PNCT N241 84-01

Record Of Presentations On Status Of Demonstration FBR Plant in Japan Prepared For Recent International Meetings

January, 1984

Fast Breeder Reactor Development Project
Power Reactor and Nuclear Fuel Development Corporation

PNCT N241 84-01

Record of Presentations on Status of Demonstration FBR Plant in Japan Prepared for Recent International Meetings

奈 良 義 彦 ＊

要　　旨

最近2年間に開かれた国際会議の場で行なった高速増殖実証炉の現況についての口頭説明の内容を記録したものである。

内容は設計研究の進捗情況と結果が主なものである。

＊高速増殖炉開発本部　開発調整室　実証炉ブロック

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まえがき

本報告は，最近２年間に開かれた動燃と各国との高速炉会議の場で行なった高速増殖実証炉の現況についての口頭発表の内容を記録したものである。

これらの会議では，動燃と電気事業連合会双方から現況説明をしており，本報告にのせている発表はすべて動燃側のものである。

内容は主に設計研究の進捗状況と結果などであるが，口頭説明のため概略にとどまっている。

この間に，ＩＡＥＡ／ＩＷＧＦＲ等への総括報告の一部としても同題の報告を載せており，関連資料として抜萃し，付録に加えた。

この機会に，資料作成に直接たずさわった方々（清水一民，松本精夫，古平　清，佐々木修一，神戸　満の各氏）に謝意を表したい。

1. 1981年11月の日米PEWGへの説明

Status of Demonstration FBR Plant in Japan

(Oral paper for PEWG in Tokyo, Nov. 9, 1981)

(1) Covering:

Good morning, Gentlemen;

I am very happy to have opportunity to speak about status of the demonstration fast breeder reactor plant development in Japan.

One demonstration plant will stand on the way from JOYO and MONJU to commercial fast breeder reactor plants.

Design Studies of the demonstration plant have been and are being conducted these years. The present is just transition stage from a studying period to a focussing period in which two matters will be required, such as; (1) preparation of the specification for the fundamental design, and (2) starting up of the Research and development activities for the demonstration plant.

(2) Development Schedule of FBR in Japan:

Japanese fast breeder reactor development program is now under review by government organizations where PNC representative participates in as well as private companies' representatives and so on.

This figure shows the development schedule of fast breeder reactor in Japan. You can find here a demonstration phase before commercialization. So-called demonstration plant is positioned as the first plant to be constructed in this phase, and followed by a few same class plants. They expect that reliability and economy of the fast breeder plant system must be proven through this demonstration phase as a competitive system with another generating source system such as light-water-reactor system in the following commercial phase.

(3) Organization of Demonstration Plant Design Study:

Well, to return to the present, a contract of the demonstration plant conceptual design study with the leading nuclear power plant suppliers is in progress. The power supplying companies will be associated in as a member of the design meeting.

In PNC, a fast breeder reactor demonstration plant group functions as a coordinator in cooperation with all R & D groups and Oarai Engineering Center.

(4) Outline of Conceptual Design:

In the conceptual design-two which began last year after the conceptual design-one, primary pump position and reactor vessel inlet nozzle position were changed. And also shoot type with transfer cell fuel-charge-and-discharge system was adopted in stead of caskcar type.

(5) Major Plant Parameters:

In consequence, for example, the reactor vessel diameter becomes larger, and the reactor cover gas pressure lower.

(6) Plane Arrangement in Containment:

The primary heat transport system arrangement was rearranged in conceptual design-two aiming to make the containment vessel compact.

(7) Reactor Building Vertical Section:

This figure is a reactor building vertical section view which shows an ex-vessel storage tank, a fuel transfer cell and location of the secondary system.

The building is approximately one-hundred and ten meters square and one-hundred meters height.

(8) Core Configuration:

The core consists of 420 fuel assemblies which contain 217 pins each.

(9) Status of Design Study:

The story briefly spoken above is a section view of the moment in the stream of design study sponcered by PNC.

The electric power companies coordinated by FPO have been conducting design study of the demonstration plant also.

Both streams are just on the point of flowing into a specification unification effort. This effort must be one of key activities for early realization of the demonstration fast breeder reactor plant development in Japan.

Thank you.

A 013—DWG 81—02(3)

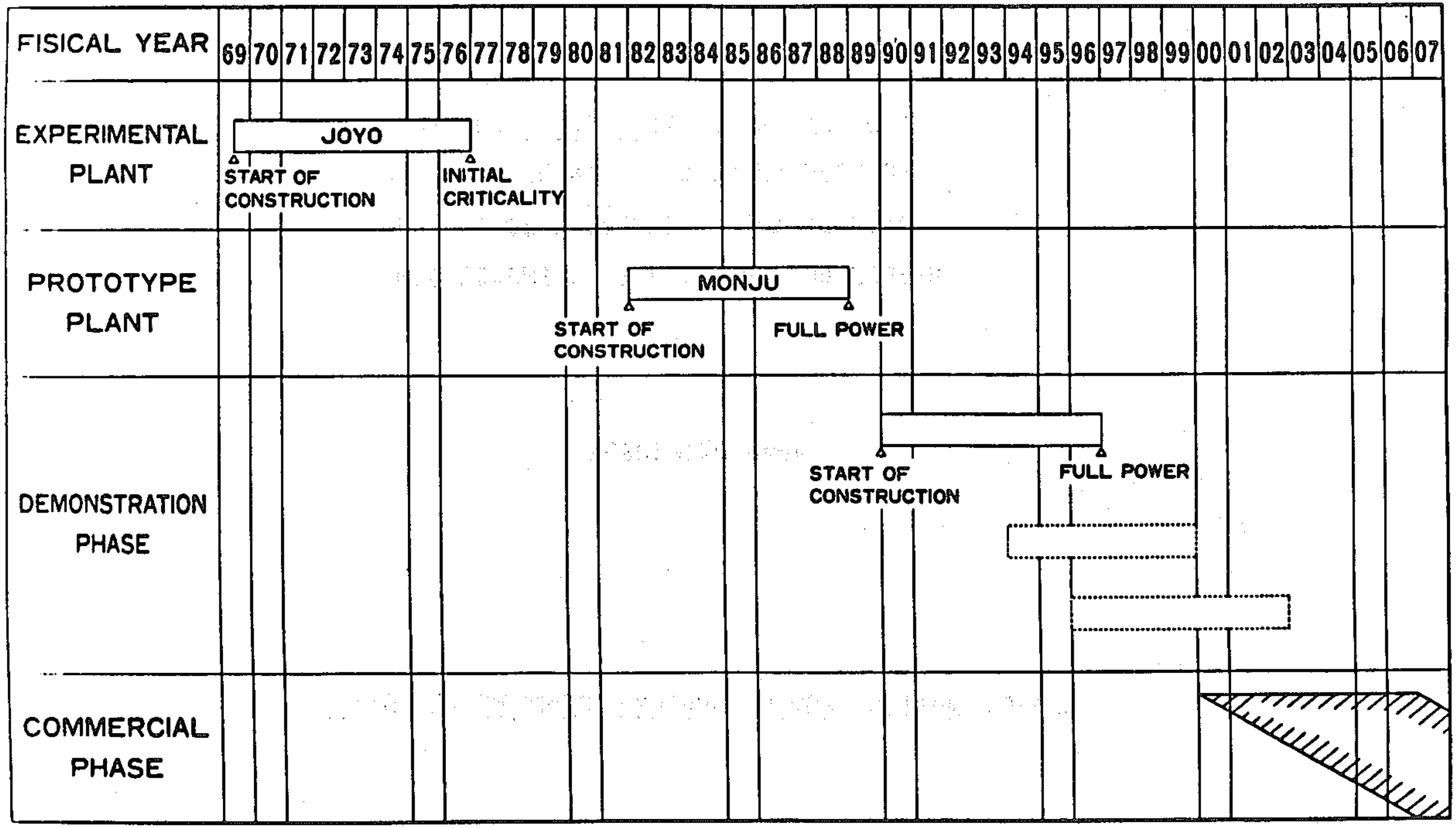
STATUS OF JAPANESE PROGRAM "DEMONSTRATION PLANT"

YOSHIHIKO NARA

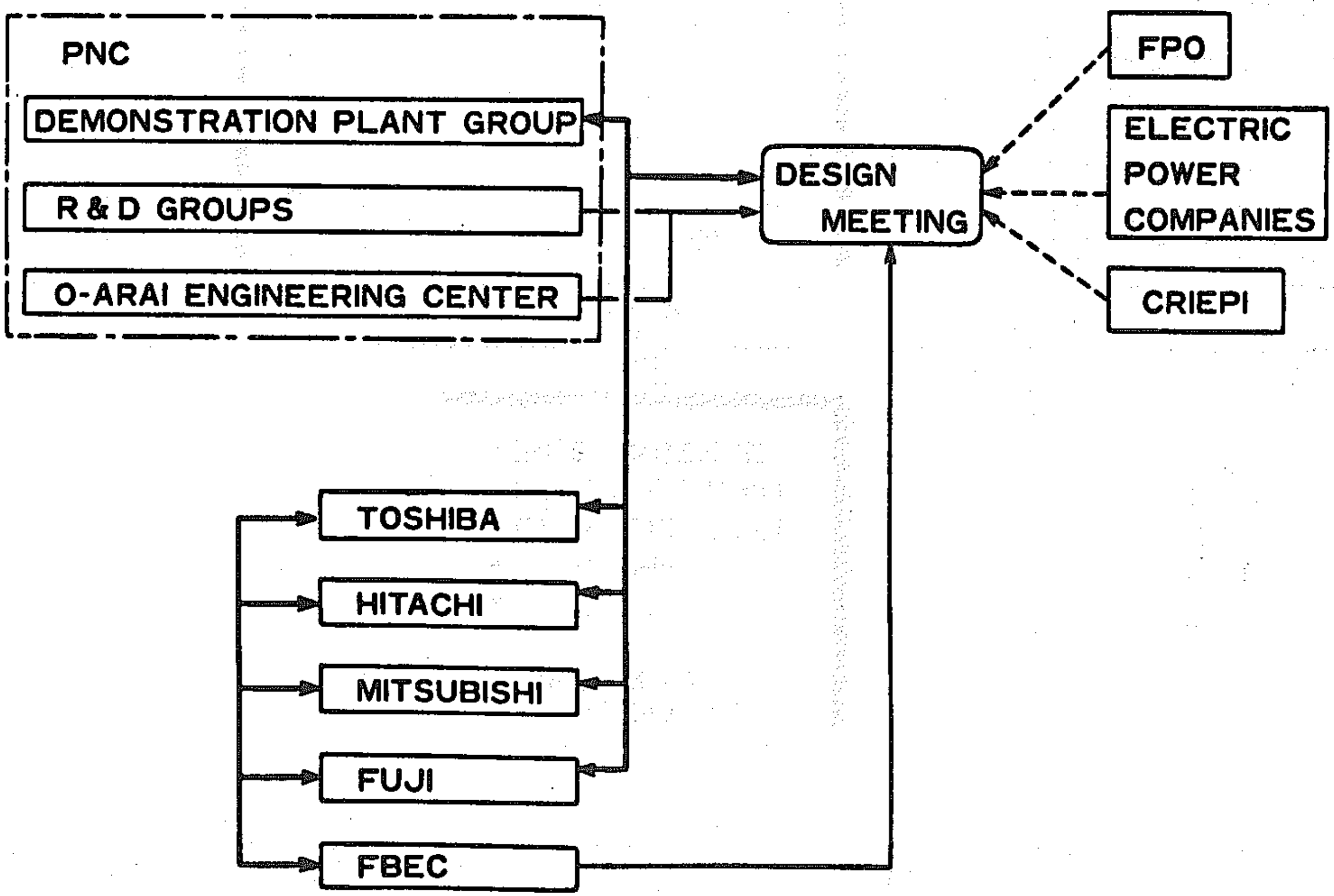
THIS DOCUMENT IS PREPARED FOR FOURTH MEETING OF PNC/USDOE JOINT WORKING GROUP ON PLANT EXPERIENCE, HELD ON NOVEMBER 9-11, 1981 AT PNC TOKYO

