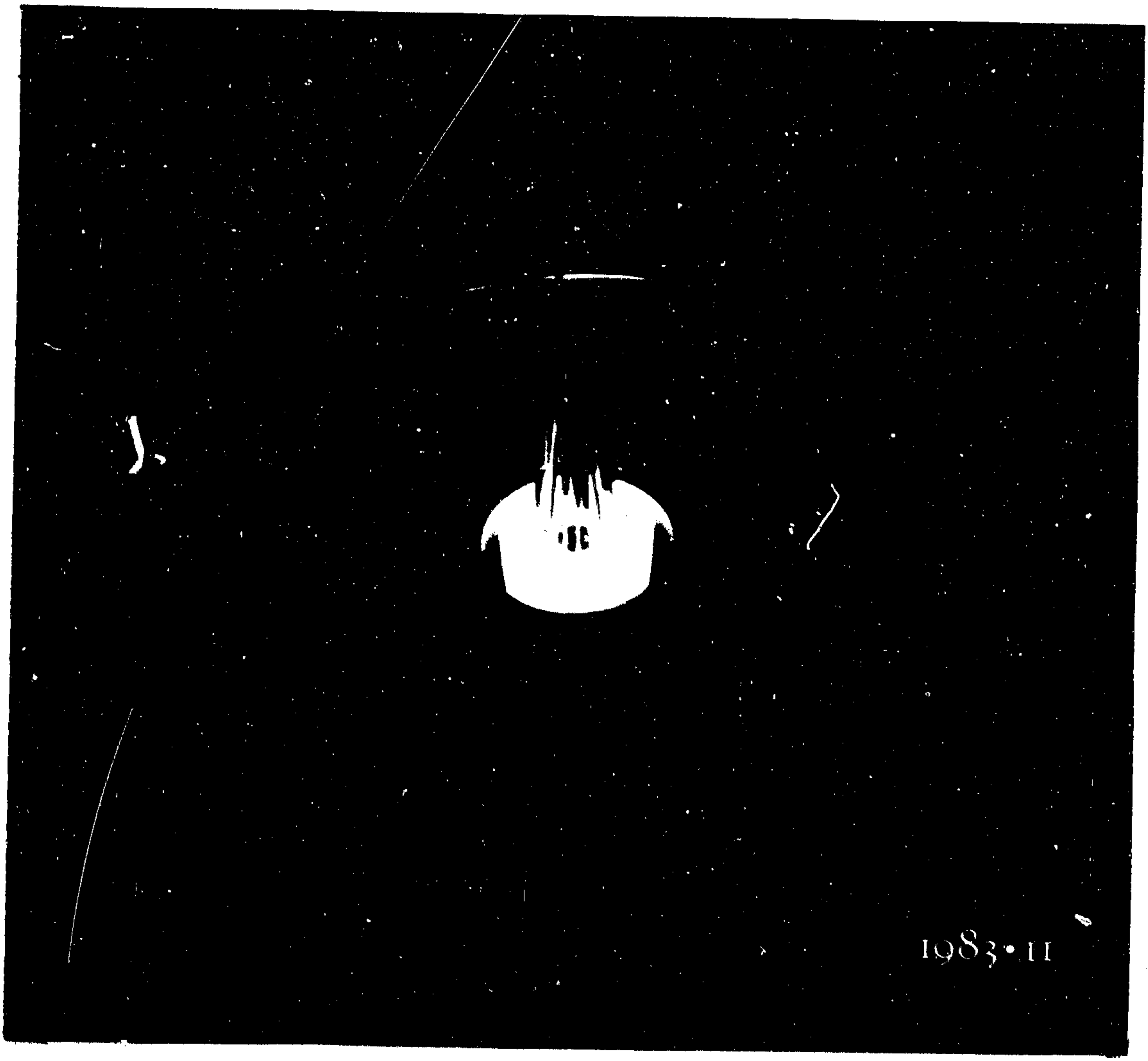
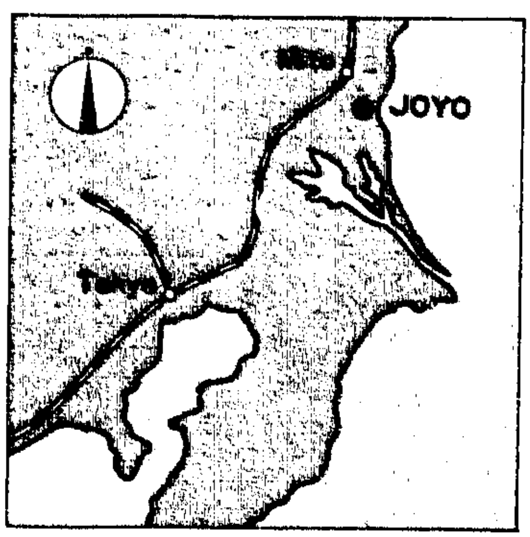
PNCT N953 83-01Tr.

"JOYO"
IRRADIATION TEST

THE OUTLINE OF "JOYO" MARK-II PROGRAM



CONTENTS



Location of JOYO

Cover photo : The cover photo shows the INTA (See page 21) cable penetration under brazing by high frequency heater. The brazing temperature is about 1100℃.

1 INTRODUCTION

The Experimental Fast Reactor "JOYO" is the first liquid metal fast reactor in Japan. In 1970, construction was started at O-arai in Ibaraki Prefecture, about 100 kilometers northeast of Tokyo. "JOYO" reached initial criticality on Apr. 24, 1977. Since initial criticality, the experimental fast reactor "JOYO" has demonstrated good performance, and has produced valuable operating experience. At the present time, the reactor has completed the following programs: low power test, 50MWt power up test, two 50MWt duty cycles, 75 MWt power up test, six 75MWt duty cycles.

The MK-II operation started in November 1982 when it attained initial criticality. After that, in August, 1983, the first 100MWt duty cycle began, following which various irradiation tests will be performed.

The construction of "JOYO" was authorized and its objectives were described by the Japan Atomic Energy Commission in the "Guideline for the Power Reactor Development" as follows:

- to obtain technical and engineering experience needed for the development of the prototype fast breeder reactor.
- to use the reactor as a fast neutron irradiation facility for the development of fuels, materials, and other components required for the LMFBR program.

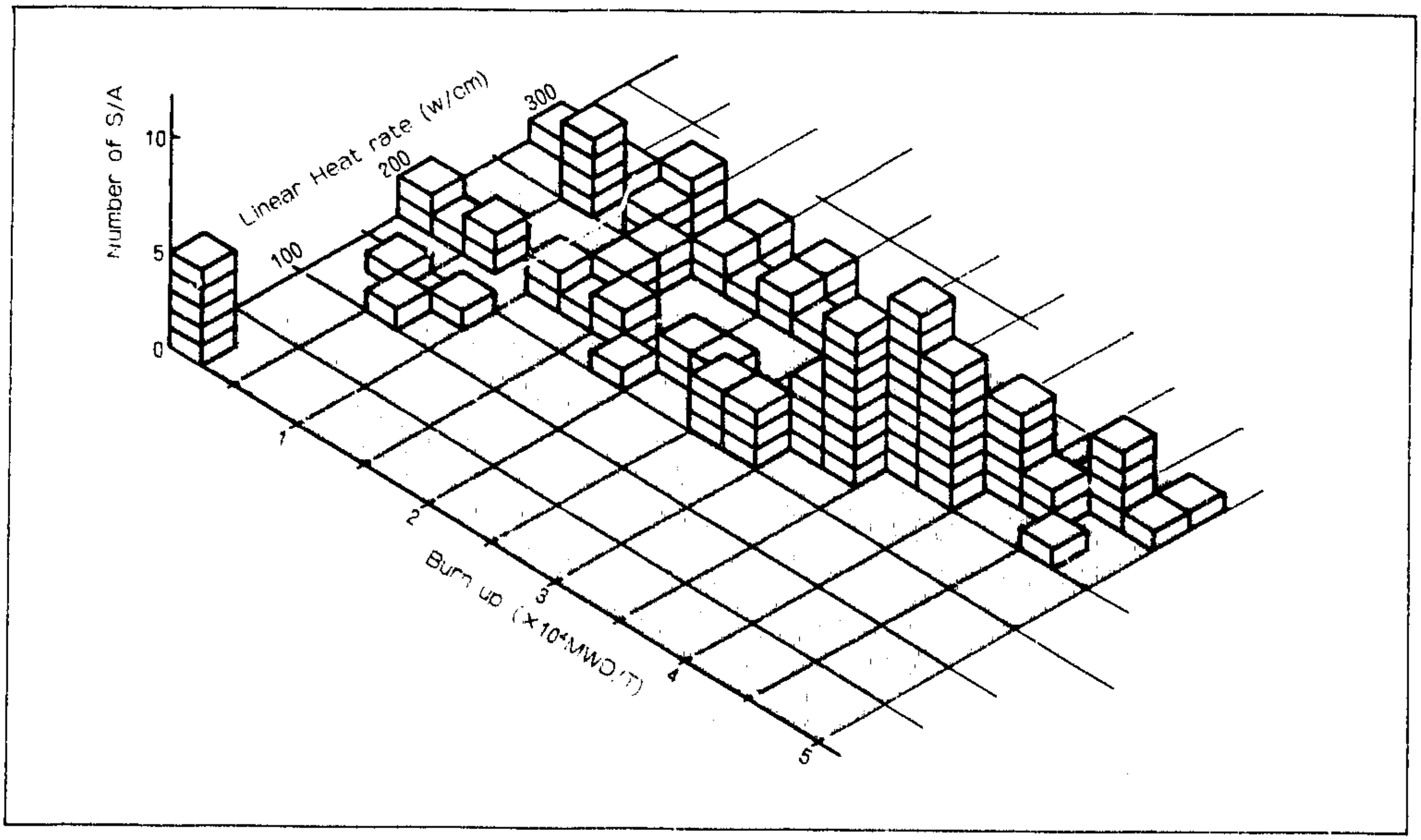


Fig. 1 Results of JOYO MK-I irradiation tests

Through design, construction, testing, operation and maintenance experience to date, "JOYO" has contributed much to the Japanese fast breeder reactor development program. In addition to providing operating experience, the role as a fast neutron irradiation facility has begun. Knowledge of the irradiation behavior of fuels, materials and components is very important, and is dependent on the effective use of "JOYO" which will lead to design of fuels, materials and components which show good performance under high fast neutron fluence.

Of course, "JOYO" will be operated to gain much more experience of nuclear power plant systems and components required for the development of the liquid metal fast breeder reactor, and further technical improvement will be accomplished through the construction and operation of the prototype fast breeder reactor "MONJU".

Since fuels, materials and components in fast breeder reactors are exposed to much higher fast neutron flux and temperature than those in LWRs, their irradiation performance is of much interest and will be informative both for developing the fast breeder reactor and using the nuclear fuels effectively.
Also, in "JOYO", irradiation test devices have been planned. Much effort has been made for research and development of these devices.

Fig. 1 shows the results of "JOYO" MK-I irradiation tests.

2 THE JOYO MARK-II IRRADIATION TEST PROGRAM

As mentioned above, "JOYO" is the only fast reactor in our country and knowledge of the irradiation behavior of fuels, materials and components is very important for developing the fast breeder reactor. Therefore, irradiation tests using JOYO play a significant role in our FBR program.

Fuels show various behavior under high fast neutron exposure and elevated temperature, such as:

- swelling (fuels and materials swell mainly due to the nuclear reaction.)
- thermal expansion
- change of physical properties (such as thermal conductivity of fuels, mechanical strength of materials)
- PCCI (Pellet-Clad-Chemical Interaction: the internal surface of the fuel cladding is chemically attacked by oxygen and fission products during fuel burnup.)
- PCMI (Pellet-Clad-Mechanical Interaction: for example,due to thermal expansion and swelling, the fuel cladding wears or welds with the fuel pellets.)
- redistribution of fuel composition and restructuring
- fuel pin internal pressure increase.

Other items to be tested are those when the reactor is operated under abnormal operating conditions, such as:

- when irradiation of failed fuel is continued,
- when coolant flow rate is reduced,
- when fuel is subjected to overpower conditions.

Tests for verification of the design are also required, such as:

- coolant mixing effects
- hydraulic behavior of subchannel edge
- hot spot factor.

Further irradiation test activities may include the use of carbide fuel and grid type fuel supports.

As support for these irradiation tests, three post-irradiation examination (PIE) facilities have been constructed at the O-arai Engineering Center. They are the Fuel Monitoring Facility (FMF), Alpha Gamma Facility (AGF), and Materials Monitoring Facility (MMF).

Examinations which have been conducted in these facilities are listed below:

- visual inspection
- dimensional measurements for duct and fuel pin
- burnup measurement
- metallurgical examinations
- material mechanical test
- fuel physical properties measurements.

Let us now review the outline of the irradiation test program.

