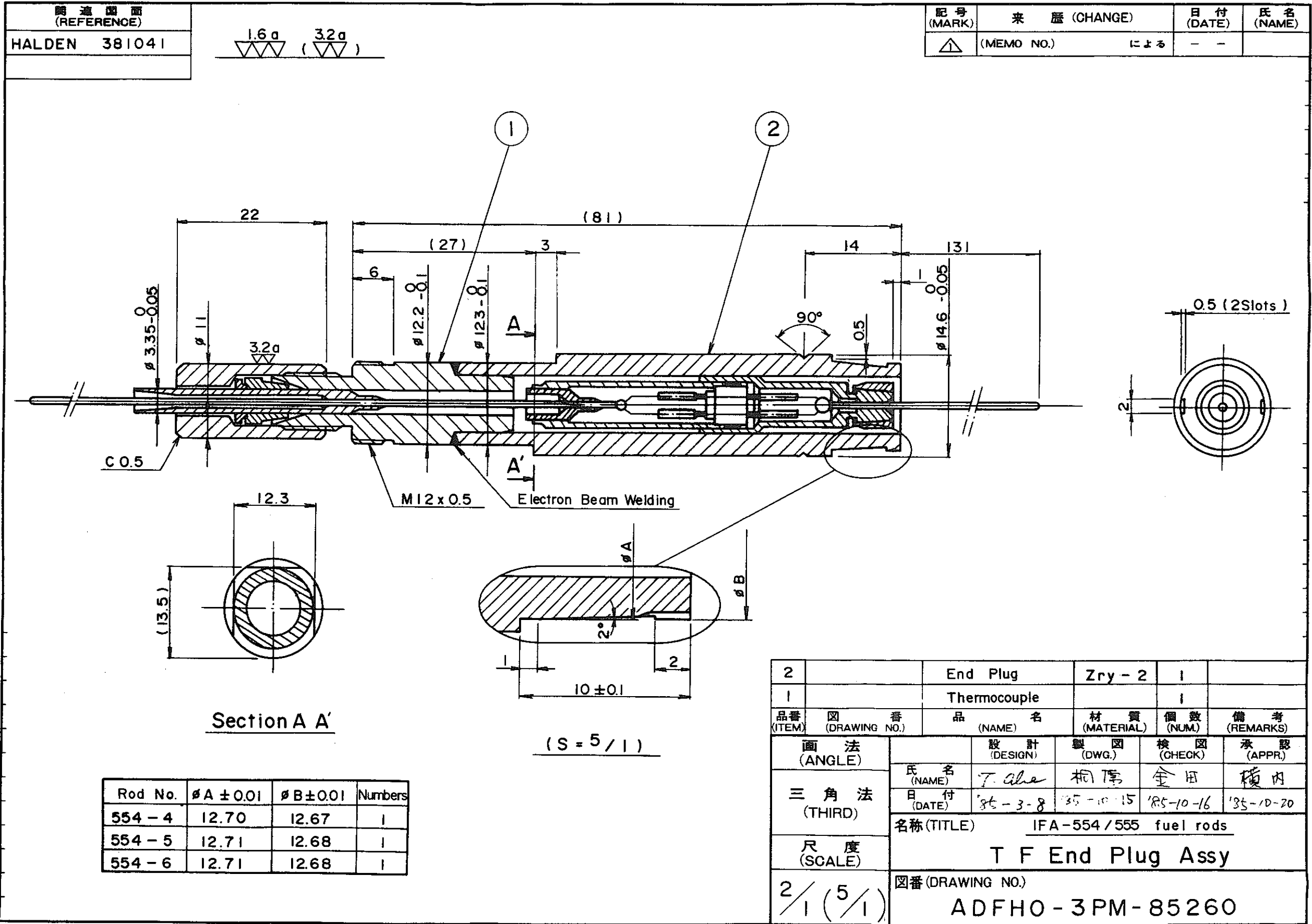
(S = 50 / 1)

Rod No.	φ A ± 0.01	φ B ± 0.01	Numbers
555 - 1	12.71	12.68	1
555 - 2	12.71	12.68	1

3		Locking Pin φ 2 x 12	Zry - 2	1	
2		Body	Zry - 2	1	
1		End Plug	Zry - 2	1	
品番 (ITEM)	図 番 (DRAWING NO.)	品 名 (NAME)	材 質 (MATERIAL)	個 数 (NUM.)	備 考 (REMARKS)
画 法 (ANGLE)		設 計 (DESIGN)	製 図 (DWG.)	検 査 (CHECK)	承 認 (APPR.)
氏 名 (NAME)		T. Aho	桐 蔭	金 田	横 内
日 付 (DATE)		'85-3-8	'85-10-15	'85-10-16	'85-10-20
三 角 法 (THIRD)		名称 (TITLE) IFA-554/555 fuel rods			
尺 度 (SCALE)		E C End Plug Assy (A)			
2 / 1 (5/50 / 1/1)		図番 (DRAWING NO.) ADFHO-3 PM-85259			

整理No < - >

動力炉・核燃料開発事業団 東海事業所  
(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS)



関連図面  
(REFERENCE)  
HALDEN 381041

記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
△	(MEMO NO.) による	- -	

Rod No.	φA ±0.01	φB ±0.01	Numbers
554-4	12.70	12.67	1
554-5	12.71	12.68	1
554-6	12.71	12.68	1

2	End Plug	Zry-2	1		
1	Thermocouple		1		
品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUM)	備考 (REMARKS)
画法 (ANGLE)	氏名 (NAME)	設計 (DESIGN)	製図 (DWG.)	検図 (CHECK)	承認 (APPR.)
三角法 (THIRD)	日付 (DATE)	氏名 (NAME)	氏名 (NAME)	氏名 (NAME)	氏名 (NAME)
尺度 (SCALE)	名称 (TITLE) IFA-554/555 fuel rods				
2/1 (5/1)	T F End Plug Assy				
図番 (DRAWING NO.) ADFHO-3PM-85260					