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION

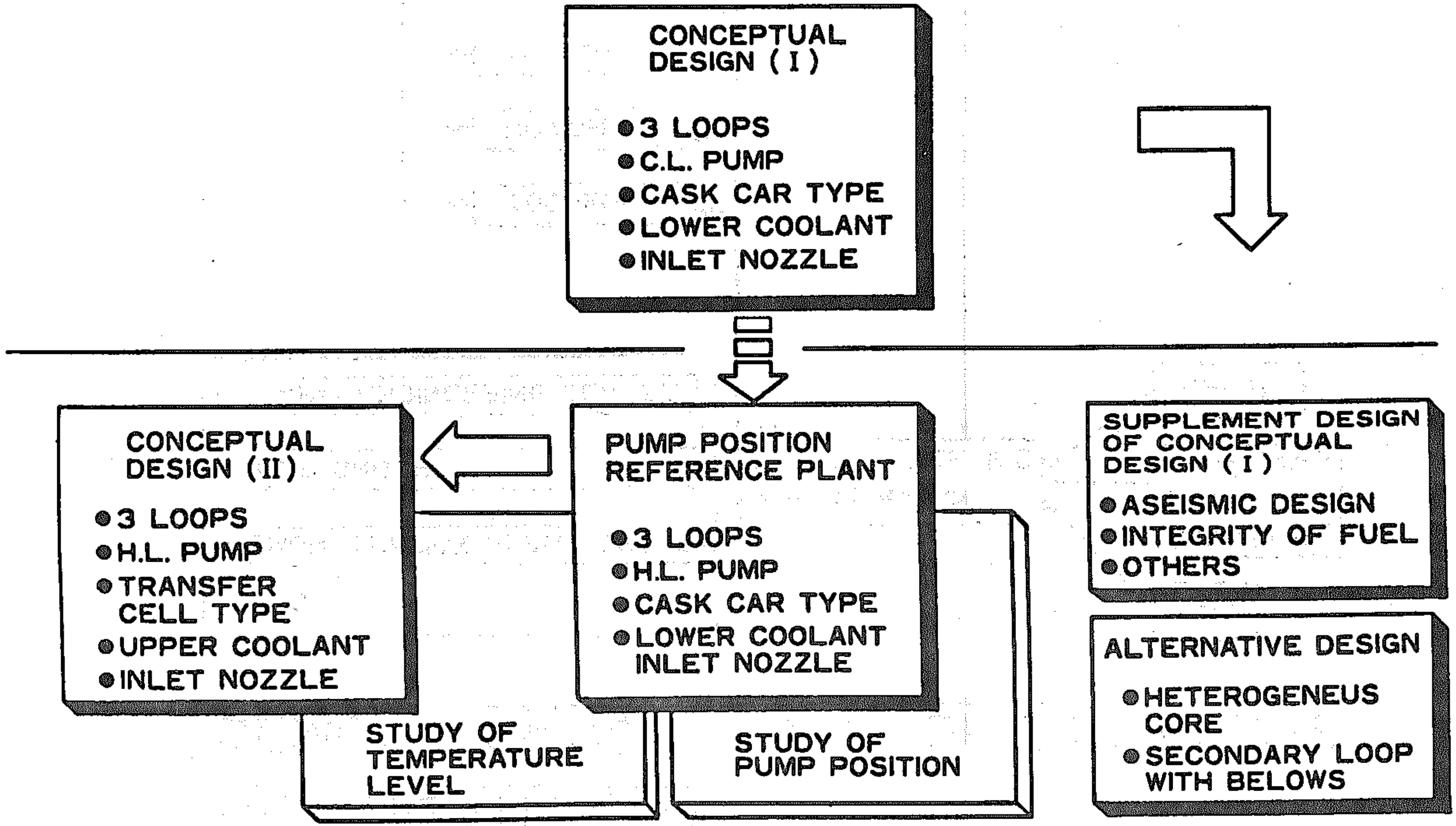
DEVELOPMENT SCHEDULE OF FBR IN JAPAN



ORGANIZATION OF DEMONSTRATION PLANT DESIGN STUDY

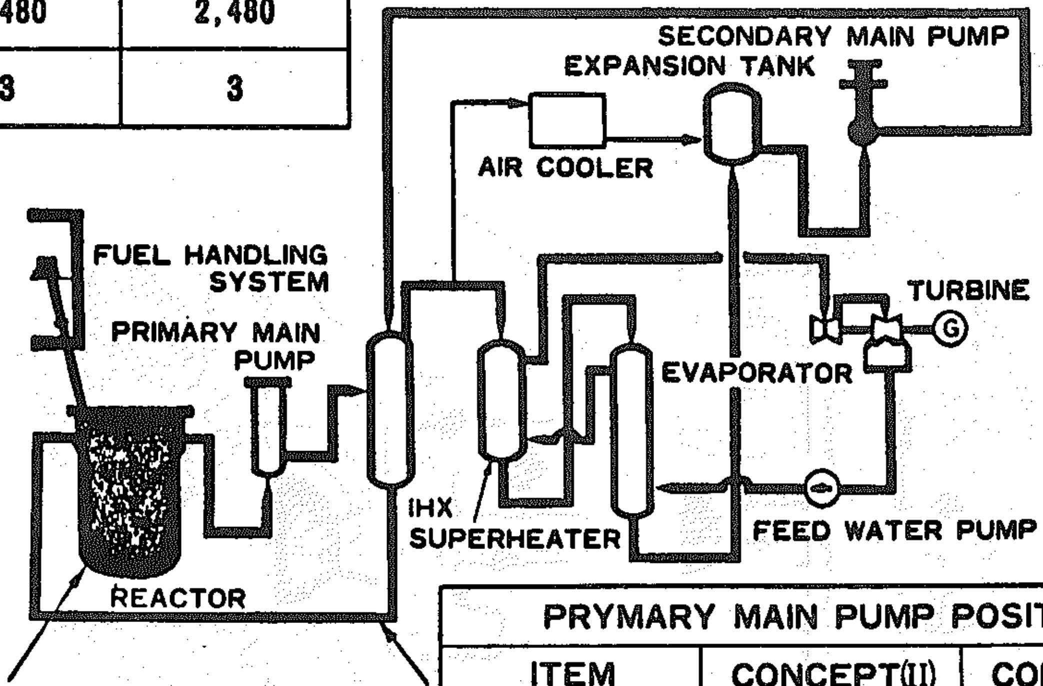


OUTLINE OF CONCEPTUAL DESIGN



MAJOR PLANT PARAMETERS

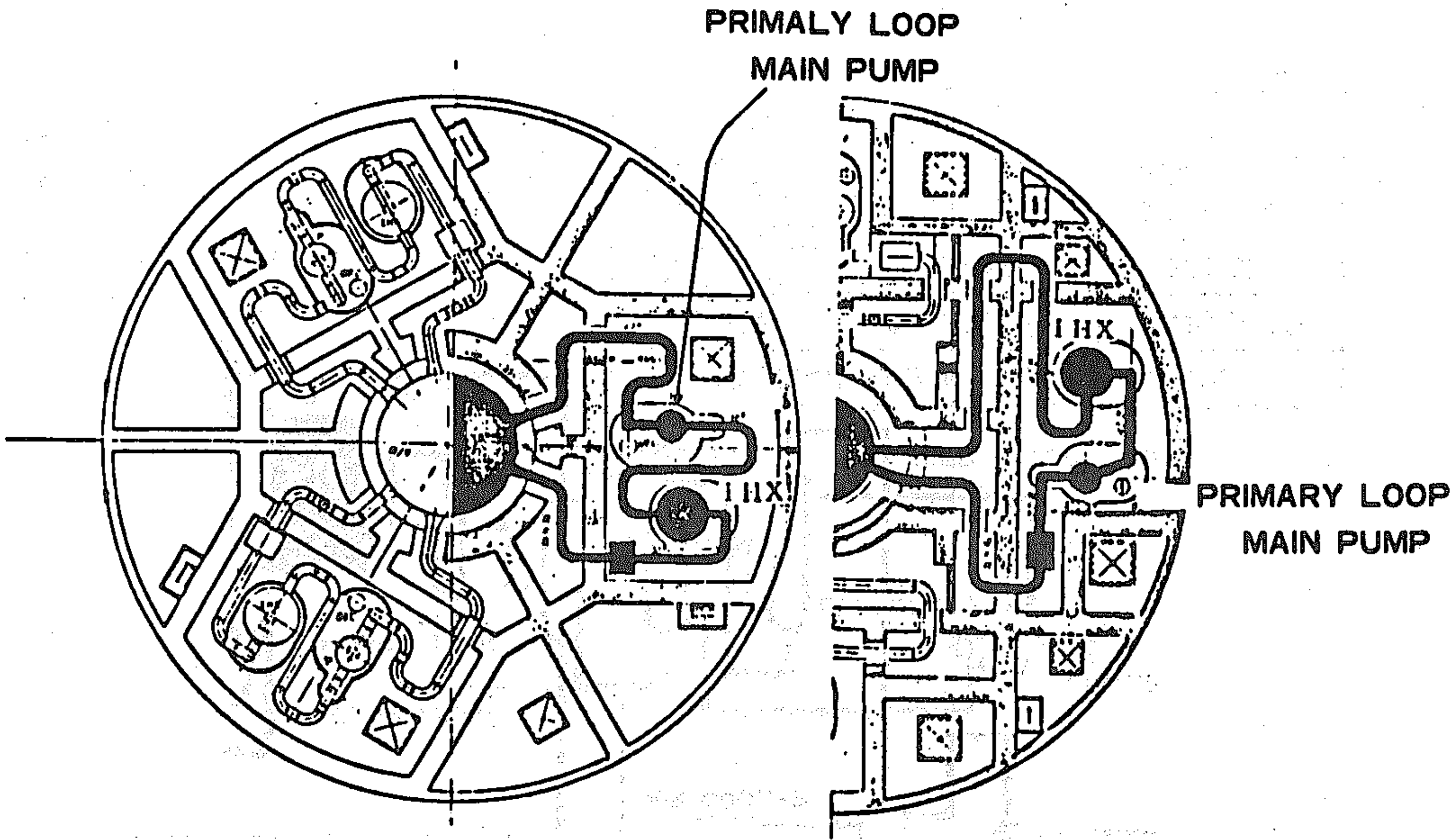
ITEM	CONCEPT(II)	CONCEPT(I)
ELECTRICAL OUTPUT (MWe)	1,000	1,000
TERMINAL OUTPUT (MWt)	2,480	2,480
NUMBER OF LOOPS	3	3



REACTOR FUEL HANDLING SYSTEM		
ITEM	CONCEPT(II)	CONCEPT(I)
REACTOR VESSEL (mm) INNER DIA.	13,000/12,000	9,500
COOLANT FLOW NOZZLE POSITION	UPPER	LOWER
FUEL HANDLING SYSTEM	CHUTE & TRANSFER CELL TYPE	CASK CAR TYPE

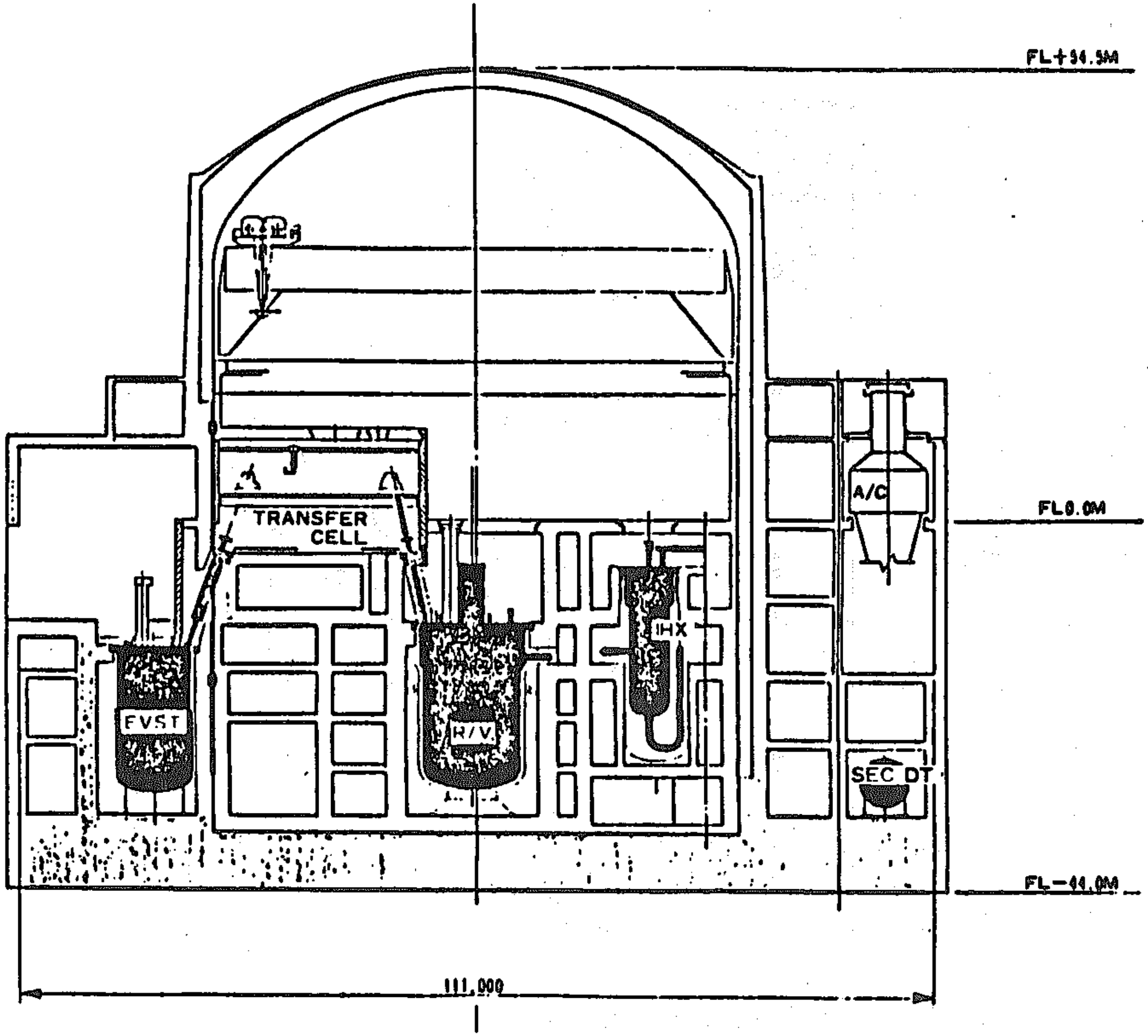
PRYMARY MAIN PUMP POSITION		
ITEM	CONCEPT(II)	CONCEPT(I)
H·L/C·L TEMP. (°C)	530/385	530/385
PRYMARY MAIN PUMP POSITION	HOT LEG	COLD LEG
IHX TYPE	CROSS FLOW	PARALLEL FLOW
COVER GAS PRESS. (mmAq)	5,400	11,200

SECONDARY MAIN PUMP POSITION		
H·L/C·L TEMP. (°C)	505/325	505/325
COVER GAS PRESS. (mmAq)	50,000	15,000

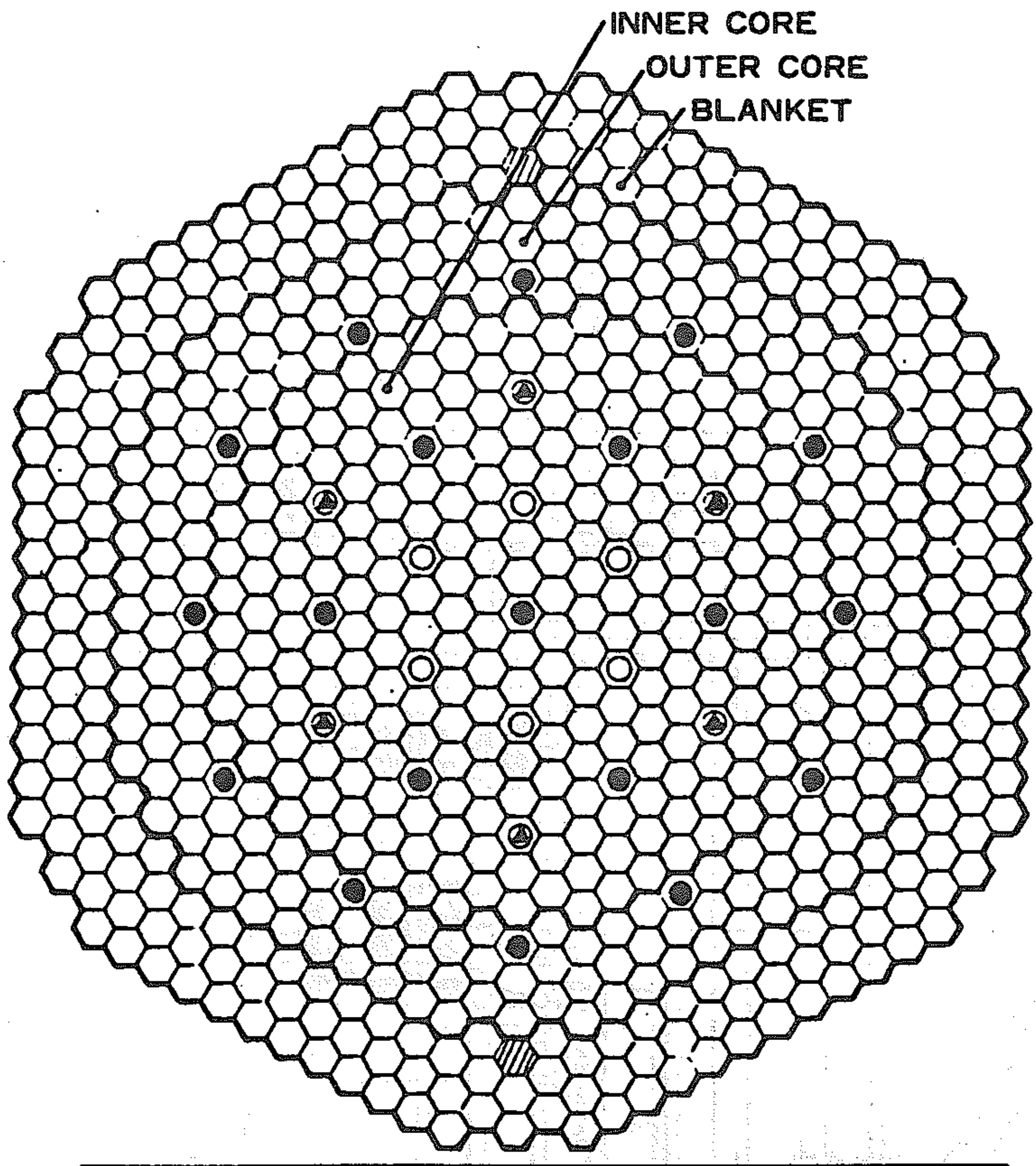


CONCEPTUAL DESIGN (II)   CONCEPTUAL DESIGN (I)

PLANE ARRANGEMENT IN CONTAINMENT



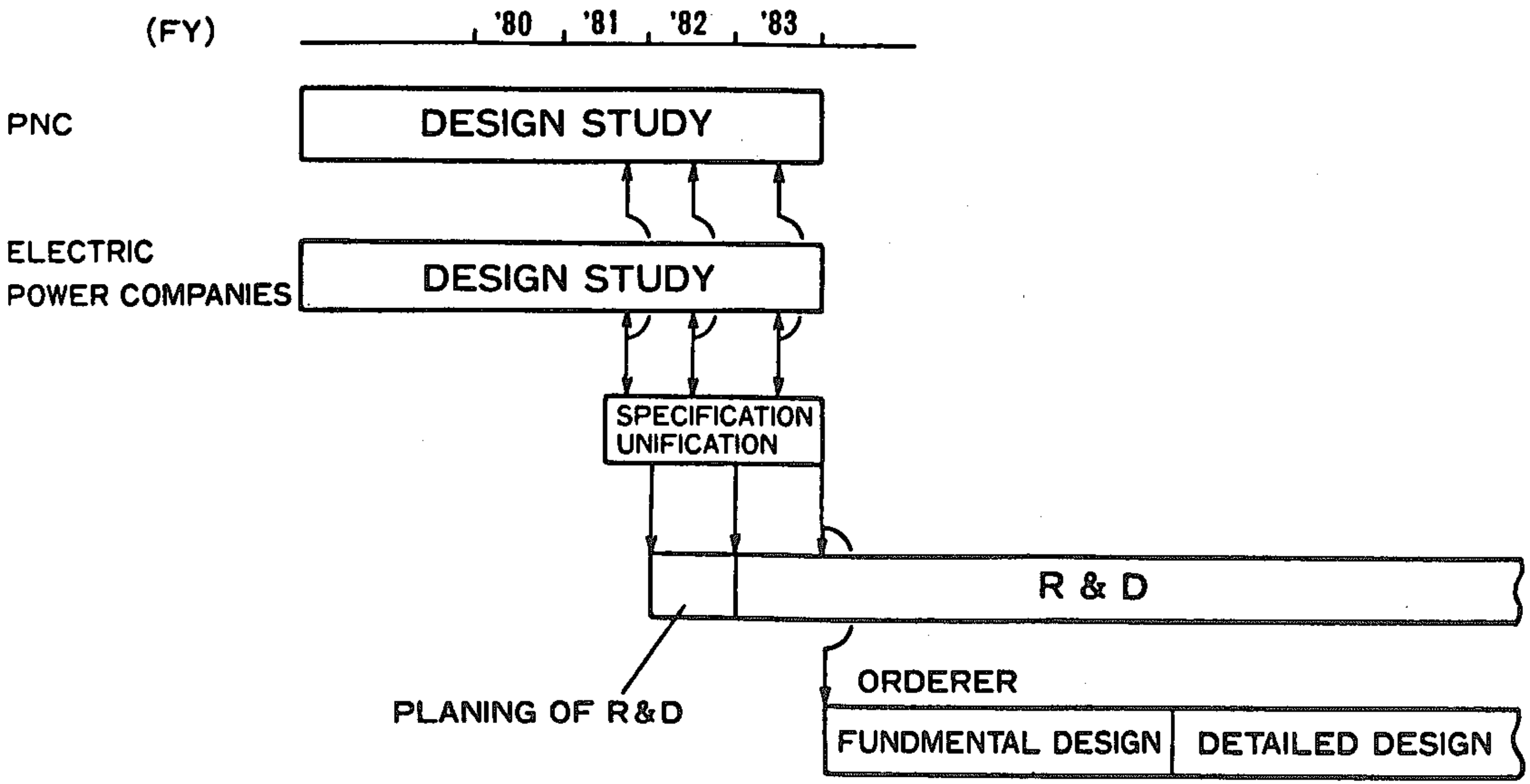
REACTOR BUILDING VERTICAL SECTION



		NUMBER	SYMBOL
CORE SUBASSEMBLY	INNER CORE	234	
	OUTER CORE	186	
BLANKET SUBASSEMBLY		250	
NEUTRON SOURCE SUBASSEMBLY		2	
CONTROL ROD	PRIMARY	25	
	BACK UP	6	
NEUTRON REFLECTOR		408	

CORE CONFIGURATION

STATUS OF DESIGN STUDY



2. 1982年5月の日米JCCへの説明

Status of Demonstration FBR Plant in Japan
(Oral paper for JCC in Tokyo, May 11, 1982)

(1) ________:

Good morning, Gentlemen;

I am very happy to have opportunity to talk about the status of the demonstration fast breeder reactor plant development in Japan.