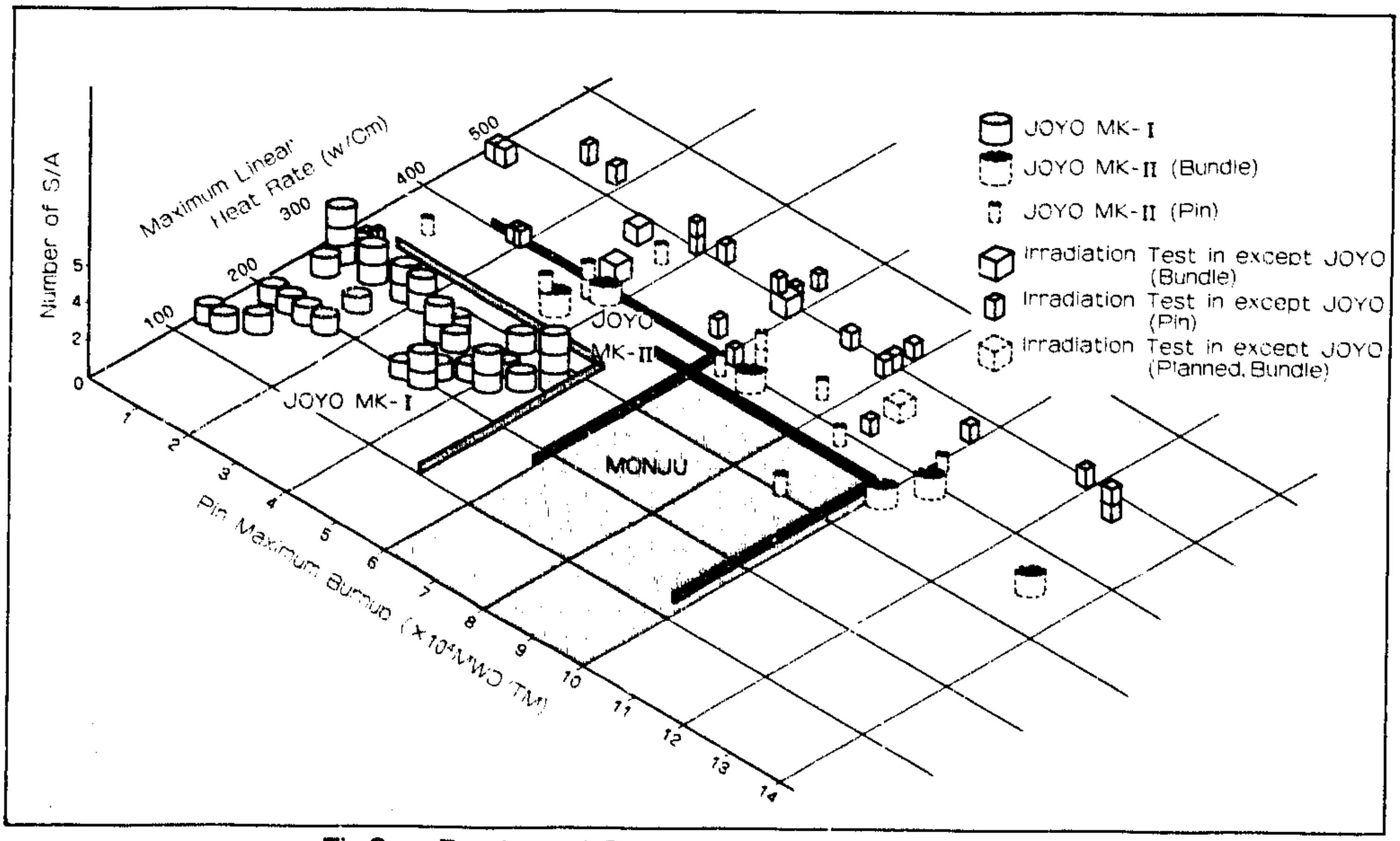


Fig.2 Results and Schedule of Irradiation Test in Fuel

In the Mark-I core, ten core subassemblies were loaded which were especially inspected, quality-controlled, and data-logged at every manufacturing and assembling stage. These subassemblies were removed after pre-determined exposures, transferred to the PIE facilities, and examined non-destructively or destructively. In addition, various core components including driver subassemblies, control rods, etc, were taken out to investigate the basic problems of the fuels and materials irradiation behavior. Information obtained from these examinations will play an important role in our FBR development program.

For the construction of the prototype and demonstration plants, however, the information only from "JOYO" driver fuel post-irradiation examination is not necessarily sufficient. Since irradiation testing of fuels for the prototype or demonstration reactor should also be achieved, "JOYO" has been modified to be suitable for these advanced irradiation conditions. That is what we call the "JOYO Mark-II" program.

The outline of the "JOYO Mark-II" program is described below.

The following were required for "JOYO" to be modified as a powerful fast flux irradiation facility.

- Core conversion to increase the irradiation capability
- Introduction of various irradiation test devices suitable for irradiation purposes
- Modification or increase of the existing system capability consistent with the new irradiation test devices

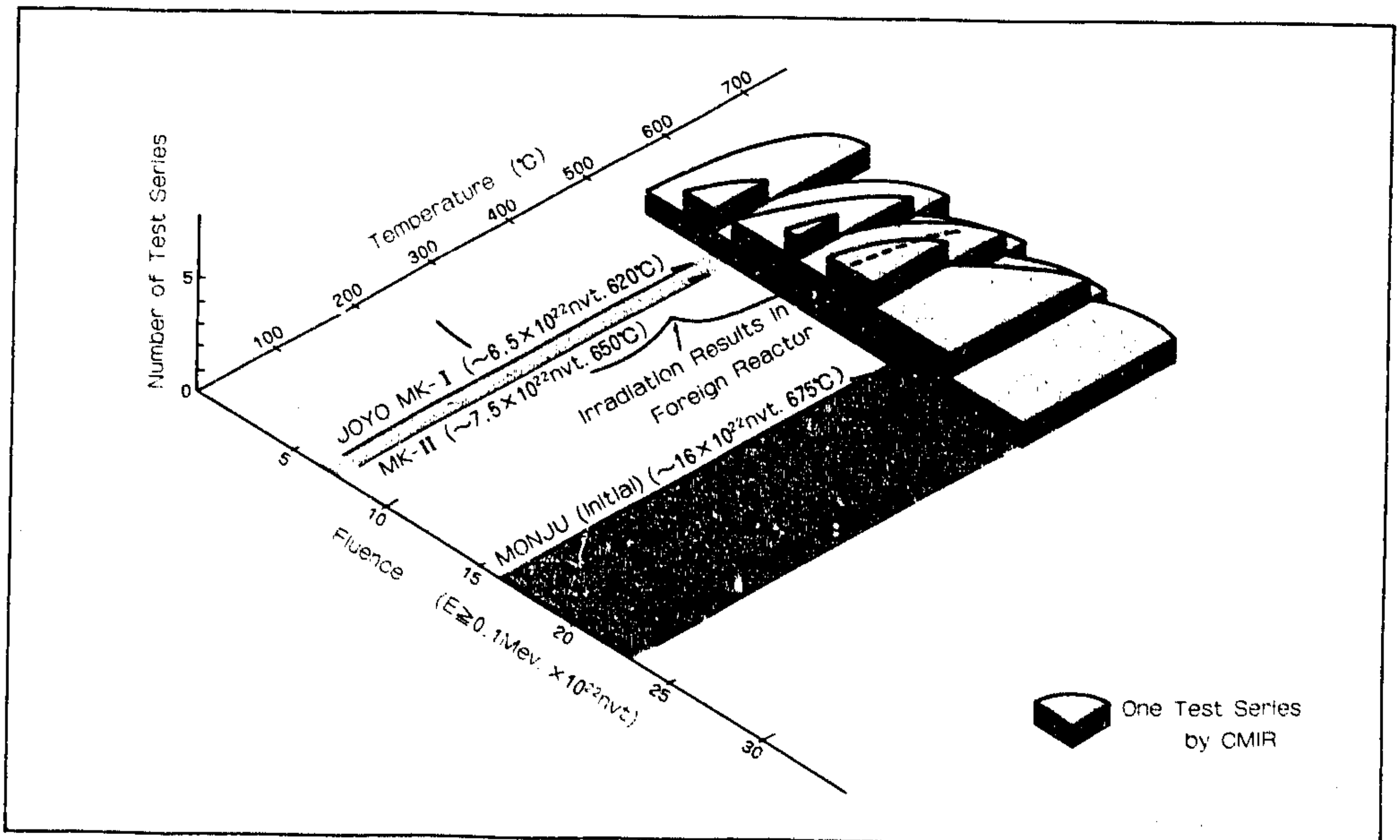


Fig.3 Results and Schedule of Irradiation Test in Core Materials

Construction of the Irradiation Rig Assembling Facility (IRAF)

Work to be done includes not only these modifications, but also research and development of the irradiation test devices, data collection, planning and evaluations of the pre-irradiation inspections, performing the irradiation operations, and the post-irradiation examinations. Also, those documents required for obtaining approvals by government regulatory organizations must be prepared and submitted. The organization performing various irradiation services must be established.

The "JOYO Mark-II" program must be realized soon to provide the test results for the construction of our prototype fast breeder reactor "MONJU".

"JOYO" is expected to be a useful fast flux irradiation test vehicle suitable for various kinds of test purposes, since it is a relatively small but flexible fast experimental reactor. Accordingly, before "MONJU" begins commercial operation, irradiation tests for verifying the "MONJU" initial core subassembly design and materials will be scheduled. After that, tests of advanced fuels and materials for the "MONJU" reactor will be performed. In addition, tests of carbide fuels and of fuels and materials for the demonstration plant are planned, when "MONJU" begins commercial operation.

These tests are conducted by using the special irradiation device, Uninstrumented Irradiation Subassembly (UNIS), in accordance with its test purposes. Fuel pins to be tested in JOYO MK-II core should accomodate the limitations described below.

- Type of fuel material : Plutonium-Uranium mixed oxide
- PuO_2 content : less than 30 w/o
- Type of pin closure : Sealed by welding filled with inert gas
- Pellet/Cladding outer diameter :
  - (I) 4.6/5.4 -5.8 mm
  - (II) 5.4/6.4 -6.8 mm
  - (III) 5.3-7.5/6.4-8.5 mm
- Pellet density :
  - (I) less than 94% T.D.
  - (II) less than 87% T.D.
  - (III) less than 95% T.D.
- U-235 enrichment :
  - (I) less than 41 w/o
  - (II) less than 35 w/o
  - (III) less than 20 w/o
- Cladding thickness :
  - (I) 0.3 - 0.5 mm
  - (II) 0.4 - 0.6 mm
  - (III) 0.4 - 0.7 mm
- Liner heat rate (norminal) :
  - (I) less than 450 w/cm
  - (II) less than 530 w/cm
  - (III) less than 480 w/cm
- Liner heat rate (over power) :
  - (I) less than 510 w/cm
  - (II) less than 600 w/cm
  - (III) less than 540 w/cm
- Pin pitch : 6 - 11 mm

The limitations above are provided by the licensed report by the government. Irradiation tests beyond the limitations could be possible when the licensing is renewed.

Moreover, the Instrumented Test Assembly (INTA), which can continuously monitor fuel behavior during irradiation, and the JOYO Closed In-pile Loop (JOCIL), in which research on reactor safety and fuel behavior under off-normal irradiation conditions are investigated.

3 FEATURES OF THE "JOYO MK-II" CORE

For the effective irradiation of fuels and materials, the present core configuration and core elements are modified. As result of modification, the following benefits are obtained:

- Increased neutron flux
- Increased power density
- Enlarged fast neutron zone

The core fuel assemblies will be modified as follows :

- by increasing plutonium enrichment
- by decreasing fuel pin diameter and increasing their number
- by shortening the height of the core zone
- by exchanging the axial blanket to a stainless steel reflector

Radial blanket fuel assemblies will be replaced with two kinds of reflectors.

There will be six control rods of the same structure. All of the control rods will have the function of safety rods as well as regulating rods. In order to increase the life time, the control rods will be composed of helium gas-vented elements.

The results of the above modifications are shown in Fig. 4. and Table 1. in comparison with MK-I core. Comparison with foreign irradiation test beds is shown in Table 2.

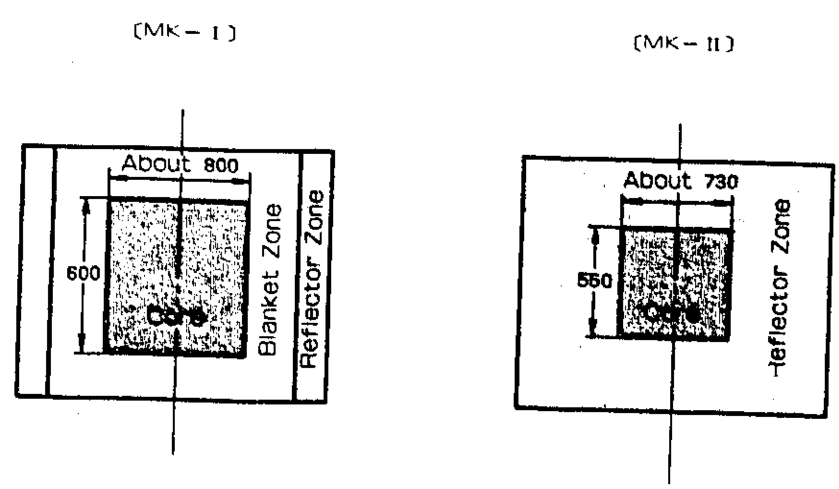


Fig.4 Core Modification

Table I Main Core Parameters of "JOYO"

		MK－I First	MK－I Second	MK－II
Reactor Output	MWt	50	75	100
Primary Coolant Flow Rate	t/h	～2,200	～2,200	～2,200
Reactor Inlet Temperature	℃	370	370	370
Reactor Outlet Temperature	℃	～435	～470	～500
Core Stack Length	cm	60	60	55
Core Volume (max.)	ℓ	～294	～304	～250
Linear Heat Rate (max.)	W/cm	～210	～320	～400
Fuel Pin Diameter	mm	6.3	6.3	5.5
Fuel Pin Number/One Subassembly		91	91	127
Height of Axial Blanket Fuel	cm	Upper 40 lower 40	Upper 40 lower 40	－
Height of Axial Reflector	cm	－	－	30
$PuO_2/(PuO_2+UO_2)$	W/O	～18	～18	～30
U^{235} Enrichment	W/O	～23	～23	～12
Location of Blanket Fuel Subassembly	row	5 ～9	5 ～9	－
Location of Reflector	row	10	10	Inner 5 ～6 Outer(A) 7 ～9 Outer(B) 10
Neutron Flux (max.)	n/cm²·sec	2.1×10^{15}	3.2×10^{15}	5.1×10^{15}
Neutron Flux (Core av.)	n/cm²·sec	1.4×10^{15}	2.0×10^{15}	3.7×10^{15}
Max. Excess Reactivity	%ΔK/K	4.5 (100℃)	4.5 (100℃)	5.5
Control Rod Number		Safety Rod 4 Regulating Rod 2	Safety Rod 4 Regulating Rod 2	Control Rod 6
Type of Control Rod Element		sealed	sealed	vented
Control Rod Worth	%ΔK/K	Safety Rod ～5.6 (4) Regulating Rod ～2.8 (2)	Safety Rod ～5.6 (4) Regulating Rod ～2.8 (2)	9.0 (6)
Max. Burn Up (pin av.)	MWD/t	25,000	42,000	50,000
Operation Cycle		45 days Operation 15 days Outage	45 days Operation 15 days Outage	45 days Operation 15 days Outage