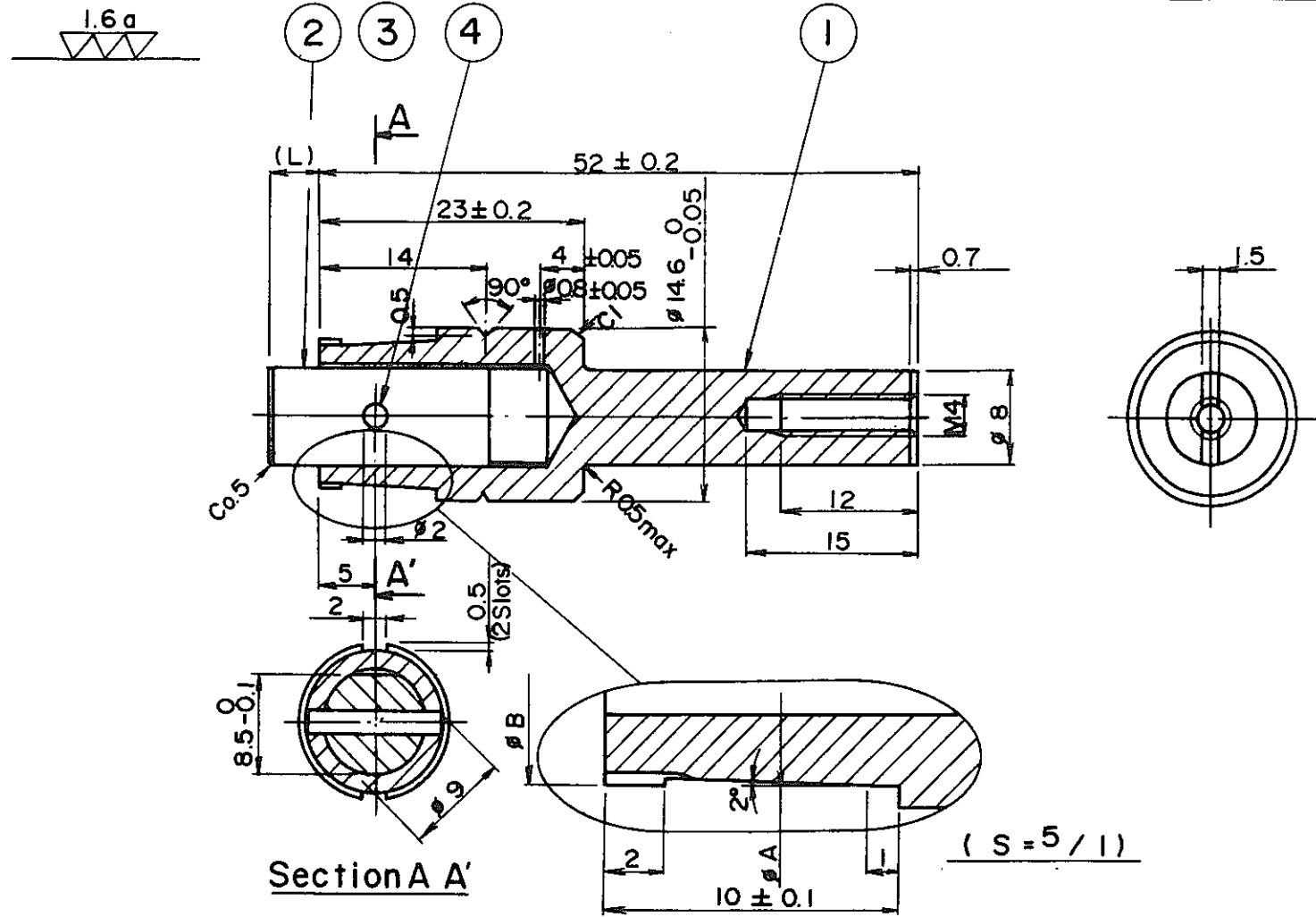
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(POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. TOKAI WORKS)



関連図面 (REFERENCE)
HALDEN 480575
HALDEN 480576

記号 (MARK)	来歴 (CHANGE)	日付 (DATE)	氏名 (NAME)
△	(MEMO NO.) による	- -	



Rod No.	φA ± 0.01	φB ± 0.01
554 - 4	12.71	12.68
554 - 5	12.71	12.68
554 - 6	12.70	12.67

**EC End Plug**

	(B)	(C)
L	8.5	3
	554-4,-5	554-6

1	2	4	Locking Pin φ2 x 12	Zry - 2			
1	3		Body (B)	Zry - 2			
	2	2	Body (A)	Zry - 2			
1	2	1	End Plug	Zry - 2			
(B x 1)	(A x 2)	品番 (ITEM)	図番 (DRAWING NO.)	品名 (NAME)	材質 (MATERIAL)	個数 (NUM.)	備考 (REMARKS)
EC End Plug (C)	ADFHO-3PM-85261-GP	EC End Plug (B)	ADFHO-3PM-85261-G1				
画法 (ANGLE)	設計 (DESIGN)	製図 (DWG.)	検図 (CHECK)	承認 (APPR.)			
三角法 (THIRD)	氏名 (NAME)	桐原	金田	横内			
尺度 (SCALE)	日付 (DATE)	1985-3-8	1985-10-15	1985-10-16	1985-10-20		
2/1 (5/1)	名称 (TITLE)	IFA-554/555 fuel rods					
	EC End Plug Assy (B),(C)						
	図番 (DRAWING NO.) ADFHO-3PM-85261						

整理記 < - >