One demonstration plant will stand on the way from JOYO and MONJU to commercial fast breeder reactor plants.

Design studies of the demonstration plant have been and are being conducted these years.
The present is just transition stage from a studying period to a focussing period in which two matters will be required, that is;
(1) preparation of the specification for the fundamental design, and (2) starting up of the research and development activities for the demonstration plant.

(2) Development Programme of FBR in Japan:

This figure shows the development programme of fast breeder reactor in Japan. You can find here a demonstration phase before commercialization.
So-called demonstration plant is positioned as the first plant to be constructed in this phase, and followed by a few same class plants.

Japanese fast breeder reactor development programme is now under review by government organizations where PNC representative participates in as well as private companies representatives.

They expect that reliability and economy of the fast breeder plant system must be proven through this demonstration phase as a "symbiosis" system with light-water-reactor system in the following commercialization phase.

(3) Organization of Demonstration Plant Design Study:

A contract of the demonstration plant conceptual design study with the leading nuclear power plant suppliers is in progress. The power supplying companies are associated in as a member of the design meeting.

In PNC, a fast breeder reactor demonstration plant group functions as a coordinator in cooperation with all R & D groups and Oarai Engineering Center.

(4) Conceps studied in Present conceptual Design:

In the design study, some concepts shown in this table have been discussed and compared each other.

For example, the reference core configuration is rectangular cylindrical homogeneous core while the radial and axial heterogeneous cores are also investigated, comparing their breeding and safety performances.

The larger fuel pin diameter different from those of JOYO and MONJU is adopted as a reference because of its potenciality to realize higher breeding gain with lower pressure drop, and higher linear heat rate without center melt.

The hot-leg pump for the primary heat transport system is required to give lower cover gas pressure without increasing piping diameter. However, recently, demerits of the hotleg pump concept such as pressure increase in the intermediate heat exchanger are coming up to the surface.

(5) Status of Design Study:

The story briefly spoken above is a section view of the moment in the stream of the design study sponcered by PNC.

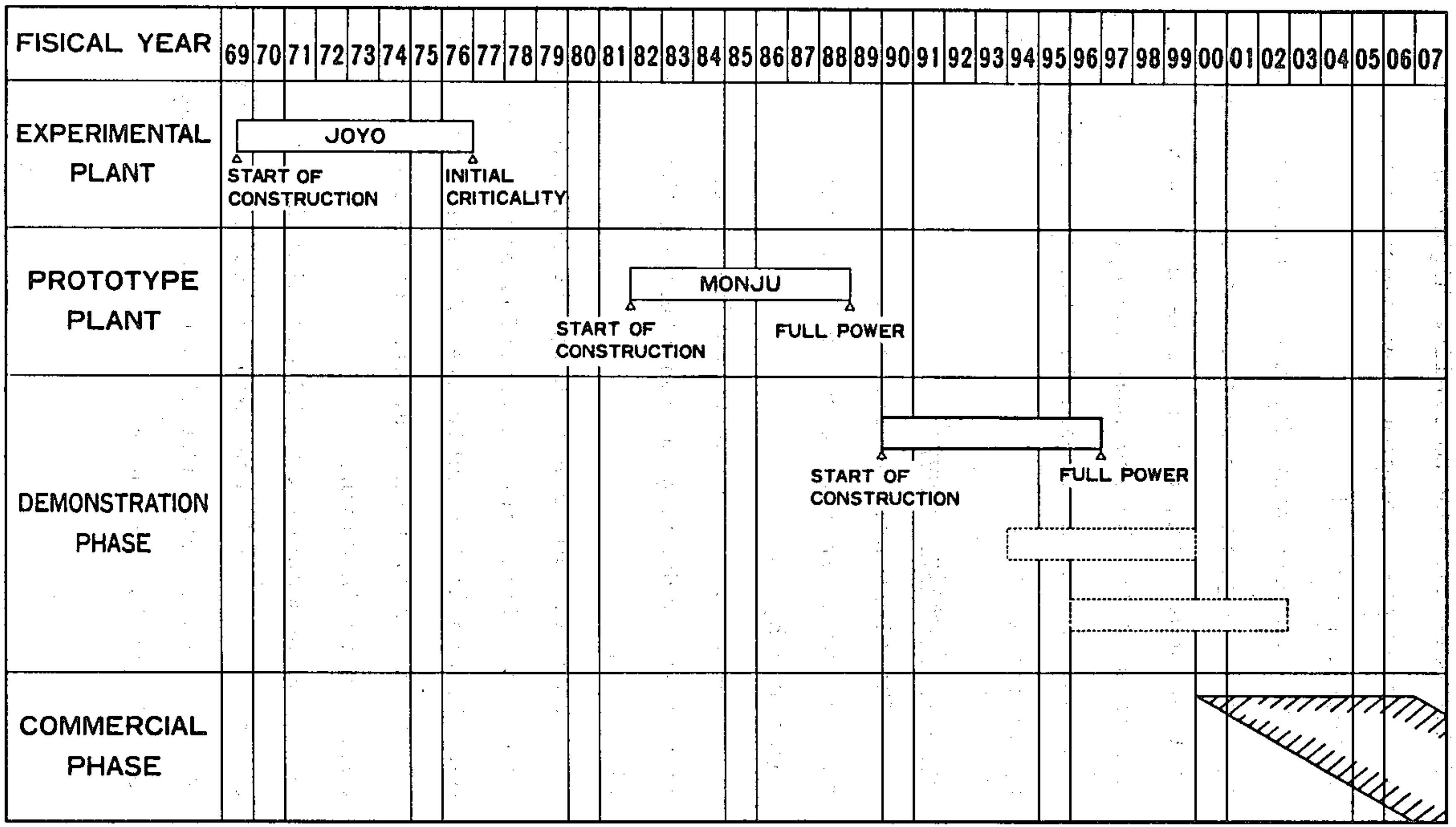
The electric power companies coordinated by FPO have been conducting design study of the demonstration plant also.

Both streams are just on the point of flowing into a specification unification effort. This effort must be one of key activities for early realization of the demonstration fast breeder reactor plant development in Japan.

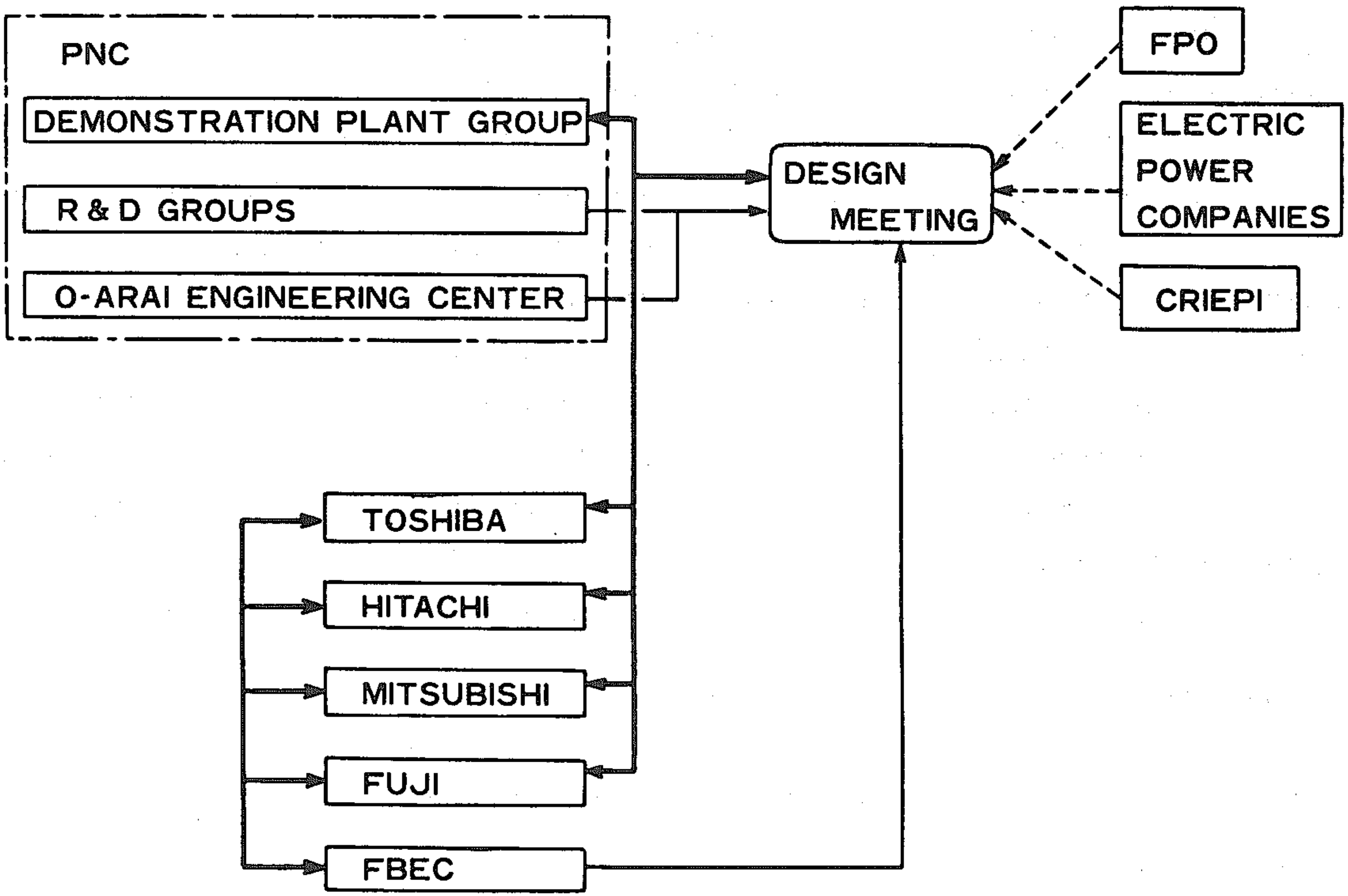
The demonstration FBR coordinating committee abbreviated by DCC was established last November by PNC and FPO to make the effort and to promote every activities for the DFBR.

Thank you.

DEVELOPMENT SCHEDULE OF FBR IN JAPAN



ORGANIZATION OF DEMONSTRATION PLANT DESIGN STUDY



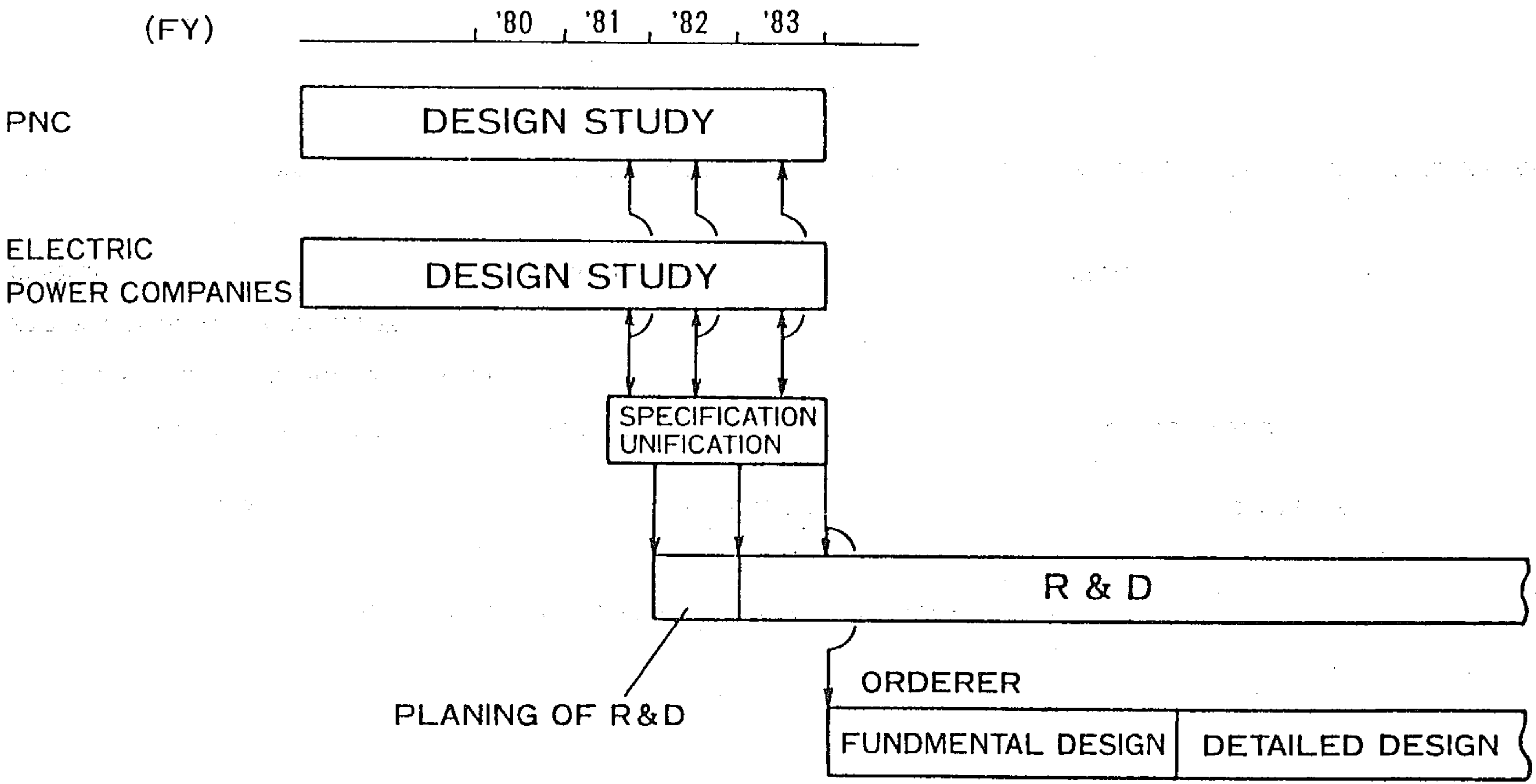
REFERENCE AND ALTERNATIVE CONCEPTS

ITEM	REFERENCE	ALTERNATIVE
CORE CONFIGULATION	HOMOGENEOUS	AXIAL HETEROGENEOUS RADIAL HETEROGENEOUS
FUEL PIN DIAMETER	7.4 mm	6.5 mm
FUEL SUBASSEMBLY	217 pins/ass'y	271 pins/ass'y
FUEL PIN SPACER	WRAPPING WIRE	GRID SPACER
GAS PLENUM LOCATION	LOWER	UPPER
REACTOR VESSEL INLET NOZZLE	UPPER PART OF REACTOR VESSEL	LOWER PART OF REACTOR VESSEL
PRIMARY MAIN PUMP LOCATION	HOT LEG	COLD LEG
PRIMARY MAIN PUMP TYPE	SINGLE SUCTION	DOUBLE SUCTION
AUXILIARY CORE COOLING SYSTEM	IRACS	IRACS AND DRACS
IN-VESSEL FUEL HANDLING SYSTEM	DOUBLE ROTATING PLUGS WITH FIXED OFF-SET ARM	DOUBLE ROTATING PLUGS WITH PANTOGRAPH ARM
EXTERNAL VESSEL FUEL HANDLING SYSTEM	CHUTE TYPE WITH TRANSFER CELL	CASK CAR TYPE
EXTERNAL VESSEL STORAGE TANK	FIXED FUEL STORAGE RACK	ROTATING FUEL STORAGE RACK

REFERENCE AND ALTERNATIVE CONCEPTS (CONTINUED)

ITEM	REFERENCE	ALTERNATIVE
COMPENSATION OF SECONDARY PIPING SYSTEM THERMAL EXPANSION	PIPE BEND	BELLOUS JOINT
STEAM GENERATOR WATERSIDE SYSTEM	BENSON	SULZUR
STEAM GENERATOR TYPE	HERICAL COIL WITHOUT COVER GAS	STRAIGHT TUBE WITHOUT COVER GAS