Table 2 Irradiation Bed Parameters of the World

	JOYO MK-I 50 MW	JOYO MK-I 75 MW	JOYO MK-II 100 MW	EBR-II	FFTF	RAPSODIE: RAPSODIE	RAPSODIE: Fortissimo	Phenix	PFR	KNK-II	BR-5
Reactor Power (MW)	50	75	100	62.5	400	24	37.4	560	600	58	5
Max. Neutron Flux (n/cm²·s) Total	2.1×10^{15}	3.2×10^{15}	5.1×10^{15}	5.7×10^{15}	7×10^{15}	1.8×10^{15}	3×10^{15}	7.2×10^{15}	7.5×10^{15}	1.67×10^{15}	1×10^{15}
Fast ($\geq$0.1 MeV)	1.4×10^{15}	2.0×10^{15}	3.7×10^{15}	—	4.5×10^{15}	1.5×10^{15}	2.5×10^{15}	4.5×10^{15}	4.5×10^{15}	1.39×10^{15}	—
Core Volume (ℓ)	241	252	210	60	1,034	486	427	1,227	—	320	172
Number of Fuel Assembly	70	73	67	47	75	64	59	103	71	29	80
Fuel											
Pellet Diameter (mm)	5.4	5.4	4.6	—	5.84	5.57	4.23	5.5	4.95	7.6	5.0
Stack Length (mm)	600	600	550	361	915	340	320	850	915	600	280
Number of Fuel Pin in Assembly	91	91	127	7	217	37	61	217	325	121/102	19
$PuO_2/(PuO_2+UO_2)$ (%)	18	18	30	—	22/28	25	30	19/27	22/30	30	100
U^{235} Enrichment (%)	23	23	12	49	nat.	60	85	nat.	nat.	91	—
Core Inlet Temp. (℃)	370	370	370	371	~330 (initial)	405	410	400	417	360	375
Core Outlet Temp. (℃)	435	470	500	473	~482 (initial)	495	530	560	32	527	450
Primary Flow Rate (m³/h)	2,570	2,570	2,570	2,000	7,400	890	1,060	11,700	12,240	1,162	—
Linear Heat Rate (w/cm)	210	320	400	376	410	380	400	430	450	436	300