STATUS OF DESIGN STUDY

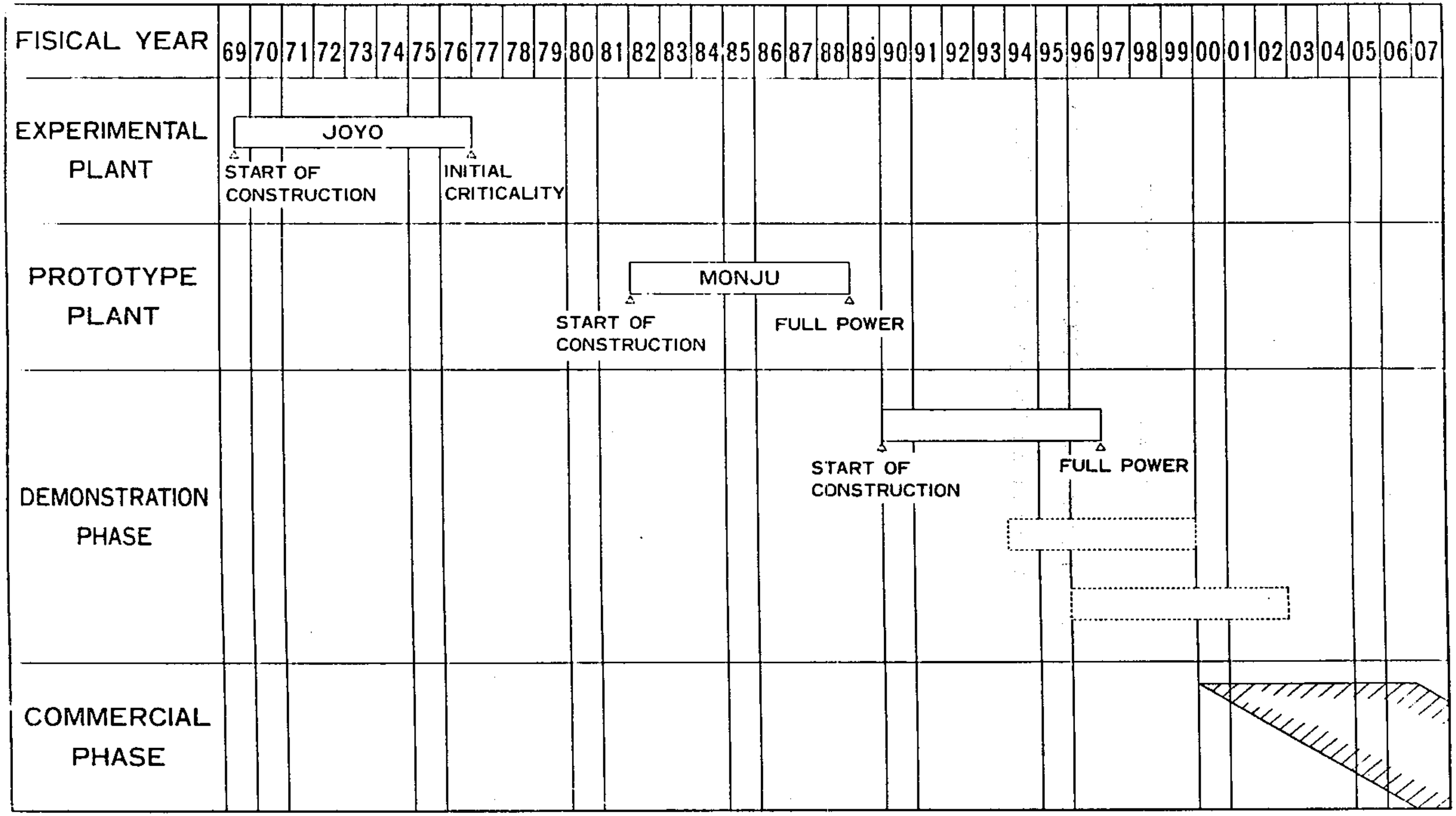


3. 1982年6月の日独仏高速炉会議への説明

Demonstration FBR Plant

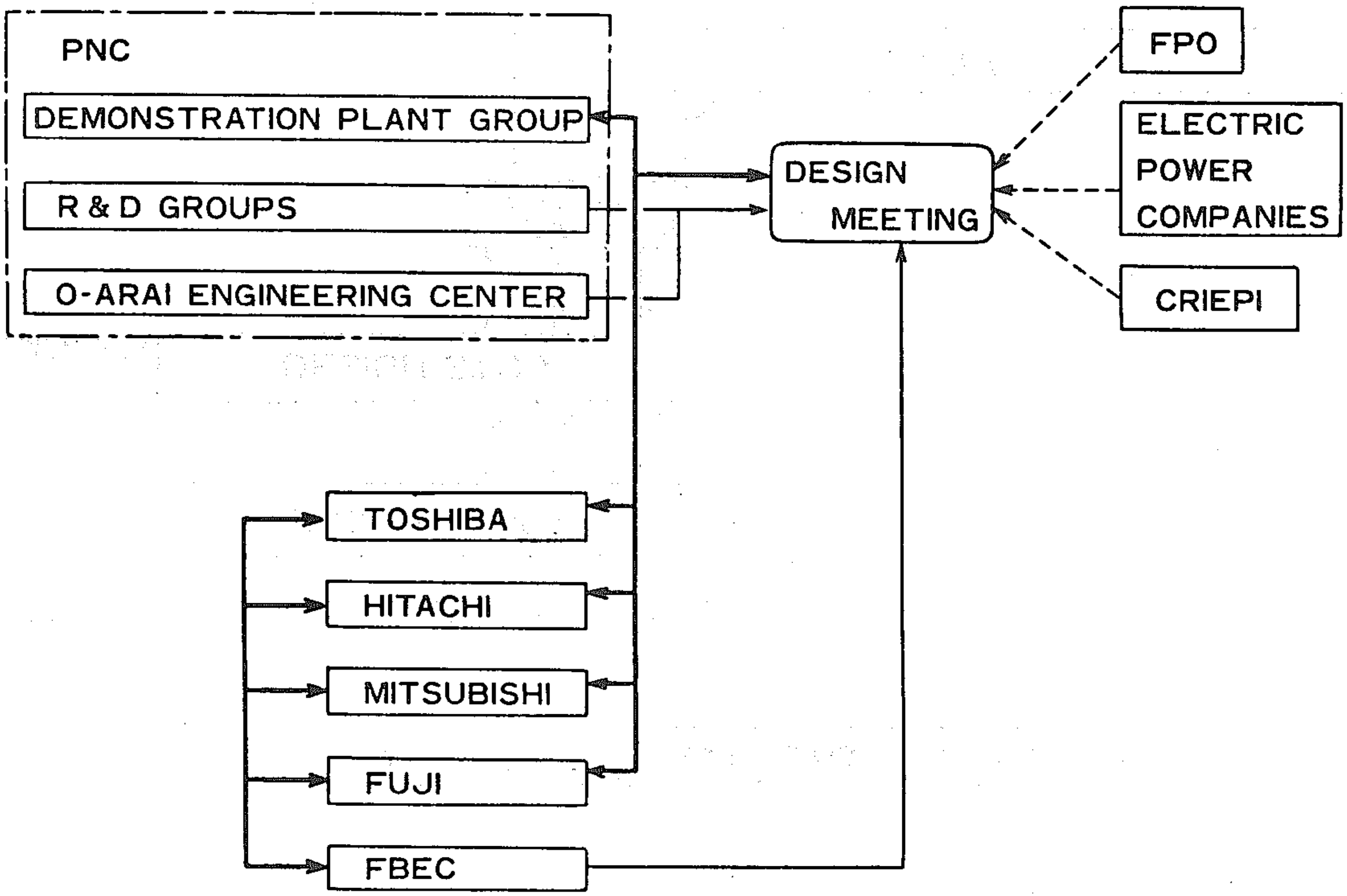
(Paper for the 3rd PNC/DEBENE/CEA Review Meeting in Tokyo, June 14, 1982)

DEVELOPMENT SCHEDULE OF FBR IN JAPAN

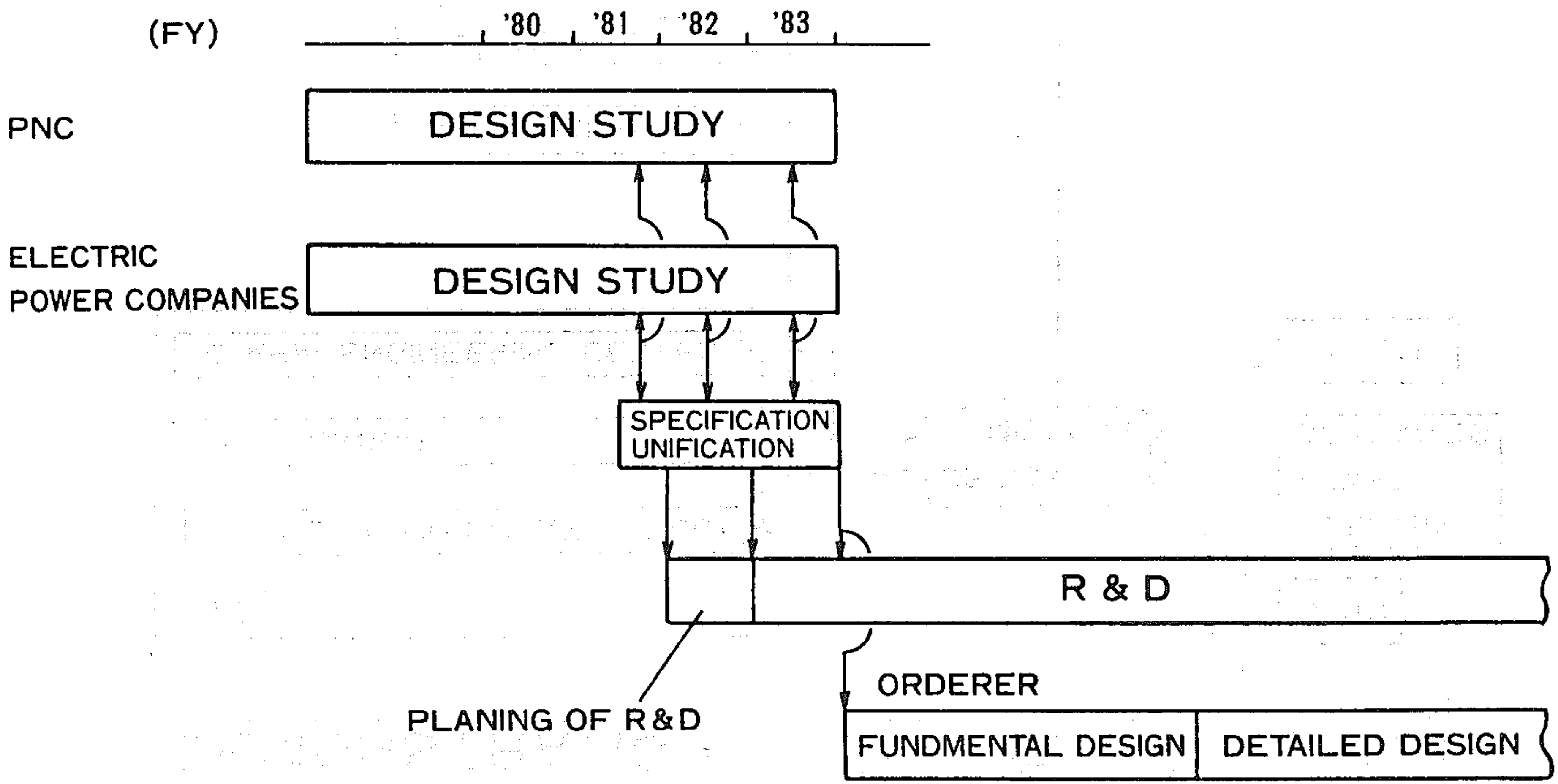


ORGANIZATION OF

DEMONSTRATION PLANT DESIGN STUDY



STATUS OF DESIGN STUDY



REFERENCE AND ALTERNATIVE CONCEPTS

ITEM	REFERENCE	ALTERNATIVE
CORE TYPE	HOMOGENEOUS	AXIAL HETROGENEOUS RADIAL HETROGENEOUS
FUEL SUBASSEMBLY	217 FUEL PINS	271 FUEL PINES
EXCHANGE BATCH NUMBER OF RADIAL BLANKET FUEL	3	4 - 6
FUEL SUBASSEMBLY GAS PLENUM LOCATION	UPPER	LOWER
MINIMUM COOLANT PRESSURE IN PRIMARY PIPING	POSITIVE	NEGATIVE
LOCATION OF PRIMARY COOLANT INLET	UPPER PART OF REACTOR VESSEL	LOWER PART OF REACTOR VESSEL
PRIMARY MAIN PUMP TYPE	SINGLE SUCTION	DOUBLE SUCTION
PRIMARY MAIN PUMP LOCATION	HOT LEG	COLD LEG
AUXILIARY CORE COOLING SYSTEM	IRACS	IRACS + DRACS
FUEL HANDLING SYSTEM	CHUTE TYPE, DOUBLE ROTATABLE PLUGS AND FIXED OFF-SET ARM	CASK CAR TYPE, DOUBLE PLUGS AND PANTOGRAPH ARM
STEAM GENERATOR TYPE	HERICAL COIL	STRAIGHT TUBE

4. 1982年10月の日英高速炉会議への説明

Status of Demonstration FBR Plant in Japan
(Oral paper for Eighth Review Meeting
of UK/JAPAN in Tokyo, Oct. 1, 1982)

(1) Covering:

Good morning, Gentlemen;

I am very happy to have opportunity to talk about the status of the demonstration fast breeder reactor plant development in Japan.

One demonstration plant will stand on the way from JOYO and MONJU to commercial fast breeder reactor plants.

Design studies of the demonstration plant have been and are being conducted these years.

The present is just transition stage from a studying period to a focussing period in which two matters will be required, that is;
(1) preparation of the specification for the fundamental design, and (2) starting up of the research and development activities for the demonstration plant.

(2) Organization of Demonstration Plant Design Study:

A contract of the demonstration plant conceptual design study with the leading nuclear power plant suppliers is in progress. The power supplying companies are associated in as a member of the design meeting.

In PNC, a fast breeder reactor demonstration plant group functions as a coordinator in cooperation with all R & D groups and Oarai Engineering Center.

The primary conceptual design study directing the extrapolation of the prototype FBR "MONJU", was performed from 1972 to 1981. It will be utilized as a candidate design of the demonstration plant.

(3) Plant Arrangement of DFBR:

This figure shows a result of the study as a birdsview of the nuclear steam supply system of 1,000 MWe class loop type FBR plant.

The building is a rising-sun flag or the Japanese flag shape building which consists of 64m diameter center circle of the containment vessel and 110m square of the surrounding building in which steam generators are placed in dispersion.

(4) Reactor System:

This graph shows a section view of the reactor vessel which has a diameter of 13m and a height of 19m.

As a result of the primary conceptual design, it is recognized that further investigation is necessary on such items as following; one is a further reduction of the seismic floor response of the reactor building; we call it "a seismic isolation concept approach".

The second one is a problem of the strength of the IHX tube sheet.

The other one is how to keep the integrity of the reactor vessel, especially near sodium surface.

(5) Main Features of 2ry Conceptual Design:

The secondary conceptual design aiming at reduction of construction cost is in progress, according to the long-range plan issued last June by Japan Atomic Energy Committee.

Some design features to be investigated in the study are shown in this view graph:

(i) Introduction of bellows joint for main heat-transport-system piping,

(ii) Reduction of the number of control rods and rows of radial blanket assembly,

(iii) Elimination of handling of the outer row of shielding assembly by fuel handling machine,

(iv) Reduction of the diameter of reactor biological-shielding concrete, relating to above improvement.

(6) Status of Design Study:

The above descriptions are based on the design study offered by PNC with great background based on the technology accumulated through JOYO and MONJU experiences.

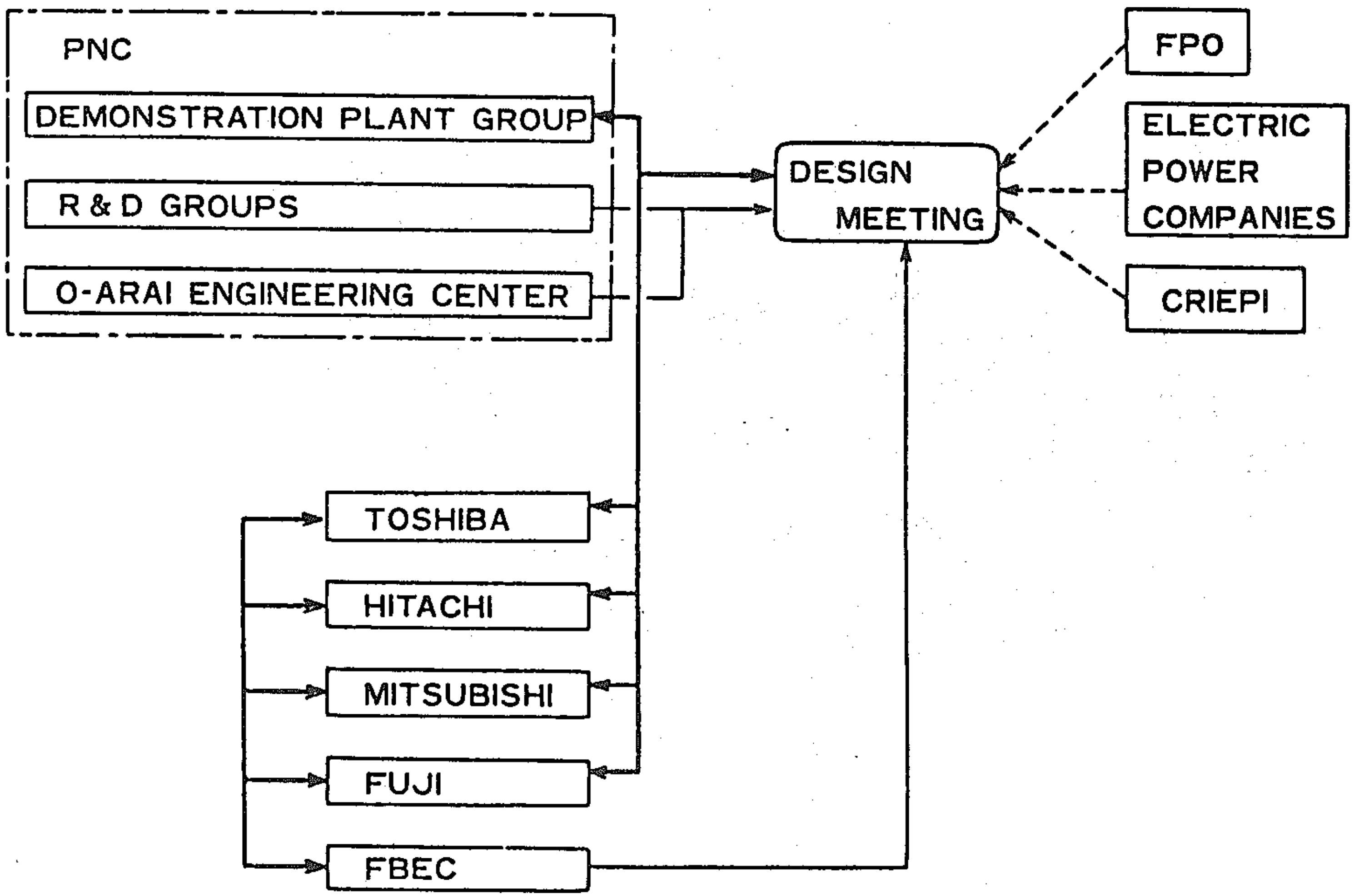
The electric power companies coordinated by Federation of Electric Power Companies have been conducting design study of the demonstration plant also.

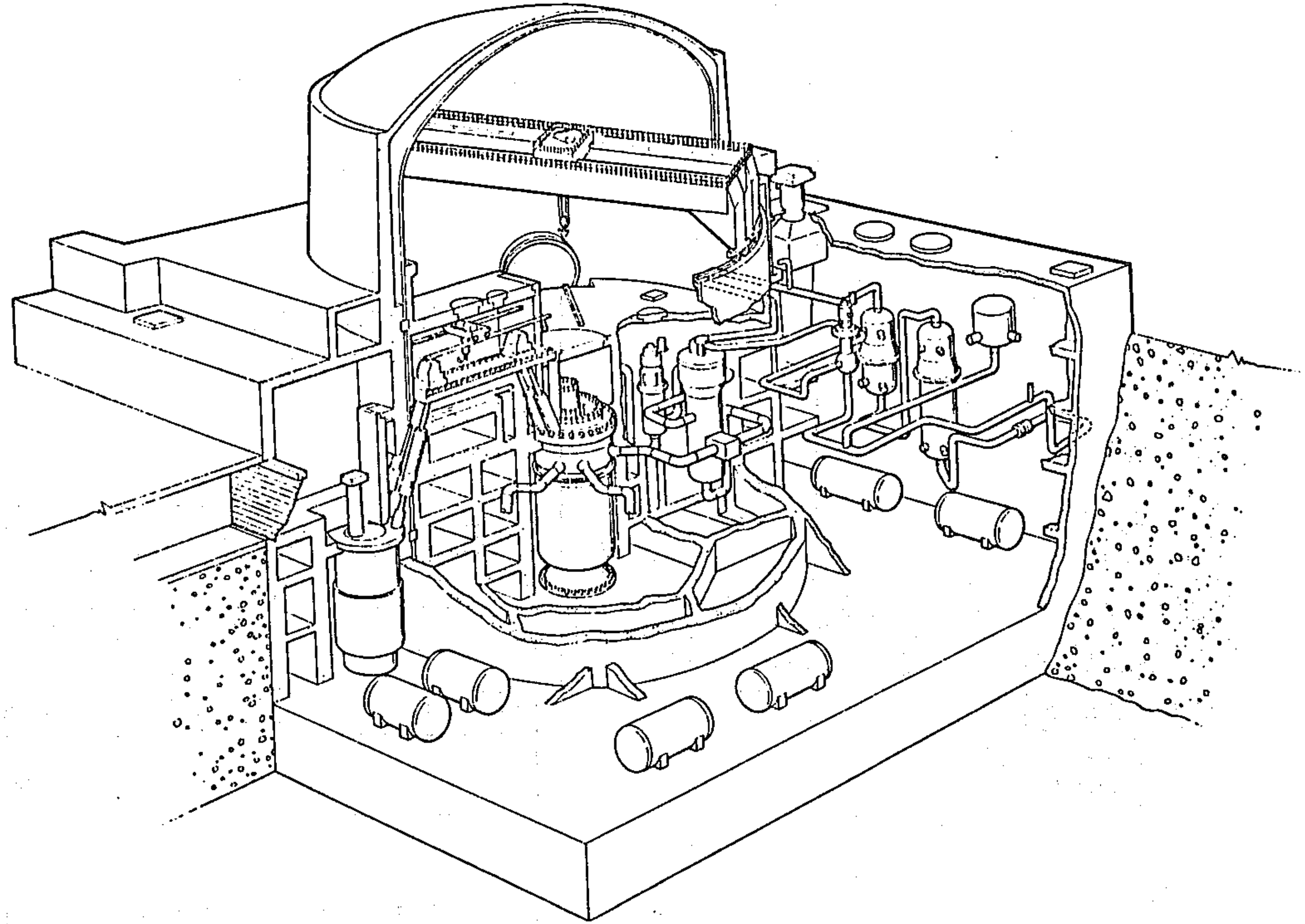
Both streams are just on the point of flowing into a design unification effort. This effort must be one of key activities for early realization of the demonstration fast breeder reactor plant development in Japan.

The demonstration FBR coordinating committee was established last November by PNC and Federation of Electric Power Companies to make the effort and to promote every activities for the DFBR.

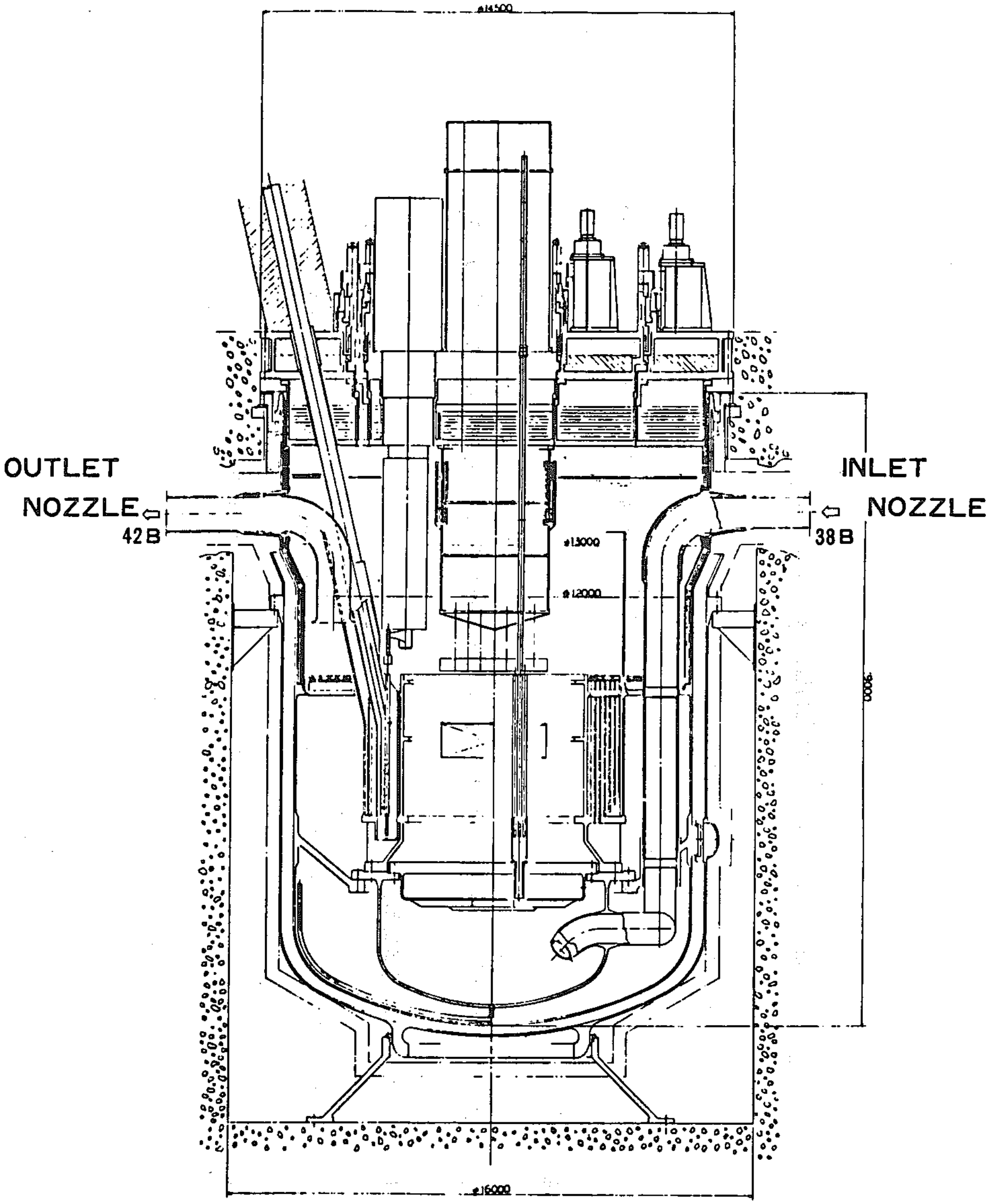
Thank you.

ORGANIZATION OF DEMONSTRATION PLANT DESIGN STUDY





PLANT ARRANGEMENT OF DFBR



REACTOR SYSTEM

Main Design Features of Secondary Conceptual Design

(1) Introduction of Bellows Joint

(2) Reduction of Number of Control Rods and Rows of Radial Blanket

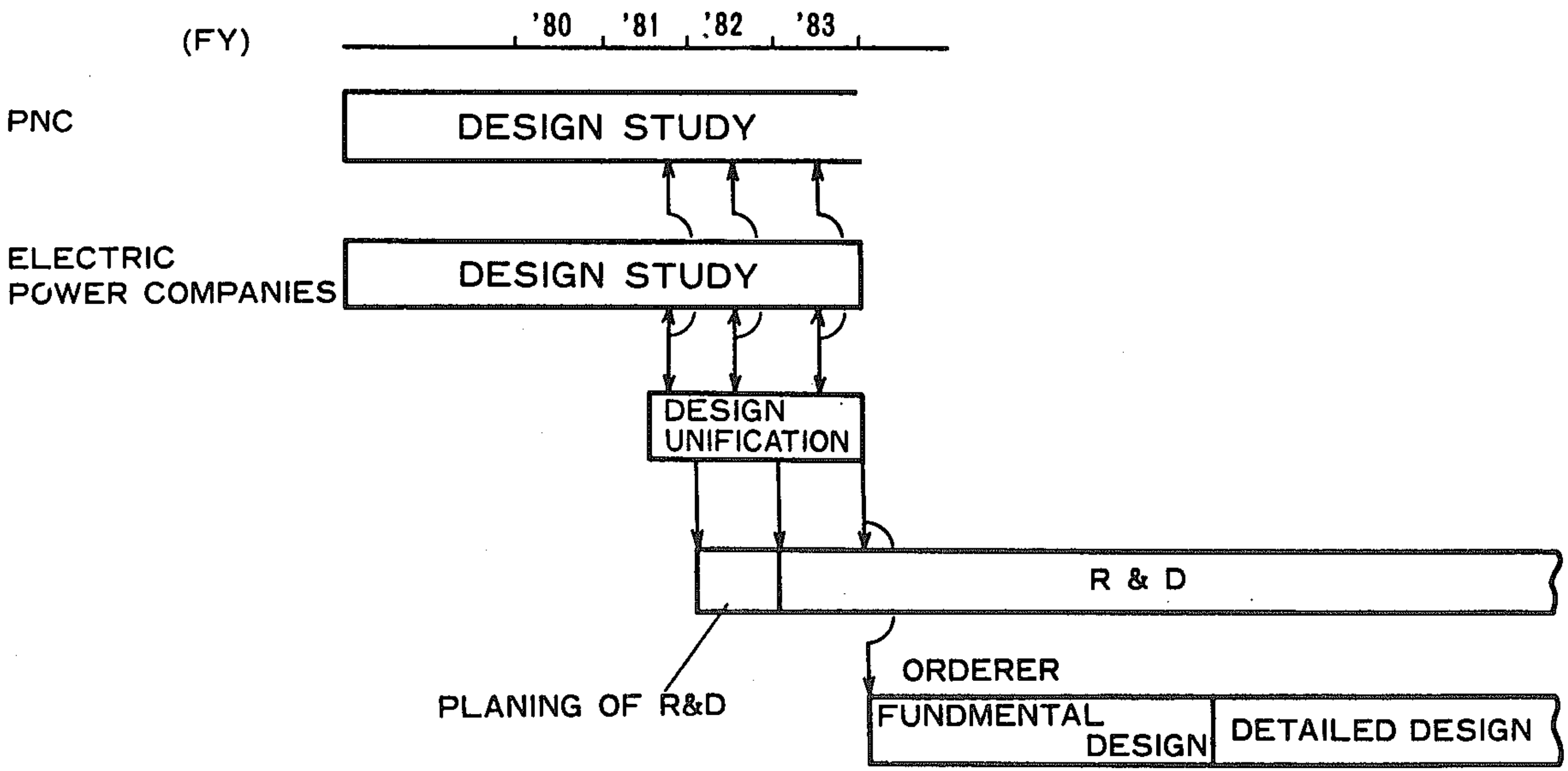
(3) Elimination of Handling of Outer-Row of Shielding Assembly by Fuel Handling Machine

(4) Reduction of Diameter of Reactor Biological Shielding Concrete

(5) Plant System Parameter Survey for Optimization

(6) Reviewing Design Criteria, Codes, Standards

STATUS OF DESIGN STUDY



5.　１９８３年４月の日米ＰＥＷＧへの説明

Status of DFBR Design Study by PNC
(Oral paper for Fifth PEWG Meeting
at Richland, April 25, 1983)

(0) ________:

I am very glad to see you again here. Just two years ago, I was here as a head of the delegation from JOYO, and discussed about the operational experience of JOYO and the FFTF.

At that time, the weather was very hot and dry. I remember all the day-time and night-time meetings. I am sure that the exchanges of the past were fruitful and I am also sure that this meeting will be successful for the both of us.

In Japan we have brought out many successful results with our JOYO reactor and this is symbolized by the achievement of reaching 100Mw this March.

I would like to take this occasion to thank Mr. Jones for all the cooperation and help we have had.

(1) Covering:

I would now like to introduce to you about our status of DFBR design study sponsored by PNC and performed by leading nuclear power plant suppliers.

(2) Flow of FBR Plant Development:

One demonstration plant, so-called DFBR, will follow JOYO and MONJU and will lead the way to commercial fast breeder reactor plants.

Both PNC and the Power Supplying Utility Companies have been and are being carried out design studies of the DFBR these years.

I would like to state briefly PNC's design study. Mr. Kataoka of FPO will present the state of their design study afterwards.

(3) Time Table of Design Study for DFBR:

We started the preliminary design study in 1975 followed by the first conceptual design.

The second conceptual design is in progress in a three-years phase.

We also started a comparative study related to the type of reactors.

(4) Topics Studied Through Preliminary and First Conceptual Design Studies:

In the preliminary and first conceptual design studies, many trade-off studies have been carried out, making a reference plant design to confirm each selection or optimization consistent as a balanced plant.

In the preliminary design, we studied, for example, number of loops, breeding performance, coolant temperatures and so on.

In the first conceptual design, we studied, for example, fuel pin diameter, fuel charge-discharge machine, reactor vessel inlet nozzle position, etc., resulting in a reference plant design which could be one of candidate designs for future discussion to establish the specification for the fundamental design of DFBR.

Some results from these studies are used in the next second conceptual design.

(5) Cut Away and Plant Layout of DFBR in First Conceptual Design:

This view graph shows the cut away view and the plot plan of the first conceptual design.

This reactor containment vessel is 64 meters in diameter. The size of the auxiliary building is 110 meters square.

These figures compared with those of light water reactor plants typically inspired us to a simple question, "Can FBR be economical in future through this approach?"

(6) Major Plant Parameters of JOYO, MONJU and DFBR:

Let us now look at the developmental change of concepts or parameters on the stream of FBR development from JOYO and MONJU to the DFBR.