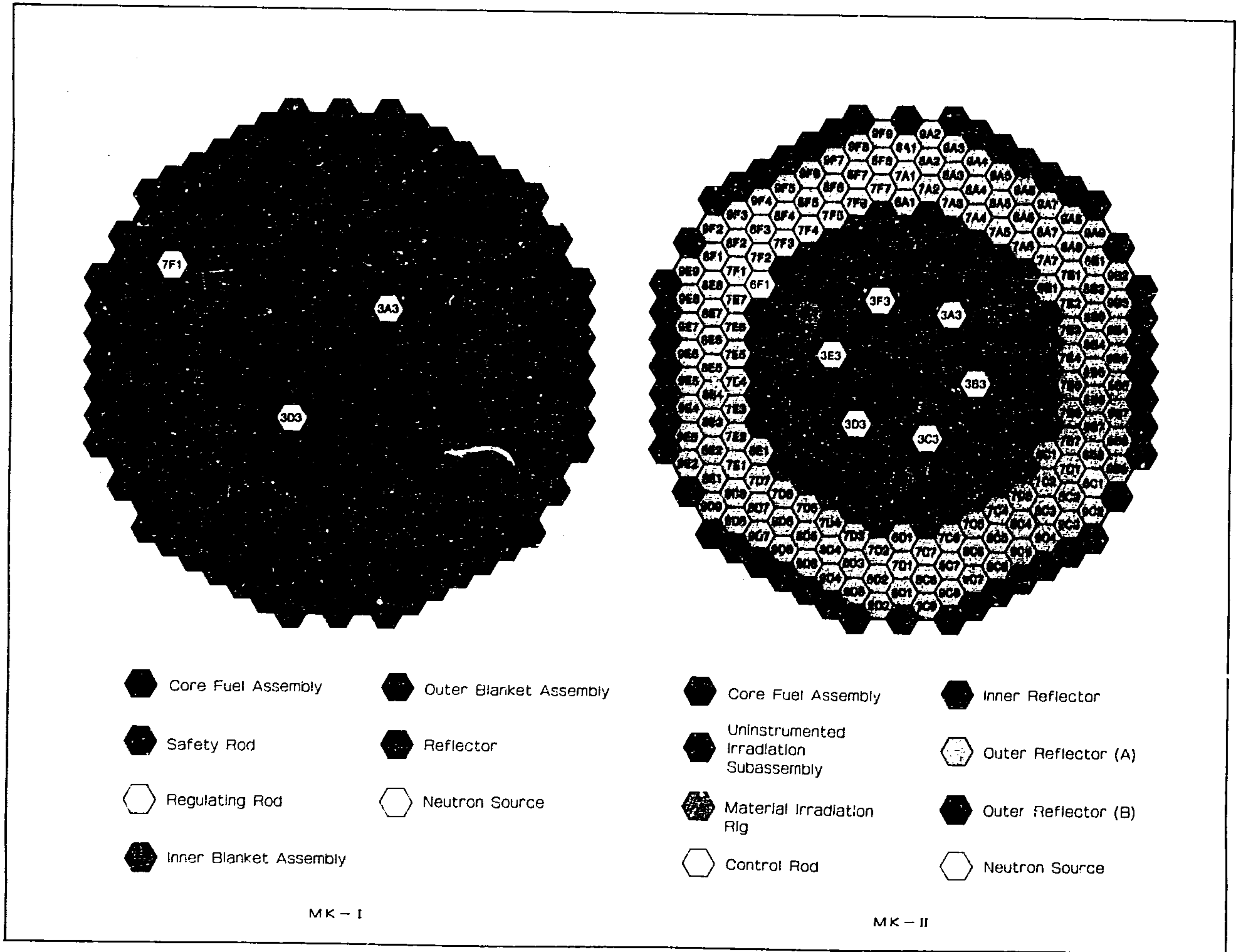


Fig.5 Core and Fuel Assembly

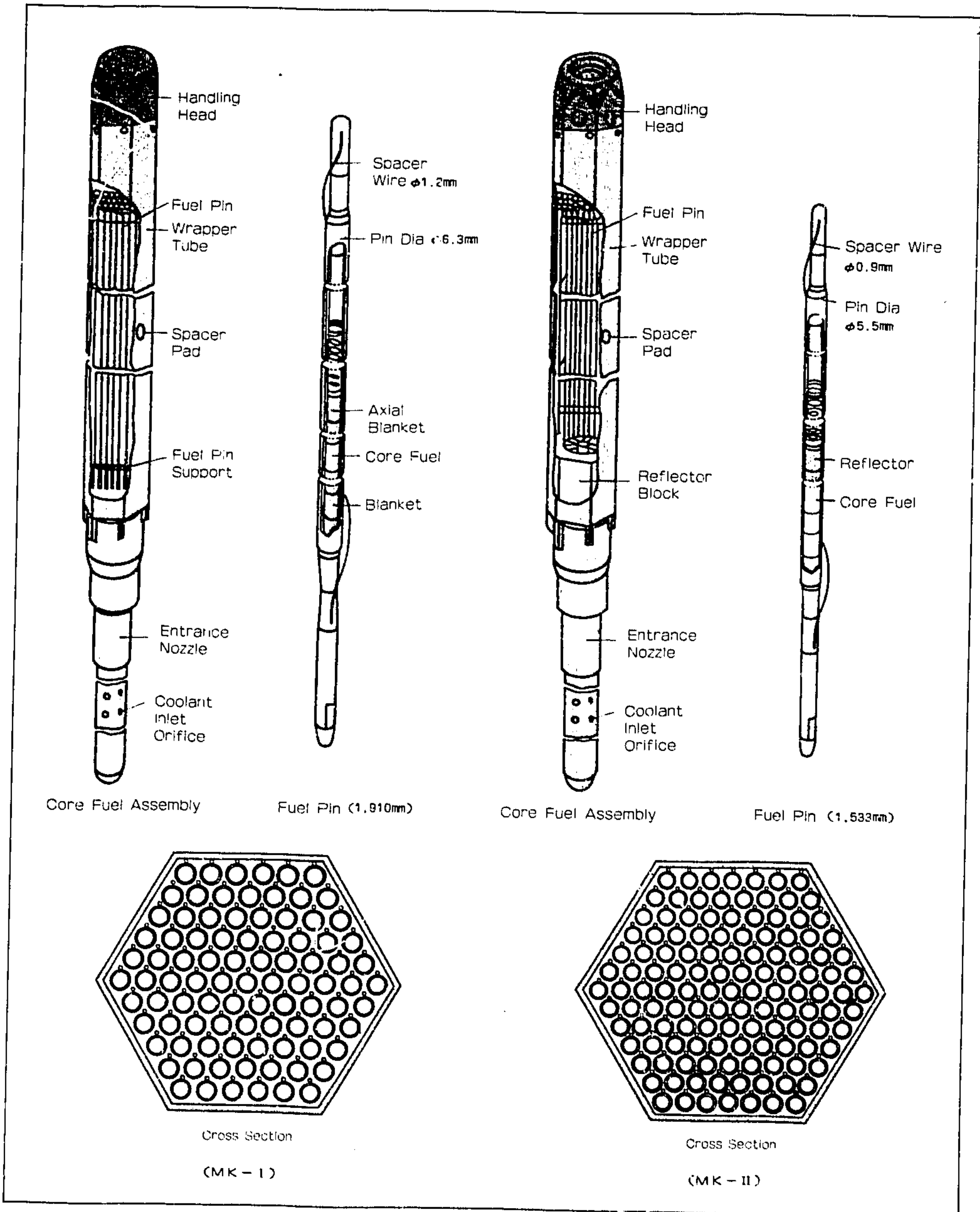


Fig.6 Core Element

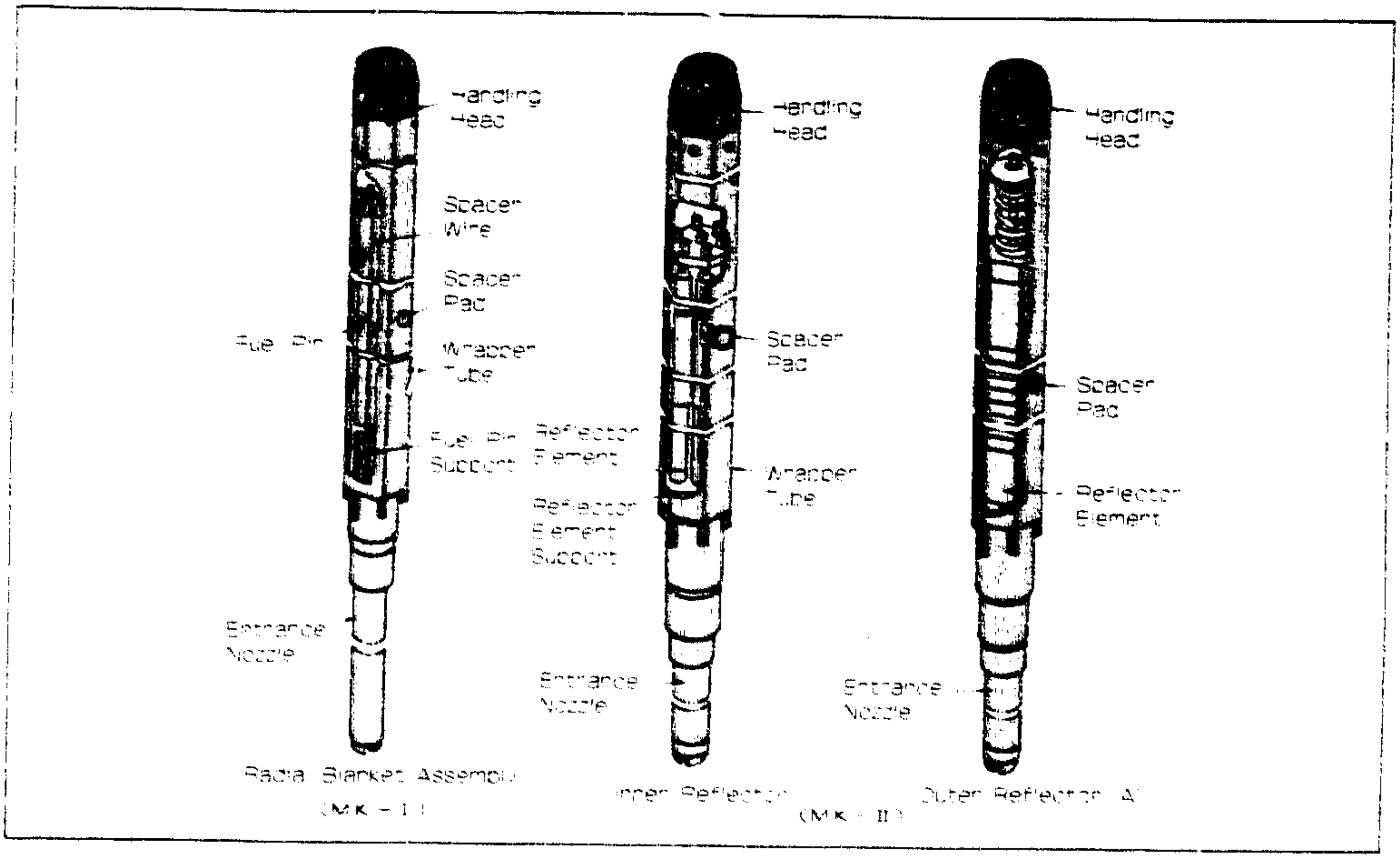


Fig.7 Core Element

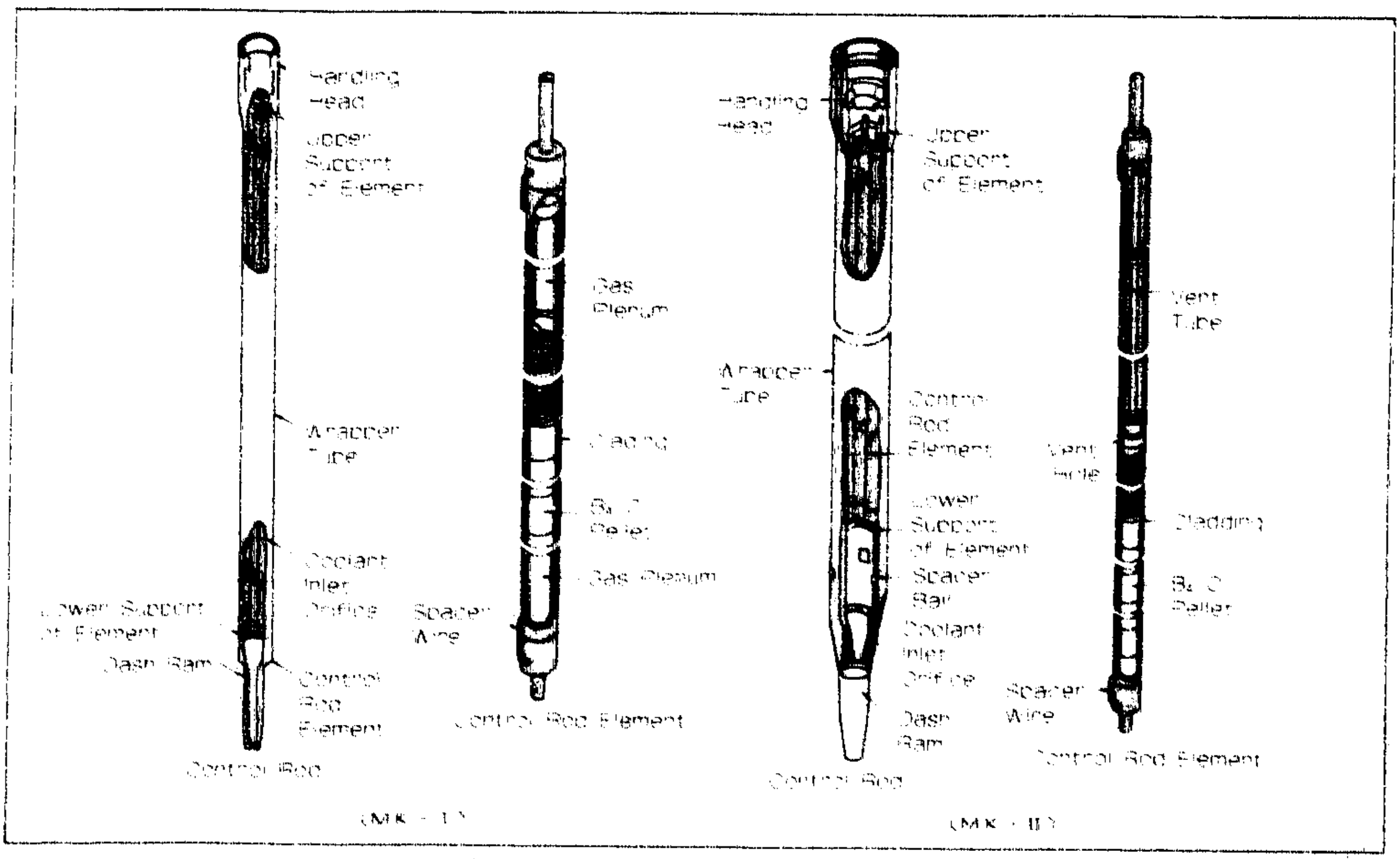


Fig.8 Core Element

4 IRRADIATION CONDITIONS

"JOYO" will be normally operated at a thermal reactor power of 100MW for 45 days and then shut down for maintenance and refueling for 15 days. The position in which the sub-assemblies will be inserted is determined in accordance with the purpose of the irradiation test based on calculation of the neutron flux and reaction rate. The irradiation conditions at the core center and midplane are shown in Fig. 9 - Fig. 10.

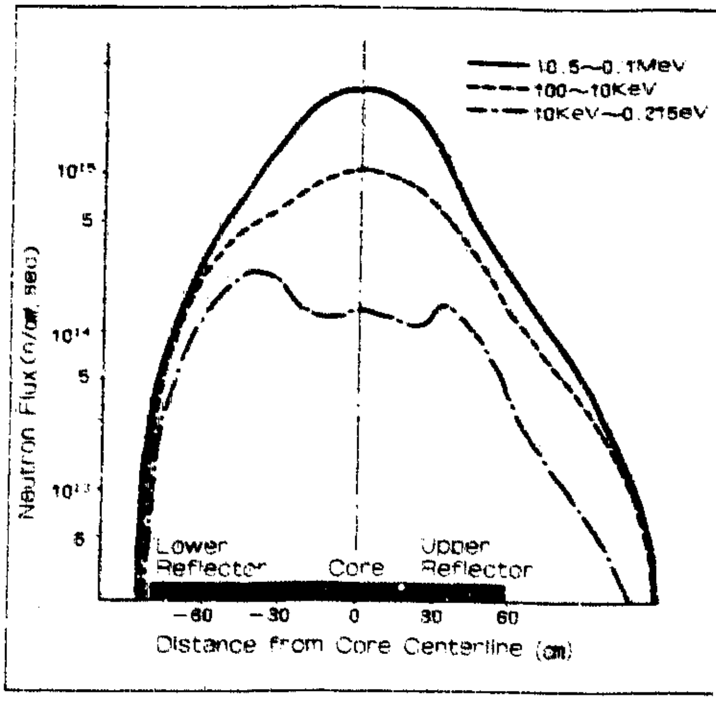


Fig.9 Equilibrium Core Axial Neutron Flux [Core Center]

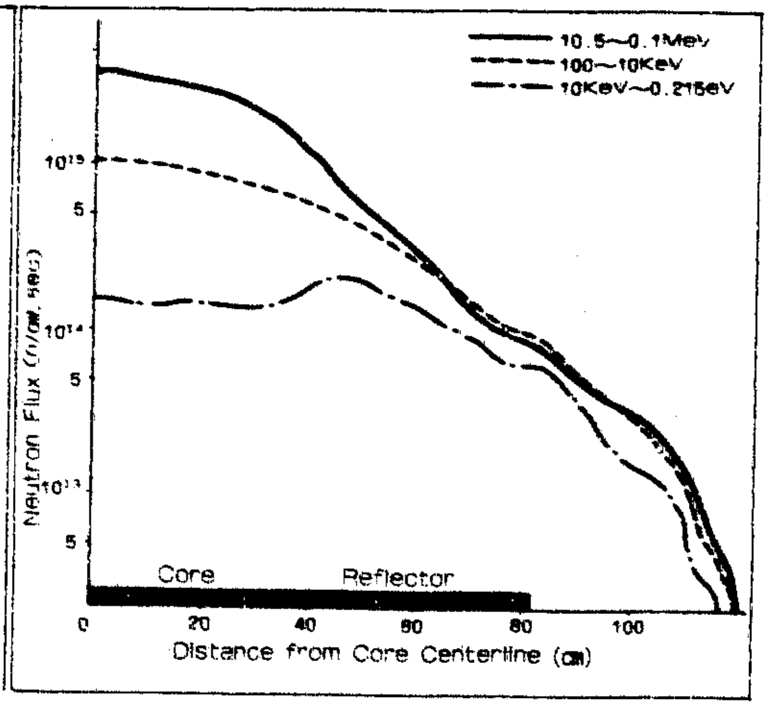


Fig.10 Equilibrium Core Radial Neutron Flux [Core Midplane]

5 THE IRRADIATION TEST DEVICES

Irradiation test devices specific for each test purpose are required to perform the irradiation tests effectively. In "JOYO" the following types of irradiation test devices will be chiefly utilized:

- the Uninstrumented Irradiation Subassembly (UNIS)
- the Materials Irradiation Rig (MIR)
- the Instrumented Test Assembly (INTA)
- the Upper Core Structure Irradiation Plug Rig (UPR)

■ Others (under investigation)

- the JOYO Closed In-pile Loop (JOCIL)
- the Encapsulated Fuel Pin
- the In-pile Creep test device

The specific features of these devices are described below.

Table 3 Main Purpose of the Phase 1 Irradiation Test

Rig-Type		Main Irradiation Purpose
Uninstrumented Irradiation Subassembly	UNIS-A	High power testing for MONJU fuel pins
	UNIS-B	Examine performance of UNIS-B type
		High burn up testing for MONJU fuel pins
	UNIS-C	Examine performance of UNIS-C type
		High burn up testing for MONJU fuel bundle
Materials Irradiation Rig	CMIR	Examine behavior of core materials
	AMIR	Examine behavior of absorber materials (B_4C, etc)
	SMIR	Examine behavior of structure materials for MONJU core barrel and core support plate
Instrumented Test Assembly (INTA)		Continuous in-pile monitoring of irradiation condition for fuel performance code
Upper Core Structure Irradiation Plug Rig (UPR)		Examine behavior of structure materials for MONJU reactor vessel

Uninstrumented Irradiation Subassembly (UNIS)

Three types of irradiation test rigs are now being manufactured or irradiated. The uninstrumented irradiation sabassembly type A (UNIS-A) has the minimal substitution reactivity for driver fuels. Prototype design study is now in progress and the first irradiation test will be conducted in late 1984. The UNIS-B is a very flexible irradiation test rig. It can be taken out to the post-irradiation test facility for non-destructive testing and then reassembled to be loaded back in the JOYO reactor for further irradiation. The first two irradiation test articles were loaded into the first core of JOYO MARK-II. The UNIS-C can contain a maximum of 91 type (I) test pins and 61 type (II) or type (III) test pins. Also this subassembly has a set of flow orifices at the bottom of the inner wrapper tube, so that the test pin length is limited to less than about 1900 mm. The irradiation tests using this test article will be conducted in late 1983.

This test vehicle has the same outer shape as the core driver fuel subassembly; therefore it can be transferred through the "JOYO" Fuel Handling Facility into and out of the reactor core. It can be exchanged for driver fuel and irradiated at any core position. The UNIS contains certain monitors to describe typical irradiation conditions by post-irradiation examinations. Typical examples of types A, B, and C are shown in Fig. 11 - Fig. 13.

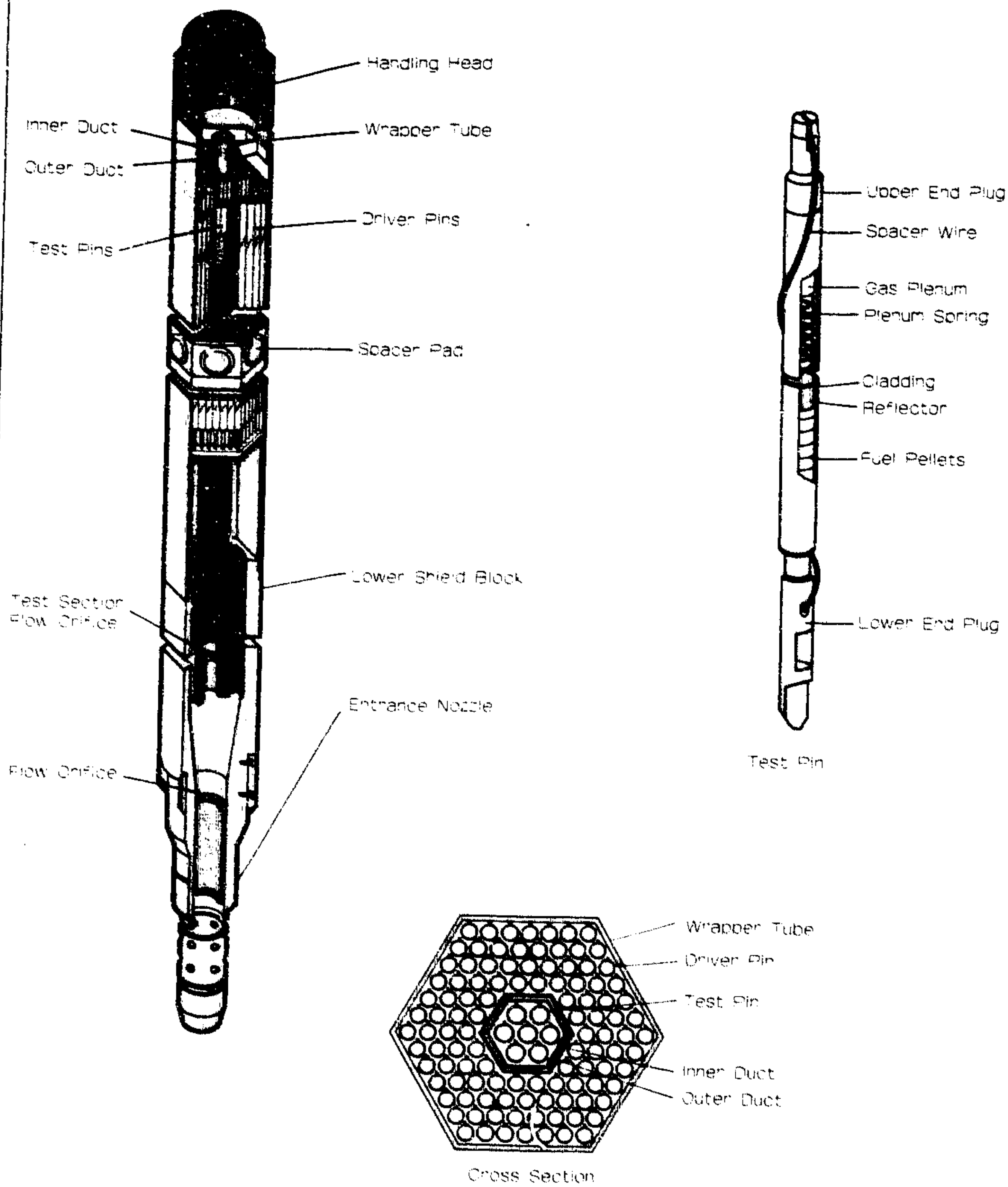


Fig. 11 Uninstrumented Irradiation Subassembly A-Type (UNIS-A)

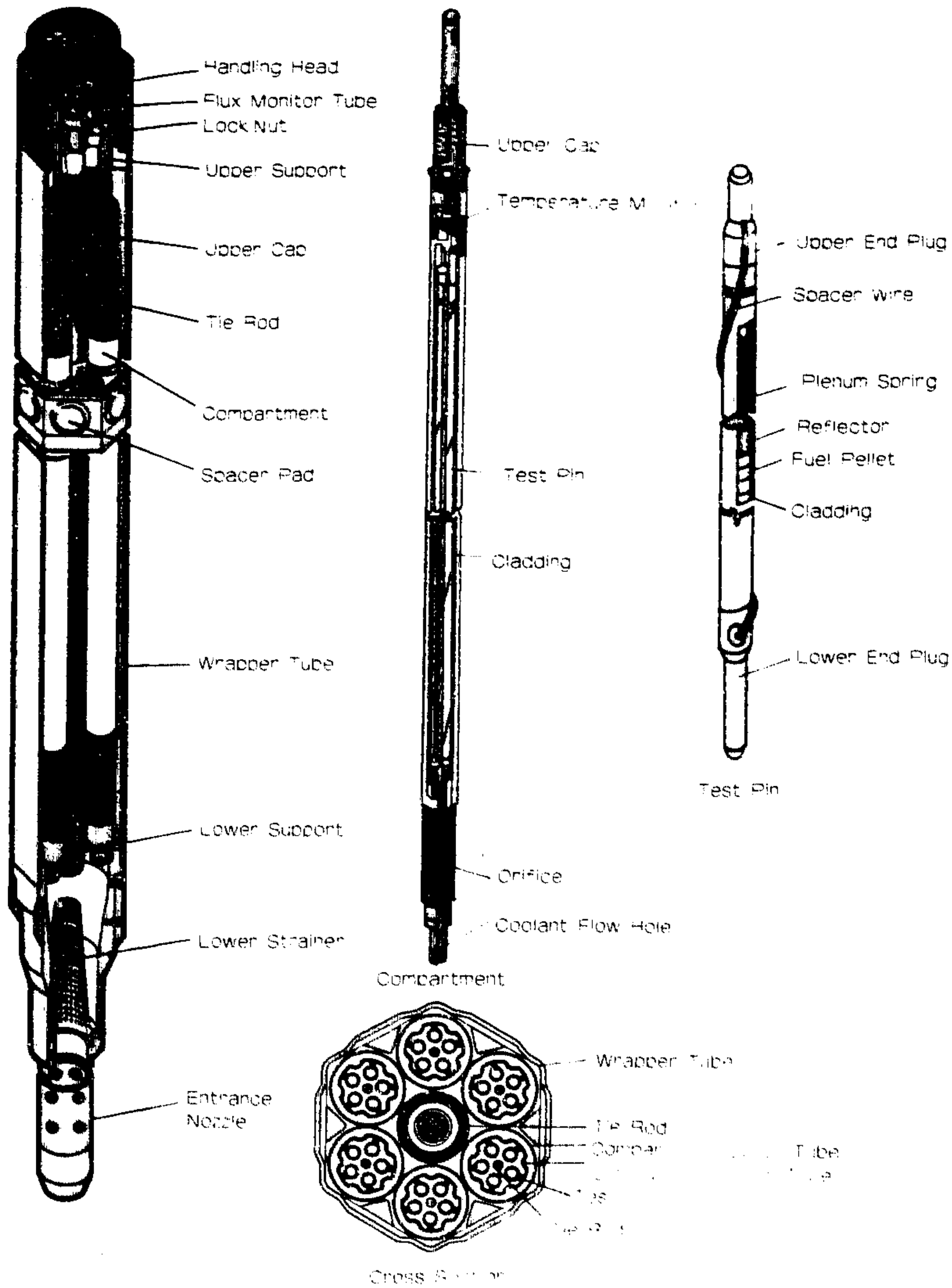


Fig. 12 Uninstrumented Irradiation Subassembly B-Type (UNIS-B)

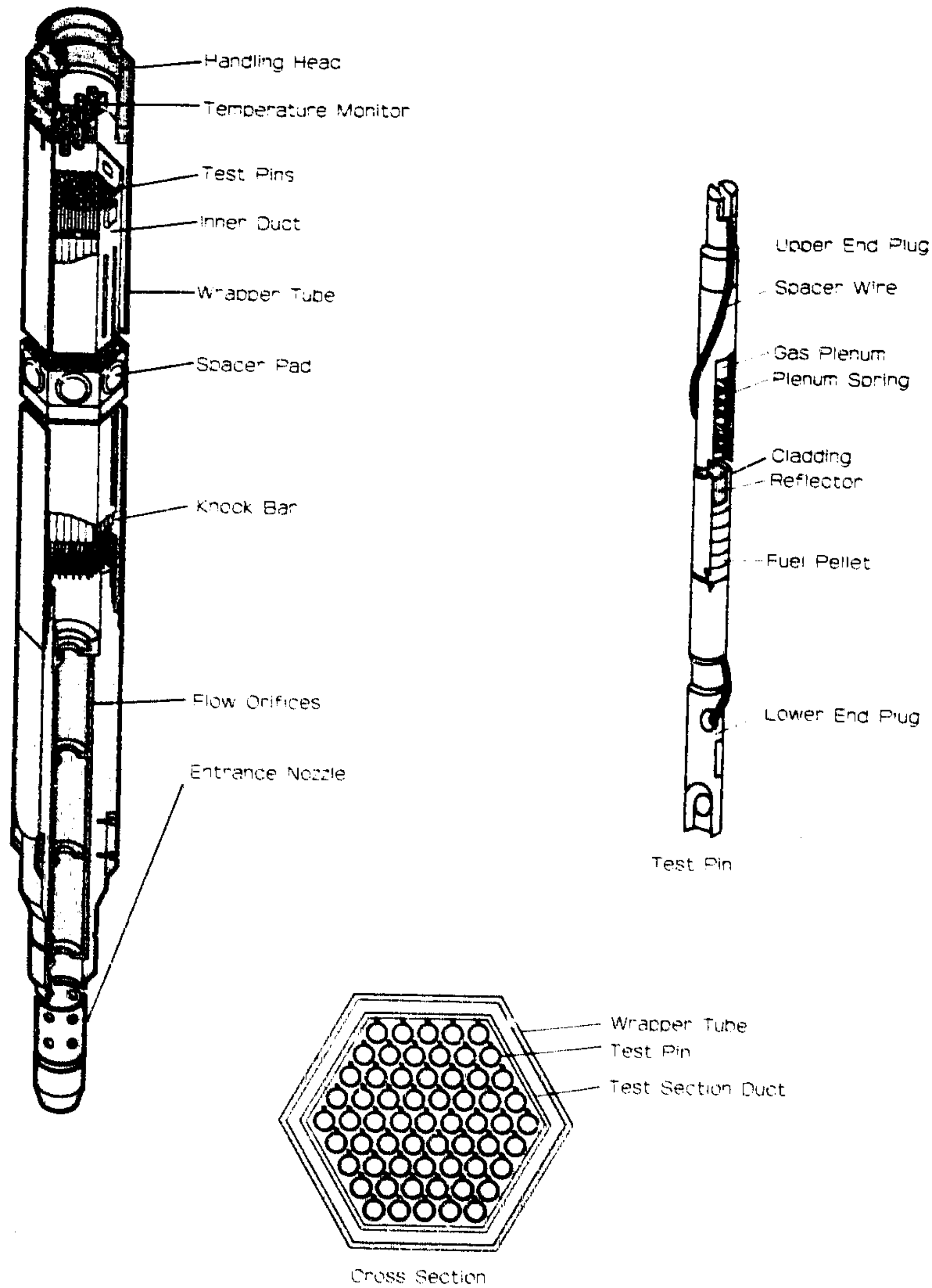


Fig. 13 Uninstrumented Irradiation Subassembly C-Type (UNIS-C Type II)

Materials Irradiation Rig (MIR)

Three types of irradiation test rigs for component materials testing are now being manufactured or irradiated.

The CMIR is the test device for irradiation test of core materials (for example, cladding, wrapping wire and so on). The first irradiation test has finished in July 1983.

The AMIR is the test device for irradiation test of absorber materials (for example, boron carbide etc.). The first irradiation test will be conducted in early 1984.

The SMIR is the test device for irradiation test of structure materials (for example, core barrel, reactor vessel and so on). The first irradiation test using this test device was loaded in August 1983.

The CMIR, AMIR and SMIR are modification of UNIS-B, which can be reassembled and reloaded into the reactor after interim-irradiation examinations.

Typical examples of the MIR are shown in Fig. 14 - Fig. 16.

Instrumented Test Assembly (INTA)

The INTA has been developed as a test rig capable of monitoring fuels and materials behavior during irradiation.

On-line instrumentation is installed in the INTA which monitors many irradiation conditions and describes fuels and materials behavior. Since these instruments are located close to the irradiation samples in the reactor core, they may be exposed to elevated temperatures and to saverely high fast neutron fluences. They should be so small as to be contained in a fuel pin bundle. To obtain high quality information, the development of these instruments is very important and is now in progress with much effort.

Signal from these instruments will be logged continuously during irradiation, i.e., during reactor operation. Signals will be sent to the data acquisition system by the instrument leads penetrating the reactor vessel boundary through the reactor upper internals. Accordingly, the INTA is a very long test rig which is installed at the top of the reactor vessel and which penetrates into the reactor core from above.

After irradiation, the fuel section will be transported from the reactor core into the PIE facilities by the "JOYO" Fuel Handling Facility. For this purpose, the instrument leads will be cut before unloading. The part to be cut is of course located under opaque liquid sodium and just above the core region. The cutting operation is remote-controlled from the top of the reactor and cannot be confirmed visually.

Since the INTA is irradiated continuously for several operating cycles, the INTA must be raised in the reactor upper internals from the core after each cycle, so that the rotating plugs can be operated for refueling.

Upper Core Structure Irradiation Plug Rig (UPR)

The UPR has been developed as a test rig under the high temperature, low flux and low flow rate conditions. This rig is equipped with on-line instrumentation which contains a flow velocity meter, theremocouple and neutron detector to measure the condition of the upper core structure during irradiation.

Signals from these instruments will be logged continuously during irradiation, i.e., during reactor operation. Signals will be sent to the data acquisition system.

After irradiation, the test piece rig can be transferred from the main body of UPR to the PIE facilities, independently.

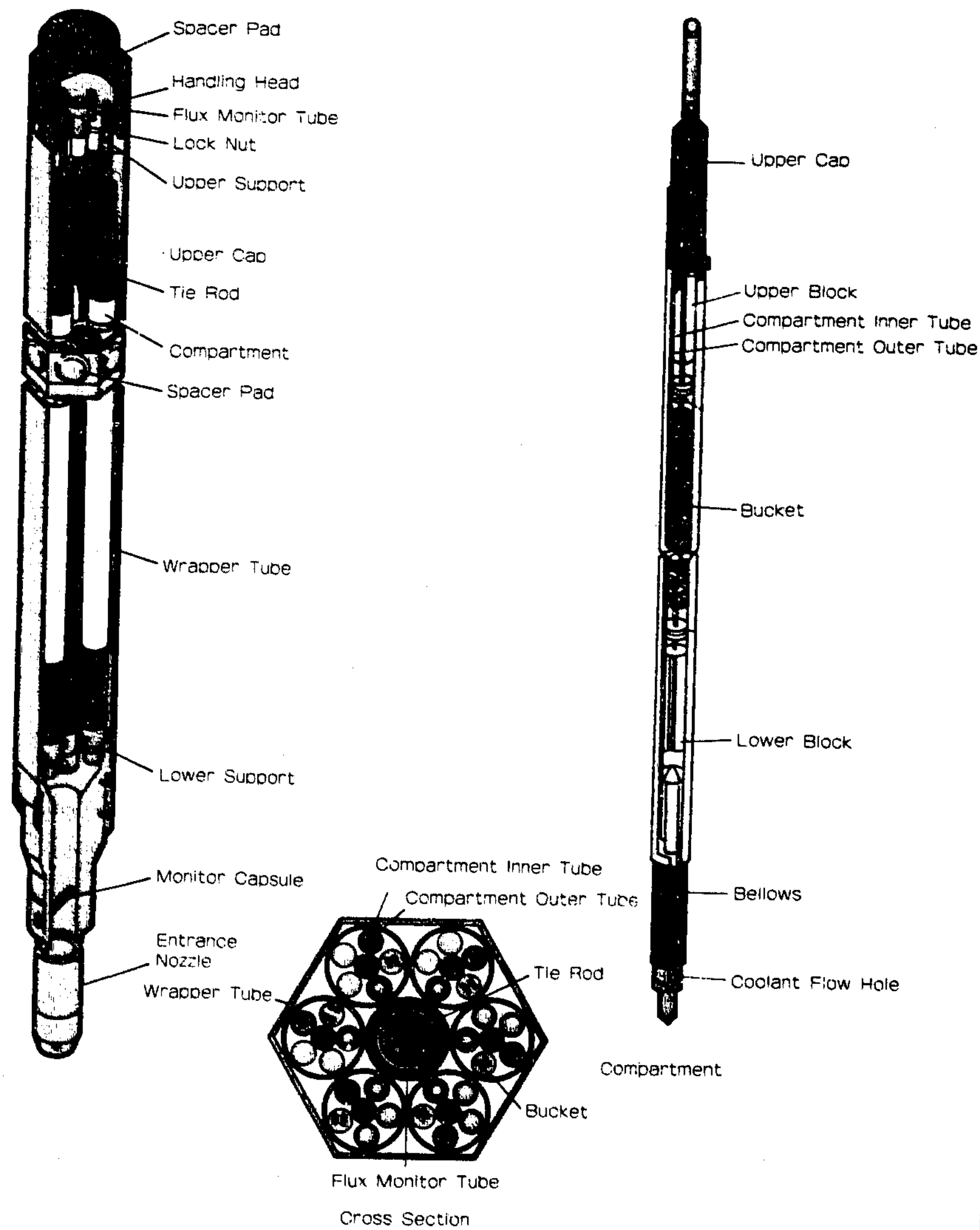


Fig. 14 Core Materials Irradiation Rig (CMIR)