We can find many improvements in each step or in each age.

Nevertheless, they need much more wisdom!

(7) Objective of the Second Conceptual Design Study:

After many times of discussions in the preparation period of one-half year, we established the objective of the second conceptual design.

That is, in order to develop an integrated and effective R & D program for DFBR to enable the start of construction by the early 1990s, the study efforts shall be concentrated as follows:

First, to reduce construction cost while maintaining safety; second, to fully extend the techniques and know-how accumulated through activities for JOYO and MONJU, and, third, to expand the techniques expected until the start of construction.

(8) Main Target of Second Conceptual Design Study:

Then, we discussed how to realize the objective. It resulted in an ordinary approach. Our approach was, as an old Chinese saying says, "look back and find the entrance to a new discovery."

We have investigated many many trade-off or parametric studies for DFBR as I mentioned before and this includes MONJU and JOYO. And also we have learned much efforts performed by people of your country and the other foreign countries.

To re-evaluate these past efforts and, of course, to add new original ideas were adopted as fundamental specifications for the second conceptual design.

Main targets shown here such as piping bellows are applied in the specification to show the direction of the study.

The objective, approach method and main targets have been reported to and approved by the top manager of FBR project and the director board of PNC.

(9) Initial Cost Reeduction Method Items Being Studied in Second Conceptual Design Study:

Since it started last year, more than 130 of potential ideas to be investigated for construction cost reduction method have been picked up.

About 40% are under discussion.

(10) Typical Core Matrix with Reduced Numbers of Control Rods and Blanket Rows:

For example, a compact core with reduced number of control rods and radial blanket rows results in 300 mm reduction of circumscribed circle diameter of outer shielding assemblies.

(11) Typical Cases of Layout of Primary heat Transport System with Bellows Piping:

Other example is bellows piping for main heat transport system.

This view graph shows two cases from eight cases. Reactor building diameter of less than 50 meters for both cases is promising.

(12) Typical Cases of Layout of Secondary Heat Transport System with Bellows Piping:

These are examples of the secondary system layout. The size of the auxiliary building is promising less than 90 meters square.

(13) Technical Features of Bellows Piping System:

Bellows piping system is thought to have some technical features different from conventional piping system as shown here.

(14) Provisions for Design Conception:

This table shows the provisions for design conception of the second conceptual design.

Top priority is set on construction cost reduction under some conditions such as safety, operability and so on.

Breeding ratio itself be sacrificed to cost reduction.

Expansion of accident prevention ability.

(15) Planning Procedure for DFBR R & D Program:

Performing the design study, we are making the R & D program for DFBR.

Thank you.

SA 013 DWG 83—01

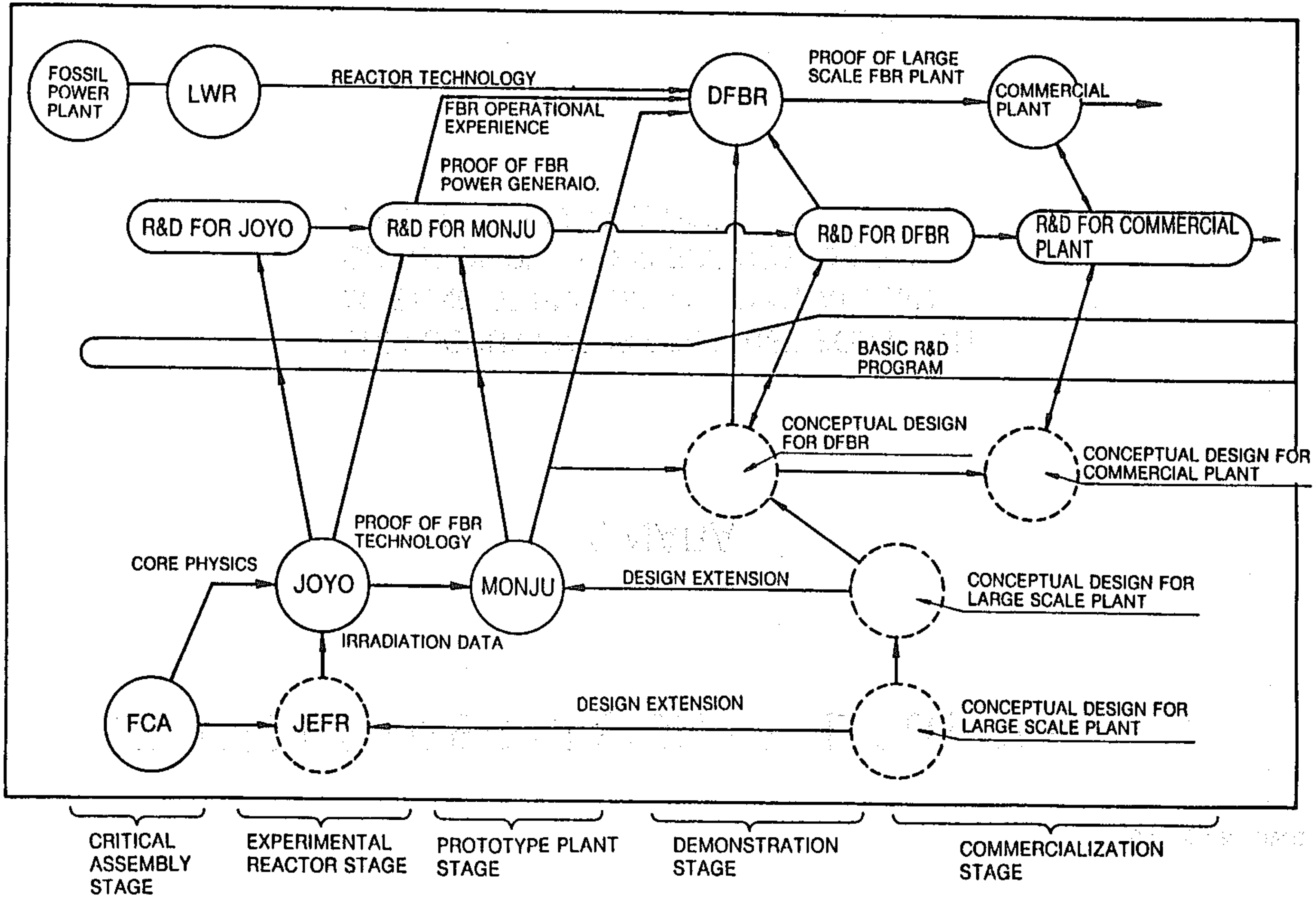
STATUS OF DFBR DESIGN STUDY BY PNC

Y. NARA

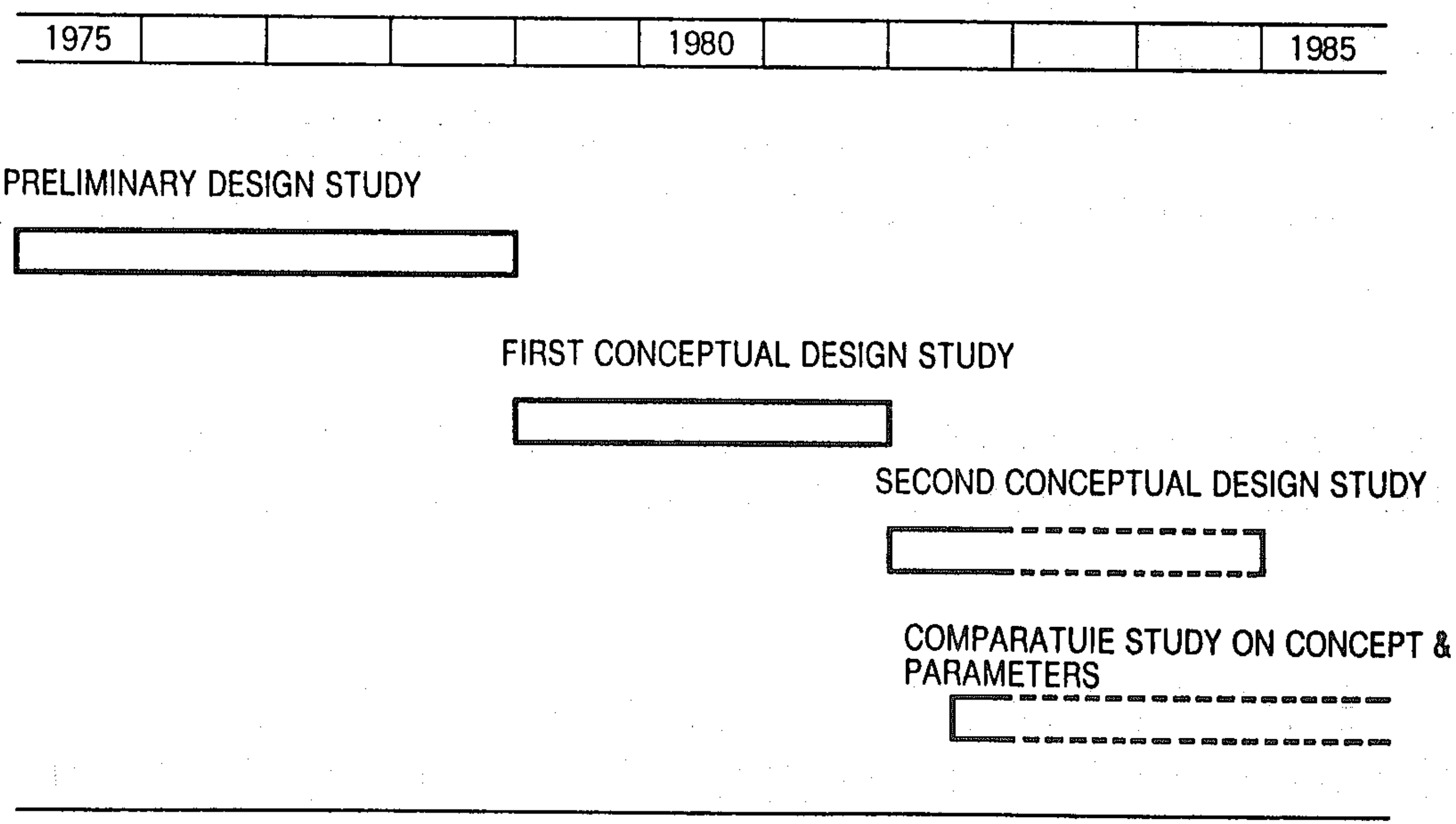
THIS DOCUMENT IS PREPARED FOR FIFTH MEETING OF PNC/USDOE JOINT WORKING GROUP ON PLANT EXPERIENCE, HELD ON APRIL 25—30, 1983 AT HEDL

POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION

FLOW OF FBR PLANT DEVELOPMENT



TIME TABLE OF DESIGN STUDY FOR DFBR



TOPICS STUDIED THROUGH PRELIMINARY AND FIRST-CONCEPTUAL DESIGN STUDIES

MANY TRADE-OFF STUDIES HAVE BEEN CARRIED OUT, TO ACHIEVE A REFERENCE PLANT DESIGN TO CONFIRM EACH SELECTION AND OPTIMIZATION CONSISTENT WITH A WHOLE PLANT.

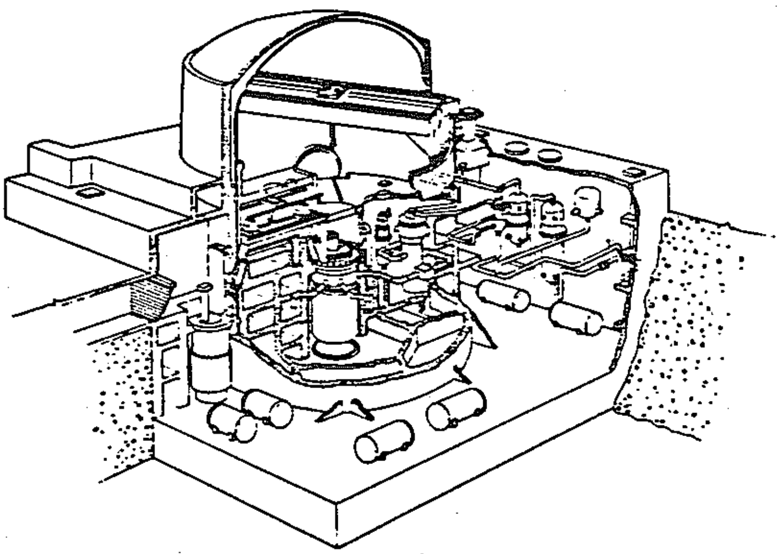
(PRE LIMINARY DESIGN)

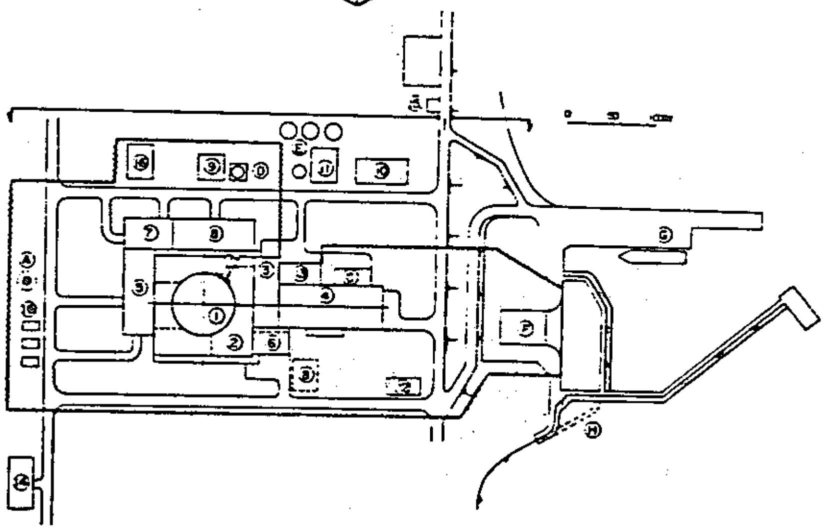
FIRST FY	• PARAMETRIC SURVEY (REACTOR TYPE, NO OFF LOOPS, STEAM CYCLE, FUEL CYCLE COST, ETC.)
SECOND FY	• TOPICS STUDIES (BREEDING PERFORMANCE, REACTOR STRUCTURE, ETC.)
THIRD FY	• COOLANT TEMP. OPTIMIZATION, PIPING LAYOUT CONPARISON, WHOLE PLANT DESIGN.
FOURTH FY	• COMPARATIVE STUDY WITH MONJU EXTENDED PLANT.

(FIRST-CONCEPTUAL DESIGN)

FIRST FY	• FUEL PIN DIA (6.5→7.4mmϕ) • FHM (PANTOGRAPH → OFFSET ARM TYPE)
SECOND FY	• PUMP LOCATION (COLD LEG → HOT LEG) • FUEL CHARGE-DISCHARGE MACHINE (CASK CAR → CHUTE-HOT CELL) • R/V INLET NOZZLE POSITION (BOTTOM → UPPER)
THIRD FY	• INTEGRATION AS A WHOLE PLANT • R & D PROGRAMMING

CUT AWAY AND PLANT LAYOUT OF DFBR IN FIRST CONCEPTUAL DESIGN





1. CONTAINMENT VESSEL
2. REACTOR AUXILIARY BUILDING
3. CONTROL BUILDING
4. TURBINE GENERATOR BUILDING
5. PLANT SERICE BUILDING
6. DIESEL GENERATOR BUILDING
7. SERVICE BUILDING
8. MAINTENANCE BUILDING
9. HOUSE BOILER
10. SWITCH YARD
11. DEMINERALIZED WATER SUPPLY FACILITY
12. RADWASTE AREA
13. ADMINISTRATION BUILDING
14. SOLID WASTE STORAGE BUILDING
15. GATE HOUSE
16. WAREHOUSE

Ⓐ VENT STACK
Ⓑ DIESEL FUEL TANK
Ⓒ TRANSFORMER
Ⓓ BOILER FUEL TANK
Ⓔ RAW WATER TANK
Ⓕ WATER INTAKE AND PUMP YARD
Ⓖ BARGE UNLOADING AREA
Ⓗ WATER OUTLET

MAJOR PLANT PARAMETERS OF JOYO, MONJU AND DFBR

PLANT	JOYO	MONJU	DFBR (FIRST CONCEPTUAL DESIGN)	DFBR (SECOND CONCEPTUAL DESIGN)
THERMAL POWER	100 MWt	714 MWt	≒2,500 MWt	
CORE OUTLET TEMPERATURE	500 °C	529 °C	530 °C	
CLADDING OUTER DIAMETER	6.3 mm/5.5 mm (MK-I) (MK-II)	6.5 mm	7.4 mm	
GAS PLENUM LOCATION	TOP	TOP	BOTTOM	
R/V GUARD SYSTEM	GUARD VESSEL	GUARD VESSEL	GUARD VESSEL	LEAK JACKET
ROTATING PLUG	DOUBLE	SINGLE	DOUBLE	
FUEL HANDLING MACHINE	VERTICAL MECHANISM	PANTOGRAPH ARM	OFFSET ARM	
FUEL CHARGE-DISCHARGE MACHINE	TRANSFER MACHINE	TRANSFER MACHINE	CHUTE-TRANSFER CELL	
R/V INLET NOZZLE LOCATION	LOWER	LOWER	UPPER	
PRIMARY PIPING LAYOUT	CONVENTIONAL VERTICAL EXPANSION LOOP	CONVENTIONAL HORIZONTAL EXPANSION LOOP AT HIGHER LEVEL.	CONVENTIONAL HORIZONTAL EXPANSION LOOP AT HIGHER LEVEL.	BELLOWS EXPANSION JOINTS
COVERGAS PRESSURE OF R/V	100 mmAq	5,500 mmAq	4100 mmAq	
STEAM GENERATOR TYPE	—	HELICAL COIL TYPE WITHOUT SODIUM SURFACE	HELICAL COIL TYPE WITHOUT SODIUM SURFACE	
DECAY HEAT REMOVAL SYSTEM	DRACS	IRACS	IRACS	DRACS + SGAHRS
SPENT FUEL COOLING	IN-VESSEL	EX-VESSEL	EX-VESSEL	
FFDL	SIPPING METHOD	TAG GAS METHOD	UNDER CONSIDERATION	
STEAM GENERATOR LAYOUT	—	INTEGRATED	CLUSTERED AROUND THE MAIN BUILDING	

OBJECTIVE OF THE SECOND CONCEPTUAL DESIGN STUDY

IN ORDER TO DEVELOP AN INTEGRAL AND EFFECTIVE RESEARCH AND DEVELOPMENT PROGRAM FOR DFBR TO ENABLE THE START OF CONSTRUCTION BY THE EARLY 1990S, STUDY EFFORTS SHALL BE CONCENTRATED AS FOLLOWS :

(1) TO REDUCE CONSTRUCTION COST WHILE MAINTAINING SAFETY

(2) TO FULLY EXTEND THE TECHNOLOGY AND KNOW-HOW ACCUMULATED THROUGH ACTIVITIES FOR "JOYO" AND "MONJU", AND

(3) TO EXPAND THE TECHNOLOGY EXPECTED UNTIL THE START OF CONSTRUCTION.