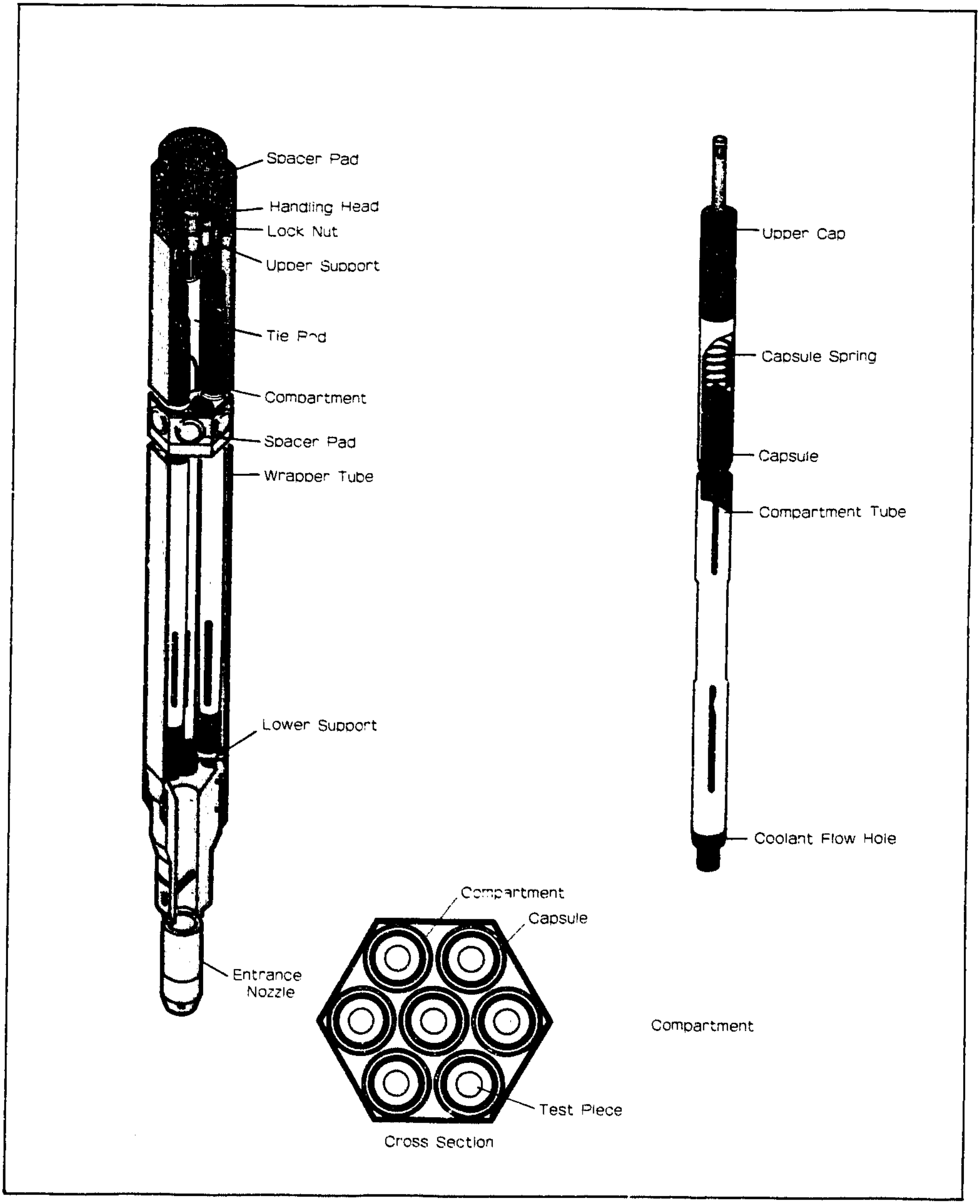


Fig. 15 Absorber Materials Irradiation Rig (AMIR)

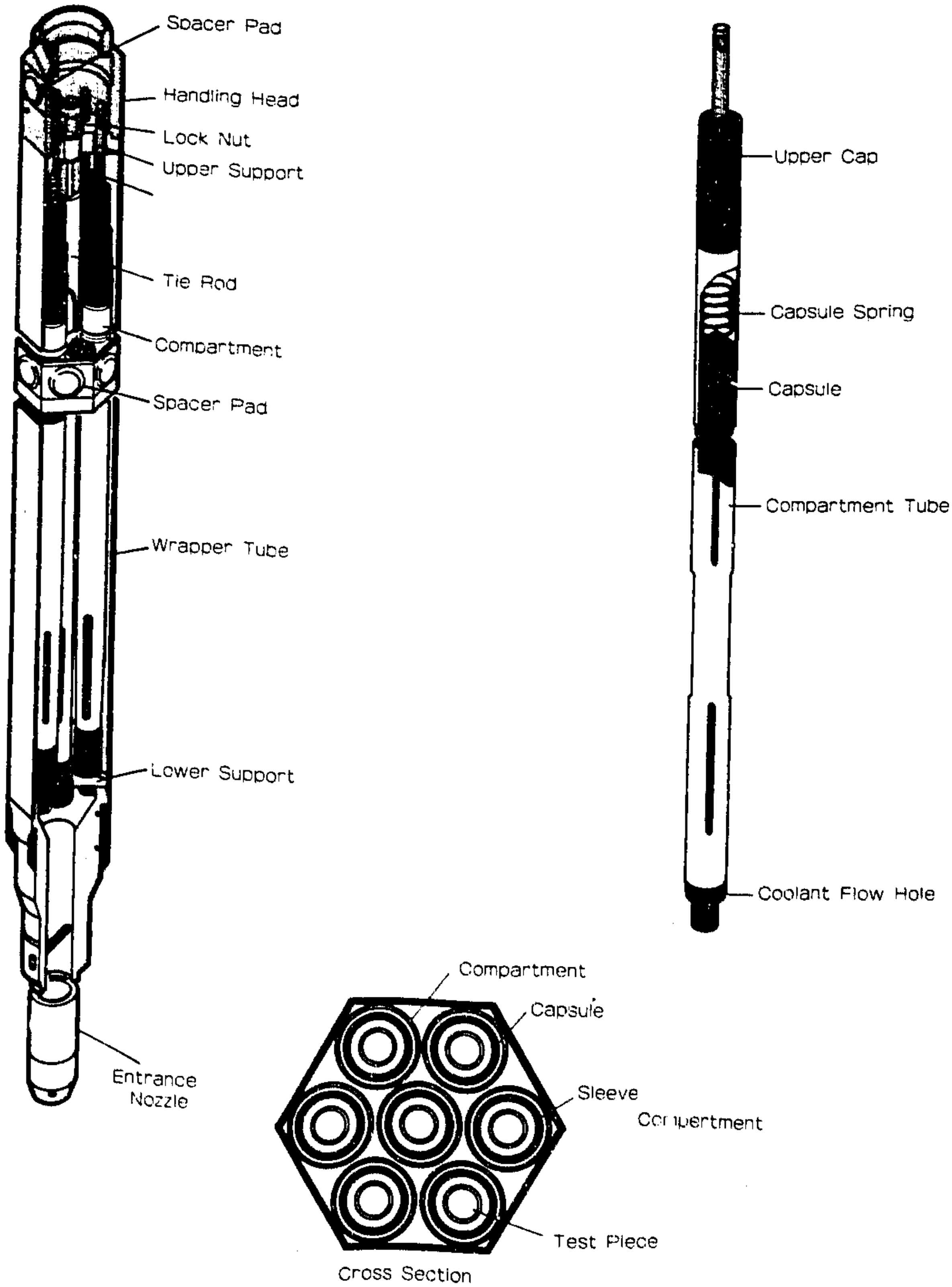


Fig. 16 Structure Materials Irradiation Rig (SMIR)

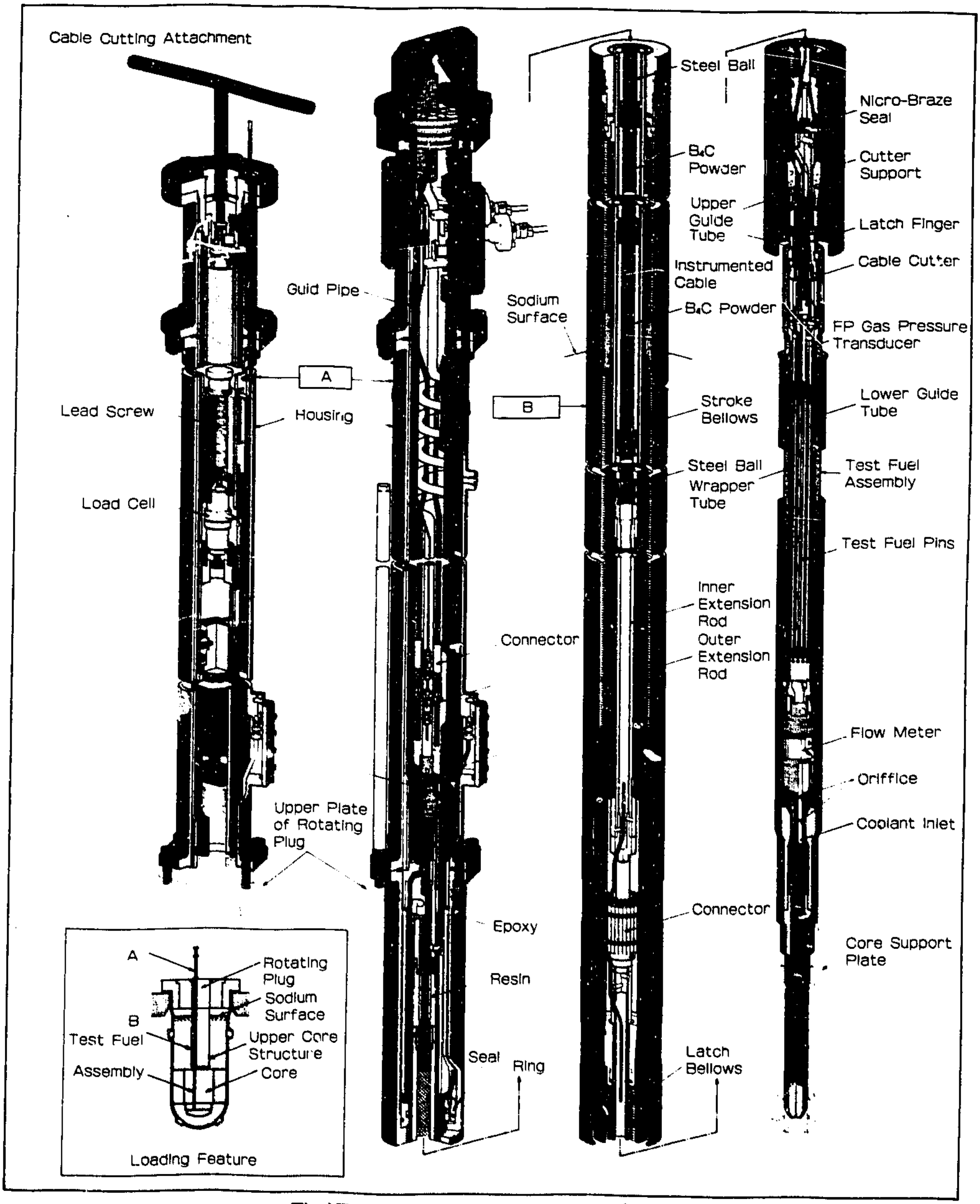


Fig. 17 Instrumented Test Assembly (INTA)

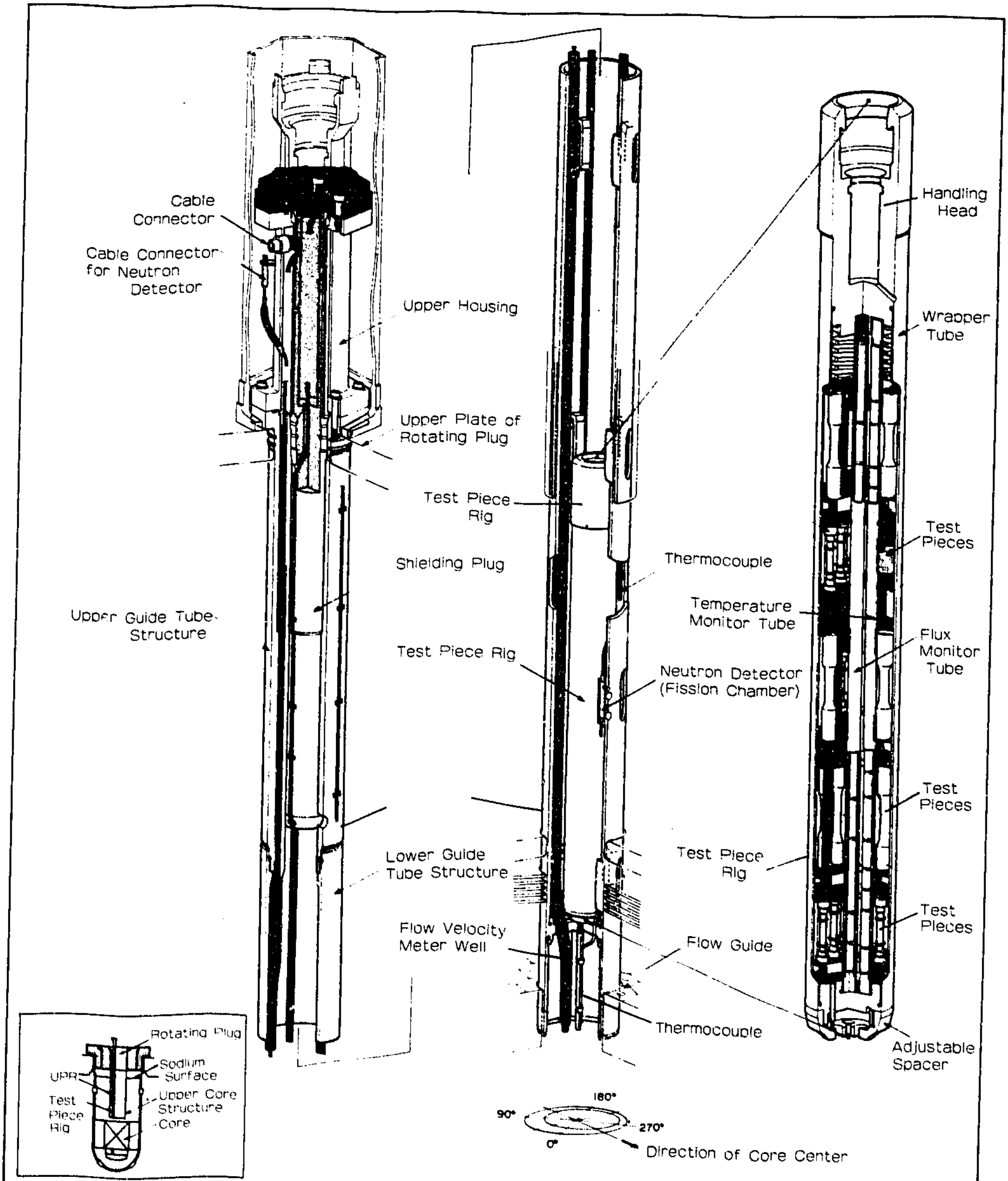


Fig. 18 Upper Core Structure Irradiation Plug Rig (UPR)

Others

The JOCIL is a safety research and off-normal fuel behavior test device which has an independent cooling system isolated from the "JOYO" primary system. Also this device penetrates from the top into the core of the reactor, and the instrument leads and the cooling system come out into the reactor pit.

Since this loop is independent of the "JOYO" primary system, the following experiments can be performed without any influence on the "JOYO" primary system.

- Irradiation beyond pin failure
- Experiment on fuel melting
- Fuel coolant interaction
- Reduced flow or channel blockage experiment

These experiments will verify design and analysis for fast reactor safety studies and will demonstrate the actual phenomena by using the actual fast reactor core. From this point of view, these experiments are considered very important in our FBR development program.

The JOCIL is a very long and independent system. It contains fuel, coolant sodium, and components necessary for heat removal and loop temperature control independent of the "JOYO" primary system. Many modifications to the reactor and auxiliary systems are required to install or to remove the JOCIL. Much care must be given to the planning and execution of the post-irradiation

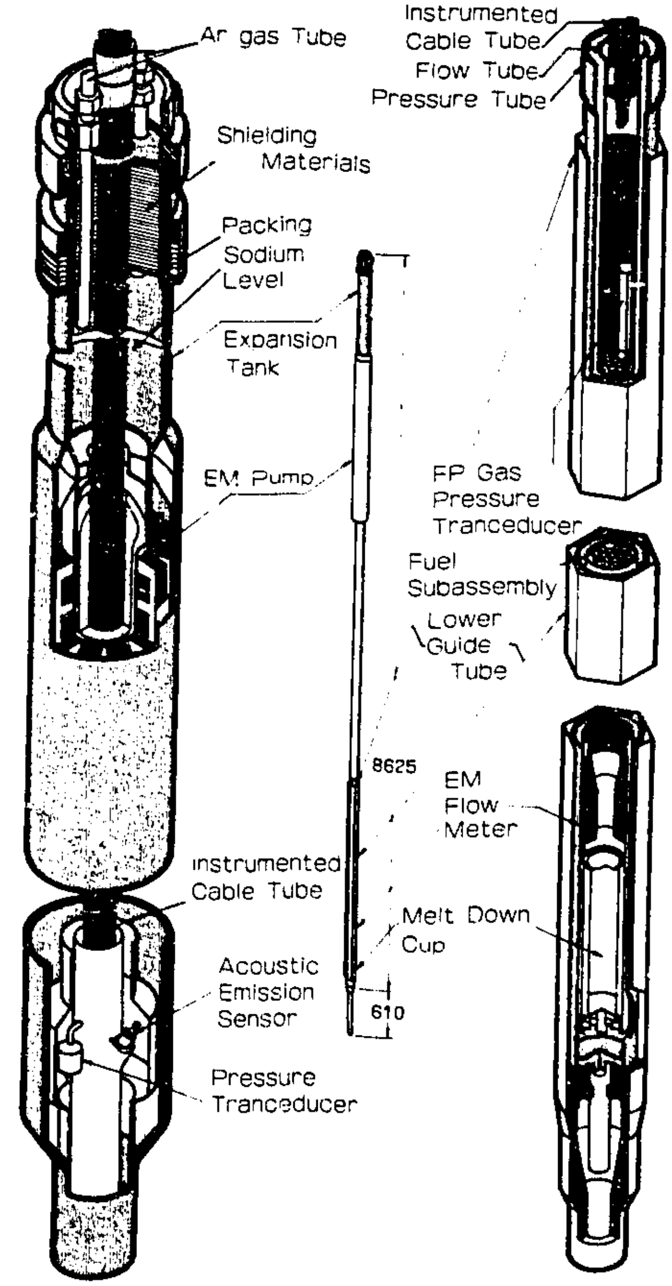


Fig. 19 JOYO Closed In-Pile Loop

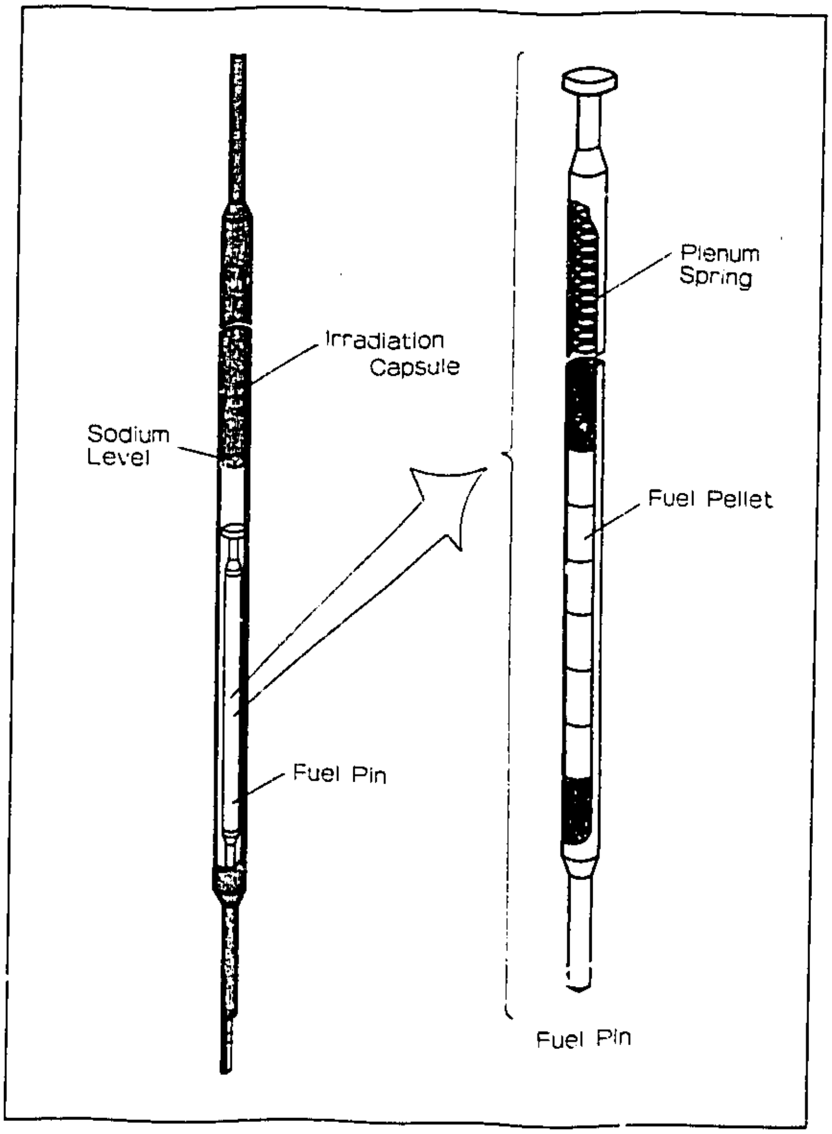


Fig.20 Encapsulated Fuel Pin

disassembling and examinations of the JOCIL.

Encapsulated Fuel Pin

Investigation of the Encapsulated Fuel Pin has been under way. This test device is to be irradiated under off-normal conditions and will be assembled in the UNIS or the INTA during irradiation test. Typical examples of the Encapsulated Fuel Pin is shown in Fig.20.

In-pile Creep Test Device

Investigation of the in-pile creep test device has been under way. This test device is to be irradiated under high stress conditions and will be assembled in the INTA.

6 IRRADIATION RIG ASSEMBLING FACILITY (IRAF)

As described previously, many kinds of irradiation test devices have been proposed and developed. Each device has specific functions and compositions. Many new kinds of devices will be fabricated and tested. Assembling and preirradiation inspection of these devices should be performed carefully to insure the smooth execution of the irradiation testing and also to present the basic test data for on-line or post irradiation evaluation. Additionally, the irradiation test devices are diversified. To meet the various requirements, the Irradiation Rig Assembling Facility (IRAF) was constructed close to the "JOYO" reactor building.

This facility permits final assembly of the irradiation test device with materials test elements, instrument sensors, structural components, and fuel test pins.

Fuel test pins, however, will be fabricated and sealed at the fuel fabrication facility at the Tokai Works. Various pre-irradiation test and inspection data are also taken in this facility. Also, for the INTA, the UPR and the JOCIL, the instrument lead connections, the fit up of the reactor primary boundary parts, the welding of the loop pressure tube, assembly of the long structural components, and the functional tests are carried out. Moreover, sodium charging and purification of the JOCIL will be also performed. And finally, the INTA, the UPR and the JOCIL are contained in a loading cask in this facility and transported to the "JOYO" reactor building.

To accommodate these above requirements, this facility will have various rooms and pits for accepting and inspecting materials or subcomponents, fabricating and assembling components, machining and doing post-treatment or inspection of the welded parts, assembling to the final configuration and testing, and for charging and purifying sodium.

inspection of the welded parts, assembling to the final configuration and testing, and for charging and purifying sodium.

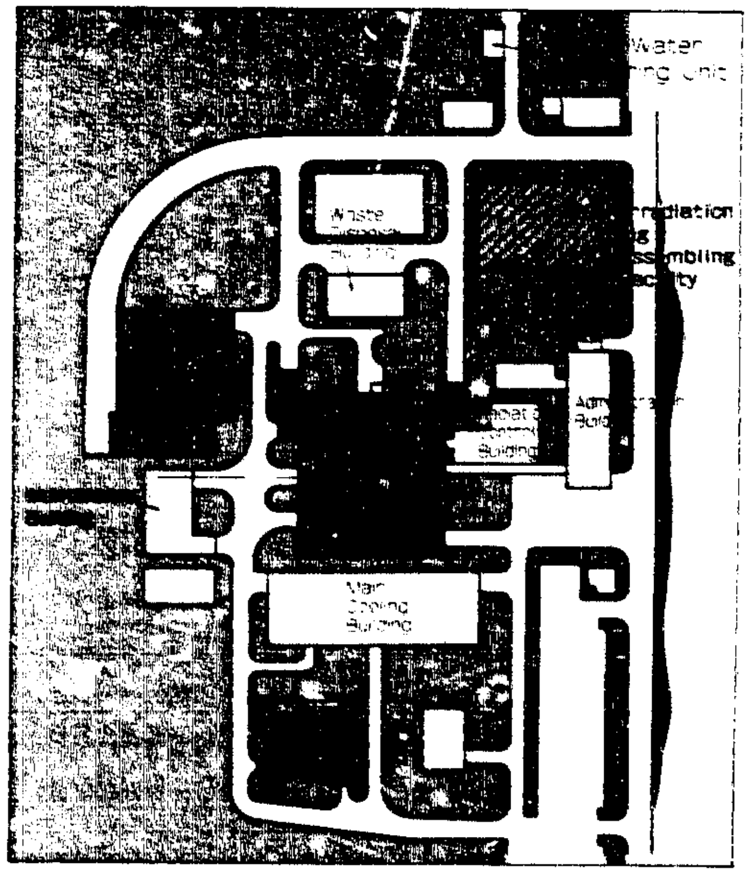


Fig.21 Building Layout of "JOYO" and Irradiation Rig Assembling Facility

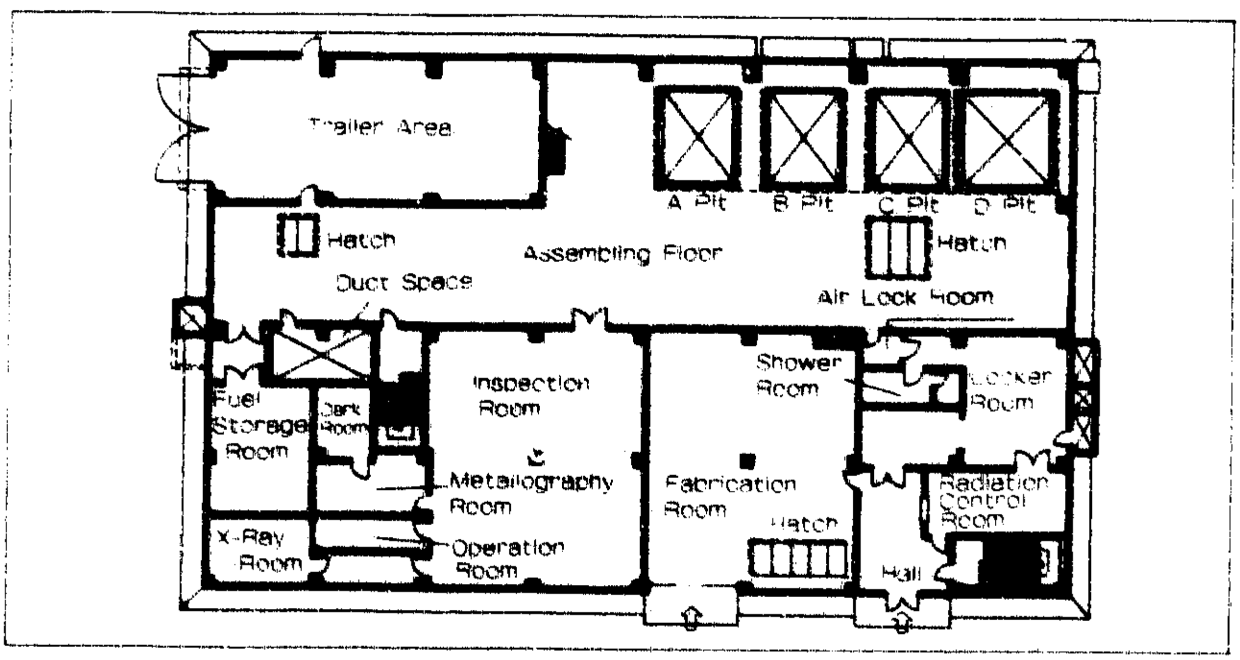


Fig.22 Irradiation Rig Assembling Facility : 1st Floor Plan

7 POST IRRADIATION EXAMINATION FACILITIES

Irradiation test assemblies are transferred for post-irradiation examinations to the PIE facilities constructed around the JOYO reactor site. Brief descriptions of the PIE facilities are given below.