MAIN TARGET OF SECOND CONCEPTUAL DESIGN STUDY

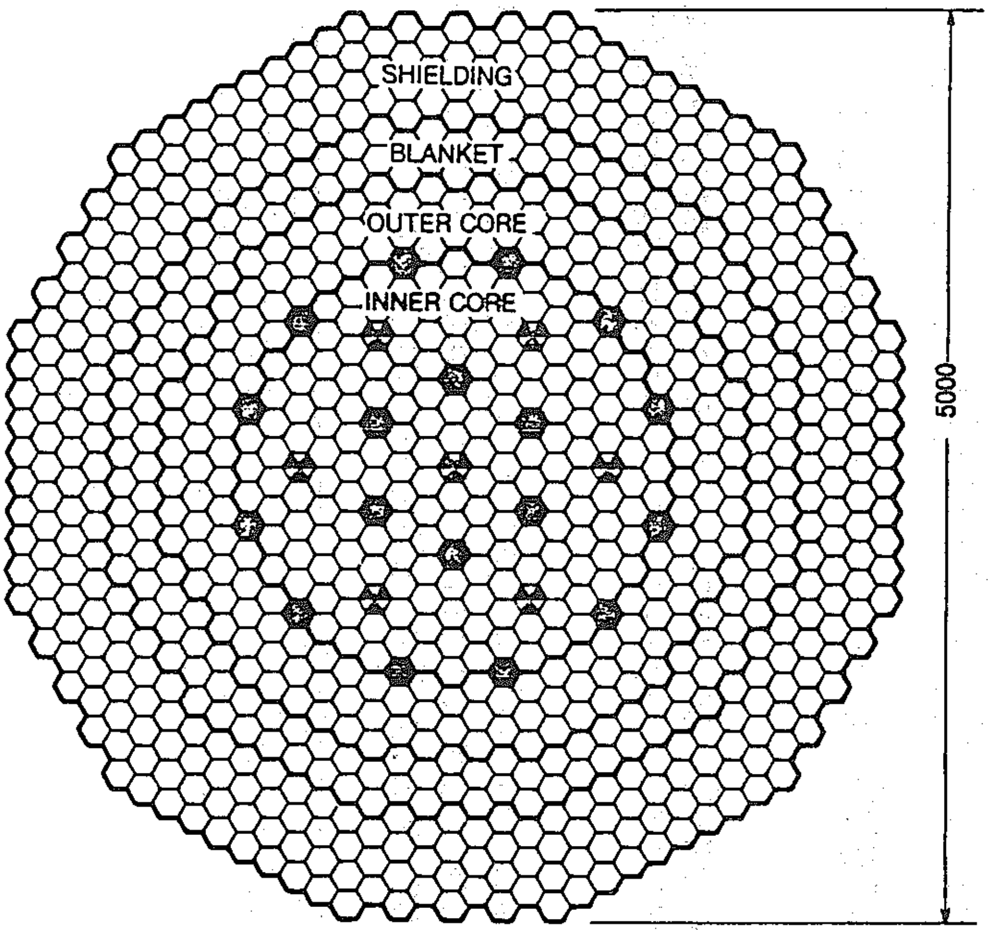
TARGET	INTRODUCTION OF NEW TECHNOLOGY	IMPROVEMENT OF PROVEN TECHNOLOGY
REDUCTION OF CONSTRUCTION COST	• BELLOWS EXPANSION JOINT (PRIMARY & SECONDARY COOLING SYSTEM) • SEISMIC ISOLATION	• RADIAL BLANKET REDUCTION • NO CHANGE OF OUTER SHIELDING ASSEMBLIES • EVST CAPACITY REDUCTION • DECAY HEAT REMOVAL BY SG
EXPANSION OF ACCIDENT PREVENTION ABILITY	• DIVERSIFIED SHUTDOWN SYSTEM (SELF ACTUATED SHUTDOWN SYSTEM) • DIVERSIFIED DECAY HEAT REMOVAL SYSTEM (DIRECT REACTOR AUXILIARY COOLING SYSTEM)	———
ADDITIONAL ACTIVITIES		• REACTOR VESSEL THERMAL ISOLATION • IHX INTEGRITY • IN-VESSEL INSPECTION METHOD

INITIAL COST REDUCTION METHOD ITEMS BEING STUDIED IN SECOND-CONCEPTUAL DESIGN STUDY

-MORE THAN 130 ITEMS ARE UNDER DISCUSSION.
EXAMPLES ARE ;

- CORE & FUEL : REDUCTION OF NUMBER OF CONTROL RODS AND ROWS OF RADIAL BLANKET, LARGE FUEL ASSEMBLY, LINEAR HEAT RATE INCREASE WITH LARGE DIAMETER, ETC.
- REACTOR : THERMAL INSULATION, SELF ACTUATED SHUT DOWN SYSTEM, REACTOR VESSEL SUSPENDED FROM DECK, KEY-CONNECTED UPPER CORE STRACTURE, SURPRESSING FP GAS RISE-UP IN HEAD CLOSURE ANNULUS, ETC.
- COOLING SYSTEM : BELLOWS JOINT PIPING SYSTEM, IMMERSION TYPE COLD TRAP, DOUBLE WALL TUBE S.G., ONCE-THROUGH UNIT TYPE S.G., SMALL SIZE FLOW METER, COMBINATION OF COLD TRAP AND DRACS, COMBINATION OF SELECTOR VALVE FFDL AND PLUGGING INDICATOR, ETC.
- FUEL HANDLING SYSTEM : DOUBLE IN-VESSEL FHM, A-FRAME CHARGE-DISCHARGE MACHINE, FUEL STORAGE WITHOUT CANNING, REDUCTION OF SPENT FUEL STORAGE CAPACITY, IVST, ETC.
- PLANT : CONCRETE & STEP TYPE CONTAINMENT VESSEL,SEISMIC ISOLATION, MODERATION OF THERMAL TRANSIENT CONDITION, OPTICAL FIBER USAGE, IN CONTAINMENT COOLING WITH WATER, ETC.

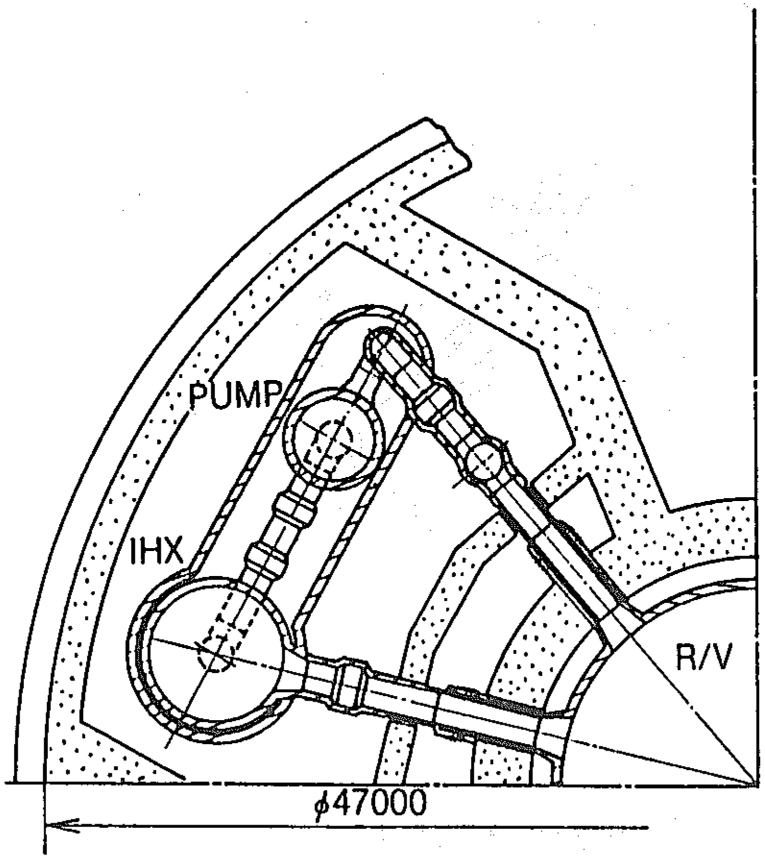
TYPICAL CORE MATRIX WITH REDUCED NUMBERS OF CONTROL RODS AND BLANKET ROWS



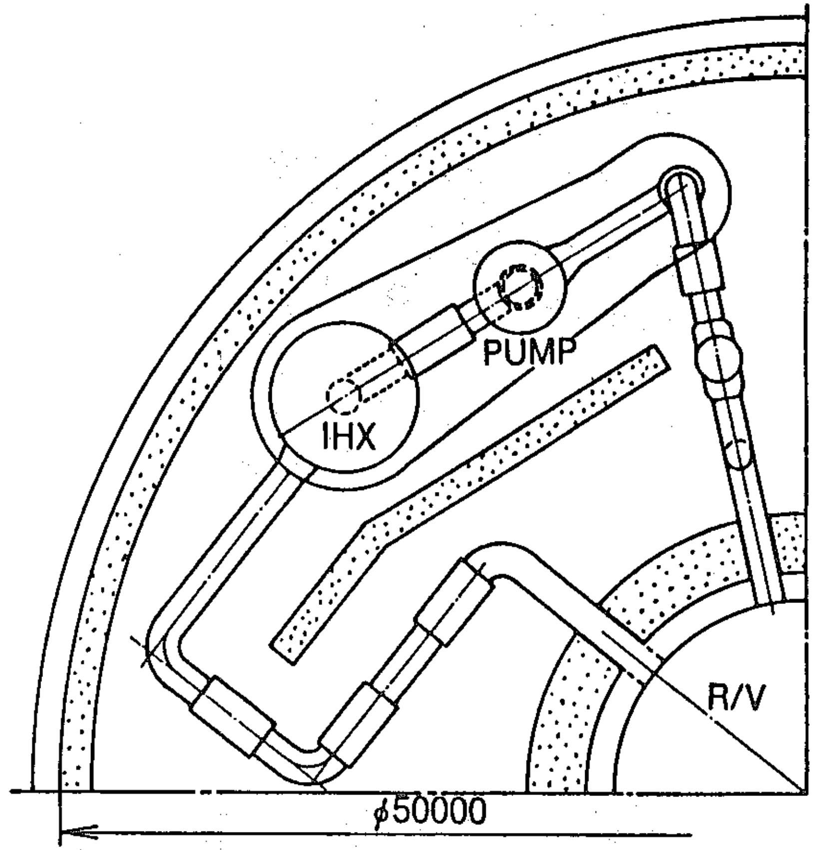
	NUMBER OF ASSEMBLIES		
CORE FUEL	INNER FUEL	174	(TOTAL)
	OUTER FUEL	162	336
RADIAL BLANKET-FUEL			150
CONTROL ROD	PRIMARY CONTROL ROD	18	(TOTAL)
	BACK-UP CONTROL	7	25

(NOTE : CORE FUEL ASSEMBLY WITH 271 FUEL ELEMENTS)

TYPICAL CASES OF LAYOUT OF PRIMARY HEAT TRANSPORT SYSTEM WITH BELLOWS PIPING

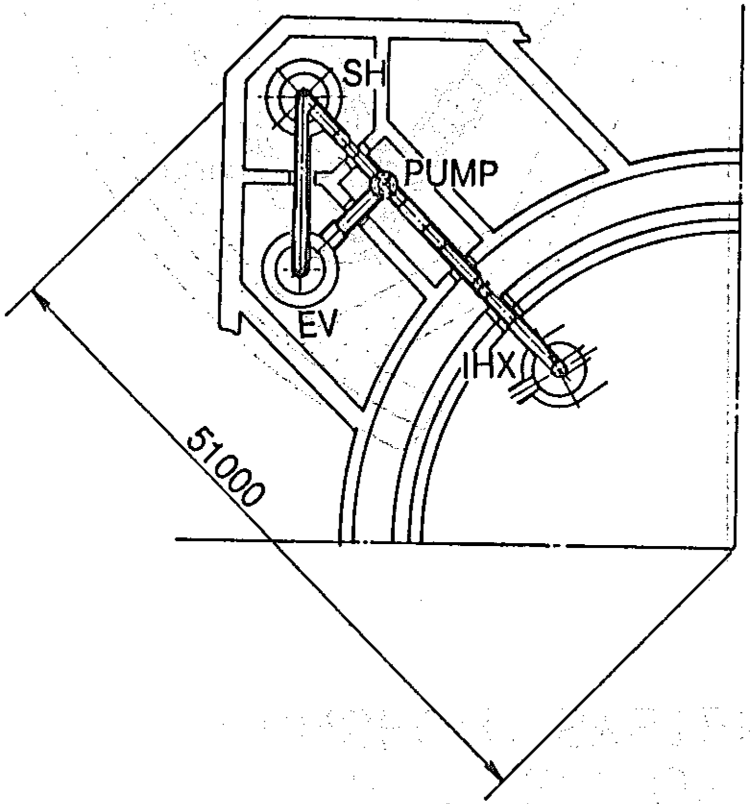


[CASE A]

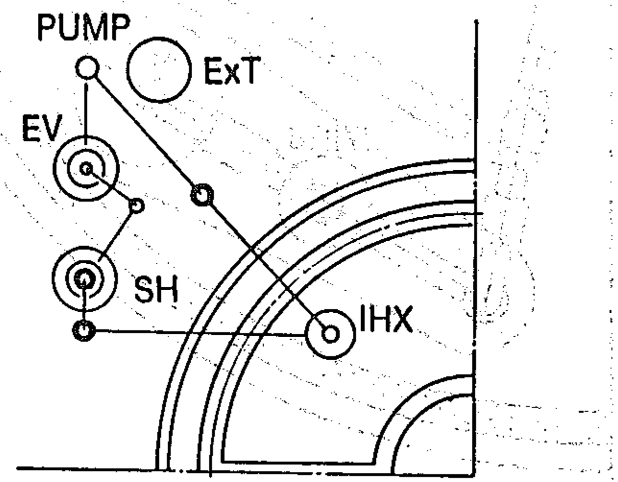


[CASE B]

TYPICAL CASES OF LAYOUT OF SECONDARY HEAT TRANSPORT SYSTEM WITH BELLOWS PIPING



[CASE A]



[CASE B]

TECHNICAL FEATURES OF BELLOWS PIPING SYSTEM

(1) WHOLE PIPING DIVIDED INTO SEVERAL BLOCKS CONNECTED BY "SOFT" PARTS.

(2) EASY TO REDUCE PRESSURE DROP IN PIPING DUE TO FLEXIBILITY INCREASE FOR SELECTING PIPING DIAMETER.

(3) REQUIRED TO MAKE COMPONENTS SHAPE SUITABLE FOR BELLOWS PIPING SYSTEM.

(4) PIPE RUPTURE ACCIDENT SCENARIO ALTERED BECAUSE OF INTRODUCTION OF "WEAK POINT PART" CONCEPT.

(5) INCREASE IN IMPORTANCE OF INSPECTION AND MAINTENANCE IN DESIGN OF PIPING SYSTEM AS "COOLANT BOUNDARY".

PROVISIONS FOR DESIGN CONCEPTION

(1) TOP PRIORITY ON CONSTRUCTION COST REDUCTION UNDER DEFINITE CONDITIONS.

(2) BREEDING RATIO ITSELF BE SACRIFICED TO COST REDUCTION, CONSIDERING THE POTENTIAL FOR ITS FLEXIBILITY.

(3) BASE LOAD OPERATION WITH MINIMUM LOAD FOLLOWING.