There are three PIE facilities :

- Fuel Monitoring Facility (FMF)
- Alpha Gamma Facility (AGF)
- Materials Monitoring Facility (MMF)

FMF has been construted next to the "JOYO" reactor building. It can both receive the irradiated test assemblies by direct transfer from the "JOYO" fuel transfer cask car to the FMF cask car for travel through underpass, and can also receive them contained in a shipping cask. The UNIS and the fuel section of the INTA will be directly transferred through the same route. The UNIS-B type will be disassembled, inspected, reassembled at the FMF, and reloaded in the "JOYO" core via the cask car route. The JOCIL will be also disassembled and reassembled at this facility after modification for this purpose. Work and examinations to be performed at FMF include the following:

- Non-destructive testing and disassembly of the subassembly
- Non-destructive testing and cutting of the fuel element
- Metallography of the fuel element, including cladding
- Sample preparation for AGF and MMF

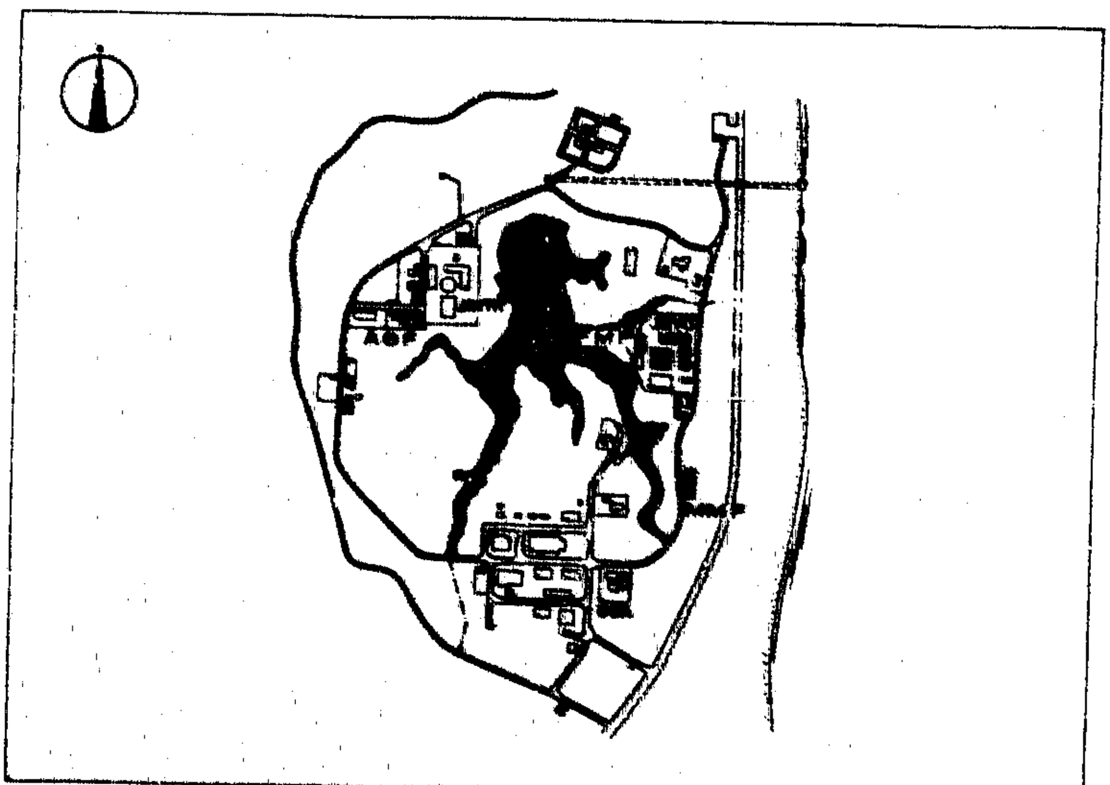


Fig.23 The Post-Irradiation Examination Facilities at O-arai Engineering Center

AGF is a facility in which mainly fuel material and alpha-contaminated materials are examined. The disassemled fuel elements are transferred to this facility from FMF, prepared, and examined. Some test specimens will be sent to MMF.

Main features of the AGF examinations are listed below:

- Metallography of the fuel element including cladding
- Burnup measurement
- Measurement of the fuel properties

MMF accepts the material test specimens prepared at FMF and AGF. The main examinations performed at MMF are the material's mechanical strength and properties. The MMF examinations are summarized as follows:

- Metallography of the materials excluding fuel
- Mechanical testing of the materials excluding fuel
- Physical property measurements of the materials, excluding fuel

8 IRRADIATION SERVICES AND DATA APPLICATION

Now, let us look at the activities involving irradiation services and data application. Fig. 25 shows flow schemes of the irradiation test facilities and the irradiation data. The entire scope covers a very wide area. In order to make the "JOYO" irradiation test program fruitful, close co-operation among various organizations is required. Listing only the work which must be performed in the Fast Experimental Reactor Division, the following should be mentioned:

Obtain construction and operation permits for the irradiation devices and for modifications to the existing reactor systems.

Plan and prepare the irradiation test program.

Review the safety evaluation for the introduction of the irradiation test devices and specimens, and prepare the acceptance criteria.

Assemble and prepare the irradiation test devices and specimens.

Initiate the irradiation test operations, including the trasfer, installation, and removal of the test devices.

Construct and operate the Irradiation Rig Assembling Facility.

Obtain, record, process and evaluate the data from the reactor system and from the irradiation test devices during irradiation.

Besides those listed above, much additional work may be identified in order to execute the irradiation testing smoothly. Resources to accomodate this routine support work are necessary and are now being organized within the Fast Experimental Reactor Division.

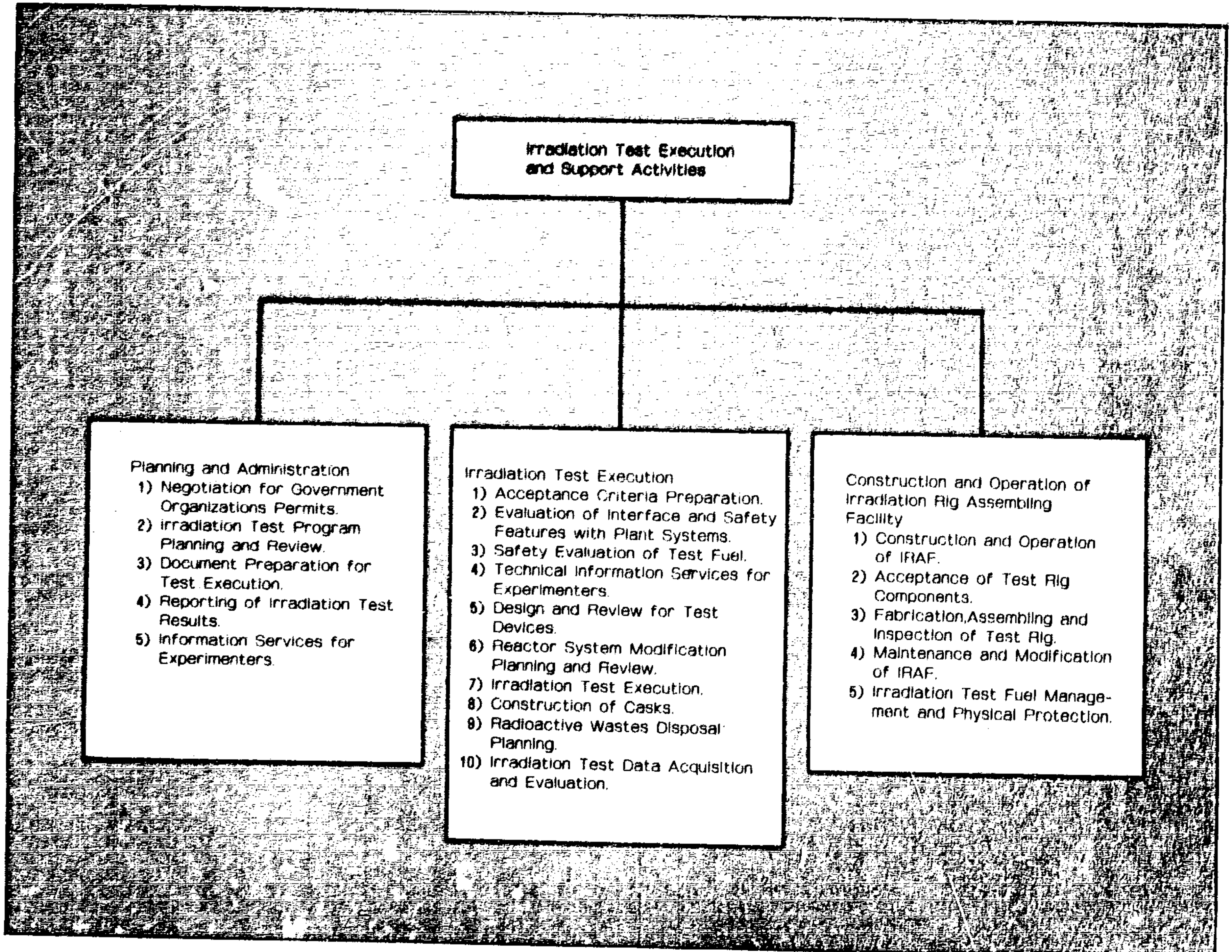


Fig.24 Activities for Irradiation Test Execution

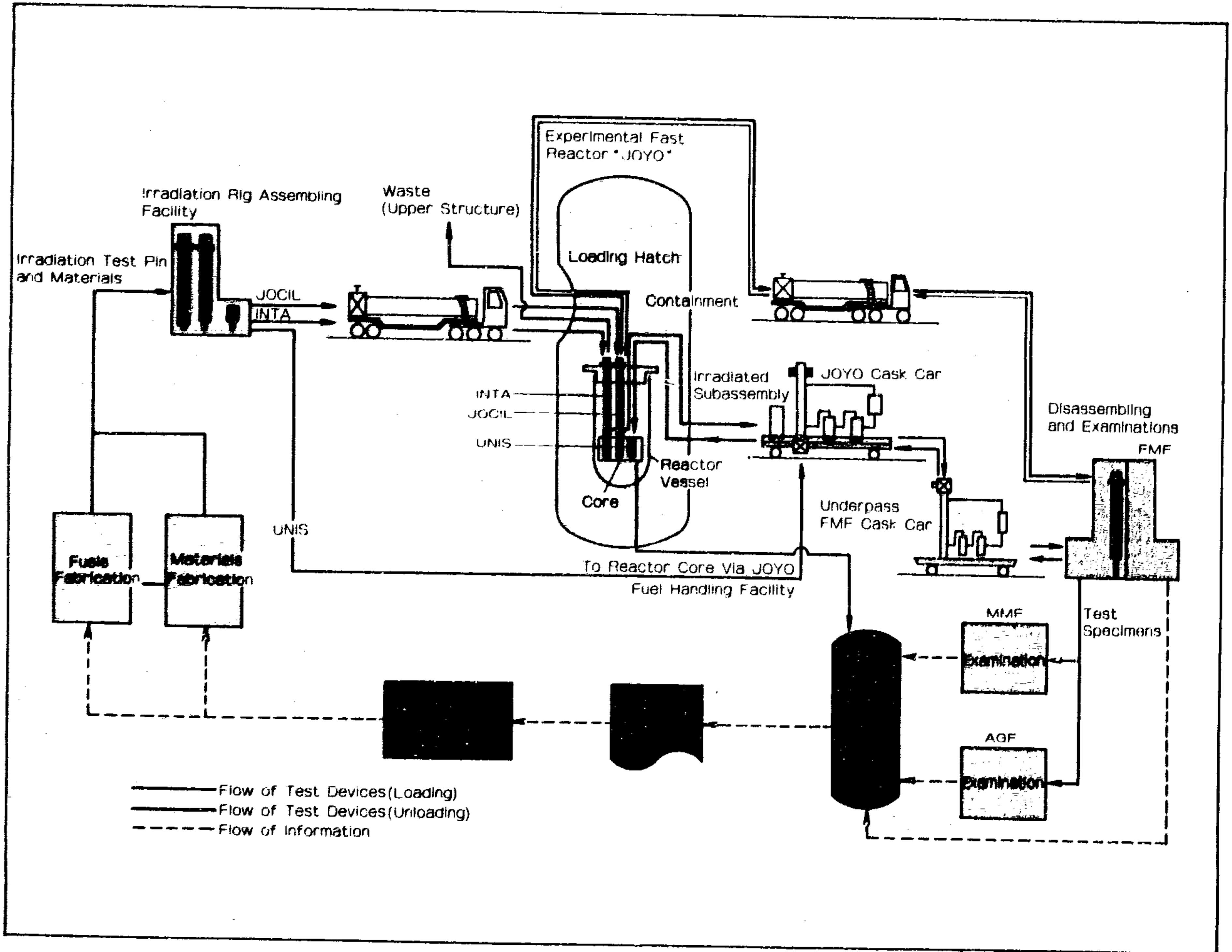


Fig.25 Flow Schemes of Irradiation Test Facilities and Data