(4) PLANT SHUT DOWN WITH FUEL FAILURE EXCEEDING 0.01%.

(5) INHERENT SAFETY WITH RESPECT TO NATURAL LAWS.

(6) EXPANSION OF ACCIDENT PREVENTION ABILITY.

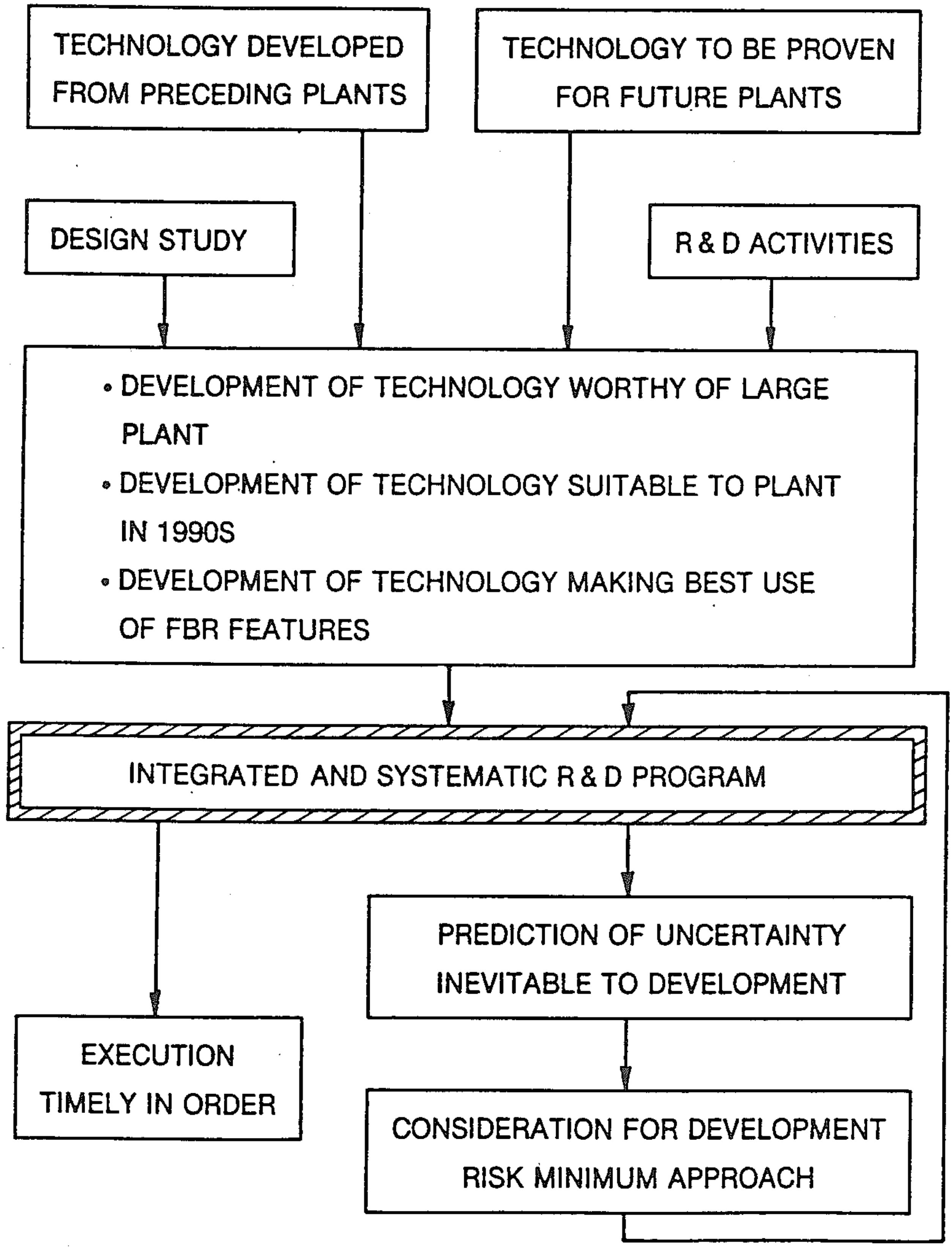
(7) DESIGN PREPARATION LOGIC UTILIZE FBR SAFETY FEATURES, CONSIDERING TRENDS OF LWR REGULATION.

(8) MAXIMUM REDUCTION OF SEISMIC FLOOR RESPONSE ACCELERATION.

(9) STRENGTHENING THERMAL ISOLATION OF MAIN STRUCTURE FROM THERMAL TRANSIENT OR CYCLING.

(10) RATIONAL DESIGN MARGIN RESULTING FROM REEVALUATION OF CALCULATION ACCURACY AND RISK AFTER OPERATION.

PLANNING PROCEDURE FOR DFBR R & D PROGRAM



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Status of Demonstration FBR Plant

Prepared for the 15th IAEA/IWGFR annual meeting

as a part of

A REVIEW OF FAST REACTOR PROGRAMME IN JAPAN

(March, 1982) PNC N941 82-85

Demonstration FBR Plant

One demonstration plant will be constructed on the way from JOYO and MONJU to commercial fast breeder reactor plants.

Design Studies of the demonstration plant which is 1,000 MWe loop type plant aiming its commencing of construction in 1990, have been and are being conducted in these years. We are now in just transition stage from a studying period to a focussing period and two matters will soon be required;

(1) Preparation of an unified specification for the fundamental design, and (2) Starting up of the research and development activities for the demonstration plant.

In the conceptual design-(II) performed in FY 1980 primary pump position and reactor vessel inlet nozzle position were changed to hot-leg and to upper inlet type, respectively. And chute type fuel-charge-and-discharge system was adopted in stead of cask-car type. These are being kept in the conceptual design-(III) which is in progress at present.

In consequence, the reactor vessel diameter becomes larger, and the reactor cover gas pressure is lowered.

The core consists of 420 fuel assemblies which contain 217 pins each. The number of cooling loops are three.

The building is approximately one-hundred and ten meters square with a dome of 64 meters in diameter.

The above descriptions are based on the design study sponcered by PNC.

Also the utility group is conducting design study of a four-loop type demonstration plant separately.

Both streams are just flowing into a specification unification stage. The unification effort will be a key for the early realization of the demonstration plant in Japan. A development schedule of FBR in Japan in shown in Table 4-1.

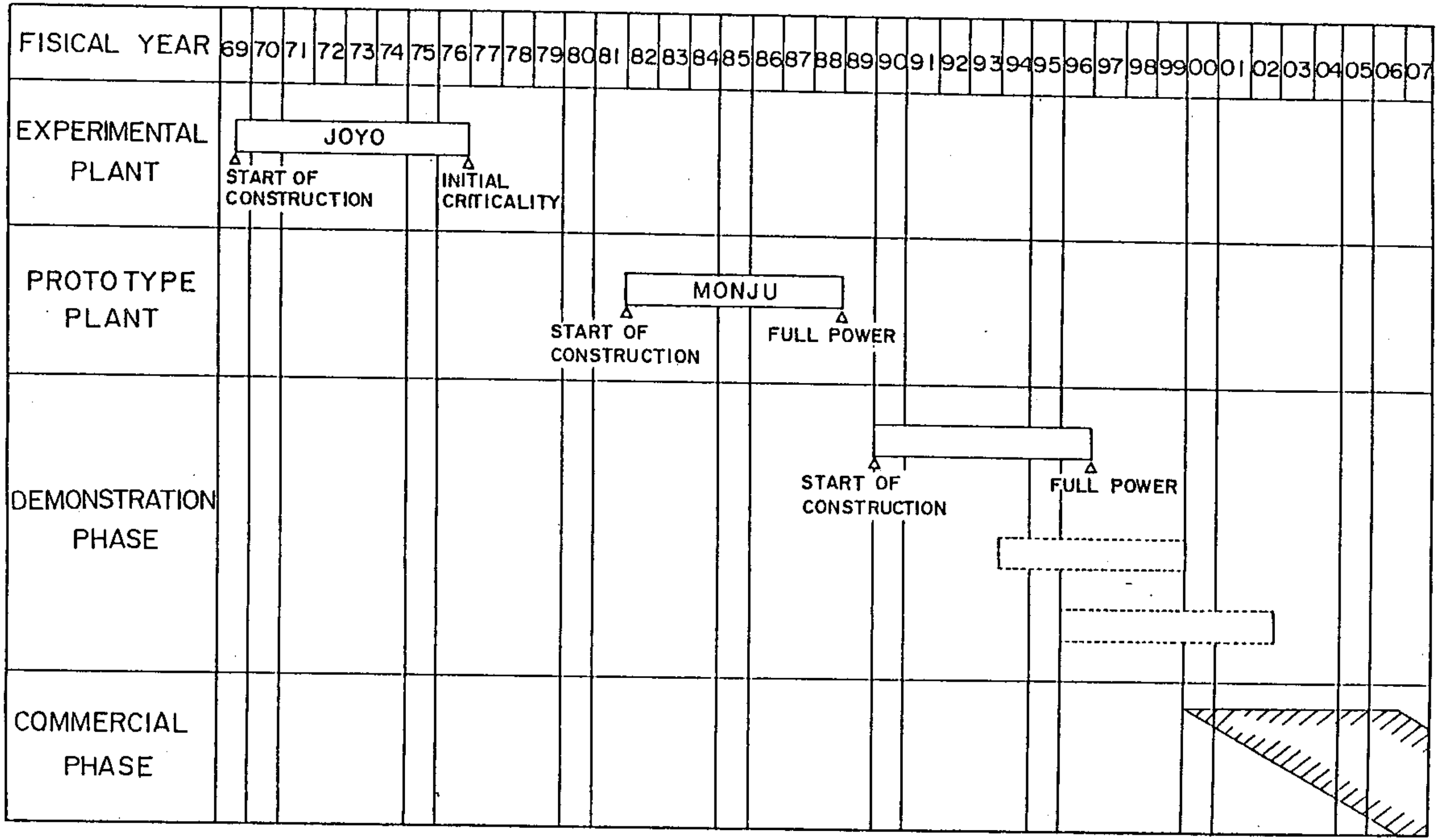

Fig. 4-1 Development Schedule of FBR in Japan

(付 — 2)

Status of Demonstration FBR Plant

Prepared for IAEA/IWGFR 16th Annual Meeting

as a part of

A REVIEW OF FAST REACTOR PROGRAM IN JAPAN

(April, 1983) PNCT N943 83-02

Demonstration FBR Plant

One demonstration plant will be constructed on the way from JOYO and MONJU to commercial fast breeder reactor plants. A development schedule of FBR in Japan is shown in Figure 4-1.

Design studies of the demonstration plant which is 1,000 MWe loop type plant aiming its commencing of construction in the beginning of 1990s, have been and are being conducted in these years.

Japan is now in just transition stage from a studing period to a focussing period in which two matters will be required, that is (1) preparation of a unified specification for the fundamental design, and (2) starting up of the research and development activities for the demonstration plant.

The primary conceptual design directing the extrapolation of the prototype FBR "MONJU", was performed from 1979 to 1981. It will be utilized as a candidate design of the demonstration FBR plant.

The secondary conceptual design aiming mainly at reduction of construction cost has been started in 1982. National economical condition requires the construction cost be less than the twice of LWR from the view point of future commercialization of FBR. Some design features to be investigated in the study are as follows:

(1) Introduction of bellows joint for main heat-transport-system piping

(2) Reduction of the number of control rods and rows of radial blanket assembly

(3) Elimination of handling of the outer row of shielding assembly by fuel handling machine

(4) Reduction of the diameter of reactor biological-shielding concrete relating to above improvement

(5) Size reduction in whole system and components of the plant

(6) Making simpler and smaller fuel handling system

(7) Making the plant system parameter survey for optimization

(8) Reviewing the design criteria, codes, standards relating to cost reduction.

The above descriptions are based on the design study sponsored by PNC. Also the utility group is conducting design study of a demonstration plant separately. In 1981, the DFBR Coordinating Committee (DCC) was established by PNC and the Federation of Electric Power Companies to coordinate the design and R & D activities for the DFBR and to promote the preparatory activities for starting its construction. The effort acting in the DCC will be one of key activities for early realization of the demonstration plant in Japan.

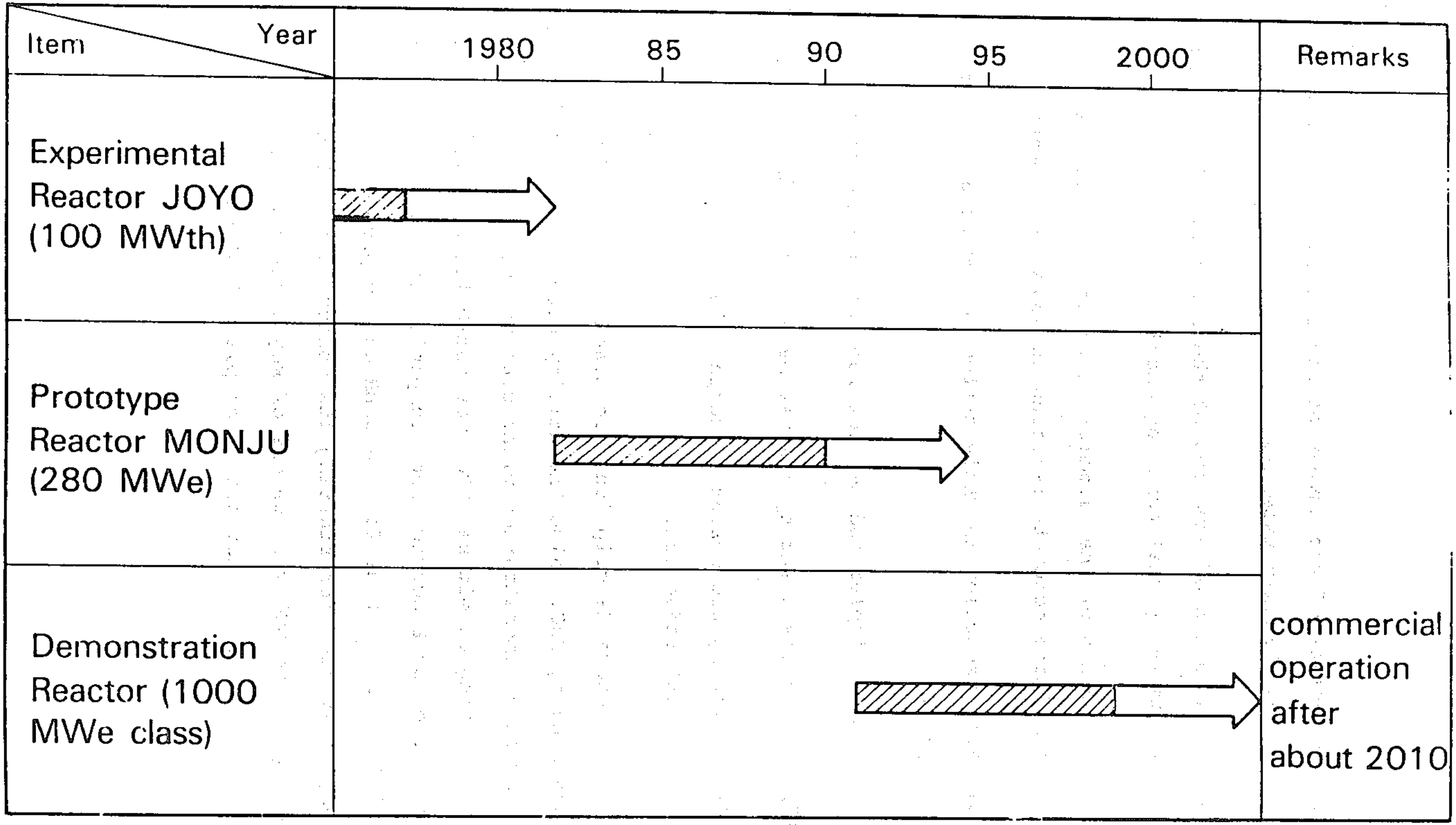

Fig. 4.1 Development Schedule of FBR in Japan

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Status of Demonstration FBR Plant

Prepared for 6th USDOE/PNC Joint Coordinating Committee Meeting

as a part of

A REVIEW OF FAST REACTOR PROGRAM IN JAPAN

(Nov., 1983) PNC SA012 83-06

Demonstration FBR Plant

Design studies of the 1000 MW demonstration plant aiming its commencing of construction in the beginning of 1990s, have been and are being conducted in these years.

In the area of the design studies of the demonstration reactor, conceptual design of a loop-type reactor has been under taken with fully utilizing the technology accumulaced in "JOYO" and "MONJU", and with giving the priority to reduction of construction costs in order achieve a demonstration reactor with more economic viavility.

The primary conceptual design directing the extrapolation of the prototype FBR "MONJU", was performed from 1979 to 1981.

The secondary conceptual design aiming mainly at reduction of construction cost has been started in 1982. The construction cost should be less than the twice of LWR from the view point of future commercialization of FBR. Some design features to be investigated in the study are as follows:

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(8) Reviewing the design criteria, codes, standards relating to cost reduction.

In addition to above activities, design studies were started in 1983 with the aim of preparing the materials necessary for the selection of basic specifications, including the selection of the type of reactor, for the demonstration reactor by around 1986.

Such design studies are now under way in a close cooperation with concerned authorities and utilities, as well as investigations of the way of conducting necessary research and development.